Appendix K.4a

Report of the Phase II RCRA Facility Investigation (RFI) Conducted on the Union Carbide Corporation Woodbine, Georgia Facility (Appendices A, B)

Apex Environmental, Inc

September 1996

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Apex environmental, inc.

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REPORT OF THE PHASE II RCRA FACILITY INVESTIGATION (RFI)

Conducted on the

Union Carbide Corporation
Woodbine, Georgia
Facility

Apex Job No. 097.001

September 20, 1996

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
1.1 Background 3
1.2 Environmental Setting 13
1.2.1 Location and Physiology 13
1.2.2 Geology 15
1.2.3 Soils 16
1.2.4 Hydrogeology 17
1.2.5 Surface Water and Sediment 23
1.2.6 Air and Meteorology 25
1.2.7 Demographics 25

2.0 PHASE I INVESTIGATION - LAW 26
2.1 SWMU 02 26
2.2 SWMU 03 27
2.3 SWMU 04 28
2.4 SWMU 05 29
2.5 SWMU 06 30
2.6 SWMU 07 31

3.0 PHASE II INVESTIGATION - APEX 32
3.1 SWMU 02 32
3.2 SWMU 03 32
3.2.1 Burn Area 35
3.2.2 Aldicarb Disposal Area 37
3.3 SWMU 04 39
3.4 SWMU 05 41
3.5 SWMU 06 41
3.6 SWMU 07 48
3.7 Methodology 50
3.7.1 Geophysics 50
3.7.1.1 GPR 50
3.7.1.2 EM-31 52
3.7.1.3 Magnetometer 53
3.7.1.4 Geophysical Field Study 53
3.7.2 Soil Sampling 54
3.7.2.1 Headspace Analysis 54
3.7.2.2 Soil Probes 56
3.7.2.2.1 Background Soil Probes 56
3.7.2.2.2 SWMU Characterization Soil Probes 57
3.7.2.2.3 SWMU 03 - Aldicarb Disposal Area and Burn Area . . 58
3.7.2.2.4 SWMU 04 - Acetone Evaporation Pond 58
3.7.2.2.5 SWMU 06 - Trench Area 1 59
3.7.2.3 Test Pitting 59

TABLE OF CONTENTS (cont'd)

3.7.3 Monitoring Wells . . . 60
3.7.4 Ground Water . . . 62
3.7.5 Decontamination . . . 63

4.0 RESULTS . . . 64
4.1 Background Statistical Analyses . . . 64
4.2 SWMU 02 . . . 65
4.3 SWMU 03 . . . 65
4.3.1 Burn Area . . . 68
4.3.1.1 Geophysical and Test Pit Results . . . 71
4.3.1.2 Soil Borings . . . 72
4.3.1.3 Soil Analytical Results . . . 73
4.3.1.4 Ground Water Analytical Results . . . 75
4.3.1.5 Waste Description . . . 75
4.3.2 Aldicarb Disposal Area . . . 75
4.3.2.1 Geophysical and Test Pit Results . . . 76
4.3.2.2 Soil Borings . . . 78
4.3.2.3 Soil Analytical Results . . . 78
4.3.2.4 Ground Water Analytical Results . . . 80
4.3.2.5 Waste Description . . . 80
4.4 SWMU 04 . . . 81
4.4.1 Soil Borings . . . 81
4.4.2 Soil Analytical Results . . . 81
4.4.3 Ground Water Analytical Results . . . 83
4.5 SWMU 05 . . . 87
4.5.1 Soil . . . 87
4.5.2 Ground Water . . . 87
4.6 SWMU 06 . . . 87
4.6.1 Geophysical Survey and Test Pits . . . 90
4.6.2 Trench 2 . . . 94
4.6.2.1 Soil . . . 94
4.6.2.2 Waste Description . . . 97
4.6.3 Borrow Pit Area . . . 97
4.6.3.1 Test Pits . . . 98
4.6.3.2 Analytical Results . . . 98
4.6.3.3 Waste Description . . . 100
4.6.4 Ground Water . . . 100
4.7 SWMU 07 . . . 102
4.7.1 Initial Investigation . . . 102
4.7.2 Geophysical Survey . . . 102
4.7.3 Exploratory Test Pits . . . 103
4.7.4 Ordnance Recovery . . . 105
4.7.5 Investigative Test Pits . . . 106
4.7.5.1 Area A - CS Disposal Area . . . 106
4.7.5.1.1 Analytical Summary . . . 107
4.7.5.1.2 Waste Description . . . 110

TABLE OF CONTENTS (cont'd)

4.7.5.2 Area B - Construction and Building Debris Disposal Area . . . 110
4.7.5.2.1 Analytical Summary . . . 110
4.7.5.2.2 Waste Description . . . 111
4.7.5.3 Area C - Trip Flare Disposal Area . . . 111
4.7.5.3.1 Analytical Results . . . 112
4.7.5.3.2 Waste Description . . . 112
4.7.5.4 Area D - Garbage Disposal Area . . . 113
4.7.5.4.1 Analytical Results . . . 113
4.7.5.4.2 Waste Description . . . 114
4.7.6 Ground Water . . . 115

5.0 CONCLUSIONS AND RECOMMENDATIONS . . . 117
5.1 SWMU 02 . . . 117
5.2 SWMU 03 . . . 117
5.3 SWMU 04 . . . 118
5.4 SWMU 05 . . . 119
5.5 SWMU 06 . . . 120
5.6 SWMU 07 . . . 121

APPENDICES
Appendix A Boring Logs, Test Pit Logs, and Well Construction Diagrams
Appendix B Drum Log
Appendix C Geophysics Report
Appendix D Analytical Data Sheets
Appendix E UXO Report

Figures and Tables

Figure 1 Site Plan . . . 2
Figure 2 SWMU 02 - Site Map . . . 7
Figure 3 SWMU 03 - Site Map . . . 8
Figure 4 SWMU 04 - Site Map . . . 10
Figure 5 SWMU 05 - Site Map . . . 11
Figure 6 SWMU 06 - Site Map . . . 12
Figure 7 SWMU 07 - Site Map . . . 14
Figure 8 SWMU 03 - Potentiometric Surface Map . . . 20
Figure 9 SWMU 04 - Poteniometric Surface Map . . . 21
Figure 10 SWMU 06 - Potentiometric Surface Map . . . 22
Figure 11 SWMU 07 - Potentiometric Surface Map . . . 24
Figure 12 SWMU 02 - Background Sample Locations . . . 33
Figure 13 SWMU 03 - Background Sample Locations . . . 34
Figure 14 SWMU 03 Burn Area - Sample Locations . . . 36
Figure 15 SWMU 03 Aldicarb disposal Area - Sample Locations . . . 38
Figure 16 SWMU 04 - Sample Locations . . . 40

TABLE OF CONTENTS (cont'd)

Figure 17 SWMU 05 - Sample Locations 42
Figure 18 SWMU 06 - Background Sample Locations 43
Figure 19 SWMU 06 - Trench 1 - Sample Locations 44
Figure 20 SWMU 06 - Trench 2 - Sample Locations 45
Figure 21 SWMU 06 Borrow Pit Area - Sample Locataions 46
Figure 22 SWMU 07 - Exploratory Test Pit Location 49
Figure 23 SWMU 07 - Test Pit Sample Location 51
Figure 24 SWMU 07 - Identification of Waste Areas 104

Table 1 Summary - RFI Phase I and II 4
Table 2 Ground Water Elevations, Phase I and II RFI 18
Table 3 Sample Containers, Quantities, and Preservatives, Phase II RFI 55
Table 4 Background Metals Statistical Analysis 66
Table 5 SWMU 02, Phase I RFI, Soil Sample Analytical Results 67
Table 6 SWMU 03, Phase I RFI, Subsurface Disposal, Soil Sample Analytical Results . 69
Table 7 SWMU 03, Phase I and II RFI, Ground Water Analytical Results 70
Table 8 SWMU 03, Phase II RFI, Bum Areas, Soil Sample Analytical Results 74
Table 9 SWMU 03, Phase II RFI, Aldicarb Disposal Area, Soil Sample Analytical Results 79
Table 10 SWMU 04 Phase I RFI Soil Sample Analytical Results 82
Table 11 SWMU 04 Phase II RFI Soil Sample Analytical Results 84
Table 12 SWMU 04, Phase I and II RFI, Ground Water Analytical Results 86
Table 13 SWMU 05, Phase I RFI, Soil Sample Analytical Results 88
Table 14 SWMU 05, Phase I and II RFI, Ground Water Analytical Results 89
Table 15 SWMU 06 Phase I RFI Soil Sample Analytical Results 91
Table 16 SWMU 06, Trench 1, Phase II RFI, Soil Sample Analytical Results 95
Table 17 SWMU 06, Trench 2, Phase II RFI, Soil Sample Analytical Results 96
Table 18 SWMU 06 Borrow Pit Area, Phase II RFI, Soil Sample Analytical Results 99
Table 19 SWMU 06, Phase I and II RFI, Ground Water Analytical Results 101
Table 20 SWMU 07, Phase II RFI, Soil Sample Analytical Results 108
Table 21 SWMU 07, Phase I and II RFI, Ground Water Analytical Results 116

1.0 INTRODUCTION

This Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report has been prepared for the Thiokol Corporation (Thiokol), which previously operated a facility in Woodbine, Georgia. Thiokol previously transferred title to the property to Union Carbide Corporation (UCC) and no longer operates the facility. The Phase II RFI was completed in response to the Georgia Environmental Protection Division's (GAEPD's) letters dated November 3, 1994 and August 10, 1995. The Phase II RFI was performed in accordance with Apex Environmental, Inc.'s (Apex's) proposal dated June 9, 1995, and the Work Plan which is dated February 2, 1995, and was approved by the GAEPD on September 21, 1995. The Phase II RFI is intended to provide supplemental information to the Phase I RFI submitted by Law Engineering (Law).

The facility was previously used for the production of munitions and agri-chemicals. UCC identified seven (out of a total of 22) solid waste management units (SWMUs) in the Part B Permit Application for Post Closure Core detailed September 29, 1986 (and revised in July, 1987). The seven SWMUs were investigated by Law in the Phase I RFI dated February 5, 1993. Apex completed additional investigation of the seven SWMUs on behalf of Thiokol. The work (Phase II RFI) was performed at the SWMUs identified on Figure 1 by Thiokol pursuant to agreement with UCC.

In accordance with site permit HW-063(D), the following RFI activities and correspondence have taken place prior to the completion of Apex's Phase II of the RFI (reported herein):

- A Phase I RFI work plan prepared by Law was submitted by UCC on July 29, 1992. The Work Plan was approved by the GAEPD on August 7, 1992.
- The Phase I work was implemented by Law and a report was submitted to the GAEPD on February 5, 1993.
- A Notice of Deficiency (NOD) letter was issued by the GAEPD on September 30, 1993, and UCC responded to the NOD letter on January 25, 1994.
- A Review of the Response to the RFI Report's NOD was issued by the GAEPD on September 9, 1994, and UCC responded by letter on October 19, 1994.
- A letter requesting the Phase II RFI Work Plan was issued by the GAEPD on November 3, 1994.
- Discussions were held between UCC and GAEPD on January 11, 1995, requesting an extension of the schedule for submittal of the Phase II RFI Work Plan.
- The Phase II Work Plan which was submitted by Apex on February 2, 1995.

Figure 1

(Included in Pocket Behind Page 121)

- A meeting was attended by GAEPD, UCC, Thiokol, and Apex on March 8, 1995, to discuss the Phase II RFI Work Plan.
- The GAEPD outlined comments on the Phase II RFI Work Plan to Thiokol in a letter dated August 10, 1995.
- The Phase II RFI Work Plan was approved by GAEPD on September 21, 1995.

This report presents a summary of the results of the Phase I RFI prepared by Law and the Phase II RFI completed by Apex. Table 1 summarizes the work completed during the Phase I and II investigations.

Apex's Phase II RFI included the collection of background soil samples for metals analysis, completion of surface geophysics of selected SWMUs, collection of subsurface soil samples, installation and sampling of monitoring wells, test pitting, and identification, removal, and deactivation of unexploded ordnance (UXO) from selected SWMUs. Each SWMU is presented separately in each section in order to distinguish between different investigative strategies.

1.1 Background

SWMU 02 is located along the north and south sides of the main road leading to the closed RCRA landfill (Figure 2). It was reportedly used for surface storage of empty drums containing residuals of malononitrile, orthochlorobenzaldehyde, and orthochlorobenzylidene malononitrile (also known as "CS" gas or tear gas).

SWMU 03 contains three separate disposal areas: the Buried CS Trench and Surface Debris Area, the Burn Area, and the Aldicarb Disposal Area (Figure 3). During the Phase I investigation, only the Buried CS Trench and Surface Debris areas were identified. However, additional information became available after the Phase I investigation that identified the two additional areas.

The locations of the Buried CS Trench and Surface Debris Areas are shown on Figure 3. The surface debris area was reportedly used from 1967 to 1976, for surface storage/disposal of:

- scrap metal and miscellaneous materials originating from "CS" gas formulation equipment, and
- approximately 2000 pounds of ordnance and related materials.

Table 1

Summary - RFI Phase I and II

Thiokol - Woodbine Facility

SWMU	RFI Phase	Ground Water Investigation	Ground Water Analytes	Soil Investigation	Soil Analytes	Geophysical Survey	Ordnance
2	Phase I	none	none	4 - shallow sample locations 4 - samples	VOC, BNA, metals, CS compounds	none	none
	Phase II	None	None	6 - background soil samples	Metals	none	none
3 - CS Burial/ Trench/Surface Disposal	Phase I	3 - monitoring wells 3 - samples	VOCs, BNA, metals, CS compounds	5 - test pits (CS Burial) 1 - sample 3 - test pits (Trench) 2 - samples 6 - shallow sample locations 6 - samples	VOC, BNA, metals, aldicarb, CS compounds	none	Surface Sweep
	Phase II	3 - samples	VOC, BNA, metals, aldicarb, CS compounds	6 - background soil samples	metals	none	none
3 - Burn Area	Phase II	1 - monitoring well 1- sample	VOC, BNA, metals, aldicarb, CS compounds	4 - test pits 6 - samples 6 - soil borings 1 - soil sample 6 -background soil samples	VOCs, BNA, metals, aldicarb, CS compounds	GPR, magnetometer	40 mm grenades (CS and HE)
3 - Aldicarb disposal Area	Phase II	1- monitoring well 1-sample	VOC, BNA, metals, aldicarb, CS Compounds	5-test pits 10 - samples 3-soil borings 6-background soil samples	VOCs, BNA, metals, aldicarb, CS Compounds	GPR, EM31, magnetometer	Surface sweep

R481:thiok02(097.001);njm

Table 1 (cont'd)

SWMU	RFI Phase	Ground Water Investigation	Ground Water Analytes	Soil Investigation	Soil Analytes	Geophysical Survey	Ordnance
4 - Borrow Pit/ Evaporation Pond	Phase I	4 - monitoring wells 4- samples	VOC, BNA, metals, aldicarb	5 - shallow sample locations (evaporation pond) 5 - samples 7 - test pits (Borrow Pit) 2 - samples	VOC. BNA, metals, aldicarb, pH	none	none
4 - Evaporation Pond	Phase II	4 - samples	VOCs, BNA, metals, aldicarb	6 - hand auger locations 12 - samples 6 - background soil samples	VOC, BNA, metals, aldicarb	none	none
5	Phase I	1 - monitoring well 1 - sample	VOC, BNA, metals, aldicarb	5 - shallow sample locations 5 - samples 1 - waste material sample	VOC, BNA, metals, aldicarb	none	none
	Phase II	1-sample	VOC, BNA, metals, aldicarb	6 - background soil samples	metals	none	none
6 - Surface Disposal	Phase I	1 - monitoring well (MW -603) 1 - sample	VOC, BNA, metals, aldicarb, CS Compounds	3 - shallow sample locations 3 - samples	VOC. BNA, metals, aldicarb, CS Compounds	none	none
	Phase II	1 - sample	VOC, BNA, metals, aldicarb, CS Compounds	6 - background soil samples	VOC. BNA, metals, aldicarb, CS Compounds	none	none
6 - Trench I	Phase I	1 - monitoring well (MW -602) 1 - sample	VOC, BNA, metals, aldicarb, CS Compounds	7 - test pits	none	none	none
	Phase II	1 - sample	VOC, BNA, metals, aldicarb, CS Compounds	3 - soil borings 6 - samples 6 - background soil samples	VOC, BNA, metals, aldicarb, CS compounds	none	none

R481:thlok02(097.001);njm

Table 1 (cont'd)

SWMU	RFI Phase	Ground Water Investigation	Ground Water Analytes	Soil Investigation	Soil Analytes	Geophysical Survey	Ordnance
6 - Trench II	Phase I	1 - monitoring well (MW-604) 1 - samples	VOCs, BNA, metals, aldicarb, CS compounds	6 - test pits 4 - samples (1 duplicate)	VOC, BNA, metals, aldicarb, CS Compounds	none	none
	Phase II	1 - sample	VOCs, BNA, metals, aldicarb, CS Compounds	6 - test pits 3 - samples 6 - background soil samples	VOC, BNA, metals, aldicarb, CS Compounds	GPR, EM31	none
6 - Borrow Pit	Phase I	1 - monitoring well (MW-601) 1 - samples	VOCs, BNA, metals, aldicarb, CS Compounds	5 - test pits 2 - samples	VOC, BNA, metals, aldicarb, CS Compounds	none	none
	Phase II	1 - sample	VOCs, BNA, metals, aldicarb, CS Compounds	4 - test pits 5 - samples 6 - background soil samples	VOC, BNA, metals, aldicarb, CS Compounds	GPR, EM31	none
SWMU 7	Phase I	4 - monitoring wells 4 - samples	VOC, BNA, metals, aldicarb, CS Compounds	none	none	none	none
	Phase II	4 -samples	VOC, BNA, metals, aldicarb, CS compounds	31 - exploratory test pits 18 - test pits 18 - samples 6-background soil samples	VOCs, BNA, metals, aldicarb, CS compounds	Magnetometer	408 drums of ordnance related items .

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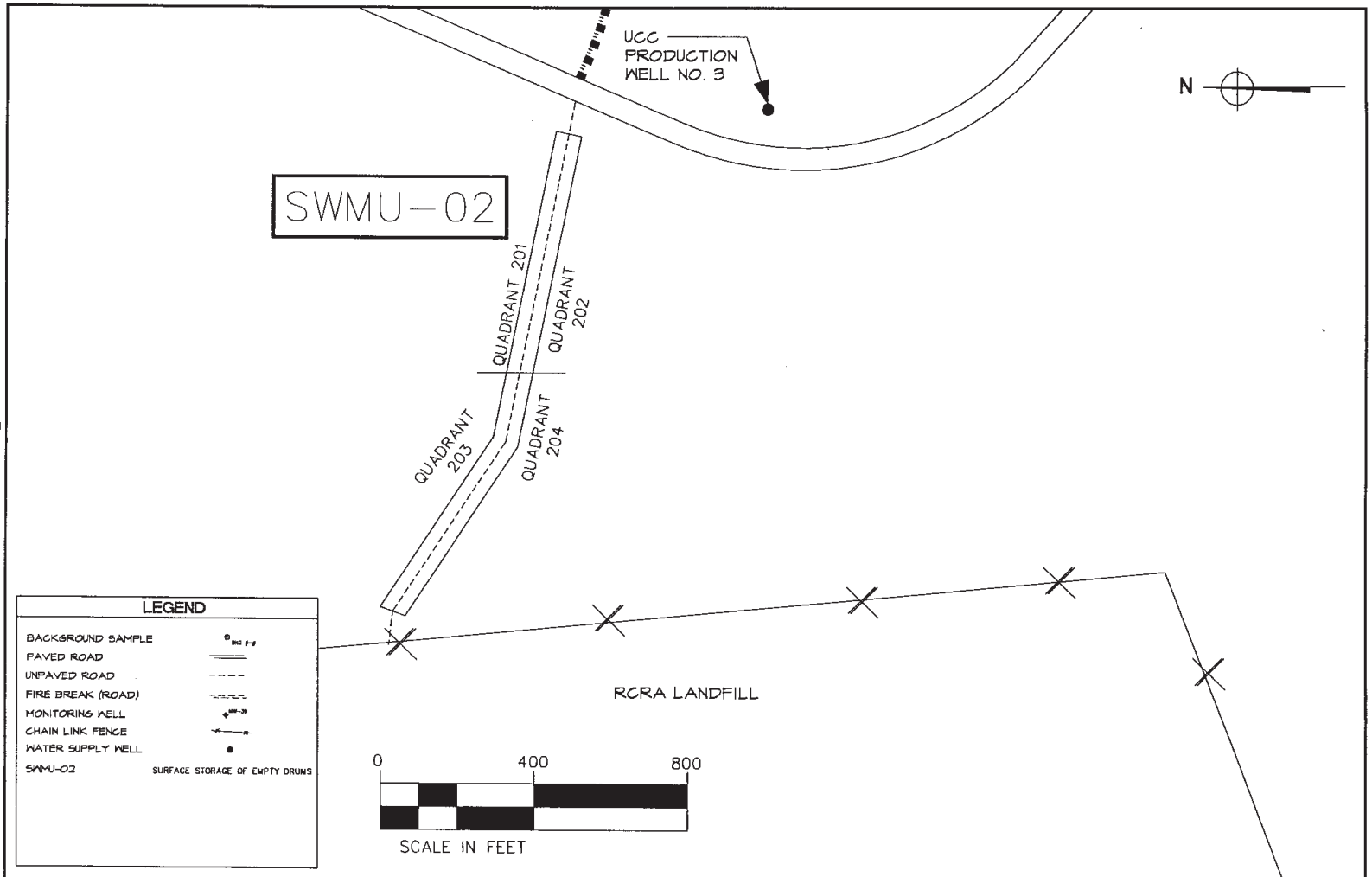

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FIGURE 2
SWMU 02
SITE MAP
WOODBINE, GEORGIA

Date: 7-15-96	Project Title: THIOKOL CORPORATION WOODBINE, GA		
Drawn By: CDC			
Project Number: 097.001	CAD File: SWMU2	Scale: AS SHOWN	Client: THIOKOL CORP

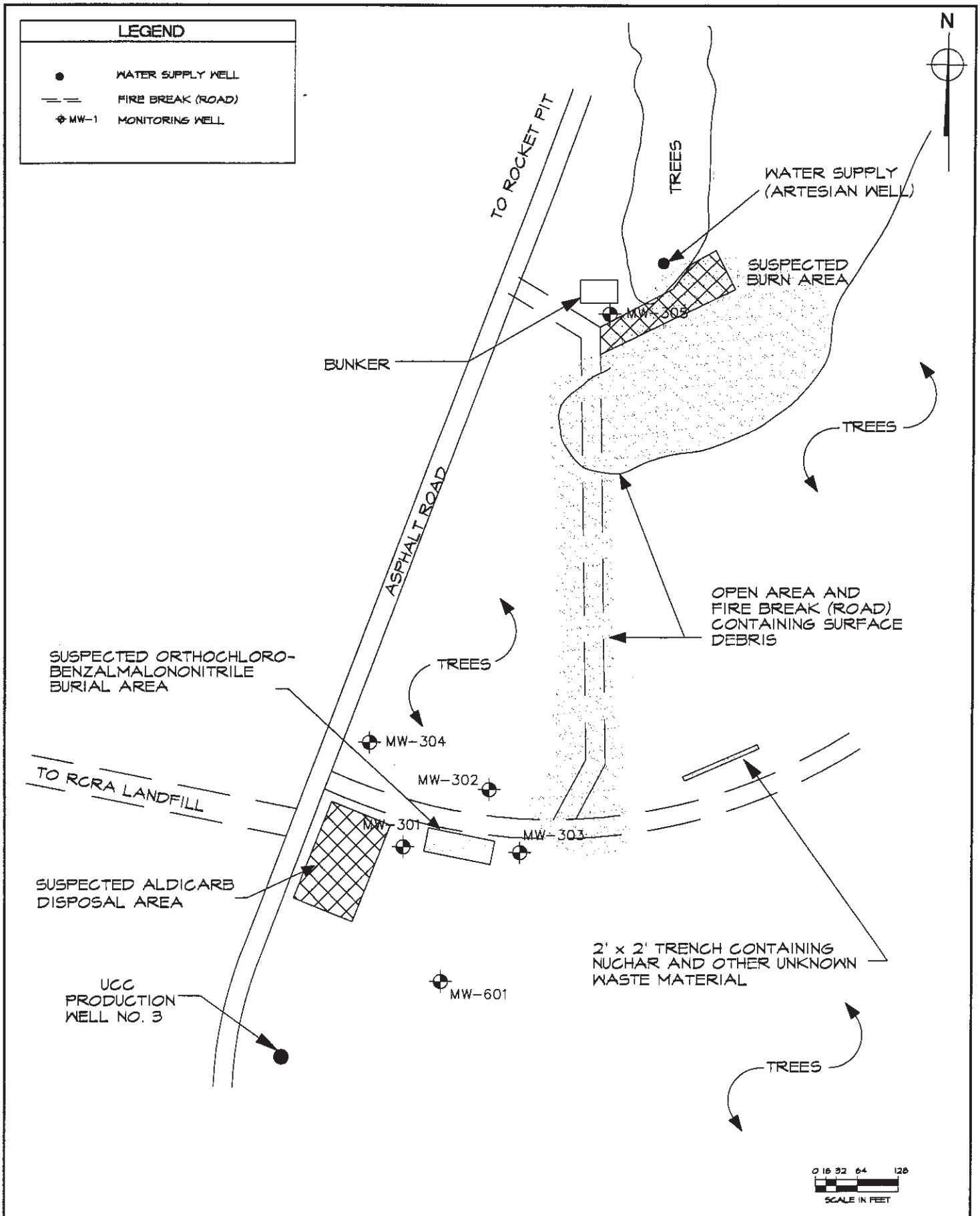

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FIGURE 3
SWMU 03
SITE MAP
WOODBINE, GEORGIA

PHASE II RFI
THIOKOL CORPORATION
WOODBINE, GA

7-18-96	CDC	097.001
UNION-2	AS SHOWN	THIOKOL CORP.

The Buried CS Trench was also reportedly used for subsurface disposal of:

- CS material, and
- Nuchar and other unknown waste materials.

Subsequent to the submittal of the Phase I RFI, a Burn Area for ordnance was identified by UCC. The location of the Burn Area was reported to be in the northern section of SWMU 03, but its exact location was unknown. The Phase II investigation of the Burn Area was intended to locate (if present) the ordnance Burn Area using geophysical methods, install a monitoring well downgradient of the Burn Area, and sample the ground water. In addition, a minimum of eight test pits were to be completed in the Burn and Aldicarb Disposal Areas as requested by the GAEPD.

In addition to the Burn Area, a second area was identified after submittal of the Phase I RFI. This area is known as the Aldicarb Disposal Area. The Aldicarb Disposal Area is a flat topped mound located on the east side of the paved road across from the entrance road to the RCRA landfill (Figure 3). This area was identified by UCC after completion of the Phase I RFI.

SWMU 04 is located in an area 1200 feet north of Loop Road on the east and west sides of a firebreak road (Figure 4) and was reportedly used from 1968 until 1970. The Acetone Evaporation Pond to the east of the firebreak road was used for surface disposal of acetone. Another part of the SWMU, located to the west of the firebreak road, was used for subsurface disposal of Nuchar and raw corn cob grit.

SWMU 05 is located east of the intersection of Loop Road and the firebreak road leading to the on-site air strip (Figure 5) and was used for a one-time disposal in approximately 1973. It is a small trench that contained a drum which reportedly held aldicarb oxime.

