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OAK RIDGE
Y-12
PLANT

MARTIN MARIETTA

ALTERNATIVES/ACTION PLAN REPORT

FOR

OUTFALL 17

Y-12 Plant
U.S. Department of Energy
Oak Ridge, Tennessee

November 1994

Prepared by
Martin Marietta Energy Systems
Engineering Division

Oak Ridge Y-12 Plant
Managed by
Martin Marietta Energy Systems, Inc.
for the
U.S. Department of Energy
Under Contract DE-AC05-84OR21400

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY
DOE-OR-21400

MASTER

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Abstract

This Document contains information pertaining to alternatives/action associated with controlling ammonia entering through outfall 17. This document identifies the location of contaminate source, the ammonia concentration levels entering East Fork Poplar Creek, and the action taken to reduce/eliminate the toxicity problem.

Classification Review

This document has been reviewed for classification level by the classification office and determined to be UNCLASSIFIED AND NONSENSITIVE.

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1.0 INTRODUCTION

The Y-12 Plant, located within the Oak Ridge Reservation (ORR), is owned by the U.S. Department of Energy (DOE) and managed by Martin Marietta Energy Systems, Inc. (Figure 1). Within the Y-12 Plant is East Fork Poplar Creek. The creek generally runs from west to east through Y-12 and leaves the plant through Lake Reality. EFPC is fed by local runoff, groundwater spring discharge, and point source discharges from industrial operations in the plant. In late December 1992, and late February 1993, fish kills were observed in the creek near National Pollutant Discharge Elimination System (NPDES) permit Outfall 17, a small spring at the base of the north slope of East Chestnut Ridge. The reason for the fish kills was two-fold: (a) the presence of ammonia in the outfall and (b) the startup of the dechlorination system on 11/30/92.

The source of ammonia in outfall 17 was believed to be road salt used for road deicing. Road salt was stored in uncovered storage bins adjacent to the East Patrol Road from late 1985 to December 1992. Urea, a component of road salt was the primary suspect for ammonia observed in water discharged from outfall 17. Urea in the soil is transformed by soil microorganisms into ammonia (NH_3) and ammonium (NH_4^+) which is considered toxic to aquatic life forms.

The creek has had a long term chlorine problem. It is believed that the excess chlorine in the creek oxidized the ammonia coming from outfall 17. To resolve the chlorine problem the Y-12 Plant installed several dechlorination units to remove or oxidize chlorine. Once the chlorine was removed the ammonia, a toxic pollutant, was no longer oxidized and hence fish kills resulted in the creek near outfall 17. Immediately following the discovery that salt/urea may have caused elevated ammonia concentration in the spring, the material was removed to a covered area.

In accordance with the draft Y-12 NPDES permit for outfall 17, Y-12 shall attain compliance with the ammonia as nitrogen permit limits of 32.4 mg/l monthly average and 64.8 mg/l daily maximum by March 1, 1997. The Y-12 Plant is required to submit to the State a proposed action plan and preliminary engineering report for the prevention of instream toxicity to aquatic organisms in EFPC. The permittee, Y-12, has a submittal schedule of 180 days from the effective date of the issued permit. This report is intended to satisfy requirements imposed by the Division of Water Pollution Control, Tennessee Department of Environment and Conservation.

2.0 GENERAL DATA

2.1 Geology, Seismology, and Soils

The Y-12 Plant, which is located at the DOE Oak Ridge Reservation,

Figure 1. Oak Ridge Reservation showing location of Y-12.

lies within the Valley and Ridge Physiographic Providence. The location geology, seismology, and soil characteristics have been studied extensively. For a general overview of these geologic features, reference is made to document Y/TS-730, "Environmental Assessment," published in March 1991.

2.2 Drainage System

The Oak Ridge area is drained by the Clinch River and some of its tributary streams. Bear Creek and EFPC are two tributary streams that drain the Y-12 Plant. Area runoff from the contaminated site is relatively small and no significant quantities of runoff is suspected to enter outfall 17 or EFPC.

2.2.1 East Fork Poplar Creek

The headwaters of EFPC originate in the Y-12 Plant area. Stream flow is equalized by Lake Reality, located on the east side of the plant. After leaving the lake, the stream flows northwest before changing to an approximate southwest course. The creek flows through the city of Oak Ridge before entering pasturelands and hardwood forests. The stream first joins Bear Creek, and then Poplar Creek, before discharging into the Clinch River near the K-25 Site.

2.2.2 Bear Creek

Bear Creek flows in a southwest direction from the plant through hardwood and softwood forests. At White Wing Road, the creek turns northwest converging with EFPC at mile 1.5. The Bear Creek basin has a drainage area of approximately 4,736 acres, with 65 percent of the area being wooded.

2.3 Meteorology

According to the U.S. Department of Commerce, mean rainfall for the Oak Ridge area is 52.6 in/yr; mean snowfall is 10 in/yr; and the mean yearly temperature is 57.8°F. Detailed meteorological information, including wind patterns and frequency of severe storms, can be found in Document DOE/EA-0182. Weather conditions will have an effect as to the concentration of ammonia and quantity of water released from the spring to the creek.

2.4 Type of Industry

The Oak Ridge Y-12 Plant is one of several facilities managed by Martin Marietta Energy Systems, Inc., for the DOE. The plant occupies an area of approximately 811 acres located on the DOE Reservation, adjacent to the city of Oak Ridge. The plant site can be divided into two sections: (1) the western area which is

devoted to reclamation and storage of Nuclear material, and (2) the eastern area which is devoted to various nonproduction plant support activities (i.e., development, maintenance, shipping, receiving, and engineering) and the research facilities operated by the Oak Ridge National Laboratory (ORNL).

It is Y-12's mission to serve as a key manufacturing technology center for the development and demonstration of importance to the Department of Energy (DOE) and the nation.

This is accomplished through the reclamation and storage of nuclear materials, manufacture of nuclear materials, manufacture of components for the nation's defense capabilities, support to national security programs, and services provided to other customers as approved by DOE.

We are recognized by our people, the community, and our customers as innovative, responsive, and responsible. We are a leader in worker health and safety, environmental protection, and stewardship of our national resources.

3.0 Study Area

Outfall 17 is a naturally occurring spring located on the northwestern side of East Patrol road within the southeastern corner of the Y-12 plant as seen in Figure 2. The spring is one of the discharge points for groundwater from Chestnut Ridge, the localized recharge area. Outfall 17 is believed to be indicative of fracture flow which is characteristic of the Knox aquifer.

The area contributing ammonia to the spring is centered on the Y-12 coordinates of North 28,520 and East 61,710 (Figure 3). The area is primarily asphalt covered. Prior to December 1992, the area contained two, u-shaped wooden bins that were used for storage of road salts. The material was removed from the area in late 1992 and now the storage bins contain sandbags and gravel.

Analysis of water samples collected from the spring in late December 1992, indicated elevated levels of ammonia and nitrate. In addition to water samples, three boreholes drilled to auger refusal and 14 hand excavated soil sample were taken at or near the site of contamination and analyzed for ammonia and nitrate. Analytical results from continuous split spoon sampling indicated that high concentration levels of ammonia (9152 ppm) exist in the area closest to the storage bin while lower concentrations (108 ppm) exist in the area approximately 60 feet southwest of the storage area. The hydrology of the area is such that water generated from rainfall infiltrates into the ground flows through conduits or rock outcrops and subsequently emerges out of the spring. Water infiltrating through the soil dissolves the ammonia and nitrate and surfaces out at outfall 17. There is no

Figure 2 Site Location

Figure 3 Site Plan of Study Area.

constructed collection system existing at the spring. Once the water surfaces through rock outcrop it is routed to the creek by an eighteen inch concrete pipe.

4.0 CHARACTERIZATION

4.1 Spring Sampling

Chemical characterization data for outfall 17 was provided by the Y-12 Analytical Services Organization. Ammonia concentration levels sampled from the spring are shown in Appendix B. Also, included in these data are total Kjeldahl nitrogen (TKN) and nitrate. Data in Figure 4 represents the TKN and ammonia as nitrogen concentration resulting from spring sampling. It should be emphasized that high concentrations of ammonia occurred during the initial detection of the problem. Once the source was located and removed, concentration levels fluctuated, and, after approximately 3 months, decreased in concentration as shown in Figure 4. The initial fluctuation in outfall 17 ammonia concentration is attributed to an increase in groundwater flow from the spring. During heavy precipitation, water infiltrates the site dissolving ammonia and nitrate. This water flows downward to the original clay ground surface where the large decrease in hydraulic conductivity causes lateral flow along the interface between the fill and the natural clay. This flow then reaches groundwater through areas of macroporosity in the clay, rock outcrops or other vertical conduits and subsequently flows to the spring.

4.2 Creek Sampling

In-stream characterization of EFPC was performed to verify that the creek or no other outfalls were contributing ammonia. This was accomplished by analyzing water samples taken in the creek and outfall 17. A total of five samples were collected and analyzed for ammonia. Four in-stream water samples, (two samples collected at 15 and 300 feet upstream and two samples at 200 and 500 feet downstream) and one spring sample provide the necessary data. Since ammonia was the primary concern the water samples were only analyzed for ammonia as nitrogen. In-stream sampling performed on February 1, 1994, shown in Figure 5, indicated that outfall 17 was the primary source of ammonia contamination.

4.3 Soil Sampling

Test-drilling in the contaminated site was performed by Ogden Environmental and Energy Services. Hand excavated samples and environmental assessment of the site was made by Environmental Consulting Engineers, Inc.(ECE). The Ogden subsurface sampling report and the environmental assessment "Study of Ammonia and Nitrate Contamination of Outfall 17 at the Y-12 Plant" are included

Outfall 17 Sampling Results

Figure 4 Spring Sampling Results

Figure 5 In-stream Sampling Points

as separate attachments. Analytical sample results, located near the former road salt storage site, indicated that ammonia was present in the various layers of fill. Test-drilling included three boreholes drilled to auger refusal and 14 hand excavations (Figure 6). The boreholes were used to determine the lithology of the area and provide coring samples. Hand excavation were used to determine if area runoff contributes to ammonia concentrations to the spring. According to the boreholes and split spoon sampling three basic layers exist, the first is a clayey fill, the next is a sandy fill and the final layer is a natural silty clay geology. There were some variations in depth of each layer but basically the same general pattern of fill and original soil layer existed for each borehole. The lithologic cross sections of the subsurface investigation are shown in Figures 7 and 8. Analytical results taken from each borehole, shown in Figure 9, indicated high ammonia levels in borehole 1 (B-1) and borehole 2 (B-2) were present. Borehole 3 (B-3) confirmed ammonia but at much lower concentrations. During the time of the test-drilling, August 5, 1993, no groundwater was encountered.

Hand excavated samples, dug to a depth of 16-18 inches, indicated an ammonia concentration less than 1.0 mg/l. The lack of high ammonia concentration levels from the hand samples indicate that surface runoff is not a major source of ammonia to the spring.

5.0 ANALYSIS/TRENDS

Basically there are two mechanisms responsible for the removal of ammonia in the soil containing urea. The first is biological nitrification under aerobic conditions and the second is transportation.

Based on the nitrate concentrations data, shown in Appendix A, nitrification or the transformation of NH_4^+ to NO_3^- contributes to the removal of ammonia in the soil. Biological nitrification does not remove ammonia but converts it to the nitrate form, thereby eliminating problems of toxicity to fish and other aquatic life. Ammonia conversion to nitrate is a two phase process performed by autotrophic bacteria.

Transportation, the second removal mechanism, was identified as a contaminate pathway when elevated ammonia concentration levels were found in the spring. The transportation of flush out of ammonia for the contaminated site was more noticeable when the spring discharged at a higher flow rate (a discharge rate greater than base flow). The transport hypothesis is, as precipitation seeps through the ground, ammonia is flushed out of the soil. This causes an increase in ammonia concentration in the spring, and consequently, decreases the level of ammonia in the soil. Based on the existing data, the ammonia levels peaked in late winter/early spring and decreased from that point on. A curve fit on the

Figure 6 Site Plan of Sampling Area

Figure 7 Cross Section of Subsurface Investigation.

Figure 8 Cross Section of Subsurface Investigation.

Ammonia and Nitrate Concentrations in Soil (ppm)

[illegible]

Figure 9 Results of Ammonia/Nitrate Soil Analysis.

ammonia concentration data, collected from the spring, depicts the decreasing trend in concentration (Figure 10). It is believed that enough ammonia has been flushed from the contaminated area that no one rain event should have a significant impact on the spring (i.e. ammonia limits set under the NPDES permit are achievable with no treatment).

In an attempt to model the flushout of ammonia, a preliminary calculation was performed. The calculation, shown in Appendix B, estimated spikes of ammonia in the spring for six months to six years. The variation in time is dependent on the percentage of infiltration assumed, 50 to 20 percent. Therefore, it is predicted that the ammonia concentration for both the soil and the spring will continue to decrease.

6.0 ALTERNATIVES

Four alternatives for reduction of ammonia concentrations in outfall 17 were identified during the scope of this study. The alternatives were screened base on implementation and engineering judgement. Alternatives considered include:

- Alternative 1 - Source Removal;
- Alternative 2 - Soil Removal;
- Alternative 3 - Site Isolation/Containment;
- Alternative 4 - Water Treatment.

A description of each of these alternatives is included in the following subsection.

6.1 Alternative 1 - Source Removal

This alternative has been implemented by the Y-12 Plant. Road salt stored in opened storage bins were removed, once the problem was identified, to a covered storage area. By stopping the input of ammonia or eliminating the source, the ammonia concentration levels in the spring decreased. Because the ammonia concentration levels dropped to below the limits identified by the Y-12 NPDES permit (32.4 mg/l monthly average and 62.4 mg/l daily max) the spring is no longer considered a major problem. The Y-12 plant will continue to monitor the spring for flow, pH, TKN, and NH_3 on a weekly basis.

6.2 Alternative 2 - Soil Removal

The soil removal alternative would consist of developing a sampling plan to determine the extent of contamination (horizontal and vertical) and levels of ammonia in the soil. All soil, identified in the soil sampling analysis, exceeding a predetermined level, would be removed and replaced with clean fill or decontaminated and replaced. This alternative would most likely include excavating a

Outfall 17

Figure 10 Ammonia Concentration Curve Fit

section of East Patrol Road. During excavation the necessary measures would be taken to minimize/eliminate runoff and runoff. This option has a high degree of uncertainty associated since it will depend on the sampling analysis and excavation of the area, which, would be very difficult due to the very steep slopes. Because of the difficulty associated with excavation and possible disposal of the soil, this alternative was not considered to be a valid option for addressing the problem.

6.3 Alternative 3 - Site Isolation/Containment

This alternative would consist of constructing surface barriers and french drains around the site area. The structures and drains would prevent runoff from entering the site. However, it would not eliminate water entering the site from direct rainfall. Investigation of the area showed runoff and surface runoff was not considered a significant pathway of outfall 17 and literature research reveals french drains are not permanently effective therefore, this alternative was dismissed from further consideration.

6.4 Alternative 4 - Water Treatment

No pilot plant or treatability studies have been conducted to support a conceptual design for ammonia treatment. Selection of the unit processes were based on operations which are typical for the extraction of ammonia.

Three treatment alternatives, according to literature review were considered feasible for meeting limits defined by the Y-12 NPDES Permit. These water treatment technologies include:

- Ammonia Stripping
- Breakpoint Chlorination
- Ion Exchange

6.4.1 Alternative A. Ammonia Stripping

This alternative would consist of installing a clarifier, pH adjustment, a stripping tower, final pH adjustment and final filtration. The processing equipment will be located in a prefabricated engineered structure equipped with heating and ventilation. In the air stripping process, the water containing ammonia at elevated pH is sprayed over an inert tower packing and contacts the air flowing up the tower as the water trickles down the packing. Free ammonia (NH_3) is stripped from the falling water droplets into the air stream which is then discharged to the atmosphere. Lime or caustic soda is added prior to the stripping to raise the pH of the wastewater within the range of 10.8 to 11.5 converting essentially all ammonium ions to ammonia gas which can

be stripped by air. Process controls required for the operation are the proper pH adjustment of the influent wastewater, and maintenance of proper air and water flows.

