

**ADDENDUM 1 TO
RESOURCE CONSERVATION AND
RECOVERY ACT (RCRA)
FACILITY INVESTIGATION REPORT
FOR IRP SITES NO.17, NO.18, AND NO.21**

VOLUME I

**148th FIGHTER GROUP
MINNESOTA AIR NATIONAL GUARD
DULUTH AIR NATIONAL GUARD BASE
DULUTH, MINNESOTA**

OCTOBER 1995



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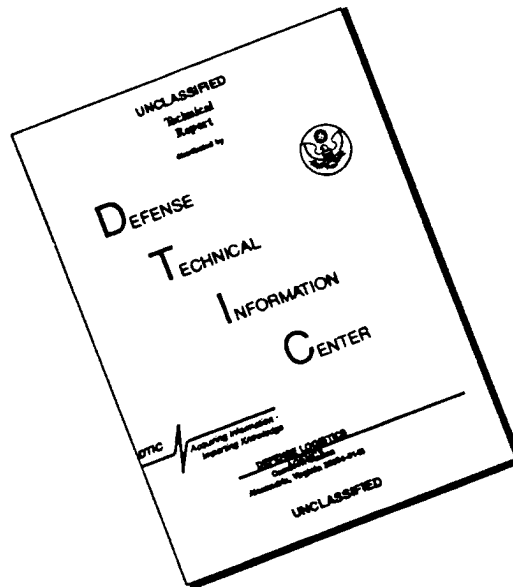
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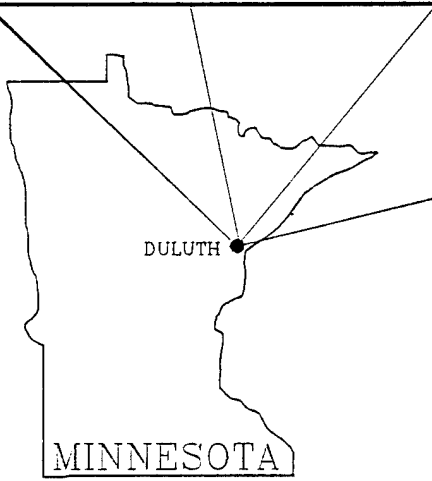
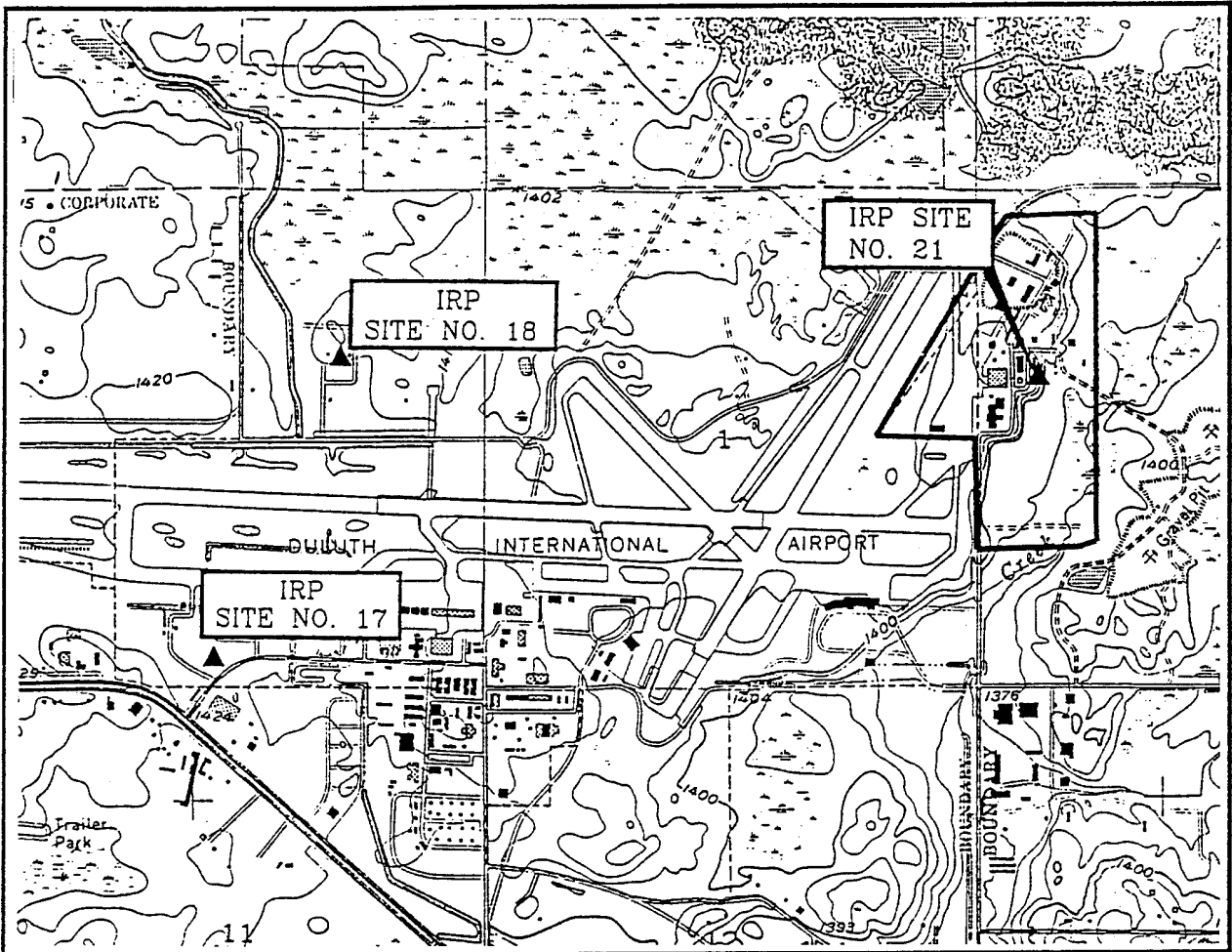
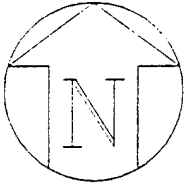
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IRP SITES NO.17, NO.18,
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SEPTEMBER 1995

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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE OCTOBER 1995	3. REPORT TYPE AND DATES COVERED Facilities Investigation Report	
4. TITLE AND SUBTITLE Addendum 1 to Resource Conservation and Recovery Act (RCRA) Facility Investigation Report for IRP Sites NO. 17, 18, and 21. Vol. I Duluth ANG, Duluth, MN			5. FUNDING NUMBERS	
6. AUTHOR(S) N/A				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) OPTECH San Antonio, Texas			8. PERFORMING ORGANIZATION REPORT NUMBER 1308-101-39	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) ANGRC/CEVR 3500 Fetchet Ave Andrews AFB, MD 20331-5157			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Addendum 1 to Resource Conservation and Recovery Act (RCRA) Facility Investigation Report for IRP Sites 17, 18, and 21 Volume I. This report presents the results of the investigation activities conducted in July 1994, October 1994, and May 1995 at IRP sites 17, 18 and 21, located at the 148 FG, Duluth, MN. The Minnesota Pollution Control Agency (MPCA) responded to the findings of the RFI report (OPTECH 1992) with recommendations for further investigations at these sites. The results are that contamination exists at all three sites and a Corrective Measures Study (CMS) be completed to provide alternatives for remediation.				
14. SUBJECT TERMS Installation Restoration Program; Resource Conservation and Recovery Act (RCRA); Air National Guard; Facility Investigation; Duluth ANG, Duluth, MN			15. NUMBER OF PAGES 290	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT none	

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**ADDENDUM 1 TO
RESOURCE CONSERVATION AND
RECOVERY ACT (RCRA)
FACILITY INVESTIGATION REPORT
FOR IRP SITES NO.17, NO.18, AND NO.21**

VOLUME I

**148th FIGHTER GROUP
MINNESOTA AIR NATIONAL GUARD
DULUTH AIR NATIONAL GUARD BASE
DULUTH, MINNESOTA**

OCTOBER 1995

Prepared For
**HQ ANG/CEVR
ANDREWS AFB, MARYLAND**

Prepared By
**Operational Technologies Corporation
4100 N.W. Loop 410, Suite 230
San Antonio, Texas 78229-4253
(210) 731-0000**

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Duluth, Minnesota

LIST OF ACRONYMS

1,2-DCE	1,2-dichloroethene
ANGB	Air National Guard Base
ANGS	Air National Guard Station
ARARs	Applicable or Relevant and Appropriate Requirements
BH	Borehole
BLS	Below Land Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel Range Organics
DUP	Duplicate
ft BLS	feet Below Land Surface
FG	Fighter Group
GC	Gas Chromatography
GRO	Gasoline Range Organics
HQ ANG/CEVR	Air National Guard Readiness Center
HRLs	Hazard Ranking Limits
IRP	Installation Restoration Program
ITTS	Imhoff Tank Treatment System
MCLs	Maximum Contaminant Levels
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MN ANG	Minnesota Air National Guard
MPCA	Minnesota Pollution Control Agency
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MW	Monitor Well
OpTech	Operational Technologies Corporation
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PM	Piezometer
QA/QC	Quality Assurance/Quality Control
RALs	State Recommended Allowable Limits
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVOCs	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
$\mu\text{g}/\text{kg}$	micrograms per kilogram
$\mu\text{g}/\text{L}$	micrograms per liter
U. S.	United States
USAF	United States Air Force

**RCRA Facility Investigation Report Addendum 1
Duluth Air National Guard Base
Duluth, Minnesota**

LIST OF ACRONYMS (Concluded)

USDA
USEPA
VOCs

United States Department of Agriculture
United States Environmental Protection Agency
Volatile Organic Compounds

ADDENDUM 1 TO RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION REPORT FOR IRP SITES NO. 17, NO. 18, AND NO. 21

EXECUTIVE SUMMARY

This Addendum 1 to the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report presents the results of the investigation activities conducted in July 1994, October 1994, and May 1995 at Installation Restoration Program (IRP) Sites No. 17, No. 18, and No. 21, located at the 148th Fighter Group (FG), Duluth Air National Guard Base (ANGB), Duluth, Minnesota. The Minnesota Pollution Control Agency (MPCA) responded to the findings of the RFI Report (OpTech, 1992) with recommendations for further investigations at these three sites.

IRP SITE NO. 17 (BASE SUPPLY/DEFENSE REUTILIZATION AND MARKETING OFFICE STORAGE AREA)

IRP Site No. 17 is located directly southeast of the Defense Reutilization and Marketing Office (DRMO) warehouse in the southwest corner of the Duluth International Airport. The storage area consists of an 80-foot by 120-foot impervious pad with five feet wide by three feet high perimeter dikes. The drain sump, located in the northwest corner of the pad, has an outlet to a drainage ditch that is located along the west side of the pad.

In 1994, 11 soil borings were drilled for collection of soil samples to fully define the areal extent of semivolatile organic compounds (SVOCs) and total petroleum hydrocarbons (TPH). In 1995, 10 soil borings were drilled for collection of soil samples to fully define the areal extent of SVOCs and TPH. Soil samples collected during the 1995 sampling event were also analyzed for mercury to confirm the presence of this metal.

SVOCs, mostly polycyclic aromatic hydrocarbons (PAHs), were detected in soil samples collected from IRP Site No. 17 at concentrations less than the maximum concentrations utilized in the risk assessment. TPH diesel range organics (DRO) were detected at concentrations of 144 milligrams per kilogram (mg/kg) and 189 mg/kg in near-surface soil samples. Concentrations were less than concentrations reported in the RFI Report (OpTech, 1992). Because the concentrations of the contaminants did not exceed the maximum concentrations utilized in the risk assessment of the RFI, the chemical results have not altered the risk assessment performed for the RFI. Therefore, no carcinogenic or non-carcinogenic risks exist for each receptor at each pathway for VOCs, SVOCs, pesticides, and metals detected in the samples collected from each media.

each pathway for VOCs, SVOCs, pesticides, and metals detected in the samples collected from each media.

The recommendation for IRP Site No. 17 is as follows:

- No further action with institutional control as recommended in the Corrective Measures Study (CMS). The CMS will provide alternatives for remediation.

IRP SITE NO. 18 (HAZARDOUS WASTE STORAGE AREA, BUILDING 513)

IRP Site No. 18 is located on the north side of the main east-west runway. Building 513 is an eight-bay segregated ammunition storage building. Each bay measures five feet by eight feet with concrete walls and floor.

In 1994, two soil borings were hand augered for collection of soil samples to determine the presence of volatile organic compounds (VOCs). The VOC xylenes (total) was detected at a concentration of 74 micrograms per kilogram ($\mu\text{g}/\text{kg}$) in the soil sample collected from the area of the suspected fuel-related contamination determined by the United States Environmental Protection Agency (USEPA) sampling. No non-carcinogenic risk exists for each receptor at each pathway for VOCs and metals detected in the samples collected from each media.

- No additional investigation is required for this site. This site will be included in the CMS as per recommendations of the MPCA. No further action with institutional control as recommended in the CMS.

IRP SITE NO. 21 (IMHOFF TANK TREATMENT SYSTEM)

The Imhoff Tank Treatment System (ITTS) is located on the east side of Duluth International Airport. The outfall pipe discharged to Miller Creek, located approximately 750 feet southeast of the ITTS.

In 1994, 11 soil borings were drilled for collection of soil samples to fully define the areal extent of VOCs, SVOCs, pesticides, metals, and TPH contamination in sediment and soil and to determine the areal extent of VOC contamination in groundwater. In 1995, three soil borings were drilled for collection of soil samples to fully define the areal extent of TPH contamination each of the ITTS area.

VOCs, SVOCs, TPH, pesticides, and metals were detected in the soil samples collected during the Addendum 1 RFI. The concentrations of SVOCs in one surface soil sample did exceed maximum concentrations reported in the RFI Report (OpTech, 1992). No SVOCs were detected in soil samples that were collected from soil boring locations surrounding the locations that had detected SVOCs reported in the RFI Report (OpTech, 1992). The TPH concentrations were less than the maximum concentrations reported in the RFI Report (OpTech, 1992). The source of the BTEX contamination in IRP Site No. 25 (Old Motor Pool Area), which is located upgradient from IRP Site No. 21. The extent of SVOC contamination associated with IRP Site No. 21 is in the vicinity of the ITTS. The maximum TPH was detected at a concentrations of 15,000 mg/kg from a soil sample collected from soil boring 021-007BH located in the area of the ITTS.

The VOC trichloroethene (TCE), copper, and lead were detected in a groundwater sample collected from a monitor well located downgradient from the ITTS with maximum concentrations of 68 micrograms per liter ($\mu\text{g/L}$), 384 $\mu\text{g/L}$, and 26.80 $\mu\text{g/L}$, exceeding the Federal maximum contaminant level (MCL) of 5 $\mu\text{g/L}$, 100 $\mu\text{g/L}$, and 15 $\mu\text{g/L}$, respectively. Nickel was detected in a groundwater sample collected from a monitor well upgradient from the ITTS with a concentration of 620 $\mu\text{g/L}$ exceeding the Federal MCL of 100 $\mu\text{g/L}$.

Benzene, SVOCs, TPH, and metals were detected in the sediment samples collected from the swampy area downgradient of ITTS. The concentrations of these constituents were less than concentrations reported in the RFI Report (OpTech, 1992).

Since the concentrations of the contaminants did not exceed the maximum concentrations utilized in the risk assessment of the RFI, the chemical results have not altered the risk assessment performed for the RFI. Therefore, no carcinogenic risk exists for each receptor at each pathway for VOCs, pesticides, and metals detected in samples collected from each media. Slight non-carcinogenic risk exists only for children through ingestion of groundwater.

The recommendation for IRP Site No. 21 is as follows:

- Due to the close geographic proximity of IRP Sites No. 21 and No. 25, and due to the similar contamination existing at both sites, IRP Site No. 21 should be remediated concurrently with IRP Site No. 25.

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SECTION 1.0 INTRODUCTION

This Addendum 1 to the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report presents the results of the investigation activities conducted between July and October 1994 at Installation Restoration Program (IRP) Sites No. 17, No. 18, and No. 21, located at the 148th Fighter Group (FG), Duluth Air National Guard Base (ANGB), Duluth, Minnesota (Figure 1.1).

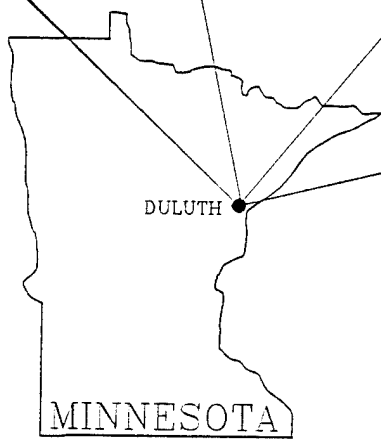
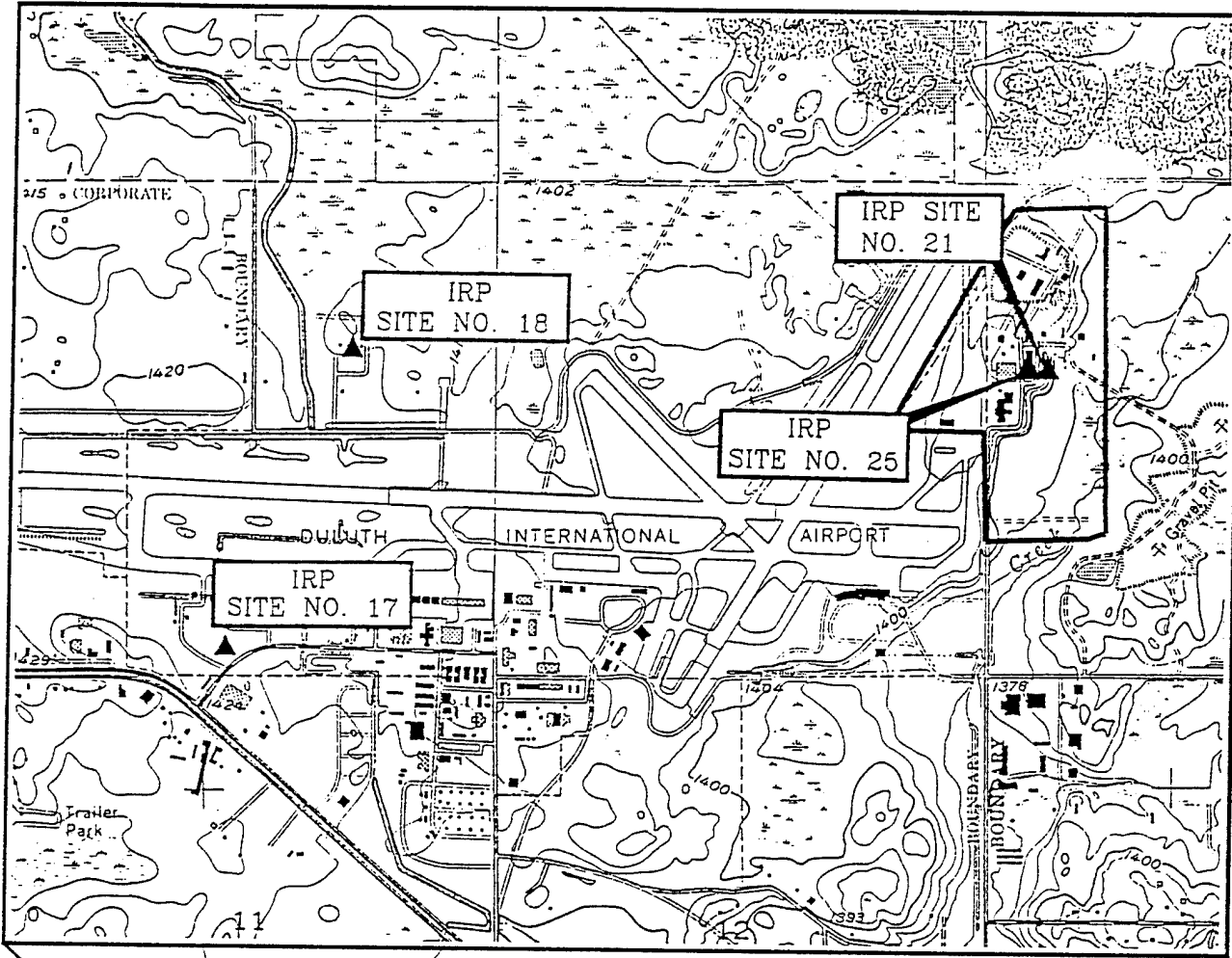
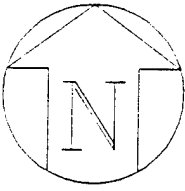
An extensive amount of baseline data exists on Duluth ANGB from previous IRP environmental investigations. Accordingly, this Addendum 1 Report supplements the RCRA Facility Investigation of Solid Waste Management Units, 148th Tactical Fighter Group, Minnesota Air National Guard, Minnesota Air National Guard Base, Duluth, Minnesota, prepared by OpTech in August 1992 (hereinafter referred to as the *1992 RFI Report*). The Addendum 1 to Resource Conservation and Recovery Act (RCRA) Facility Investigation Work Plan for Sites No. 17, 18, and 21, 148th Fighter Group, Minnesota Air National Guard, Duluth Air National Guard Base, Duluth, Minnesota, prepared by OpTech in June 1994 (hereinafter referred to as the *1994 RFI Work Plan Addendum*) was utilized during the Addendum 1 RFI. Information provided in this Work Plan is also referenced from the Installation Restoration Program Preliminary Assessment of the 148th Fighter Group Report, 148th Fighter Group, Minnesota Air National Guard, Duluth Air National Guard Base, Duluth, Minnesota, prepared by OpTech in August 1993 (hereinafter referred to as the *1993 PA Report*).

To avoid extensive informational redundancy within this Report, references to the following sections will be found in the baseline information contained in the aforementioned documents:

- Background Information on Duluth Air National Guard Base;
- Previous Investigations at the Sites and Surrounding Areas;
- Background Information on Base RCRA Sites; and
- Environmental Setting.



1.1 PURPOSE AND SCOPE OF INVESTIGATION


An RFI was conducted at five IRP Sites (No. 17, No. 18, No. 19, No. 21, and No. 22) during the months of January through April 1992 to satisfy the permit requirements as set forth in Section A of Part XI of the Minnesota Pollution Control Agency (MPCA) Hazardous Waste Storage Facility Permit (ID# MN000773341). The RFI Report was finalized in August 1992.



SOURCE: USGS DULUTH HEIGHTS, MN
1:24,000 QUADRANGLE

LEGEND

-  IRP SITES
-  DULUTH ANGB

0  2000
SCALE IN FEET

DRAFT
FIGURE 1.1

IRP SITES NO.17, NO.18, NO.21,
AND NO.25 LOCATION MAP
Duluth Air National Guard Base
Duluth, Minnesota

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On 9 December 1992, the MPCA responded to the findings of the Report with a recommendation for further investigation at three of the IRP Sites (No. 17, No. 18, and No. 21). The additional RFI work was conducted in response to the following MPCA comments on the *1992 RFI Report*:

- The areal extent of semivolatile organic compounds (SVOCs) and total petroleum hydrocarbons (TPH) contamination in soils at IRP Site No. 17 needs to be defined;
- Another round of sampling is needed to confirm the RFI results in the area of concern identified in the Jacobs Engineering Report at IRP Site No. 18; and
- The areal extent of volatile organic compounds (VOCs), SVOCs, 4,4-DDD, metals, and TPH contamination in sediments and soils at IRP Site No. 21 needs to be defined, and an additional downgradient well should be placed to fully define the groundwater contamination plume.