SWMU 06 is located south of Loop Road and along a firebreak road (Figure 6) and was used from 1966 until 1970. Four different disposal areas are present in SWMU 06. These are the Surface Disposal Area, Trench Area 1, Trench Area 2, and the Borrow Pit. The Surface Disposal Area was reportedly used for disposal of scrap metal, concrete, asphalt, and tar. Former Trench Area 1 was reportedly used for subsurface disposal of Nuchar and corn cob grit. Former Trench Area 2 was reportedly used for subsurface disposal of Nuchar, corn

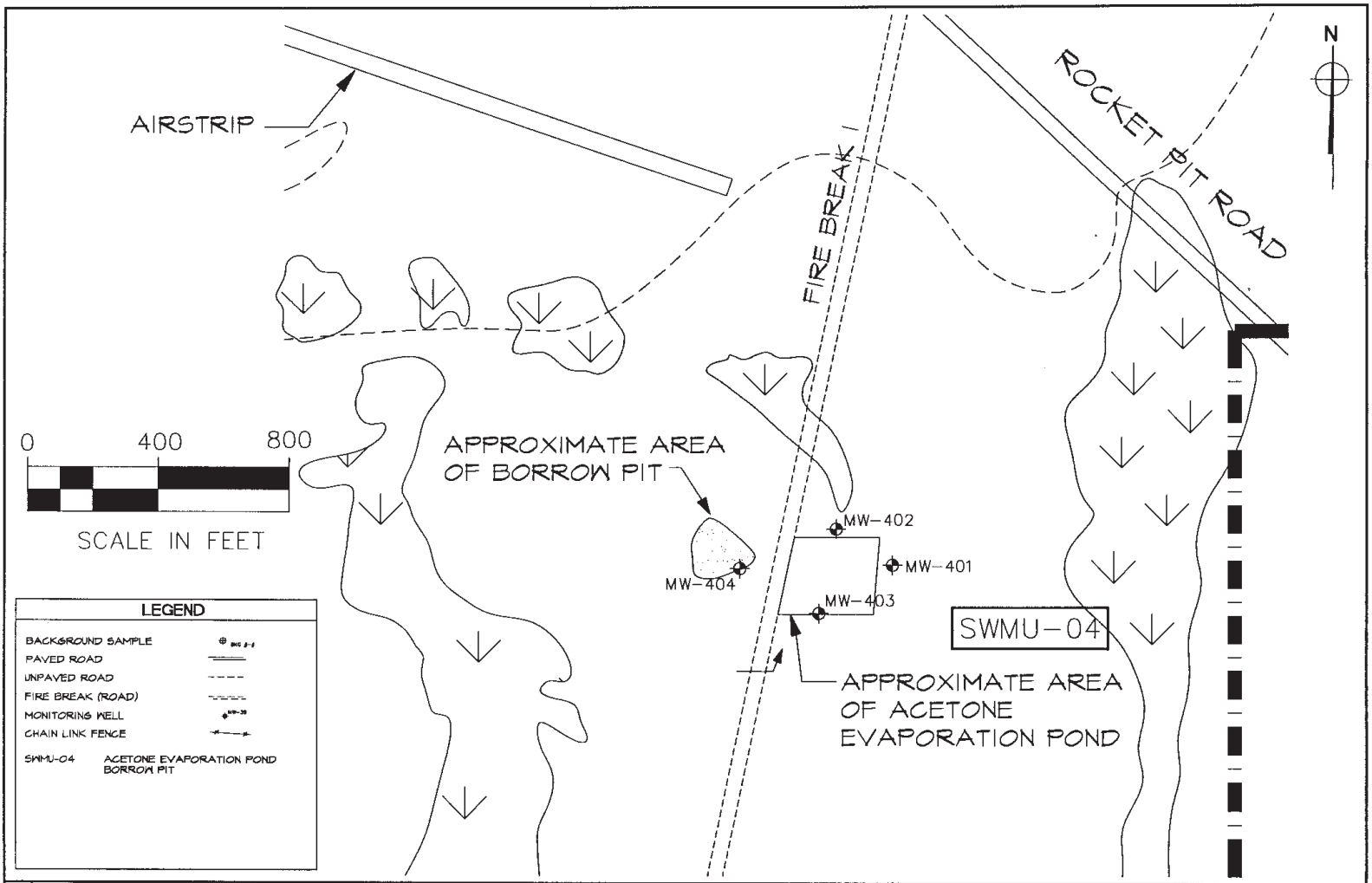

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FIGURE 4
SWMU 04
SITE MAP
WOODBINE, GEORGIA

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Drawn By: SJR			
Project Number: 097.001	CAD File: BKG4	Scale: AS SHOWN	Client: THIOKOL CORP

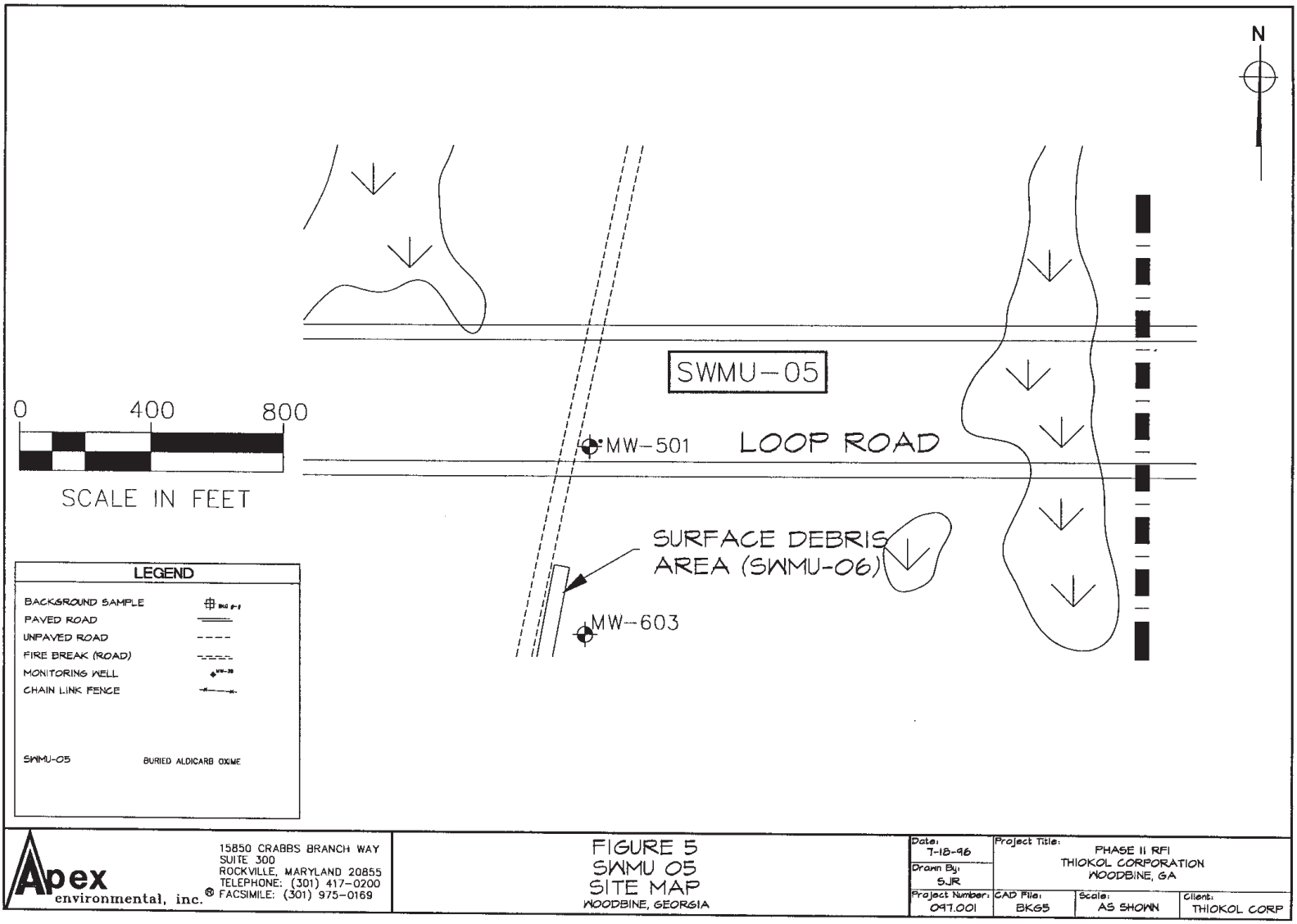

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FIGURE 5
SWMU 05
SITE MAP
WOODBINE, GEORGIA

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Drawn By: SJR			
Project Number: 097.001	CAD File: BKG5	Scale: AS SHOWN	Client: THIOKOL CORP

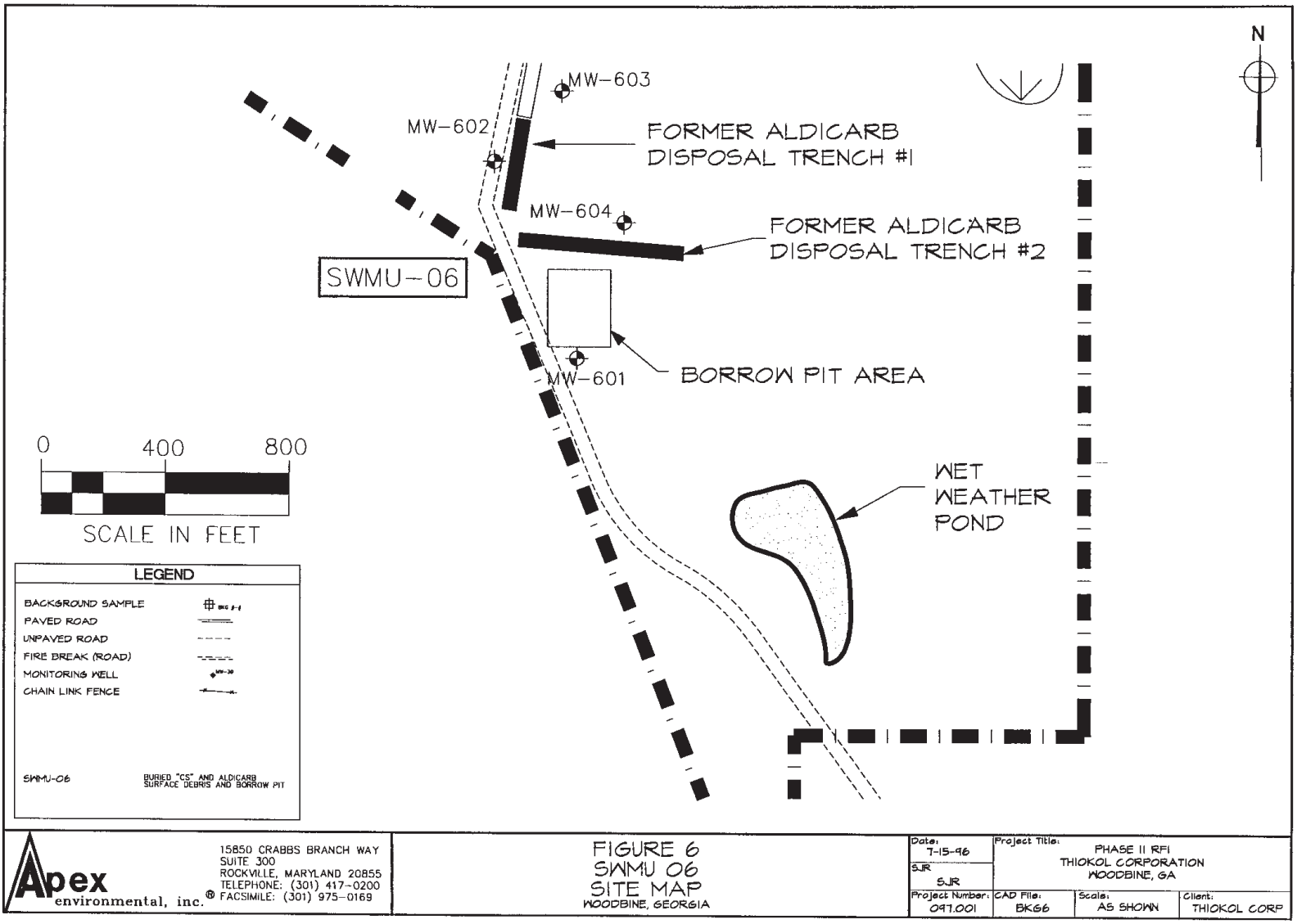

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FIGURE 6
SWMU 06
SITE MAP
WOODBINE, GEORGIA

Date:	Project Title:		
7-15-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
SJR			
SJR			
Project Number:	CAD File:	Scale:	Client:
097.001	BK66	AS SHOWN	THIOKOL CORP

cob grit, gypsum granules, and miscellaneous waste materials (e.g., plastic bags, a steel drum). The Borrow Pit was reportedly used for incineration activities and subsurface disposal of CS gas, Nuchar, corn cob grit, and construction wastes (e.g., tree stumps).

SWMU 07 is located on the east and west sides of the firebreak road leading to Floyd Cemetery and was reportedly used from 1966 until 1976 (Figure 7). It was used for surface disposal activities (i.e., burning excess and off-specification energetic materials from trip flares, illuminating mortar flares, and CS pyromix). Subsurface disposal was reportedly used for:

- approximately 50 drums containing trip flares and concrete,
- approximately 40 drums containing CS gas, and
- an unknown number of drums containing aldicarb.

1.2 Environmental Setting

1.2.1 Location and Physiology

The facility is located in the Atlantic Coastal Plain Physiographic Province. The topography has been influenced by changing Pleistocene sea levels. The changing sea levels created a series of terraces that regionally are topographically higher as one travels westward throughout the region.

The facility and SWMUs are located on flat uplands on a point known as Floyds Neck. The topography is generally flat with slight depressions and shallow drainage ways. Adjacent rivers – Todd Creek, Floyd Basin, and Cumberland River – have eroded steep banks. The facility grounds itself has few natural streams. Storm water is controlled by culverts located along the roadways. There are several depressions and seasonally flooded areas throughout the upland areas. Elevation of the SWMUs is between 15 and 25 feet above mean sea level.

SWMUs 04, 05, 06, and 07 are located in areas of previous tree farming activities. The slash or loblolly pines are planted in rows and, based on the trees cut down at SWMU 07 to clear the site, were planted approximately 15 to 20 years ago. SWMUs 02 and 03 are located in relatively unharvested areas. The trees in these two areas are oaks and other hardwoods. The Borrow Pit at SWMU 06 is the only area

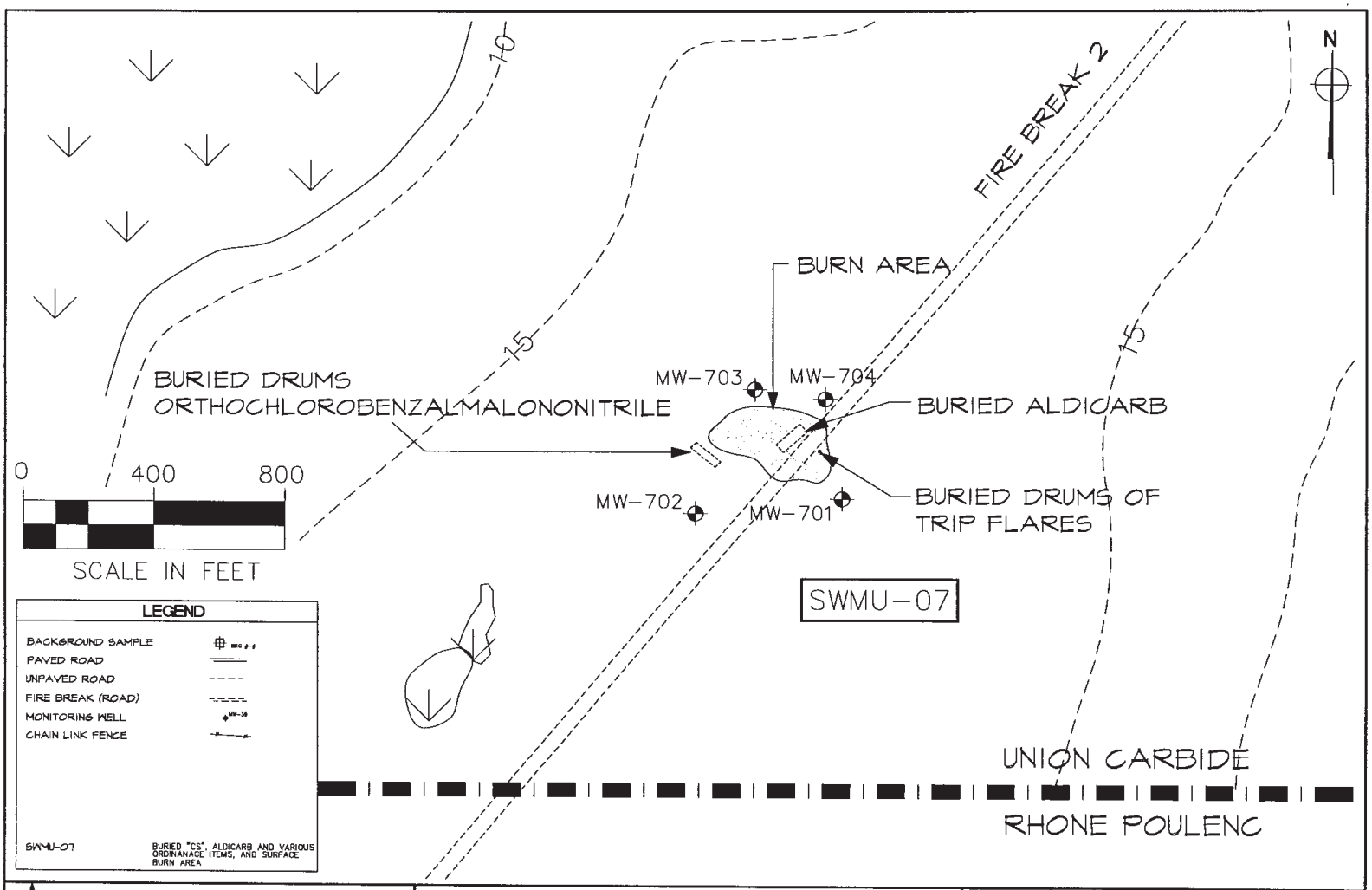

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FIGURE 7
SWMU 07
SITE MAP
WOODBINE, GEORGIA

Date:	Project Title:		
7-15-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: SJR			
Project Number: 097.001	CAD File: BKG7	Scale: AS SHOWN	Client: THIOKOL CORP

that was not forested. While the SWMUs and buildings are on the upper areas, the property boundaries do extend north and east through several miles of tidal salt marshes.

1.2.2 Geology

The facility is located in the Barrier Island Sequence District of the Atlantic Coastal Plain Physiographic Province. The Barrier Island Sequence is a series of barrier island and salt marsh deposits, deposited during Pleistocene sea level changes, that are similar to present day conditions. The deposits are parallel to the present coastal shoreline.

The facility is situated on the Princess Anne terrace complex. The terrace deposits consist of a mantle of undifferentiated surficial sands and the underlying Santilla Formation. The Santilla Formation consists of variably fossilferous, shelly sands and clays of offshore, inner shelf origin; bedded and non-bedded barrier island deposits; and marsh deposits. The Santilla Formation exposed at areas of bank erosion mentioned above consists of fine to medium, indistinctly bedded sand overlaying a layer of reddish humate-cemented sandstone. Humate is produced by the percolation of acids from the organic topsoil above the sands. An excellent exposure is visible north of the Rocket Test Pad near SWMU 03 where Todd Creek has eroded the bank.

All disposal at the Woodbine facility is reported to have occurred in the near surface materials represented by the Princess Anne terrace complex and the Santilla Formation. The following is a brief description of the geologic units located stratigraphically below the Santilla Formation. Waste activities at the site are not thought to have impacted any of the lower units. A more complete description of the local and regional geology is found in Law's Phase I RFI report.

The Santilla Formation is underlain by the predominantly sandy Cypress Head Formation. The Cypress Head Formation is fine to coarse and pebbly, poorly sorted sand. The formation is characterized by thinly-bedded, fine sand with thin clay layers. Due to their lithologic similarity and lack of distinct marker beds, it is difficult to distinguish the Cypress Head Formation from the overlying Santilla Formation.

Beneath the late Pliocene to Recent aged Cypress Head and Santilla Formations is the Miocene aged Coosawhatchie Formation of the Hawthorne Group. The Coosawhatchie Formation consists predominantly of the Ebenezer and lower Berryville Clay Members. The sandy upper Ebenezer Member consists of thinly layered, fine to medium, moderate to well sorted, gray to olive-gray colored sand. The upper part of the member locally contains lenses of gravelly sand with some discoidal pebbles. The lower Berryville Clay Member consists principally of light olive-gray, silty, somewhat phosphoritic clay. The clay is generally very thinly bedded and laminated with silt.

1.2.3 Soils

The two dominant soil types at the facility are mapped by the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) as the Mandarin fine sand and Pottsburg sand. Both soils are found on ridges and flats of coastal areas. Both soils are described by the SCS as deep, poorly drained, highly acidic, and moderately permeable. A third soil type -- Rutledge fine sand -- is deep, very poorly drained, highly acidic, and moderately permeable. Other soil types are found in the tidal marshes surrounding the property, however, no SWMUs are located in or near these soils. Small areas of other soil types are typically included in the mapped areas.

The Mandarin fine sand is a deep, somewhat poorly drained, nearly level soil on slight ridges and broad flats. The subsurface soil is underlain by typically 15 inches of an organic hardpan layer. The permeability is rapid (6 to 20 inches per hour) except in the hardpan where the permeability is moderate (0.6 to 2 inches per hour). Mandarin soils are found at SWMUs 04, 05, 06, and 07. The hardpan layer encountered at the SWMU 06 Trench Area 1 was hard enough to prevent hand auguring or probing.

The Pottsburg sand has characteristics very similar to the Mandarin soils. The main difference is the depth and thickness of the hardpan layer which, in the typical soil profile, is at a depth of 63 to 80 inches. Although not listed, the permeability of the hardpan layer is probably similar to the Mandarin soils. Pottsburg soils are found at SWMUs 02 and 03.

Rutledge soils are found in shallow depressions and drainage ways. A hardpan layer is not characteristic of the Rutledge soils. Background samples collected around SWMU 04 appeared to be more characteristic of the Rutledge soils.

1.2.4 Hydrogeology

The uppermost aquifer below the site is the Pliocene to Recent aquifer system. The system extends to a depth of approximately 265 feet as reported in the Phase I report. The underlying confining layer is the Miocene Berryville Clay Member of the Coosawhatchie Formation. Aquifers below the Berryville Clay are part of the Miocene aquifer system. The principle aquifer used for drinking water supplies in Coastal Georgia occurs at a depth of approximately 430 feet.

From monitoring well data at the facility, ground water occurs at a depth of less than 10 feet. Ground water levels ranged from less than two feet below the ground surface at SWMU 07 to approximately eight feet below the ground surface at SWMU 03. This uppermost, unconfined aquifer is found in unconsolidated sands of the Santilla formation. Monitoring wells in the two RFI investigations were installed to depths ranging from approximately 13 to 20 feet below the ground surface.

Aquifer testing was conducted by Law during the Phase I investigation on wells at SWMU 03, 04, 05, 06, and 07. Hydraulic conductivity values ranged from 5.6 to 7.9 x 10^{-3} feet per minute with an average of 6.8 x 10^{-3} feet per minute. Ground water velocities were calculated to be from 27 to 82 feet per year. The ground water velocity calculated for the nearby RCRA landfill is 88 feet per year.

Depth to ground water measurements were collected during the Phase I and II investigations. Table 2 summarizes the ground water elevations from the two investigations. Although ground water elevations have changed, the relative changes are consistent. The ground water flow directions appear to have changed only minimally between the two measurement events, except at SWMU 07 where flow is perpendicular to that stated in the Phase I report.

Table 2

Ground Water Elevations
Phase I and II RFI

Thiokol - Woodbine Facility

Well No.	Top of Casing (feet)	Ground Water Elevation - 10/92 (feet)	Ground Water Elevation - 12/92 (feet)	Ground Water Elevation - 11/95 (feet)	Ground Water Elevation - 03/96 (feet)
MW-301	26.89	16.83	15.77	18.80	16.75
MW-302	28.20	16.14	15.15	18.11	16.04
MW-303	27.60	16.6	15.6	18.52	16.55
MW-304	25.85	NI[1]	NI	NI	15.38
MW-305	24.41	NI	NI	NI	9.95
MW-401	21.20	18.08	18.11	17.94	NG[2]
MW-402	23.92	18.54	18.41	18.25	NG
MW-403	23.01	18.94	18.45	18.37	NG
MW-404	23.33	19.30	18.79	18.70	NG
MW-501	22.43	18.86	18.38	18.46	NG
MW-601	21.76	17.13	15.79	16.13	NG
MW-602	22.47	18.85	17.65	17.99	NG
MW-603	23.23	18.70	17.92	18.21	NG
MW-604	21.37	18.00	17.14	17.48	16.04
MW-701	19.32	15.22	14.59	14.81	NG
MW-702	19.78	15.44	14.68	14.95	NG
MW-703	19.35	14.89	13.99	14.87	NG
MW-704	17.64	14.85	14.08	14.84	NG

[1]NI = well not installed as of this date.
[2]NG = not gauged during this sampling event.

Depth to ground water data were collected by Apex from the monitoring wells prior to sampling. Using survey data collected by Law for the Phase I RFI and the data generated by Apex, ground water elevations were calculated. The ground water elevation data is summarized in Table 2.

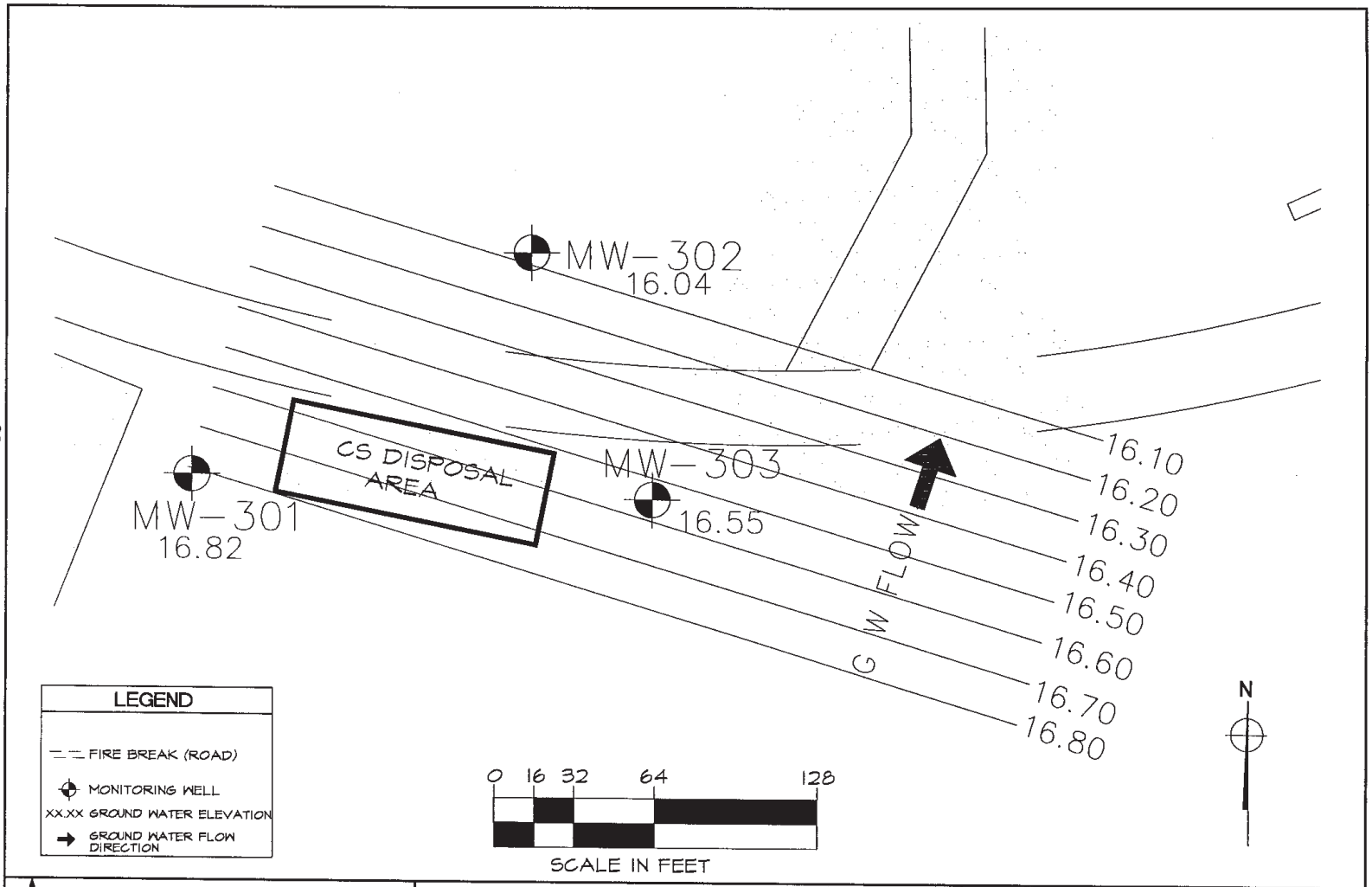
Ground water data were collected at SWMU 03 by Apex during sampling efforts in November 1995 and again after the installation of monitoring wells MW-304 and 305. Ground water flow direction was calculated using data from MW-301, 302, and 303. MW-304 and MW-305 are too far away from the previously installed monitoring wells to be used for the calculation of local flow direction.

As shown in Figure 8, ground water flow at SWMU 03 is to the north-northeast. The hydraulic gradient calculated by Apex was 0.007 ft/ft compared to the gradient calculated by Law of 0.006 ft/ft. The calculated ground water flow velocity is therefore approximately the same as calculated by Law at 82 feet per year.

Ground water data were collected at SWMU 04 during the sampling efforts in November 1995. Ground water flow direction was calculated using data from MW-401, 402, 403, and 404. As shown in Figure 9, ground water flow at SWMU 04 is to the east. The hydraulic gradient calculated by Apex was 0.002 ft/ft. The hydraulic gradient was not calculated in Law's Phase I RFI.

Using the same assumptions as in the Phase I RFI by Law on effective porosity and Phase I RFI hydraulic conductivity measurements, Apex calculated the ground water flow velocity at SWMU 04. Where the effective porosity is 0.26, hydraulic conductivity is 6.1×10^{-3} feet per minute (3.2×10^{3} feet per year), with a hydraulic gradient of 0.002, the calculated ground water flow velocity is approximately 25 feet per year.

Ground water data were collected by Apex at SWMU 06 during the sampling efforts in November 1995. Ground water flow direction was calculated using data from MW-602, 603, and 604. As shown in Figure 10, ground water flow at SWMU 06 is to the south-southeast. The hydraulic gradient calculated by Apex was 0.002 ft/ft. The hydraulic gradient was not calculated in Law's Phase I RFI.



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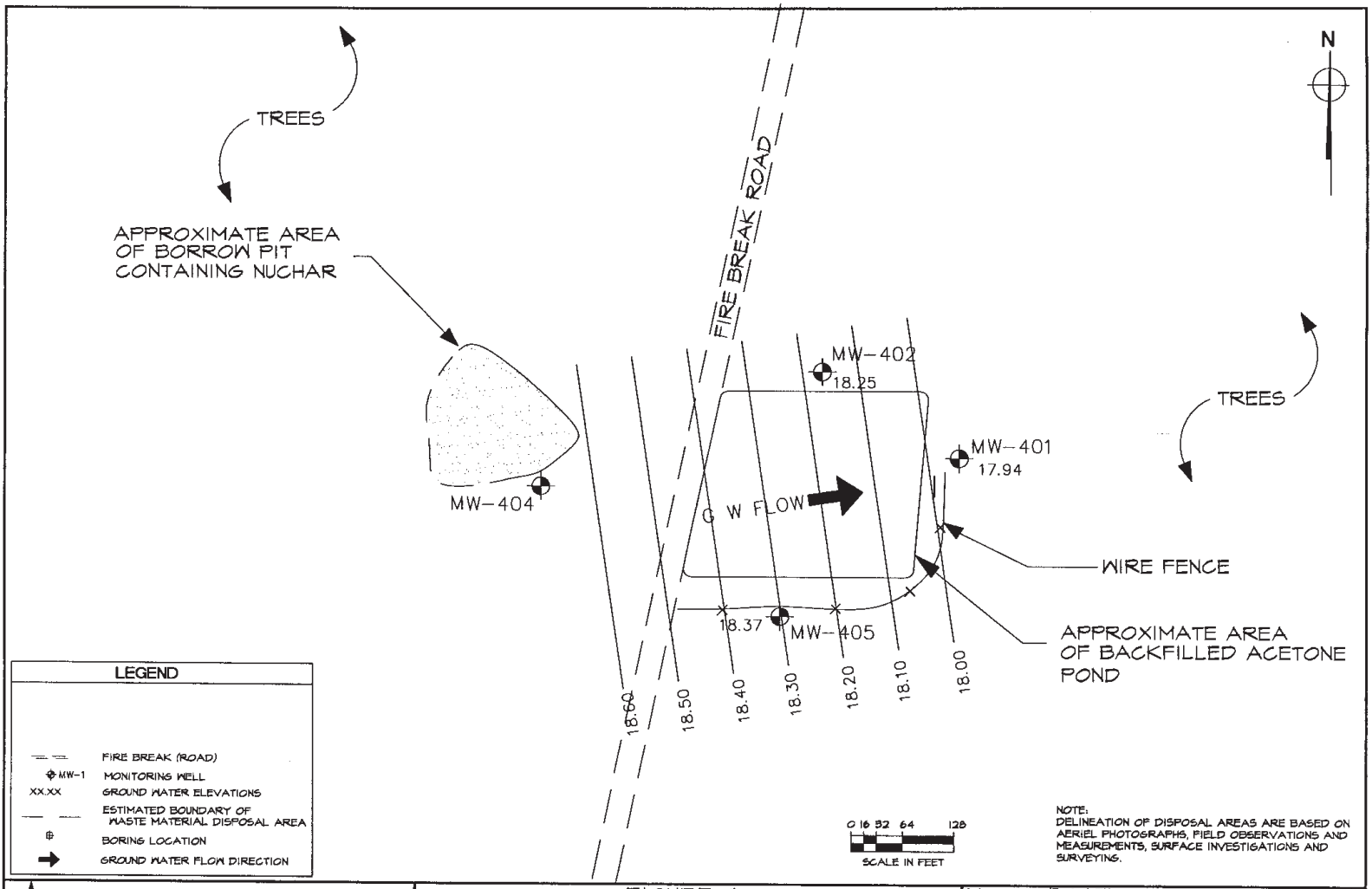
FACSIMILE: (301) 975-0169

FIGURE 8
SWMU 03
POTENTIOMETRIC SURFACE MAP
WOODBINE, GEORGIA

Date: 7-16-96	Project Title: THIOKOL CORPORATION WOODBINE, GA		
Drawn By: JCC			
Project Number: 097.001	CAD File: UNION-4	Scale: AS SHOWN	Client: THIOKOL CORP.



