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INSTALLATION RESTORATION PROGRAM

RI/FS REPORT

NIAGARA FALLS INTERNATIONAL AIRPORT

NIAGARA FALLS, NEW YORK

MAY 1991

INSTALLATION RESTORATION PROGRAM (IRP)

RI/FS

VOLUME I

Section 1 through 3

Niagara Falls International Airport
Niagara Falls, New York

Science Applications International Corporation (SAIC)
One Sears Drive
Paramus, New Jersey 07652

May 1991

Remedial Investigation/Feasibility Study
(RI/FS) Report 1987-1990

PREPARED FOR

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098-6001

UNITED STATES AIR FORCE
HUMAN SYSTEMS DIVISION (AFSC)
IRP PROGRAM OFFICE (HSD/YAQI)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

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EXECUTIVE SUMMARY

The executive summary is a brief synopsis for the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study (RI/FS) at Niagara Falls International Airport (IAP), Niagara Falls, New York, The Department of Defense (DoD) Installation Restoration Program was implemented to identify and evaluate environmental contamination and associated public health hazards at DoD facilities , and to eliminate any hazards that pose a threat to public health and environment.

Since the passage of the Superfund Amendments and Reauthorization Act (SARA) in October 1986, The United States Air Force (USAF) has aligned the IRP more closely with the U.S. Environmental Protection Agency's (EPA) Remedial Investigation/Feasibility Study (RI/FS) process. The RI/FS process replaced the historical four phases of the IRP, in order for RI and FS activities to be conducted concurrently.

A Phase I (Initial Assessment/Records Search) was conducted by Engineering Science (ES) for Niagara Falls International Airport (IAP) in 1983. The study utilized record searches and interviews with Base personnel to identify both inactive and active hazardous material management sites and assess the potential for environmental contamination and threats imposed by contaminant migration. The Phase I study identified thirteen sites as potentially having hazardous contaminant problems based on compilation of scores achieved using the USAF Hazard Assessment Rating Methodology (HARM). Of the thirteen sites identified, four were determined to have an insufficient potential to create environmental contamination and hence no follow-up investigation was recommended.

Science Applications International Corporation (SAIC) conducted a Phase II, Stage 1 field study between September 1984 to April 1986. The goals of the study were to determine the presence, magnitude, and potential migration of contaminants associated with past waste disposal practices. Twelve sites were identified for the specific study:

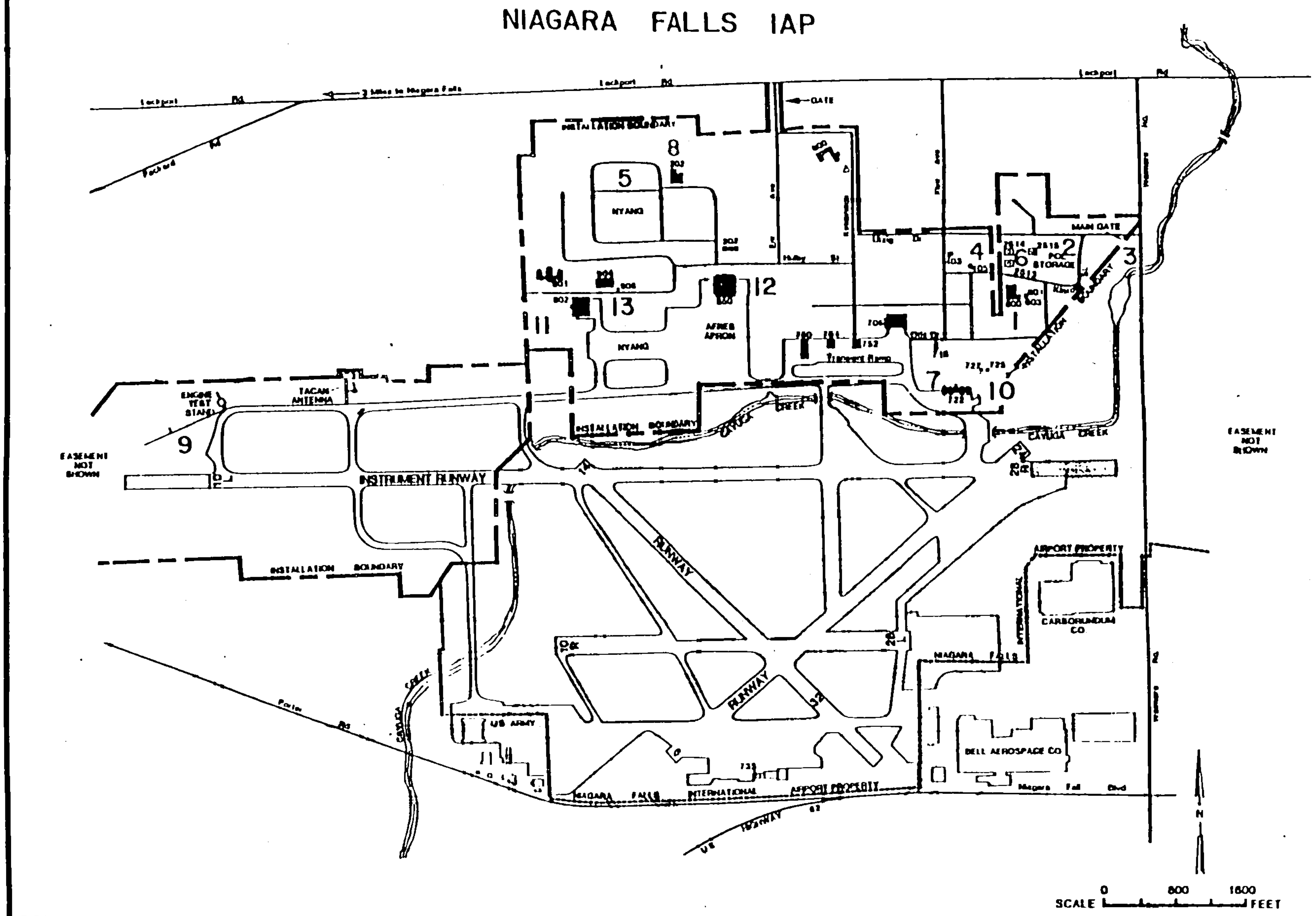
- Site 1 - Bldg. 600 JP-4 Pipeline Leak
- Site 2 - POL JP-4 Tank C
- Site 3 - Landfill
- Site 4 - BX MOGAS Tank Leak
- Site 5 - NYANG Hazardous Waste Drum Storage
- Site 6 - POL JP-4 Tank A
- Site 7 - JP-4 Tank A
- Site 8 - Bldg. 202 Drum Storage Yard
- Site 9 - Fire Training Facility No. 3
- Site 10 - Fire Training Facility No. 1
- Site 11 - Fire Training Facility No. 2
- Site 12 - Bldg. 850 Drum Storage Yard

A general summary of the results from the Phase II, Stage 1 follows:

- Potential contaminants were detected in groundwater samples at each of the 10 sites where monitoring wells were installed.
- Elevated concentrations of a number of parameters were detected in surface/sediment samples at five sites.
- Potential soil contamination was detected at each of four sites where sampling occurred.

Results from the Phase II, Stage 1 were only successful in determining the presence or absence of potential contamination at the sites investigated. Specific contaminants were not identified; therefore, there was not sufficient data on the extent of contamination migration form the sites.

The IRP RI/FS was conducted by SAIC as a follow-up and expanded investigation of the sites identified as likely contaminant sources during previous studies. The RI/FS investigated the 12 sites investigated under the Phase II, Stage 1 study, in addition to a new site, designated Site 13 - 4,000 Gallon Underground Storage Tank Pit. The location of these sites are shown in figure ES-1. Table ES-1 describes the sites and areas under this IRP RI/FS effort, including the RI activities conducted at each site during this study.