The scope of additional work for the RFI is as outlined in an Headquarters Air National Guard (HQ ANG/CEVR) 30 March 1993 letter to the MPCA in response to MPCA's comments on the *1992 RFI Report*. The investigation at Duluth ANGB (also referred to as the Base) included, the following actions:

- Definition of the areal extent of SVOC and TPH contamination in soils at IRP Site No. 17;
- Confirmation of the previous RFI findings in the immediate area of concern as identified in the 1988 Jacobs Engineering Report at IRP Site No. 18; and
- Definition of the areal extent of VOC, SVOC, 4,4-DDD, metal, and TPH contaminations in soils and sediments, and definition of the groundwater contamination plume at IRP Site No. 21.

The results of the study will provide the technical basis needed to support a decision for a Corrective Measures Study (CMS) at IRP Sites No. 17 and No. 21, and a closure report for IRP Site No. 18.

1.2 REPORT ORGANIZATION

This Addendum 1 Report presents the results of the Addendum 1 RFI conducted for the three sites at the Duluth ANGB and is organized into an executive summary, six sections and thirteen appendices.

The **Executive Summary** summarizes the work that was done, significant findings, and recommendations.

- Section 1 Introduction**, defines the purpose and scope of the investigation, and summarizes the context of this Addendum 1 Report.
- Section 2 Investigation Description**, describes the investigative program conducted at each of the three sites. Site-specific field investigations were designed to follow the Addendum 1 to RFI Work Plan for all phases of field and analytical programs. Details on the field investigation methods used, as well as a description of the analytical and field quality control programs are provided in this section.
- Section 3 Investigative Findings**, presents the results of the non-chemical analyses program. The results of geology and hydrogeology investigations are presented.
- Section 4 Nature and Extent of Contamination and Contaminant Fate and Transport**, presents the results of the chemical analyses investigation. These results define whether or not contaminants are present at each site and, if present, the areal extent of the contamination. The results presented in Section 3.0 and this section to evaluate the future extent of the contamination.
- Section 5** Presents the **Conclusions and Recommendations** for each site.
- Section 6** Presents the **References** cited in the Addendum 1 Report.
- Appendix A** Presents the **Statement of Work**.
- Appendix B** Presents the **Procedures and Protocols**.
- Appendix C** Presents the **Boring Logs**.

Appendix D Presents the **Monitor Well Construction Record**.

Appendix E Presents the **Well Development Log**.

Appendix F Presents the **Well Purging and Sampling Logs**.

Appendix G Presents the **Field Gas Chromatograph Analysis Results**.

Appendix H Presents the **Inspection Derived Waste Management**.

Appendix I Presents the **Data Validation**.

Appendix J Presents the **Analytical Results of the Soil, Groundwater, and Sediment Samples**.

Appendix K Presents the **Analytical Results of the Quality Assurance/Quality Control Samples**.

Appendix L Presents the **Field Log Book Data**.

Appendix M Presents the **Laboratory Data Packages**.

1.3 PROGRAM SCHEDULE

The approved Addendum 1 to RFI Work Plan was submitted to the HQ ANG/CEVR and MPCA in June 1994. Field work for the Addendum 1 RFI began on 11 July 1994, and was completed on 27 July 1994. Groundwater, soil, and sediment samples were recollected from 4 October to 6 October 1994. These samples were recollected due to delays in laboratory receipt of samples during the field activity in July 1994, which invalidated the samples.

1.4 PROJECT TEAM

The OpTech project team consisted of the following key professionals:

The Program Manager, Mr. John Morris, was responsible for the overall execution of this project.

The Project/Site Manager, Ms. Kathryn Pritchett, directly supervised the project team, provided technical direction and technical interface with the HQ ANG/CEVR, directed field operations, and coordinated all OpTech support.

The OpTech Director of Quality Management Mr. Steve Wilson, was responsible for developing standardized quality assurance procedures for this project, and for assuring that effective procedures and controls were implemented to achieve a high level of quality.

The Health and Safety Manager, Mr. Shelton Birch, C. I. H., was responsible for assuring that physical and chemical hazards were appropriately mitigated through effective execution of the Health and Safety Plan. The Health and Safety Officer was Mr. Joe Byrd, Jr., who was available on-site during field activities.

Project personnel included Mr. Joe Byrd, Jr., Project Scientist, and Mr. Ruben Torres, Environmental Scientist.

The field investigations required the use of subcontractors. Southern Petroleum Environmental Laboratory, Inc., of Houston, Texas, performed the laboratory analyses. The drilling contractor was Huntington Engineering & Environmental Corp., of Duluth, Minnesota. The project surveyor was RREM, Inc., of Superior, Wisconsin.

1.5 FACILITY BACKGROUND INFORMATION

Duluth ANGB is located at the Duluth International Airport (IAP), in St. Louis County in northeastern Minnesota, approximately seven miles northwest of the City of Duluth (Figure 1.1). The airport encompasses an estimated 2,000 acres of relatively flat terrain. The Base is the home of the 148th FG, which has a mission to maintain air sovereignty, atmospheric attack warning and assessment, and air defense of its assigned airspace according to applicable plans and directives. The 148th FG controls 306 acres in the northwestern quadrant of the airport facility; 19 acres are fee-owned, 135 acres are public domain land, and 152 acres are leased lands.

The organizational history of the 148th Fighter Group, historic installation waste disposal practices, and information of previous IRP investigations are included in both the *1992 RFI Report* and the *1993 PA Report*. Both the U. S. Air Force (USAF) Air Combat Command (previously Tactical Air Command) and the Minnesota Air National Guard (MN ANG) are

conducting environmental actions as part of the IRP on Duluth ANGB. Both commands are responsible for five IRP sites.

1.5.1 IRP Site Descriptions

The three sites of concern are provided in Table 1.1.

Table 1.1
Sites of Concern
Duluth Air National Guard Base, Duluth, Minnesota

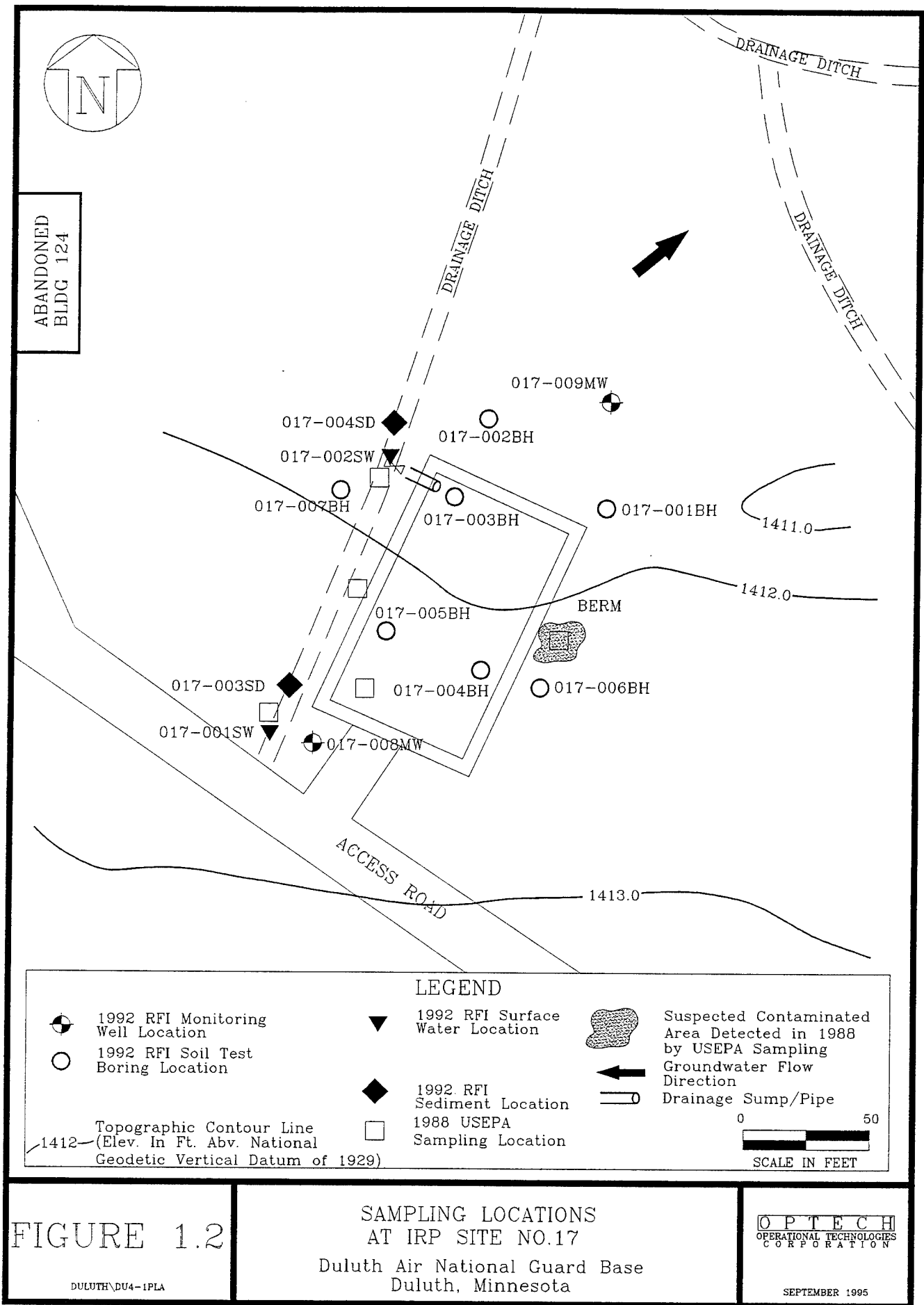
CERCLA Site No.	SWMU No.	Site Description
17	12	Base Supply, DRMO Storage Area
18	11	Hazardous Waste Storage Area, Building 513
21	13	Imhoff Tank Treatment System

CERCLA – Comprehensive, Environmental Response, Compensation, and Liability Act.
SWMU – Solid Waste Management Unit.

1.5.1.1 IRP Site No. 17 – Base Supply/DRMO Storage Area

IRP Site No. 17 is located directly south of the Defense Reutilization and Marketing Office (DRMO) warehouse in the southwest corner of the Duluth International Airport (Figure 1.1). The storage area consists of an 80-foot by 120-foot impervious pad, with 5-foot wide by 3-foot high perimeter dikes (Figure 1.2). The drain sump, located in the northwest corner of the pad, has an outlet to a drainage ditch, located along the west side of the pad. The discharge pipe runs from the drain sump to the ditch and is controlled by a control valve. The use of this valve over time is unknown; it may have been left open continuously or closed to control spills on the pad. Sheet flow across the pad is to the northwest and liquids collect in the drainage sump. Known spills of materials have previously been pumped from the drain sump and placed in containers for disposal.

No spills are reported to have occurred at this site. However in 1988, the U. S. Environmental Protection Agency (USEPA) Region V (subcontracted to Jacobs Engineering Group, Inc., under Project No. 05-B88-00), conducted surface water and sediment sampling adjacent to IRP Site No. 17. A total of five sediment samples were collected as indicated on Figure 1.2. Distressed vegetation was observed and low levels of VOCs were detected by field screening and laboratory analysis at the sample location east of the site.



In 1992, OpTech conducted an RFI at IRP Site No. 17. Seven soil borings were drilled and two monitor wells were installed. Two surface water and two surface sediment sampling stations were established at the site (Figure 1.2). SVOC, TPH, and metal contaminations were present in sediment samples collected from the drainage ditch located on the west side of the DRMO pad. The highest concentrations of these parameters were detected at sediment (SD) sampling location 017-004SD near the outfall of the drain pipe from the DRMO pad.

SVOC, TPH, and metal contaminations were present in subsurface soil; however, the metals concentrations were not significantly greater than the background concentrations.

1.5.1.2 IRP Site No. 18 – Hazardous Waste Storage Area, Building 513

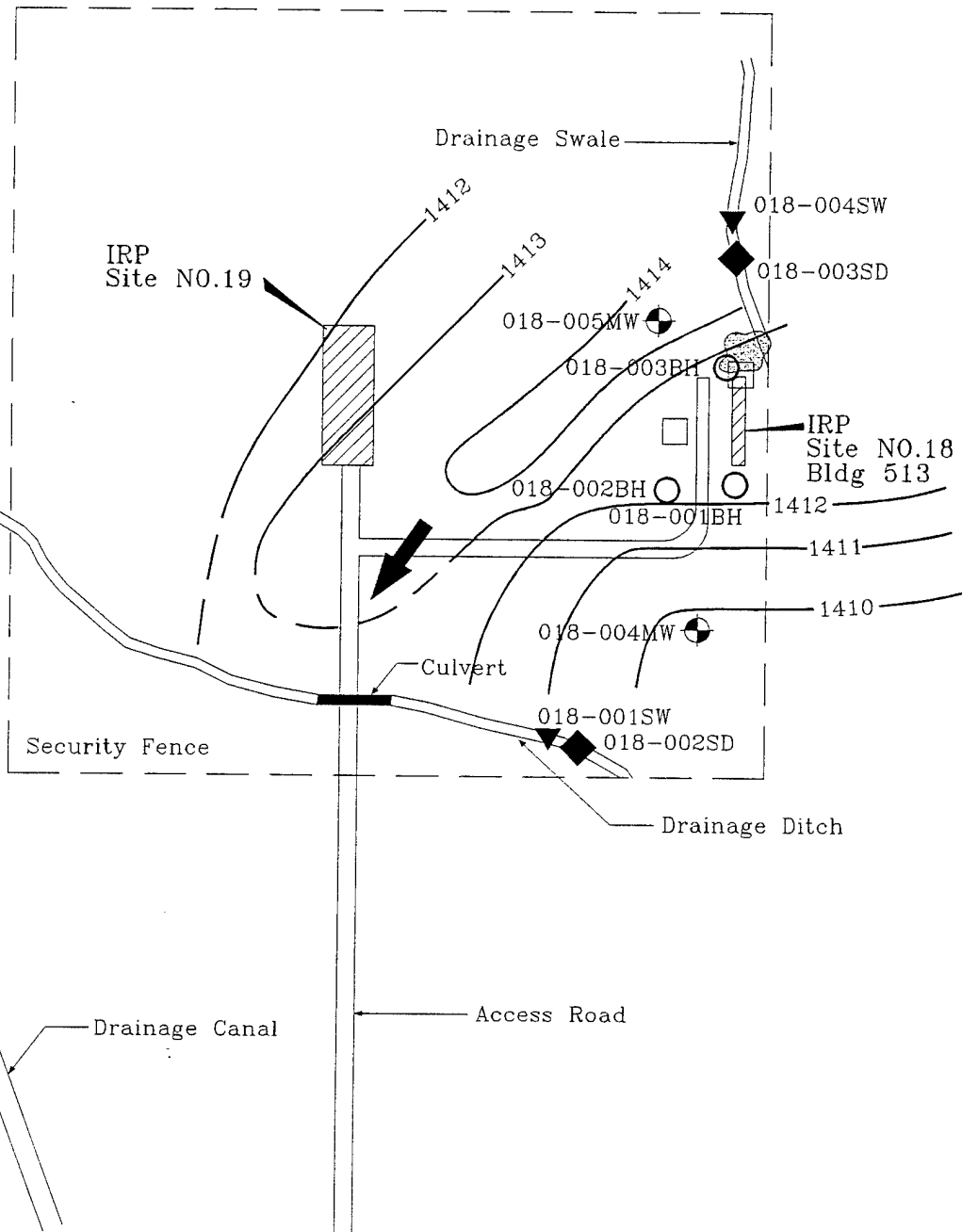
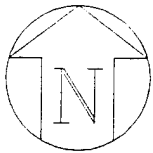
This site is located on the north side of the main east-west runway (Figure 1.1). Building 513 is an eight bay segregated ammunition storage building. Each bay is five feet by eight feet with concrete walls and floor. The building is located on the east side of an area secured by an 8-foot high fence and locked gate (Figure 1.3). The access drive for this building was constructed at the same time as the building.

No spills were reported to have occurred at this site. However, a sampling visit conducted by a USEPA contractor (Jacobs Engineering Group, Inc.) in 1988, found high levels of 2-hexanone, toluene, and xylene in soil samples collected from the sampling location located immediately northeast of Building 513 as shown on Figure 1.3. Stressed vegetation was also observed in that immediate area.

In 1992, OpTech conducted an RFI at IRP Site No. 18. Three soil borings were drilled and two monitor wells were installed. Two surface water and two surface sediment sampling stations were established at the site (Figure 1.3). TPH and lead were detected in sediment samples collected from the drainage ditch and swale. The lead concentration detected was not significantly greater than the background concentration. TPH were detected in subsurface soil samples.

1.5.1.3 IRP Site No. 21 – Imhoff Tank Treatment System

The ITTS was constructed in 1949 as an on-site sewage treatment system for the National Guard facilities located on the east side of Duluth IAP (Figure 1.1). The Imhoff Tank Treatment System (ITTS) consisted of three compartments; an influent compartment, the main treatment tank, and an effluent compartment. The ITTS outfall pipe discharged to Miller Creek, located



LEGEND

1992 RFI Monitoring Well Location	1992 Surface Water Location	Suspected Contaminated Area Detected in 1988 by USEPA Sampling
1992 RFI Soil Test Boring Location	1992 RFI Sediment Location	Topographic Contour Line (Elev. In Ft. Abv. National Geodetic Vertical Datum of 1929)
Groundwater Flow Direction	1988 USEPA Sampling Location	0 120 SCALE IN FEET

FIGURE 1.3

**PREVIOUS SAMPLING LOCATIONS
AT IRP SITE NO.18**

Duluth Air National Guard Base
Duluth, Minnesota

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approximately 750 feet to the southeast of the ITTS (Figure 1.4). The adjacent sludge drying beds were each about eight feet by fifteen feet and were constructed on an underdrain covered by rock, gravel, and sand, in that order.

In 1992, OpTech conducted an RFI at IRP Site No. 21. Ten soil borings were drilled, two piezometer and three monitor wells were installed, and three surface sediment sampling stations were established at the site (Figure 1.4). TPH, VOCs, SVOCs, metals, and 4,4-DDD were detected in sediment samples collected from the marshy area located downgradient of the ITTS. VOCs, SVOCs, metals, and TPH were detected in subsurface soil samples. The greatest concentration of SVOC and TPH contamination is located downgradient of the ITTS. The VOC trichloroethene was detected in one monitor well, 021-014MW, located downgradient of the ITTS. IRP Site No. 25 (Old Motor Pool Area), located west and upgradient to the ITTS, is the suspected source of hydrocarbon contamination detected at IRP Site No. 21.

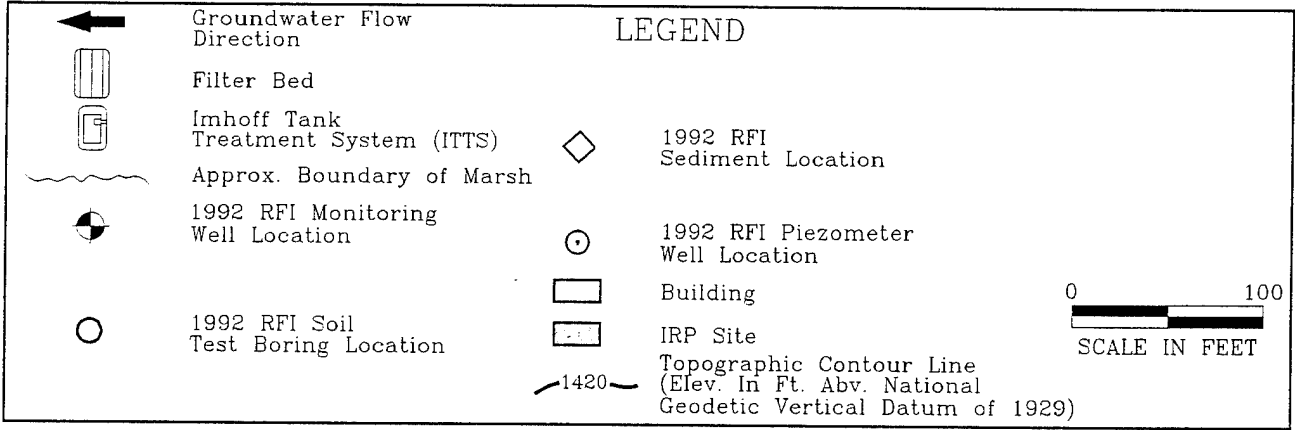
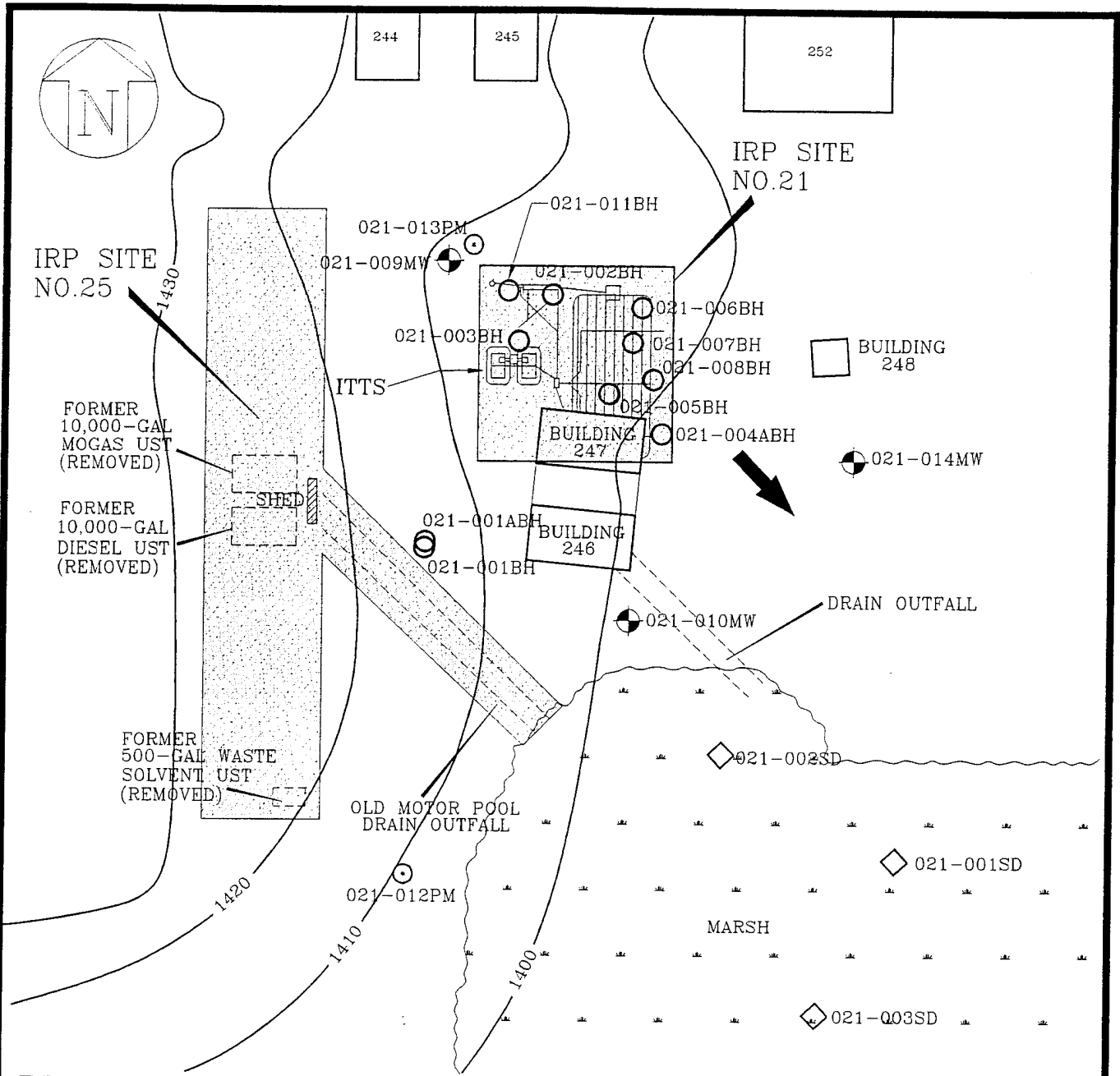


FIGURE 1.4

PREVIOUS RFI SAMPLING LOCATIONS
AT IRP SITE NO.21

Duluth Air National Guard Base
Duluth, Minnesota



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SECTION 2.0 INVESTIGATION DESCRIPTION

2.1 INTRODUCTION

This section provides a brief description of the investigation for the Addendum 1 RFI and then a detailed description of the investigation at IRP Sites No. 17, No. 18, and No. 21. The site locations are presented in Figure 1.1.