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FACSIMILE: (301) 975-0169

FIGURE 9
SWMU 04
POTENTIOMETRIC SURFACE MAP
WOODBINE, GEORGIA

Date:	Project Title:		
7-16-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: EMD			
Project Number: 097.001	CAD File: UNION-1	Scale: AS SHOWN	Client: THIOKOL CORP

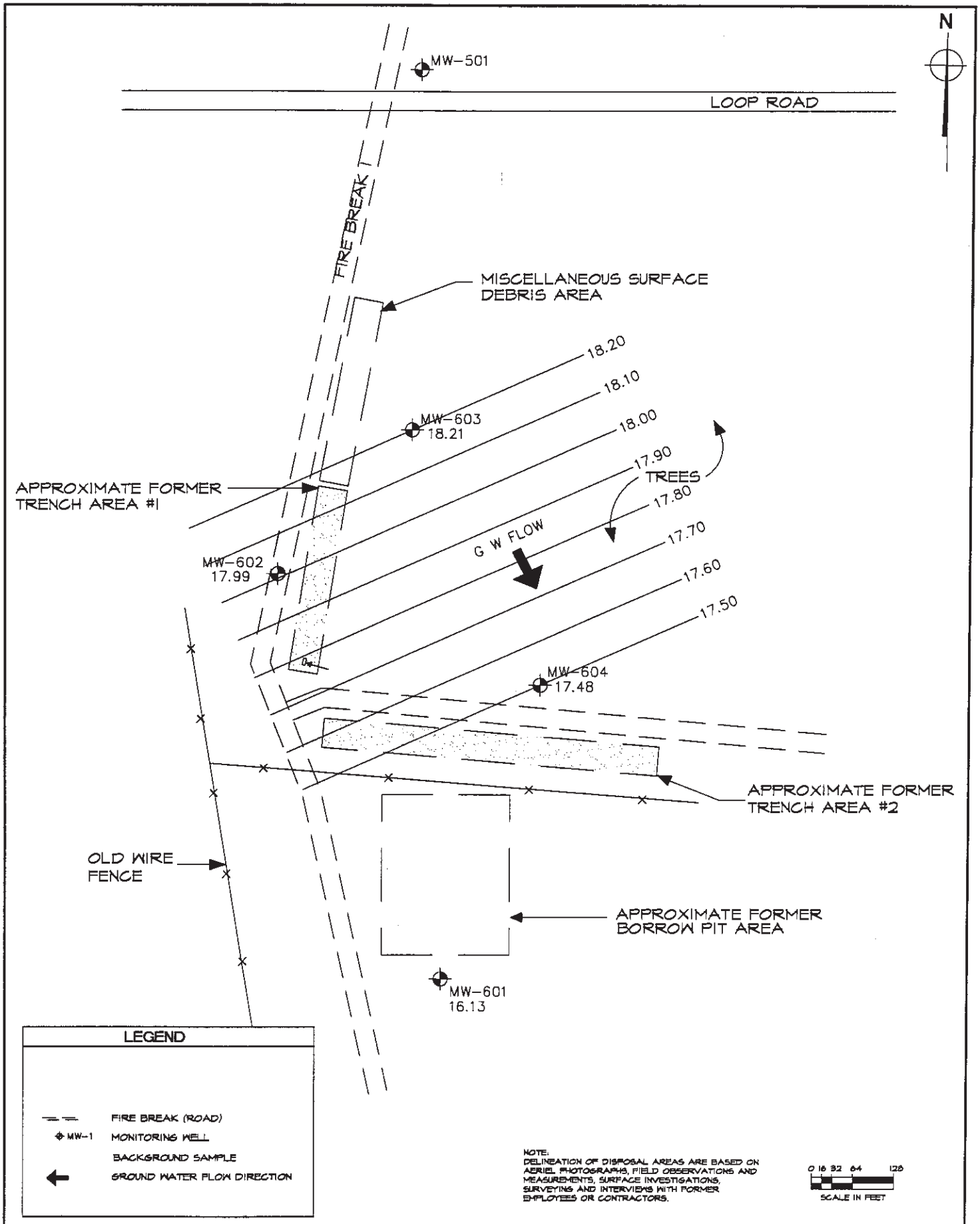

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FIGURE 10
SWMU 06
POTENTIOMETRIC SURFACE MAP
NOVEMBER, 1995
WOODBINE, GEORGIA

PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
7-18-96	CDC	097.001
UNION-2	AS SHOWN	THIOKOL CORP.

Using the same assumptions as in the Phase I RFI by Law on effective porosity and Phase I RFI hydraulic conductivity measurements, Apex calculated the ground water flow velocity at SWMU 06. Where the effective porosity is 0.26, hydraulic conductivity is 5.6 x 10^{-3} feet per minute (2.9 x 10^{3} feet per year), with a hydraulic gradient of 0.002 ft/ft, the calculated ground water flow velocity is approximately 23 feet per year.

Ground water data were collected by Apex at SWMU 07 during the sampling efforts in November 1995. Ground water flow direction was calculated using data from MW-701, 702, 703, and 704. As shown in Figure 11, ground water flow is to the east. The hydraulic gradient calculated by Apex was 0.002 ft/ft. The hydraulic gradient was not calculated in Law's Phase I RFI.

Using the same assumptions as in the Phase I RFI by Law on effective porosity and Phase I RFI hydraulic conductivity measurements, Apex calculated the ground water flow velocity at SWMU 07. Where the effective porosity is 0.26, hydraulic conductivity is 7.3 x 10^{-3} feet per minute (3.8 x 10^{3} feet per year), with a hydraulic gradient of 0.002 ft/ft, the calculated ground water flow velocity is approximately 30 feet per year.

1.2.5 Surface Water and Sediment

As noted in Section 1.1, the site is bounded by Todd Creek to the north. Todd Creek is a meandering tidal creek flowing from west to east which eventually merges with Floyd Creek east of the site, which in turn merges with the Cumberland River.

Todd Creek is an intertidal, estuarine-type creek with numerous salt marshes and eroded bluffs. The northern boundary of the facility is typified by a series of eroded bluffs 10 to 30 feet above the creek. The creek is bounded to the north by salt marshes which separate the creek from Cumberland Island. A more complete discussion of the surface water in the vicinity of the Woodbine site may be found in the Phase I RFI report prepared by Law.

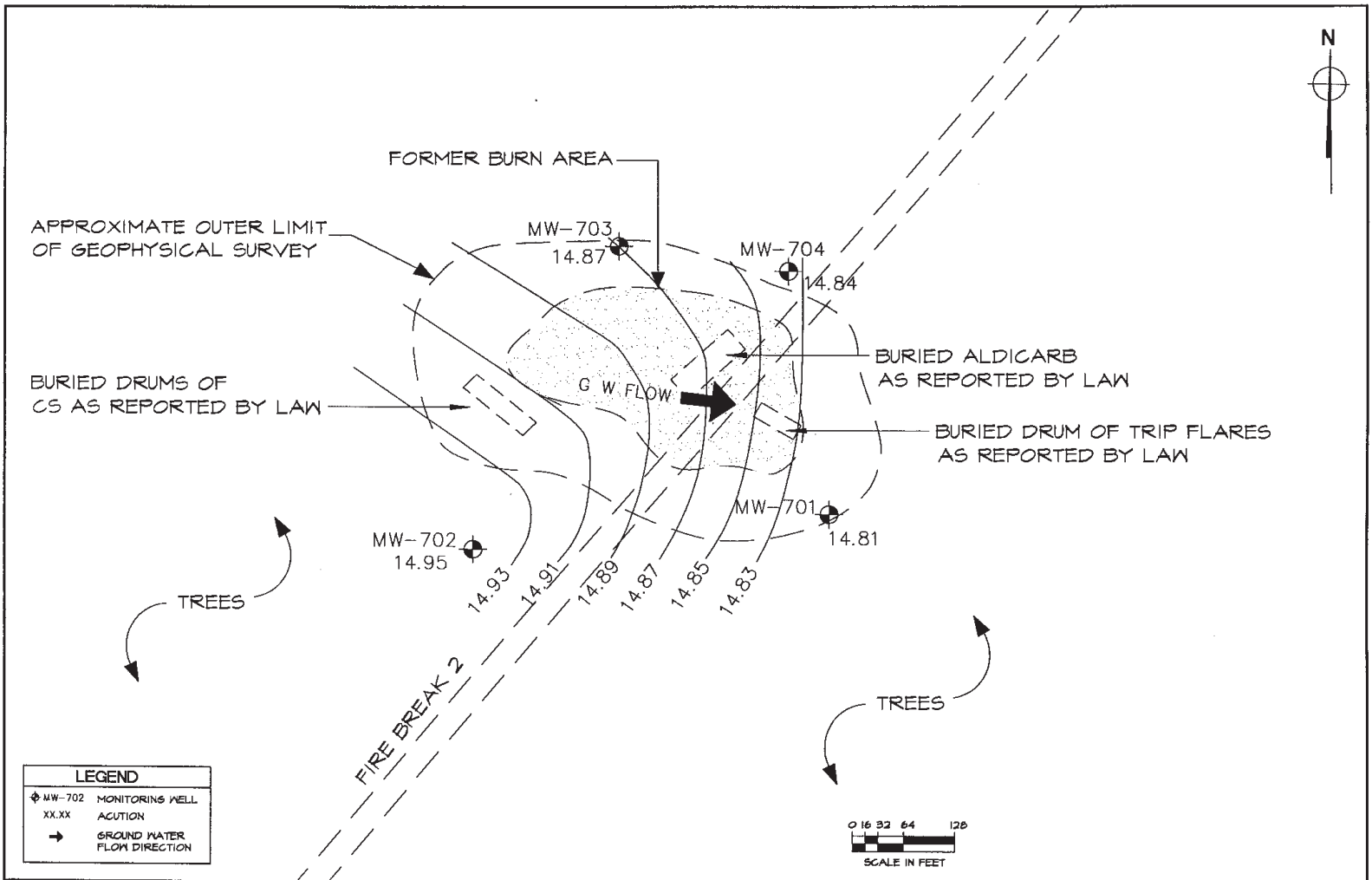

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FIGURE 11
SWMU 07
POTONTIOMETRIC SURFACE MAP
NOVEMBER, 1995
WOODBINE, GEORGIA

Date:	Project Title:		
7-15-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: EMD			
Project Number: 097.001	CAD File: UNION-X	Scale: AS SHOWN	Client: THIOKOL CORP

1.2.6 Air and Meteorology

The closest meteorologic data available for the facility is located in Brunswick, Georgia, and maintained by the National Weather Service (NWS). The Woodbine site is located approximately 12 miles south of Brunswick. The area is typified by a mean temperature of 68.5 degrees Fahrenheit (°F) and average precipitation of 51.13 inches per year. More detail on the regional climatological data is found in Law's Phase I RFI report.

1.2.7 Demographics

The following population estimates were calculated from the 1990 U.S. Census Bureau's databases. Population was estimated based on zip code boundaries. The facility is located within the 31569 zip code area. Surrounding zip codes are 31558 (St. Marys, Georgia), 31548 (Kingsland, Georgia), and 31565 (Waverly, Georgia). Populations are:

- zip code 31569 - population 4,399, 1,555 households, 2.8 average population/household size;
- zip code 31558 - population 15,714, 4,377 households, 3.6 average population/household size;
- zip code 31548 - population 8,722, 3,016 households, 2.9 average population/household size;
- zip code 31565 - population 400, 144 households, 2.8 average population/household size; and
- total population - 29,235 people, 9,092 households, and a population household average of 3.2 people.

2.0 PHASE I INVESTIGATION - LAW

A more complete discussion of Law's Phase I RFI may be found in it's report dated February 5, 1993.

2.1 SWMU 02

Potential releases from SWMU 02 were investigated during Law's Phase I RFI by the collection of surficial soil samples (SS-201 to SS-204) which were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and malononitrile, orthochlorobenzaldehye and orthochlorobenzalmalononitrile (hereafter described as CS and its degradation products).

Law reported that negligible contamination was detected. Low part per billion (ppb) concentrations of five VOCs were detected in the samples at below the proposed Subpart S action levels (where one exists), the Georgia Hazardous Site Response Act (HSRA) corrective action concentrations (i.e., 100 times the media target concentrations for ground water), and the maximum allowable contaminant level (MACL) derived using the U.S. Environmental Protection Agency's (EPA's) Organic Leaching Model (OLM). SVOCs were not detected. Analysis indicated that metals were present in soil at this SWMU. Law did compare these results with published values for the entire United States (U.S.) and concluded that the levels were within the published norms. GAEPD subsequently rejected the use of Subpart S action levels and published metals concentrations for comparison. CS and its degradation products were not detected. A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results, it was concluded by Law that SWMU 02 does not appear to present a risk to potential receptors. No further action was recommended by Law for SWMU 02. The GAEPD reviewed Law's Phase I RFI and determined that metals data should be compared with natural concentrations in soil at the site. GAEPD directed that background samples be collected in sufficient number to allow for a statistical comparison with the concentrations reported by Law. The GAEPD comments on the Phase I RFI are found in its letter dated August 10, 1995.

2.2 SWMU 03

Site reconnaissance work for SWMU 03 noted inflatable buildings, debris piles, paint wastes, a boiler, an air handler structure, and ordnance materials. The live ordnance materials were deactivated and surface debris (e.g., scrap metal, miscellaneous materials, empty and live flares) was removed by Law in 1993.

Potential releases from surface disposal activity were investigated with the collection of surficial soil samples (SS-301 to 306 from Law's Phase I report) which were analyzed for VOCs, SVOCs, metals, aldicarb, and CS. No organic constituents were detected in these samples. Metals were detected in soils at this SWMU. Law compared these concentrations with published average concentrations for the entire U.S. and concluded that the concentrations at the SWMUs were within the published norms. The GAEPD rejected the use of published metals concentrations as action limits.

Potential releases from buried nuchar waste were investigated with test pit excavations and sampling of waste and underlying soil samples from the pits. Samples were analyzed for VOCs, SVOCs, metals, aldicarb, and CS. Samples from these pits (SO-306A and SO-306B from Law's Phase I report) contained some organic constituents at low ppb concentrations less than the proposed Subpart S action levels (where they exist), the HSRA corrective action concentrations, and the MACL.

Potential releases from a trench discovered during the investigation by Law were assessed using test pit excavations. A waste material sample (SO-304 from Law's Phase I report) was collected and analyzed for VOCs, SVOCs, metals, aldicarb, and CS. No organic constituents, aldicarb, or CS were found; only low levels of metals were detected in this sample.

Ground water samples were obtained from three wells (MW-301, MW-302, and MW-303) installed by Law during Phase I of the RFI and analyzed for VOCs, SVOCs, metals, and CS. Only low concentrations of barium were found in the samples; no organics or CS were detected. A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results, Law concluded that SWMU 03 does not appear to present a risk to potential receptors. Based on this data, no further action was recommended

by Law. However, following submittal of the Phase I RFI report, information was discovered regarding additional disposal areas at this SWMU. The GAEPD reviewed the Phase I report and the subsequent information and determined that additional investigation was required. The GAEPD required the completion of test pitting within the recently identified disposal areas to assess the potential for releases from these areas. The GAEPD also required the completion of soil borings and monitoring wells downgradient from both areas (referred to herein as the Burn Area and the Aldicarb Disposal Area).

2.3 SWMU 04

Potential releases from the Acetone Evaporation Pond were investigated by Law with borings, collection of soil samples (SS-401 to SS-405 from Law's Phase I report), and laboratory analysis for VOCs, SVOCs, metals, aldicarb, and pH. Acetone and other organics were detected in these samples at low level concentrations less than the proposed Subpart S action levels (where they exist), the HSRA corrective action concentrations, and the MACL. Metals were detected in soils at this SWMU. Law compared these concentrations with published average concentrations for the entire U.S. and concluded that the concentrations at the SWMU were within the published norms.

Potential releases from the Nuchar pits were investigated with test pit excavations by Law. Soil samples collected from the pits (SO-402A and SO-402B from Law's Phase I report) were analyzed for VOCs, SVOCs, metals, aldicarb, and pH. Organics and aldicarb were detected in these samples at concentrations less than the proposed Subpart S action levels (where they exist), the HSRA corrective action concentrations, and the MACL. Metals were detected in soils at this SWMU. Law compared these concentrations with published average concentrations for the entire U.S. and concluded that the concentrations at the SWMU were within the published norms. The GAEPD subsequently rejected the use of the proposed Subpart S action levels and the comparison of metals with published norms.

Ground water samples were collected from wells MW-401, MW-402, MW-403, and MW-404 installed during the Phase I RFI. Cis-1,2-dichloroethene was the only organic constituent detected and it was found in only one well, MW-401, at below its maximum contaminant limit (MCL). A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results, it was concluded by Law that SWMU 04 does not appear to present a risk to potential receptors. No further action was recommended; however, the GAEPD requested that the overflow ditch near the Acetone Evaporation Pond be investigated. As with the other SWMUs, the GAEPD also required the collection of background soil samples for comparison with metals results from within SWMU 04. The background soil samples were analyzed for metals to be compared statistically with the data collected during the Phase I RFI.

2.4 SWMU 05

Site reconnaissance work for SWMU 05 noted asphalt and an empty drum reportedly containing aldicarb oxime which was found in an open trench. These were removed by Law prior to the site sampling program.

Potential releases from this SWMU were investigated by collecting soil samples (SS-501 to 505 from Law's Phase I report) and a sample of a white material (waste) which were analyzed for VOCs, SVOCs, metals, and aldicarb. A rinse sample of the drum was collected during surface debris removal activities. Aldicarb and associated degradation products were not detected in the drum sample. Low concentrations of organics were detected in the soil samples. The white material (waste) sample contained aldicarb at a very low concentration. Metals were detected in soils at this SWMU. Law compared these concentrations with published average concentrations for the entire U.S. and concluded that the concentrations at the SWMU were within the published norms. Detected constituent concentrations were less than the proposed Subpart S action levels (where they exist), the HSRA corrective action concentrations, and the MACL. The GAEPD subsequently rejected the use of published metals concentrations and the Subpart S action levels for comparison.

A ground water sample was taken from monitoring well MW-501 which was installed during the Phase I of the RFI. Metals and naphthalene were found in the ground water at very low levels. Metals were detected below MCLs and naphthalene was detected below the proposed Subpart S action level and the HSRA corrective action limit. A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results, Law concluded that SWMU 05 does not appear to present a risk to potential receptors. No further action was recommended by Law. However, the GAEPD requested the collection and analysis of background soil samples for metals for

the statistical comparison of data within SWMU 05 and the resampling of the monitoring well installed by Law during the Phase I RFI.

2.5 SWMU 06

Site reconnaissance work for SWMU 06 noted asphalt, building debris, and corn cob grit. Potential releases from this SWMU were investigated by collecting soil samples (SS-601 to 603 from Law's Phase I report) from the surface disposal area. Test pits were excavated to investigate the areal and vertical extent of waste disposal in trench areas and the Borrow Pit Area. The waste and soil samples were analyzed for VOCs, SVOCs, metals, aldicarb, and CS. A crushed drum was encountered in Former Trench Area 2.

Waste and soil samples were taken from two of the six test pits (TP-624 and TP-625) within the Former Trench Area 2 [SO-624A (waste), SO-624B (waste, duplicate of SO-624A), SO-624C (soil), and SO-625 (waste)]. Soil samples were taken from the Borrow Pit Area from test pit TP-607 (SO-607A and SO-607B). The waste material in Trench Area 1 was reported by Law to be similar to waste material encountered in Trench Area 2, so no samples were taken there, as discussed in the approved Work Plan.

Chemical constituents were not detected in the surface disposal area samples except SS-601 which contained a small amount of toluene. Metals were detected in soils at this SWMU. Law compared these concentrations with published average concentrations for the entire U.S. and concluded that the concentrations at the SWMU were within the published norms. The Borrow Pit samples contained some organics and metals. A drum was also discovered in the Borrow Pit, but its contents were not sampled. The drum was observed to contain a clear liquid and was backfilled within the test pit where it was discovered. Organic constituents were detected below the proposed Subpart S action levels or the MACLs. All were also below the HSRA corrective action concentrations except benzoic acid, p-cresol, isopropyl, toluene, and 1,2,4-trimethylbenzene which are not regulated substances listed in the HSRA media target concentrations table. The GAEPD subsequently rejected the use of published metals concentrations and the Subpart S action levels for comparison.

Ground water samples were obtained from four monitoring wells (MW-601 through MW-604) installed for the Phase I RFI. Metals were detected in the ground water below MCLs. No organic compounds were detected in the ground water samples. A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results, it was concluded by Law that SWMU 06 does not appear to present a risk to potential receptors, except the Borrow Pit Area may contain buried drums. Further assessment was recommended by Law to locate additional drums, if any, and characterize their contents.

The GAEPD concurred with this view. GAEPD recommended test pitting in Trench Area 2 and the Borrow Pit Area, as well as hand auger sampling of the waste material and underlying soil from Trench Area 1. GAEPD also required resampling of the monitoring wells installed by Law during the Phase I RFI and the collection of background soil samples for metals analysis.

2.6 SWMU 07

As outlined in the approved work plan prepared by Law, intrusive soil sampling was not performed at SWMU 07 during the Phase I RFI.

Ground water samples were obtained from four monitoring wells (MW-701 through MW-704) installed outside of the area delineated by Law for Phase I of the RFI at SWMU 07. Metals were detected in the ground water at concentrations below MCLs, but no organic compounds were detected in MW-701, MW-702, or MW-703. Benzene and chromium were detected slightly above their MCLs and several other organics were detected below their MCLs in well MW-704. Also detected in this well was 2,4-dimethylphenol. An MCL does not exist for this compound. A more complete discussion of Law's Phase I RFI may be found in the report dated February 5, 1993.

Based on the sampling results and the absence of potential ground water receptors, it was concluded by Law that SWMU 07 releases to ground water do not appear to present a risk to potential receptors. Concern existed regarding the buried material (i.e., trip flares and ordnance) and an additional assessment was recommended to locate and characterize it. Following the Phase I RFI report, information was discovered regarding potential additional disposal areas at this SWMU.

3.0 PHASE II INVESTIGATION - APEX

3.1 SWMU 02

The Phase II investigation at SWMU 02 was limited to the collection of background soil samples for analysis of metals concentrations in the soil (Figure 12). Six background soil samples were collected from three soil borings (BKG 2-1, BKG 2-2, BKG 2-3) and analyzed for metals. The samples were collected at depths of two and four feet from each boring as requested by the GAEPD.

Metals concentrations from soil samples collected during the Phase I investigation by Law were statistically compared to the concentrations from background samples collected at SWMU 02 by Apex. The results of analysis of soil samples for SWMU 02 are presented in Section 4.2. The discussion of the statistical comparisons is presented in Section 4.1.

3.2 SWMU 03

SWMU 03 is located on the east side of the asphalt road leading to the Rocket Test Pad. SWMU 03 contains four areas identified as potential waste areas. The four areas are the Buried CS Trench, the Surface Debris Area, the Burn Area, and the Aldicarb Disposal Area. The Buried CS Trench and Surface Debris Area were previously investigated by Law. The Burn Area and Aldicarb Disposal Area were identified subsequent to completion of the Phase I RFI. These areas are included in the Phase II RFI.

The Phase II investigation at the Buried CS Trench, and Surface Debris Areas of SWMU 03 was limited to the collection of background soil samples from near the disposal area and ground water samples from the three monitoring wells installed during the Phase I investigation. Ground water samples were analyzed for VOCs, base neutral acids (BNAs), aldicarb, metals, and CS. Soil samples were analyzed for metals.

Six background soil samples were collected from three soil borings (BKG 3-1, BKG 3-2, BKG 3-3) and analyzed for metals (Figure 13). The samples were collected at depths of two and four feet as requested by the GAEPD. Metals concentrations from soil samples collected during the Phase I investigation were statistically compared to the background concentrations from samples collected in the same mapped soil type as the background samples collected at SWMU 03. The discussion of the statistical comparisons is presented in Section 4.1.

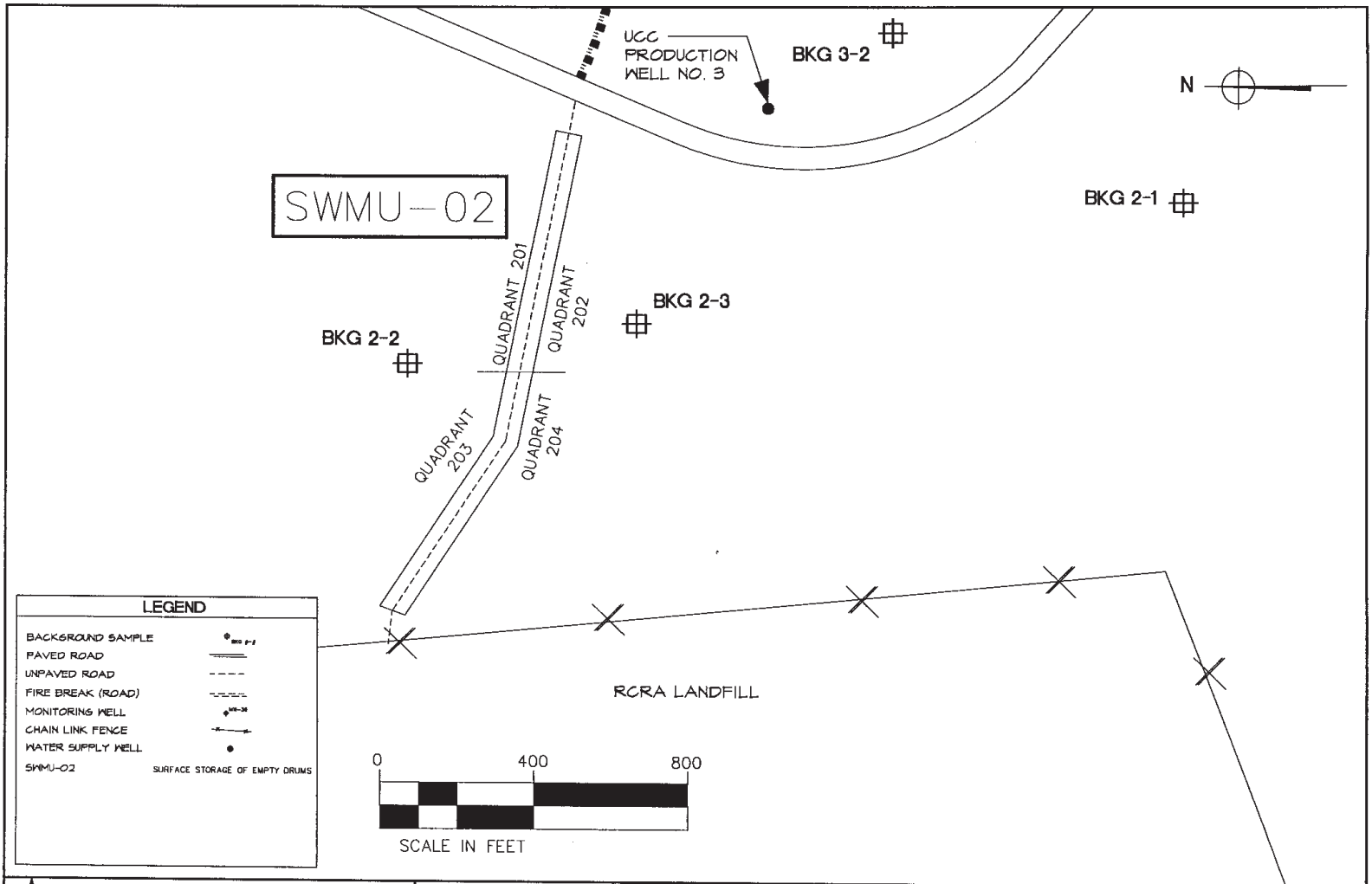

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FIGURE 12
SWMU 02
SITE MAP
BACKGROUND SAMPLE LOCATIONS
WOODBINE, GEORGIA

Date:	Project Title:		
7-15-96	THIOKOL CORPORATION WOODBINE, GA		
Drawn By: CDC			
Project Number: 097.001	CAD File: SWMU2	Scale: AS SHOWN	Client: THIOKOL CORP

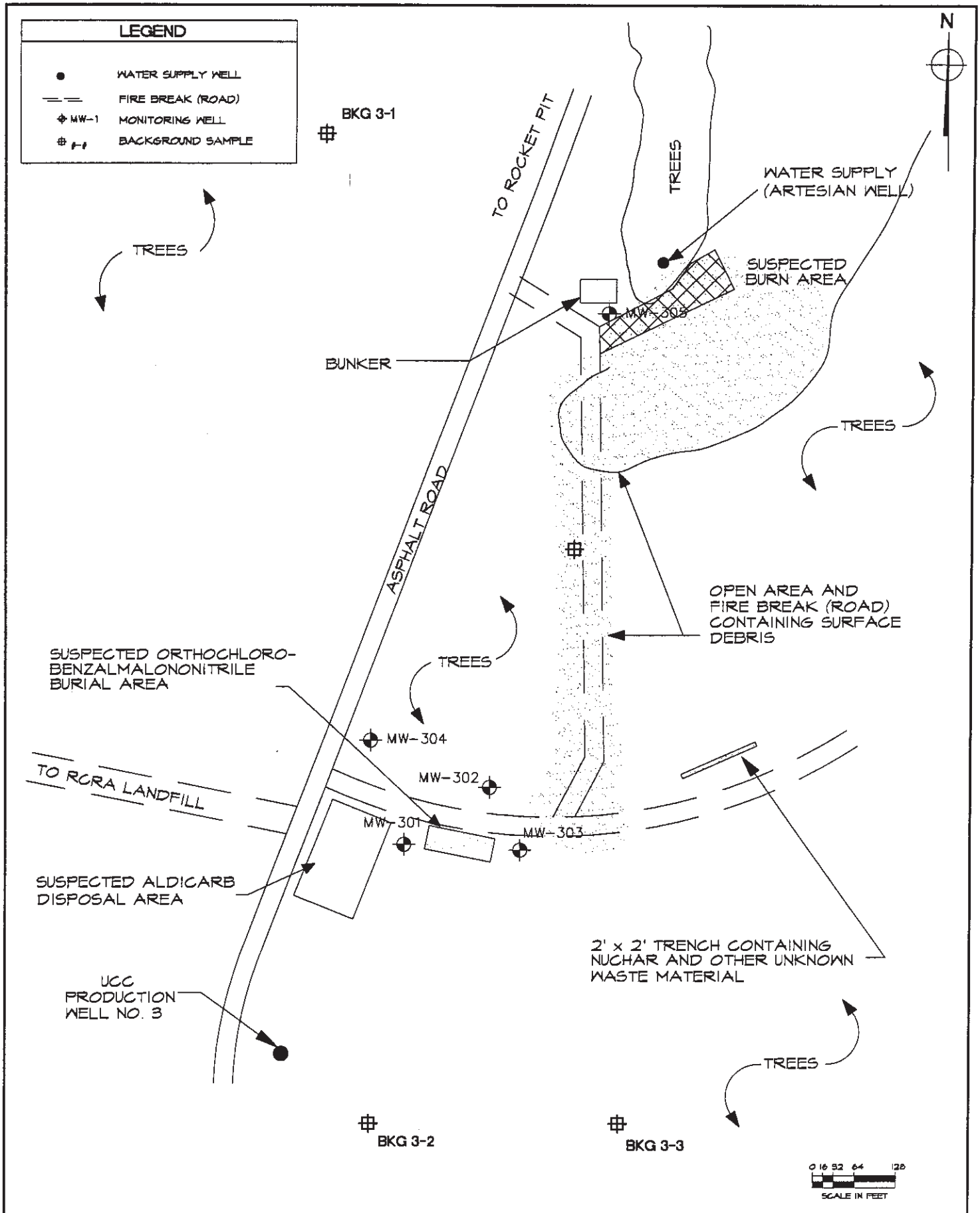

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FIGURE 13
SWMU 03
BACKGROUND SAMPLE LOCATIONS
WOODBINE, GEORGIA

PHASE II RFI
THIOKOL CORPORATION
WOODBINE, GA

7-18-96	CDC	097.001
UNION-2	AS SHOWN	THIOKOL CORP.