6.4.2 Alternative B. Breakpoint Chlorination

The breakpoint chlorination process involves the addition of chlorine to wastewater containing ammonium ions in a mixing tank, where practically all the ammonium ions are oxidized to nitrogen gas. The amount of chlorine addition is precisely adjusted to a level (the breakpoint) which is sufficient for the oxidation and results in minimal residual chlorine and by-product formation. Hydrochloric acid is co-produced during the oxidation and must be neutralized by adding lime or caustic soda. Equipment needs are relatively simple but control requirements for chlorine dosage and pH adjustment are sophisticated and important.

6.4.3 Alternative C. Ion Exchange

This alternative would remove ammonia from the water by ion exchange. The ion exchange process can be utilized to reduce the ammonium ion concentration in wastewater. The medium is usually clinoptilolite, a natural ion exchange material. Wastewater, following filtration to reduce suspended solids, is passed downflow through the ion-exchange bed until the bed reaches the point of exhaustion. The bed is considered exhausted when the ammonia concentration in the effluent reaches a predetermined value. The exhausted bed can be regenerated with 2 percent NaCl solution. The effluent from the regeneration process is called spent regenerant, and it amounts to 2.5 to 5 percent of the waste stream and may contain more than 300 mg/l of ammonia. The key to the application of the ion exchange process is the method of handling of the spent regenerant. The process for individual beds is batch but, by using multiple beds, continuous operation can be accomplished. The spent regenerant requires some form of processing for separation of ammonia so that the regenerant can be reused.

6.5 Water Technologies Assessment

For each of the above alternatives ion exchange is considered the process of choice for treatment of aqueous ammonia. Some reasons for choosing ion exchange include; a low volume sludge stream, time delay associated with air permitting in relation to air stripping, and concerns of overstepping the chlorine limit established in the NPDES permit if breakpoint chlorination was used. Further, ion exchange has favorable qualities of reliability, ease of operation, and variable application associated with the unit process. Interim treatment using ion exchange could be accomplished through a fixed-price subcontract. Under the subcontract the Vendor or Seller would provide an interim treatment system using ion exchange as the principal unit process to remove

ammonia from the spring water. The system would be preassembled, prepiped, and prewired. All construction work external to the system, such as concrete foundations and utility extensions, would be accomplished by the Company. Any equipment external to the system, such as feed pumps, would be provided by the Seller but installed by the Company. The Seller would provide conceptual design information to allow the Company to design and construct all elements of the facility external to the treatment system.

For long term or permanent treatment a new facility for ammonia treatment could be constructed. The new facility would remove ammonium, the ion typically removed from the waste stream. The process would provide a basin, sump pump, a surge tank, filtration and ion exchange. Because the flow in the spring is not constant but dependent on the amount of rainfall an emergency spillway would be constructed from the spring to the creek.

7.0 ACTION

For this report four alternatives were considered for ammonia remediation. The first, source removal, is the only action taken by the Y-12 Plant to date. This option was included in the report because it is considered to be the most feasible alternative. The data in Appendix A and Figure 11 show that the ammonia concentration has decreased. The draft NPDES Permit limits to be achieved by March 1, 1997, have already been met. Continued monitoring of outfall 17 will ensure these limits are maintained. Since the source of contamination, road salt containing urea, has been removed and stopped the input of ammonia into the soil no further corrective actions is considered necessary.

8.0 COST DATA

During the investigative phase of the alternative study treatment options were evaluated in relation to implementation and cost. The treatment technology selected for cost analysis was ion exchange. The cost estimate for the interim and long term treatment alternatives using ion exchange are \$441,000, and \$3,114,000, respectively. Cost estimates were developed from conceptual designs.

9.0 RECEIVING STREAM

The receiving stream for outfall 17 is EFPC. The spring discharge will continue as it has in the past. The only change is a future project implementing additional flow to the creek (Flow Management). Flow Management Project will discharge water to the creek to ensure 7 million gallon per day flow in EFPC. The Flow Management project would further reduce potential impact of remaining ammonia in the spring to the creek resulting from flush out.

Outfall 17

Figure 11 Ammonia Concentration in Relation to Outfall 17 Y-12 NPDES Permit

Appendix A

Ammonia Washout Calculation

Assumption used in calculation; solubility of ammonia in cold water (89.9 g/100cc), an area of 1,406,250 cubic feet, 45 inches of annual rainfall and an average ammonia concentration of 1300 ppm.

Estimated volume of contaminated material

$$75\text{ft} \times 125\text{ft} \times 150\text{ft} = 1,406,250 \text{ cf}$$

Rainfall Volume

$$\text{RainfallVol} = \frac{45}{12} \left(\frac{\text{ft}}{\text{yr}} \right) \times 75\text{ft} \times 125\text{ft} = 35,156 \frac{\text{ft}^3}{\text{yr}}$$

Ammonia Washout

Assume 89.9 g/100 cc = 900 g/l

$$\text{Sol.} = 900 \frac{\text{g}}{\text{L}} \times 3.78 \frac{\text{l}}{\text{gal}} \times 8.34 \frac{\text{gal}}{\text{ft}^3} \times \frac{\text{lb}}{454\text{g}} = 62.5 \frac{\text{lb Ammonia}}{\text{ft}^3}$$

If @ solubility and 50% infiltration

$$\frac{285,137 (2)}{35,156 (62.5)} = 0.25\text{yrs}$$

If @ 10% solubility and 20% infiltration

$$\frac{285,137 (5)}{35,156 (62.5 \times .10)} = 6.48 \text{ yrs}$$

Appendix B
Spring Sampling Data

DATE	AMMONIA (mg/l)	TKN (mg/l)	NITRATE (mg/l)
12/27/92	200	--	--
12/30/92	100	100	19.0
12/31/92	89	99	17.0
01/01/93	83	90	18.0
01/02/93	70	78	16.0
01/03/93	71	67	16.0
01/04/93	56	65	16.0
01/05/93	43	43	12.0
01/06/93	43	41	12.0
01/07/93	45	43	10.0
01/08/93	51	45	11.0
01/25/93	48	48	14.0
02/05/93	71	45	19.0
02/12/93	32	22	15.0
02/19/93	25	31	10.0
02/24/93	220	210	36.0
03/05/93	84	82	15.0
03/19/93	18	30	9.5
03/26/93	140	130	28.0
04/02/93	55	66	14.0
04/08/93	25	24	7.2
04/16/93	18	24	9.0
04/23/93	26	19	10.0
04/30/93	18	15	10.0
05/07/93	19	22	12.0
05/14/93	7.8	17	12.0
05/21/93	9.1	13	11.0
05/28/93	16	16	11.0
06/03/93	29	30	14.0
06/11/93	29	32	14.0
06/18/93	23	27	13.0
06/25/93	24	24	14.0
07/02/93	22	14	28
07/08/93	28	14	28
07/16/93	25	15	26
07/22/93	25	14	28
07/30/93	22	15	17
08/06/93	2.2	15	23
08/13/93	17	14	13
08/20/93	16	16	26
08/30/93	29	17	26
09/07/93	26	15	22
09/20/93	25	16	25
10/01/93	51	18	51

Continued

DATE	AMMONIA (mg/l)	TKN (mg/l)	NITRATE (mg/l)
10/20/93	47	17	46
01/10/94	21.7	14	22
02/17/94	73	68	15
02/24/94	21	20	44
03/03/94	33	14	31
03/10/94	18	8.5	17
03/17/94	15	8.9	14
03/22/94	15	9.8	14
03/31/94	44	12	41
04/07/94	5.6	7.7	13
04/14/94	28	16	27
04/28/94	6.2	6.5	7.9
05/05/94	5.9	6.5	6.1
05/12/94	7.4	7.0	6.5
05/19/94	8.7	7.5	7.7
06/02/94	9.2	10	9.1
06/10/94	10	11	9.3
06/17/94	13	14	11.0
06/23/94	14	15	11.0
06/30/94	27	14	12.0
07/08/94	13	13	12
07/15/94	12	10	
07/21/94	17	17	
07/29/94	22	22	
08/04/94	17	18	
08/12/94	17	16	
08/18/94	16	15	
08/26/94	21	17	
09/02/94	18	20	
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**SITE SAFETY AND HEALTH PLAN
FOR
THE AMMONIUM NITRATE STUDY SITE
AT OAK RIDGE Y-12 PLANT**

Prepared for:

Martin Marietta Energy Systems, Inc.

Prepared by:

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June 18, 1993

Ogden Project No. 0-4267-0074

ENVIRONMENTAL AND ENERGY SERVICES

**SITE SAFETY AND HEALTH PLAN
FOR
THE AMMONIUM NITRATE STUDY SITE
AT OAK RIDGE Y-12 PLANT**

Prepared for:

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June 18, 1993

Ogden Project No. 0-4267-0074

OGDEN

PLAN APPROVAL

This Site Safety and Health Plan (SSHP) has been written for the use of Ogden's employees on this project. Ogden claims no responsibility for its use by others. The SSHP is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

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Y-12 Industrial Hygiene

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The Safety and Health Plan contained herein has been prepared by Ogden Environmental and Energy Services Co., Inc. (Ogden) for Martin Marietta Energy Systems, Inc. to be used at the Oak Ridge Y-12 Plant for the express purpose of completing the geotechnical investigation at the Ammonium Nitrate Study Site. This Plan is written in compliance with applicable federal, state, and local regulations and ordinances in effect and published at the time of preparation. This Plan is not warranted or guaranteed to comply with any changes to law or regulation issued after either the date of publication or the latest subsequent revision. Any use of this Plan, in whole or in part, for any reason other than the specific site, project and purpose for which it was originally intended, shall void all warranties associated with this Plan, either contractually, expressed, or implied.

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1.0 INTRODUCTION

This document has been prepared to provide a Site Safety and Health Plan (SSHP) for the Ammonium Nitrate Study Site.

This project is located in the southeast corner of the Y-12 Plant. The geotechnical work (drilling and soil sampling) is being undertaken by Ogden Environmental and Energy Services (Ogden) under contract to Martin Marietta Energy Systems (MMES), Oak Ridge, Tennessee. Environmental Consulting Engineers (ECE) has been charged with the task of characterizing the referenced site for MMES. The purpose of this document is to establish standard health and safety procedures for Ogden in performance of this work. Site activities shall be performed in accordance with: Ogden and MMES safety and health policies and procedures; Department of Energy (DOE) Orders; Occupational Safety and Health Administration (OSHA) Standards 29 CFR Part 1910 and 1926; applicable Environmental Protection Agency (EPA) requirements; and consensus standards. Where the words "shall" or "must" are used, the provisions of this plan are mandatory.

The levels of protection and the procedures specified in this plan are based on the best information available from reference documents and site characterization data. Therefore, these recommendations represent the minimum health and safety requirements to be observed by all personnel engaged in this project. Unforeseeable site conditions or changes in scope of work may warrant a reassessment of protection levels and controls stated. All adjustments to the SSHP Plan must have prior approval by the Ogden ES&H Manager, the Ogden Site Health and Safety Officer (SHSO), the Y-12 Project Manager, Ogden Project Manager, and receive approval from those signing the original plan.

All personnel involved in this project must read this document carefully. All questions or concerns should be addressed to the Ogden SHSO and ES&H Manager. Personnel on-site shall: (1) follow all appropriate health and safety procedures; (2) be alert to the hazards associated with work on a construction site; (3) be aware of the hazards associated with working in close proximity to heavy equipment; and (4) exercise reasonable caution at all times.

All visitors that need to enter the site to observe site conditions or operations, must receive prior approval from the SHSO. Upon arrival, visitors will report to the SHSO in the Support Zone where he/she will be logged in the Site Log Book and undergo a safety and evacuation orientation. Orientation includes reading the SSHP and signing the "Visitors Notice" form. Visitors will be expected to comply with relevant OSHA requirements such as medical surveillance, training, and respiratory protection as determined by the SHSO. Visitors not complying with the SSHP will be requested to leave the work area.

2.0 SITE DESCRIPTION AND FEATURES

The Y-12 Plant is operated by MMES for DOE, and is located in Oak Ridge, Tennessee. The Y-12 Plant is located in Bear Creek Valley, which is bounded by Chestnut Ridge to the south, and Pine Ridge to the north. The general location for this project will be adjacent to East Patrol Road in the southeast corner of the Y-12 Plant.

The scope of work needed to complete this project requires that activities be conducted in one general area. The site is on a flat, paved area. The back portion of the site drops off to a fairly steep hill.

3.0 SITE BACKGROUND/HISTORY

The site is an outdoor storage area, adjacent to East Patrol Road. Prior to December 1992, the area contained bins that were used for storage of calcium chloride, sodium chloride and urea. The material was covered with plastic sheeting. These chemicals were used to deice roads at the Y-12 Plant. The material was removed from the area in late 1992 and now the storage bins contain sandbags and gravel.

The area, in the past and at the present time, was never used as a storage area for Resource Conservation and Recovery Act (RCRA) wastes and is not listed as a Hazardous Waste Site. The area is not known to have been contaminated with radioactive materials.

The area may have underground lines and piping. There is a single overhead electrical line, supplying power to a light over the storage bin area.

FIGURE 1
SITE LOCATION

4.0 SITE ORGANIZATION AND COORDINATION

The Y-12 management will have overall responsibility for environmental protection, safety, and health for activities conducted at the facility. This responsibility includes stop work authority. Ogden has the responsibility for managing the implementation of the project.

The following section details the organizational structure for this project. Key personnel and their project responsibility are listed.

Project Role	Name	Phone Number
Ogden Project Manager	Terry M. Harms	481-8002
Ogden ES&H Manager	William P. Garibay	481-8002
Ogden Site Health & Safety Officer	Leonard D. Hayden*	481-8002
Y-12 Project Manager	Elliott J. Barnett	574-9595
ECE Project Manager	Bob Yager	691-3668

*** CPR/FIRST AID CERTIFIED**

4.1 SITE HEALTH & SAFETY OFFICER (SHSO)

Reports to the Ogden Project Manager and to the ES&H Manager for all aspects of the project. Primary on-site contact for safety and health during field activities. Oversees the on-site execution of all field activities regarding safety and health procedures. Has the authority to stop all work if conditions are judged to be hazardous to on-site personnel or to the public. Other specific responsibilities are as follows:

1. Require specific health control precautions prior to work area entry by Ogden or visitors including briefing of personnel on project and potential hazards, ensuring personnel have reviewed the SSHP, on-site safety meetings, and reviewing planned emergency response procedures.

2. Require any Ogden personnel to obtain immediate medical attention in the case of a work-related injury or illness.
3. Deny access to all or any portion of the work area by workers or visitors.
4. May order work to cease, evacuation of the work area by all personnel, and re-establish safe working conditions.
5. Control access to the site by visitors. Advise visitors of their responsibility before entry is allowed.
6. Ensure the correct field execution of the SSHP including workplace and personnel monitoring.
7. Perform radiation and industrial hygiene monitoring/sampling of site hazards for exposure and hazard evaluation.
8. Advise emergency response personnel in an emergency.
9. Establish site work zones and level of protection.
10. Coordinate and minimize the number of personnel and amount of equipment in the exclusion zone required for safe and effective site operations.
11. Calibrate all monitoring equipment that will be used on a daily basis and recording the results on the daily calibration log.
12. Coordinate accident prevention plan by oversight of field activities and being aware of site operations.

4.2 OGDEN ENVIRONMENTAL, HEALTH & SAFETY MANAGER ROLE

Responsible for development of the SSHP and coordinating the execution of safety and health procedures. Responsible for development and approval of all changes to the approved SSHP. Responsible for on-site briefing of SSHP to employees prior to commencement of work.

4.3 Y-12 PROJECT MANAGER ROLE

Primary contact at Y-12. Will coordinate access and security to the site, and advise Ogden of proper access, training and security procedures.