The field investigation included borehole drilling, lithologic descriptions, soil sampling, installation of a monitor well, groundwater sampling, sediment sampling, field screening, water level measurements, and surveying. A summary of the type of work done at each site is presented in Table 2.1. Details of the field investigation methods used during the Addendum 1 RFI are presented in Appendix B, Procedures and Protocols. Details of the field screening using a field gas chromatograph (GC) are presented in Appendix G, Field Gas Chromatography Analysis Results.

Table 2.1
Summary of Investigation Work by Site
Duluth Air National Guard Base, Duluth, Minnesota

Title of Report Section	Type of Work	IRP Site No. 17	IRP Site No. 18	IRP Site No. 21
Geological Investigations	Lithologic Descriptions	X	X	X
Soil Investigations	Soil Sampling	X	X	X
	Field Screening	X	X	X
	Surveying	X	X	X
Groundwater Investigations	Monitor Well Construction	N/A	N/A	X
	Field Screening	N/A	N/A	X
	Groundwater Sampling	N/A	N/A	X
	Water Levels Measurements	N/A	N/A	X
	Surveying	N/A	N/A	X
Sediment Investigations	Sediment Sampling	N/A	N/A	X
	Field Screening	N/A	N/A	X
	Surveying	N/A	N/A	X

IRP – Installation Restoration Program.

N/A – Not Applicable.

A total of 24 soil borings were drilled, and a total of 63 soil, five groundwater, four sediment, and 44 quality control/quality assurance (QA/QC) samples were collected for chemical analyses. One monitor well was installed during the field investigation. A summary of drilling and sampling activity is presented in Table 2.2.

Table 2.2
Drilling and Sampling Summary – July 1994
Duluth Air National Guard Base, Duluth, Minnesota

IRP Site No.	Monitor Wells	Groundwater Samples	Soil Borings	Soil Samples	Sediment Samples	QA/QC Samples
17	0	0	11	29	0	11
18	0	0	2	4	0	4
21	1	5	11	30	4	29
Total	1	5	24	63	4	44

IRP – Installation Restoration Program.

QA/QC – Quality Assurance/Quality Control.

The field investigation was performed in two segments. The first segment occurred 11 July to 26 July 1994 and consisted of drilling soil borings, installing one monitor well, collecting soil, groundwater, and sediment samples at IRP Sites No. 17, No. 18, and No. 21. The second segment occurred 4 October to 6 October 1994 and consisted of recollecting soil, groundwater, and sediment samples at IRP Sites No. 17, No. 18, and No. 21 due to a delay in shipment arrival at the laboratory. Recollected samples consist of one surface soil sample from the soil boring location 017-010BH at IRP Site No. 17, six soil samples from two soil borings at IRP Site No. 18, four groundwater samples from four monitor wells at IRP Site No. 21, and four sediment samples from IRP Site No. 21.

Additional field investigation was performed in May 1995 to fully delineate the extent of SVOC and TPH contaminations IRP Site No. 17 and the extent of TPH contamination at IRP Site No. 21. Soil samples were also analyzed for mercury to confirm the presence of this metal. The field investigation included drilling soil borings to collect soil samples for chemical analyses. A summary of the drilling and sampling activities is presented in Table 2.3.

2.2 IRP SITE NO. 17 – BASE SUPPLY/DRMO PAD STORAGE AREA

The work conducted at IRP Site No. 17 consisted of geological and soil investigations. A summary of the work performed at IRP Site No. 17 is presented in Table 2.1. The sampling

Table 2.3
Drilling and Sampling Summary – May 1995
Duluth Air National Guard Base, Duluth, Minnesota

IRP Site No.	Monitor Well	Groundwater Samples	Soil Borings	Soil Samples	Sediment Samples	QA/QC Samples
17	0	0	10	16	0	3
16	0	0	0	0	0	0
21	0	0	3	6	0	2
Total	0	0	13	22	0	5

IRP – Installation Restoration Program.

QA/QC – Quality Assurance/Quality Control.

locations utilized during this investigation and those existing from previous investigations are presented on Figure 2.1.

Eleven soil borings were drilled to collect soil samples at IRP Site No. 17 during the Addendum 1 RFI. Soil samples were collected from the soil borings for laboratory analyses of SVOCs and TPH to determine the vertical and horizontal extent of these contaminants at the DRMO Storage Pad area. All soil borings were plugged with cement/bentonite grout and abandoned when completed. All soil boring locations were surveyed.

An additional ten soil borings were drilled in 1995 to collect soil samples and to define the areal extent of SVOCs and TPH. Soil samples were also analyzed for mercury to confirm whether the presence of mercury was above regulated levels. Soil samples were analyzed for TPH by the Modified Wisconsin Department of Natural Resources (WDNR) TPH gasoline range organics (GRO) and diesel range organics (DRO) Method due to the high organic content in the local soil and to confirm the TPH data of the 1992 and 1994 sampling events. Soil samples collected in 1992 and 1994 were analyzed for TPH using the USEPA 418.1 Method.

2.2.1 Geologic Investigation

The geologic investigation consisted of lithologic descriptions. The lithologic descriptions were taken upon examination of the split-spoon samples taken during the drilling of the soil borings. A split-spoon sample was collected at every 5-foot interval. The soil borings are listed in Table 2.4 and soil boring locations are presented in Figure 2.1.

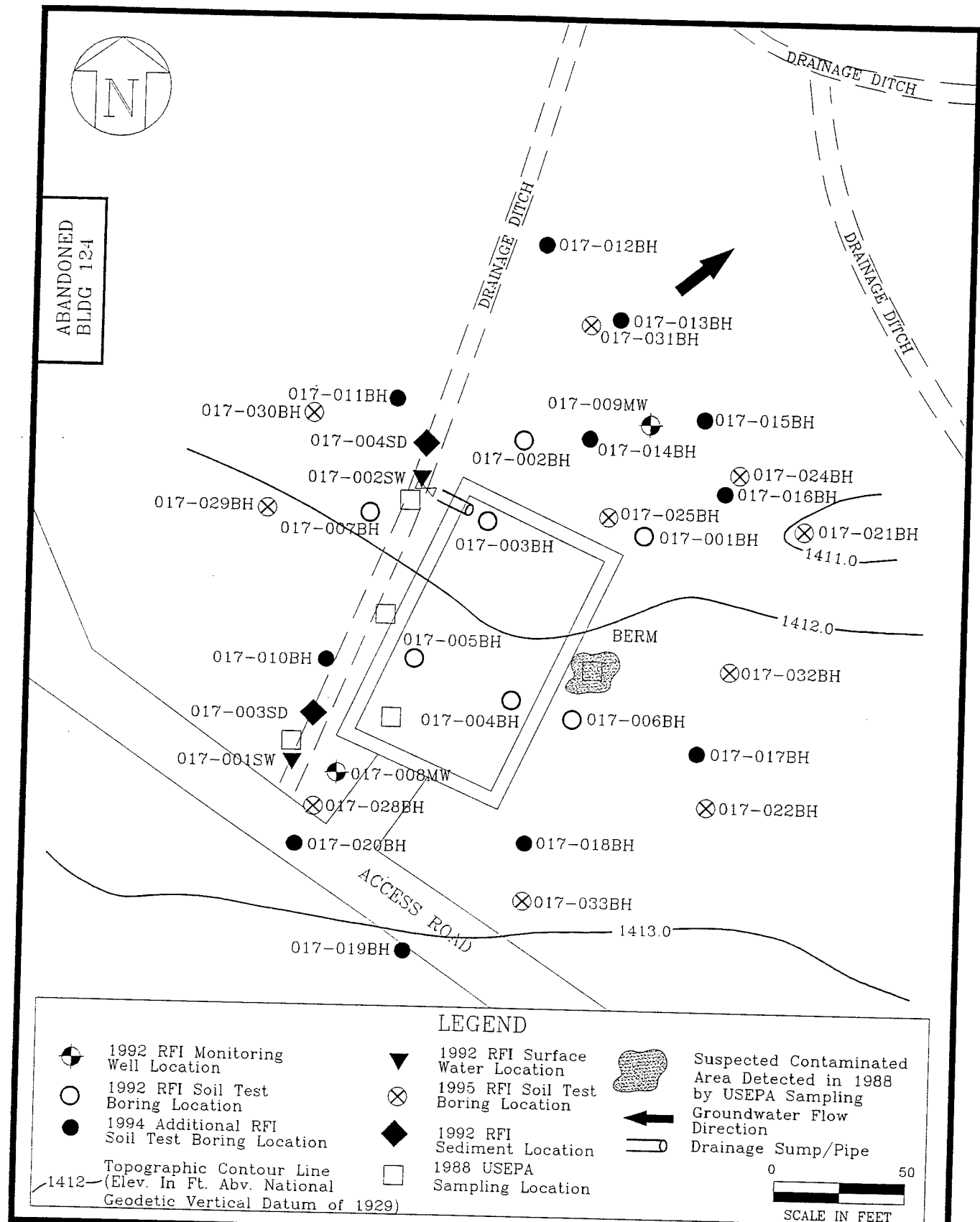


FIGURE 2.1

SAMPLING LOCATIONS
AT IRP SITE NO.17
Duluth Air National Guard Base
Duluth, Minnesota

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Table 2.4
Chemical Analyses Performed on IRP Site No. 17 Soil Samples
Duluth Air National Guard Base, Duluth, Minnesota

Location Number	Sample Depth (ft BLS)	QA/QC	Soil Analyses		
			SVOCs	TPH	Mercury
017-010BH	0.5 - 1.0	Duplicate	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-011BH	1.5 - 2.0	N/A	X	X	N/A
	5.0 - 5.5		X	X	N/A
017-012BH	2.0 - 2.5	N/A	X	X	N/A
	5.0 - 5.5		X	X	N/A
017-013BH	1.5 - 2.0	MS/MSD	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-014BH	1.5 - 2.0	Duplicate	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-015BH	2.0 - 2.5	N/A	X	X	N/A
	5.5 - 6.0		X	X	N/A
	9.5 - 10.0		X	X	N/A
017-016BH	1.5 - 2.0	N/A	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-017BH	2.0 - 2.5	MS/MSD	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-018BH	1.5 - 2.0	Duplicate	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-019BH	2.0 - 2.5	N/A	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-020BH	1.5 - 2.0	N/A	X	X	N/A
	5.0 - 5.5		X	X	N/A
	9.0 - 9.5		X	X	N/A
017-021BH	1.5 - 2.0	N/A	X	X	X
	5.0 - 5.5		X	X	X
017-022BH	1.5 - 2.0	N/A	X	X	X
017-023BH	1.5 - 2.0	N/A	X	X	X
	5.0 - 5.5		X	X	X

Table 2.4 (Concluded)
Chemical Analyses Performed on IRP Site No. 17 Soil Samples
Duluth Air National Guard Base, Duluth, Minnesota

Location Number	Sample Depth (ft BLS)	QA/QC	Soil Analyses		
			SVOCs	TPH	Mercury
017-024BH	2.0 - 2.5	N/A	X	X	X
	5.5 - 6.0		X	X	X
017-025BH	2.0 - 2.5	N/A	X	X	X
	5.0 - 5.5		X	X	X
017-028BH	1.5 - 2.0	N/A	X	X	X
	5.0 - 5.5		X	X	X
017-029BH	1.5 - 2.0	Duplicate	X	X	X
017-030BH	1.5 - 2.0	N/A	X	X	X
017-031BH	1.5 - 2.0	Duplicate*	X	X	X
	5.0 - 5.5		X	X	X
017-032BH	1.5 - 2.0	N/A	X	X	X
	Equipment Rinseate Blanks (3)	N/A	X	X	N/A
			X	X	N/A
			X	X	N/A
	Field Blanks (3)	N/A	X	X	N/A

BH – Borehole.

N/A – Not Applicable.

TPH – Total Petroleum Hydrocarbons.

IRP – Installation Restoration Program.

QA/QC – Quality Assurance/Quality Control.

SVOCs – Semivolatile Organic Compounds.

ft BLS – feet Below Land Surface.

MS/MSD – Matrix Spike/Matrix Spike Duplicate.

* – The duplicate sample was not analyzed for SVOCs due to a lab error.

The lithologic descriptions for each soil boring were recorded in the site geologist's field logbook and are presented in Appendix C, Boring Logs. A copy of the field notes is presented in Appendix L, Field Documentation.

2.2.2 Soil Investigation

Soil samples were obtained every 5-foot interval from soil borings. Soil borings were drilled with a drill rig equipped with hollow-stem augers (HSAs). Soil samples were collected with a stainless-steel California-style, split-spoon sampler, equipped with four 6-inch long, 2.5-inch diameter brass sleeves. Soil boring 017-010BH, interval 1.5 to 2.0 feet (ft) below land surface (BLS), was sampled with a stainless-steel hand-auger sampler, equipped with two 5-inch long, 2-inch diameter brass sleeves, due to poor recoveries with the split-spoon sampler. A minimum

of one soil sample from immediately below the surface and one soil sample from immediately above the water table were collected and submitted for laboratory analyses of SVOCs and TPH from each soil boring location. Soil samples were also collected from every 5-foot interval for screening of BTEX using a field gas chromatograph (GC). Data obtained from the field GC were used to supplement data obtained from samples sent to the laboratory for chemical analyses and to aid in selecting the additional soil sample. The soil and QA/QC samples that were collected during the 1994 sampling event were analyzed for SVOCs and TPH. The soil and QA/QC samples that were collected during the 1995 sampling event were analyzed for SVOCs, TPH (GRO/DRO), and mercury.

A summary of the kinds and number of analyses performed on the soil samples is given in Table 2.4. Analytical results are provided in Appendix J, Analytical Results of Soil, Groundwater, and Sediment Samples. A discussion of the analytical results is presented in Section 4.0.

2.3 IRP SITE NO. 18 – HAZARDOUS WASTE STORAGE AREA, BUILDING 513

The work conducted at IRP Site No. 18 consisted of geological and soil investigations. A summary of the work performed at IRP Site No. 18 is presented in Table 2.1. The sampling locations utilized during this investigation and those existing from previous investigations are presented on Figure 2.2. The soil boring locations were surveyed.

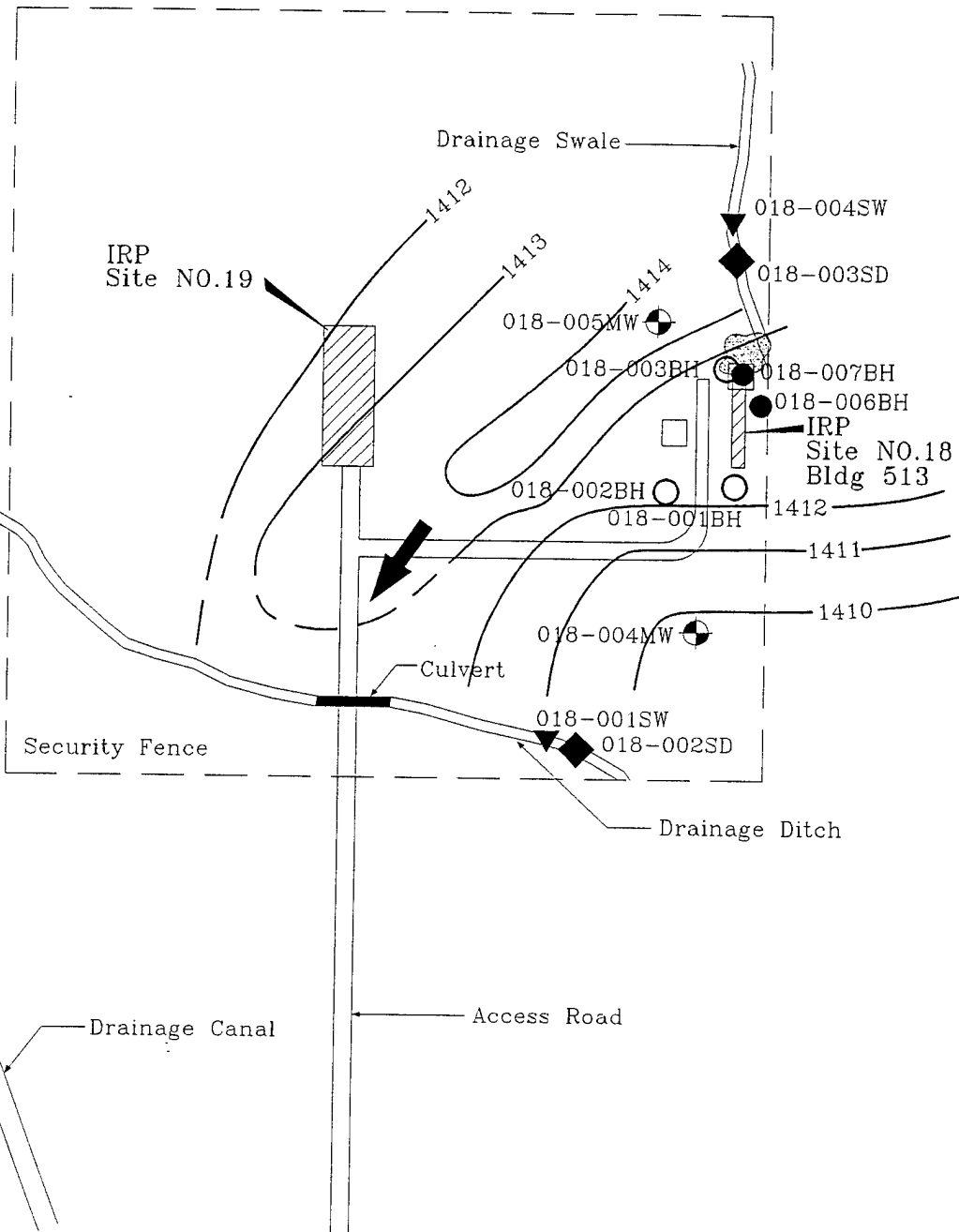
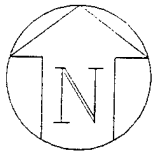
2.3.1 Geologic Investigation

The geologic investigation consisted of lithologic descriptions. The lithologic descriptions were obtained from the samples collected using a stainless-steel hand auger. The samples were collected continuously to total depth of soil boring. The soil borings are listed in Table 2.5 and soil boring locations are presented in Figure 2.2.










The lithologic descriptions for each soil boring were recorded in the site geologist's field logbook and are presented in Appendix C, Boring Logs. A copy of the field notes is presented in Appendix L, Field Documentation.

2.3.2 Soil Investigation

Soil samples were obtained continuously to a total depth of 2.5 ft BLS from two soil borings at IRP Site No. 18 using a hand auger. Samples were collected with a stainless-steel hand-auger



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-  1992 RFI Monitoring Well Location
-  1992 RFI Soil Test Boring Location
-  1994 Additional RFI Soil Test Boring Location
-  1992 Surface Water Location
-  1992 RFI Sediment Location
-  1988 USEPA Sampling Location
-  Suspected Contaminated Area Detected in 1988 by USEPA Sampling
-  1412 Topographic Contour Line (Elev. In Ft. Abv. National Geodetic Vertical Datum of 1929)
-  Groundwater Flow Direction

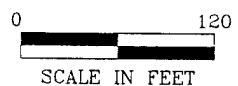


FIGURE 2.2

SAMPLING LOCATIONS
 AT IRP SITE NO.18
 Duluth Air National Guard Base
 Duluth, Minnesota

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Table 2.5
Chemical Analyses Performed on IRP Site No. 18 Soil Samples
Duluth Air National Guard Base, Duluth, Minnesota

Location Number	Sample Depth (ft BLS)	Soil Analyses	
		QA/QC	VOCs
018-006BH	0.8 - 1.3	MS/MSD	X
	1.3 - 1.7		X
	2.1 - 2.5		X
018-007BH	1.3 - 1.7 2.1 - 2.5	Duplicate	X X
		Trip Blanks (1)	X
		Equipment Rinseate Blank (1)	X
		Field Blanks (2)	X

BH - Borehole.

N/A - Not Applicable.

IRP - Installation Restoration Program.

ft BLS - feet Below Land Surface.

QA/QC - Quality Assurance/Quality Control.

MS/MSD - Matrix Spike/Matrix Spike

Duplicate.

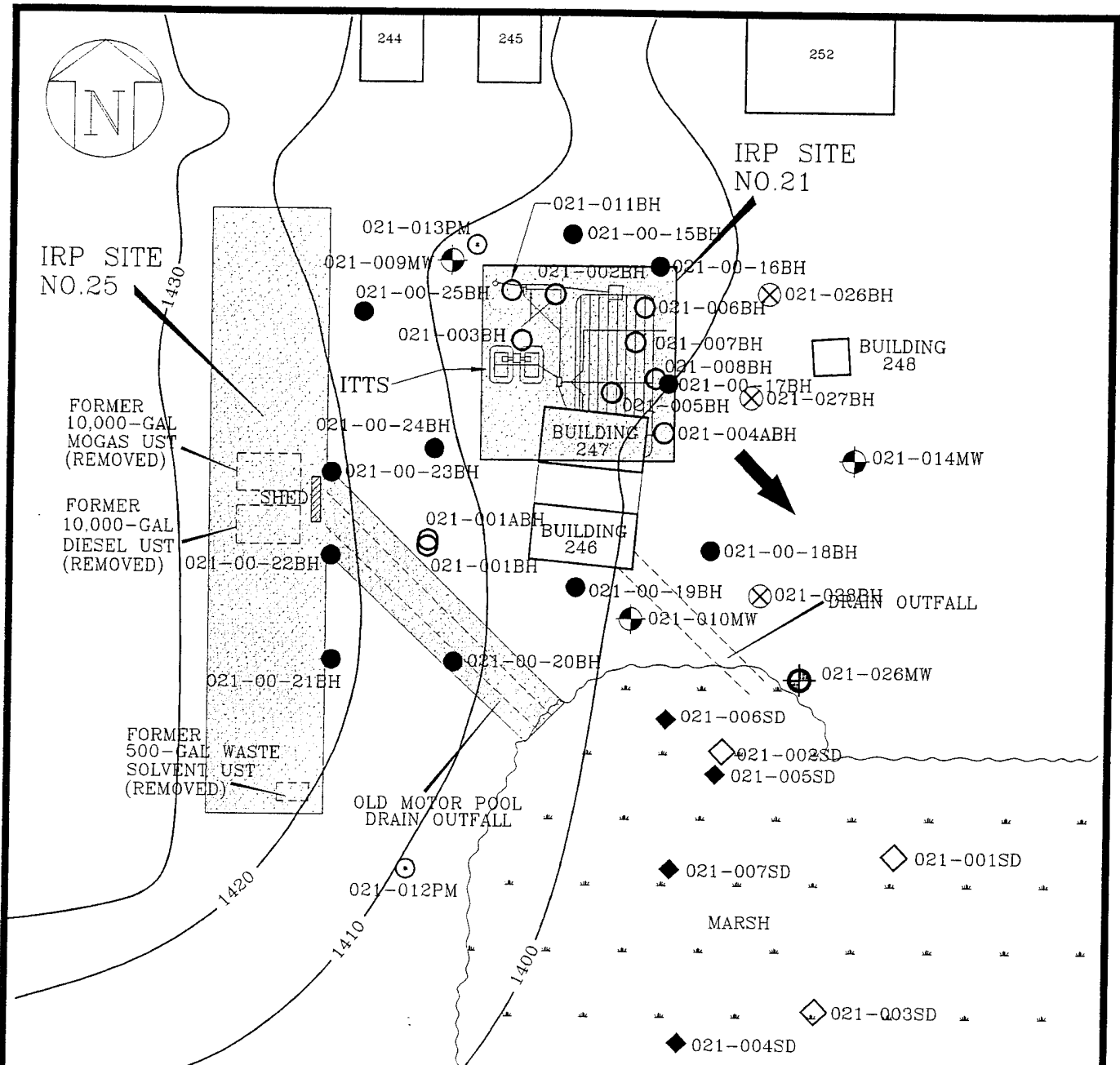
VOCs - Volatile Organic Compounds.

sampler, equipped with two 5-inch long, 2-inch diameter brass sleeves. Two soil samples were collected and submitted for laboratory analyses of VOCs from each soil boring location. Soil samples were also collected for screening for BTEX using a field GC. Data obtained from the field GC were used to supplement data obtained from samples sent to the laboratory for chemical analyses. A total of four soil and four QA/QC samples were analyzed for VOCs.