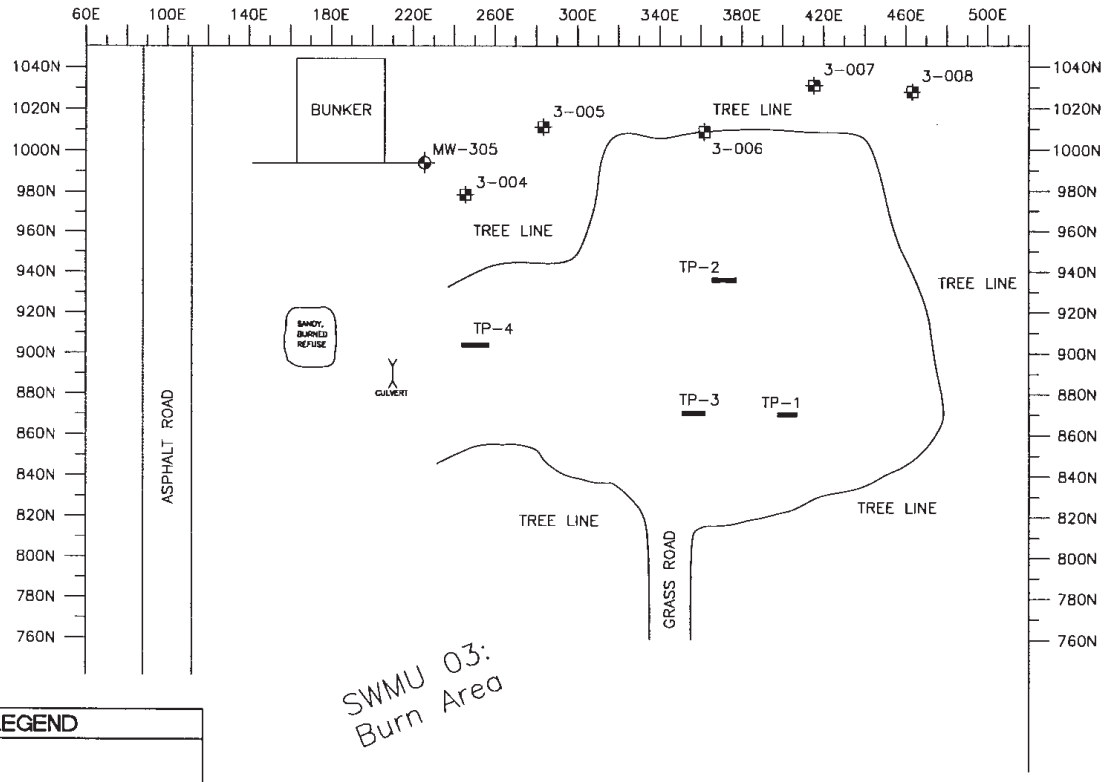
3.2.1 Burn Area

Subsequent to the submittal of the Phase I RFI, a Burn Area for ordnance was identified by UCC. The location of the Burn Area was reported to be in the northern section of SWMU 03, but its exact location was unknown. The Phase II investigation of the Burn Area was intended to locate (if present) the ordnance Burn Area using geophysical methods, install a monitoring well downgradient of the Burn Area, and sample the ground water. In addition, a minimum of eight test pits were to be completed in the Burn and Aldicarb Disposal Areas as requested by the GAEPD.

Prior to commencing the investigation of this SWMU, the surface and near surface areas were swept for ordnance due to the observance of 40 mm grenades in and around the area. Four 40 mm grenades were located within the area under investigation and deactivated by EOD Technology (EOD).

After the site was cleared of ordnance, a ground penetrating radar (GPR) survey was conducted to locate the Burn Area. The GPR survey identified four anomalous areas within the survey area which may have been associated with the Burn Area. Four test pits were completed in the area to examine the anomalous geophysical areas (Figure 14). One test pit, TP-4, located a possible Burn Area due to the presence of charcoal found in the subsurface and the GPR signature. Additional test pits revealed either buried nonordnance metal objects or concrete. Three soil samples were collected from the bottom of the test pits and analyzed for VOCs, BNAs, metals, aldicarb, and CS. Results of the analysis of these soil samples are presented in Section 4.

Five soil borings were completed using a hydraulic truck-mounted soil sampler on the north side of the Burn Area of SWMU 03 to identify a location for the installation of a monitoring well. In one soil boring (3-004) at four to five feet, an anomalously elevated headspace reading was recorded. A single soil sample was submitted for laboratory analysis of VOCs, BNAs, metals, aldicarbs, and CS from this boring. One type II monitoring well was installed downgradient of boring 3B-002 and the Burn Area. One ground water sample was collected from the installed monitoring well (MW-305). The sample was analyzed for VOCs, BNAs, metals, aldicarb, and CS.



LEGEND

- SOIL BORING LOCATION
- MONITOR WELL
- GEOPHYSICAL SURVEY GRID COORDINATES

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FIGURE 14
SWMU3-BURN AREA
SAMPLE LOCATIONS
WOODBINE, GA

Date:	Project Title:		
7-18-96	THIOKOL CORPORATION WOODBINE, GA		
Drawn By: CDC			
Project Number: 097.001	CAD File: SWMUBA	Scale: NTS	Client: THIOKOL CORP

Six background soil samples were collected from three soil borings and analyzed for metals outside the limits of SWMU 03. The samples were collected at depths of two and four feet as requested by the GAEPD in its letter dated August 10, 1995.

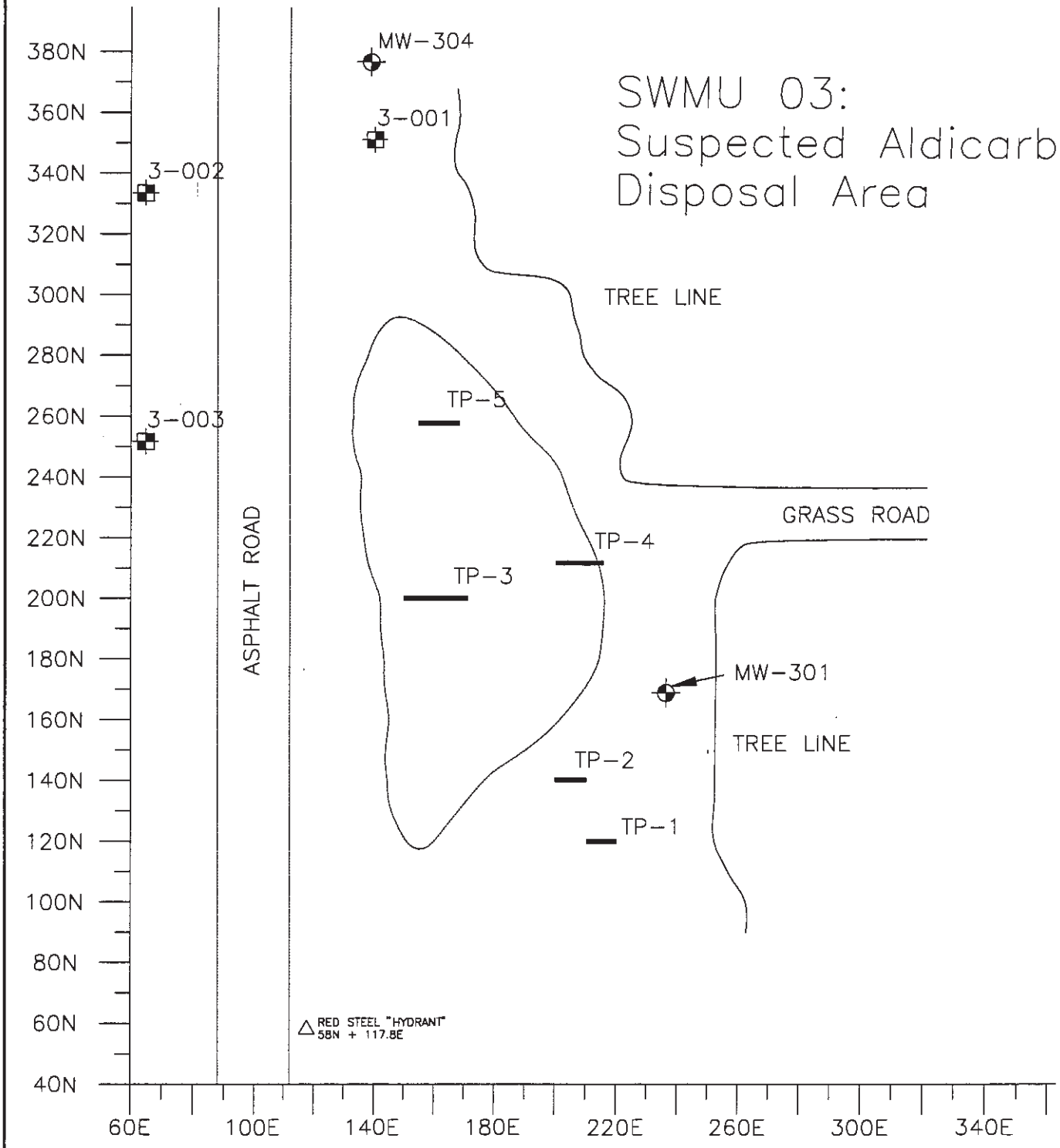
Metals concentrations from soil samples collected during the Phase I investigation were statistically compared to the background concentrations from samples collected in the same mapped soil type as the background samples collected at SWMU 03. The discussion of the statistical comparisons is presented in Section 4.1.

3.2.2 Aldicarb Disposal Area

The Aldicarb Disposal Area is a flat topped mound located on the east side of the paved road across from the entrance road to the RCRA landfill (Figure 15). This area was identified by UCC after completion of the Phase I RFI.

The Phase II investigation of the SWMU 03 Aldicarb Disposal Area was intended to locate (if present) buried aldicarb in the mound area using geophysical methods, install a monitoring well downgradient of the disposal area, and sample the ground water. A minimum of eight test pits were to be completed in the Burn and Aldicarb Disposal Areas as requested by the GAEPD; five were completed in the Aldicarb Disposal Area. It was unknown whether aldicarb had been disposed in drums or dumped onto the ground. Prior to commencing investigation of this SWMU, the area was swept for ordnance due to the observance of 40 mm grenades and a M301 timing train fuse in and around the area.

After the area was cleared of ordnance related items, two geophysical surveys were conducted on the mound suspected to be the Aldicarb Disposal Area. An EM31 electromagnetic survey and a GPR survey were conducted to locate buried metal objects (i.e., drums) or changes in the soil properties that may indicate the disposal of aldicarb. The geophysical surveys indicated that there were no large buried ferrous objects in the mound. However, a change in conductivity in the mound could be interpreted as material with different physical properties from the surrounding soils.



LEGEND

- TEST PITS
- MONITORING WELL
- SOIL BORING LOCATION
- GEOPHYSICAL SURVEY GRID COORDINATES

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FIGURE 15
SWMU3-ALDICARB
DISPOSAL AREA
SAMPLE LOCATIONS
WOODBINE, GA

Project Title:
THIOKOL CORPORATION
WOODBINE, GA

Date:	Drawn By:	Project Number:
7-18-96	CDC	097.001
CAD File:	Scale:	Client:
SWMU3B	N.T.S	THIOKOL CORP

After the geophysical surveys were completed, five test pits were excavated to examine the geophysical results. The test pits indicated that the disposal of solid material was unlikely to have occurred in this area. Soil samples were collected from the bottoms of the five test pits for laboratory analysis for VOCs, BNAs, metals, aldicarbs, and CS.

Three soil borings were completed using a hydraulic truck-mounted soil sampler on the north and west sides of the SWMU to identify a location for the installation of a monitoring well downgradient of the Aldicarb Disposal Area. Headspace readings on soil samples collected during the completion of soil borings were all within background levels. As such, a single type II monitoring well (MW-304) was installed approximately 50 feet downgradient of the Aldicarb Disposal Area. One ground water sample was collected from the newly installed monitoring well. The sample (as with the samples from the previously installed wells) was analyzed for VOCs, BNAs, metals, aldicarb, and CS.

Metals concentrations from soil samples collected during the Phase I investigation by Law were statistically compared to the concentrations from background samples collected at SWMU 03 by Apex. The results of analysis of soil samples for SWMU 03 are presented in Section 4.3. The discussion of the statistical comparisons is presented in Section 4.1.

3.3 SWMU 04

Phase II work at SWMU 04 was intended to investigate the overflow ditch on the east and south sides of the Acetone Evaporation Pond (Figure 16). The four monitoring wells installed by Law during the Phase I investigation were also resampled.

Six shallow borings (4-001, 4-002, 4-003, 4-004, 4-005, 4-006), three on the east side and three on the south side of the evaporation pond, were completed to depths of five feet. Soil samples were collected continuously using manually driven, direct push rods. The soil was screened at one foot intervals to a depth of five feet. The sample depth interval in the upper four feet with the highest headspace reading was submitted for laboratory analysis. A second sample was collected from each borehole at a depth of five feet. A total of twelve soil samples were submitted for laboratory analysis from these borings.

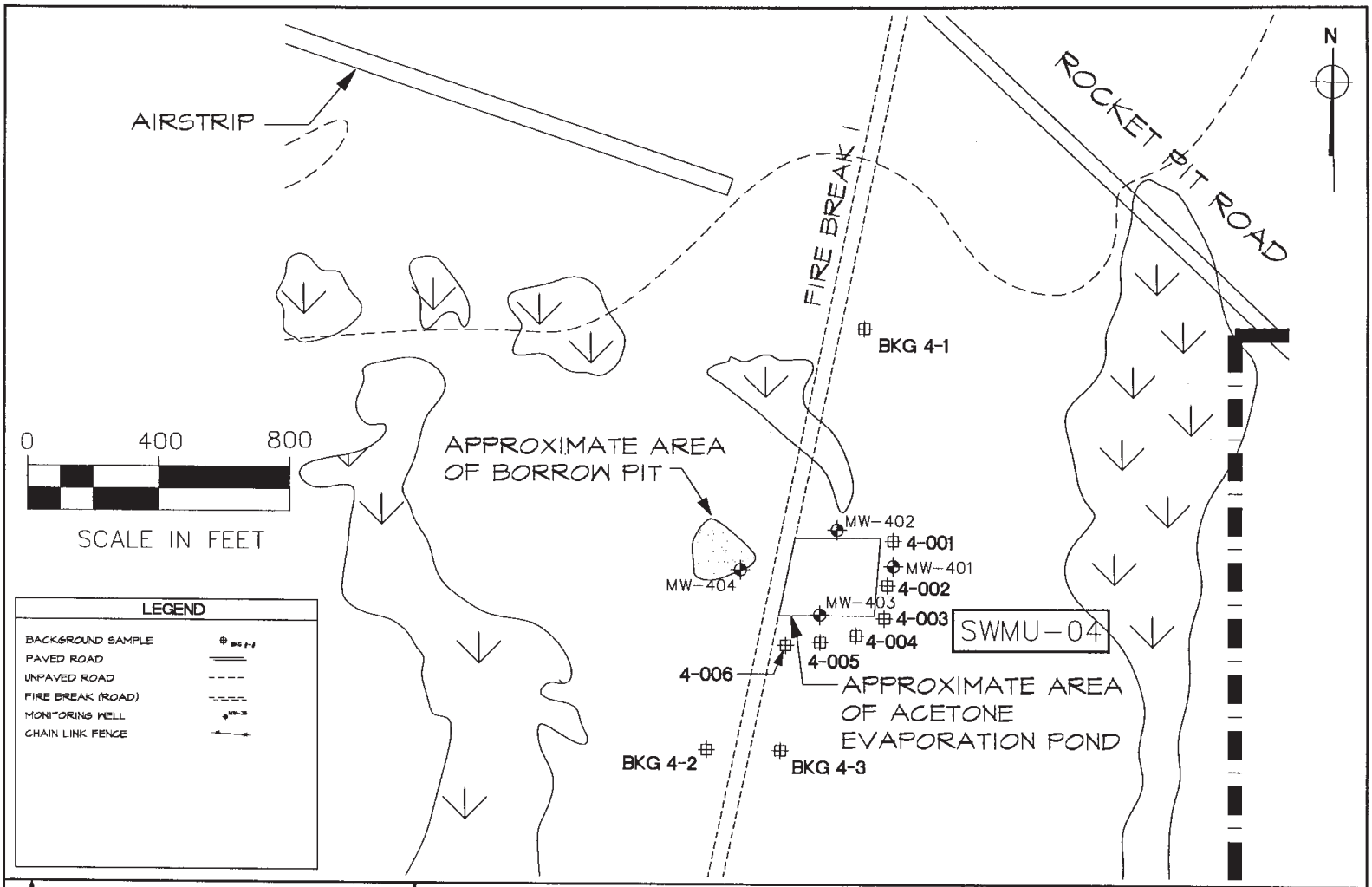

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FIGURE 16
SWMU 04
SAMPLE LOCATIONS
WOODBINE, GEORGIA

Date:	Project Title:		
7-11-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: SJR			
Project Number: 097.001	CAD File: BKG4	Scale: AS SHOWN	Client: THIOKOL CORP

A ground water sample was collected from each of the four pre-existing wells (MW-401, MW-402, MW-403, MW-404). Each ground water sample was analyzed for VOCs, BNAs, metals, and aldicarb.

Six background soil samples were collected from three soil borings (BKG 4-1, BKG 4-2, BKG 4-3) and analyzed for metals (Figure 16). As with all background samples, the samples were collected at depths of two and four feet as requested by the GAEPD.

Metals concentrations from soil samples collected during the Phase I investigation were statistically compared to the concentrations from background samples collected at SWMU 04. The results of analysis of soil samples for SWMU 04 are presented in Section 4.3. The discussion of the statistical comparisons is presented in Section 4.1.

3.4 SWMU 05

Phase II work at SWMU 05 was limited to the collection of background soil samples for analysis of metals concentrations in the soil and the collection of one ground water sample from the monitoring well installed during the Phase I investigation. Six background soil samples were collected from three locations (BKG 5-1, BKG 5-2, BKG 5-3) and analyzed for metals (Figure 17). The results of analysis of soil samples for SWMU 05 are presented in Section 4.3. The discussion of the statistical comparisons is presented in Section 4.1.

A single, pre-existing monitoring well was sampled by Apex during the Phase II RFI. The sample was analyzed for VOCs, BNAs, metals, aldicarbs, and CS.

3.5 SWMU 06

The Phase II investigation of SWMU 06 was completed in three phases. The first phase of the investigation was to collect background soil samples for metals analysis (Figure 18) and to complete shallow soil probes in Trench Area 1 to collect samples of the waste material and the underlying soil (Figure 19). The second phase was to use geophysical methods to identify and locate buried drums in Trench Area 2 (Figure 20) and the Borrow Pit Area (Figure 21). The final phase involved sampling the monitoring wells installed during the Phase I investigation.

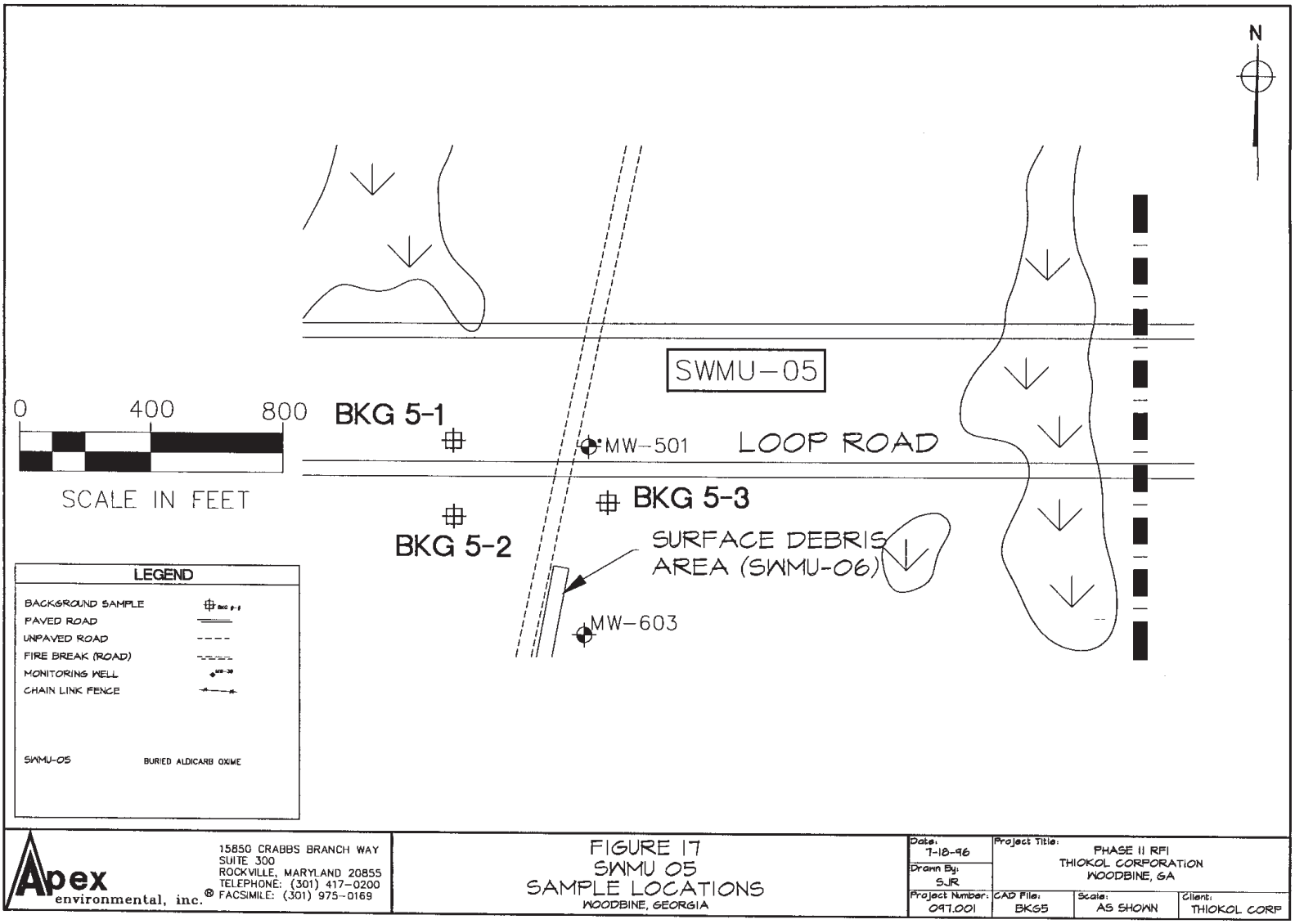

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FIGURE 17
SWMU 05
SAMPLE LOCATIONS
WOODBINE, GEORGIA

Date:	Project Title:		
7-18-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: SJR			
Project Number: 097.001	CAD File: BKG5	Scale: AS SHOWN	Client: THIOKOL CORP

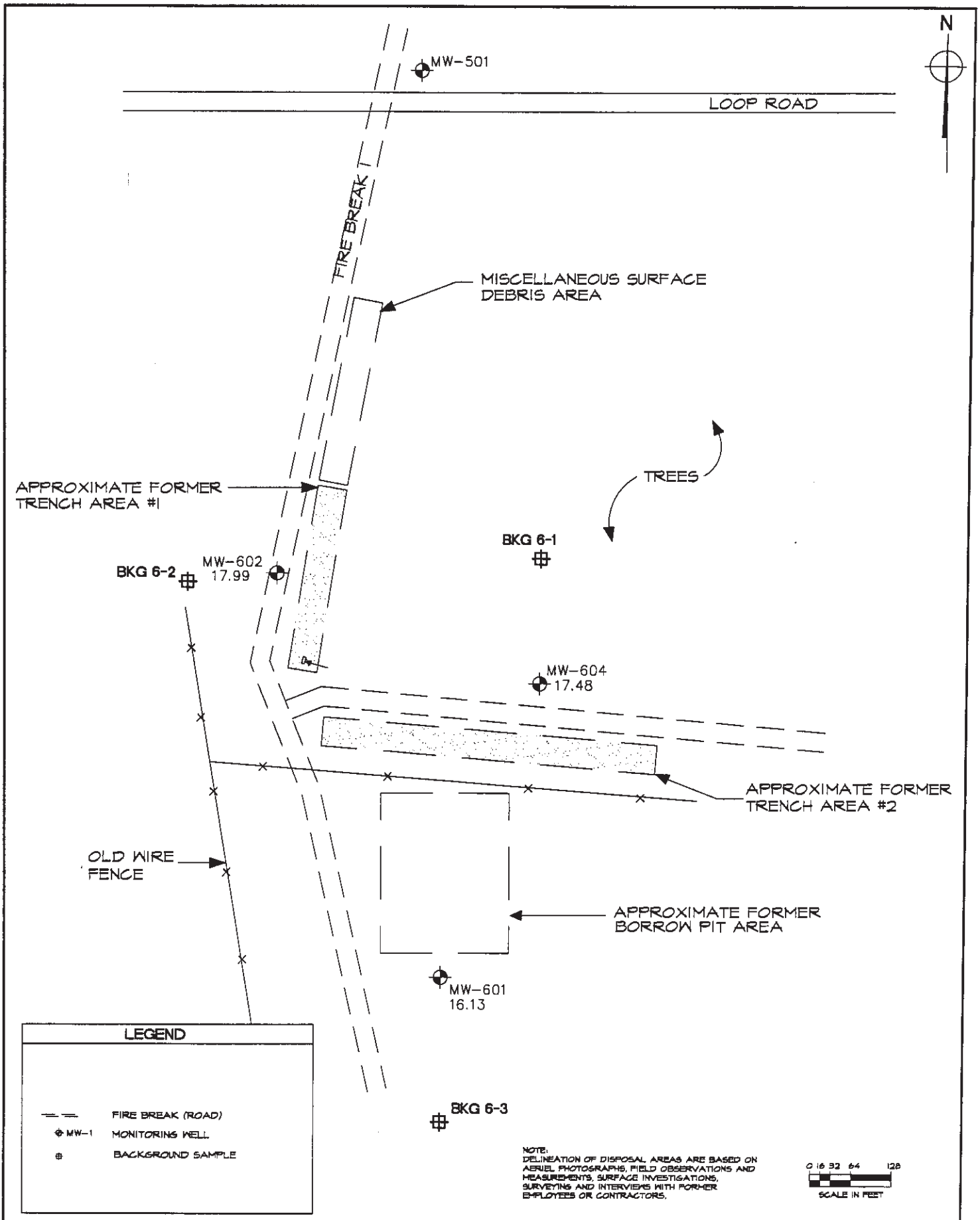

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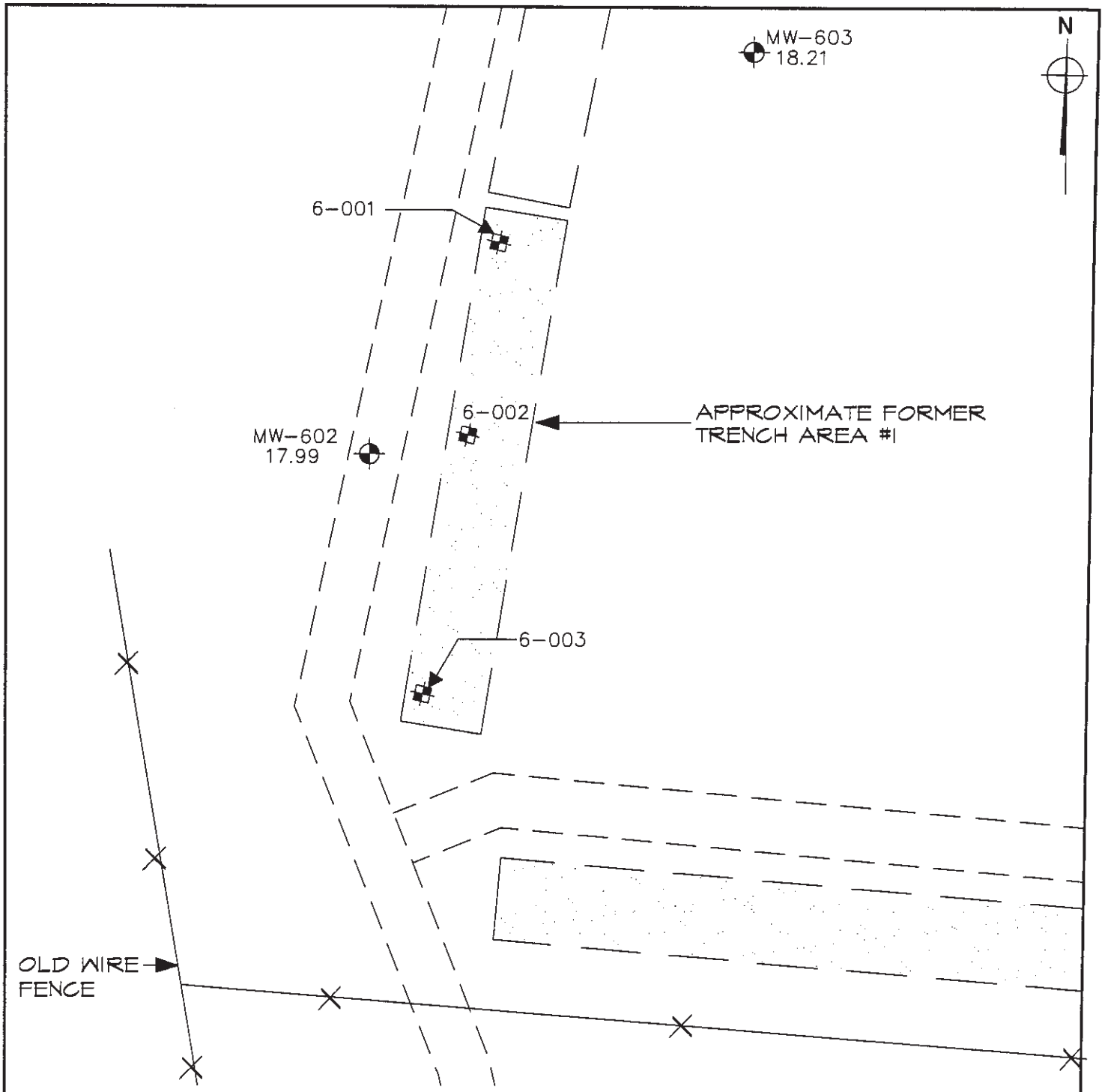
FIGURE 18
SWMU 06
BACKGROUND SAMPLE LOCATIONS
WOODBINE, GEORGIA

PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
7-18-96	CDC	097.001
UNION-2	AS SHOWN	THIOKOL CORP.



LEGEND

	FIRE BREAK (ROAD)
MW-1	MONITORING WELL
6-003	SOIL BORING LOCATION

NOTE:
DELINEATION OF SURFACE DEBRIS AREA AND ESTIMATED LOCATION OF BURIED WASTE ARE BASED ON AERIEL PHOTOGRAPHS, FIELD OBSERVATIONS AND MEASUREMENTS, SURVEYING AND INTERVIEWS WITH FORMER EMPLOYEES OR CONTRACTORS.