4.4 OGDEN PROJECT MANAGER ROLE

Primary contact for changes in scope of work and coordinating efforts between Ogden and Y-12. Responsible for review and approval of all documents including the SSHP. Will issue the notice to proceed on site after approval of the Waste Management Plan and SSHP.

4.5 FIELD PERSONNEL

All Ogden personnel who will be involved in the on-site execution of the investigation, including supervision, monitoring, testing, and sampling activities are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees; being alert to potentially harmful situations.
2. Performing only those tasks that they believe they can do safely and immediately reporting any accidents and/or unsafe conditions to the SHSO and/or the Y-12 Project Manager.
3. Notifying the SHSO of any special medical conditions (i.e., allergies, contact lenses, pregnancy, diabetes) and, if necessary, ensuring that all on-site personnel are aware of the condition.
4. Preventing spillage to the extent possible. In the event spillage occurs, contain the spillage, notify the SHSO, and clean up immediately using safe clean up measures as directed by the SHSO. Do not engage in spill containment or clean up if conditions are not safe.
5. Avoid splashing materials to the extent possible.
6. Practicing good housekeeping by keeping the work area neat, clean, and orderly to the extent possible.
7. Reporting all injuries, no matter how minor.
8. Comply with all health and safety recommendations, precautions, and use of levels of personal protective equipment as determined by this SSHP and/or the SHSO.

5.0 SCOPE OF WORK/PLANNED SITE ACTIVITIES

The overall objective of this project is for Ogden to conduct a subsurface exploration of the above mentioned site area. The site has been identified as an outside storage area where road deicing material has been previously stored. Another consultant firm, Environmental Consulting Engineers (ECE) has been tasked with characterizing the referenced site. Ogden's technical approach for completing their part of the project is described in the following paragraphs:

Ogden will explore the subsurface conditions by making three borings in the area of the study. These borings will be at locations selected by ECE personnel and with the approval of MMES. Continuous split-spoon sampling will be required. ECE will take portions of the split-spoon samples for analysis. Ogden will archive the remainder of the samples. Ogden will not be required to perform any laboratory or engineering analysis of the samples.

Ogden will provide a full time, on-site geologist/engineer to log the soil samples and a Safety and Health Officer to monitor all drilling operations.

6.0 WASTE CHARACTERIZATIONS

WASTE TYPES: (Check all that apply)

☐	Liquid	☐	Sludge	☐	Unknown
☒	Solid	☐	Gas		

WASTE CHARACTERISTICS: (Check all that apply)

☐	Corrosive	☐	Flammable	☐	Radioactive
☐	Toxic	☐	Volatile	☐	Reactive
☐	Inert	☐	Carcinogenic	☒	Unknown

HAZARDOUS MATERIALS SUMMARY (Check all that apply)

Chemicals

☐	Acids	☐	Metals	☐	Phenols
☐	Causics	☐	Pesticides	☐	Paints
☐	Halogen	☐	PCBs	☐	Solvents
☐	Other: Calcium Chloride, Sodium Chloride, Urea				

Oils/Fuels

☐	Fuel oil	☐	Gasoline	☐	Diesel
☐	Other:				

Sludges

☐	Metal sludges	☐	Oil sludges	☐	Septic sludges
☐	Other: _____				

Solids

☐	Asbestos	☐	Landfill refuse	☐	Tailings
☐	Other: _____				

NOTES:

7.0 PROJECT HAZARD EVALUATION

7.1 HAZARD ANALYSIS OF WORK TASK

7.1.1 Task for Mobilization/Demobilization

Potential Hazards: (Check all that apply to either existing conditions or are a result of site operations)

☒ Rotating Machinery	☐ Projectiles	☐ Confined Space
☒ Heat Stress	☒ Physical Exertion	☐ Biological
☐ Cold Stress	☒ Noise (> 85 dBA)	☒ Electrical (utilities)
☒ Heavy Equipment	☒ Vehicle Traffic	☐ Chemical Exposure
☐ Intrusive Activity	☐ Fire Explosion	☒ Radioactive Material
		☒ Other (List)
		Slips, trips, and falls

Control or Protective Measures: (Check all that apply)

☒ Tailgate Meetings	☒ PPE	☒ Safe Work Practices
☒ Operator Training	☒ Site Control	☐ Decontamination
☒ Engineering Controls: Plastic installed under drill rig		
☒ Other: Install flagging around openings		

INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT FOR ASSIGNED TASK:

Initial levels of PPE have been assigned for this work task per the potential for exposure. Levels may be upgraded or downgraded depending on monitoring data and site conditions, as determined by the protocol outlined in section 12.0 Exposure Monitoring and deemed necessary by the SHSU.

Level of protection:	☐ A	☐ C	☐ Modified
	☐ B	☒ D	
Respirator:	☐ SCBA, Airline	☐ Fullface Resp	☐ 1/2 Face Resp.
	☐ OV/HEPA Combo Cart.	☐ Other Cart. _____	
Protective clothing:	☐ Encapsulating Suit	☐ Tyvek	☐ PE Tyvek
	☐ Sarcos	☐ Splash Suit	☐ Other
Head/eye/ear:	☒ Hard Hat	☒ Safety Glasses	☐ Goggles
	☐ Splash Shield	☐ Ear Plug	☐ Other
Gloves(Outer/Inner)	☐ Nitrile (outer)	☐ Neoprene	☐ PVC
	☐ Latex (inner)	☐ Vinyl	☒ Other: Leather work gloves as needed
Footwear:	☒ Steel-toed Leather	☐ Chemical Overboots	
	☐ Steel-toed Rubber	☐ Other	

Note: (T) Ear plugs are to be used if monitoring equipment indicates levels greater than 85 dBA.

7.1.2 Task for Soil Boring: Driller's/Driller's Helper Duties

Potential Hazards: (Check all that apply to either existing conditions or are a result of site operations)

☒ Rotating Machinery	☐ Projectiles	☐ Confined Space
☒ Heat Stress	☒ Physical Exertion	☐ Biological
☐ Cold Stress	☒ Noise (>85 dBA)	☒ Electrical (utilities)
☒ Heavy Equipment	☒ Vehicle Traffic	☐ Chemical Exposure
☒ Intrusive Activity	☐ Fire/Explosion	☐ Radioactive Material
		☒ Other (List)
		Slips, trips and falls.

Control or Protective Measures: (Check all that apply)

☒ Tailgate Meetings	☒ PPE	☒ Safe Work Practices
☒ Operator Training	☒ Site Control	☒ Decontamination
☐ Engineering Controls:		
☒ Other: <u>Initial flagging around operations</u>		

INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT FOR ASSIGNED TASK:

Initial levels of PPE have been assigned for this work task per the potential for exposure. Levels may be upgraded or downgraded depending on monitoring data and site conditions, as determined by the protocol outlined in section 12.0 Exposure Monitoring and deemed necessary by the SHSO

Level of protection:	☐ A	☐ C	☐ Modified
	☐ B	☒ D	
Respirator:	☐ SCBA, Airline	☐ Fullface Resp	☐ 1/2 Face Resp
(Level C or above)	☐ OV/HEPA Combo Cart,	☐ Other Cart. _____	
Protective clothing:	☐ Encapsulating Suit	☐ Tyvek	☐ PE Tyvek
	☐ Saranex	☐ Splash Suit	☐ Other
Head/eye/ear:	☒ Hard Hat	☒ Safety Glasses	☐ Goggles
	☐ Splash Shield	☐ Ear Plug	☐ Other
Gloves:(Outer/Inner)	☐ Nitrile (outer)	☐ Neoprene	☐ PVC
	☒ Latex (inner)	☐ Vinyl	☒ Other: Leather work gloves - as needed
Footwear:	☒ Steel-toed Leather	☐ Chemical Overboots	
	☐ Steel-toed Rubber	☐ Other:	

Note: (†) Ear plugs are to be used if monitoring equipment indicates levels greater than 85 dBA.

7.1.3 Sampling Site: Continuous Split-Spoon Sampling

Potential Hazards: (Check all that apply to either existing conditions or are a result of site operations)

☒ Rotating Machinery	☐ Projectiles	☐ Confined Space
☒ Heat Stress	☒ Physical Exertion	☐ Biological
☐ Cold Stress	☒ Noise (> 85 dBA)	☒ Electrical (utilities)
☒ Heavy Equipment	☒ Vehicle Traffic	☒ Chemical Exposure
☒ Intrusive Activity	☐ Fire/Explosion	☐ Radioactive Material
		☒ Other (List)
		Contact with contaminated soil.
		Slips, trips and falls.

Control or Protective Measures: (Check all that apply)

☒ Tailgate Meetings	☒ PPE	☒ Safe Work Practices
☒ Operator Training	☒ Site Control	☒ Decontamination
☒ Engineering Controls: <u>Soil to be drummed</u>		
☒ Other: <u>Install flagging around operations</u>		

INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT FOR ASSIGNED TASK:

Initial levels of PPE have been assigned for this work task per the potential for exposure. Levels may be upgraded or downgraded depending on monitoring data and site conditions, as determined by the protocol outlined in section 12.0 Exposure Monitoring and deemed necessary by the SHSQ.

Level of protection:	☐ A	☐ C	☐ Modified
	☐ B	☒ D	
Respirator:	☐ SCBA, Airline	☐ Fullface Resp	☐ 1/2 Face Resp.
(Level C or above)	☐ OV/HEPA Combo Cart.	☐ Other Cart. _____	
Protective clothing:	☐ Encapsulating Suit	☐ Tyvek	☐ PE Tyvek
	☐ Saranex	☐ Splash Suit	☐ Other
Head/eye/ear:	☒ Hard Hat	☒ Safety Glasses	☐ Goggles
	☐ Splash Shield	☐ Ear Plug	☐ Other
Gloves:(Outer/Inner)	☐ Nitrile (outer)	☐ Neoprene	☐ PVC
	☐ Latex (inner)	☐ Vinyl	☐ Other
Footwear:	☒ Steel-toed Leather	☐ Chemical Overboots	
	☐ Steel-toed Rubber	☐ Other:	

Note: (†) Ear plugs must be worn during drilling operations if monitoring equipment indicates levels greater than 85 dBA.

7.1.4 Task for Sampling Site: Soil Sampling by Geologist

Potential Hazards: (Check all that apply to either existing conditions or are a result of site operations)

☐ Rotating Machinery	☐ Projectiles	☐ Confined Space
☒ Heat Stress	☒ Physical Exertion	☐ Biological
☐ Cold Stress	☒ Noise (>85 dBA)	☒ Electrical (utilities)
☒ Heavy Equipment	☒ Vehicle Traffic	☒ Chemical Exposure
☒ Intrusive Activity	☐ Fire/Explosion	☐ Radioactive Material
		☒ Other (List)
Slips, trips and falls.

Control or Protective Measures: (Check all that apply)

☐ Tailgate Meetings	☒ PPE	☒ Safe Work Practices
☒ Operator Training	☒ Site Control	☒ Decontamination
☒ Engineering Controls: <u>Soil to be drummed</u>		
☒ Other: <u>Install flagging around operations</u>		

INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT FOR ASSIGNED TASK:

Initial levels of PPE have been assigned for this work task per the potential for exposure. Levels may be upgraded or downgraded depending on monitoring data and site conditions, as determined by the protocol outlined in section 12.0 Exposure Monitoring and deemed necessary by the SHSO.

Level of protection:	☐ A	☐ C	☐ Modified
	☐ B	☒ D	
Respirator:	☐ SCBA, Airline	☐ Fullface Resp	☐ 1/2 Face Resp.
(Level C or above)	☐ OV/HEPA Combo Cart.	☐ Other Cart. _____	
Protective clothing:	☐ Encapsulating Suit	☐ Tyvek	☐ PE Tyvek
	☐ Saranex	☐ Splash Suit	☐ Other
Head/eye/ear:	☒ Hard Hat	☒ Safety Glasses	☐ Goggles
	☐ Splash Shield	☐ Ear Plug	☐ Other
Gloves:(Outer/Inner)	☐ Nitrile (outer)	☐ Neoprene	☐ PVC
	☐ Latex (inner)	☐ Vinyl	☐ Other
Footwear:	☒ Steel-toed Leather	☐ Chemical Overboots	
	☐ Steel-toed Rubber	☐ Other:	

Note: (f) Ear plugs must be worn during drilling operations if monitoring equipment indicates levels greater than 85 dBA

7.1.5 Task for Sampling Site: Drumming Soil

Potential Hazards: (Check all that apply to either existing conditions or are a result of site operations)

☐ Rotating Machinery	☐ Projectiles	☐ Confined Space
☒ Heat Stress	☒ Physical Exertion	☐ Biological
☐ Cold Stress	☐ Noise (>85 dBA)	☒ Electrical (utilities)
☒ Heavy Equipment	☒ Vehicle Traffic	☒ Chemical Exposure
☒ Intrusive Activity	☐ Fire/Explosion	☐ Radioactive Material
		☒ Other (List)
		Slips, trips and falls.

Control or Protective Measures: (Check all that apply)

☒ Tailgate Meetings	☒ PPE	☒ Safe Work Practices
☒ Operator Training	☒ Site Control	☒ Decontamination
☒ Engineering Controls: <u>Use proper drum handling techniques</u>		
☒ Other: <u>Install flagging around operations</u>		

INITIAL LEVEL OF PERSONAL PROTECTIVE EQUIPMENT FOR ASSIGNED TASK:

Initial levels of PPE have been assigned for this work task per the potential for exposure. Levels may be upgraded or downgraded depending on monitoring data and site conditions, as determined by the protocol outlined in section 12.0 Exposure Monitoring and deemed necessary by the SHSO.

Level of protection:	☐ A	☐ C	☐ Modified
	☐ B	☒ D	
Respirator:	☐ SCBA, Airline	☐ Fullface Resp	☐ 1/2 Face Resp.
(Level C or above)	☐ OV/HEPA Combo Cart.	☐ Other Cart. _____	
Protective clothing:	☐ Encapsulating Suit	☐ Tyvek	☐ PE Tyvek
	☐ Saranex	☐ Splash Suit	☐ Other
Head/eye/ear:	☒ Hard Hat	☒ Safety Glasses	☐ Goggles
	☐ Splash Shield	☐ Ear Plug	☐ Other
Gloves:(Outer/Inner)	☐ Nitrile (outer)	☐ Neoprene	☐ PVC
	☐ Latex (inner)	☐ Vinyl	☐ Other
Footwear:	☒ Steel-toed Leather	☐ Chemical Overboots	
	☐ Steel-toed Rubber	☐ Other:	

Note: (†) Ear plugs must be worn during drilling operations if monitoring equipment indicates levels greater than 85 dBA.

7.2 CHEMICAL HAZARDS

The primary chemical hazards are calcium chloride, sodium chloride and urea. These chemicals are no longer stored at this site. There is a possibility of ammonia being present in the soil.

Chemical analysis of water, from a natural spring down the hill near the site, has shown elevated levels of ammonia. The water from this spring flows into East Fork Poplar Creek (EFPC) and is a suspected source of fish kills that occurred in December 1992 and February 1993 in EFPC.

7.3 RADIOLOGICAL HAZARDS

Y-12 categorizes the investigation area as Category I, meaning there is a low probability of encountering radioactive material. A preliminary site survey of the surface will be conducted by Y-12's radiation protection group as part of the Excavation/Penetration Permit approval process.

7.4 PHYSICAL HAZARDS

This site is not classified as a hazardous waste site. It would be similar to a typical construction site with its usual hazards. On two sides of the site, there is a steep incline, dropping down to a creek. Also, obstacles are present, so site personnel must be alert to prevent slips, trips or falls.