A summary of the kinds and number of analyses performed on the soil samples is given in Table 2.5. Analytical results are provided in Appendix J, Analytical Results of Soil, Groundwater, and Sediment Samples. A discussion of the analytical results is presented in Section 4.0.

2.4 IRP SITE NO. 21 - IMHOFF TANK TREATMENT SYSTEM

The work conducted at IRP Site No. 21 consisted of geological investigations, soil investigations, groundwater investigations, and sediment investigations. A summary of the work performed at IRP Site No. 21 is presented in Table 2.1. The sampling locations utilized during this investigation and those existing from previous investigations are presented on Figure 2.3. The soil boring, monitor well, and sediment locations were surveyed.



LEGEND	
	Groundwater Flow Direction
	Filter Bed
	Imhoff Tank Treatment System (ITTS)
	Approx. Boundary of Marsh
	1992 RFI Monitoring Well Location
	1994 RFI Monitoring Well Location
	1992 RFI Soil Test Boring Location
	1994 RFI Additional Soil Test Boring Location
	1994 RFI Additional Location After Addendum
	1992 RFI Sediment Location
	1995 RFI Soil Test Boring Location
	1992 RFI Piezometer Well Location
	Building
	IRP Site
	Topographic Contour Line (Elev. In Ft. Abv. National Geodetic Vertical Datum of 1929)

SCALE IN FEET

FIGURE 2.3

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**SAMPLING LOCATIONS
AT IRP SITE NO.21**

Duluth Air National Guard Base
Duluth, Minnesota

Eleven soil borings were drilled to collect soil samples, one monitor well was installed, and four sediment samples were collected during the Addendum 1 RFI. All soil borings were plugged with cement/bentonite grout and abandoned when completed. All soil boring locations, surface sediment stations, and monitor well locations were surveyed.

One groundwater monitor well was installed at IRP Site No. 21 during the Addendum 1 RFI. Monitor well 021-026MW, located southeast of Building 248, was drilled to a total depth of 19 ft BLS and the screen set from 7 to 17 ft BLS. The soil samples were collected with a stainless-steel, split-spoon sampler from the borehole at intervals shown in Table 2.6 for field screening and lithologic descriptions.

Groundwater samples were collected from 021-009MW, 021-010MW, 021-014MW, and 021-026MW during one sampling event. A groundwater sample was collected from 021-026MW during a second sampling event. The four sediment samples were collected during one sampling event.

An additional three soil borings were drilled for collection of soil samples to fully define the areal extent of TPH contamination east of the ITTS area. The soil samples were analyzed for WDNR TPH GRO/DRO Method. Soil samples that were collected in 1992 and 1994 were analyzed for TPH using the USEPA 418.1 Method.

2.4.1 Geologic Investigation

The geologic investigation consisted of lithologic descriptions. The lithologic descriptions were taken from the split-spoon samples during the drilling of the soil borings. A split-spoon sample was collected every 5-foot interval. The soil borings are listed in Table 2.6 and soil boring locations are presented in Figure 2.3.

The lithologic descriptions for each soil boring were recorded in a field logbook and are presented in Appendix C, Boring Logs. A copy of the field notes is presented in Appendix L, Field Documentation.

2.4.2 Soil Investigation

Soil samples were obtained every 5-foot interval from the soil borings. Soil borings were drilled with a drill rig equipped with HSAs. Soil samples were collected with a stainless-steel California-style, split-spoon sampler, equipped with four 6-inch long, 2.5-inch diameter brass

Table 2.6
Chemical Analyses Performed on IRP Site No. 21 Soil Samples
Duluth Air National Guard Base, Duluth, Minnesota

Location Number	Sample Depth (ft BLS)	QA/QC	Soil Analyses				
			VOCs	SVOCs	TPH	Metals	Pesticides/PCBs
021-015BH	1.5 - 2.0	N/A	X	X	X	X	X
	6.0 - 6.5		X	X	X	X	X
021-016BH	1.5 - 2.0	N/A	X	X	X	X	X
	6.0 - 6.5		X	X	X	X	X
021-017BH	1.5 - 2.0	Duplicate	X	X	X	X	X
	6.0 - 6.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-018BH	1.5 - 2.0	MS/MSD Duplicate	X	X	X	X	X
	10.0 - 10.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-019BH	1.0 - 1.5	N/A	X	X	X	X	X
	6.0 - 6.5		X	X	X	X	X
	10.0 - 10.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-020BH	1.5 - 2.0	N/A	X	X	X	X	X
	6.0 - 6.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-021BH	1.5 - 2.0	N/A	X	X	X	X	X
	11.0 - 11.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-022BH	1.5 - 2.0	N/A	X	X	X	X	X
	11.0 - 11.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-023BH	1.5 - 2.0	Duplicate	X	X	X	X	X
	11.0 - 11.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-024BH	1.5 - 2.0	N/A	X	X	X	X	X
	10.0 - 10.5		X	X	X	X	X
	16.0 - 16.5		X	X	X	X	X
021-025BH	1.5 - 2.0	MS/MSD	X	X	X	X	X
	10.0 - 10.5		X	X	X	X	X
	14.0 - 14.5		X	X	X	X	X
021-026MW	0.5 - 2.5 7.0 - 9.0 10.0 - 12.0 15.5 - 17.5	N/A	Field screened for BTEX using a field gas chromatography.				
021-026BH	2.0 - 2.5 9.0 - 9.5	N/A	N/A N/A	N/A N/A	X X	N/A N/A	N/A N/A

Table 2.6 (Concluded)
Chemical Analyses Performed on IRP Site No. 21 Soil Samples
Duluth Air National Guard Base, Duluth, Minnesota

Location Number	Sample Depth (ft BLS)	QA/QC	Soil Analyses				
			VOCs	SVOCs	TPH	Metals	Pesticides/PCBs
021-027BH	2.0 - 2.5	Duplicate	N/A	N/A	X	N/A	N/A
	9.0 - 10.0		N/A	N/A	X	N/A	N/A
021-028BH	2.0 - 2.5	MS/MSD	N/A	N/A	X	N/A	N/A
	5.0 - 5.5		N/A	N/A	X	N/A	N/A
		Equipment Blanks (5)	X	X	X	X	X
		Trip Blanks (7)	X	N/A	N/A	N/A	N/A
		Field Blanks (3)	X	X	X	X	X

BH – Borehole.
 TPH – Total Petroleum Hydrocarbons.
 IRP – Installation Restoration Program.
 ft BLS – feet Below Land Surface.
 QA/QC – Quality Assurance/Quality Control.
 PCBs – Polychlorinated Biphenyls.

VOCs – Volatile Organic Compounds.
 MS/MSD – Matrix Spike/Matrix Spike Duplicate.
 SVOCs – Semivolatile Organic Compounds.
 MW – Monitor Well.
 N/A – Not Applicable.

sleeves. A minimum of one soil sample from immediately below the surface and one soil sample from immediately above the water table was collected and submitted for laboratory analyses of VOCs, SVOCs, TPH, pesticides/PCBs, and metals from each soil boring location. Soil samples were also collected for screening of BTEX using a field GC. Data obtained from the field GC were used to supplement data obtained from samples sent to the laboratory for chemical analyses and to aid in selecting the additional soil sample. The soil and QA/QC samples collected during the 1994 sampling event were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals. The soil and QA/QC samples that were collected during the 1995 sampling event were analyzed for TPH (GRO/DRO).

A summary of the kind and number of analyses performed on the soil samples is given in Table 2.6. Analytical results are provided in Appendix J, Analytical Results of Soil, Groundwater, and Sediment Samples. A discussion of the analytical results is presented in Section 4.0.

2.4.3 Groundwater Investigation

The groundwater investigation consisted of water level measurements, surveying of all water level measuring points and locations, and laboratory analyses of groundwater samples.

2.4.3.1 Aquifer Investigation

Water level measurements were taken twice during the Addendum 1 RFI, once during the first segment and again during the second segment. The water level measurements that were taken during the first segment were taken from the monitor well that was constructed during the Addendum 1 RFI and from the existing monitor wells and piezometers that were constructed during the RFI. The water level measurements that were taken during the second segment were taken from the monitor well that was constructed during the Addendum 1 RFI and from the existing monitor wells that were constructed during the RFI. All monitor well and piezometers locations had been surveyed. The water level data was used to aid in determining the direction of groundwater movement at the site.

2.4.3.2 Groundwater Sampling Investigation

Groundwater samples were obtained from one monitor well constructed during the Addendum 1 RFI and from three monitor wells previously constructed during the RFI for total of four sampling locations. An additional round of a groundwater samples was collected from the monitor well that was constructed during the Addendum 1 RFI.

Groundwater samples were also collected for screening BTEX using a field GC. Data obtained from the field GC were used to supplement data obtained from samples sent to the laboratory for chemical analyses.

An additional monitor well, 021-026MW, was constructed to determine the downgradient extent of the contaminants that were detected in the groundwater sample collected from the existing monitor well 021-014MW.

A total of five groundwater and three QA/QC samples were analyzed for VOCs and metals. A summary of the kinds and numbers of analyses performed on the groundwater samples for each monitor well location is given in Table 2.7. Analytical results of the analyses are presented in Appendix J, Analytical Results of Soil, Groundwater, and Sediment Samples. A discussion of

Table 2.7
Chemical Analyses Performed on IRP Site No. 21 Groundwater Samples
Duluth Air National Guard Base, Duluth, Minnesota

Monitor Well	Sample Rounds	QA/QC	Groundwater Analyses				
			VOCs	SVOCs	TPH	Metals	Pesticides/PCBs
021-009MW	1		X	N/A	N/A	X	N/A
021-010MW	1	Duplicate	X	N/A	N/A	X	N/A
021-014MW	1		X	N/A	N/A	X	N/A
021-026MW	2		X			X	
		Equipment Rinseate Blank (1)	X	X	X	X	X
		Field Blanks (2)	X	X	X	X	X
		Trip Blank (1)	X	N/A	N/A	N/A	N/A

BH - Borehole.
 TPH - Total Petroleum Hydrocarbons.
 IRP - Installation Restoration Program.
 QA/QC - Quality Assurance/Quality Control.
 PCBs - Polychlorinated Biphenyls.

VOCs - Volatile Organic Compounds.
 MS/MSD - Matrix Spike/Matrix Spike Duplicate.
 SVOCs - Semivolatile Organic Compounds.
 MW - Monitor Well.
 N/A - Not Applicable.

the analytical results is presented in Section 4.0. The analytical results of the groundwater samples were used to determine the extent of the contamination.

2.4.4 Sediment Investigation

Sediment samples were collected at four locations in the marshy area located downgradient of the ITTS. This marshy area is believed to be the outfall area for the ITTS; thus, sediments were investigated to determine if contaminants migrated from the ITTS. VOCs, SVOCs, TPH, 4,4-DDD, and metals were detected in sediment samples collected during the RFI. The sediment sampling locations utilized during the Addendum 1 RFI and those existing from the RFI are presented on Figure 2.3.

Sediment samples were also collected for the field GC screening of BTEX. Data obtained from the field GC were used to supplement data obtained from samples sent to the laboratory for chemical analyses.

A total of four sediment and six QA/QC samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals. A summary of the kinds and number analyses performed on sediment samples is given in Table 2.8. Analytical results of the analyses are presented in

Table 2.8
Chemical Analyses Performed on IRP Site No. 21 Sediment Samples
Duluth Air National Guard Base, Duluth, Minnesota

Sediment Location	Sample Rounds	QA/QC	Sediment Analyses				
			VOCs	SVOCs	TPH	Metals	Pesticides/PCBs
021-004SD	1	MS/MSD	X	X	X	X	X
021-005SD	1	Duplicate	X	X	X	X	X
			X	X	X	X	X
021-006SD	1	MS/MSD	X	X	X	X	X
021-007SD	1	Duplicate	X	X	X	X	X
		Equipment Rinseate Blank (1)	X	X	X	X	X
		Trip Blank (1)	X	N/A	N/A	N/A	N/A
		Field Blanks (2)	X	X	X	X	X

BH - Borehole.

TPH - Total Petroleum Hydrocarbons.

IRP - Installation Restoration Program.

QA/QC - Quality Assurance/Quality Control.

PCBs - Polychlorinated Biphenyls.

VOCs - Volatile Organic Compounds.

MS/MSD - Matrix Spike/Matrix Spike Duplicate.

SVOCs - Semivolatile Organic Compounds.

MW - Monitor Well.

N/A - Not Applicable.

Appendix J, Analytical Results of Soil, Groundwater, and Sediment Samples. A discussion of the analytical results is presented in Section 4.0.

SECTION 3.0 INVESTIGATIVE RESULTS

The non-chemical results of the Addendum 1 RFI are presented in this section. This section includes the geology of IRP Sites No. 17, No. 18, and No. 21 and the hydrogeology of IRP Site No. 21. The results of the chemical analyses are presented in Section 4.0.

3.1 GEOLOGY

Lithologic descriptions were obtained from the split-spoon and augered samples of the soil borings for IRP Sites No. 17, No. 18, and No. 21 during the Addendum 1 RFI. These lithologic descriptions were used to provide additional geological information. Lithologic logs from soil borings drilled during the Addendum 1 RFI are presented in Appendix D, Boring Logs.

Descriptions of the subsurface geology beneath IRP Sites No. 17, No. 18, and No. 21 are presented in the RFI Report (OpTech, 1992). The lithologic descriptions recorded during the Addendum 1 RFI support the geologic interpretation reported in the RFI Report.

3.2 HYDROGEOLOGY

The groundwater occurs in both unconsolidated glacial deposits and in the underlying gabbro bedrock. The principal aquifer exists in the glacial till and varies from 20 to 25 feet in thickness (OpTech, 1992). The water table occurs at depths generally less than 5 feet and is believed to be continuous with surface drainage, thus, indicative of an unconfined aquifer.

Potentiometric surface maps interpreted from the water level data collected during the RFI for IRP Sites No. 17 and No. 18 are presented as Figures 3.1 and 3.2, respectively. Potentiometric surface maps interpreted from the water level data collected during the Addendum 1 RFI are presented as Figures 3.3 and 3.4. The water level data collected at IRP Site No. 21 are presented in Table 3.1. The direction of groundwater movement appears to be towards the northeast at IRP Site No. 17, southwest at IRP Sites No. 18 and No. 19, and towards the southeast at IRP Site No. 21 as interpreted in the RFI Report (OpTech, 1992).

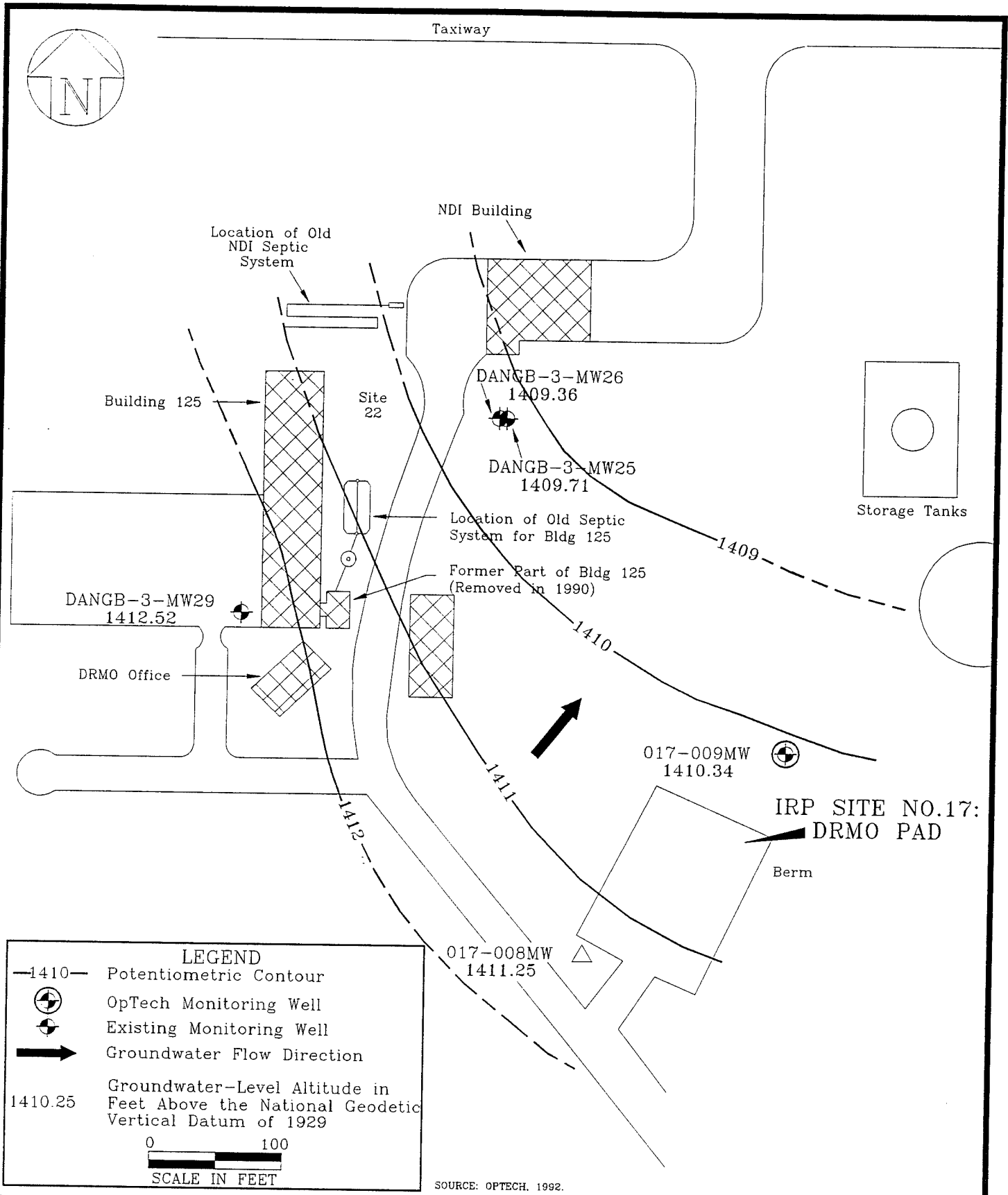


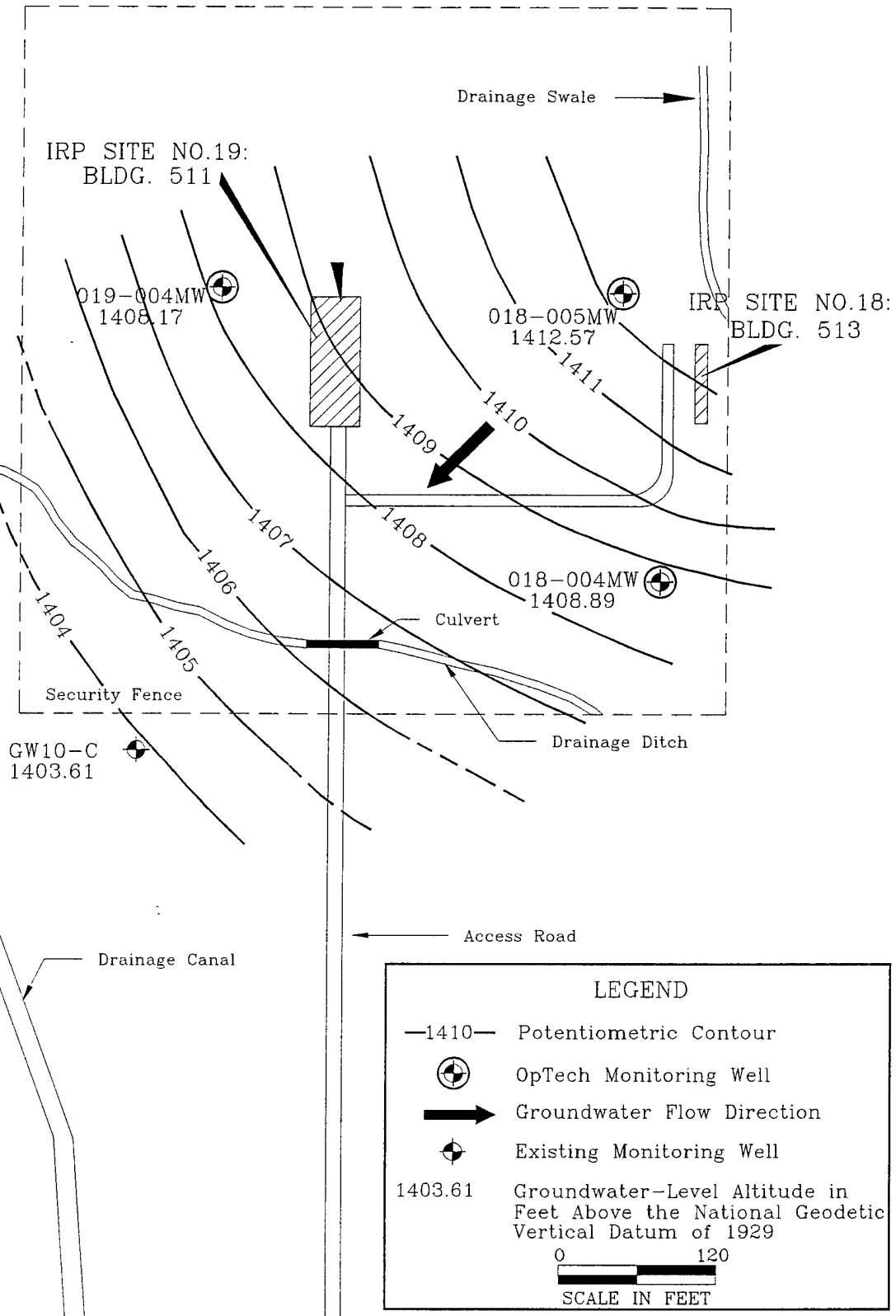
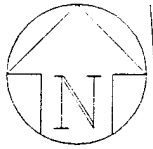
FIGURE 3.1

POTENTIOMETRIC SURFACE MAP
 AS OF 28 MARCH 1992
 FOR IRP SITE No.17
 Duluth Air National Guard Base
 Duluth, Minnesota

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SOURCE: OPTECH, 1992.