0 16 32 64 128
SCALE IN FEET

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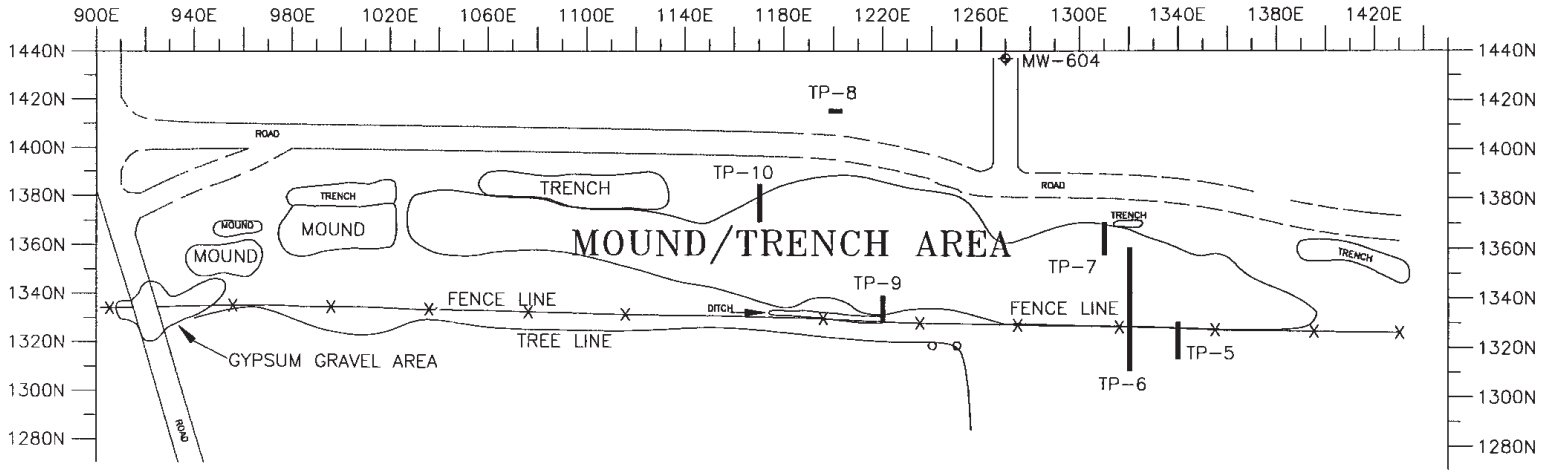
FIGURE 19
SWMU 06
TRENCH 1
SAMPLE LOCATIONS
WOODBINE, GEORGIA

Project Title:
PHASE II RFI
THOIKOL CORPORATION
WOODBINE, GA

Date:	Drawn By:	Project Number:
7-26-96	CDC	097.001
CAD File:	Scale:	Client:
SWMU6-23	AS SHOWN	THIOKOL CORP.



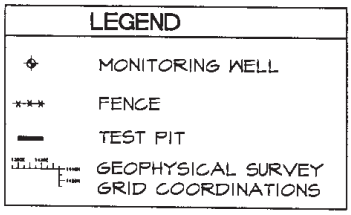


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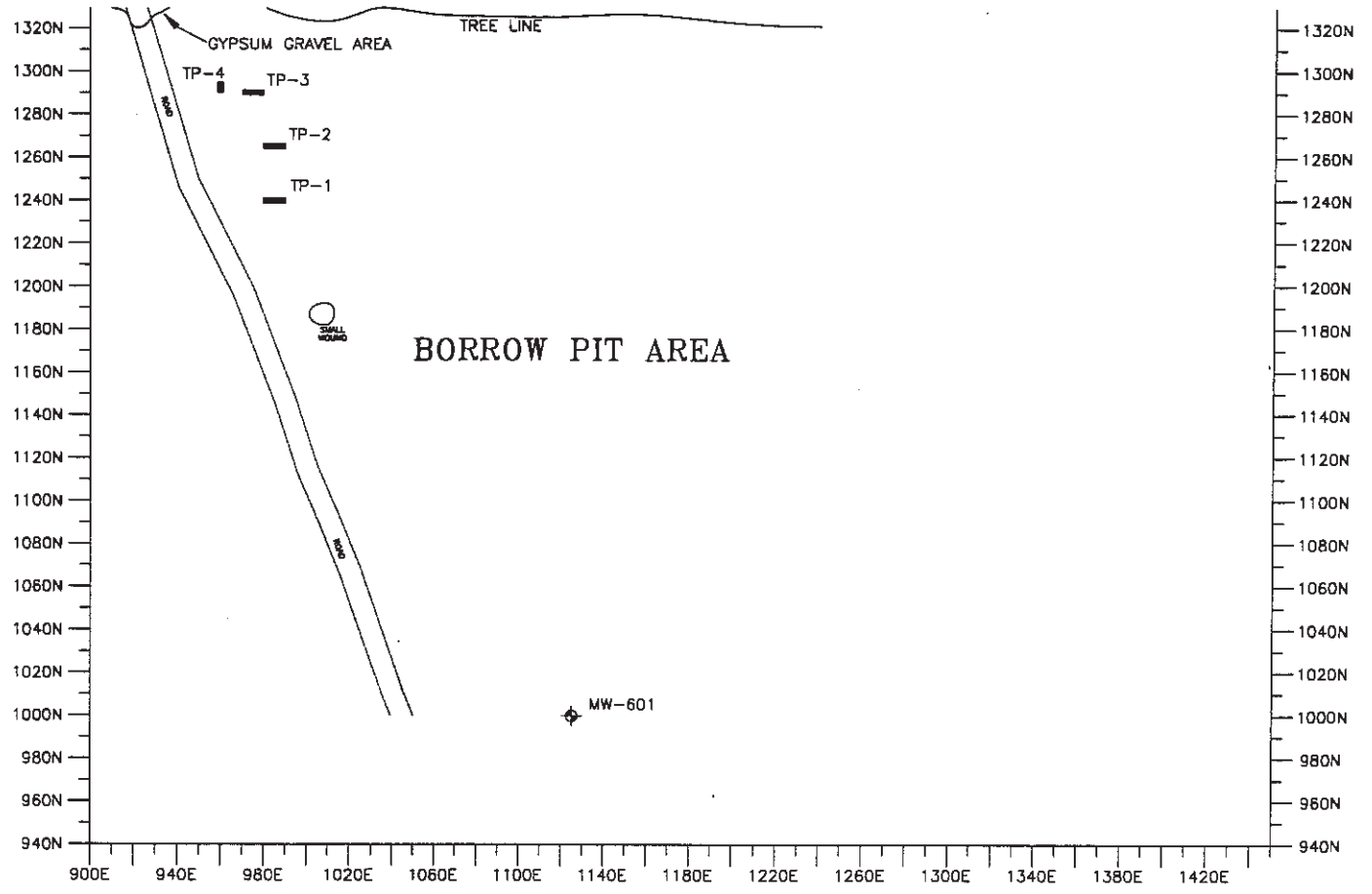
FIGURE 20
SWMU 06
TRENCH II AREA
SAMPLE LOCATIONS
WOODBINE, GEORGIA

Date: 7-17-96	Project Title: THOIKOL CORPORATION WOODBINE,GA		
Drawn By: CDC			
Project Number: 097.001	CAD File: SWMU6A	Scale: NTS	Client: THOIKOL CORP



LEGEND

- MONITORING WELL
- TEST PITS
- GEOPHYSICAL SURVEY GRID COORDINATES

N

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FIGURE 21
SWMU 06
BORROW PIT
SAMPLE LOCATIONS
WOODBINE GEORGIA

Project Title:
THIOKOL CORPORATION
WOODBINE, GEORGIA

Date:	Drawn By:	Project Number:
7/18/96	CDC	097.001
CAD File:	Scale:	Client:
SWMU6	N.T.S	THIOKOL CORP

Three soil samples of the waste material buried in Trench Area 1 were collected using hand probes and augers. Soil samples of the undisturbed soils below the trench could not be collected at the same time due to a hardpan layer directly under the trench that could not be penetrated by hand augering. Also, perched ground water was present above the undisturbed oils and cross contamination was possible if the hard pan was penetrated. Therefore, Apex collected soil samples from below the trench using a truck-mounted hydraulic soil sampler that could penetrate the hardpan layer. To limit the possibility of cross contamination, a discrete soil sampler rather than a continuous sampler was used, which minimized the potential for cross contamination by the downward migration of perched water.

A total of three samples of trench material and three samples of the underlying soil were submitted for laboratory analysis. The samples were analyzed for VOCs, BNAs, metals, aldicarb, and CS.

Geophysical surveys were conducted on the Borrow Pit Area and Trench Area 2. The GPR and EM-31 surveys were used to identify disposal areas and buried drums within the two areas. Several anomalous areas were identified in the Borrow Pit and Trench Areas. Test pits were excavated to investigate areas with anomalous signatures identified by the GPR and EM-31 survey.

A total of ten test pits were completed at SWMU 06: four in the Borrow Pit Area and six in Trench Area 2. A total of eight soil samples were collected from the excavations for laboratory analysis. Each sample was analyzed for VOCs, BNAs, metals, aldicarbs, and CS. Four ground water samples were submitted for laboratory analysis. Each ground water sample was analyzed for VOCs, BNAs, metals, aldicarbs, and CS.

Six background soil samples were collected from three soil borings and analyzed for metals. The samples were collected at depths of two and four feet as requested by the GAEPD. Metals concentrations from soil samples collected during the Phase I investigation were statistically compared to the concentrations from background samples collected at SWMU 06. The results of analysis of soil samples for SWMU 06 are presented in Section 4.3. The discussion of the statistical comparisons is presented in Section 4.1.

3.6 SWMU 07

The Phase II investigation of SWMU 07 was intended to locate and characterize three reported disposal areas herein referred to as the CS Disposal Area, the Aldicarb Disposal Area, and the Trip Flare Disposal Area. The investigation of SWMU 07 was completed using a phased approach. The first phase consisted of a visual surface sweep followed by the completion of a geophysical survey. The second phase consisted of the completion of shallow test pits to expose the sources of anomalous areas identified using geophysics. Further, test pitting and excavation of drummed material was performed to assess the potential for a release to the environment in the final phase.

A magnetometer survey of the SWMU was conducted to locate ordnance-related items and buried ferrous objects. Other geophysical surveys were not conducted due to the ubiquitous metal scrap present on and near the ground surface. Nineteen areas of anomalous magnetometer readings were identified during this sweep. Thirty-one exploratory test pits were excavated to identify the sources of the anomalous magnetic readings (Figure 22). Test pit logs are included in Appendix A. The test pits were intended to identify the work that would be required to analyze the site and confirm the location and extent of disposal areas. Therefore, samples were not collected from the test pits during this initial phase.

A trench containing 408 concrete capped drums was excavated from Area C. The material inside the drums was sorted for live ordnance related items. Four hundred eight 55-gallon drums of live ordnance were recovered and destroyed. Also found were 3,000 warhead components of the 40 mm grenade rounds. All 3,000 rounds were destroyed by detonation. To support the destruction of the recovered ordnance, a burn pit and blasting area were constructed at the rocket test pad adjacent to SWMU 03. A drum log is provided as Appendix B.

Following the recovery of the ordnance, an additional 18 test pits were excavated to investigate and characterize the area. A total of 19 soil samples were collected from these test pits and submitted for analysis. Each sample was analyzed for VOCs, BNAs, metals, aldicarbs, and CS. Four monitoring wells installed by Law during the Phase I investigation were resampled. Each sample was analyzed for VOCS, BNAs, metals, aldicarbs, and CS. Six background soil samples were collected from three soil borings and analyzed for metals. The samples were collected at depths of two and four feet as requested by the GAEPD.

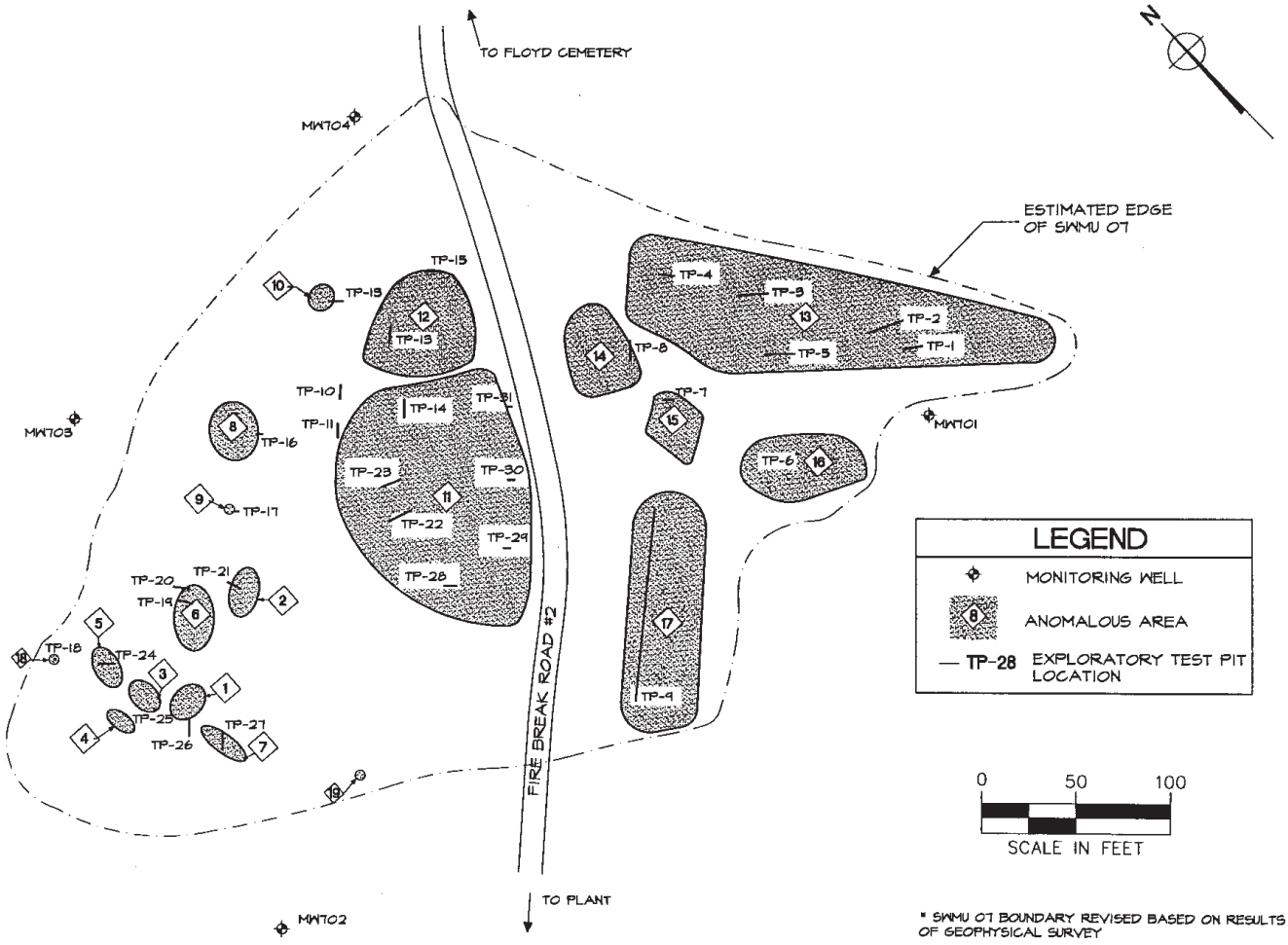

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FIGURE 22
SWMU 07
EXPLORATORY TEST PITS
WOODBINE, GEORGIA

Date: 7-15-96	Project Title: PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: EMD			
Project Number: 097.001	CAD File: UNION-3	Scale: AS SHOWN	Client: THIOKOL CORP

Metals concentrations from soil samples collected during the Phase I investigation were statistically compared to the concentrations from background samples collected at SWMU 07. The discussion of the statistical comparisons is presented in Section 4.1. Sample locations for all samples collected from SWMU 07 are shown on Figure 23 within the original 19 geophysical anomaly areas.

3.7 Methodology

This section describes the general procedures used in performing the work at the facility and the SWMUs including procedures followed in collecting environmental samples, performing geophysical surveys, and handling ordnance. SWMU-specific procedures and variations from the Work Plan are also defined.

3.7.1 Geophysics

Geophysical methods were used to accomplish three tasks: locate buried metallic objects, locate shallow buried ordnance, and locate disposal or burn areas without metallic objects. Three different geophysical methods were used to evaluate and locate objects in the subsurface at the facility: GPR, EM-31 conductivity instruments, and magnetometers. The GPR and EM-31 surveys were performed by North American Exploration (NAEVA) of Charlottesville, Virginia. The NAEVA report is presented as Appendix C. The magnetometer surveys were performed in areas of suspect UXO by EOD of Knoxville, Tennessee.

The GPR and EM-31 surveys both measure the conductivity of the soil underneath the instrument. Changes in the properties of the soil are due to buried metallic objects, buried material with a different conductivity than the native soil, and changes in the conductive properties of the foreign material. The magnetometer responds to changes in the local magnetic fields resulting from buried ferrous objects.

3.7.1.1 GPR

The GPR survey was conducted using a Sensors and Software Pulse EKKO 100 GPR system equipped with 100 Mhz antennas. Readings

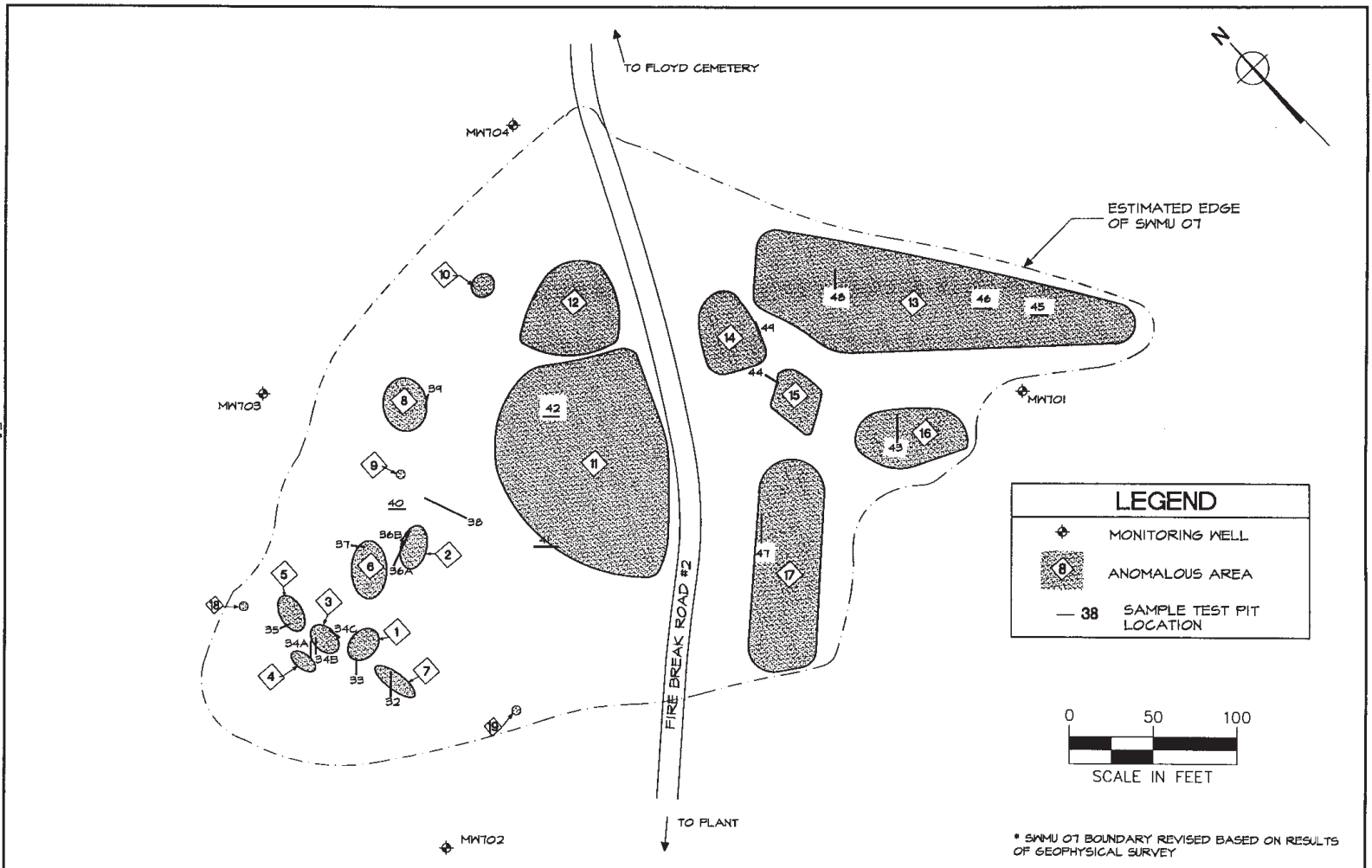

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FIGURE 23
SWMU 07
TEST PIT SAMPLE LOCATIONS
WOODBINE, GEORGIA

Date:	Project Title:		
7-15-96	PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: EMD			
Project Number: 097.001	CAD File: UNION-3	Scale: AS SHOWN	Client: THIOKOL CORP

were collected at 20-centimeter intervals along the lines, using a wheel odometer to trigger the system. The GPR system is based on the propagation and reflection of electromagnetic (EM) fields. Conductive materials and/or fluids can quickly attenuate the radar signal, limiting depth of penetration. In general, undisturbed ground may be distinguished from an excavated area, and metallic objects ordinarily are evident if isolated in uniform materials.

A common mid-point (CMP) sounding was performed in the southeastern corner of the field at SWMU 06 to provide information on the velocity of the GPR signal through the subsurface (see Section 3.7.1.4 on the Geophysical Field Study below). CMP data were analyzed in a Sensors & Software program, yielding a velocity of 0.08 meters per nanosecond (0.262 feet per nanosecond). The velocity obtained from the analysis was applied to the GPR data to provide a measure of depth.

3.7.1.2 EM-31

For the electromagnetic method, a Geonics EM-31 terrain conductivity instrument was used, providing an output of both the quadrature (terrain conductivity) and in-phase components of the induced electromagnetic field which are recorded simultaneously. The quadrature component measures electrical conductivity in milliSiemens per meter (mS/m). Terrain conductivity is a function of permeability, conductivity of included soil moisture, degree of saturation, as well as soil and rock type. Absolute values of terrain conductivity are not usually diagnostic, but their spatial variations are important. The ability to identify lateral variations in the conductivity of the shallow subsurface makes quadrature EM-31 data extremely useful in mapping changes across the site. The in-phase component is primarily used in searching for buried metal, measuring in relative parts per thousand (ppt) units. A negative response is most commonly expected over areas containing shallow buried metal debris. EM-31 readings were collected in vertical dipole mode at 2.5-foot stations along survey lines. EM-31 data was processed through Geonics DAT31 software program and contoured using Golden's SURFER program.

3.7.1.3 Magnetometer

EOD used Schonstedt GA5/B and GA52 magnetic locators during the sweep of SMWUs 03 and 07. The instrument uses two magnetic-field sensors to locate buried ferrous objects. Magnetic objects will cause a change in the magnetic-field strength in the two sensors. The change in the field strength is indicated by a audible response that varies in pitch and loudness. The response is controlled by the depth and size of the object.

3.7.1.4 Geophysical Field Study

In order to assess the suitability of the selected geophysical methods (GPR, EM, magnetometer) at this site, Apex completed a pilot field study. This was accomplished by excavating a test pit within an area just outside an identified waste area (SWMU 06). A source (drum couplet) was placed in the pit, backfilled, and geophysical survey line was completed over the test pit.

On December 7, 1995, a small test trench 13.5 feet long and approximately 4 feet wide was excavated southeast of the grid in the field at SWMU 06 to a depth of 58 inches. Two empty 55-gallon steel drums were placed in the trench, one in a vertical position, the other horizontal. The drums laid approximately six feet apart. The EM-31 data was collected as two discrete surveys on lines spaced 10 feet apart, with 2.5-foot stations along lines.

The EM-31 recognizes one anomaly over the two drums, as they are buried too close to each other for the instrument to resolve the two sources at the 10-foot line spacing. This exercise clearly demonstrated that the presence of buried drums within the SWMUs would not have gone undetected with EM-31 data collected at the employed 10-foot line spacing. GPR data were collected on 10 lines through the test area. While the GPR anomalies directly over the drums confirm the EM anomalies, it is apparent that using GPR alone it would be difficult to interpret these features as drums.

3.7.2 Soil Sampling

Soil samples were collected from the SWMUs to detect possible contaminants related to past activities at the facility. In addition, background samples were analyzed for metals concentrations to compare statistically to the metals analytical data from the Phase I and II investigations with background concentrations. The soil samples were collected from soil probes, test pits, and stockpiles (soil generated during test pitting). Table 3 lists the analytical methods, glassware, and preservatives for each of the SWMUs. All analysis, sample volumes, glassware, and preservatives are consistent with EPA Methodologies and GAEPD requirements except for the analytical methodology for CS compounds. CS compounds were analyzed using a Department of Defense (DOD) methodology specifically developed for detecting tear gas in soil and ground water (Method Reference MIL-R51029C).

Test pit and geoprobe samples were collected from a discrete location and time as grab samples. Grab samples are indicative of the concentrations at the location at the time the sample was collected. Stockpile samples were collected as composite samples. Composite samples were collected by obtaining an equal amount of soil from each location. The soil was placed in a pyrex bowl and mixed with a stainless steel spoon to a uniform consistency. The composited material was then placed into the sample jars. Since VOCs are readily lost by mixing, composite samples submitted for VOC analysis were collected by obtaining an equal quantity of soil from each location and placing it directly into the sample container. Composite samples are collected from several locations and analyzed as one sample. Composite samples are used to obtain an overall view of contaminant levels over a wide area over a long period of time.

3.7.2.1 Headspace Analysis

Collection of headspace data was used as an indicator to determine depth intervals where soil samples were to be collected for laboratory analysis. Headspace readings were collected by placing a quantity of the soil in a Ziploc bag and allowing the soil in the bag to volatilize for several minutes. The boring identification, depth, and time were written on the bag.

Table 3

Sample Containers, Quantities, and Preservatives
Phase II RFI

Thiokol - Woodbine Facility

Matrix	Sample Containers and Quantities				
	VOCs	BNAs	Aldicarb	CS Compounds	Metals
Soil	125 ml amber glass (1)	250 ml clear glass (1)	100 ml clear glass (1)	100 ml clear glass (1)	250 ml plastic (1)
Aqueous	40 ml glass vial (3)	1 liter amber glass (3)	125 ml amber glass (1)	1 liter amber glass (1)	500 ml plastic (1) 250 ml plastic (1) mercury

Matrix	Preservatives				
	VOCs	BNAs	Aldicarb	CS Compounds	Metals
Soil	Ice	Ice	Ice	Ice	Ice
Aqueous	Hydrochloric acid	Ice	Ice	Ice	Nitric Acid

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After the material in the bag had a chance to volatilize, the readings were collected with a photoionization detector (PID). An MSA Photon and Microtip HL-2000 equipped with a 10.6 eV bulb were used to collect headspace readings. These instruments detect levels of VOCs, including those typically associated with organic solvents. The PID was calibrated using 400 parts per million (ppm) toluene as requested by the GAEPD.

3.7.2.2 Soil Probes

Soil probes were used to collect soil or waste material from discrete depth intervals or continuously from the surface to a selected depth. Soil probes are either manually or hydraulically driven steel tubes that collect soil continuously over a two- to four-foot interval. The soil is recovered in a disposable acetate liner. Two-foot sample tubes were used for manually collected samples and four-foot tubes were used to collect the hydraulically collected samples. Prior to collecting the initial sample, and after each sample location, the sampling equipment was decontaminated as described in Section 3.7.5.

3.7.2.2.1 Background Soil Probes

Background soil samples were taken for metals analysis at SWMU 02 through SWMU 07 for statistical comparison with metals data from both phases of the RFI. The distribution of metals in soils at the site was unknown, therefore, the initial background sampling at each SWMU consisted of three borings drilled in locations deemed not to have been impacted by activities associated with that particular SWMU. Each location was selected in the field. Samplers referred to published information on soil types (USDA soil survey maps) and attempted to locate each boring within a different soil type. Borings were hand augered and two soil samples were collected from each boring from approximately two feet and four feet below ground surface, for a total of six samples per SWMU resulting in 36 total metals background samples collected for the site. These soil samples were analyzed for the six metals

(arsenic, barium, chromium, cadmium, lead, and mercury) that were analyzed for during the Phase I RFI investigation.

3.7.2.2.2 SWMU Characterization Soil Probes

Boring locations were selected in the field and placed in areas most likely to detect subsurface contamination based on site layout, predicted hydraulic gradient, and field screening results. Soil borings were drilled with a Geoprobe soil sampler attached to three-foot sections of flush-threaded, one-inch diameter, hardened steel probe rod. The sampler and probe rods were driven using Apex's Concord drill rig until the desired sampling depth was reached. Soil borings were also used to determine the depth to ground water and assess the potential for contaminant migration away from the Burn Area and Aldicarb Disposal Area of SWMU 03. Additionally, direct push borings were used to collect background soil samples at all SWMUs and to collect samples of soil and waste material at SWMU 04 and SWMU 06.

During drilling, soil samples were collected continuously using a 48-inch stainless steel core sampler. Contained within the interior of the soil sampler is a disposable acetate liner; the recovered soil sample is retained within the liner for inspection when brought to the surface. A log of each sampling location was maintained to characterize the types of soils and any stratification or other factors that could influence the rate and direction of ground water flow. Copies of the geologic logs of the soil borings are included in Appendix A. Between each boring location, the soil sampler was thoroughly decontaminated using industry standard procedures as described below. Each 48-inch soil sample was split into two 24-inch sections and a portion placed in the appropriate container (Table 3) for possible laboratory analysis. The remainder of each sample was placed in a sealable plastic bag for lithologic characterization and, after allowing sufficient time

for volatilization of fluids, screened for VOCs. Field screening was conducted with a calibrated Photovac Microtip HL-2000 PID equipped with a 10.6 electron volt (eV) lamp. Results of the field screening are included on the geologic logs of the soil borings included in Appendix A.

All contact drilling and sampling equipment was decontaminated prior to drilling and between each boring location using a nonphosphate soap solution and rinsed with deionized water. In addition, disposable polyvinyl chloride (PVC) gloves were worn during all phases of sampling and changed as needed. The Geoprobe sampling system collects environmental samples using a hammer driven method; therefore, no waste soils were generated during completion of direct push soil borings.

The following sections describe the soil probing procedures that were specific to a SWMU or deviated from the Work Plan.

3.7.2.2.3 SWMU 03 - Aldicarb Disposal Area and Burn Area

Soil probes at the SWMU 03 Aldicarb Disposal and Burn Areas were completed using the truck-mounted hydraulic soil sampler. Samples were collected in the 48-inch stainless steel core sampler with an acetate liner. Samples were collected continuously from the surface to ground water. Headspace data was collected at one-foot intervals.

3.7.2.2.4 SWMU 04 - Acetone Evaporation Pond

Soil probes at SWMU 04 were completed by hand using a 24-inch stainless steel core sampler with an acetate liner. Samples were collected continuously from the surface to four feet. Headspace readings were collected at one-foot intervals with a PID and the interval with the highest headspace reading was submitted for laboratory analysis. One sample from each

boring was collected from below the bottom to assess the vertical extent of contamination, if present.

3.7.2.2.5 SWMU 06 - Trench Area 1

Samples of waste material in Trench Area 1 were collected by hand with a 24-inch stainless steel core sampler with an acetate liner or a hand auger. The samples from below the bottom of the trench could not be collected using hand equipment because of a hard soil horizon below the trench and the shallow ground water.

Samples below the bottom of the trench were collected using the truck-mounted hydraulic soil sampler with a 48-inch stainless steel core sampler and acetate liner. The spoon used a discrete sampling device that allowed the samples to be collected below the bottom of the trench without having to do continuous sampling through the waste material.

3.7.2.3 Test Pitting

Test pits were excavated using a Case backhoe. Excavated soil was placed on 6-mil polyethylene sheeting and covered with the same following excavation. During excavation, the process was continuously observed by Apex. At appropriate depth intervals or visual clues, samples were grabbed for headspace readings. Care was taken to ensure that samples submitted for laboratory analysis were collected from undisturbed soil in the center of the backhoe bucket.

Test pit excavations were conducted in Level C personal protection equipment (PPE). Following the completion of test pits, personnel downgraded to Level D PPE and, with continuous air monitoring, photographed the test pits and made notes on the soil stratigraphy.