7.5 OPERATIONAL HAZARDS

7.5.1 Heavy Equipment

Heavy equipment, such as a drilling rig, shall be operated by an experienced operator and shall be operated in a safe manner. When high profile equipment is moved on the site, a spotter will assist the driver in watching for and locating overhead utilities, pedestrian traffic, vehicular traffic, or other hazards. A clearance of fifteen feet shall be maintained from all overhead utilities by high profile equipment on site. A Construction Excavation/Penetration Permit shall be obtained by the Y-12 Project Manager prior to commencement of drilling or excavation work. Heavy equipment and components shall be inspected prior to coming on site and on a daily basis for unsafe conditions and/or faulty components, such as worn hydraulic hoses, excessive broken strands on wire cables, fuel line leaks, missing pins/bolt attachments, etc. Hoisting and Rigging will be reviewed and approved by Y-12 Industrial Safety. Physical hazards inherent to construction activities and power operated equipment hazards will exist.

7.5.2 Electrical Hazards

Prior to commencement of construction activities, a site reconnaissance by on-site personnel will be conducted to identify any visible hazards such as overhead or underground utilities. Site drawings shall be used for verification of underground utilities.

All tools and equipment used on this project shall be inspected and maintained to be safe and adequate for the designated use. All temporary 120/125-volt, single-phase, 15 and 20 ampere receptacles and cord sets shall be protected by approved ground fault circuit interrupters (GFCIs).

7.5.3 Noise Hazard

Operation of heavy equipment may present a noise hazard exposure to workers. Each person will be provided with hearing protection to be used when noise levels are greater than 85 dBA. Monitoring of noise levels and noise exposure to personnel will be conducted with frequency as deemed necessary by the SHSO. Areas with noise levels greater than 85 dBA will be posted as high noise areas, requiring the use of hearing protection.

7.5.4 Heat Stress/Cold Stress

Seasonal weather conditions in the Oak Ridge area are conducive to producing both heat or cold stress. Monitoring by the SHSO, and worker knowledge of the signs and symptoms of heat and cold stress will be essential to avoiding these conditions.

7.5.4.1 Heat Stress

Heat stress monitoring of workers and the environment will be initiated by the SHSO when the ambient temperature exceeds 70°F and workers are dressed out in modified Level "D" protective clothing or greater. To prevent heat stress, personnel monitoring (checking pulse rate or body temperature) will be used as well as scheduled work/rest periods. Workers determined by the SHSO to be displaying symptoms of advanced heat stress will be promptly referred to Y-12 Medical Services. Work/rest periods will be adjusted based on results of personnel monitoring, work load and condition of the worker. The warning symptoms of heat stress include fatigue; loss of strength; reduced accuracy, comprehension, and retention; and reduced alertness and mental capacity. Heat stroke represents an advanced form of heat stress and is associated with physical symptoms of hot, dry skin, elevated body temperature ($> 104^{\circ}\text{F}$), rapid pulse rate, and advanced symptoms of dizziness, nausea, and confusion, which may lead to delirium, convulsions, coma,

and possible death. Personnel shall monitor themselves for heat stress as instructed by the SHSO. Self-monitoring shall include checking of pulse rate within two to five minutes into the work break. A pulse rate > 110 beats per minute (bpm) shall require shortening of the next work period by $1/3$ the time. A pulse rate recorded > 110 bpm during the next rest period shall warrant the same action, and so on. The taking of oral temperature is not planned at this time, but may be enacted when pulse rate measurements exceed 110 bpm. An oral temperature taken during the same time period which is $> 99.6^{\circ}\text{F}$ shall warrant the same actions to be taken. A worker recording an oral temperature $> 100.6^{\circ}\text{F}$ shall be prohibited from wearing non- or semi-impermeable protective clothing. Heat stress monitoring will be coordinated and documented by the SHSO.

7.5.4.2 Cold Stress

Cold injury (frostbite and hypothermia) and impaired ability to work are dangers during cold weather and when the wind-chill factor is low. To guard against cold stress, personnel will be advised to wear appropriate clothing. Clothing, shelter, scheduled work/rest periods, and personnel monitoring will be used to prevent cold exposure hazards. The warning symptoms of cold overexposure include reduced coordination, drowsiness, impaired judgement, fatigue, and numbing of toes, fingers, nose, or ears.

7.6 OXYGEN DEFICIENCY

Oxygen deficient conditions are not anticipated during the course of the field activities.

7.7 FIRE PROTECTION

No flammable operations (welding and cutting) are scheduled for this project. Fire protection shall be provided by a minimum of two, 10-pound ABC type portable fire extinguishers. These fire extinguishers shall be readily available to trained personnel on-site. In addition, personnel will be familiar with how to summon for emergency assistance from the Y-12 Fire Department. Any flammable liquids and solvents to be used on-site shall be transported and stored in UL listed and FM approved safety containers.

7.8 STRESS - GENERAL

Both physiological and psychological stress effect hazardous waste clean-up personnel. Wearing protective clothing and equipment increases the risk of accidents. This is due to the fact that many forms of PPE add weight, are cumbersome, decrease dexterity and agility, interfere with vision, and produce fatigue. Personnel are often required to perform strenuous tasks under stressful conditions, and they may face chemical exposure and various emergencies. These factors all increase emotional and physical stress and the potential for accidents.

8.0 HAZARD COMMUNICATION AND TRAINING ASSIGNMENTS

8.1 HAZARD COMMUNICATION TRAINING

All site personnel shall be trained in the hazards associated with this project prior to commencement of work activities. Material Safety Data Sheets (MSDS's) for any fuels, solvents and decontamination fluids shall be kept on site and available to all workers at all times. The SHSO shall be responsible for upkeep of MSDSs. Refer to Attachment 1 for MSDS inventory information.

8.2 HAZARDOUS WASTE WORKER TRAINING

All site staff will have completed the OSHA 40-hour Hazardous Waste Operations Training, additional 24 hour field supervised training and appropriate annual updates. In addition, site supervisors will have completed OSHA 8-hr Supervisory Training and First Aid/CPR Training. Occasional site workers that will not receive exposures exceeding permissible exposure limits require only 24 hours of OSHA Hazardous Waste Operations Training and one day of on-site training and supervision. Documentation that training assignments have been met will be required prior to site entry.

8.3 FIRST AID/CPR TRAINING

A minimum of one on-site person shall be trained in basic first aid and cardiopulmonary resuscitation (CPR) as administered by the American Red Cross. A first aid kit will be available at all times that work is in progress. The kit will be stored in a project vehicle and all personnel will be advised of its location.

9.0 MEDICAL SURVEILLANCE REQUIREMENTS

All personnel working on the site shall participate in a medical surveillance program which is consistent with the requirements of 29 CFR 1910.120 for hazardous waste site operations. The

purpose of the program is to assess and monitor employee health prior to employment, during the course, and at the end of work.

The program consists of scheduled baseline exams, follow-ups, termination exams, and other exams as needed. The basic exam protocol is as follows:

1. An occupational and medical history;
2. A physical exam;
3. Laboratory tests including blood chemistry, CBC, reticulocyte count;
4. Urinalysis;
5. EKG;
6. Stool guaiac;
7. Spirometry with chest x-ray;
8. Audiometric testing;
9. Vision tests; and
10. Respirator quantitative fit test.

Medical clearance releases for each on-site worker are maintained in their individual personnel file at their respective office of employment.

10.0 COMMUNICATIONS

The "buddy system" will be enforced for field activities involving potential exposure to hazardous or toxic materials, and during any work within the exclusion zone. Each person will observe their partner for symptoms of chemical overexposure or heat/cold stress, and provide emergency assistance when warranted.

The following emergency hand signals shall be used:

• Thumbs up	OK; understand
• Thumbs down	No; negative
• Grasping buddy's wrist	Leave site now
• Hands on top of head	Need assistance.

11.0 SANITATION

Rest rooms and field washing facilities are not available on site for use on this project.

12.0 EXPOSURE MONITORING

No routine monitoring is scheduled for this site. However, the possibility exists of ammonia contamination in the soil due to the urea that was once stockpiled in this area. If any individual notices an ammonia-like odor, work will be halted and air sampling will be conducted using colormetric detector tubes and a hand sampling pump.

Although the potential is low for encountering radioactive material, radiological detection equipment (e.g., pancake-type Geiger Muller and alpha scintillation detectors) will be utilized on all drilling equipment before work begins and at the completion of drilling. Field activities will cease and Y-12's Radiation Protection staff will be contacted if radioactive material is detected. Field activities will restart after the SHSO and Ogden ES&H Manager have met with the Y-12 Health Physics contacts, to determine what additional precautions that must be used.

12.1 EXPOSURE MONITORING SCHEDULE

There will be no established monitoring schedule for this site, other than the radiation monitoring (see Section 12.0). Sampling for ammonia, with colormetric tubes, will be on an "as needed" basis only.

High noise levels and heat stress conditions anticipated for segments of this project will dictate the need for the SHSO to monitor the work environment and personnel for these physical stresses. Noise monitoring will be conducted at the initiation of new activities involving heavy equipment to allow for posting of high noise areas, and specify the level of hearing protection.

12.2 EQUIPMENT TO BE USED

<u>Equipment Name or Type</u>	<u>Contaminant or Hazard to be Detected</u>
Colormetric Detector Tubes	Ammonia
Sound Level Meter	High noise areas and equipment
Pancake G-M Probe/Rate meter	Beta/Gamma Radiation
Alpha-Scintillation Probe/Rate meter	Alpha Radiation

12.3 ACTION LEVELS

The following action levels are to be used for upgrading/downgrading levels of PPE, determining when work stoppages should occur, and for issuing evacuation orders:

<u>Equipment/Contaminant</u>	<u>Action Level</u>	<u>Action to be Taken</u>
Colormeter Detector Tubes for Ammonia	12 ppm	Evacuate personnel in area. The SHSO will contact the Ogden Project Manager, the Ogden ES&H Manager and the Y-12 Project Manager to determine course of action.
Sound Level Meter	> 85 dBA	Post area as high noise area and require use of hearing protection devices.
Alpha-Scintillation Probe/ Rate meter	300 dpm/100 cm ²	Halt work. The SHSO will contact the Ogden Project Manager, the Ogden ES&H Manager, and the MMES Health Physics Department at Y-12 for guidance.
Pancake G-M Probe/ Rate meter	1000 dpm/100 cm ²	Halt work. The SHSO will contact the Ogden Project Manager, the Ogden ES&H Manager, and the MMES Health Physics Department at Y-12 for guidance.

13.0 WORK ZONE DELINEATION

The SHSO will coordinate access control and security on the site. A safe perimeter will be established around areas where work is in progress and will be bordered by a flagged area and monitored periodically.

Additional zones and signs may be required depending on monitoring results. The roped/flagged area will be designated as the Work Zone.

14.0 SAFE WORK PRACTICES

Employees and visitors will be required to follow and maintain good hygiene/work practices that include:

- Unauthorized personnel are not allowed on-site.
- Work groups will always consist of at least two team members.
- Smoking, eating, drinking, chewing gum or tobacco, taking medication, and applying cosmetics will not be permitted within the work zone.
- Wearing of contact lenses is prohibited.
- Personnel under the obvious influence of alcohol or controlled substances are not allowed on-site.
- Thoroughly wash hands, arms, and face before breaks or any hand to mouth activity such as eating, drinking, smoking, use of chewing tobacco or application of cosmetics.
- Personnel will discard and replace any damaged, or heavily soiled protective clothing.
- Personnel should notify the SHSO of any defective monitoring, emergency, or other safety equipment.
- A supply of potable water, electrolyte replacement solutions, and a shaded area will be available on-site. Sanitary facilities will be accessible to personnel.
- All site personnel will familiarize themselves with these and the emergency procedures by use of daily tailgate safety meetings.

15.0 PERSONAL PROTECTIVE EQUIPMENT

All personnel entering the site and the work zone will be required to be in Level D PPE. No contingency for upgrading to Level C is included in this SSHP. If levels exceed the action levels for Level D, a stop work order will be issued by the SHSO and all personnel will be required to leave the work zone to a safe, upwind location. A summation of Level D protection is as follows:

1. Work shirt and long pants, no loose or dangling clothing due to proximity to power equipment;
2. Hard hat;
3. Safety glasses
4. Steel-toed shoes; and
5. Hearing protection.

16.0 DECONTAMINATION

The purpose of decontamination is to prevent contaminants that may be present on protective clothing and equipment from coming into contact with personal as they un-suit. Also, decontamination protects workers from hazardous substances that may contaminate and eventually permeate the PPE used onsite; it protects personnel by minimizing the transfer of harmful materials into clean areas. Decontamination consists of physically removing contaminants or changing their chemical nature to innocuous substances. Combining decontamination with the correct sequential method of removing personal protective equipment will prevent exposure to personnel leaving the work areas as well as off-site migration of contaminants. Generally decontamination is accomplished by starting at the first station with the most heavily contaminated item and progressing to the last station with the least contaminated item.

The purpose of equipment decontamination is to prevent exposure to personnel during loading, transporting, and unloading at another site. It is also to prevent off-site migration of contaminants from one site to another or during transportation of the equipment.

16.1 PERSONNEL DECONTAMINATION

Removal of loose mud or other substrate from personnel and equipment will be performed before leaving the work zone. Additional material will be removed by brushing, scraping, or washing as necessary. Personnel will remove any disposable PPE and dispose it in provided containers before leaving the work zone. Personnel shall thoroughly wash hands and face before leaving the area.

16.2 EQUIPMENT DECONTAMINATION

All equipment shall be decontaminated before entering the site. All split-spoon samplers will be decontaminated before being placed into a boring. An adequate containment system shall be set up so all wash water and cleaning fluids may be contained for proper disposal, in accordance with MMES ESP-1000, "Waste Management".

17.0 EMERGENCY RESPONSE

The purpose of this section is to safeguard human health and the environment in the event of an emergency. This section also addresses the emergency actions to be taken in response to an emergency. The responsibility of the regular day-to-day implementation of this information primarily lies with the SHSO. During an actual response situation, the SHSO will serve as the Emergency Coordinator until the Plant Shift Superintendent (PSS) or emergency team arrives.

17.1 PRE-EMERGENCY PLANNING

The SHSO will perform the following pre-emergency tasks before starting field activities and will coordinate emergency response with Y-12 when appropriate:

1. Locate nearest telephone and alarm station.
2. Confirm and post emergency telephone numbers.
3. Post site map marked with evacuation routes and emergency equipment and supplies.
4. Evaluate capabilities of Y-12 emergency response teams.
5. Inform Y-12 PSS of the nature of the project hazards and potential emergencies.
6. Review and revise emergency response plan in the event of a failure of the plan in an emergency, changes in site conditions, changes in the scope of work, or personnel availability.
7. Inventory and check out on-site emergency equipment and supplies.

17.2 LINES OF AUTHORITY

The SHSO has primary responsibility for expediting Y-12 Response Operations onsite to include reporting to the Y-12 PSS and correcting as conditions allow and responding to and correcting emergency situations. The SHSO has the authority to stop any site activities posing an immediate health and safety hazard to site personnel and the public. Possible actions may involve notification of the Ogden ES&H Manager and the Project Manager, and ensuring that corrective measures are implemented, appropriate authorities are notified, and follow-up reports completed.

17.3 EMERGENCY PREVENTION AND RECOGNITION

Prevention of emergencies will be aided by the effective implementation of the SSHP personnel awareness, contingency planning, and the briefing held with personnel at the beginning and during the execution of the field activities.

17.4 NOTIFICATION

In the event of an emergency, a verbal instruction or site alarm will be sounded to:

1. Notify all on-site personnel,
2. Stop work activities,
3. Lower noise levels to facilitate communications,
4. Begin emergency procedures, and
5. Notify on-site emergency response personnel about the emergency.

17.5 EVACUATION ROUTES AND PROCEDURES

In the event of an emergency that requires an evacuation of the site, an alarm will be sounded or verbal instruction given by the on-site supervisor to evacuate the area. Personnel will exit the area to the upwind, pre-designated support area. At this point, the SHSO will account for all personnel, ascertain information about the emergency, and advise further instructions to the on-site personnel. The SHSO will also advise responding off-site emergency personnel of the situation, if necessary. In all situations that require evacuation, personnel shall not re-enter the work area until the conditions causing the emergency have been corrected, the hazard reassessed, the SSHP has been revised, if necessary, and reviewed with on-site personnel, and instructions given for authorized re-entry.