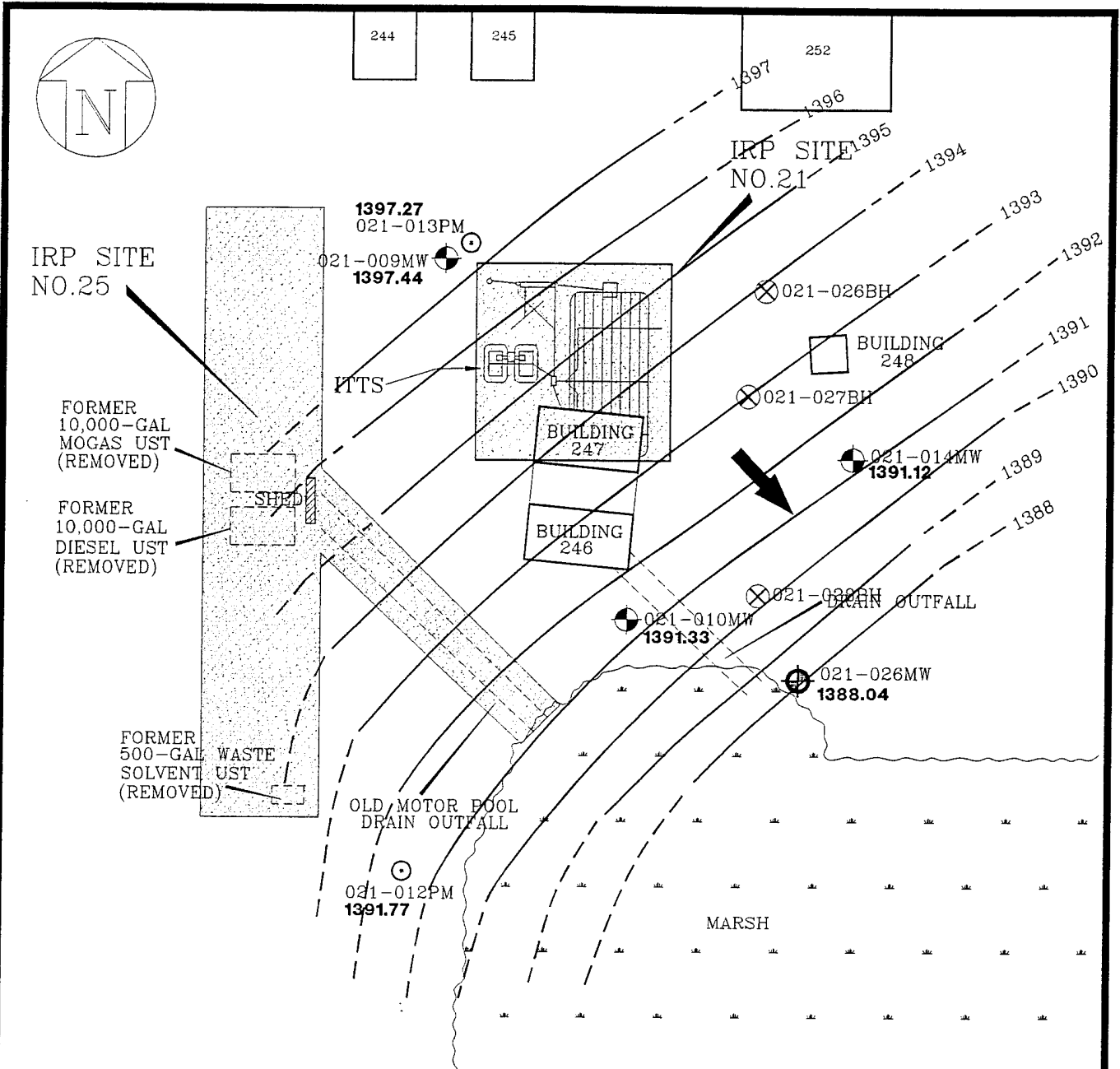
FIGURE 3.2

POTENTIOMETRIC SURFACE MAP
AS OF 28 MARCH 1992
FOR IRP SITES NO.18 AND NO.19
Duluth Air National Guard Base
Duluth, Minnesota

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	Groundwater Flow Direction	LEGEND		1397	Potentiometric Contour
	Filter Bed				1995 RFI Soil Test Boring Location
	Imhoff Tank Treatment System (ITTS)			1992 RFI Piezometer Well Location	
	Approx. Boundary of Marsh			Building	
	1992 RFI Monitoring Well Location			IRP Site	
	1994 RFI Monitoring Well Location				
	Groundwater-Level Altitude in Feet Above the National Geodetic Vertical Datum of 1929				

1388.04

0 100
SCALE IN FEET

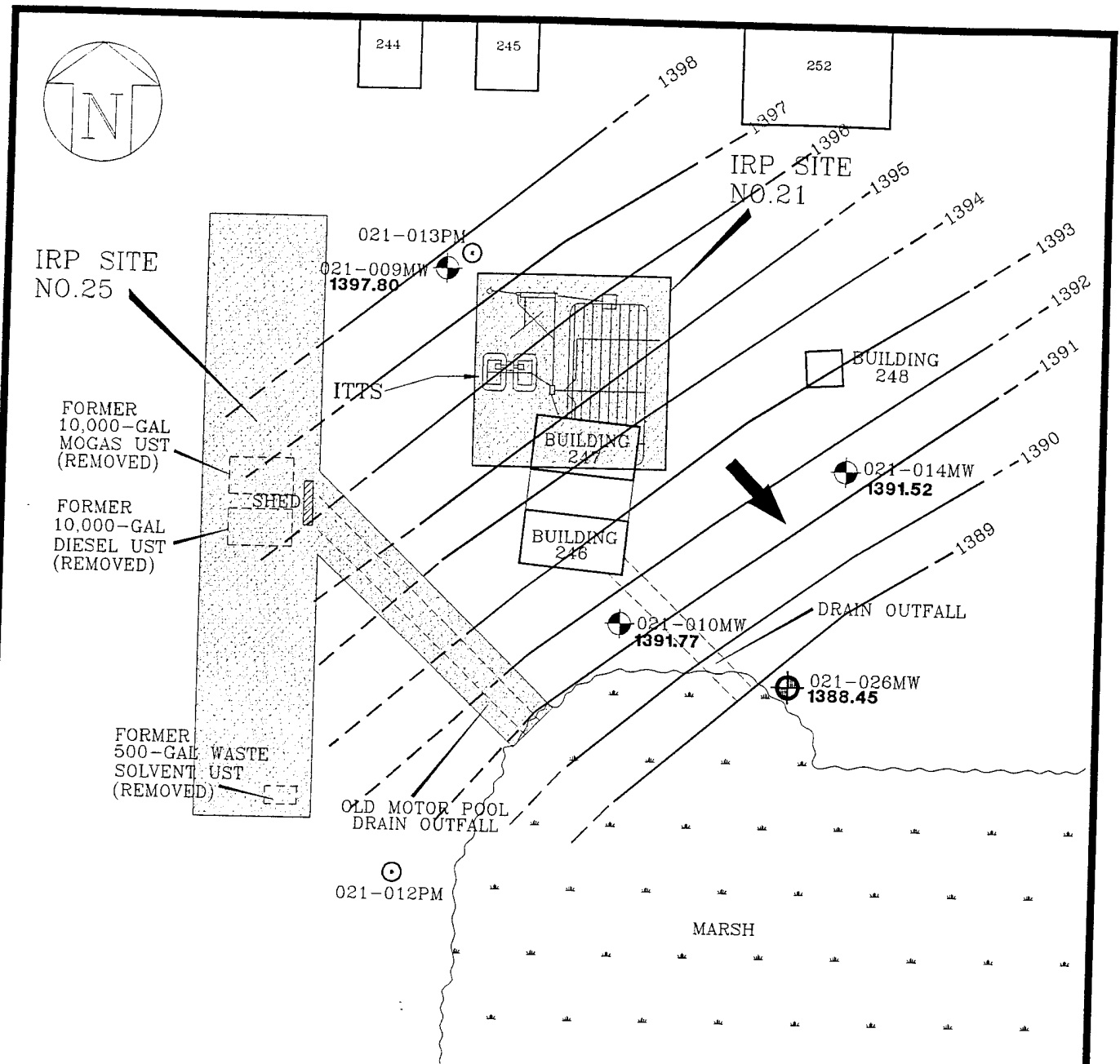
FIGURE 3.3

POTENTIOMETRIC SURFACE MAP
AS OF 26 JULY 1994 FOR
IRP SITE NO. 21
Duluth Air National Guard Base
Duluth, Minnesota

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LEGEND

- Groundwater Flow Direction
- Filter Bed
- Imhoff Tank Treatment System (ITTS)
- Approx. Boundary of Marsh
- 1992 RFI Monitoring Well Location
- 1992 RFI Piezometer Well Location
- Building
- IRP Site
- 1397— Potentiometric Contour
- Groundwater-Level Measurements Were Taken on 6 October 1994
- Groundwater-Level Altitude in Feet Above the National Geodetic Vertical Datum of 1929
- 0 100 SCALE IN FEET

FIGURE 3.4

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POTENTIOMETRIC SURFACE MAP AS OF 6 OCTOBER 1994 FOR IRP SITE NO. 21 Duluth Air National Guard Base Duluth, Minnesota

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Table 3.1
Water Level Measurements – IRP Site No. 21
Duluth Air National Guard Base, Duluth, Minnesota

Well No.	Measurement Date	Measurement Time	Depth to Water from TOC (ft)	Altitude of Measuring Point*	Water Altitude Level*
021-009MW	07/26/94	15:18	11.88	1,409.32	1,397.44
	10/06/94	09:45	11.52		1,397.80
021-010MW	07/26/94	15:24	7.23	1,398.56	1,391.33
	10/06/94	13:20	6.79		1,391.77
021-012PM	07/26/94	15:27	7.79	1,399.56	1,391.77
021-013PM	07/26/94	15:15	13.35	1,410.62	1,397.27
021-014MW	07/26/94	15:20	5.23	1,396.35	1,391.12
	10/06/94	10:30	4.83		1,391.52
021-026MW	07/26/94	15:22	8.06	1,396.10	1,388.04
	10/06/94	14:15	7.65		1,388.45

MW – Monitor Well.
 PM – Piezometer.
 ft – feet.

TOC – Top of Casing.
 * – Altitude measured in feet above the National Geodetic Vertical Datum of 1929.

SECTION 4.0 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the chemical analyses performed on soil, groundwater, and sediment samples collected during the RFI. Only analytes that were detected are presented in this section. The analytical results for each sample, analytical method, and method detection limit are provided in Appendix J, Analytical Results of the Soil, Groundwater, and Sediment Samples.

The word contaminant and contamination are used throughout the text of this section. Contamination, in the context of this Addendum 1 Report, is defined as the presence of a substance introduced into the environment as a result of man's activities without regard to whether the concentrations have reached levels that may cause a significant level of water quality degradation and does not imply a risk to human health. A contaminant is the substance causing the contamination.

Four VOCs, 2-butanone, methylene chloride, chloroform, and acetone, and one SVOC, bis(2-ethylhexyl)phthalate, are not reported as site contaminants in this section as they are believed to be laboratory-induced sample contaminants. The analytical results of the quality assurance/quality control (QA/QC) are presented in Appendix K, Analytical Results of Quality Assurance/Quality Control Samples.

All analytical results were evaluated at Level III to assure the quality of the chemical data. A summary of the evaluation of the analytical data is presented in Appendix I, Discussion of Laboratory Analyses Problems and Data Evaluation.

4.1 IRP SITE NO. 17 – BASE SUPPLY/DRMO STORAGE AREA

The results of the chemical analyses for the soil samples collected at IRP Site No. 17 during the Addendum 1 RFI are presented in this section. The analytical results for the soil samples collected at IRP Site No. 17 during the RFI are presented in the 1992 RFI Report (OpTech, 1992). The analytical results from the 1992 RFI Report (OpTech, 1992) and Addendum 1 RFI are interpreted to determine the extent of contamination of the soil.

4.1.1 Source of Contamination

The suspected source area at IRP Site No. 17 is the DRMO Storage Area, an impervious pad approximately 80 feet by 120 feet, with five feet wide by three feet high perimeter dikes,

(Figure 2.1). This area was used for the storage of containers of fuels, lubricants, hydraulic fluids, and antifreeze.

4.1.2 Soil Quality and Extent of Contamination

Twenty-nine soil samples were collected from eleven soil borings during the 1994 sampling event. Sixteen soil samples were collected from ten soil borings during the 1995 sampling event. The locations of these soil borings are shown in Figure 2.1. These soil samples were analyzed for SVOC and TPH parameters as listed in Table 2.4. Soil samples collected during the 1995 sampling event were also analyzed for mercury. A summary of analytes detected in soil samples collected from IRP Site No. 17 during the Addendum 1 RFI is presented in Tables 4.1 through 4.4.

SVOCs were detected in four of the 29 soil samples collected from IRP Site No. 17 during the Addendum 1 RFI. Most of the SVOCs detected in the three near-surface soil samples collected are polycyclic aromatic hydrocarbons (PAH) (Table 4.1). PAHs were detected at concentrations ranging from 370 micrograms per kilogram ($\mu\text{g}/\text{kg}$) (chrysene) to 5,800 $\mu\text{g}/\text{kg}$ (fluoranthene). The maximum concentrations were detected in the near-surface, 1.5- to 2-foot interval, soil sample collected from location 017-011BH. The greatest concentrations of SVOCs were detected in soil samples collected from 017-001BH, 017-007BH, and 017-008MW during the RFI (OpTech, 1992). Most of the SVOCs that were detected in the soil samples collected during the RFI were PAHs. The PAH pyrene was detected with the maximum concentration of 12,000 $\mu\text{g}/\text{kg}$. SVOCs, PAHs, were detected in three of the 16 soil samples collected during the 1995 sampling event. The maximum concentrations were detected in the near-surface soil samples at locations 017-030BH, 017-032BH, and 017-025BH ranging from 380 $\mu\text{g}/\text{kg}$ (benzo(k)fluoranthene) to 6,000 $\mu\text{g}/\text{kg}$ (fluoranthene) (Table 4.2).

TPH (USEPA 418.1 Method) were detected at concentrations ranging from 12 to 13,000 mg/kg in the soil samples collected at IRP Site No. 17 during the 1992 and 1994 sampling events (Table 4.3). TPH (WDNR DRO) were detected at concentrations from 5.6 mg/kg to 189 mg/kg in soil samples collected during the 1995 sampling event (Table 4.4). TPH DRO (WDNR GRO/DRO Method) were detected in a near-surface soil sample collected from soil boring 017-025BH with a concentration of 144 mg/kg. Soil samples were collected from the location 017-025BH to confirm TPH contamination near the soil boring 017-001BH where soil samples collected contained the maximum concentration of 13,000 mg/kg for TPH (USEPA 418.1 Method). An isoconcentration map of the TPH analyzed by the USEPA 418.1 Method is presented as Figure 4.1.

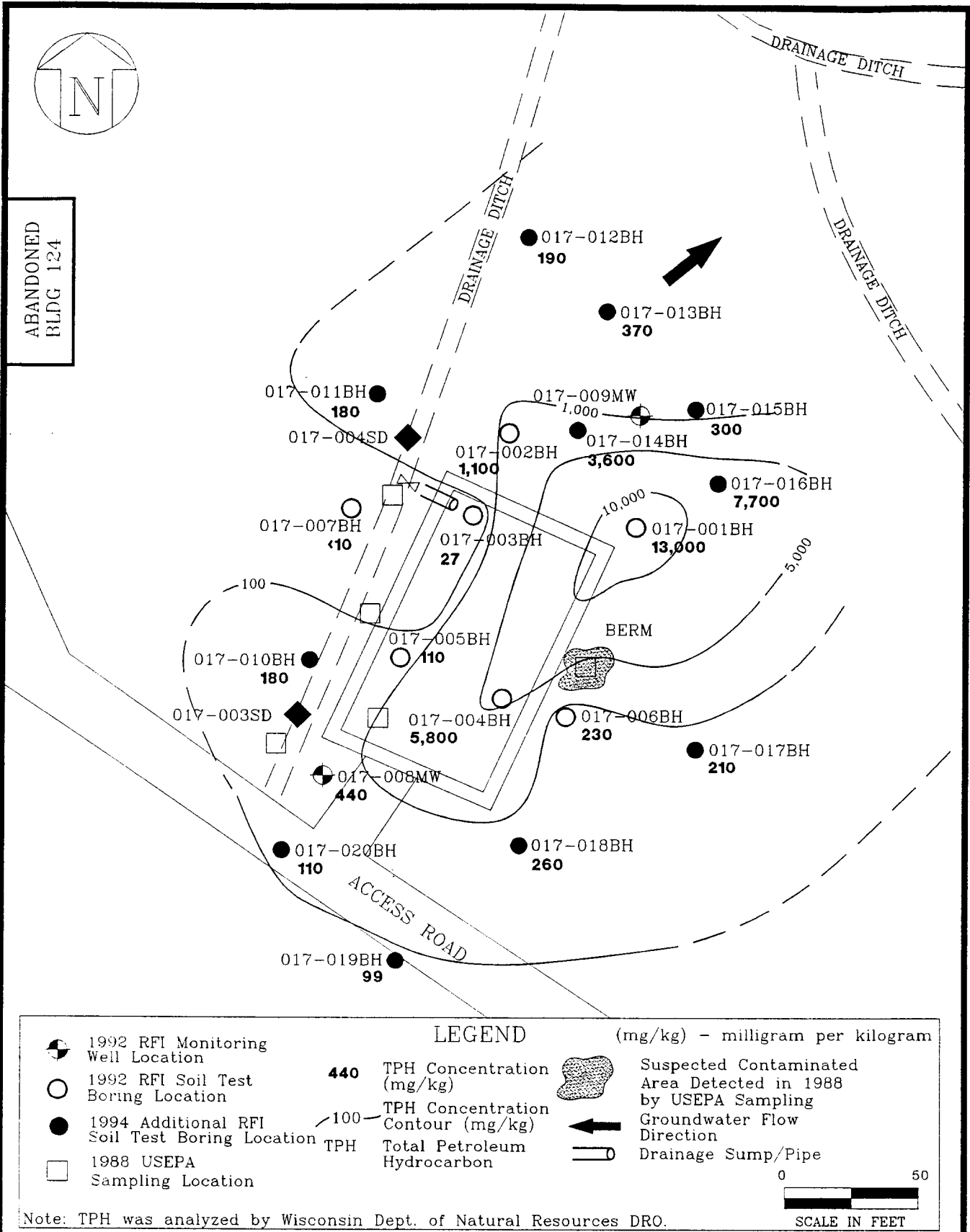


FIGURE 4.1

ISOCONCENTRATION MAP OF TPH
 CONCENTRATION AT VARIOUS DEPTHS
 AT IRP SITE NO.17
 Duluth Air National Guard Base
 Duluth, Minnesota

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Table 4.1
Summary of Semivolatile Organic Compounds
Detected in Soil Samples Collected from IRP Site No. 17 During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Analyte	Sample Location Number: Sample Depth (ft BLS):	017-011BH 1.5 - 2.0 (µg/kg)	017-013BH 1.5 - 2.0 (µg/kg)	017-013BH 9.0 - 9.5 (µg/kg)	017-018BH 1.5 - 2.0 (µg/kg)
Acenaphthene		1,000	330 U	330 U	330 U
Benzo(a)Anthracene		2,800	330 U	330 U	330 U
Benzo(b)Fluoranthene		330 U	420	330 U	330 U
Benzo(k)Fluoranthene		2,900	330 U	330 U	330 U
Benzo(a)Pyrene		3,100	330 U	330 U	330 U
Benzo(g,h,i)Perylene		2,000	330 U	330 U	330 U
di-n-Butylphthalate		330 U	330 U	330 U	330 U
Carbazole		870	330 U	430	330 U
Chrysene		3,600	330 U	330 U	330 U
Dibenzofuran		450	330 U	330 U	330 U
bis(2-Ethylhexyl)Phthalate		330 U	330 U	330 U	330 U
Fluoranthene		5,800	590	330 U	600
Indeno(1,2,3-cd)Pyrene		1,800	330 U	330 U	330 U
Naphthalene		400	330 U	330 U	330 U
Phenanthrene		4,900	390	330 U	470
Pyrene		4,900	640	330 U	460

U - Indicates compound analyzed for but not detected.
ft BLS - feet Below Land Surface.
BH - Borehole.

IRP - Installation Restoration Program.
µg/kg - micrograms per kilogram.

Bold Value - Indicates concentration that was above the method detection limit.

Table 4.2
Summary of Semivolatile Organic Compounds Detected in
Soil Samples Collected from IRP Site No. 17 During the May 1995 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location No.: Sample Depth (ft BLS): SVOCs	017-025BH 2' - 2.5' (µg/kg)	017-030BH 1.5' - 2' (µg/kg)	017-032BH 1.5' - 2' (µg/kg)
Benzo(a)Anthracene	3,300 U	640	660 U
Benzo(B)Fluoranthene	3,300 U	880	660 U
Benzo(k)Fluoranthene	3,300 U	380	660 U
Benzo(a)Pyrene	3,300 U	640	660 U
Benzo(g,h,i)Perylene	3,300 U	440	660 U
Chrysene	3,300 U	720	1,600 U
Fluoranthene	6,000	1,100	800
Indeno(1,2,3-cd)Pyrene	3,300 U	390	1,600 U
Phenanthrene	4,400	1,000	1,400
Pyrene	4,300	1,800	1,600

IRP - Installation Restoration Program.

U - Indicates compound analyzed for but not detected.

ft BLS - feet Below Land Surface.

BH - Borehole.

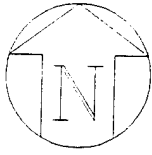
SVOCs - Semivolatile Organic Compounds.

µg/kg - micrograms per kilogram.

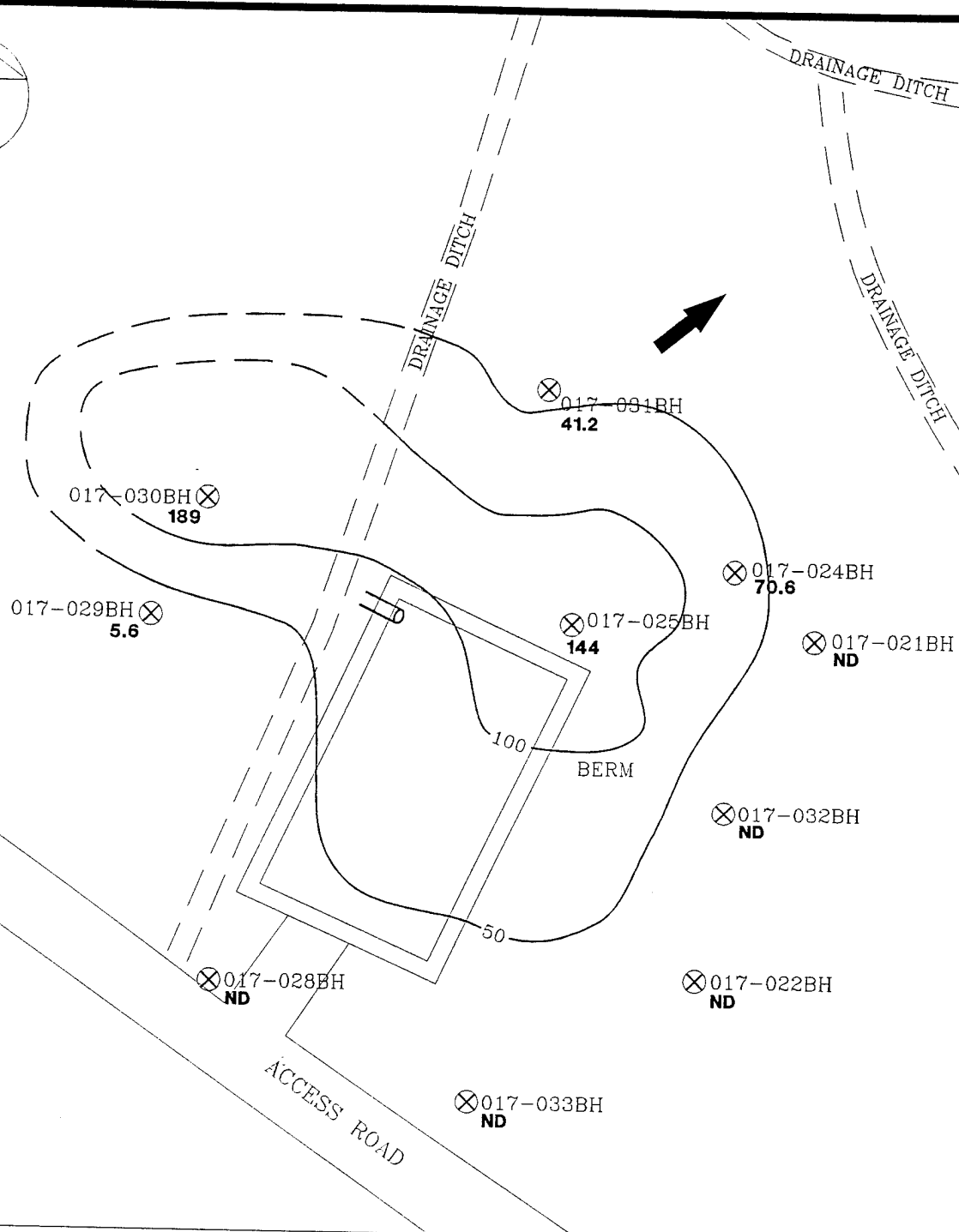
Bold Value - Indicates concentration that was above the method detection limit.