Following the completion of test pits within a SWMU, the backhoe was decontaminated. Composite soil samples were collected from the

stockpiles and submitted for laboratory analyses. Test pits were backfilled after receiving the laboratory data. Composite samples were collected separately from SWMU 03 (Burn Area), SWMU 03 (Aldicarb Disposal Area), SWMU 06, SWMU 07 (Area A), SWMU 07 (Area B), SWMU 07 (Area C), and SWMU 07 (Area D).

3.7.3 Monitoring Wells

All drilling was performed by Ellis and Associates of Jacksonville, Florida, an experienced, licensed drilling company. Soil borings were drilled using a truck-mounted drill rig equipped with continuous-flight hollow-stem augers with an internal diameter of 6.25 inches. All soil borings were drilled to ten feet below the water table surface which was encountered at a depth of approximately nine feet below grade. During the performance of soil borings, soil samples were collected every five feet using a 24-inch long, split-spoon sampler.

During boring advancement, penetration, testing, and split-spoon sampling of soils was performed in accordance with ASTM Standard Method D-1586. This method uses a two-inch outside diameter split-barrel sampler driven by a 140-pound hammer freefalling 30 inches. The soil penetration is measured by the number of hammer blows necessary to drive the sampler each of the four six-inch increments required per sample. During drilling, soil retrieved in the split-spoon sampler was divided and a portion placed into a precleaned, four-ounce jar with a Teflon-lined lid for possible laboratory analysis. The remainder of each sample was placed into a sealable plastic bag for lithologic characterization and, after allowing sufficient time for volatilization of fluids, screened for VOCs. Field screening was conducted with a calibrated Photovac Microtip HL-2000 PID equipped with a 10.6 eV lamp. This instrument detects levels of VOCs, including those typically associated with organic solvents. The soil characteristics, sampler penetration rate, and field screening results are reported on the geologic logs of the soil borings included in Appendix A.

All contact drilling and sampling equipment was decontaminated prior to drilling and between each boring using a high-pressure steam cleaner with a design discharge temperature of 180°F. Split-spoon samplers were washed with a nonphosphate soap solution and rinsed with deionized water between each sampling event. Water for the steam cleaner was obtained from a publicly supplied system.

In addition, disposable PVC gloves were worn by field personnel during all phases of sampling and changed as needed. Soil cuttings generated during the subsurface investigation were containerized in U.S. Department of Transpiration (DOT)-approved 17-H, 55-gallon drums and stored temporarily on site.

Upon completion of the two soil borings drilled at SWMU 03, ground water monitoring wells were installed. The locations of the two ground water monitoring wells were selected based on site layout and assumed ground water flow direction, as well as the previously discussed geoprobe soil borings. The two wells were constructed to a depth of 15 feet below existing surface grade.

The monitoring wells were constructed according to industry standard practices and procedures acceptable to the GAEPD for monitoring wells installed in unconsolidated formations. Monitoring wells were constructed of two-inch diameter, Schedule 40 PVC casing and machine-slotted, 0.020-inch screen. A 10-foot long section of screen was installed in both wells. The screens installed were placed to bracket the local ground water interface with five feet of screen above and five feet of screen below the water table. In each monitoring well, the screen was connected to a sufficient length of flush-threaded riser pipe to reach the ground surface. Silica filter pack (no. 2 Morie sand) was placed in the well annulus to a height of two feet above the top of the screen. A two-foot pelletized bentonite seal was placed above the filter pack and hydrated with public water. The remainder of the annulus was filled with a lean cement grout. The well bottoms were sealed with PVC plugs and the tops were capped with locking expansion caps. Locked, stick-up well casing was installed and protected by a concrete pad and ballasts. Well construction diagrams and boring logs are provided in Appendix A.

After installation, each monitoring well was developed using an electric suction pump and dedicated PVC lines to remove silt and sediment from around the screen. A sufficient volume of water was removed to eliminate turbidity caused by formation disturbance during drilling. Water removed from the wells during development was containerized in DOT-approved, 17-H, 55-gallon drums and stored temporarily on site. All wastes generated by Apex during the Phase II RFI are scheduled for off site disposal during the month of October 1996.

3.7.4 Ground Water

Eighteen monitoring wells, including 16 previously installed by Law and two installed by Apex during the Phase II investigation, were sampled using protocols consistent with those used by Law during the Phase I RFI. Monitoring wells were all constructed of two-inch PVC pipe with either a locking well cap or a locking stick-up casing. Prior to sampling, the monitoring wells at each SWMU were opened and allowed to vent for at least five minutes. A PID was used during the initial opening of each monitoring well to screen for VOCs that may have built up inside the well casing.

After venting the well, an ORS oil/water interface probe was used to measure the depth to Light NonAqueous Phase Liquids (LNAPLs), depth to water, Dense NonAqueous Phase Liquids (DNAPL), and depth to bottom of the well. LNAPLs and DNAPLs were not encountered in any of the monitoring wells. Water level measurements were made from marks on the outside PVC casing of each well.

Well volume to be purged was calculated by subtracting the depth to water from the total depth of the well and multiplying the result by 0.16 gallons of water per foot of two-inch pipe. Wells were purged by lowering a disposable Teflon bailer slowly into the well and recovering the water in a five-gallon pail. The wells were purged slowly enough not to allow the recharge to cascade into the well. Care was taken not to agitate the water while lowering and filling the bailer.

A small quantity of purge water from the beginning of each well volume was placed into a four-ounce jar for water quality measurements. The measurements were made immediately after the water was collected. Three water quality measurements were made after each well volume was purged from the well: pH, conductivity, and temperature. Ground water samples were collected after a minimum of three well volumes were purged and if the water quality measurements did not vary by more than ten percent from the previous well volume. A maximum of five well volumes would have been purged if the water quality measurements had not stabilized.

Once the water quality measurements were within the required tolerances, the well was allowed to recharge before sampling. The wells at the facility recharged very fast and most samples were collected within five minutes of the last well volume

purged. Table 3 summarizes the analytes, preservative, and container size and material. Samples were collected in the following order: VOCs, BNA, aldicarb, mercury, and metals.

Samples were collected in glassware supplied by the analytical laboratory -- Savannah Laboratories of Savannah, Georgia. Samples that required preservatives other than ice had pre-measured aliquots of preservative already in the glassware. Immediately after collection, the samples were stored on ice and maintained under strict chain of custody.

3.7.5 Decontamination

Personnel decontamination stations were set up at each SWMU during subsurface excavations. The decontamination corridor was set up as outlined in Apex's Health and Safety Plan (HASP), dated November 3, 1995.

The remoteness and lack of facilities at most of the SWMUs made decontamination of the backhoe difficult. A decontamination pad was set up at SWMU 03 near UCC production well no. 3. The pad consisted of a double layer of 6-mil polyethylene sheeting bermed on three sides with lumber. The pad was set up on a slight incline to catch the decontamination water at the foot of the slope. A hand operated, non-sparking pump was used to transfer the decontamination water to 55-gallon drums. A steam generator was used to decontaminate the backhoe. Care was taken while excavating test pits to keep the equipment as clean as possible. Gross contamination was removed at the SWMU prior to transport to the decontamination pad at SWMU 03 near the rocket test pad.

4.0 RESULTS

This section details the findings of geophysical surveys, test pitting, and laboratory analysis of soil, waste material, and ground water samples collected by Apex during completion of the Phase II RFI. A discussion of Law's Phase I RFI results is limited to the comparison of previously collected metals data with the background metals data collected during the Phase II RFI. A more complete discussion of Law's Phase I RFI is presented in Law's Phase I RFI report dated February 5, 1993.

Geophysical surveys were conducted during the Phase II RFI at selected SWMUs, as outlined in Apex's approved Work Plan, to identify disposal areas or locate ordnance related items. The geophysical surveys were also used to identify sample and test pit locations. Geophysical surveys were conducted at SWMU 03 - Burn Area, SWMU 03 - Aldicarb Disposal Area, SWMU 06 - Trench 2, SWMU 06 - Borrow Pit, and SWMU 07.

Background soil samples were collected for all SWMUs to compare background metals concentrations to SWMU specific metals concentrations. Metals are naturally occurring and background reference concentrations were needed to compare to the potential waste disposal influence. Background metals concentrations were compared to the previously analyzed soil samples collected during the Phase I RFI. No additional soil samples were collected at SWMUs 02 and 05.

Additional soil, ground water, or waste material samples were collected by Apex at SWMUs 03, 04, 06, and 07 as outlined in Apex's approved Work Plan. Appendix D contains all laboratory analytical results.

4.1 Background Statistical Analyses

Background metals data were statistically evaluated quantitatively using a statistical program entitled "SAS JMP Statistical Discovery Software v 3.1.4" and qualitatively using plots and graphs. A rank order data analysis was completed first, and data from each SWMU was assessed to determine if it represented a parametrically described "normal" distribution or "log-normal" distribution.

A total SWMU background concentration was calculated for each metal using the upper tolerance level of the background data, defined as the 95 percent level of confidence that at least 95 percent of the data fall below this value for the entire background population (36 samples). The upper tolerance level was also calculated similarly for each SWMU (but

for a reduced sample population of six samples per SWMU) and compared with the facility-wide value. Whichever value was higher was used to establish the background level at each SWMU. This approach maximized the use of the background information collected while reducing the potential of setting too low a background level at any one SWMU. Apex collected samples of soil and waste material during completion of the Phase II RFI. Metals results for waste samples were not compared to the background upper tolerance limit calculated for natural soils due to the differences in matrices. The results of Apex's statistical analysis of background soil samples for metals are presented in Table 4.

4.2 SWMU 02

SWMU 02 was an area reportedly used for the surface storage of drums (Figure 2). The Phase II RFI required the collection of background soil samples for metals analyses. These background sample concentrations were then compared to the metals concentrations found during the Phase I RFI.

Metals concentrations in samples collected by Law, when compared to the background concentrations in samples collected by Apex, showed barium exceeding the background upper mean concentrations (BUMC) from all sample locations. Lead exceeded the upper mean in samples from SS-203 and SS-204. Both lead and barium were within one order of magnitude of the respective BUMCs. Analytical results are summarized in Table 5.

4.3 SWMU 03

SWMU 03 contains an approximately two-acre clearing connected by a fire break road to a two- by two-foot trench and the CS Disposal Area (Figure 3). The southern portion of the clearing contained an air handler (used in the manufacturing of CS), paint waste containers, and metal debris. The trench contained Nuchar and other unknown waste material, and the CS Disposal Area reportedly was used for the disposal of CS wastes. Prior to field activities by Law, EOD removed and deactivated ordnance on the ground surface.

In addition to the disposal areas identified during the Phase I RFI, two additional disposal areas were identified at SWMU 03. These are the Burn Area and Aldicarb Disposal Area. The work performed during the Phase II at each new area is described below.

Table 4

Background Metals Statistical Analysis

Thiokol - Woodbine Facility

	All SWMUs		SWMU SPECIFIC											
	SWMU-2		SWMU-3		SWMU-4		SWMU-5		SWMU-6		SWMU-7			
	upper mean	lower mean	upper mean	lower mean	upper mean	lower mean	upper mean	lower mean	upper mean	lower mean	upper mean	lower mean	upper mean	lower mean
As	1.2	1.1	1.1	1.0	1.1	1.0	1.3	1.2	1.3	1.1	1.2	1.1	1.3	1.2
Ba	3.7	2.2	5.4	3.0	9.4	3.3	2.8	1.0	2.6	1.4	2.8	0.8	2.0	0.9
Cr	3.2	2.3	3.8	2.9	4.8	2.0	3.7	1.3	4.7	0.2	3.8	2.0	2.5	1.3
Cd	0.79	0.54	0.55	0.52	0.54	0.52	0.66	0.61	0.93	0.23	0.61	0.57	0.64	0.61
Pb	2.9	2.2	3.3	1.9	4.7	1.7	2.8	1.3	4.1	1.9	3.2	1.6	2.8	1.4
Hg	0.020	0.010	0.030	0.010	0.020	0.010	0.010	0.010	0.020	0.010	0.020	0.010	0.020	0.010

All results reported in mg/kg.

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Table 5

SWMU 02 - Phase I RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/Element	Background		Sample Location			
	upper mean	lower mean	SS-201	SS-202	SS-203	SS-204
Barium	5.4	3.0	7.5	6.9	7.8	7.7
Chromium	3.8	2.9	2.7	3.5	3.5	3.2
Lead	3.3	2.0	3.2	3.1	4.8	3.5
Mercury	0.032	0.0080	0.027	0.020	0.030	0.013

All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

In addition to the investigation associated with the two new areas, the Phase II RFI included collecting ground water samples from the three existing monitoring wells at the CS Disposal Area and the collection of six background soil samples for metals analyses. The background sample concentrations were then compared to the metals concentrations found during the Phase I RFI.

Soil samples were submitted for laboratory analysis of VOCs, BNAs, metals, aldicarb, and CS-related compounds. Organic compounds were not detected above reporting levels from SS-301 through SS-306. Sample SS-302 (paint waste containers) exceeded the BUMCs for barium, chromium, and lead. Lead concentrations exceeded the BUMCs in samples SS-301, SS-302, SS-303, and SS-306. Mercury was also detected above the BUMC in SS-301 through SS-306. All metals results for the Phase I RFI were within one order of magnitude of the BUMC. Soil analytical results are summarized in Table 6.

Phase I RFI ground water samples collected by Law did not show detections of VOCs, BNAs, CS compounds, or aldicarb. No metals were detected above their respective MCLs in the previous metals samples. Ground water analytical results are summarized in Table 7. Laboratory analysis for ground water samples submitted for the Phase II RFI did not detect VOCs, BNAs, CS compounds, or aldicarb above the instrument reporting levels. Total metals concentrations for arsenic, barium, and mercury were not detected in concentrations greater than the allowable MCLs. MW-302 had concentrations of cadmium (0.009 mg/L), chromium (0.22 mg/L), and lead (0.057 mg/L) exceeding their respective MCLs. Chromium was the only metal to exceed the respective MCL in MW-301 (0.23 mg/L), MW-302 (0.15 mg/L), and MW-304 (0.12 mg/L).

4.3.1 Burn Area

The SWMU 03 Burn Area was reportedly used for burning CS gas-related ordnance. The Phase I RFI identified the site as formerly containing manufacturing buildings and equipment. The area investigated during the Phase II RFI was a small grassy clearing approximately two acres in size with several trees.

An area on the northern edge of SWMU 03 was reportedly used to burn ordnance-related items (Figure 14). During the initial site walkover by Apex, several 40 mm grenades were observed lying on the surface of the clearing and along the dirt

Table 6

SWMU 03 - Surface Disposal - Phase I RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Element/Compound	Background		Location					
	upper mean	lower mean	SS-301	SS-302	SS-303	SS-304	SS-305	SS-306
Barium	9.4	3.3	7.6	11.0	9.1	7.4	6.4	9.2
Chromium	4.8	2.0	3.8	4.9	2.4	1.9	3.0	3.4
Lead	4.7	1.7	8.9	8.2	6.1	4.3	2.9	4.8
Mercury	0.022	0.0088	0.051	0.021	0.025	0.029	0.022	0.026

All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

Table 7

SWMU 03 - Phase I and II RFI
Ground Water Analytical Results

Thiokol - Woodbine Facility

Compound/Element	MCL	Phase I RFI Analytical Results			Phase II RFI Analytical Results				
		Sampled in October 1992			Sampled on November 17, 1995			Sampled on March 12, 1996	
		MW-301	MW-302	MW-303	MW-301	MW-302	MW-303	MW-304	MW-305
Arsenic	0.050	ND[1]	ND	ND	0.010	0.031	0.017	ND	ND
Barium	2.0	ND	0.019	0.020	0.53	0.41	0.29	0.25	0.22
Cadmium	0.0050	ND	ND	ND	ND	0.009	ND	ND	ND
Chromium	0.10	ND	ND	ND	0.23	0.22	0.15	0.12	0.088
Lead	0.050	ND	ND	ND	0.031	0.057	0.030	0.034	0.021
Mercury	0.0020	ND	ND	ND	0.00058	0.00056	0.00036	0.00034	0.00042

[1]ND = Not detected above MDL.
All results reported in mg/L.
Shaded results are concentrations equal to or greater than the MCL for that compound.

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road. The area to be investigated was first cleared by EOD personnel using a Schoenstedt magnetometer to locate surface and near surface ordnance. Three 40 mm grenades and one 40 mm CS grenade were located. Since the composition of the non-CS grenades could not be determined based on visual examination, the rounds were considered to be high explosive rounds and destroyed in place using shaped charges.

After the SWMU 03 Burn Area had been cleared of ordnance-related items, several large areas that presented anomalous magnetometer readings were flagged for later investigation. Signal characteristics, surface expressions, and the shape of the anomalies suggested that the anomalies were not due to buried drums, ordnance, or other disposal features but rather to buried piping, concrete, or building foundations. An additional sweep of the area was conducted by EOD prior to NAEVA conducting the GPR survey. Two additional 40 mm rounds were found on the perimeter of the clearing. Both rounds were deactivated in place using shaped charges. A copy of the EOD report of UXO removal operations is included as Appendix E.

4.3.1.1 Geophysical and Test Pit Results

GPR data collected over the sandy area south of the bunker revealed no evidence of a pit. A point reflector was evident at the south end of lines 150E, 160E, and 170E, probably resulting from a pipe or cable buried at approximately 876N. Shallow subsurface disturbances, highlighted in yellow, can be seen on each of the four profiles (included in Appendix C) over this sandy area, most notably on line 180E.

Evidence of a possible covered pit on the GPR records is highlighted in yellow on profiles (included in Appendix C) for lines 240E and 260E. Characteristics identified that seem to support the existence of a pit were sloping reflectors and shape offsets in reflective events. No obvious large point-source reflectors indicative of buried metallic objects were evident in this area. These GPR features represent the only suspected pit targets in the data set.

Gopher tortoise holes, large trees immediately adjacent to lines, and tree roots are visible in the GPR records. Many of the dipping reflectors may be stratigraphic in origin. Line 890N was surveyed between 180E and 240E. The metal culvert is very conspicuous at 210E. Copies of the geophysical data are provided with the NAEVA report in Appendix C.

The GPR survey located several small anomalous areas of which only one was identified as being a possible burn pit. Four test pits were completed to investigate the burn pit and three of the more prominent anomalies (Figure 14).

Test pit 2 located what appears to be a concrete building footer. The structure is buried from one to three feet and surrounded by a very pale brown sand. Test pit 4 located a concrete pad near the surface and a dark brown silty fine sand layer with a charcoal layer at two feet. The other two test pits revealed only buried scrap metal or metal conduit.

4.3.1.2 Soil Borings

A series of five soil borings were completed on the north side of the Burn Area in the location expected to be hydraulically downgradient of the site. The borings began at the west between the Burn Area and the bunker, and were approximately equally spaced to the eastern edge of the clearing (Figure 14). The borings were used to identify the best location for the single monitoring well that was requested by the GAEPD to be installed downgradient of the area. Soil boring logs are found in Appendix A.

Only one boring, 3-004, showed elevated headspace readings in the soil samples collected. One soil sample was collected from the interval showing the highest readings (4 to 5 feet) and was submitted for laboratory analysis. Based on the elevated PID reading, one monitoring well (MW-305) was installed hydraulically downgradient of this boring location.

4.3.1.3 Soil Analytical Results

GAEPD requested that two soil samples be submitted for laboratory analysis from each test pit completed and that a minimum of eight test pits be completed at the SWMU 03 Burn and Aldicarb Disposal Areas combined. GAEPD also required that the two samples to be submitted for analysis from each pit consist of one shallow sample from waste material and one soil sample from below the waste material. The samples were to be analyzed for VOCs, BNAs, aldicarb, CS and related compounds, and metals. Analytical results are summarized in Table 8.

Three pairs of samples were submitted from three of the four test pits (TP-1, TP-2, and TP-4) completed in the Burn Area and one from the one soil boring (3-004) that showed an elevated headspace reading. No soil sample was collected from TP-3 because the anomalies were the result of a metal conduit just below the ground surface and not obvious contamination. Since headspace screening and visual observations detected no obvious waste material in the test pits, one shallow sample was collected from a depth of two feet to detect possible contaminants and one deep sample was collected from the bottom of each test pit.

Analytical results did not show any compounds above the detection levels for VOCs, BNAs, aldicarb, or CS and its degradation products. Metals concentrations, when compared to the background concentrations, exceeded the BUMC for barium, chromium, lead, and mercury (Table 8). Mercury exceeded the BUMC in the shallow and deep soil sampled from TP-1. Chromium was detected above the BUMC in the deep sample from TP-1. Barium exceeded the BUMC in the deep sample from TP-2, and lead exceeded the BUMC in the deep sample from TP-4. In general, the metals were within one order of magnitude of the BUMC. Section 4.1 provides a description of the statistical analyses used to compare SWMU-specific metals concentrations to background metals concentrations.

Table 8

SWMU 03 - Burn Area - Phase II RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/ Element	Background		9113	9114	9115	9116	9117	9118	9099
	upper mean	lower mean	Test pit 1 (2 feet)	Test pit 1 (6 feet)	Test pit 2 (2 feet)	Test pit 2 (6 feet)	Test pit 4 (2 feet)	Test pit 4 (6 feet)	3-004 (4-5 feet)
Barium	9.4	3.3	8.2	7.1	6.8	10	9.6	6.9	7.9
Chromium	4.8	2.0	2.7	7.6	2.0	3.4	3.3	4.1	4.1
Lead	4.7	1.7	3.5	4.7	2.7	3.8	3.5	5.0	3.4
Mercury	0.022	0.0088	0.029	0.042	0.011	0.017	0.014	ND[1]	0.013

[1]ND = not detected above method detection limit (MDL).
All results reported in mg/kg.
Shaded results are concentrations equal to or greater than the respective BUMC.

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4.3.1.4 Ground Water Analytical Results

One ground water sample was collected from the monitoring well (MW-305) installed during the Phase II RFI. The ground water sample was analyzed for VOCs, BNAs, aldicarb, CS-related compounds, and total metals. Analytical results are summarized in Table 7.

Laboratory analyses did not detect VOCs, BNAs, CS compounds, or aldicarb above the instrument reporting levels. Total metal concentrations for arsenic, barium, chromium, and mercury were not detected in concentrations greater than the allowable MCLs. Cadmium was detected at concentrations near or at the MCL. Lead concentrations were detected near the MCL.

4.3.1.5 Waste Description

No subsurface wastes were identified from the geophysical surveys and this was confirmed by subsurface investigation (test pitting). However, numerous 40 mm rounds were located in the vicinity of the Burn Area and the dirt road to the CS Disposal Area.

Five 40 mm rounds of unknown capability and two 40 mm CS grenades were found during the initial surface sweep, the geophysical survey by NAEVA, and subsequent work in the area by Apex. The 40 mm rounds were suspected to be inert rounds used for ballistic tests. The bodies of the rounds were blue which indicates an inert round; however, the ogives (nose cones) were gold which indicates a high explosive (HE) round. Forty mm CS grenade rounds are silver with a red stripe. Due to the ambiguous color coding of the non-CS 40 mm grenades, they were treated as HE rounds. A more complete discussion of ordnance activities is found in Section 4.7.4 and Appendix E.

4.3.2 Aldicarb Disposal Area

The SWMU 03 Aldicarb Disposal area is a mound north of UCC production well no. 3 and was reportedly used for the disposal of aldicarb (Figure 15). The area

is defined by a grassy mound adjacent to the paved road to the rocket test pad. This area was identified after submission of the Phase I RFI.

During the initial site walkover by Apex, a timing train fuse from an M301 illumination round was found on the surface of the Aldicarb Disposal Area. Due to the presence of the ordnance and the 40 mm grenade rounds at the Burn Area and along the dirt road, EOD was requested by Apex to sweep the Aldicarb Disposal Area prior to NAEVA conducting the geophysical surveys of the area. EOD encountered numerous small anomalies that were found to be scrap metal and not ordnance-related materials. No other ordnance-related items were found by EOD at the Aldicarb Disposal Area.

4.3.2.1 Geophysical and Test Pit Results

A grassy, elliptical-shaped mound is present and thought to cover the excavation reported to contain buried aldicarb. This area was the focus of the geophysical survey in this portion of SWMU 03. The area encompassed in the geophysical survey is shown on Figure 15.

The survey grid established over the suspected Aldicarb Disposal Area was placed to provide coverage over the grassy mound and as much background outside the mound as was practically possible. A baseline was established in the center of the paved road leading to the rocket test pit, with coordinates painted every 20 feet along the line. A total of 14 lines were then established perpendicular to the baseline, marked by labeled, white PVC pin flags on all 150E and 200E stations, and at the end of each line. The locations of two permanent features, a monitoring well and a red-painted utility fixture, were recorded so the grid could be recovered, should the flags be removed. The eastern margin of the grid was restricted somewhat by densely vegetated woods. The following is a brief summary of the geophysical survey and results at SWMU 03. A more complete discussion of the geophysical survey and results may be found in Appendix C.

EM-31 data were collected on east-west lines spaced 10 feet apart, with readings collected at 2.5-foot intervals along lines. The contoured EM-31 quadrature data shows two high amplitude anomalies which correspond

to known cultural features. The north-south oriented feature immediately east of the asphalt road is reported to be a water pipe, probably constructed of cast iron. The other high amplitude feature consists of a nearly circular high and a low resulting from the monitoring well (MW-303).

A subtle expression of lower conductivity forms a closed feature, the surface trace of which corresponds very closely to the mound thought to cover the excavation. It is apparent that while the area of lower conductivity corresponds closely to the margins of the mound, it does extend beyond the mound on the southeastern side.

In contrast to the quadrature data, the in-phase contour map images only known cultural features (the water pipe and monitoring well). The lack of other in-phase anomalies demonstrates no buried drums are present in the mound. Small, near-surface metallic objects detected by EOD using Schonstedt magnetic locators on the mound are very likely too small to produce a significant response in the EM-31.

The GPR profiles for the suspected Aldicarb Disposal Area were collected on east-west lines spaced 20 feet apart. GPR data indicates that the water pipe is a very strong reflector, evident on the western side of all of the profiles. The diffraction tails extending beyond the pipe's location are typical of strong metallic reflectors, which are "visible" to the radar even some distance away. Several reflectors are interpreted as disturbed ground caused by the previous excavation. East of the mound, a very pronounced difference in the continuity of the subsurface reflectors can be seen as a result of undisturbed ground. West of the mound, broken, discontinuous reflectors extend to the water pipe and are probably the result of excavation in this vicinity. The limits of the disturbed subsurface, as defined by the GPR data, are interpreted as the boundaries of the excavated area. Five test pits were completed in the mounded area to investigate geophysical anomalies (Figure 15).

The five test pits were placed in locations deemed to be best suited to investigate geophysical anomalies and the reflective layers identified by GPR. The first two test pits were intended to identify small anomalies that

could be due to buried metallic objects. Both TP-1 and TP-2 showed only small scrap metal pieces buried at a shallow depth (less than two feet). TP-3, TP-4, and TP-5 were completed on top of the mound to investigate the layer identified in the GPR survey. The three test pits revealed natural soils below four feet as described by a dark brown, weakly cemented layer overlying a pale brown very fine sand, overlying a dark brown organic cemented sand. The cemented layer is the suspected source of the GPR anomaly and is believed to be a natural feature.

4.3.2.2 Soil Borings

A series of three soil borings (Figure 15) were completed on the north and west sides of the Aldicarb Disposal Area in the expected downgradient ground water flow direction. The borings began north of the mound and were placed approximately equidistant in an arc to the west. The borings were used to identify the best location for one monitoring well, as requested by the GAEPD. Field headspace screening of the soil with a PID showed no elevated readings above ambient background levels. Boring logs are found in Appendix A.

4.3.2.3 Soil Analytical Results

GAEPD requested that two soil samples be submitted for laboratory analysis from each test pit completed and that a minimum of eight test pits be completed at the SWMU 03 Burn and Aldicarb Disposal Areas combined. A total of five test pits were completed in the Aldicarb Disposal Area to investigate geophysical anomalies previously identified. GAEPD also required that the two soil samples to be submitted for analysis from each pit consisting of one shallow soil sample from waste material and one soil sample from below the waste material. The soil samples were analyzed for VOCs, BNAs, Aldicarb, CS and related compounds, and metals. Analytical results are summarized in Table 9.

Table 9

SWMU 03 - Aldicarb Disposal Area - Phase II RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/ Element	Background		9107	9108	9109	9110	9111	9112
	upper mean	lower mean	Test pit 3 (4 feet)	Test pit 3 (9 feet)	Test pit 4 (4 feet)	Test pit 4 (8 feet)	Test pit 5 (4 feet)	Test pit 5 (8 feet)
Barium	9.4	3.3	6.1	5.2	7.3	7.0	6.2	4.6
Chromium	4.8	2.0	2.8	7.7	3.0	6.3	2.6	5.6
Lead	4.7	1.7	4.3	2.9	3.8	4.8	3.7	7.6
Mercury	0.022	0.0088	0.031	0.018	ND[1]	ND	0.033	ND

[1]ND = not detected above MDL.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

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Three pairs of samples were submitted from the five test pits completed in the Aldicarb Disposal Area. Since headspace screening and visual observations detected no obvious waste material in the test pits, one shallow sample was collected from a depth of two to four feet and one deep sample was collected from the bottom of each test pit.

Analytical results did not indicate any compounds above the detection levels for VOCs, BNAs, aldicarb, or CS and its degradation products. Metals concentrations, when compared to the background concentrations, exceeded the BUMC for chromium, lead, and mercury. Mercury was detected above the BUMC in TP-3. Chromium was detected above the BUMC in all three test pits from the deep soil samples. Lead was detected above the BUMC from the deep soil samples in TP-4 and TP-5. In general, the metals concentrations were within one order of magnitude of the BUMC. Section 4.1 provides a description of the statistical analyses used to compare SWMU- specific metals concentrations to background metals concentrations.

4.3.2.4 Ground Water Analytical Results

One ground water sample was collected from the monitoring well installed during the Phase II RFI (MW-304). The ground water sample was analyzed for VOCs, BNAs, aldicarb, CS-related compounds, and total metals. Analytical results are summarized in Table 7.

Laboratory analysis did not indicate VOCs, BNAs, CS compounds, or aldicarb above the instrument reporting levels. Total metals concentrations for arsenic, barium, chromium, lead, and mercury were not detected at levels greater than the allowable MCLs. Cadmium (0.12 mg/L) was detected at a concentration slightly above the MCL.

4.3.2.5 Waste Description

No subsurface wastes were identified during the investigation of the Aldicarb Disposal Area. Based on visual observations during completion of the test pits and field screening of the soils, the mound appears not to have been used as a disposal area for solids.

4.4 SWMU 04

SWMU 04 contains two sites: an Acetone Evaporation Pond and Borrow Pit. The Acetone Evaporation Pond is located on the east side of the fire break road and was used for the surface disposal of acetone. The Borrow Pit was reportedly used for the disposal of Nuchar wastes.

4.4.1 Soil Borings

As directed by GAEPD, six soil borings were completed on the east and south sides of the Acetone Evaporation Pond in an overflow drainage ditch during the Phase II RFI. The soil was continuously screened at one foot intervals and the sample from the interval with the highest PID reading was submitted for analysis. A second sample was submitted from each boring from a depth of five feet to assess the vertical extent of contamination, if present. GAEPD also requested that one sample be submitted which exhibited low PID readings, at or near zero, to confirm that there were no false negatives from the PID screening.

The soil borings were located at approximately equal spacings beginning at the northeast corner and proceeding south and west to the southwest corner (Figure 16). Two soil samples were analyzed from depths exhibiting PID readings at or near zero. Therefore, Apex did not collect additional samples beyond the two per boring. GAEPD had requested additional analysis from a sample with a zero reading on the PID to assess whether the PID gave false negative readings.