17.6 EMERGENCY MEDICAL TREATMENT AND FIRST AID

In the event of an emergency involving personal injury or illness, first aid should be rendered by a First Aid trained person and emergency medical services summoned through contact with PSS. Personnel with injury or illness will be decontaminated to the extent possible without further injury. Life saving and first aid procedures take priority over personnel decontamination efforts. The SHSO will have final authority on the decision to require additional professional medical services (i.e., paramedics, hospital visit, etc.) for any illness or injury.

17.7 FIRE OR EXPLOSION

In the event of a fire or explosion, the PSS will be notified immediately. The PSS will summon the Y-12 Fire Department and coordinate the emergency response. When the fire-fighting personnel arrive at the site, the SHSO should advise the fire commander of the situation. If it is safe to do so, on-site personnel may use available fire-fighting equipment to control and/or extinguish the fire and remove or isolate flammable or other hazardous materials which contribute to the fire or inhibit control of the fire.

17.8 SPILL OR LEAK

In the event of a spill or leak (regardless of quantity), on-site personnel will:

1. Send co-worker to inform the ES&H Manager and PSS immediately,
2. Locate the source and stop the spillage if it can be done safely, and
3. Begin containment and recovery of spilled material.

17.9 EMERGENCY CONTACTS

Emergency resources are as follows:

Y-12 Emergency Response	911
Y-12 Plant Shift Superintendent	574-7172
Y-12 Health Service Center	911
Y-12 Fire Department	911
Poison Control Hotline	1-800-522-4611
EPA National Response Center	1-800-424-8802
Ogden Project Manager	481-8002
Ogden ES&H Manager	481-8002
Y-12 Project Manager	574-9595

* On-site phones use last 5 digits only

Directions to Y-12 Health Service Center

North on East Patrol Road (Down the hill toward the main plant)
West on Third Street
North on "B" Road
West on First Street
Continue to Building 9706-2 (Left side of First Street)

Directions to Methodist Medical Center of Oak Ridge

North on East Patrol Road (Down the hill toward the main plant)
Left on Third Street
Right on "B" Road
Right onto First Street
Through Main Portal
Left onto Scarboro Road
Half-right onto Lafayette
Right onto Oak Ridge Turnpike
Left onto Tennyson
Follow signs to emergency entrance

17.10 EMERGENCY EQUIPMENT

It shall be the responsibility of the SHSO to maintain the site emergency equipment in good working order; weekly inspections shall be performed and documented.

Equipment shall be readily available and clearly identified by signs, and workers trained in its use by the SHSO.

<u>Item</u>	<u>Location</u>
First Aid Kit	Project Vehicle
Fire Extinguishers	On-site (2-10 pound ABC)
Evacuation Air Horns	On-site
Eye Wash	On-site

18.0 STANDARD PROCEDURE FOR REPORTING EMERGENCIES

The following information should be provided and the Corporate Health and Safety and Personnel offices notified:

1. Name of person making call,
2. Telephone number at location of person making call,
3. Name of person(s) exposed or injured,
4. Nature of emergency, and
5. Actions already taken.

18.1 FOLLOW-UP ACTIVITIES

Before normal activities are resumed, on-site personnel must be prepared and equipped to handle another emergency. The follow-up activities should be completed:

1. Notify appropriate government agencies as required in conjunction with Y-12 (Reminder: OSHA must be notified if there have been any fatalities or five or more hospitalizations).
2. Restock all equipment and supplies.
3. Review and revise all aspects of the SSHP as necessary to address future emergencies of this type and new site conditions.

18.2 EMERGENCY RESPONSE DOCUMENTATION

Investigation and documentation of any emergency response shall be initiated by the SHSO. This is important in all cases, but especially so when the incident has resulted in personal injury, property damage, or environmental impact. The documentation will be a written report, and will be:

- a. Accurate: All information must be recorded objectively.
- b. Authentic: Each person making an entry must sign and date that entry. Nothing is to be removed or erased. If details are changed or revised, the person making the change should strike out the old material and initial and date the change.
- c. Titles and names of personnel involved.
- d. Actions taken, decisions made, orders given, to whom, by whom, when, what, where, and how as appropriate.
- e. Summary of data available (air monitoring, chemical concentrations, etc.).
- f. Possible exposure of personnel.
- g. Copies of all the Supervisor's Accident Investigation Reports and Employer's Report of Occupational Injury or Illness.

19.0 PROJECT DOCUMENTATION

Hazardous waste site operations generate enormous amounts of information. This information shall be documented with the use of the reporting forms shown in this section. The logs and records shall be the ultimate responsibility of the SHSO and shall be maintained on site for review. However, all personnel shall be individually responsible for completion of the information required by the logs.

The safety and health logs and records, included as attachments and summarized below, shall be kept on record, and maintained by Ogden, for a period of no less than 30 years:

Plan Approval Signature Sheet	Page i
Site Safety and Health Plan Acceptance	Appendix A
Visitors Notice Form	Appendix B
Daily Project Log	On-site Recordbook
Daily Sign In Log - Visitors	On-site Recordbook
Training/Safety Briefing Log	On-site Recordbook
Accident/Illnesses Reports	Ogden Forms
Safety Inspection Reports - Equipment	Ogden Forms

APPENDIX A
OGDEN SAFETY AND HEALTH PLAN ACCEPTANCE

Appendix A

OGDEN ENVIRONMENTAL AND ENERGY SERVICES, INC.

SITE SAFETY PLAN ACCEPTANCE

PROJECT:

I have read the Site Safety and Health Plan for the above referenced project and understand the requirements. My signature below indicates my understanding of the safety requirements and my agreement to abide by these regulations.

NAME	SSN	DATE	SIGNATURE

APPENDIX B
OGDEN VISITORS NOTICE FORM

Appendix B

OGDEN ENVIRONMENTAL AND ENERGY SERVICES, INC.

VISITORS NOTICE

PROJECT:

The area you are requesting entry to is a hazardous waste site. Entry into the work areas designated as the exclusion zone or the contamination reduction zone require compliance with the restrictions in accordance with OSHA 29 CFR 1910.120. These specified requirements are: OSHA 40 hour or 24 hour offsite training; on the job training; site-specific safety and health training; reading the Site Safety and Health Plan; the use of personal protective clothing and equipment; medical surveillance; briefings related to emergency response planning and practice, and knowledge of decontamination procedures.

Site visitors requesting entry to the support zone only are required to receive a site orientation of the hazards associated with the site, and briefing of the emergency response and evacuation plan.

All visitors including subcontractors, shall receive the appropriate on and offsite training prior to entering the requested work zones.

Please sign below as an indication you have complied with the above mentioned requirements and understand the site-specific information, and will abide with these requirements pertaining to the area in which you plan to enter.

NAME	COMPANY	DATE	TIME

**DRAFT
WASTE MANAGEMENT PLAN
FOR
EXPLORATORY DRILLING AT THE CALCIUM CHLORIDE,
SODIUM CHLORIDE AND UREA STORAGE AREA (PATROL
ROAD AT NORTH 28,000, EAST 62,400)**

**Prepared for:
MARTIN MARIETTA ENERGY SYSTEMS, INC.
CONTRACT 88B99977V
RELEASE C-70**

**Prepared by:
Ogden Environmental and Energy Services
1009 Commerce Park Drive, Suite 100
Oak Ridge, TN 37830**

June 21, 1993

Ogden File No. 0-4267-0074

**DRAFT
WASTE MANAGEMENT PLAN
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1. INTRODUCTION

1.1 PURPOSE

Field activities for the ammonium nitrate study will involve drilling, sampling and measurement of various environmental media. Exploratory drilling and sampling will occur in areas suspected to be contaminated with ammonium nitrate; therefore, it is anticipated that contaminated solid and liquid, as well as noncontaminated wastes may be generated as a result of these activities. Handling of these waste materials will be accomplished in accordance with the procedures referenced throughout the plan. In addition, the following sections summarize the waste characterization and handling requirements specific to these exploratory activities.

1.2 BACKGROUND

For several years road salts have been stored in this location at Y-12. The salts have been (and correctly are being) stored in open wood bins resting on an asphalt pavement. The road salts include calcium chloride, sodium chloride and urea.

The paved area has presumably been formed by cutting and filling to form a bench on the western side of the patrol road. The ground surface in this area slopes steeply downward to the north. Figure 1.1 shows the site and its relationship to 4-12.

2. WASTE CHARACTERIZATION

2.1 WASTE GENERATING ACTIVITIES

2.1.1 Auger Drilling

The normal practice for obtaining subsurface soil samples involves driving a split-spoon sampler through a hollow stem auger. The auger drilling aspect of this sampling technique raises soil cuttings to the surface that are unwanted by-products of the sampling process. Additionally, if the volume needed for a sample is less than the volume of material removed from the split-spoon sampler, the split-spoon soil remnant become waste material.

All auger cuttings will be collected in drill pans at the ground surface. These drill pans provide for positive containment of the cuttings until the cuttings have been monitored to determine their contamination status. The cuttings are then removed from the drill pan and placed in a lined 55-gallon drum.

2.1.2 Decontamination Activities

Given the possibility of encountering contaminated materials during the investigation, it is likely that equipment, tools, and materials used will become contaminated. Therefore, all drilling tools used for sampling must be decontaminated between samples. All reasonable efforts will be taken to reduce or eliminate the potential for such contamination, including minimizing the number of tools and pieces of equipment used. It will not be possible, however, to prevent contamination of some items (e.g., augers tools and containment pans because of the manner in which they are used. In such cases, these items will be decontaminated onsite, as needed.

2.1.3 Miscellaneous

Other associated activities may generate various types of waste. These activities will include collection of discarded protective clothing/equipment (e.g., disposable gloves, and coveralls and any fluid leaks from the drill equipment.

2.2 POTENTIAL WASTE FORMS

The activities identified in Sect. 2.1 will result in three basic forms of waste material, as detailed in the following subsections.

2.2.1 Solid Wastes

For the purpose of this plan, solid waste is subcategorized as shown in the following paragraphs.

2.2.1.1 Solid compactible waste

The category of waste includes materials such as plastic, gloves, paper, protective clothing, plastic sample containers, and tape generated during exploration and sampling activities.

2.2.1.2 Solid noncompactible waste

This category of waste is primarily soil cuttings, which will be generated by augering. Other solid noncompactible wastes that may be generated during the field investigation include contaminated glass or metal sample containers. All soil will be field checked by the onsite Ogden health and safety officer for field radiation above background levels and volatile organics and classified as radioactive, hazardous, mixed or non-contaminated.

2.2.2 Liquid Wastes

The largest volume of liquid waste is expected to be water from decontamination of drilling tools and sampling equipment. Significant volumes of liquid waste may also be generated if groundwater is encountered, and if it is augered back to the surface. Water will be field checked and classified by the onsite Ogden health and safety officer as noted in 2.2.1.2.

2.2.2.1 Water

Waste water will be contained and field tested for radiological and hazardous contaminants by the onsite Ogden safety and health officer and classified as noted in 2.2.1.2.

2.2.2.2 Lubricating and hydraulic fluids and fuels

Inadvertent spills and leaks from operating equipment will immediately be recovered and containerized. Unless otherwise directed by the Martin Marietta Energy Systems (MMES) drilling coordinator, these materials will be handled as hazardous waste.

2.2.3 Sludges

As indicated in Sects. 2.1.1 through 2.1.3, drilling operations may result in the generation of saturated soil or soil with free water. Because of its solid/liquid mixture, such soil is not properly classified as either solid or liquid waste. Inasmuch as possible, free liquids will be pumped away from the soil and combined with liquids of the same characteristics.

2.3 WASTE DETERMINATION

Field activities will be conducted in accordance with the project safety and health plan (S&H) which requires that the Ogden health and safety officer assess all field activities that have a potential for exposing project personnel or the environment to contaminated materials. An Ogden health and safety specialist will continuously monitor soil cuttings and samples for both radiation/radioactive materials and volatile organics.

Monitoring instruments will include field alpha and beta-gamma radiation detectors, portable photoionization detectors, and 0₂/LEL meters.

If solid or liquid wastes are encountered that are classified by the Ogden safety and health officer as contaminated, all drilling activities will cease and Ogden will request guidance from MMES as to the pursuit of additional work at this site.

3. WASTE VOLUME GENERATION

Because of the investigatory nature of this work, it is unlikely, but possible that the sampling approach may be modified as the investigation progresses to adequately define the nature and extent of potential contaminants. As a consequence, it is impossible to accurately predict volume, form, and content of wastes that are anticipated to result from the investigation. Table 3.1 provides estimates based on the currently proposed work scope consisting of 150 LF of drilling.

Table 3.1. Estimated volumes of wastes generated during this study^a.

Waste Form	Radioactive	Hazardous	Mixed	Noncontaminated
Solids				
Compactibles	0	0	0	1
Noncompactibles (soil)	0	0	0	10
Liquids				
Decontamination water	0	0	0	4

^a Volumes are all in units of 55-gal drums (ft³).

4. WASTE HANDLING PROCEDURES

After the waste has been field classified and placed in drums, (Sect. 2.3), Ogden supplied 55 gallon drums with liners will be labeled classifying their contents. Wastes stored in drums will be segregated according to waste type.

Ogden will label the drums using MMES supplied labels. MMES will accept ownership of the drums at the site and dispose of the drums.

5. UNUSUAL WASTE FORMS

Unusual waste forms found by the exploration will be segregated in one or more drums and labeled by the Ogden health and safety officer as unusual waste. Martin Marietta Energy Systems will classify the unusual waste.

6. TRAINING

All Ogden project personnel assigned to field work will have the following:

- 40-Hour SARA/OSHA training and applicable updates;
- Be medically monitored;
- Have been approved and fit tested for respirator wear;
- Be badged.
- Have valid GET training or site access training.

Training documents will be kept in each individual's personnel files at Ogden's office in Oak Ridge.

7. RECORDS

The Ogden health and safety site officer will maintain a log of the number of drums filled with solid waste and the number filled with liquid wastes.

The Ogden health and safety officer will maintain a log of all instrument readings as discussed in Section 19.0 of the Site Safety and Health Plan.

**SUBSURFACE INVESTIGATION AND
ENVIRONMENTAL SAMPLING
AMMONIUM NITRATE STUDY
Y-12 PLANT
OAK RIDGE, TENNESSEE**

**CONTRACT NO. 88B-99977V
RELEASE C-70**

**Prepared for:
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P.O. Box 2003, K-1550-U
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Attention: Mr. John D. Long**

**Prepared by:
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August 25, 1993

Ogden File No. 0-4267-0074

**SUBSURFACE INVESTIGATION AND
ENVIRONMENTAL SAMPLING
AMMONIUM NITRATE STUDY
Y-12 PLANT
OAK RIDGE, TENNESSEE**

**CONTRACT NO. 88B-99977V
RELEASE C-70**

**Prepared for:
Martin Marietta Energy Systems, Inc.
P.O. Box 2003, K-1550-U
Oak Ridge, TN 37831-7231
Attention: Mr. John D. Long**

**Prepared by:
Ogden Environmental and Energy Services
1009 Commerce Park Drive, Suite 100
Oak Ridge, TN 37830**

August 25, 1993

Ogden File No. 0-4267-0074

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August 25, 1993

Martin Marietta Energy Systems, Inc.
P.O. Box 2003, K-1550-U
Oak Ridge, TN 37831-7231

ATTN: Mr. John D. Long

RE: Subsurface Investigation and Environmental Sampling
Ammonium Nitrate Study
Y-12 Plant
Oak Ridge, Tennessee
Contract No. 88B-99977V
Release C-70
Ogden File No. 0-4267-0074

Ladies and Gentlemen:

We have completed our limited study for the above-referenced project and herein present the subsurface data, well logs, and other data accompanied by a discussion on site conditions and procedures used for exploration. No engineering analysis was requested.

The principal purposes of this investigation were to:

1. Obtain subsurface data;
2. Visually classify the soil samples;
3. Provide soil samples to Environmental Consulting Engineers for chemical testing;
and
4. Install two temporary monitoring wells.