Because there is a high peat content at IRP Site No. 17, using USEPA Method 418.1 may give false positives for TPH since peat has a high organic content. The WDNR GRO/DRO Method determines concentrations of TPH representative of man-made petroleum products. An isoconcentration map of TPH DRO (WDNR DRO) is presented as Figure 4.2. USEPA Method 418.1, as opposed to WDNR methods for gasoline/diesel, varies in the methodology when viewing TPH ranges. USEPA Method 418.1 is primarily used as a screening method to identify group frequencies within the hydrocarbon range. Group frequencies often make it possible to establish the probable presence or absence of a given functional group. WDNR methods for gasoline/diesel can be utilized for reliable identification of the compound through the use of the gas chromatograph/mass spectrometer instrumentation. Compounds are referenced to and identified through a Mass Spectrometer Library for positive identification.

Similar formulated compounds of natural organics have often displayed interference or accumulated peaks in the frequency range that make it difficult to identify the range of compounds when utilizing USEPA Method 418.1 (Cross, 1964). USEPA Method 418.1 has had tendencies to reflect falsely high values when pure oils are analyzed. Also, lighter hydrocarbons will be reflected as higher values, while heavier hydrocarbons will have lower maximum results in the analyses depending on the matrix analyzed.

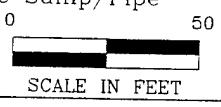


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- 100 — DRO Concentration Contour (mg/kg)
- ND Not Detected
- 189 DRO Concentration (mg/kg)
- TPH Total Petroleum Hydrocarbon
- Groundwater Flow Direction
- (mg/kg) — milligram per kilogram
- 1995 RFI Soil Test Boring Location
- Drainage Sump/Pipe



Note: TPH was analyzed by Wisconsin Dept. of Natural Resources DRO.

FIGURE 4.2

ISOCONCENTRATION MAP OF
TPH (DRO) AT VARIOUS DEPTHS
AT IRP SITE NO.17
Duluth Air National Guard Base
Duluth, Minnesota



SEPTEMBER 1995

DULUTH\DU4-1PLA

Table 4.3
Summary of Total Petroleum Hydrocarbons Detected in
Soil Samples Collected from IRP Site No. 17 (USEPA 418.1 Method)
During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS) (mg/kg)	Concentration (mg/kg)
017-010BH	0.5 - 1.0	180
017-010BH	5.0 - 5.5	36
017-010BH	5.0 - 5.5 DUP	22
017-011BH	1.5 - 2.0	180
017-011BH	5.0 - 5.5	25
017-012BH	2.0 - 2.5	190
017-012BH	5.0 - 5.5	13
017-013BH	1.5 - 2.0	275
017-013BH	5.0 - 5.5	370
017-013BH	9.0 - 9.5	34
017-014BH	1.5 - 2.0	3,600
017-014BH	5.0 - 5.5	350
017-014BH	5.0 - 5.5 DUP	49
017-014BH	9.0 - 9.5	17
017-015BH	2.0 - 2.5	300
017-015BH	5.5 - 6.0	110
017-015BH	9.5 - 10.0	22
017-016BH	1.5 - 2.0	7,700
017-016BH	5.0 - 5.5	270
017-016BH	9.0 - 9.5	22
017-017BH	2.0 - 2.5	140
017-017BH	5.0 - 5.5	210
017-017BH	9.0 - 9.5	110
017-018BH	1.5 - 2.0	260
017-018BH	5.0 - 5.5	250
017-018BH	5.0 - 5.5 DUP	27
017-018BH	9.0 - 9.5	12
017-019BH	2.0 - 2.5	99
017-019BH	9.0 - 9.5	14
017-020BH	1.5 - 2.0	24
017-020BH	5.0 - 5.5	110
017-020BH	9.0 - 9.5	29

ft BLS - feet Below Land Surface.
 BH - Borehole.
 DUP - Duplicate.

Bold Value - Indicates concentration that was above the method detection limit.
 mg/kg - milligrams per kilogram.

4.2 IRP SITE NO. 18 - HAZARDOUS WASTE STORAGE AREA, BUILDING 513

The results of the chemical analyses for the soil samples collected at IRP Site No. 18 during the Addendum 1 RFI are presented in this section. The analytical results for the soil samples collected at IRP Site No. 18 during the RFI are presented in the 1992 RFI Report (OpTech,

Table 4.4
Summary of Total Petroleum Hydrocarbons Detected in
Soil Samples Analyzed by WDNR GRO/DRO Methods for IRP Site No. 17
During the May 1995 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS)	DRO (mg/kg)
017-024BH	1.5 – 2.0	13.4
017-024BH	5.0 – 5.5	70.6
017-025BH	1.5 – 2.0	144.0
017-025BH	5.5 – 6.0	9.92
017-029BH	2.0 – 2.5	4.2
017-029BH	2.0 – 2.5	5.6
017-030BH	2.0 – 2.5	189.0
017-031BH	2.0 – 2.5	19.3
017-031BH	2.0 – 2.5	4.02
017-031BH	5.5 – 6.0	41.2

DRO – Diesel Range Organics.
ft BLS – feet Below Land Surface.
BH – Borehole.

U – Indicates compound analyzed for but not detected.

Bold Value – Indicates concentration that was above the method detection limit.
mg/kg – milligrams per kilogram.

1992). The analytical results from the 1992 RFI Report (OpTech, 1992) and Addendum 1 RFI are interpreted to determine the extent of contamination of the soil.

4.2.1 Source of Contamination

The suspected source area at IRP Site No. 18 is Building 513, an eight bay segregated ammunition storage building (Figure 2.2). This building was used for the storage of PCBs, pesticides, paints, solvents, adhesives, sealants, fuels, lubricants, oil, and antifreeze.

4.2.2 Soil Quality and Extent of Contamination

Four soil samples were collected from two soil borings during the Addendum 1 RFI. The locations of these soil borings are shown in Figure 2.2. These soil samples were analyzed for VOCs as listed in Table 2.5.

The VOC xylene was detected in a soil sample collected from the 2.1- to 2.5-foot interval at location 018-007BH with a concentration of 74 $\mu\text{g}/\text{kg}$. The location 018-007BH is located directly north of Building 513 approximately at the area of the suspected contamination determined by the USEPA sampling.

4.3 IRP SITE NO. 21 – IMHOFF TANK TREATMENT SYSTEM

The results of the chemical analyses for the soil, groundwater, and sediment samples collected at IRP Site No. 21 during the Addendum 1 RFI are presented in this section. The analytical results for the soil, groundwater, surface water and sediment samples collected at IRP Site No. 21 during the RFI are presented in the 1992 RFI Report (OpTech, 1992). The analytical results from the 1992 RFI Report (OpTech, 1992) and Addendum 1 RFI are interpreted to determine the extent of contamination of the soil, groundwater, and sediment.

4.3.1 Source of Contamination

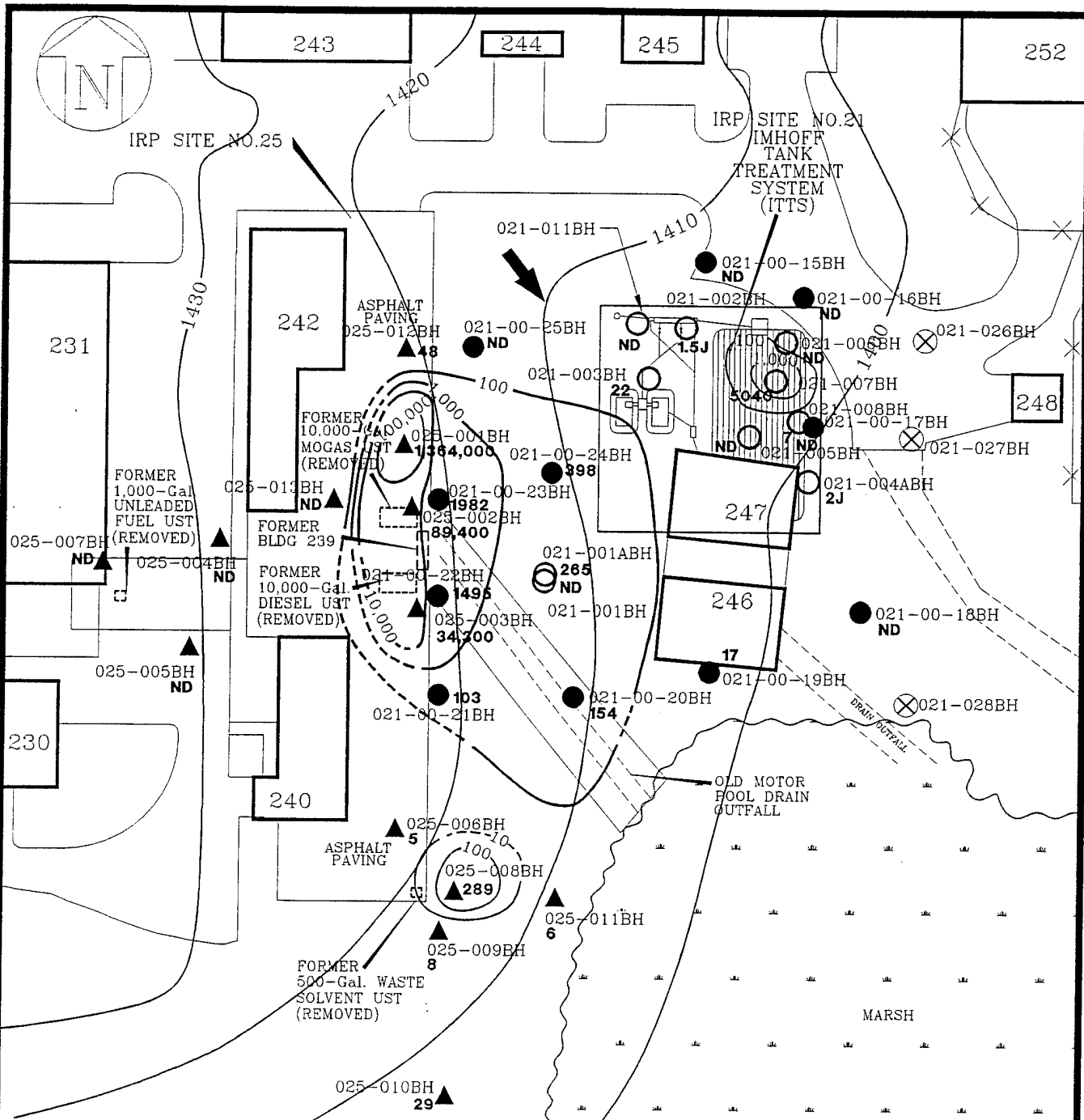
The suspected source area at IRP Site No. 21 is the Imhoff Tank Treatment System (ITTS) which provided primary and secondary sewage treatment for the industrial and administrative areas of the Base (Figure 2.3).

4.3.2 Soil Quality and Extent of Contamination

Thirty soil samples were collected from eleven soil borings during the 1994 sampling event. Six soil samples were collected from three soil borings during the 1995 sampling event. The locations of these soil borings are shown in Figure 2.3. Soil samples that were collected during the 1994 sampling event were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals as listed in Table 2.6. Soil samples that were collected during the 1995 sampling event were analyzed for TPH. A summary of analytes detected in soil samples collected from IRP Site No. 21 during the Addendum 1 RFI is presented in Tables 4.5 through 4.9.

Five VOCs, benzene, 1,2-dichloroethene (1,2-DCE), ethylbenzene, toluene, and xylenes (total), were detected in soil samples collected at IRP Site No. 21 (Table 4.5). The maximum benzene and 1,2-DCE concentrations were detected in the soil sample collected at the 14- to 14.5-foot interval from soil boring 021-023BH. Benzene was only detected in the soil samples collected upgradient from the ITTS. 1,2-DCE was also detected in soil samples collected in the ITTS area. BTEX contamination is migrating from IRP Site No. 25 (Old Motor Pool Area) which is located upgradient from IRP Site No. 21. An isoconcentration map of the area extent of BTEX contamination in soil is presented as Figure 4.3.

SVOCs, mostly PAHs, were detected in soil samples collected from IRP Site No. 21 (Table 4.6). PAHs were detected at concentrations ranging from 530 $\mu\text{g}/\text{kg}$ (indeno (1,2,2-cd)pyrene) to 14,000 (fluoranthene). The greatest concentrations of SVOCs were detected



SOURCE: ADDENDUM 1 TO RCRA FACILITY INVESTIGATION, OPTTECH 1994.

LEGEND

- | | | | |
|---------|---------------------------------------------------------------------------------------|---------------|-----------------------------------------------|
| ----- | DIRT ROAD | ⊗ | 1995 RFI SOIL TEST BORING LOCATION |
| ➔ | GROUNDWATER FLOW DIRECTION | ○ | 1992 RFI SOIL TEST BORING LOCATION |
| ~~~~~ | APPRX. MARSH BOUNDARY | ● | 1994 RFI ADDITIONAL SOIL TEST BORING LOCATION |
| ✕-✕-✕ | FENCE | ▲ | 1995 SOIL TEST BORING LOCATION |
| □ | BUILDING | 0 | 0 |
| ⊠ | UST (NOT TO SCALE) | 90 | 90 |
| —1420— | TOPOGRAPHIC CONTOUR LINE (ELEV. IN FT. ABV. NATIONAL GEODETIC VERTICAL DATUM OF 1929) | SCALE IN FEET | |
| —1,000— | BTEX CONCENTRATION CONTOUR (ug/kg) | | |
| J | ESTIMATED VALUE | | |
| ND | NOT DETECTED | | |

FIGURE 4.3

ISOCONCENTRATION MAP OF BTEX IN SOIL AT IRP SITE NO. 21/25

Duluth Air National Guard Base
Duluth, Minnesota

OPTTECH
OPERATIONAL TECHNOLOGIES CORPORATION

SEPTEMBER 1995

DULUTH\SI-2521

Table 4.5
Summary of Volatile Organic Compounds
Detected in Soil Samples Collected from IRP Site No. 21
During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS) ($\mu\text{g}/\text{kg}$)	Benzene ($\mu\text{g}/\text{kg}$)	1,2-Dichloroethene ($\mu\text{g}/\text{kg}$)	Ethylbenzene ($\mu\text{g}/\text{kg}$)	Toluene ($\mu\text{g}/\text{kg}$)	Xylenes (Total) ($\mu\text{g}/\text{kg}$)
021-019BH	10.0 - 10.5	17	5 U	5 U	5 U	5 U
021-019BH	14.0 - 14.5	8	5 U	5 U	5 U	5 U
021-020BH	6.0 - 6.5	140	5 U	5 U	14	5 U
021-021BH	14.0 - 14.5	47	5 U	8	19	34
021-022BH	11.0 - 11.5	120	5	130	500	740
021-022BH	14.0 - 14.5	79	5 U	5 U	6	18
021-023BH	11.0 - 11.5	170	33	9	33	33
021-023BH	11.0 - 11.5 DUP	630	39	5 U	5 U	5 U
021-023BH	14.0 - 14.5	1,100	52	110	350	370
021-024BH	10.0 - 10.5	640	5 U	21	8	5 U
021-024BH	16.0 - 16.5	330	7	61	5 U	5 U

U - Indicates compound analyzed for but not detected.

BH - Borehole.

ft BLS - feet Below Land Surface.

DUP - Duplicate.

IRP - Installation Restoration Program.

Bold Value - Indicates concentration that was above method detection limit.

$\mu\text{g}/\text{kg}$ - micrograms per kilogram.

Table 4.6
Summary of Semivolatile Organic Compounds
Detected in Soil Samples Collected from IRP Site No. 21
During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Number: Sample Depth (ft BLS): Compound	021-018BH 1.5 - 2.0 ($\mu\text{g}/\text{kg}$)	021-023BH 1.5 - 2.0 ($\mu\text{g}/\text{kg}$)
Acenaphthene	1,000	330 U
Anthracene	1,900	330 U
Benzo(a)Anthracene	6,400	690
Benzo(b)Fluoranthene	9,300	330 U
Benzo(k)Fluoranthene	4,800	1,200
Benzo(a)Pyrene	5,500	760
Benzo(g,h,i)Perylene	3,500	610
Carbazole	1,500	330 U
Chrysene	7,000	860
Fluoranthene	14,000	1,500
Fluorene	920	330 U
Indeno(1,2,3-cd)Pyrene	3,900	530
Phenanthrene	8,800	990
Pyrene	12,000	1,500

U - Indicates compound analyzed for but not detected.

BH - Borehole.

DUP - Duplicate.

$\mu\text{g}/\text{kg}$ - micrograms per kilogram.

ft BLS - feet Below Land Surface.

Bold Value - Indicates concentration that was done above method detection limit.

in the near-surface soil sample collected from soil boring 021-018BH. The pesticides aldrin and chlordane (technical) were detected in soil samples collected upgradient of the ITTS. A summary of the SVOCs detected in the soil samples collected from IRP Site No. 21 is presented in Figure 4.4.

Two pesticides, aldrin and chlordane (technical), were detected in the soil samples collected during the Addendum 1 RFI. Aldrin was detected in a soil sample collected from the 11- to 11.5-foot interval from location 021-022BH with a concentration of 1.3 $\mu\text{g}/\text{kg}$. Chlordane (technical) was detected in the soil sample collected from the 1.5- to 2-foot BLS interval from location 021-023BH with a concentration of 47 $\mu\text{g}/\text{kg}$. Both of these soil borings are located upgradient from the ITTS. No PCBs were detected in the soil samples collected during the Addendum 1 RFI. No pesticides/PCBs were detected in soil samples collected during the RFI (OpTech, 1992).

Nine metals were detected in the soil samples collected during the Addendum 1 RFI. The detected metals included aluminum, arsenic, beryllium, cadmium, chromium, copper, nickel,

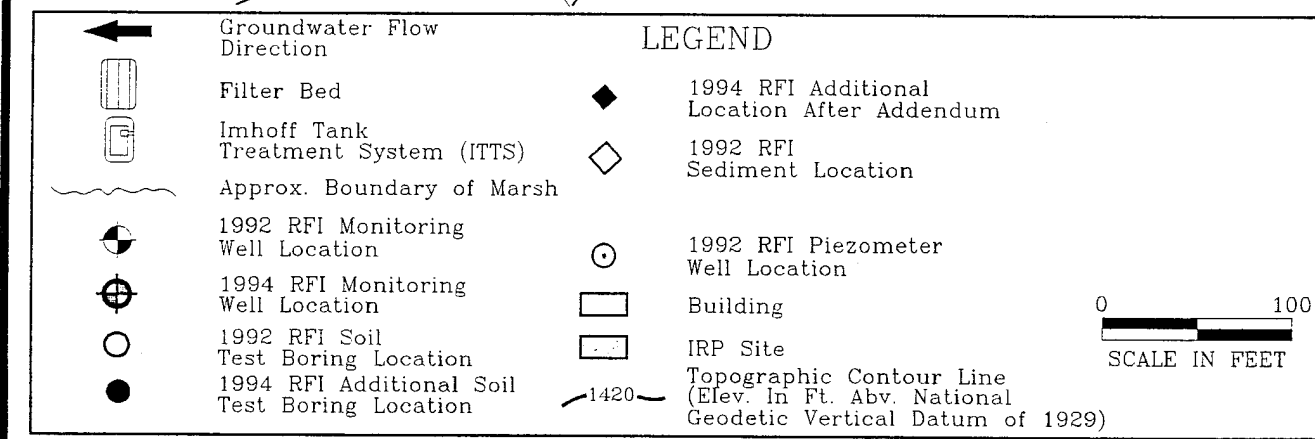
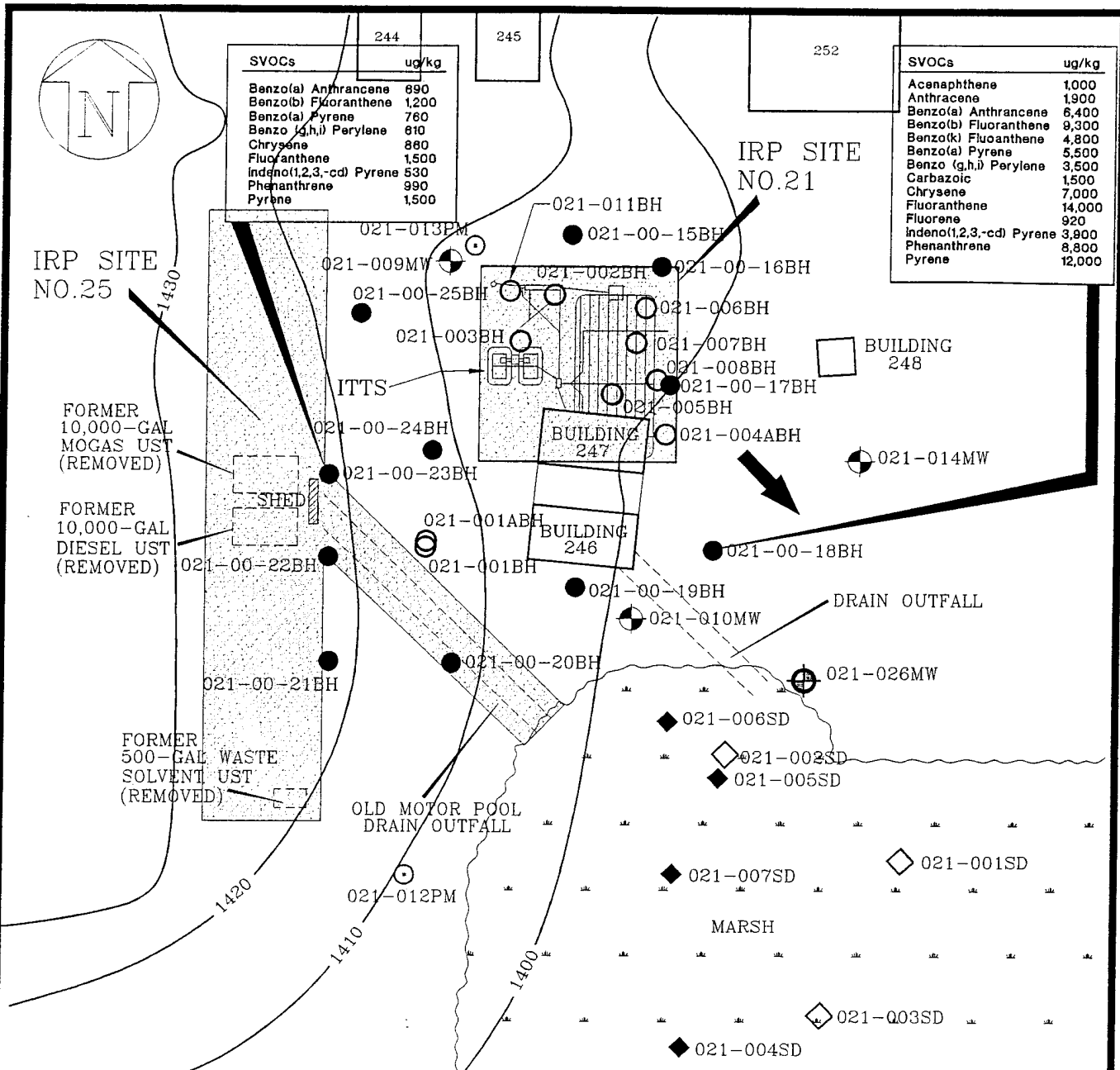