4.4.2 Soil Analytical Results

The Phase I shallow soil samples from within the Acetone Evaporation Pond contained acetone in all of the samples except SS-405. In addition, tetra-chloroethane, toluene, 1,1,1-trichloroethane, and total xylenes were detected in soil borings SS-401, 402, 403, and 405. Soil analytical results from the Phase I RFI are summarized in Table 10.

Table 10

SWMU 04 - Phase I RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/ Element	Background		SS-401	SS-402	SS-403	SS-404	SS-405
	upper mean	lower mean	Evap. Pond	Evap. Pond	Evap. Pond	Evap. Pond	Evap. Pond
Barium	2.8	1.0	4.5	14.0	12.0	7.7	4.0
Chromium	3.7	1.3	ND[1]	1.3	4.2	4.2	ND
Lead	2.8	1.3	3.4	4.5	2.1	2.4	2.7
Mercury	0.015	0.012	0.037	0.04	0.016	ND	0.025
Acetone	NA[2]	NA	0.034	0.13	0.13	0.091	ND
Tetrachloroethene	NA	NA	ND	0.014	ND	ND	0.018
Toluene	NA	NA	0.032	0.076	0.021	ND	0.066
1,1,1-trichloroethane	NA	NA	ND	ND	ND	ND	0.0075
Xylenes, total	NA	NA	0.0084	0.0093	ND	ND	ND

[1]ND = Not detected above MDL.
[2]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

Soil samples were submitted for laboratory analysis of VOCs, BNAs, aldicarb, and metals during the Phase II RFI. Analytical results from the Phase II RFI are summarized in Table 11. Laboratory analysis detected acetone and toluene in the soil samples. Acetone was found in all soil samples collected except three samples (4-004 shallow, 4-005 shallow, and 4-006 deep). Toluene was detected in two samples (4-002 shallow and 4-004 shallow). Bis(2-ethylhexyl)phthalate was also detected in shallow soil samples 4-001 and 4-004, and from the deep soil sample from 4-003.

Metals concentrations, when compared to the background concentrations, exceeded the BUMC for barium, chromium, lead, and mercury (Tables 10 and 11). Barium exceeded the BUMC in all of the soil samples from the Phase I and Phase II investigations except for three shallow samples from the Phase II investigation (4-003 shallow, 4-004 shallow, and 4-006 shallow). Chromium exceeded the BUMC in two samples from the Phase I investigation (SS-403 and 405), and half of the samples from the Phase II investigation (4-001 shallow and deep, 4-002 deep, 4-003 deep, 4-004 deep, 4-005 shallow and deep, and 4-006 deep). Lead was found in concentrations exceeding the BUMC in about half of the samples from the Phase I and II investigations: SS-401 and SS-402, 4-002 shallow and deep, 4-003 shallow and deep, 4-004 deep, 4-005 shallow and 4-006 deep. Mercury also exceeded the BUMC in most of the soil samples (except SS-404, 4-004 shallow and deep, and 4-006 shallow). In general, metals were within one order of magnitude of the BUMC. Section 4.1 provides a description of the statistical analyses used to compare SWMU-specific metals concentrations to background metal concentrations.

4.4.3 Ground Water Analytical Results

MW-401 is located hydraulically downgradient from the Acetone Evaporation Pond; MW-402 and 403 are located laterally north and south, respectively, from the evaporation pond. MW-404 is located upgradient of the evaporation pond.

Laboratory analyses for ground water samples (which were analyzed for VOCs, SVOCs, aldicarb, and metals) submitted during the Phase II RFI did not detect BNAs or aldicarb above the instrument reporting levels (Table 12). 1,1,2-trichloroethane was detected in MW-401 at 0.005 mg/L, which is at the MCL. Total

Table 11

SWMU 04 - Phase II RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/ Element	Background		9036	9037	9038	9039	9040	9041	9042	9043
	upper mean	lower mean	4-001S[1]	4-001D[2]	4-002S	4-002D	4-003S	4-003D	4-004S	4-004D
Barium	2.8	1.0	2.7	6.5	4.3	8.7	2.6	16	1.5	8.0
Chromium	3.7	1.3	3.9	4.8	3.6	6.5	2.5	6.0	2.5	9.9
Lead	2.8	1.3	2.7	1.9	3.5	3.6	3.3	10	2.6	3.6
Mercury	0.015	0.012	0.019	0.024	0.015	0.022	0.017	0.057	ND[4]	ND
Acetone	NA[3]	NA	0.61	0.35	0.80	0.12	0.72	0.71	ND	1.1
Toluene	NA	NA	ND	ND	0.034	ND	ND	ND	0.57	ND
bis(2-ethyl-hexyl) phthalate	NA	NA	0.670	ND	ND	ND	ND	0.49	0.45	ND

[1]S = Shallow sample.
[2]D = Deep sample.
[3]NA = Not applicable; statistics not generated for VOCs.
[4]ND = Not detected above MDL.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

Table 11 (cont'd)

Compound/Element	Background		9044	9045	9046	9047
	upper mean	lower mean	4-005S[1]	4-005D[2]	4-006S	4-006D
Barium	2.8	1.0	8.4	17	1.4	4.6
Chromium	3.7	1.3	ND[3]	3.1	1.8	8.3
Lead	2.8	1.3	3.6	1.1	2.5	3.2
Mercury	0.015	0.012	0.027	0.026	ND[3]	0.020
Acetone	NA[4]	NA	ND	0.27	0.76	ND
Toluene	NA	NA	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	NA	NA	ND	ND	ND	ND

[1]S = Shallow sample.
[2]D = Deep sample.
[3]ND = Not detected above MDL.
[4]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

Table 12

SWMU 04 - Phase I and II RFI
Ground Water Analytical Results

Thiokol - Woodbine Facility

Compound/Element	MCL	Phase I RFI Analytical Results				Phase II RFI Analytical Results			
		MW-401	MW-402	MW-403	MW-404	MW-401	MW-402	MW-403	MW-404
Arsenic	0.050	ND[1]	0.011	0.011	0.017	0.15	0.16	0.020	0.040
Barium	2.0	0.097	0.12	0.036	0.038	1.7	2.3	0.24	0.36
Cadmium	0.0050	ND	ND	ND	ND	0.015	0.009	ND	ND
Chromium	0.10	ND	0.017	ND	ND	0.32	0.11	0.058	0.077
Lead	0.050	0.005	0.0058	ND	ND	0.10	0.16	0.018	0.020
Mercury	0.0020	ND	ND	ND	ND	0.0013	0.0012	0.00024	0.00048
1,1,2-trichlorethane	0.0050	ND	ND	ND	ND	0.005	ND	ND	ND
cis-1,2-dichloroethene	0.070	0.028	ND	ND	ND	ND	ND	ND	ND

[1]ND = Not detected above MDL.
All results reported in mg/L.
Shaded results show concentrations equal to or greater than the respective MCL.

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metals concentrations of arsenic, cadmium, chromium, and lead in MW-401 and MW-402 exceeded the respective MCLs. Barium exceeded the MCL in MW-402. Total metals concentrations were below the MCLs in MW-403 and 404.

4.5 SWMU 05

SWMU 05 was reportedly used as a surface disposal area. One drum, which reportedly contained aldicarb oxime, was found by Law in an open trench. Additional work required for the Phase II RFI included resampling the one monitoring well and comparing background soil metals concentrations to those concentrations found during the Phase I RFI.

4.5.1 Soil

Metals concentrations exceeded the BUMC calculated by Apex for barium and mercury (Table 13). Barium exceeded the BUMC in soil samples SS-501, 503, 504. Mercury was found exceeding the BUMC from soil samples SS-501 and SS-505. In general, the metals concentrations were within one order of magnitude of the BUMC. Section 4.1 provides a description of the statistical analyses used to compare SWMU-specific metals concentrations to background metals concentrations.

4.5.2 Ground Water

The ground water sample from the Phase I RFI detected arsenic, barium, and napthalene below their respective MCLs (Table 14). Laboratory analysis did not detect VOCs, BNAs, and aldicarb above the instrument reporting levels for samples collected during the Phase II RFI. Total metals concentrations were all below their respective MCLs.

4.6 SWMU 06

SWMU 06 consists of four previously identified areas: Surface Debris Area, Trench 1, Trench 2, and Borrow Pit Area (Figure 6). The Surface Debris Area contained mounds of asphalt, tar, and scrap metal. The surface debris was removed by Law prior to the Phase I

Table 13

SWMU 05 - Phase I RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/Element	Background		SS-501	SS-502	SS-503	SS-504	SS-505	SO-501
	upper mean	lower mean	Soil	Soil	Soil	Soil	Soil	Waste
Barium	2.6	1.4	2.7	2.1	2.7	4.1	2.5	3.6
Chromium	4.7	0.21	3.4	2.3	2.7	2.5	3.0	ND
Lead	4.1	1.9	2.5	2.8	3.3	3.9	2.6	ND
Mercury	0.024	0.0070	0.028	0.016	0.015	0.013	0.022	ND

[1]ND = Not detected above MDL.
All results reported in mg/L.
Shaded results show concentrations equal to or greater than the respective BUMC.

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Table 14

SWMU 05 - Phase I and II RFI
Ground Water Analytical Results

Thiokol - Woodbine Facility

Compound/Element	MCL	Phase I RFI Analytical Results	Phase II RFI Analytical Results
		MW-501	MW-501
Arsenic	0.050	0.026	0.011
Barium	2.0	0.092	0.20
Chromium	0.10	ND	0.029
Lead	0.050	ND	0.010
Naphthalene	1.4	0.018	ND

[1]ND = Not detected above MDL.
All results reported in mg/L.
Shaded results show concentrations equal to or greater than the respective MCL.

RFI. Trenches 1 and 2 were reportedly used for the disposal of Nuchar. Subsurface disposal activities were suspected within the Borrow Pit Areas. Phase I soil results are summarized in Table 15.

4.6.1 Geophysical Survey and Test Pits

A geophysical survey was completed at SWMU 06 and carried out in the former site of a Borrow Pit, over a linear, east-west oriented mound, north of this field (Trench 2). No surface expression of the Borrow Pit was visible. The southern boundary of the survey grid was defined by an existing monitoring well in the field. The western boundary extended slightly west of a grassy road. The eastern boundary of the Borrow Pit Area lies west of a patch of woods. In the vicinity of the mound, the orthern boundary of the survey area lies 10 to 20 feet north of an east-west oriented grassy road. The Borrow Pit Area was mowed to remove tall weeds and briars, and a point was established 125 feet due west of the monitoring well and assigned coordinates 100N, 100E. Due north-south lines were established, spaced 10 feet apart, through the field and over the mound terminating north of the grassy road. The grid in the mound area extended approximately 30 feet east of the eastern end of the mound. The following is a brief discussion of the results of the geophysical surveys at SWMU 06. A more complete discussion of the geophysical survey and results may be found in Appendix C.

The EM-31 quadrature indicated significant changes in conductivity across the site within the mound area. An east-west oriented conductivity high was present north of the fence line from approximately 960E to 1420 E. An area of highly anomalous conductivity existed within this feature, centered at approximately 1200N. Background conductivity values at SWMU 06 appeared to be approximately 5 to 7 mS/m, on the outer margins of the surveyed area. Conductivity values of 8 to 14 mS/m defined the linear conductive zone north of the fence. The highly conductive zone centered at 1210E, 1360N was defined by values of approximately 14 to 26 mS/m.

Outside the region of the highest conductivity, the mounded area showed a less pronounced but elevated conductivity. Shallow trench-like depressions are present immediately north of the highest mounds in the western portion of the grid.

Table 15

SWMU 06 - Phase I RFI
Soil Sample Analytical Results Summary

Thiokol - Woodbine Facility

Compound/Element	Background		SS-601	SS-602	SS-603	SO-607A	SO-607B	SO-624A	SO-624B	SO-624C	SO-625
	upper mean	lower mean	Scrap	Scrap	Scrap	Borrow Pit	Borrow Pit	Trench II	Trench II	Trench II	Trench II
Barium	2.8	0.8	2.3	1.9	7.4	1.6	1.7	ND[1]	ND	3.1	8.9
Chromium	3.8	2.0	2.1	1.9	3.6	4.5	2.0	ND	ND	4.2	ND
Lead	3.2	1.6	1.3	2.6	3.5	3.4	1.2	ND	ND	1.9	ND
Mercury	0.017	0.010	0.023	0.015	0.018	0.014	ND	ND	ND	0.0.15	0.013
Aldicarb	NA[2]	NA	ND	ND	ND	ND	ND	ND	ND	0.22	ND
Benzoic acid	NA	NA	ND	ND	ND	ND	ND	41.0	73.0	5.3	ND
p-isopropyltoluene	NA	NA	ND	ND	ND	ND	ND	0.021	ND	ND	ND
p-cresol	NA	NA	ND	ND	ND	ND	ND	17.0	17.0	4.2	ND
Naphthalene	NA	NA	ND	ND	ND	0.014	ND	ND	ND	ND	0.0095
Toluene	NA	NA	0.02	ND	ND	ND	ND	0.11	ND	ND	ND
1,2,4-trimethylbenzene	NA	NA	ND	ND	ND	0.0094	ND	ND	ND	ND	ND

[1]ND = Not detected above MDL.
[2]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

R481:thiok02(097.001);njm

A subtle expression of low conductivity was observed over these features from 970 to 1015E and from 1048 to 1090E. In addition, two small mounds in the northwestern portion of the grid demonstrated similar signatures.

In addition to the linear east-west conductive anomaly, several other quadrature features are worthy of note. Strong, negative conductivity anomalies occured in several locations. The wire fence was responsible for an east-west linear negative anomaly. An area in the northwest corner of the field, roughly 25 to 30 feet east of the road, showed a cluster of negative responses unexplained by any surface features. Other negative features occured north of the fence and one was north of the mound. Lastly, a broad, roughly circular feature was defined by the quadrature contours in the Borrow Pit Area. This feature was very roughly 150 feet across and was slightly more conductive at its center compared to the margins. The circular feature appeared to define the location of the former borrow pit.

The in-phase data for SWMU 06 clearly delineated areas of buried metal in the field, in the mound, and north of the mound. A group of negative in-phase anomalies was evident in this area. These anomalies varied in amplitude, the strongest occurring on the western edge of this group. Two other areas of strong negative in-phase anomalies were visible. One area in the eastern portion of the mound consisted of three strong negative responses. All three of these anomalies were of sufficient amplitude to represent drums or groups of drums.

GPR profiles for SWMU 06 were run in two blocks. The southern block corresponded to the Borrow Pit Area. The northern block covered the mound/trench area. The plots of GPR profiles for the southern block revealed excellent correlation between EM in-phase anomalies and radar anomalies. The area of in-phase anomalies in the northwestern portion of the southern survey block was supported by an abundance of GPR anomalies. The patterns were created by highly disturbed ground, probably resulting from the excavation or reclamation of the old borrow pit. The edges, and in some places the bottom of the former borrow pit, were clearly visible in many of the GPR records. No evidence of smaller pits or trenches was evident in the Borrow Pit Area.

The most outstanding characteristic of GPR lines run across the mound/trench area was the attenuation of signal in the vicinity of the longer linear

mound. The attenuation of the radar signal was attributed to the higher conductivity of the mound area. The degree of attenuation varies from place to place, and the attenuated zone's position in relation to the mound also varies. On some profiles, the attenuation reached southward to the fence and a short distance beyond. A sharp boundary was frequently apparent between the northern edge of the mound/trench area and the road as far east as 1160E. Between 1170E and 1270E, the zone of attenuation extended below and north of the road. Whether conductive material was buried this far to the north, or the attenuation was a result of conductive fluid migration or a conductive cap, was not apparent. A great number of hyperbolic and sloping reflectors attested to the disturbed subsurface within the northern survey block. Few metallic objects were evident in the GPR records in the mound area.

Two test pits (TP-6 and TP-7) were completed to examine the anomalous signal attenuation area. TP-6 was also used to investigate possible buried metallic objects (Figure 20). In both TP-6 and TP-7 there was Nuchar from the ground surface to a depth of three to six feet. The Nuchar was found on the north side of the mounded area. TP-6 showed that the mound was probably excavated soils from the trench, with Nuchar being found in the trench at or near the ground surface and probably natural soils under the mound. The Nuchar found in TP-6 was dark brown in color while the Nuchar in TP-7 was a yellowish brown. A fermenting odor was noticed during the completion of TP-7.

Test pits TP-5, TP-8, TP-9, and TP-10 were completed to investigate EM-31 anomalies. The EM-31 survey of Trench 2 was complicated by a barbed wire fence separating the trench from the Borrow Pit Area. However, despite the presence of the fence, several anomalies were identified within the trench area. The anomalies suggested isolated concentrations of buried metallic objects. All of the anomalies were related to pieces of scrap metal as determined during test pitting. A Schoenstadt magnetometer was used to confirm the presence or lack of further metal in the test pits.

A large concrete conduit section approximately five feet in diameter was encountered in TP-10. The conduit appeared to be of the type associated with storm water drainage and did not appear to be related to any process of the facility. Nuchar and a white clayey material were evident in the east side of the test pit near the conduit.

Soil and waste material samples were submitted for laboratory analyses for VOCs, BNAs, aldicarb, and metals during the Phase II RFI (Table 16). Acetone was the only organic compound detected in the waste material samples. Acetone was detected from the north trench samples (6-001 shallow) at a concentration of 0.085 mg/kg, and the middle sample (6-002 shallow) at a concentration of 0.032 mg/kg. No organic compounds were detected from the south trench sample (6-003 shallow). Metals results of waste samples were not compared to the BUMC due to matrix differences.

Soil samples collected from below the waste material showed no detectable concentrations of organic compounds with the exception of aldicarb. Aldicarb was detected at 0.038 mg/kg in 6-002 deep. However, barium and chromium were detected at concentrations exceeding the BUMC. Barium exceeded the BUMC in all three samples (6-001, 6-002, and 6-003) and chromium exceeded the BUMC in the middle and south trench areas (6- 002 deep and 6-003 deep). In general, the metals were within one order of magnitude of the BUMC.

4.6.2 Trench 2

The Phase II RFI of Trench 2 began with the clearing of brush to lay grid lines for the geophysical surveys. Since Trench 2 and the Borrow Pit Area were adjacent, both areas were surveyed at the same time using the same lines. Following the geophysical survey and data analyses, test pits were excavated to investigate anomalies.

4.6.2.1 Soil

Two samples of the Nuchar waste material were collected by Apex during the Phase II RFI (Table 17). One sample of dark brown Nuchar was collected from TP-6 and one sample of the yellowish brown Nuchar was collected from TP-7. One sample of the white clayey material was collected from TP-10. All of the samples were analyzed for VOCs, BNAs, aldicarb, metals, and CS compounds. CS compounds were not detected in any of the submitted samples.

Table 16

SWMU 06 - Trench 1 - Phase II RFI
Soil Samples Analytical Results

Thiokol Woodbine Facility

Compound/ Element	Background		9048	9100	9050	9101	9052	9102
	upper mean	lower mean	6-001S[1] Waste	6-001D[2]	6-002S Waste	6-002D	6-003S Waste	6-003D
Barium	2.8	0.8	1.7	7.3	ND[3]	5.4	11	7.3
Chromium	3.8	2.0	3.5	3.0	1.9	18	1.6	4.4
Lead	3.2	1.6	3.1	1.0	1.1	2.0	1.2	1.3
Mercury	0.017	0.010	0.015	ND	ND	ND	ND	ND
Acetone	NA[4]	NA	0.085	ND	0.032	ND	0.55	ND
Aldicarb	NA	NA	ND	ND	ND	0.038	ND	ND

[1]S = Shallow Sample.
[2]D = Deep Sample.
[3]ND = Not detected above MDL.
[4]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

Table 17

SWMU 06 - Trench 2 - Phase II RFI
Soil Sample Analytical Results Summary

Thiokol - Woodbine Facility

Compound/ Element	Background		9136	9137	9138
	upper mean	lower mean	Test Pit 6 Waste	Test Pit 7 Waste	Test Pit 10
Barium	2.8	0.8	ND[1]	ND	2.9
Chromium	3.8	2.0	5.0	ND	ND
Lead	3.2	1.6	4.1	ND	1.0
Acetone	NA[2]	NA	0.83	460	ND
m&p-cresol	NA	NA	ND	12	ND
2,4-dimethylphenol	NA	NA	ND	1.3	ND

[1]ND = Not detected above MDL.
[2]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations above the respective BUMC.

Acetone was found in the Nuchar samples submitted from TP-6 and TP-7. Acetone was detected in the yellowish brown Nuchar at 460 mg/kg. Cresol (m and p isomers) was also detected in the yellowish brown Nuchar, but not in the brown Nuchar. Metals results of waste material have not been compared to the BUMC due to matrix differences.

4.6.2.2 Waste Description

Waste encountered in Trench 2 appears to be mostly Nuchar-related waste, especially in the eastern half of the trench where Nuchar was found in most of the test pits. The western half of the trench appears to contain lesser amounts of Nuchar and a quantity of the white clayey and granular material–possibly gypsum. The trench also contains other material including the crushed drum found during the Phase I RFI and the concrete conduit found during the Phase II Investigation.

Analytical results found only aldicarb in the deepest sample collected below the waste material (SO 624C, Phase I RFI). Acetone was found in the yellowish brown Nuchar, as well as other organic compounds were detected during the Phase I RFI. The dark brown Nuchar found in TP-6 during the Phase II RFI also detected acetone. The dark brown Nuchar was found on top of the yellowish brown Nuchar. The lower concentrations in the dark brown Nuchar would suggest that the material had oxidized and the organic constituents have oxidized, volatilized, or biodegraded.

4.6.3 Borrow Pit Area

The Phase II RFI Investigation of the Borrow Pit Area began with the clearing of brush to lay grid lines for the geophysical surveys. Since Trench 2 and the Borrow Pit Area were adjacent, both areas were surveyed at the same time using the same lines. Section 4.6.1 presents the results of the geophysical survey for the Borrow Pit Area and Trench 2 Areas. Following the geophysical survey and data analyses, test pits were excavated to investigate the anomalies.

4.6.3.1 Test Pits

The Trench 2 and Borrow Pit Areas were surveyed with GPR and EM-31 on December 4, 6, and 9, 1995. The GPR and EM-31 surveys both showed the extent of the Borrow Pit. The limits of the Borrow Pit were indicated on the GPR survey by the change in signal between the native soil and fill material. The EM-31 shows the Borrow Pit by concentric lines of increasing conductivity.

Only small anomalies were identified by GPR and EM-31 from within the Borrow Pit. Strong anomalies were encountered in the northwest corner of the field. Four test pits (TP-1 through TP-4) were completed in this area to identify the anomalies (Figure 21).

TP-1 and TP-2 contained scrap metal and plastic drum liners, some containing material. Four samples were collected of the different wastes: TP-1 - cream colored granular material (sample no. 9131); TP-2 - yellow granular material (sample no. 9132), white crystalline solid (sample no. 9133), and green clayey solid (sample no. 9134).

TP-3 and TP-4 also contained scrap metal and what appeared to be construction or building debris. High PID readings were encountered from 1.5 to 4 feet in TP-3 and one soil sample was collected from this interval (sample no. 9135).

4.6.3.2 Analytical Results

Waste materials were encountered in the northwest area of the field containing the Borrow Pit. The material appears to be leftover process material and generally consists of small volumes contained in plastic bags. The plastic bags appear to have originally been drum liners. Analytical results are summarized in Table 18.

Table 18

SWMU 06 - Borrow Pit - Phase II RFI
Soil Sample Analytical Results

Thiokol - Woodbine Facility

Compound/ Element	Background		9131	9132	9133	9134	9135
	upper mean	lower mean	Test Pit 1 Waste	Test Pit 2 Waste	Test Pit 2 Waste	Test Pit 2 Waste	Test Pit 3 Waste
Barium	2.8	0.8	13	ND[1]	ND	15	4.1
Chromium	3.8	2.0	3.7	ND	7.5	4.5	7.9
Lead	3.2	1.6	4.0	0.64	59	44	5.7
Mercury	0.017	0.010	0.73	ND	ND	0.023	0.012
Acetone	NA[2]	NA	0.059	0.58	ND	0.034J[3]	ND
Carbon disulfide	NA	NA	ND	ND	ND	0.30	ND
Benzene	NA	NA	ND	0.078	ND	ND	ND
Toluene	NA	NA	ND	0.44	ND	ND	ND
Ethylbenzene	NA	NA	ND	0.15	ND	ND	ND
Xylenes, total	NA	NA	ND	0.82	ND	ND	ND

[1]ND = Not detected above MDL.
[2]NA = Not applicable; statistics not generated for VOCs.All results reported in mg/L.
[3]J = Estimated value below detection limit.

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The yellow granular material from TP-2 contained acetone (0.058 mg/kg), benzene (0.078 mg/kg), toluene (0.440 mg/kg), ethylbenzene (0.150 mg/kg), and xylenes (0.820 mg/kg). The clear granular material from TP-2 contained only acetone at a concentration of 0.590 mg/kg. The white crystalline material from TP-2 did not contain organic compounds but did contain chromium at 7.5 mg/kg and lead at 59 mg/kg. The green material from TP-2 contained concentrations of barium, chromium, lead, and mercury. Acetone and carbon disulfide were also detected. The soil from TP-3 did not contain organic compounds but barium, chromium, and lead were present. The soil collected from TP-3 exceeded the BUMC for barium, chromium, and lead. Results of metals analysis on waste material from TP-1 and TP-2 is not compared to the BUMCs due to matrix differences.

4.6.3.3 Waste Description

The waste material encountered in the Borrow Pit Area was found in the northwest corner of the field. The waste appeared to be small, unused quantities of unknown material contained in plastic bags. The plastic bags appeared to be container liners (probably 55-gallon drum liners). Analyses of the material generally detected concentrations of barium, chromium, lead, and organic solvents. TP-607, completed during the Phase I RFI, was near the disposal area. Analysis of the one soil sample collected from this area during the Phase II RFI did not detect organic compounds, despite the high field headspace screening, but did detect concentrations of barium, chromium, and lead.

4.6.4 Ground Water

As requested by GAEPD, ground water was resampled by Apex from the four monitoring wells previously installed by Law. Ground water samples were analyzed for VOCs, BNAs, aldicarb, CS compounds and degradation products, and total metals. Analytical results are summarized in Table 19.

Table 19
SWMU 06 - Phase I and II RFI
Ground Water Analytical Results Summary

Thiokol - Woodbine Facility

Compound/ Element	MCL	Phase I RFI Analytical Results				Phase II RFI Analytical Results			
		MW-601	MW-602	MW-603	MW-604	MW-601	MW-602	MW-603	MW-604
Arsenic	0.050	0.016	0.016	0.016	0.032	0.015	0.086	0.017	ND
Barium	2.0	0.05	0.088	0.1	0.12	0.21	0.27	0.30	0.091
Chromium	0.10	ND	0.015	ND	0.016	0.041	0.059	0.048	0.017
Lead	0.050	ND	ND	ND	0.0061	0.011	0.020	0.014	0.0060
Mercury	0.002	ND	ND	ND	ND	ND	0.00020	ND	ND
Aldicarb	0.0030	ND	ND	ND	ND	ND	0.00050	ND	ND

[1]ND = Not detected above MDL.
All results reported in mg/L.
Shaded results show concentrations equal to or greater than the respective MCL.

R481:thiok02(097.001);njm

Laboratory analysis of ground water samples submitted during the Phase II RFI investigation did not detect VOCs or BNAs, above the instrument reporting levels. Aldicarb was detected in MW-602 of the detection limit of 0.00050 mg/L. Total metals concentrations were all below their respective MCLs except for arsenic in MW-602. Arsenic concentrations were 0.086 mg/L compared to the MCL of 0.050 mg/L.

4.7 SWMU 07

No intrusive sampling was conducted within the area of SWMU 07 during the Phase I RFI. Four monitoring wells were installed around the perimeter of the SWMU by Law.

4.7.1 Initial Investigation

Prior to field work, SWMU 07 was overgrown with shrubs, vines, and small trees. There were two obvious unvegetated patches (areas 14 and 12). Both areas contained surface debris that included gas mask filter cartridges, M301 illumination round parts, and scrap metal. Besides the fire break road, two small roads were also visible during the initial walkover.

EOD personnel began the investigation of SWMU 07 by using a magnetometer to locate and identify near surface ordnance-related items. Lanes were set up at five-foot intervals and a Schonstedt magnetometer was used to sweep each lane. However, after about three lanes were swept in the northern part of the SWMU, a large number of anomalies were identified and many M49 trip flares were located. At this point, the surface sweep was revised to a more general location of large areas of suspect material.

4.7.2 Geophysical Survey

Magnetic and electromagnetic geophysical surveys were originally planned for SWMU 07. The initial survey of the area with a magnetometer indicated a large number of metallic objects present. The work plan called for the UXO contractor to sweep the surface and identify near surface ordnance prior to entry by the geophysical crews. Investigating each anomaly would be time consuming; therefore, only a general sweep of the entire SWMU was conducted to identify whether there were any large concentrations of ferrous objects or ordnance-related items.

The survey by EOD with the magnetometer identified 19 areas (Figure 23) that gave strong anomalous readings. Selected areas (i.e., areas 18 and 19) could be attributed to a single large object, possibly a drum. Other areas consisted of large anomalous readings (area 13) or a concentration of smaller readings (areas 11 and 12).

Due to the large number of anomalies identified within a small area, Apex decided to conduct a broad sweep of the entire SWMU to identify the concentration of anomalies over the entire site. Nineteen areas of anomalous magnetometer readings were identified. The results of this magnetometer sweep are shown on Figure 22.

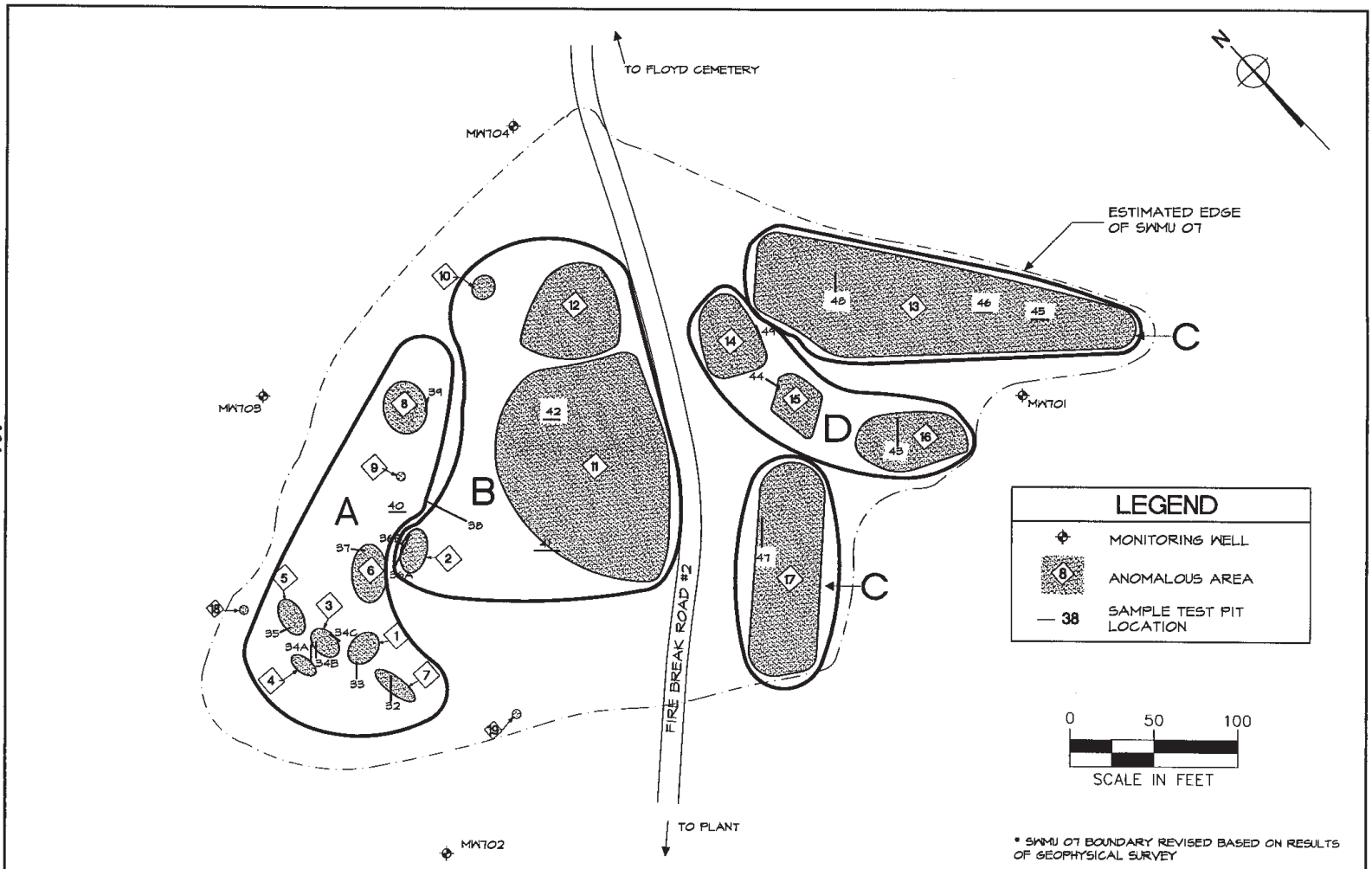
4.7.3 Exploratory Test Pits

The next phase of the initial site work involved excavating test pits to identify the sources of magnetic anomalies. The only material that had been found during brush clearing and the initial magnetometer lane sweeps was ordnance-related items (M49 trip flares, M301A3 81mm illumination rounds, and CS). The ordnance-related items were also found outside of the suspected disposal areas. Apex hoped to identify the amount and distribution of ordnance at the SWMU by completing test pits in the anomalous areas (Figure 22). Soil samples for site characterization were collected in a later phase (Figure 23).