The scope of our work did not include any environmental assessment of the site. In addition, there are other limitations to this investigation. Some of these limitations are discussed in the pamphlet prepared by the ASFE, which we have included in Appendix L.

SITE CONDITIONS

The site is located on the northwestern side of East Patrol Road within the southeastern corner of the Y-12 plant. The approximate location of the center point of the site is at Y-12 coordinates North 28,520 and East 61,710. The vicinity map included in Appendix II shows the general location of the site with respect to the surrounding topographic and cultural features as they existed in 1987.

The area is primarily asphalt covered. There are two open, u-shaped wooden bins on the southern half of the site. We understand these bins are currently used as a storage area for road salts (i.e., CaCl, NaCl, and Urea).

The area explored slopes gently downward to the northeast, with ground elevations ranging from 980.7 feet above mean sea level (MSL) at boring B-1 to 977.7 feet above MSL at boring B-3. Although the area explored is relatively flat, the surrounding terrain is steep. Surface drainage appears to be quite good.

As shown on the Plan included in Appendix II, the site is adjacent to a "switchback" in the East Patrol Road. Based on visual observation, it appears that the area has been previously filled, probably during the construction of the "switchback."

EXPLORATION

The exploration program consisted of three borings which were staked by Environmental Consulting Engineers (ECE) and subsequently approved by MMES. Prior to the start of drilling, Ogden's drill rig was surveyed and "green-tagged" by MMES Health Physics (HP) personnel.

All of the borings were drive-sampled in general accordance with ASTM D 1586 (Penetration Test and Split-barrel Sampling of Soils) to auger refusal. Specifically, the borings were continuously drive-sampled to various depths specified by Mr. Robert Yager of ECE. Thereafter, the borings were generally drive-sampled on five-foot intervals to auger refusal. Our onsite decontamination technician decontaminated the split-spoons between each use. In addition, the drill rig and tools were decontaminated before the start of work, between holes, and at the end of the job. Our drilling equipment was surveyed and "green-tagged" by MMES HP personnel at the completion of drilling.

The principal author logged the soil samples daily. The soil samples were classified as to probable origin (i.e., fill or natural soil), consistency, and soil type in accordance with the Unified Soil Classification System (USCS). Once logged, each soil sample was placed in a labeled Mason jar. After the samples were surveyed and "green-tagged" by MMES HP personnel, they were turned over to Mr. Yager for further analysis. The descriptions of the soil samples are given in the typed logs, which are presented in Appendix III.

Upon completion, each boring was monitored for the presence of groundwater. There were no existing piezometers (or monitoring wells) at this site, so two temporary piezometers were installed to measure the fluctuations in groundwater and/or perched groundwater during ECE's study period. Piezometers were set in borings B-1 and B-3, as

Martin Marietta Energy Systems, Inc.
Subsurface Investigation
Ammonium Nitrate Study - Y-12 Plant
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Page 4

instructed by Mr. Yager. A cross-section of each piezometer is presented in Appendix IV. Boring B-2 was backfilled with a 5 percent bentonite - 95 percent grout mixture.

We trust this limited report will satisfy your immediate needs. We appreciate this opportunity to be of continuing service to Martin Marietta Energy Systems, Inc. If you have any questions regarding this report, please do not hesitate to call.

Respectfully submitted,

Terry M. Harms, E.I.T.
Project Coordinator

Lawrence I. Benson
Principal Geologist

TMH/LIB/ea:kfg

NMEL/3 (AMMONIUM.RPT) 08/24/93 16:53

APPENDIX I
ASFE PAMPHLET

Subsurface Investigation and Environmental Sampling
Ammonium Nitrate Study
Y-12 Plant
Oak Ridge, Tennessee
Ogden File No. 0-4267-0074

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size and configuration, the location of the structure on the site, other improvements such as access roads, parking lots, and underground utilities, and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one
- when the size, elevation, or configuration of the proposed structure is altered,
- when the location or orientation of the proposed structure is modified,
- when there is a change of ownership, or
- for application to an adjacent site

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts. Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

APPENDIX II
VICINITY MAP AND PLAN

**Subsurface Investigation and Environmental Sampling
Ammonium Nitrate Study
Y-12 Plant
Oak Ridge, Tennessee
Ogden File No. 0-4267-0074**

SCALE: 1" = 2000'

VICINITY MAP AMMONIUM NITRATE STUDY

MARTIN MARIETTA ENERGY SYSTEMS, INC.
OAK RIDGE, TENNESSEE

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

1009 COMMERCE PARK DRIVE • SUITE 100 • OAK RIDGE, TN 37830 • 615-481-0002

8-25-93
OAK-7-0074-0000

APPENDIX III
TYPED LOGS OF BORINGS

**Subsurface Investigation and Environmental Sampling
Ammonium Nitrate Study
Y-12 Plant
Oak Ridge, Tennessee
Ogden File No. 0-4267-0074**

LOG OF SOIL BORING

Sheet 1 of 4

HOLE NO. B-1PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 53.2 FL. ELEV. 927.5PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 53.2 FL. ELEV. 927.5BORING LOCATION: N 28,499
E 61,702AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/05/93WATER FIRST ENCOUNTERED: DRY FL. DEEDATE COMPLETED: 08/06/93BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON
(Date)GROUND SURFACE 980.7 ☒ MSL, FL.
ELEVATION: ☐ ASSUMED, FL.DRILLER: CREWS HELPER: SCOTT RIG: TRUCK MOUNTED

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
Auger	0.0	1.0		0.0' - 0.2' Asphalt. 0.2' - 1.0' Crushed stone (fill).
1	1.0	3.0	7-5-12-12	1.0' - 2.7' Crushed stone and Silt, clayey, dark brown with rock fragments and wood (firm to stiff, fill). 2.7' - 3.0' Clay, silty, reddish-brown with rock fragments (very stiff, fill). SAMPLE HAD AN AMMONIA SMELL.
2	3.0	4.5	3-5-4	Clay, silty, sandy, reddish-brown, mottled black and tan with numerous rock fragments (stiff to very stiff, fill). SAMPLE HAD AN AMMONIA SMELL.
3	4.5	6.5	1-2-1-1	Crushed stone and Silt, very sandy, dark gray and black (fill). SAMPLE HAD AN AMMONIA SMELL.
4	6.5	8.5	1-1-1-1	Sand, black with a few rock fragments (fill). SAMPLE HAD A STRONG AMMONIA SMELL.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT
BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-8002Nashville, TN
1-615/333-0630

MOSES LOGS/7 (AMMONIUM LOG) on 08/24/93 16:43

LOG OF SOIL BORING

Sheet 2 of 4

HOLE NO. B-1 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 53.2 Ft. ELEV. 927.5PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 53.2 Ft. ELEV. 927.5BORING LOCATION: N 28.499AUGERED: ☒ WASHBORED: ☐E 61.702CASING ADVANCER: ☐DATE STARTED: 08/05/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/06/93WATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEPBORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER AT FEET DEEP ON (Date)GROUND SURFACE 980.7 ☒ MSL, Ft.ELEVATION: ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: TRUCK MOUNTED

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
5	8.5	10.5	1-1-1-1	Sand, black with a few rock fragments (fill). SAMPLE HAD A STRONG AMMONIA SMELL.
6	10.5	12.5	1-1-1-1	Sand, black with a few rock fragments (fill). SAMPLE HAD A STRONG AMMONIA SMELL.
7	12.5	14.5	1-1-1-1	Sand, black with a few rock fragments (fill). SAMPLE HAD A STRONG AMMONIA SMELL.
8	14.5	16.5	1/1.8' and 1/1.8'	14.5' - 15.0' Sand, black with a few rock fragments (fill). 15.0' - 15.7' Clay, silty, grayish-brown, very moist (very soft to soft, fill). 15.7' - 16.5' Clay, silty, reddish-brown with chert fragments (firm to stiff, fill). SAMPLE HAD A STRONG AMMONIA SMELL.
9	16.5	18.5	1-3-3-5	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (stiff, natural). SAMPLE HAD A STRONG AMMONIA SMELL.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-8082Nashville, TN
1-615/333-0430

MO465 LOGS/7 (AMMONIUM.LOG) 08/24/93 16:43

LOG OF SOIL BORING

Sheet 2 of 4

HOLE NO. B-1 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 53.2 Ft. ELEV. 927.5PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 53.2 Ft. ELEV. 927.5BORING LOCATION: N 28.499
E 61.702AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/05/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/06/93WATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON (Time)BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDGROUND SURFACE 989.7 ☒ MSL, Ft.
ELEVATION: ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: TRUCK MOUNTED

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
10	18.5	20.5	2-4-5-7	Clay, silty, reddish-brown with some chert fragments (stiff to very stiff).
11	20.5	22.5	3-4-5-6	Clay, silty, reddish-brown with chert fragments and sandstone fragments (firm to very stiff).
12	22.5	24.5	1-1-3-3	Clay, silty, reddish-brown, mottled tan (stiff).
13	24.5	26.5	1-3-6-8	Clay, silty, reddish-brown, mottled tan (stiff).
14	26.5	28.5	5-5-4-3	Clay, silty, reddish-brown with numerous chert fragments (firm).
15	28.5	30.5	1-1-1-5	Clay, silty, reddish-brown, mottled tan with rock fragments (soft to firm).
16	30.5	32.5	1-2-3-5	Clay, silty, reddish-brown, mottled tan with rock fragments, very moist (soft to firm).
17	32.5	34.0	2-2-1	Clay, silty, reddish-brown, mottled tan with rock fragments (soft).

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATSOak Ridge, TN
1-615/481-8062Nashville, TN
1-615/333-0630

MOSES LOGS/7 (AMMONIUM.LOG) 08/24/93 16:02

LOG OF SOIL BORING

Sheet 4 of 4

HOLE NO. B-1 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 53.2 Ft. ELEV. 927.5PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 53.2 Ft. ELEV. 927.5BORING LOCATION: N 28.499
E 61.702AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/05/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/06/93BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT _____ FEET DEEP ON _____
(Time)GROUND SURFACE 988.7 ☒ MSL, Ft.
ELEVATION: _____ ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: TRUCK MOUNTED

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
18	34.0	36.0	1-3-1-1	Clay, silty, reddish-brown with rock fragments, very moist (very soft to soft).
19	36.0	38.0	1-2-1-1	Clay, silty, reddish-brown with rock fragments, very moist (soft to firm).
20	38.0	40.0	1/1.0' and 1-1	Clay, silty, reddish-brown with rock fragments (very soft to soft).
21	40.0	40.1	15/0.1'	Sandstone, fine-grained, white.
Auger	40.1	46.8		At 43.0' the split-spoon dropped to 46.8'. (Possibly a 3.8' subsurface void.)
22	46.8	48.8	weight of hammer	Clay, silty, reddish-brown with rock fragments, wet (very soft). (Possibly groundwater, but not conclusive).
Auger	48.8	53.2		Augers leading at 52.5'.
		53.2		Auger refusal.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATSOak Ridge, TN
1-615/481-8002Nashville, TN
1-615/333-0630

MINES LOGS/7 (AMMONIUM LOG) on 08/24/93 16:43

LOG OF SOIL BORING

Sheet 1 of 5

HOLE NO. B-2PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 42.2 Ft. ELEV. 937.9PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 42.2 Ft. ELEV. 937.9BORING LOCATION: N 28.583
E 61.677AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/10/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/10/93

WATER LEVEL IN BORING UPON

BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDCOMPLETION: DRY FEET DEEPGROUND SURFACE 938.1 ☒ MSL, Ft.
ELEVATION: ☐ ASSUMED, Ft.WATER AT FEET DEEP ON (Time)DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
1	0.0	2.0	3-5-8-8	0.0' - 0.2' Topsoil. 0.2' - 2.0' Crushed stone and Clay, silty, sandy, dark brown with wood (firm to stiff, fill).
2	2.0	4.0	11-8-11-9	Clay, silty, gray and reddish-brown, mottled brown, with numerous weathered shale fragments and a few wood chips (very stiff, fill). SAMPLE HAD A STRONG AMMONIA SMELL.
3	4.0	6.0	6-6-11-9	Clay, silty, dark brown, mottled gray with numerous rock fragments and a few wood chips (stiff, fill). SAMPLE HAD A STRONG AMMONIA SMELL.
4	6.0	8.0	3-3-3-3	6.0' - 7.5' Clay, silty, sandy, brown, reddish-brown and gray with wood and rock fragments (stiff, fill). 7.5' - 8.0' Sand, black (fill). SAMPLE HAD A VERY STRONG AMMONIA SMELL.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-415/481-9002Nashville, TN
1-615/333-0630

MMES LOGS/7 (AMMONIUM.LOG) = 08/24/93 16:43

LOG OF SOIL BORING

Sheet 2 of 5

HOLE NO. B-2 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 42.2 Ft. ELEV. 937.9PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 42.2 Ft. ELEV. 937.9BORING LOCATION: N 28.503
E 61.677AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/10/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/19/93BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT _____ FEET DEEP ON _____GROUND SURFACE 980.1 ☒ MSL, Ft.
ELEVATION: _____ ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
5	8.0	10.0	2-1-1-1	8.0' - 9.9' Sand, black (fill). 9.9' - 10.0' Clay, silty, sandy, reddish-brown, mottled brown and black with roots and rock fragments (stiff, fill). SAMPLE HAD A VERY STRONG AMMONIA SMELL.
6	10.0	10.8	8-50/0.3'	Clay, silty, sandy, reddish-brown, mottled brown and black with roots and rock fragments (stiff, fill). SAMPLE HAD A VERY STRONG AMMONIA SMELL.
Auger	10.8	12.0		Probably same as above.
7	12.0	14.0	5-5-5-7	Clay, silty, slightly sandy, reddish-brown and brown mottled black with roots and rock fragments (stiff, fill). SAMPLE HAD A VERY STRONG AMMONIA SMELL.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 7" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-4002Nashville, TN
1-615/333-0630

MMES LOGS/7 (AMMONIUM)LOG on 08/24/93 16:43

LOG OF SOIL BORING

Sheet 3 of 5

HOLE NO. B-2 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 42.2 Ft. ELEV. 937.9PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 42.2 Ft. ELEV. 937.9BORING LOCATION: N 28.503
E 61.677AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/10/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/10/93WATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEPBORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER AT _____ FEET DEEP ON _____
(Dew)GROUND SURFACE 980.1 ☒ MSL, Ft.
ELEVATION: _____ ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
8	14.0	16.0	5-5-6-7	14.0' - 15.4' Clay, silty, slightly sandy, reddish-brown and brown, mottled black with roots and rock fragments (stiff, fill). 15.4' - 15.5' Sandstone fragments, coarse-grained (fill). 15.5' - 16.0' Clay, silty, reddish-brown, mottled tan with rock fragments (stiff, fill). SAMPLE HAD A VERY STRONG AMMONIA SMELL.
9	16.0	18.0	2-2-1-1	16.0' - 16.4' Clay, silty, brown, mottled reddish-brown with rock fragments (firm, fill). 16.4' - 17.0' Sand, black (fill). 17.0' - 17.2' Clay, silty, brown and reddish-brown with rock fragments (stiff, fill). 17.2' - 17.7' Sand, black (fill). 17.7' - 18.0' Clay, silty, reddish-brown with chert fragments (stiff, natural). SAMPLE HAD A VERY STRONG AMMONIA SMELL.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-4002Nashville, TN
1-615/333-0630

NMES LOGS/7 (AMMONIUM)LOG on 08/24/93 16:47

LOG OF SOIL BORING

Sheet 4 of 5

HOLE NO. B-2 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 42.2 Ft. ELEV. 937.9PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 42.2 Ft. ELEV. 937.9BORING LOCATION: N 28.503E 61.677AUGERED: ☒ WASHBORED: ☐CASING ADVANCER: ☐DATE STARTED: 08/10/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/10/93

WATER LEVEL IN BORING UPON

BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDCOMPLETION: DRY FEET DEEP

WATER AT _____ FEET DEEP ON _____

GROUND SURFACE 980.1 ☒ MSL, Ft.ELEVATION: _____ ☐ ASSUMED, Ft.DRILLER: CREWSHELPER: SCOTTRIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
10	18.0	20.0	5-5-7-9	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (stiff). SAMPLE HAD A STRONG AMMONIA SMELL.
11	20.0	22.0	11-11-12-17	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (very stiff). SAMPLE HAD AN AMMONIA SMELL.
12	22.0	24.0	7-11-15-17	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (very stiff).
13	24.0	26.0	8-10-12-14	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (very stiff).
14	26.0	28.0	7-10-13-14	Clay, silty, reddish-brown with numerous chert fragments and sandstone fragments (stiff).
15	28.0	30.0	5-6-7-9	Clay, silty, reddish-brown, mottled gray and black with a few chert fragments, very moist (firm).
16	30.0	32.0	8-12-15-17	Clay, silty, reddish-brown, mottled tan with chert fragments (stiff).