FIGURE 4.4
DULUTH\DU4-3

SVOCs DETECTED IN SOIL SAMPLES COLLECTED AT IRP SITE NO.21
Duluth Air National Guard Base
Duluth, Minnesota

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SEPTEMBER 1995

Table 4.7
Summary of Metals Detected in Soil Samples Collected from IRP Site No. 21
During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS)	Aluminum (mg/kg)	Arsenic (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
021-015BH	1.5 - 2.0	11,400	1	2 U	0.8 U	20	55.2	27	3.7	52
021-015BH	6.0 - 6.5	14,400	2	2 U	0.8 U	29	42.4	19	4.3	37
021-016BH	1.5 - 2.0	8,550	1 U	2 U	0.8 U	18	50.2	25	6.9	56
021-016BH	6.0 - 6.5	10,500	2	2 U	0.8 U	26	31.3	14	3.1	25
021-017BH	1.5 - 2.0	10,800	1 U	2 U	0.8 U	19	34.2	19	3.9	35
021-017BH	6.0 - 6.5	11,400	1	2 U	0.8 U	20	64.1	25	2.7	41
021-017BH	6.0 - 6.5 DUP	10,300	1	2 U	0.8 U	21	64.4	25	3.1	47
021-017BH	14.0 - 14.5	6,760	1 U	2 U	0.8 U	9	31.2	13	1.7	27
021-018BH	1.5 - 2.0	8,680	1 U	2 U	0.8 U	29	40.8	27	16	55
021-018BH	10.0 - 10.5	11,000	1	2 U	0.8 U	22	69.2	24	2.6	46
021-018BH	14.0 - 14.5	9,180	1	2 U	0.8 U	14	41.0	20	2.6	36
021-018BH	14.0 - 14.5 DUP	8,510	1 U	2 U	0.8 U	13	77.9	17	2.4	54
021-019BH	1.5 - 2.0	10,100	1	2 U	0.8 U	22	53.9	21	3.1	44
021-019BH	6.0 - 6.5	12,600	1	2 U	0.8 U	24	56.5	25	4.0	48
021-019BH	10.0 - 10.5	6,430	1 U	2 U	0.8 U	15	43.1	18	2.3	67
021-019BH	14.0 - 14.5	7,390	1 U	2 U	0.8 U	11	54.3	18	2.7	49
021-020BH	1.5 - 2.0	10,000	1 U	2 U	0.08	10	34.5	17	2.3	30
021-020BH	6.0 - 6.5	2,450	1 U	2 U	0.28	2.8	15.6	6	3.6	23
021-020BH	14.0 - 14.5	8,250	1 U	2 U	0.07	6	58.2	18	2.8	40
021-021BH	1.5 - 2.0	9,300	1	2 U	0.09	10	48.8	19	3.0	41
021-021BH	11.0 - 11.5	11,000	1	2 U	0.06	12	64.4	20	2.8	71
021-021BH	14.0 - 14.5	10,700	1	2 U	0.09	11	92.6	20	2.5	68
021-022BH	1.5 - 2.0	10,100	1	0.9	0.8 U	18	45	23	5.0	38
021-022BH	11.0 - 11.5	12,700	2	0.8	0.8	23	46	24	4.2	42
021-022BH	14.0 - 14.5	10,300	2	0.8	0.8 U	19	42	25	2.8	34
021-023BH	1.5 - 2.0	11,100	5 U	0.9	0.8 U	21	47	26	2.0	41
021-023BH	11.0 - 11.5	17,800	5 U	1.0	0.8 U	29	44	30	3.9	43
021-023BH	14.0 - 14.5	9,560	1 U	0.8	0.8 U	18	46	22	2.3	40
021-024BH	1.5 - 2.0	8,870	1	0.7	0.8 U	18	24	17	4.7	32
021-024BH	1.5 - 2.0	11,400	2	2 U	0.07	17	36.4	17	5.3	42
021-024BH	10.0 - 10.5	12,800	1 U	2 U	0.20	23	53.4	17	5.0	67
021-024BH	16.0 - 16.5	8,660	1 U	2 U	0.07	7	61.6	17	2.4	52
021-025BH	1.5 - 2.0	10,100	1	0.8	0.8 U	18	38	20	3.9	35
021-025BH	10.0 - 10.5	13,000	1	1.0	0.8 U	24	48	31	5.0	54
021-025BH	14.0 - 14.5	12,900	5 U	1.0	0.8 U	26	67	22	3.3	39

U - Indicates compound analyzed for but not detected.

BH - Borehole.

ft BLS - feet Below Land Surface.

IRP - Installation Restoration Program.

DUP - Duplicate.

mg/kg - milligrams per kilogram.

Bold Value - Indicates concentration that was above method detection limit.

Table 4.8
Summary of Total Petroleum Hydrocarbons Detected in
Soil Samples by WDNR GRO/DRO Methods for IRP Site No. 21
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS)	DRO (mg/kg)
021-026BH	2.0 – 2.5	88.0
021-026BH	9.0 – 9.5	8.70
021-027BH	2.0 – 2.5	27.70
021-027BH	8.0 – 9.0	29.10
021-028BH	1.5 – 2.0	0.0
021-028BH	5.5 – 6.0	6.61

DRO – Diesel Range Organics.

ft BLS – feet Below Land Surface.

Bold Value – Indicates concentration that was above method detection limit.

BH – Borehole.

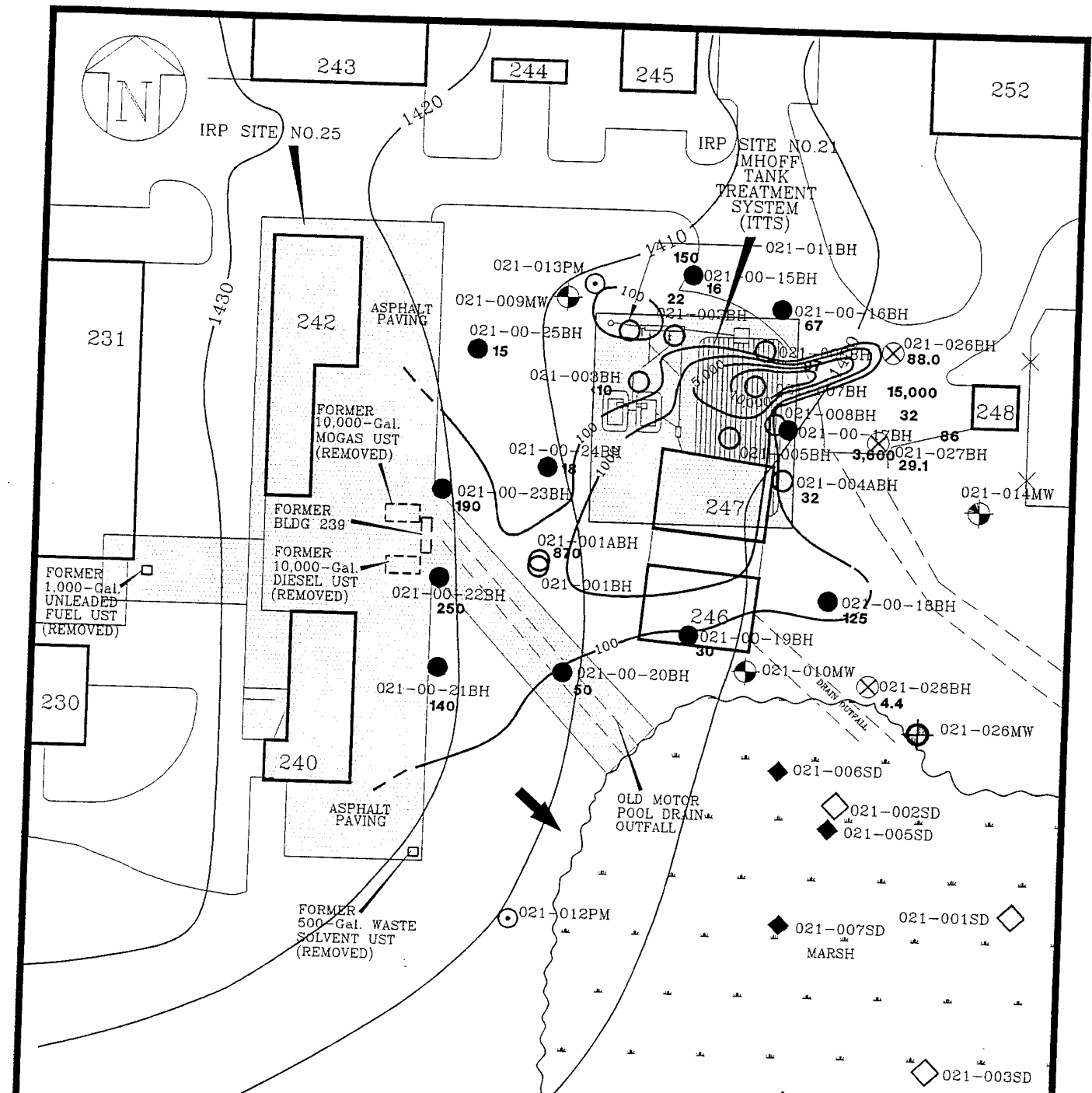
U – Indicates compound analyzed for but not detected.

mg/kg – milligrams per kilogram.

lead, and zinc (Table 4.7). The concentrations of arsenic, cadmium, chromium, and lead were less than the reported concentrations for soil samples collected during the RFI. The maximum concentrations of arsenic and lead were greater than maximum background concentrations of arsenic and lead in the soil at Duluth ANGB (Table 4.8). The concentrations of beryllium, copper, nickel, lead, and zinc are greater than mean background concentrations of soil of the Eastern U. S. but are within the observed range of background concentrations of soil in the Eastern U. S. (Table 4.8).

TPH (USEPA 418.1 Method) were detected at a maximum concentration of 15,000 mg/kg in the soil samples collected at IRP Site No. 21 during the 1992 and 1994 sampling events (Table 4.9). TPH (WDNR DRO) were detected at a maximum concentration of 88 mg/kg in soil samples collected during the 1995 sampling event (Table 4.10). An isoconcentration map for TPH is presented as Figure 4.5. Because there is a high content of organics in the soil at IRP Site No. 21, using the USEPA 418.1 Method may give false positives for TPH. The WDNR GRO/DRO Method determines concentrations of TPH representative of man-made petroleum products.

The greatest concentrations of lead were detected at depths deeper than 3 ft BLS in the soil boring that are located downgradient of ITTS (OpTech, 1992). Lead was detected at concentrations slightly greater than the background concentration of soil at Duluth ANG in soil sample collected from a location upgradient from the ITTS.



LEGEND

	Underground Storage Tank (Not To Scale)		1994 RFI Additional Location After Addendum		1992 RFI Surface Sediment Location
	Dirt Road		Topographic Contour Line (Elev. in Ft. Abv. National Geodetic Vertical Datum Of 1929)		1995 RFI Soil Test Boring Location
	Groundwater Flow Direction		1420		1992 RFI Soil Test Boring Location
	Apprx. Marsh Boundary		100		1994 RFI Additional Soil Test Boring Location
	IRP Site		TPH Concentration Contour (mg/kg)		1992 RFI Monitoring Well Location
	Fence		(mg/kg) Miligrams per Kilogram		1994 RFI Monitoring Well Location
	Building		TPH Total Petroleum Hydrocarbon TPH Concentration (mg/kg)		0
			250		90
			1992 RFI Piezometer Well Location		SCALE IN FEET

FIGURE 4.5

DULUTH SITE 2521

ISOCONCENTRATION OF TPH CONCENTRATION AT VARIOUS DEPTHS AT IRP SITE NO.21

Duluth Air National Guard Base
Duluth, Minnesota

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SEPTEMBER 1995

Table 4.9
Summary of Total Petroleum Hydrocarbons Detected in
Soil Samples Collected from IRP Site No. 21 (USEPA 418.1 Method)
During the July 1994 Investigation
Duluth Air National Guard Base, Duluth, Minnesota

Sample Location Number	Sample Depth (ft BLS)	Concentration (mg/kg)
021-015BH	1.5 - 2.0	16
021-015BH	6.0 - 6.5	15
021-016BH	1.5 - 2.0	67
021-017BH	1.5 - 2.0	86
021-017BH	6.0 - 6.5	14
021-017BH	14.0 - 14.5	22
021-018BH	1.5 - 2.0	125
021-018BH	10.0 - 10.5	15
021-018BH	14.0 - 14.5	28
021-018BH	14.0 - 14.5 DUP	13
021-019BH	1.5 - 2.0	25
021-019BH	6.0 - 6.5	30
021-019BH	10.0 - 10.5	20
021-019BH	14.0 - 14.5	22
021-020BH	1.5 - 2.0	13
021-020BH	6.0 - 6.5	50
021-020BH	14.0 - 14.5	21
021-021BH	1.5 - 2.0	140
021-021BH	11.0 - 11.5	21
021-022BH	1.5 - 2.0	250
021-022BH	11.0 - 11.5	13
021-023BH	1.5 - 2.0	190
021-023BH	11.0 - 11.5 DUP	12
021-023BH	14.0 - 14.5	18
021-024BH	1.5 - 2.0	14
021-024BH	10.0 - 10.5	18
021-025BH	1.5 - 2.0	15
021-025BH	10.0 - 10.5	15
021-025BH	14.0 - 14.5	15

IRP - Installation Restoration Program.
 BH - Borehole.
 DUP - Duplicate.
 ft BLS - feet Below Land Surface.

mg/kg - milligrams per kilogram.
Bold Value - Indicates concentration that was above method detection limit.

4.3.3 Groundwater Quality and Extent of Contamination

Five groundwater samples were collected from four monitor wells during the Addendum 1 RFI. The locations of these monitor wells are shown in Figure 2.3. These groundwater samples were analyzed for VOCs and metals as listed in Table 2.7. A summary of analytes detected in groundwater samples collected from IRP Site No. 21 during the Addendum 1 RFI is presented in Table 4.11.

Table 4.10
Summary of Background Concentrations of Metals in Soil
Duluth Air National Guard Base, Duluth, Minnesota

Metals (mg/kg)	Observed Range of Background Concentrations of Soil in Eastern U. S. ¹	Mean Background Concentrations of Soil in Eastern U. S. ¹	Maximum Background Concentrations of Soil at Duluth ANGB ²	Background Concentration of Sediment at Duluth ANGB ²
Aluminum	7,000 - > 100,000	33,000	-	-
Arsenic	< 0.1 - 73	4.8	< 1	< 1
Beryllium	< 1 - 7	0.55	-	-
Cadmium	-	-	13.6	0.8
Chromium	1 - 1,000	33	46.8	16.3
Copper	< 1 - 700	13	-	-
Nickel	< 5 - 700	11	-	-
Lead	< 10 - 300	14	16.6	4.8
Zinc	< 5 - 2,900	40	-	-

ANGB - Air National Guard Base.
 mg/kg - milligrams per kilogram.

¹Shacklette, Hansford T. and Boerngen, Josephine G., 1984. Element Concentrations in Soil and Other Surficial Materials of the Conterminous United States; U. S. Geological Survey Professional Paper 1270; Washington, D. C.

U. S. - United States.

²Engineering - Science, Inc., 1990. Remedial Investigation Report, Minnesota Air National Guard Base, Duluth International Airport, Duluth, Minnesota; Oak Ridge, Tennessee, January.

Table 4.11
 Analytes Detected in Groundwater Samples Collected at IRP Site No. 21
 Duluth Air National Guard Base, Duluth, Minnesota

Analyte	021-009MW			021-010MW			021-014MW			021-026MW		ARAR
	March 1992	April 1992	July 1994	March 1992	April 1992	July 1994	March 1992	April 1992	July 1994	July 1994	October 1994	
VOCs (µg/L)												
1,2-Dichloroethene (total)	U	U	U	U	U	U	3	2	U	U	U	4 (HRL)
Tetrachloroethene	U	U	U	U	U	U	3	U	U	U	U	5 (MCL)
Trichloroethene	U	U	U	U	U	U	62	45	68	U	U	5 (MCL)
Xylenes (total)	U	U	U	U	2	U	U	U	U	U	U	10,000 (HRL)
SVOCs (µg/L)												
Benzoic Acid	U	I	NA	U	II	NA	U	U	NA	NA	NA	30,000 (HRL)
Phenol	2	U	NA	U	U	NA	U	U	NA	NA	NA	4,000 (HRL)
Phenanthrene	U	U	NA	U	U	NA	U	2	NA	NA	NA	NA
Fluoranthene	U	U	NA	U	U	NA	U	2	NA	NA	NA	300 (HRL)
Pyrene	U	U	NA	U	U	NA	U	2	NA	NA	NA	200 (HRL)
Pesticides (µg/L)												
Heptachlor	U	U	NA	U	U	NA	U	0.077	NA	NA	NA	0.08 (HRL)
Metals (µg/L)												
Aluminum	5,730	4,500	1,060	4,490	1,180	3,000	32,500	16,300	17,100	17,100	2,960	1,300
Barium	177.00	203.00	NA	170.00 B	128.00 B	NA	779.00	870.00	NA	NA	NA	NA
Cadmium	U	U	0.2	NA	NA	0.2	U	U	0.3	0.4	0.2	0.2
Chromium	8.40 B	9.40 B	24	10.40	3.30 B	4	43.00	46.90	25	4	3	4 (HRL)
Copper	38.70	37.50	20	30	8.40 B	20	384	273	170	30	20	100 (HRL)
Lead	4.60	7.20	U	6.70	9.10	U	26.80	15.10	U	U	U	100 (MCL)
Mercury	0.28	U	U	0.29	U	U	0.32	U	U	U	U	15 (MCL) (1)
Nickel	18.80 B	23.90 B	620	53.5	24.3 B	12	119	75.10	51	9	U	2 (MCL)
Zinc	30	NA	30	26	U	20	120	64.1	70	20	20	100 (HRL)
												NA

Source: OpTech, 1992.

ARAR - Applicable or Relevant and Appropriate Requirement.

HRL - Health Risk Limits (Minnesota Department of Health, 1994).

MCL - Maximum Contaminant Levels (Federal Drinking Regulations and Health Advisories, 1992).

MW - Monitor Well.

VOCs - Volatile Organic Compounds.

µg/L - micrograms per liter.

U - Analyte was analyzed for but was not detected.

NA - Not Available.

B - Indicated a concentration less than the contract required detection limit but greater than or equal to the instrument detection limit.

Bold Value - Indicates concentration that was above method detection limit.

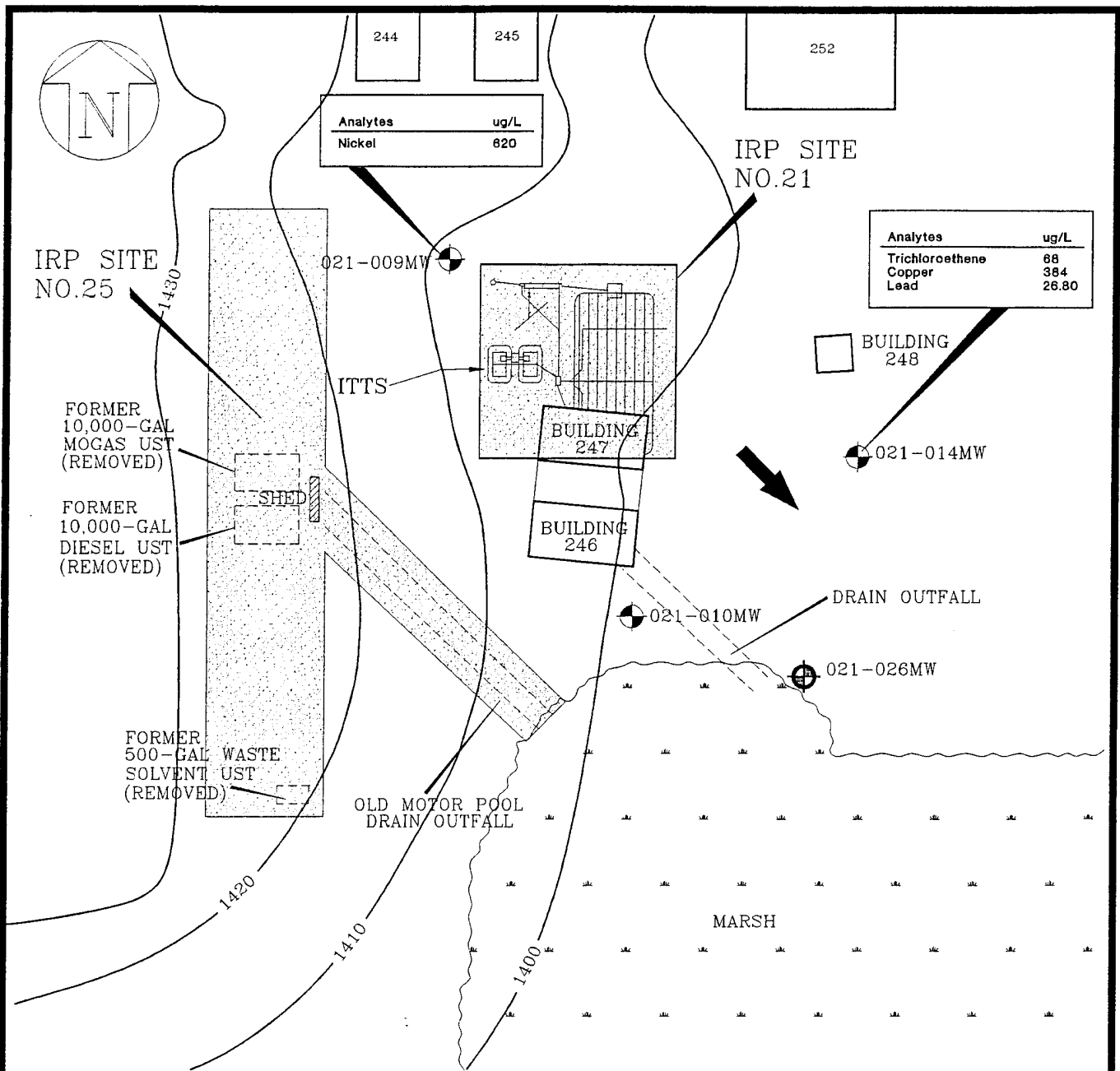
The VOC trichloroethene (TCE) was detected at a concentration of 68 micrograms per liter ($\mu\text{g/L}$) in the groundwater sample collected from monitor well 021-014MW during the Addendum 1 RFI (Figure 4.6). TCE was detected with a maximum concentration of 62 $\mu\text{g/L}$ in a groundwater sample collected from monitor well 021-014MW during the RFI (OpTech, 1992). Also VOCs 1,2-dichloroethene (1,2-DCE) and tetrachloroethene (PCE) were detected at concentrations of 3 $\mu\text{g/L}$ in a groundwater samples collected from monitor well 021-014MW in March 1992 during the RFI. No VOCs were detected in the groundwater samples collected from the monitor well 021-026MW, installed during the Addendum 1 RFI to fully define the groundwater contamination plume.