Exploratory test pits were excavated adjacent to the larger anomalies and over the smaller anomalies until the source was identified. Many of the test pits were shallow and the soils described in the test pit logs more characteristic of the native soils outside the disturbed areas. Samples were not collected during this phase of the investigation since this was an exploratory method to outline what work would be needed to characterize the SWMU.

After the completion of all the test pit excavations, four areas with similar waste materials within each area could be identified as follows (Figure 24):

- Area A - CS Disposal Area. This area contains the anomalous areas 1, 3, 4, 5, 7, and 8. Visual, olfactory, and laboratory analysis evidence indicated that these areas contain CS and its related compounds.



Apex environmental, inc.
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FIGURE 24
SWMU 07
IDENTIFICATION OF WASTE AREAS
WOODBINE, GEORGIA

Date: 7-15-96	Project Title: PHASE II RFI THIOKOL CORPORATION WOODBINE, GA		
Drawn By: EMD			
Project Number: 097.001	CAD File: UNION-3	Scale: AS SHOWN	Client: THIOKOL CORP

- Area B - Construction and Building Debris Disposal Area. This area contains the anomalous areas 2, 6, 10, 11, and 12. Visual inspections of this area detected scrap metal, non-metallic building debris, Nuchar, and bagged material (similar to TP-2 in the Borrow Pit Area, SWMU 06).

- Area C - Trip Flare Disposal Area. This area contains the anomalous areas 13 and 17. Area 17 contained trip flares on the surface. Area 13 contained loose buried trip flares on the east and drummed ordnance-related items to the west.

- Area D - Drum and Trash Disposal Area. This area contains the anomalous area 14, 15, and 16. These areas contain miscellaneous trash. During the second phase, buried drums with nonordnance-related items were found in area 16.

4.7.4 Ordnance Recovery

During the initial investigation, buried drums with concrete caps were located on the western side of area 13. The removal of the drums began on the east side of the Drum Disposal Area. The edge of the drum area was located by locating the proximity of the disposal area with the magnetometer and using the backhoe to confirm the end point of the trench.

A total of 408 drums were recovered from this area between December 12, 1995 and March 28, 1996. A summary of the drum contents is contained in Appendix B. The drums, with few exceptions, had concrete poured in the open, top end of the drum. The drums were opened gently with the backhoe and then the contents were sorted into inert scrap material or live ordnance material by EOD. Live ordnance was containerized in non-sparking drums for transport to the rocket test pad for deactivation.

Ordnance-related items recovered consisted of:

- M49 trip flares, complete rounds, candles, and primers;
- M301 81 mm illumination rounds - complete rounds, candles, ignition cartridges, increment charges, primers, and combinations of these parts (e.g., tail fin assemblies contained ignition cartridges and primers);
- 40 mm CS grenades - complete rounds, primers, and bodies;
- XM15 CS cartridges - complete rounds; and
- 40 mm warheads - warheads only, without detonators.

All of the rounds were deactivated by burning with the exception of the 40 mm warheads. The rounds to be deactivated were transported by EOD to the rocket test pad adjacent to SWMU 03 and burned. The burn residue was then sorted and unburned items were removed to be reburned. The remaining material was drummed in 55-gallon steel drums. Waste material generated during the Phase II RFI is scheduled for off site disposal in October 1996.

Eighty-one mm illumination rounds that were either complete rounds or had the timing train fuse assembly attached to the body had to be deactivated prior to burning. Deactivation was accomplished by placing a shaped charge at the junction of the timing train fuse and body. This step was necessary since an expelling charge (used to separate the timing train fuse from the body and ignite the candle) could explode during burning.

The 40 mm warheads were deactivated by detonation in two detonation pits excavated in a borrow pit near the rocket test pad. There were no indications that the 40 mm warheads were inert so they were treated as HE rounds. After the detonations, the soil was screened to ensure that all the rounds were deactivated. There were indications that at least some of the rounds may have been HE rounds. A copy of EOD's report of UXO related activities is included as Appendix E.

4.7.5 Investigative Test Pits

Following the initial exploratory test pitting (discussed in section 4.7.3) and after the removal of ordnance (section 4.7.4), test pits were completed to characterize the areas showing similar waste characteristics during initial investigation (Figure 23).

4.7.5.1 Area A - CS Disposal Area

Anomalous areas 1, 3, 4, 5, and 7 were suspected of containing CS disposal wastes. The area is in the vicinity previously identified in the Phase I RFI as reportedly containing buried drums of orthochloro-benzalmalonitrile. During initial brush clearing, CS was noted in this area as small clumps on the ground that were irritating to the nose and eyes when disturbed and from absorption by the foliage when the plants were cut that was irritating to the eyes and nose.

Buried drums containing a yellowish and reddish brown powder were encountered in TP-32, TP-33, and TP-34. Laboratory analysis also showed CS and related compounds in TP-37 (anomalous area 6) and TP-39 (anomalous area 8).

4.7.5.1.1 Analytical Summary

Samples from SWMU 07 were all analyzed for VOCs, BNAs, aldicarb, CS and related compounds (ortho-chlorobenzaldehyde, orthochlorobenzylidiene malononitrile, and malononitrile), and metals. Analytical results are summarized in Table 20.

- Lead was found at 49 mg/kg in waste material from TP-32. Acetone was also detected at 0.29 mg/kg. No other organic compounds were detected.
- Lead was found at 79 mg/kg in waste material from TP-33. Acetone was also detected at 1.4 mg/kg. CS compounds (orthochlorobenzaldehyde and orthochlorobenzylidiene malononitrile) were detected at 660 and 16,000 mg/kg. No other organic compounds were detected.
- Cadmium, lead, and mercury were present at concentrations above the BUMC in soil from TP-34. Acetone was also detected at 0.2 mg/kg in TP-34. CS compounds (orthochlorobenzaldehyde) were detected at 610 mg/kg. No other organic compounds were detected.
- Barium, chromium, lead, and mercury were detected at concentrations above the BUMC for soils in TP-37. Acetone, toluene, and xylenes were also detected at 0.220 mg/kg, 0.007 mg/kg, and 0.017 mg/kg, respectively in TP-37. CS compounds (orthochlorobenzylidiene malononitrile) were detected at 180,000 mg/kg. No other organic compounds were detected.
- Barium, and lead were present in TP-39 above the BUMC. Acetone, ethylbenzene, and xylenes were also detected at 0.83 mg/kg, 0.043 mg/kg, and 0.076 mg/kg, respectively in TP-39. CS compounds (orthochlorobenzylidiene malononitrile) were detected at 150,000 mg/kg. No other organic compounds were detected.

Table 20

SWMU 07 - Phase II RFI
Soil Sample Analytical Results Summary

Thiokol - Woodbine Facility

Compound/ Element	Background		9159 9173	9160 9174	9161 9175	9162 9176	9163 9177	9164 9178	9165 9179	9166 9180	9167 1981	9168 9182	9169 9183	9170 9184	9171 9185	9172 9186	9189 9194	9190 9195	9191 9196	9192 9197	9193 9198
	upper mean	lower mean	Test Pit 32 Waste	Test Pit 33 Waste	Test Pit 34	Test Pit 35	Test Pit 36 Waste	Test Pit 37	Test Pit 38	Test Pit 39	Test Pit 40 Waste	Test Pit 41 Waste	Test Pit 42 Waste	Test Pit 43 Waste	Test Pit 43 Waste	Test Pit 44	Test Pit 45	Test Pit 46	Test Pit 47	Test Pit 48	Test Pit 49
Arsenic	1.3	1.2	4.3	1.9	ND[1]	ND	ND	ND	ND	ND	ND	ND	1.3	5.5	3.2	ND	ND	ND	ND	ND	ND
Barium	2.1	0.88	14	74	1.7	ND	ND	2.5	ND	2.2	ND	59	130	5.6	28	1.4	1.5	7.6	95	ND	2.1
Chromium	2.5	1.3	11	15	2.2	1.2	2.1	5.2	1.8	2.4	1.7	10	15	7.3	12	3.4	ND	ND	ND	ND	650
Cadmium	0.64	0.61	4.0	2.7	1.8	ND	ND	ND	ND	ND	ND	16	1.5	ND	ND	ND	ND	ND	ND	ND	0.60
Lead	2.8	1.4	49	79	9.2	3.7	3.8	15	2.2	6.5	2.6	15	49	5.7	25	2.1	2.3	9.3	1.7	1	2
Mercury	0.021	0.010	0.27	1.5	0.024	0.020	0.015	0.058	ND	ND	ND	ND	0.016	0.72	0.040	0.028	ND	ND	ND	ND	ND
o-Chlorobenz-aldehyde	NA[2]	NA	ND	660	610	ND	ND	ND	ND	150,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-Chloro-benzylidene malononitrile	NA	NA	ND	16,000	ND	ND	ND	180,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Malononitrile	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

R481:thiok02(097.001);njm

Table 20 (cont'd)

Compound/ Element	Background		9159 9173	9160 9174	9161 9175	9162 9176	9163 9177	9164 9178	9165 9179	9166 9180	9167 1981	9168 9182	9169 9183	9170 9184	9171 9185	9172 9186	9189 9194	9190 9195	9191 9196	9192 9197	9193 9198
	upper mean	lower mean	Test Pit 32 Waste	Test Pit 33 Waste	Test Pit 34	Test Pit 35	Test Pit 36 Waste	Test Pit 37	Test Pit 38	Test Pit 39	Test Pit 40 Waste	Test Pit 41 Waste	Test Pit 42 Waste	Test Pit 43 Waste	Test Pit 43 Waste	Test Pit 44	Test Pit 45	Test Pit 46	Test Pit 47	Test Pit 48	Test Pit 49
Methyl Ethyl Ketone	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	39	ND	ND	ND	ND	ND	ND	ND
Benzene	NA	NA	ND	ND	ND	ND	ND	ND	ND	0.83	ND	ND	ND	6.6	ND	ND	ND	ND	ND	ND	ND
Acetone	NA	NA	0.29	1.4	0.20	ND	ND	0.22	ND	ND	ND	ND	ND	84	ND	0.14	ND	ND	ND	ND	ND
Ethylbenzene	NA	NA	ND	0.056	ND	ND	0.020	ND	ND	0.043	ND	0.12	0.011	ND	130	0.016	ND	ND	ND	ND	ND
Toluene	NA	NA	ND	ND	ND	ND	ND	0.0070	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, total	NA	NA	ND	0.25	ND	ND	0.027	0.017	ND	0.076	3.1	0.18	0.062	24	810	0.062	ND	ND	ND	ND	ND
4-methyl 2-pentanone	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30.0	ND	ND	ND	ND	ND	ND	ND
Pyrene	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND
2,4-dimethylphenol	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	ND	ND
m- and p-cresol	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	3.6	ND	ND	ND	ND	21	ND	ND	ND	ND	ND

[1]ND = Not detected above MDL.
[2]NA = Not applicable; statistics not generated for VOCs.
All results reported in mg/kg.
Shaded results show concentrations equal to or greater than the respective BUMC.

4.7.5.1.2 Waste Description

The CS Disposal Area contained drums with CS-related compounds. The disposal areas appeared as discrete and separate pits. Drums in the pits appeared to be haphazardly dumped. The drums were in various states of repair; some drums were intact, but many were crushed or badly corroded.

4.7.5.2 Area B - Construction and Building Debris Disposal Area

During the initial test pit investigation, construction and building debris was found in the test pits in this area. During the second test pit effort, Nuchar waste was found near anomalous area 2. TP-40 was located to investigate the northern extent of the Nuchar waste, but only native soils were encountered. TP-40 northwest of anomalous area 2 showed Nuchar wastes on the east side of the test pit and native soils on the west side. A thin layer of Nuchar was found in TP-41 on the edge of anomalous area 11. Nuchar was not found in TP-42.

Visual observations suggest that the Nuchar was disposed in small quantities throughout Area B. TP-40 and TP-42 did not show any magnetometer anomalies and no drums were encountered with the Nuchar waste; therefore, the Nuchar was likely uncontainerized when disposed and would be difficult to identify with geophysical methods considering the copious quantities of metal over the entire SWMU. Bagged chemicals similar to those found in SWMU 06 Borrow Pit TP-1 and TP-2 were found in the initial test pits and TP-41 and TP-42.

4.7.5.2.1 Analytical Summary

Samples from SWMU 07 were all analyzed for VOCs, BNAs, aldicarb, CS and related compounds (o-chlorobenzaldehyde, o-chlorobenzaldehyde malonitril, and malonitril), and metals. Analytical results are summarized in Table 20.

- TP-36 contained low concentrations of ethylbenzene and xylenes at 0.02 mg/kg and 0.027 mg/kg, respectively. No other organic compounds were detected.

- TP-38, completed to define the Nuchar disposal area, contained all metals concentrations below the BUMC. No organic compounds were detected. The soils in TP-38 appear to be native and undisturbed.

- TP-40 contained concentrations of toluene, cresol, and benzoic acid at 3.1 mg/kg, 2.4 mg/kg, and 3.6 mg/kg, respectively. The CS compound malononitrile was detected at 35 mg/kg. No other organic compounds were detected.

- TP-41 contained barium, cadmium, chromium, and lead. Ethylbenzene and xylenes were detected at 0.12 mg/kg and 0.18 mg/kg, respectively. No other organic compounds were detected.

- TP-42 contained arsenic, barium, cadmium, chromium, and lead. Ethylbenzene and xylenes were also detected at 0.011 mg/kg and 0.062 mg/kg, respectively. No other organic compounds were detected.

4.7.5.2.2 Waste Description

Wastes disposed in Area B consist of Nuchar wastes, construction and building debris, and residual chemical wastes. Nuchar was uncontainerized when disposed in various locations within Area B. Scrap metal, insulation, lumber, and other debris were found throughout this area. Wastes similar to wastes found at the Borrow Pit Area in SWMU 06 were found in Area B. Laboratory analysis detected concentrations of arsenic, barium, chromium, cadmium, lead, and mercury in some of the waste samples. Organic compounds found include ethylbenzene, xylenes, toluene, and cresol.

4.7.5.3 Area C - Trip Flare Disposal Area

Drums with concrete caps and containing ordnance-related items were removed from the eastern side of anomalous area 13. Following the drum removal, TP-45 and TP-46 were completed in

the bottom of the excavation. Only native soils were encountered below the base of the excavation.

TP-47 was completed in anomalous area 17. This area appeared to have been used for burning ordnance-related items. TP-47 indicated ordnance-related items on the surface and what can be interpreted as burned soil extending to a depth of 1.5 feet. A trench appeared to have been constructed perpendicular to the test pit.

TP-48 was completed in another area where trip flares were encountered during the initial test pitting. TP-48 contained loose trip flares and other construction wastes.

4.7.5.3.1 Analytical Results

No organic compounds were detected in the soil from this area. Barium exceeded the BUMC in TP-47 and barium and lead exceeded the BUMC in TP-46. The metals results of soil samples were within an order of magnitude of the BUMC. Analytical results are summarized in Table 20.

4.7.5.3.2 Waste Description

The majority of waste in Area C is related to ordnance items. Four hundred and eight drums of ordnance and ordnance-related scrap were recovered. Loose M49 trip flares were still located within the area. Area C, beyond the drum burial area, appeared to have been used for deactivating the ordnance by burning. The burning of the ordnance did not destroy all of the rounds; therefore, many loose intact rounds were found with burned rounds. Organic compounds were not detected in this area while barium, chromium, and lead were detected.

4.7.5.4 Area D - Garbage Disposal Area

Area D contains two mounds at anomalous areas 15 and 16. During the initial test pitting, trash and rubbish were found in anomalous area 15. Anomalous area 16 contained a crushed drum and plastic liners, similar to the other plastic bags found at SWMU 06 and 07. Area 14 contained one-quart cans of a diesel treatment fluid.

During the second phase of test pits, drums were found buried at anomalous area 16. The drums were buried relatively deep (approximately four feet) and tightly packed on their sides. The drums were not detected earlier due to the large anomaly at area 13 and the presence of ubiquitous metal near the surface. Test pits constructed on the corners of area 16 suggested that the drums were located only under the mound.

Two drums were pulled from the excavation and the contents sampled. One drum contained a red powder in a plastic liner. The second drum contained a white solid, also contained in a plastic liner. Samples of each material were collected for laboratory analysis.

4.7.5.4.1 Analytical Results

The drum containing the red powder from TP-43 contained concentrations of the solvents acetone (94 mg/kg), MEK (39 mg/kg), benzene (6.8 mg/kg), xylenes (24 mg/kg), and 4-methyl-2-pentanone (30 mg/kg). Analytical results are summarized in Table 20.

The drum containing the white solid contained concentrations of ethylbenzene (130 mg/kg) and xylenes (810 mg/kg), and lower concentrations of pyrene (1.2 mg/kg) and 2,4-dimethylphenol (2.0 mg/kg).

Soil from TP-44 contained acetone (0.140 mg/kg), ethylbenzene (0.016 mg/kg), and xylenes (0.062 mg/kg). Benzoic acid was detected at 2.1 mg/kg. No other organic compounds were detected. Mercury was present in soil from TP-44 above the BUMC.

TP-49, containing the cans of oil treatment fluid, contained a concentration of chromium at 650 mg/kg. No organic compounds were detected.

4.7.5.4.2 Waste Description

Although delineated as one area, there are three separate waste descriptions.

- Drum disposal - Analysis of samples of the drum contents showed that they contained concentrations of solvents (acetone, MEK, benzene, ethylbenzene, xylenes, 4-methyl-2-pentanone, and 2,4-dimethyl-phenol), and metals (arsenic, barium, chromium, lead, and mercury). The drums appeared to be closely and orderly packed in the disposal area.
- Trash - A soil sample from the trash found in anomalous area 15 contained only low levels of acetone, ethylbenzene, benzoic acid, and xylenes.
- Diesel treatment fluid - Numerous one-quart cans of diesel treatment fluid were found buried in anomalous area 15. The surface is void of vegetation and appears to have been used as a burn area.

Chromium was detected in the soil at 650 mg/kg. Labels on the cans indicate that they contain chromium; no other information was readily decipherable.

4.7.6 Ground Water

As requested by GAEPD, ground water was resampled by Apex from the four monitoring wells previously installed by Law (Figure 20). Ground water samples were analyzed for VOCs, BNAs, aldicarb, CS compounds and degradation products, and total metals. Analytical results are summarized in Table 21.

The Phase I RFI analytical results detected four organic compounds in MW-704: benzene (0.017 mg/L), 2,4-dimethylphenol (0.014 mg/L), ethylbenzene (0.021 mg/L), and total xylenes (0.165 mg/L). Benzene was the only organic to exceed its MCL. Chromium was the only metal found that exceeded its MCL. Chromium was found in MW-704 at a concentration of 0.16 mg/L.

Laboratory analysis of ground water during the Phase II RFI did not detect CS compounds or aldicarb. In MW-701, bis(2-ethylhexyl)phthalate was the only BNA compound detected, at a concentration of 0.03 mg/L, which is above the MCL of 0.005 mg/L. Xylenes (total or m-, p-, o-isomers) were detected below the MCL in MW-704 at a concentration of 0.040 mg/L.

Cadmium, chromium, and lead were the only metals detected above their MCLs at SWMU 07. Chromium was found in MW-701 (0.12 mg/L) and MW-702 (0.25 mg/L). Cadmium (0.0069) and lead (0.075) were found in concentrations exceeding their MCLs in MW-702.

Table 21

SWMU 07 - Phase I and II RFI
Ground Water Analytical Results

Thiokol - Woodbine Facility

Compound/Element	MCL	Phase I RFI Analytical Results				Phase II RFI Analytical Results			
		MW-701	MW-702	MW-703	MW-704	MW-701	MW-702	MW-703	MW-704
Arsenic	0.050	ND	ND	ND	0.012	0.011	0.11	0.011	ND
Barium	2.0	0.019	0.019	0.058	0.41	0.11	0.71	0.15	0.071
Cadmium	0.0050	ND	ND	ND	ND	ND	0.0069	ND	ND
Chromium	0.10	ND	ND	0.022	0.16	0.12	0.25	0.052	0.046
Lead	0.050	ND	ND	0.0098	0.04	0.029	0.075	0.023	0.0060
Mercury	0.0020	ND	ND	ND	0.00025	0.00052	0.00065	0.00024	ND
Benzene	0.0050	ND	ND	ND	0.017	ND	ND	ND	ND
2,4-dimethylphenol	NE[2]	ND	ND	ND	0.014	ND	ND	ND	ND
Ethylbenzene	0.70	ND	ND	ND	0.021	ND	ND	ND	ND
Xylenes, total	10	ND	ND	ND	0.165	ND	ND	ND	0.040
Bis(2-ethylhexyl) phthalate	0.0060	ND	ND	ND	ND	0.030	ND	ND	ND

[1]ND = Not detected above MDL.
[2]NE = MCL not established for this compound.
All results reported in mg/L.
Shaded results show concentrations equal to or greater than the respective MCL.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents a summary of the results and Apex's conclusion of the investigations concluded to date at the former Thiokol Corporation facility located in Woodbine, Georgia. The results of the Phase I and II RFIs are presented by SWMU. In addition, SWMU-specific conclusions are presented in each section. Apex's recommendations for future activities at this facility are presented in each SWMU section.

5.1 SWMU 02

The Phase I investigation at SWMU 02 detected low concentrations of VOCs in soil at the site. Law concluded that these concentrations were below the proposed federal action limits. The Phase II investigation indicated that soil samples collected during the Phase I were slightly above the BUMC for lead. These results were less than two times the BUMC and are not considered to present a risk. Ground water was not sampled as part of either the Phase I or II investigations.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that metals occur at SWMU 02 at concentrations slightly above the calculated BUMCs. No additional constituents that would suggest a risk to humans or the environment were detected in soil or ground water at this SWMU.

Based on the findings of the Phase I and Phase II investigations, Apex concurs with Law's recommendations presented in the Phase I RFI and recommends that no further action be performed at SWMU 02.

5.2 SWMU 03

The Phase I investigation at the surface disposal area at SWMU 03 detected low concentrations of VOCs in soil at the site. Law concluded that these concentrations were below the proposed federal action limits. The Phase II investigation indicated that soil samples collected by Law at the Surface Disposal Area exceeded the BUMC for barium, chromium, and lead. Two additional areas (the Burn Area and the Aldicarb Disposal Area) were investigated during the Phase II investigation. No VOCs, BNAs, or aldicarb were detected at

either area. Soil samples at the Burn Area exceeded the BUMC for mercury, chromium, barium, and lead. Soil samples at the Aldicarb Disposal Area exceeded the BUMC for mercury, chromium, and lead. In addition, UXO was observed along the fire break road located between the Burn Area and the Aldicarb Disposal Area. All soil samples at SWMU 03 had results less than two times the BUMC and are not considered to pose a risk.

No VOCs or metals were detected in the ground water collected as part of the Phase I investigation. No VOCs, BNAs, aldicarb, or CS compounds were detected in ground water during the Phase II investigation. Chromium was detected slightly above the MCL in ground water.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that metals occur at SWMU 03 at concentrations slightly above the calculated BUMCs. No additional constituents that would suggest a risk to humans or the environment were detected in soil or ground water at this SWMU. However, an unknown quantity of UXO remains on the surface outside the areas investigated during the Phase II RFI at SWMU 03.

Based on the findings of the Phase I and II investigations, Apex concurs with Law's recommendation in the Phase I RFI and recommends that no further action be performed at SWMU 03; however, a sweep of the surface area surrounding SWMU 03 should be completed to remove all UXO observed. Apex recommends that this action be performed at the same time as additional work proposed at SWMU 07.

5.3 SWMU 04

The Phase I investigation indicated that low concentrations of VOCs were present in soils collected from within the evaporation pond. Law concluded that these concentrations were below the proposed federal action limits. The Phase II investigation indicated that soil samples collected during both phases exceeded the BUMC for barium, chromium, lead, and mercury. The soil sample results were less than six times the BUMC and are not considered to pose a risk. Elevated concentrations of acetone were detected in the soil samples collected from the overflow ditch surrounding the evaporation pond. DCE and some metals were detected in ground water samples collected during the Phase I, but were all below respective MCLs. Ground water samples collected during the Phase II investigation detected 1,1,2-TCA and arsenic, barium, cadmium, chromium, and lead above their respective MCLs.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that acetone is present in soil located beneath the overflow ditch at SWMU 04. The concentrations present are of concern (given the volatility of acetone) and the location in soil may be indicative of a past release from the evaporation pond.

Based on the findings of the Phase I and II investigations, Apex recommends the following actions at SWMU 04:

- Apex recommends that additional investigations be performed downgradient of the soil borings completed in the overflow ditch. The presence of acetone in soil in this location may indicate that additional ground water monitoring wells may be necessary to evaluate whether ground water quality has been impaired.
- Apex recommends that additional geoprobe soil borings be completed south and west of the overflow ditch. Soil and ground water samples should be collected from each geoprobe to determine if additional wells are necessary.
- Apex recommends that the data be used to complete a risk assessment for SWMU 04 regarding the presence of acetone in the subsurface. The risk assessment should be used to determine future action at SWMU 04.
- Apex recommends that the additional investigation be performed at the same time as the proposed activity at SWMU 07.

5.4 SWMU 05

The Phase I investigation at SWMU 05 showed low concentrations of VOCs in soil samples at the site. Law concluded that these concentrations were below the proposed federal action limits. The Phase II investigation indicated that barium and mercury were above the BUMC in soil at SWMU 05. The soil sample results were less than two times the BUMC and are not considered to pose a risk. Ground water collected during the Phase I investigation showed naphthalene, arsenic, and barium below their respective MCLs. No constituents were detected in the ground water samples collected during the Phase II investigation.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that metals occur at SWMU 05 at concentrations slightly above the calculated BUMCs. No additional constituents which would suggest a risk to humans or the environment were detected in soil or ground water at this SWMU.

Based on the findings of the Phase I and II investigations, Apex concurs with the recommendations of Law in the Phase I RFI and recommends that no further action be performed at SWMU 05.

5.5 SWMU 06

The Phase I investigation at SWMU 06 showed low concentrations of VOCs and residual aldicarb in soil samples at the site. Law concluded that these concentrations were below the proposed federal action limits. The Phase II investigation revisited the original work at the Trench 1 Area, and performed additional investigations at the Trench 2 Area and the Borrow Pit Area. The Phase II investigation indicated that barium and chromium were above the BUMC at Trench 1 and that several VOCs, including acetone, were present in soils at Trench 1. Barium was present at Trench 2 above the BUMC, as well as acetone and other VOCs. Soils at the Borrow Pit Area contained barium, lead, and mercury above the BUMC. All soil sample results at SWMU 06 were less than six times the BUMC. In addition, samples of soil and drummed material at the Borrow Pit Area contained several VOCs at elevated concentrations. Ground water collected during the Phase I investigation contained metals below the respective MCLs. Ground water collected during the Phase II investigation contained only arsenic slightly above its respective MCL.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that metals and VOCs are present in soil beneath Trench 1, Trench 2, and the Borrow Pit Area at SWMU 06. In particular, acetone and benzene, toluene, ethylbenze, and xylenes (BTEX) compounds were detected in this area.

Based on the findings of the Phase I and Phase II investigations, Apex recommends the following action at SWMU 06.

- Additional geoprobe soil borings should be completed around the areas where VOCs were detected to assess whether ground water has been impacted in these areas. SWMU 06 is a particularly large waste management area with widely spaced monitoring wells. Additional wells may be required to assess the impact of VOC contamination documented in Phase II of the RFI.

- Apex recommends that the data collected be used to complete a risk assessment for SWMU 06 regarding the occurrence of VOCs in the subsurface. The risk assessment should be used to determine future action at SWMU 06.

- Apex recommends that this action be performed at the same time as the proposed activity of SWMU 07.

5.6 SWMU 07

No soil samples were collected during the Phase I investigation due to the extensive occurrence of metallic debris and ordnance on the ground surface. Analysis of ground water samples collected during the Phase I investigation showed chromium and benzene above the respective MCLs. Subsequent ground water sampling during the Phase II investigation detected ethylhexyl phthalate, cadmium, chromium, and lead above the respective MCLs. A total of 408 drums of ordnance and ordnance-related materials were excavated and segregated during test pitting at SWMU 07 during the Phase II investigation. Recovered ordnance was deactivated on site and containerized for later disposal. Test pitting at SWMU 07 indicated that CS and related degradation compounds are present in the soil. An unknown number of additional drums could not be removed during the Phase II investigation and remain buried at the site. Analysis of soil samples collected at various locations at SWMU 07 indicates that elevated concentrations of metals, VOCs, and CS compounds are present in soil at the site. The metals present in the soil at SWMU 07 exceed the BUMC by a factor of approximately six.

Based on the information generated during the Phase I RFI and the subsequent Phase II RFI, Apex has determined that analytical results indicate that metals, VOCs, and CS compounds (i.e., tear gas) are present in soils beneath SWMU 07. In addition, an unknown quantity of drums and loose ordnance remains buried at this site. Exposure to CS compounds is an important concern at this site.

Based on the findings of the Phase I and II investigations, Apex recommends the following actions at SWMU 07.

- Apex believes that additional work is still required at SWMU 07. The waste generated during the Phase II investigation needs to be disposed off site. In addition, an unknown number of drums remain in the subsurface and should be removed and assessed. Finally, the SWMU still contains a large number of loose trip flares and other ordnance-related debris. The GAEPD needs to be consulted as to whether these areas require remediation. If GAEPD requires remediation of these areas, then a Corrective Action Plan (CAP) should be developed and implemented.

APPENDIX A

Boring Logs, Test Pit Logs, and Well Construction Diagrams

APPENDIX B

Drum Log

APPENDIX C

Geophysics Report

APPENDIX D

Analytical Data Sheets

Soil

Ground Water

APPENDIX E

UXO Report