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATSOak Ridge, TN
1-615/481-9002Nashville, TN
1-615/333-0630

MMES LOGS/7 (AMMONIUM) LOG 08/24/93 16:43

LOG OF SOIL BORING

Sheet 5 of 5

HOLE NO. B-2 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 42.2 Ft. ELEV. 937.9PROJECT NO.: 0-4267-0874REFUSAL DEPTH: 42.2 Ft. ELEV. 937.9BORING LOCATION: N 28.503
E 61.677AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/19/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/10/93BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON (Dm)GROUND SURFACE 980.1 ☒ MSI, Ft.
ELEVATION: ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
Auger	32.0	37.0		Probably same as below.
17	37.0	39.0	5-8-31-10	Clay, silty, brown mottled tan with numerous rock fragments (stiff).
Auger	39.0	42.0		Probably same as above.
18	42.0	42.1	50/0.1'	Rock fragments.
Auger	42.1	42.2		Rough drilling.
		42.2		Auger refusal.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATSOak Ridge, TN
1-615/481-8062Nashville, TN
1-615/333-0630

MNTS LOGS/7 (AMMONIUM.LOG) on 08/24/93 16:43

LOG OF SOIL BORING

Sheet 1 of 1

HOLE NO. B-3PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 36.1 FL. ELEV. 941.6PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 36.1 FL. ELEV. 941.6BORING LOCATION: N 28.519
E 61.760AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/09/93WATER FIRST ENCOUNTERED: DRY FL. DEEPDATE COMPLETED: 08/10/93BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATEDWATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON (Date)GROUND SURFACE 977.7 ☒ MSL, Ft.
ELEVATION: ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
Auger	0.0	1.0		0.0' - 0.2' Asphalt. 0.2' - 1.0' Crushed stone (fill).
1	1.0	3.0	5-8-6-7	Crushed stone and Clay, silty, slightly sandy, reddish-brown, mottled brown with rock fragments (stiff, fill).
2	3.0	5.0	2-2-2-3	Clay, silty, reddish-brown and brown with numerous rock fragments (stiff, fill).
3	5.0	7.0	1-2-2-3	5.0' - 6.5' Clay, silty, brown, mottled reddish-brown with rock fragments (firm, fill). 6.5' - 7.0' Sand, black (fill).
4	7.0	9.0	2-1-1-1	Sand, black (fill).
5	9.0	11.0	1-1-1-2	Sand, black with a few rock fragments (fill).
6	11.0	13.0	1-2-2-1	Sand, black with a few rock fragments (fill).

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-8002Nashville, TN
1-615/333-0630

MOBIS LOGS/7 (AMMONIUM LOG) on 08/24/93 10:43

LOG OF SOIL BORING

Sheet 2 of 3

HOLE NO. B-3 (Continued)

PROJECT: AMMONIUM NITRATE STUDYTOTAL DEPTH: 36.1 Ft. ELEV. 941.6PROJECT NO.: 0-4267-0074REFUSAL DEPTH: 36.1 Ft. ELEV. 941.6BORING LOCATION: N 28.519
E 61.760AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐DATE STARTED: 08/09/93WATER FIRST ENCOUNTERED: DRY Ft. DEEPDATE COMPLETED: 08/10/93WATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON GROUND SURFACE 977.7 ☒ MSL, Ft.
ELEVATION: ☐ ASSUMED, Ft.DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
7	13.0	15.0	1-1-1-1	Sand, black with a few rock fragments (fill).
8	15.0	17.0	1-1-1-1	Sand, black with a few rock fragments (fill).
9	17.0	19.0	2-1-1-4	17.0' - 18.1' Sand, black with a few rock fragments (fill). 18.1' - 19.0' Clay, silty, brown, with a few rock fragments (firm, fill).
10	19.0	21.0	3-9-9-10	Clay, silty, reddish-brown with numerous rock fragments (stiff, natural).
11	21.0	23.0	4-4-4-5	Clay, silty, reddish-brown with numerous rock fragments (stiff).
12	23.0	25.0	2-4-5-4	Clay, silty, reddish-brown, mottled black and light gray with rock fragments (stiff).
13	25.0	27.0	2-5-10-9	Clay, silty, reddish-brown, mottled black and tan with rock fragments (stiff).

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATSOak Ridge, TN
1-615/481-8002Nashville, TN
1-615/333-0636

MMES LOGS/7 (AMMONIUM LOG) on 08/24/93 16:43

LOG OF SOIL BORING

Sheet 3 of 3

HOLE NO. B-3 (Continued)

PROJECT: AMMONIUM NITRATE STUDY

TOTAL DEPTH: 36.1 Ft. ELEV. 941.6

PROJECT NO.: 0-4267-0074

REFUSAL DEPTH: 36.1 Ft. ELEV. 941.6

BORING LOCATION: N 28.519
E 61.760

AUGERED: ☒ WASHBORED: ☐
CASING ADVANCER: ☐

DATE STARTED: 08/09/93

WATER FIRST ENCOUNTERED: DRY Ft. DEEP

DATE COMPLETED: 08/10/93

BORING ELEVATION: ☒ SURVEYED; ☐ ESTIMATED

WATER LEVEL IN BORING UPON
COMPLETION: DRY FEET DEEP
WATER AT FEET DEEP ON (Date)

GROUND SURFACE 977.7 ☒ MSL, Ft.
ELEVATION: ☐ ASSUMED, Ft.

DRILLER: CREWS HELPER: SCOTT RIG: ATV (CME-550)

SPT SAMPLE NUMBER	FROM	TO	SPT BLOWS*/OR ST RECOVERY**	DESCRIPTION AND REMARKS
14	27.0	29.0	4-4-5-6	Clay, silty, reddish-brown, mottled black and tan with rock fragments (stiff).
Auger	29.0	35.0		Probably same as above.
15	35.0	35.4	50/0.4'	Silt, slightly sandy, gray, with a few rock fragments (hard).
Auger	35.4	36.1		Probably same as above.
		36.1		Auger refusal.

*STANDARD PENETRATION TEST-NUMBER OF BLOWS PER 6" INTERVAL TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES (ASTM D 1586).

**ST = SHELBY TUBE SAMPLE (ASTM D 1587)

GATS

Oak Ridge, TN
1-615/481-4082

Nashville, TN
1-615/333-0630

MMR 1002/7 (AMMONIUM LOG) on 08/24/93 16:42

APPENDIX IV
PIEZOMETER CROSS-SECTIONS

Subsurface Investigation and Environmental Sampling
Ammonium Nitrate Study
Y-12 Plant
Oak Ridge, Tennessee
Ogden File No. 0-4267-0074

MONITORING WELL CONSTRUCTION LOG - TEMPORARY WELL

REV. 9/92

Well No.: MW-1

Facility: MMES - Y-12 PLANT

ID # NA

Project No.: 0-4267-0074

Project: AMMONIUM NITRATE STUDY

Logged By: TERRY M. HARMS

Drilling Contractor: OGDEN

Comp. Start: 8-6-93

Comp. End: 8-10-93

Built By: JEFF CREWS / ERIC SCOTT

Well Coord.: N28,499 E61,702

Top of Casing Elev. (Ft. MSL): NA

FLUSH MOUNT VAULT

Material: NA

Diameter: NA

Water Tight Seal: NA

Depth BGS: NA

GUARD POSTS No: NA Type: NA

SURFACE COMPLETION

Composition: NA

RISER PIPE

Type: SCH 40 PVC Diameter: 2.0" ID

GROUT

Compositions: CEMENT W/5% BENTONITE

Amount Used: APPROX. 1 CU. FT.

Tremied: (N)

CENTRALIZERS

Depth(s): NA

SEAL

Type: 3/8" BENTONITE PELLETS

Source: BAROID - HOUSTON, TX

Tremied: (N)

Setup/Hydration time: 1 HR.

Vol. Fluid Added: 2 GAL

FILTER PACK

Type: SILICA SAND

Amount Used: 400 lbs.

Tremied: (N)

Source: DSI-KNOXVILLE, TN Gr. Size Dist.: 12-20

SCREEN

Type: SCH 40 PVC Diameter: 2.0" ID

Slot Size & Type: 0.010" FACTORY MILLED

SILT TRAP

Type: NA

Bottom Cap: (Y)

BACKFILL PLUG

Material: 3/8" BENTONITE PELLETS

Setup/Hydration time: NA

Tremied: (N)

NOTES:

WELL SET THROUGH AUGERS.

BORING BACKFILLED WITH BENTONITE FROM

17.4 FEET TO 53.2 FEET.

NOTE: ALL DEPTHS ARE
MEASURED FROM GROUND
SURFACE

NOT TO SCALE

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

1001 COMMERCE PARK DRIVE

ONE ROCK, TN 37020

615-461-6002

MONITORING WELL CONSTRUCTION LOG - TEMPORARY WELL

REV. 9/92

Well No.: MW-3

Facility: MMS - Y-12 PLANT

ID / NA

Project No.: 0-4267-0074

Project: AMMONIUM NITRATE STUDY

Logged By: TERRY M. HARMS

Drilling Contractor: OGDEN

Comp. Start: 8-9-93

Comp. End: 8-10-93

Built By: JEFF CREWS / ERIC SCOTT

Well Coord.: N28,519 E61,760

Top of Casing Elev. (Fl. MSL): NA

NOTE: ALL DEPTHS ARE
MEASURED FROM GROUND
SURFACE

FLUSH MOUNT VAULT

Material: NA

Diameter: NA

Water Tight Seal: NA

Depth BGS: NA

GUARD POSTS

No: NA

Type: NA

SURFACE COMPLETION

Composition: NA

RISER PIPE

Type:

SCH 40 PVC

Diameter: 2.0" ID

GROUT

Compositions: CEMENT W/5% BENTONITE

Amount Used: APPROX. 8.0 CU. FT.

Tremied: (Y)

CENTRALIZERS

Depth(s): NA

SEAL

Type: 3/8" BENTONITE PELLETS

Source: BAROID - HOUSTON, TX.

Tremied: (N)

Setup/Hydration time: 1 HR.

Vol. Fluid Added: 2 GAL.

FILTER PACK

Type: SILICA SAND

Amount Used: 500 lbs.

Tremied: (N)

Source: DSI-KNOXVILLE, TN.

Gr. Size Dist.: 12-20

SCREEN

Type:

SCH 40 PVC

Diameter: 2.0" ID

Slot Size & Type: 0.010" FACTORY MILLED

SILT TRAP

Type: NA

Bottom Cap: (Y)

BACKFILL PLUG

Material: 3/8" BENTONITE PELLETS

Setup/Hydration time: NA

Tremied: NA

NOTES:

WELL SET THROUGH AUGERS.

BORING BACKFILLED WITH GROUT FROM

18.2 FEET TO 36.1 FEET.

NOT TO SCALE

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

1009 CONVERSE PARK DRIVE

DAN RIDGE, TN 37830

615-481-8002

**STUDY OF
AMMONIA AND NITRATE CONTAMINATION
OF OUTFALL 17 AT THE Y-12 PLANT**

under
P.O. Number 17B-99987V K23

for
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee 37831

for the
U.S. Department of Energy
under Contract No. DE-AC05-84OR21400

September 17, 1993

Environmental Consulting Engineers, Inc.

P.O. Box 22668
Knoxville, TN 37933
(615) 691-3668
(615) 691-0611 FAX

**STUDY OF
AMMONIA AND NITRATE CONTAMINATION
OF OUTFALL 17 AT THE Y-12 PLANT**

by

Robert E. Yager
Environmental Consulting Engineers, Inc.
P.O. Box 22668
Knoxville, Tennessee 37831

under

P.O. Number 17B-99987V K23

for

Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee 37831

for the

U.S. Department of Energy
under Contract No. DE-AC05-84OR21400

September 17, 1993

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ACRONYMS

ATDL	Atmospheric Turbulence and Diffusion Laboratory
DOE	Department of Energy
EFPC	East Fork Poplar Creek
MMES	Martin Marietta Energy Systems
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
ORR	Oak Ridge Reservation
TDEC	Tennessee Department of Environment and Conservation

1. INTRODUCTION

East Fork Poplar Creek (EFPC) drains the Y-12 plant, operated by Martin Marietta Energy Systems (MMES), on the Department of Energy (DOE) Oak Ridge Reservation (ORR) (Figure 1). The creek runs generally from west to east through Y-12 as shown in Figure 2 and leaves the plant through Lake Reality. EFPC within Y-12 is fed by local runoff, groundwater and spring discharge, and point discharges from industrial operations in the plant. In late December, 1992 and again in late February, 1993 fish kills were observed in the creek near National Pollutant Discharge Elimination System (NPDES) Outfall 17, a small spring at the base of the north slope of East Chestnut Ridge. After the spring flows from the bedrock, it is routed through an 18 inch concrete pipe to discharge into EFPC.

Analysis of water samples collected from the spring indicated elevated levels of ammonia and nitrate. The apparent source of these contaminants was a urea pile, commonly used in road deicing, adjacent to the East Patrol Road about 60 feet above the spring. Urea in the soil is transformed by soil microbes into ammonia (NH_3) and ammonium (NH_4^+) which are then further transformed into nitrites (NO_2^-) and nitrates (NO_3^-). The urea pile was removed to a covered area immediately after the discovery of the elevated ammonia concentration at Outfall 17.

Figure 1. Oak Ridge Reservation showing location of Y-12.

Figure 2. Location of study area in Y-12.

2. EXISTING DATA

After the December fish kill, Outfall 17 was intensively monitored by Y-12 personnel for nitrate and ammonia until January 8 and since then a schedule of approximately weekly grab samples has been in place (Barrett, 1993). In addition to the samples from the spring, duplicate samples were collected from EFPC above and below Outfall 17 on March 26. One set of these samples was analyzed for ammonia at the Y-12 Environmental Laboratory and the second set at the Tennessee Department of Environment and Conservation (TDEC) laboratory in Nashville. Results of these analyses are reported in Section 4.

3. CURRENT WORK

The next phase of the investigation was designed to better define the extent of the problem through a more intensive study of the source area, the spring, EFPC and the area between the source area and Outfall 17.

3.1 BOREHOLES

Between August 5 and 10, 1993, three boreholes were drilled to auger refusal near the site of the former urea pile (OGDEN 1993). Continuous split spoon sampling was performed to determine the lithology of the area and selected soil samples were analyzed to determine the vertical profile of ammonia and nitrate concentration. Detailed narrative drilling logs are included in the report by OGDEN and graphical logs are shown in Figures 3, 4 and 5. The locations of the boreholes are shown in Figure 6.

Hole B-1 was drilled to a total depth of 53.2 ft. before auger refusal. Several inches of asphalt were encountered and then clayey silt fill to a depth of 6.5 ft. From about 2.5 to 6.5 ft. there was an ammonia smell which became progressively stronger with depth. From 6.5 to 15.0 ft. the fill consisted of black sand which also had a strong smell of ammonia. The fill from 15.0 to 16.5 ft. consisted of silt, clay and rock fragments with a strong ammonia smell and the original ground surface was encountered at 16.5 ft. The ammonia smell extended into the original clay soil for no more than 2 ft. The native clay extended to auger refusal at 53.2 ft. with an apparent void from 43.0 to 46.8 feet. The groundwater table was not encountered in any of the three borings.