Six metals, aluminum, cadmium, chromium, copper, nickel, and zinc were detected in the groundwater samples collected during the Addendum 1 RFI (Table 4.11). Nickel was detected at 620 $\mu\text{g/L}$ in the groundwater sample collected from monitor well 021-009MW exceeding the Minnesota Department of Health Health Risk Limit (HRL) for drinking water of 100 $\mu\text{g/L}$. Lead and copper were detected with concentrations of 26.80 $\mu\text{g/L}$ and 384 $\mu\text{g/L}$, respectively, exceeding the Federal Maximum Contaminant Levels (MCLs) for drinking water of 15 $\mu\text{g/L}$ and 100 $\mu\text{g/L}$, respectively, in the groundwater sample collected from the monitor well 021-014MW during the RFI (OpTech, 1992). Lead was not detected in the groundwater sample collected from this monitor well during the Addendum 1 RFI.

TCE was detected with a maximum concentration of 68 $\mu\text{g/L}$ exceeding the MCL of 5 $\mu\text{g/L}$. TCE was not detected in the groundwater samples collected from monitor wells upgradient and downgradient of monitor well 021-014MW. TCE contamination is limited to the area surrounding monitor well 021-014MW. A summary of the analytes detected above ARARs in the groundwater samples is presented in Figure 4.6.

4.3.4 Sediment Quality and Extent of Contamination

Four sediment samples were collected from the swampy area located downgradient of the ITTS during the Addendum 1 RFI. The locations of these sediment locations are shown in Figure 2.3. These sediment samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals as listed in Table 2.7. A summary of analytes detected in sediment samples collected from IRP Site No. 21 during the Addendum 1 RFI is presented in Table 4.12. Summaries of the analytes detected in sediment samples collected in the marshy area downgradient from IRP Site No. 21 are presented in Figures 4.7 and 4.8.



LEGEND

- ← Groundwater Flow Direction
- Filter Bed
- Imhoff Tank Treatment System (ITTS)
- Approx. Boundary of Marsh
- 1992 RFI Monitoring Well Location
- 1994 RFI Monitoring Well Location
- Building
- IRP Site
- Topographic Contour Line (Elev. in Ft. Abv. National Geodetic Vertical Datum of 1929)

0 100
SCALE IN FEET

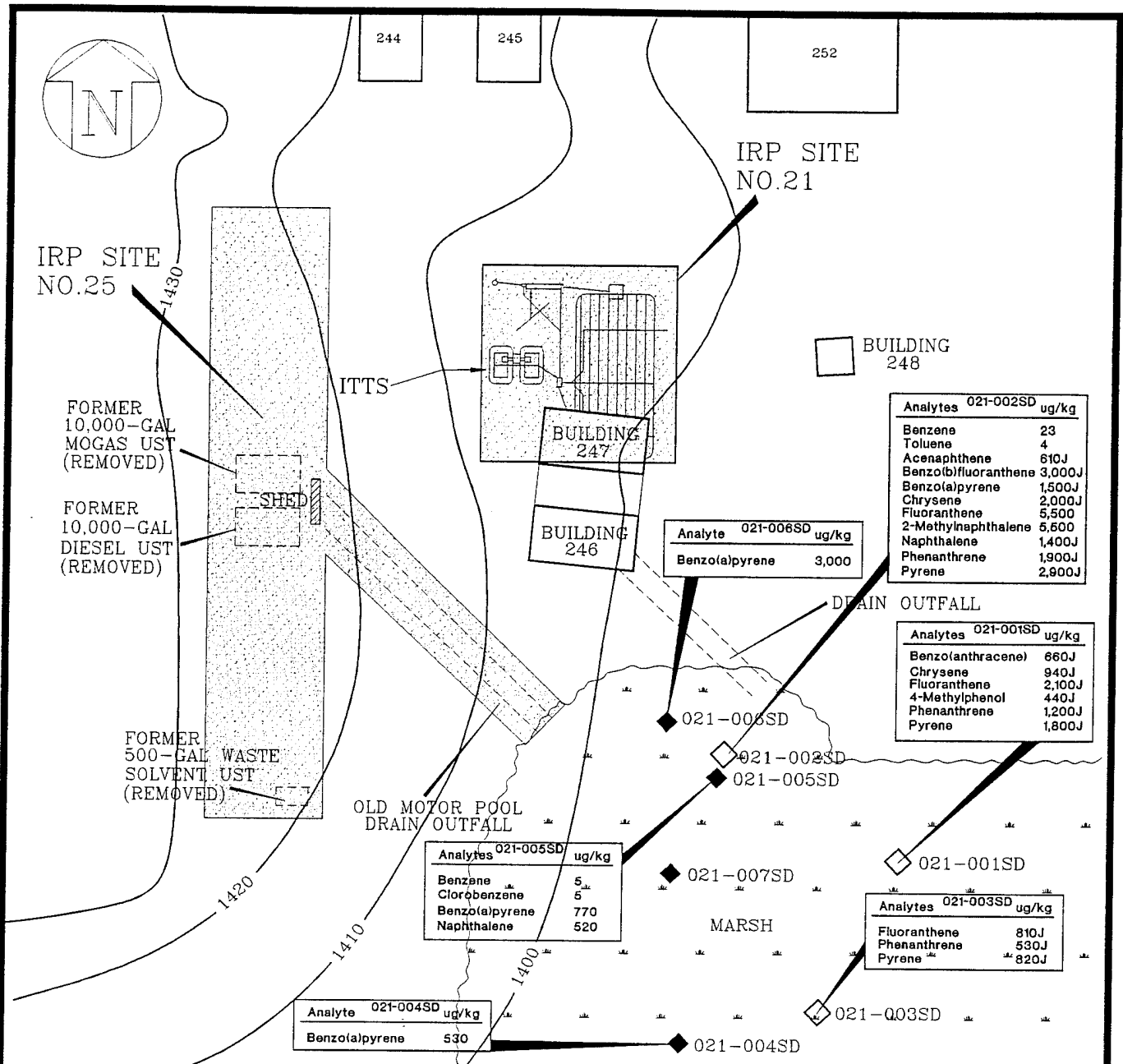
FIGURE 4.6

ANALYTES DETECTED ABOVE ARARs
IN GROUNDWATER SAMPLES
AT IRP SITE NO. 21
Duluth Air National Guard Base
Duluth, Minnesota

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DULUTH\DU4-3



LEGEND

- Filter Bed
- Imhoff Tank Treatment System (ITTS)
- Approx. Boundary of Marsh
- 1994 RFI Additional Location After Addendum
- 1992 RFI Sediment Location
- Estimated Value Less Than Detection Limit
- Building
- IRP Site
- Topographic Contour Line (Elev. In Ft. Abv. National Geodetic Vertical Datum of 1929)

0 100
SCALE IN FEET

FIGURE 4.7

DULUTH\DU4-3

**VOCs AND SVOCs DETECTED
IN SEDIMENT SAMPLES COLLECTED
AT IRP SITE NO.21**
Duluth Air National Guard Base
Duluth, Minnesota

Table 4.12
 Analytes Detected in Sediment Samples Collected at IRP Site No. 21
 Duluth Air National Guard Base, Duluth, Minnesota

Analyte	021-001SD			021-002SD			021-003SD			021-004SD	021-005SD	021-006SD	021-007SD
	March 1992	April 1992	March 1992	April 1992	March 1992	April 1992	March 1992	April 1992	October 1994	October 1994	October 1994	October 1994	
VOCs (µg/kg)													
Benzene	U	U	9	23	U	U	U	U	U	5	U	U	
Chlorobenzene	U	U	U	U	U	U	U	U	U	5	U	U	
Tetrachloroethene	U	U	8	U	U	U	U	U	U	U	U	U	
Toluene	U	U	6	4	U	U	U	U	U	U	U	U	
SVOCs (µg/kg)													
Acenaphthene	U	U	U	610 J	U	U	U	U	U	U	U	U	
Benzo(a)anthracene	U	660 J	470 J	U	160 J	U	U	U	U	U	U	U	
Benzo(b)fluoranthene	U	U	890 J	3,000 J	U	U	U	U	U	U	U	U	
Benzo(g,h,i)perylene	U	U	540 J	U	U	U	U	U	U	U	U	U	
Benzo(a)pyrene	38 J	U	740 J	1,500 J	170 J	U	U	U	U	U	U	U	
Chrysene	50 J	940 J	710 J	2,000 J	U	U	U	U	530	770	3,000	U	
Fluoranthene	90 J	2,100 J	2,200	5,500	430 J	U	U	U	U	U	U	U	
Indeno(1,2,3-cd)pyrene	7 U	U	550 J	U	U	U	U	U	U	U	U	U	
2-Methylnaphthalene	U	U	1,300	5,500	U	U	U	U	U	U	U	U	
4-Methylphenol	U	440 J	U	U	U	U	U	U	U	U	U	U	
Naphthalene	U	U	400 J	1,400 J	U	U	U	U	U	520	U	U	
Phenanthrene	44 J	1,200 J	600 J	1,900 J	220 J	530 J	U	U	U	U	U	U	
Pyrene	87 J	1,800 J	1,200	2,900 J	360 J	820 J	U	U	U	U	U	U	
Pesticides/PCBs (µg/kg)													
4,4'-DDD	U	U	120	U	U	U	U	U	U	U	U	U	

Table 4.12 (Concluded)
Analytes Detected in Sediment Samples Collected at IRP Site No. 21
Duluth Air National Guard Base, Duluth, Minnesota

Analyte	021-001SD		021-002SD		021-003SD		021-004SD	021-005SD	021-006SD	021-007SD
	March 1992	April 1992	March 1992	April 1992	March 1992	April 1992	October 1994	October 1994	October 1994	October 1994
Metals (mg/kg)										
Aluminum	10,200	10,800	25,500	15,300	20,000	14,800	1,870	11,000	9,070	4,800
Arsenic	U	6.70 B	7.80	8.30	U	6.30 B	U	U	5	2
Barium	288.00 B	147.00 B	258.00	169.00	258.00	230.00	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	U	0.6	0.7	U
Cadmium	3.20 B	2.40 B	14.60	18.60	U	U	1.1	1.3	U	1.3
Chromium	18.90	17.00	84.10	72.90	29.20	23.00	3	17	16	7
Copper	NA	NA	NA	NA	NA	NA	53	56	76	50
Nickel	U	U	63.80	43.50	U	U	U	16	14	9
Lead	60.70	84.20	406.00	952.00	58.90	144.00	5.5	26	36	7.5
Mercury	U	U	U	0.48	U	U	U	U	U	U
Zinc	154.00	103.00	573.00	563.00	157.00	112.00	48	70	135	53
TPH (mg/kg)										
TPH	15	14	3,500	550	12	14	450	230	20	74

Source: OpTech, 1992.

IRP - Installation Restoration Program.

SD - Sediment.

VOCs - Volatile Organic Compounds.

SVOCs - Semivolatile Organic Compounds.

PCBs - Polychlorinated Biphenyls.

NA - Not Analyzed.

µg/kg - micrograms per kilogram.

U - Analyte was analyzed for but was not detected.

J - Indicated an estimated value less than the detection limit.

mg/kg - milligrams per kilogram.

TPH - Total Petroleum Hydrocarbons.

B - Indicated a concentration less than the contract required detection limit but greater than or equal to the instrument detection limit.

Bold Value - Indicated concentration that was above method detection limit.

Two VOCs, benzene and chlorobenzene, were detected in the sediment sample 021-005SD with a concentration of 5 $\mu\text{g}/\text{kg}$ (Table 4.12). The maximum concentration of benzene detected in sediment samples collected during the RFI was 23 $\mu\text{g}/\text{kg}$. This maximum concentration was detected from the sediment location 021-002SD which is located approximately 16 feet north of sediment location 021-005SD (Figure 4.7). Chlorobenzene was not detected in the sediment samples collected during the RFI.

Two SVOCs, benzo(a)pyrene and naphthalene, were detected in sediment samples collected during the Addendum 1 RFI with concentrations ranging from 530 to 3,000 $\mu\text{g}/\text{kg}$ and < 300 to 520 $\mu\text{g}/\text{kg}$, respectively (Table 4.12). The maximum concentrations of benzo(a)pyrene and naphthalene were detected in sediment samples collected from locations 021-006SD and 021-005SD, respectively. Both of these sediment sample locations are near sediment location 021-002SD which had elevated concentrations of PAH in samples collected during the RFI (Figure 4.7). Benzo(a)pyrene was detected with a concentration of 530 $\mu\text{g}/\text{kg}$ in sediment sample collected from location 021-004SD but was not detected in the sediment sample collected from the upgradient location 021-007SD (Figure 4.7).

No pesticides or PCBs were detected in the sediment samples collected during the Addendum 1 RFI (Table 4.12). The pesticide 4,4'-DDD was detected at 120 $\mu\text{g}/\text{kg}$ in the sediment sample collected at location 021-002SD during the RFI. No pesticides and PCBs were detected in the sediment samples collected in mid-April during the RFI (OpTech, 1992).

TPH were detected at concentrations ranging from 20 to 450 mg/kg in the sediment samples collected during the Addendum 1 RFI (Table 4.12). The maximum concentration was detected in the sediment sample collected from location 021-004SD (Figure 4.8). The maximum concentration of 3,500 mg/kg was detected in a sediment sample collected from location 021-002SD in late March during the 1992 RFI. TPH were detected at a concentration of 550 mg/kg in a sediment sample collected from the same location in mid-April. The sediment locations, 021-002SD and 021-005SD are located in an area suspected to be the outfall area for the ITTS (Figure 4.8).

Nine metals were detected in the sediment samples collected during the Addendum 1 RFI. The detected metals included aluminum, arsenic, beryllium, cadmium, chromium, copper, nickel, lead, and zinc (Table 4.12). The concentrations of arsenic, cadmium, chromium, and lead were less than the reported concentrations for sediment samples collected during the RFI. The maximum concentrations of arsenic, cadmium, chromium, and lead were greater than maximum background concentrations of sediment at Duluth ANGB (Table 4.8). The concentrations of

arsenic, beryllium, copper, nickel, lead, and zinc are greater than mean background concentrations of soil of Eastern U. S. but within the observed range of background concentrations of soil in the Eastern U. S. (Table 4.8).

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SECTION 5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Conclusions based on the RFI are reported in the 1992 RFI Report (OpTech, 1992). Conclusions based on the Addendum 1 RFI are reported as followed:

5.1.1 IRP Site No. 17 – Base Supply/DRMO Storage Area

- SVOCs, mostly PAH, were detected at concentrations less than the maximum concentrations utilized in the risk assessment.
- TPH DRO were detected at concentrations of 144 mg/kg and 189 mg/kg in near-surface soil samples collected from soil borings. Concentrations were less than concentrations reported in the 1992 RFI Report (OpTech, 1992).
- Because the concentrations of the contaminants did not exceed the maximum concentrations utilized in the risk assessment of the RFI, the chemical results have not altered the risk assessment performed for the RFI. Therefore, no carcinogenic or non-carcinogenic risks exist for each receptor at each pathway for VOCs, SVOCs, pesticides, and metals detected in the samples collected from each media.

5.1.2 IRP Site No. 18 – Hazardous Waste Storage Area, Building 513

- The VOC xylene was detected in one near-surface soil sample collected at IRP Site No. 18 with a concentration of 74 $\mu\text{g}/\text{kg}$. This soil sample was collected from the area of the suspected fuel-related contamination detected by the previous USEPA sampling. No non-carcinogenic risk exists for each receptor at each pathway for VOCs and metals detected in the samples collected from soil, surface water, sediment, and groundwater.

5.1.3 IRP Site No. 21 – Imhoff Tank Treatment System

- VOCs, SVOCs, TPH, pesticides, and metals were detected in the soil samples collected during the Addendum 1 RFI. The concentrations of SVOCs of one surface soil sample did exceed maximum concentrations reported in the 1992 RFI

Report. No SVOCs were detected in soil samples that were collected from soil boring locations surrounding the locations that had detected SVOCs reported in the 1992 RFI Report. The TPH concentrations were less than the maximum concentrations reported in the 1992 RFI Report (OpTech, 1992).

- The source of the BTEX contamination is IRP Site No. 25 (Old Motor Pool Area) which is located upgradient from IRP Site No. 21. The extent of SVOC contamination that is associated with IRP Site No. 21 is located in the nearby vicinity of the ITTS. The maximum TPH was detected at a concentration of 15,000 mg/kg from a soil sample collected from soil boring 021-007BH located in the area of the ITTS.
- TCE, copper and lead were detected in a groundwater sample collected from a monitor well located downgradient from the ITTS with concentrations of 68 $\mu\text{g/L}$, 384 $\mu\text{g/L}$, and 26.80 $\mu\text{g/L}$, respectively, exceeding the Federal MCLs of 5 $\mu\text{g/L}$, 100 $\mu\text{g/L}$, and 15 $\mu\text{g/L}$, respectively. Nickel was detected in a groundwater sample collected from a monitor well upgradient from the ITTS with a concentration of 620 $\mu\text{g/L}$ exceeding the Federal MCL of 100 $\mu\text{g/L}$.
- Benzene, SVOCs, TPH, and metals were detected in the sediment samples collected from the swampy area downgradient of ITTS. The concentrations of these constituents were less than concentrations reported in the 1992 RFI Report (OpTech, 1992).
- Because the concentrations of the contaminants did not exceed the maximum concentrations utilized in the risk assessment of the RFI, the chemical results have not altered the risk assessment performed for the RFI. Therefore, no carcinogenic risk exists for each receptor at each pathway for VOCs, pesticides, and metals detected in samples collected from each media. Slight non-carcinogenic risk exists only for children through ingestion of groundwater.

5.2 RECOMMENDATIONS

Recommendations based on the RFI conducted are reported in the 1992 RFI Report (OpTech, 1992). Recommendations based on the RFI and Addendum 1 RFI conducted are reported as follows:

5.2.1 IRP Site No. 17 – Base Supply/DRMO Storage Area

- No further action with institutional control as recommended in the Corrective Measures Study (CMS). The CMS will provide alternatives for remediation.

5.2.2 IRP Site No. 18 – Hazardous Waste Storage Area, Building 513

- No additional investigation is required for this site. This site will be included in the CMS as recommended by the MPCA. No further action with institutional control as recommended in the CMS.

5.2.3 IRP Site No. 21 – Imhoff Tank Treatment System

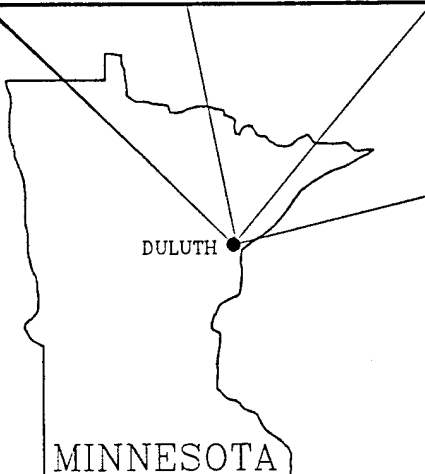
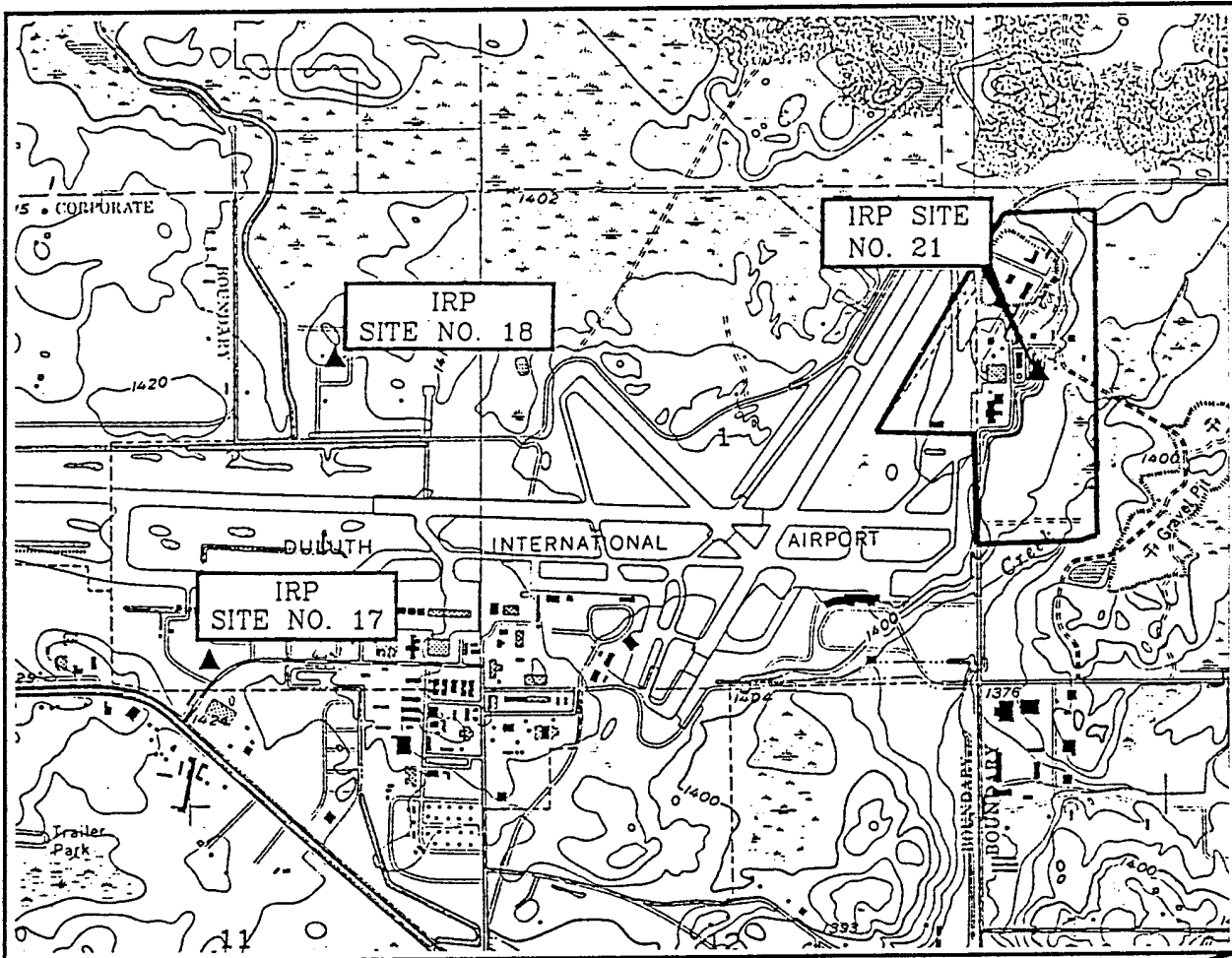
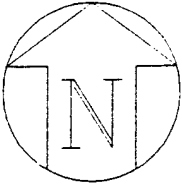
- Due to the close geographic proximity of IRP Sites No. 21 and No. 25, and due to the similar contamination existing at both sites, IRP Site No. 21 should be remediated concurrently with IRP Site No. 25.

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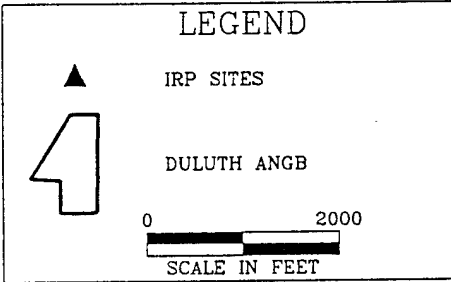
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DULUTH

MINNESOTA

SOURCE: USGS DULUTH HEIGHTS, MN
1:24,000 QUADRANGLE



INSIDE
FRONT
COVER

DULUTH/DU1-15TA

IRP SITES NO.17, NO.18,
AND NO.21 LOCATION MAP
Duluth Air National Guard Base
Duluth, Minnesota

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