Holes B-2 and B-3 revealed the same general pattern of fill and original soil except that the depths of each layer varied. B-2 had clay/silt fill to a depth of 7.5 ft, black sand from 7.5 to 9.9 ft, clay/silt fill from 9.9 to 17.7 ft and original clay soil from 17.7 ft. to auger refusal at 42.2 ft. There was a strong ammonia smell from approximately 2.0 to 20.0 ft. with the smell decreasing rapidly in the lower clay. B-3 showed silt/clay fill from the surface to 6.5 ft, black sand from 6.5 to 18.1 ft., silt/clay fill from 18.1 to 19.0 ft., and original clay from 19.0 ft to auger refusal at 36.1 ft. No ammonia smell was found in any of the samples from B-3.

Figure 7 shows a conceptual lithologic cross section through Section A-A' in Figure 6. A sample from each split spoon from B-1 and selected samples from B-2 and B-3 were analyzed for ammonia as nitrogen and nitrate as nitrogen. The analytical results from the samples from B-1 indicated that ammonia and nitrate were present in the various layers of fill but extended no more than a few feet into the original soil. Samples from B-2 and B-3 were selected for analysis to confirm or refute this conclusion. The results of these analyses are listed in Table 1 and shown in Figure 8 in the approximate locations of the samples from each borehole.

Figure 3. Graphical log of borehole B-1 showing piezometer construction (Source: OGDEN).

Figure 4. Graphical log of borehole B-2 (Source: OGDEN).

Figure 5. Graphical log of borehole B-3 showing piezometer construction (Source: OGDEN).

Figure 6. Site plan of study area showing soil sampling locations.

3.2 PIEZOMETER INSTALLATION

Piezometers were installed in boreholes B-1 and B-3 as shown in Figures 3 and 5. The bottom of the screened interval of each piezometer was placed at the top of the original ground surface to detect a possible perched water table during wet weather. An unscreened section extended into the original clay layer so that a temporary perched water table or interflow through the fill could be detected after the fact by finding water in the lowest unscreened section. As of August 20, 1993 no water was found in either piezometer.

Table 1. Analytical results from soil samples from boreholes B-1, B-2, and B-3

B-1			B-2			B-3		
Depth Below Ground Surface	NH ₃ (mg/l)	NO ₃ (mg/l)	Depth Below Ground Surface	NH ₃ (mg/l)	NO ₃ (mg/l)	Depth Below Ground Surface	NH ₃ (mg/l)	NO ₃ (mg/l)
0.0 - 1.0	1.9	3.9	2.0 - 4.0	565	67	1.0 - 3.0	< 1.0	64
1.0 - 3.0	259	73	8.0 - 10.0	1989	70	7.0 - 9.0	< 1.0	61
3.0 - 4.5	881	51	12.0 - 14.0	8005	24	15.0 - 17.0	108	402
4.5 - 6.5	349	30	16.0 - 18.0	9152	29	21.0 - 23.0	24	71
6.5 - 8.5	676	93	18.0 - 20.0	8878	39	35.0 - 35.4	< 1.0	26
8.5 - 10.5	695	145	22.0 - 24.0	1194	51			
10.5 - 12.5	966	173	26.0 - 28.0	< 1.0	8.1			
12.5 - 14.5	1288	144	37.0 - 39.0	4.3	19			
14.5 - 16.5	1985	136						
16.5 - 18.5	1495	35						
18.5 - 20.5	41	11						
20.5 - 22.5	< 1.0	7.9						
22.5 - 24.5	< 1.0	7.2						
24.5 - 26.5	< 1.0	6.8						
26.5 - 28.5	< 1.0	5.9						
28.5 - 30.5	< 1.0	6.8						
30.5 - 32.5	< 1.0	5.7						
32.5 - 34.0	< 1.0	6.1						
34.0 - 36.0	< 1.0	5.7						
36.0 - 38.0	< 1.0	13						
38.0 - 40.0	< 1.0	13						
40.0 - 40.1	< 1.0	29						
46.8 - 48.8	< 1.0	111

Figure 7. Conceptual lithologic cross section of the study site.

Figure 8. Results of ammonia/nitrate analysis of soil samples (mg/l) in approximate locations in boreholes B-1, B-2 and B-3.

3.3 HAND EXCAVATIONS

At the locations labeled H-1 through H-14 in Figure 6 holes were dug to a depth of 16-18 inches and a soil sample was collected from the bottom of the hole. These locations are at or near the toe of the fill and were chosen to help determine whether spring contamination during and after heavy precipitation may be caused by surface flow transporting ammonia and nitrate from the source area. The samples were analyzed for ammonia and nitrate by mixing 85 grams of soil with 150 ml of deionized water and using an ion specific electrode to analyze a 25 ml aliquot of the water for ammonia and another aliquot for nitrate. All the ammonia analyses indicated concentrations less than 1.0 mg/l. All the nitrate concentrations were less than 5.0 mg/l except for site H-1 which was 13.0 mg/l and site H-5. The analysis for site H-5 indicated a level too high to display. For this analysis technique, there are several interferences with nitrate measurements which could have been present and it is not clear whether this result indicates a real, high nitrate concentration or a false positive.

3.4 SPRING AND STREAM SAMPLING

In addition to the sampling program undertaken by Y-12 personnel, water samples were collected from the spring and from points in EFPC approximately 50 ft upstream and 500 ft downstream. They were analyzed for ammonia and nitrate using an ion specific electrode. Flow rate in the spring was measured at the outfall from the concrete culvert into EFPC by bucket gaging. The results of these measurements are given in Table 2.

Table 2. Analytical results from water samples collected in this study

Date	Location	Ammonia (mg/l)	Nitrate (mg/l)	Flow (gps)
07/19/93	Spring	28.5	13.5	0.17
07/28/93	Spring	28.5	12.5	0.13
07/30/93	Spring	27.6	11.4	NM
08/10/93	Spring	25.5	12.2	0.11
08/10/93	Upstream of Spring	< 0.1	5.2	NM
08/10/93	Downstream of Spring	< 0.1	5.4	NM

NM - Not Measured

4. RESULTS AND CONCLUSIONS

Table 3 gives results of the analysis of grab samples collected at Outfall 17 by Y-12 personnel. Figure 9 displays these results graphically along with daily precipitation at the Atmospheric Turbulence and Diffusion Laboratory (ATDL) of the National Oceanic and Atmospheric Administration (NOAA) (Jess Wynn personal communication). ATDL is located approximately one mile north of Outfall 17. These data indicate a strong correlation between significant rainfall events and elevated ammonia and nitrate concentrations in Outfall 17. The time delay between precipitation and high concentrations cannot be determined precisely since water samples were collected at approximately weekly intervals. It can be inferred, however, that elevated levels of ammonia and nitrate in the spring occur within 3 days of heavy rainfall and may continue for more than a week. It should be noted that the data shown were collected during the winter and early spring when the soil is normally wet. A larger rainfall event may be necessary to observe this effect in the summer when there is more vegetation, the soil is normally drier, and less rainfall infiltrates the soil.

The time delay between precipitation and ammonia/nitrate arriving at the spring suggests that the transport from the source area is subsurface, as surface runoff would cease within a few hours on this small, steep watershed. This conclusion, coupled with the results of the drilling program, leads to a conceptual flow model shown in Figure 10. During heavy precipitation, especially during the winter, water infiltrates the contaminated fill dissolving ammonia and nitrate. This contaminated water flows downward to the original clay ground surface where the large decrease in hydraulic conductivity causes lateral flow along the interface between the fill and the natural clay. This flow then reaches groundwater through areas of macroporosity in the clay, rock outcrops or other vertical conduits and subsequently flows to the spring.

The elevated levels of nitrate in the hand excavated locations H-1 and H-5 indicate that there may be some contamination by surface runoff or by infiltrated water exiting the toe of the fill. The lack of ammonia at these points, however, suggests that this is not the dominant pathway to Outfall 17 and that lateral flow of infiltrated rainfall is the principal source of contamination in the spring.

Table 4 presents the results of analysis of samples collected by Y-12 personnel on March 26, 1993 and Table 2 the results of samples collected during this study. These data can be used to test whether the spring is the only or even the major source of stream contamination. If the spring water is well mixed at the downstream sampling point in Table 4 and the spring is the only source of water and ammonia between the upstream and downstream sampling points the following mass balance equation must be satisfied.

$$C_{Down} Q_{Down} = C_{Up} Q_{Up} + C_{Spring} Q_{Spring}$$

where C = concentration of ammonia

Q = flow rate

$$Q_{Down} = Q_{Up} + Q_{Spring}$$

Using the data from Table 4 for the samples analyzed by MMES and solving for Q_{up} yields $Q_{up} = 0.45$ cfs. Solving the same equation using the TDEC results gives $Q_{up} = 0.30$ cfs. Since the flow in EFPC is estimated to be at least 5 cfs (37.4 gpm), these results indicate that no more than approximately 10% of the ammonia added to EFPC between the upstream and downstream sampling points is from Outfall 17. Unfortunately, the assumption that the spring water is well mixed with EFPC at the downstream sampling location is not well founded since the sample was taken only about 7 to 10 ft downstream from the outfall.

Using the data from Table 2, the mass balance equation gives $Q_{up} = 0.5$ cfs. In this case, the spring water should have been well mixed with EFPC, but the small difference between C_{up} and C_{down} combined with the precision of the chemical analysis makes this calculation suspect as well. It is unclear, then, whether the spring at Outfall 17 is the primary contributor of ammonia and nitrate to EFPC or whether there is significant contaminated groundwater recharge distributed along the creek downstream of the outfall.

Table 3. Analytical results from water samples collected by Y-12 personnel at Outfall 17

Date	Ammonia (mg/l)	Nitrate (mg/l)
12/27/92	200	NA
12/30/92	100	17.0
12/31/92	89	19.0
01/01/93	83	18.0
01/02/93	70	16.0
01/03/93	71	16.0
01/04/93	56	16.0
01/05/93	43	12.0
01/06/93	43	12.0
01/07/93	45	10.0
01/08/93	51	11.0
01/25/93	48	14.0
02/05/93	71	19.0
02/12/93	32	15.0
02/19/93	25	10.0
02/24/93	220	36.0
03/05/93	84	15.0
03/19/93	18	9.5
03/26/93	140	28.0
04/08/93	25	7.2

NA - Not Analyzed

Figure 9. Daily rainfall at ATDL and ammonia and nitrate concentration in Outfall 17.

Table 4. Concentration of ammonia (mg/l) in duplicate water samples collected in EFPC and Outfall 17 on 3/26/93

Laboratory	Outfall 17	Upstream of Outfall 17	Downstream of Outfall 17	Flow at Outfall 17 (gps) \
Y-12	140	0.27	43	1.50
TDEC	151	0.04	61	1.50

Figure 10. Conceptual hydrologic model of the study site.

5. SUMMARY

5.1 CURRENT CONDITIONS

Urea was stored in an open pile adjacent to the East Patrol Road for an unknown period of time. During December, 1992 and February, 1993 fish kills were observed in EFPC near Outfall 17, a spring at the base of East Chestnut Ridge. The urea pile was removed to a covered location in late December, 1992 but elevated levels of ammonia and nitrate have continued to occur in Outfall 17 following periods of heavy rainfall. Analysis of soil samples collected from boreholes in the vicinity of the former urea pile revealed high concentrations of ammonia and nitrate in the soil, particularly in a layer of black sandy fill material below the surface layer of clay and silt and above the original ground surface.

The current conceptual hydrologic model of the site is that heavy rainfall during wet weather infiltrates the site of the former urea pile. This water dissolves ammonia and nitrate and then flows laterally when it reaches the original ground surface. This contaminated infiltrated water reaches the groundwater which discharges through the spring at Outfall 17. Whether Outfall 17 is the only discharge point or there is additional distributed contaminated discharge along the creek is unknown.

5.2 MITIGATION OF PROBLEM

There are at least two possible approaches to mitigating the problem and minimizing or eliminating future fish kills in EFPC.

5.2.1 Treating Outfall 17

In order to effect an immediate solution to the problem of elevated levels of ammonia and nitrate in Outfall 17, the spring water may be treated before discharging it into EFPC. A preliminary engineering study of treatment options has been completed (Dewayne Foust, personal communication). There are two problems with this approach. Due to the lack of reliable data in EFPC during periods of high levels of ammonia and nitrate in the spring, it is not known whether significant quantities of contaminants are entering EFPC at locations other than Outfall 17. The second problem with this approach is that the source is expected to remain in place for an extended period of time and treatment will be an ongoing expense. This period of time cannot be accurately determined but is expected to be at least several years.

5.2.2 Remediating the Source

A permanent solution is to remediate the source. This would most probably have a higher initial capital cost than treating the spring water but would be a permanent solution. Remediation techniques have not been studied in detail but may include hydrologic isolation, excavation, biochemical remediation, vapor extraction, some combination of these techniques, or some approach not yet considered.

6. RECOMMENDATIONS

A conceptual model of the contamination of the spring at Outfall 17 has been proposed. While we believe this model to be generally correct, further details are needed before a remedial approach is developed.

6.1 SOURCE DELINEATION

The source of the ammonia/nitrate contamination has been identified, but its extent has not been thoroughly investigated. Since the source must be remediated to effect a permanent solution, the lateral and vertical extent of contaminated soil needs to be determined. The remedial measures to be used and their cost will be strongly influenced by the type of contaminated soil and its volume. Plans should be developed for determining these characteristics of the source and implemented as soon as possible. Techniques for accomplishing this may include additional borings, driven well points to extract vapor, study of preconstruction topographic maps, and/or surface geophysical methods. During the planning stage, other techniques may be found to be appropriate.

6.2 OUTFALL 17

Since Outfall 17 will soon have enforceable concentration limits under an NPDES permit, the outflow will need to be treated until the source can be remediated. Plans for treatment should be refined and estimates of the volume of water to be treated more accurately computed. Any treatment plan should include runoff control to minimize the volume of water to be treated.

The data from Outfall 17 and EFPC are inconclusive in determining whether treating the spring water will eliminate fish kills due to ammonia. To answer this question and, therefore, to gain a better understanding of the relative importance of source remediation and water treatment the current water sampling program should be modified.

The distribution of ammonia and nitrate concentrations along EFPC during periods of high levels of spring flow should be determined. To accomplish this, samples should be collected at five locations, four in the creek and one from Outfall 17. The first sampling location in the creek, shown as S-1 in Figure 6 is approximately 300 feet upstream from Outfall 17 at the location of the ravine which extends from the creek to a point near the source. The other locations, S-2 through S-5, are 10 to 15 feet upstream from the outfall, approximately 200 feet downstream and 500 feet downstream just upstream of the culverts under the East Patrol Road. Samples should be collected approximately bi-weekly during dry weather to establish background concentrations. Following heavy precipitation (greater than approximately 1.5 inches) during the wet season, samples should be collected daily for a period of 5 to 10 days or until all concentrations have returned to no more than 20% above their background levels. In addition, flow rate measurements of the spring and EFPC should be performed several days after heavy rainfall after surface runoff has receded. In addition to Outfall 17, these measurements should be conducted at the most upstream sampling site, just downstream from the spring and at the most downstream sampling site.

The mass of ammonia and nitrate added between the most upstream and the most downstream sites can be computed from these data and compared with that emanating from the spring. The flow measurements will allow the mass balance equation to be solved accurately and help to locate reaches of EFPC where groundwater may be entering the creek. These measurements and calculations will allow determination of the importance of Outfall 17 in the concentration of ammonia and nitrate in EFPC.

7. REFERENCES

- Barrett, 1993. MMES Internal Correspondence from Elliott Barrett to P.R. Wasilko, May 6.
- OGDEN, 1993. "Subsurface Investigation and Environmental Sampling, Ammonium Nitrate Study, Y-12 Plant, Oak Ridge, Tennessee". Ogden Environmental and energy Services.