SOURCE: NIAGARA FALLS AFRF INSTALLATION DOCUMENTS

FIGURE ES-1. SITE LOCATIONS AT NIAGARA FALLS IAP

Table ES-1
Summa Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name		Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 1:	Building 600 JP-4 Pipeline Leak*	1969	Leak in underground JP-4 hydrant system saturated ground with JP-4; fuel appeared in surface drainage after heavy rains	o Conducted a 2-day soil gas survey at Site 1 (6 sampling points) o Performed headspace analyses on 14 groundwater samples and 6 soil samples o Drilled and installed 4 shallow monitoring wells and 2 deep monitoring wells o Drilled 6 soil borings o Collected 18 soil samples o Collected 20 groundwater samples from the 15 existing wells and the 5 new RI wells o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 2:	POL JP-4 Tank C*	1982	Approximately 9,000 gallons of JP-4 leaked from underground inlet and outlet pipes leading to Tank C; fuel appeared in stormwater drainage.	
SITE NO 4:	BX MOGAS Tank Leak*	1981	Undetermined amount of gasoline leaked from underground pipe, persisted for several weeks in storm sewers	
SITE NO 6:	POL JP-4 Tank A*	1979	An underground inlet pipe from Tank A leaked greater than 4,000 gallons of JP-4, due to pipe corrosion. The leak appeared at the ground surface inside the dike and in nearby storm-drains	

*Activities listed represent the collective effort at Sites No. 1, 2, 4 and 6.

[illegible] ES-1 (CONT'D)
Summa [illegible] Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name	Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 3: Landfill	1952-1969	A disposal site for construction rubble, trash, garbage, ash from coal stoves, waste oil, shop wastes, batteries, scrap electrical parts from Bell Aerospace, car parts, trash from the Navy station, Fort Niagara and Model City	o Drilled and installed 1 shallow monitoring well and 3 deep monitoring wells o Collected 10 groundwater samples from the 6 existing wells and the 4 new RI wells o Collected 3 surface water/sediment samples and took discharge measurements at the upstream point o Collected 7 soil samples o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 5: NYANG Hazardous Waste Drum Storage**	1983	Drums containing wastes from shop operations stored since 1983; visual evidence of spill migration to surface drainage.	o Conducted a maximum 1-day soil gas survey at Site 8 (13 sampling points) o Performed headspace analyses on 6 groundwater samples from existing wells o Drilled and installed 3 shallow monitoring wells and 4 deep monitoring wells o Collected 13 groundwater samples from the 6 existing wells and the 7 new RI wells. o Collected 3 surface water and 4 sediment samples and took discharge measurements at each point o Collected 8 soil samples o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 8: Building 202 Drum Storage Yard**	1978-1983	Drums containing waste oils and hazardous waste storage area. History of small spills evident	

**Activities listed at this site represent the combined effort at Sites No. 5 and 8

Table ES-1 (CONT'D)
Summa[illegible] Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name		Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 7:	JP-4 Tank Truck Spill	1983	Tank truck overturned; approximately 2,500 gallons of JP-4 unaccounted for after cleanup	o Performed headspace analyses on 3 groundwater samples from existing wells o Collected 3 groundwater samples from existing wells o Drilled 1 soil boring o Collected 3 soil samples o Groundwater level measurements taken from all existing monitoring wells
SITE NO 9:	Fire Training Facility No. 3	1963–1983	In operation from the early 1960's to present; burned JP-4 and possibly other combustible liquids (oils, solvent, etc.); runoff to Cayuga Creek evident	o Performed headspace analyses on 1 groundwater sample from existing wells and 3 soil samples o Drilled 1 soil boring o Collected 3 soil samples o Drilled and installed 3 shallow monitoring wells o Collected 4 soil samples o Collected 4 groundwater samples from the 1 existing well and the 3 new RI wells o Collected 3 surface water/sediment samples o Groundwater level measurements taken from all new RI and existing wells o Drilled and installed 2 shallow monitoring wells during additional RI effort o Collected 6 groundwater samples from the 1 Stage 1 well and the 5 RI wells during the additional RI effort

ES-1 (CONT'D)
Summa Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name	Date of Operation or Occurrence	Description	IRP RI Activities
SITE 10: : Fire Training Facility No. 1	1955–1963	Contaminated fuel (AVGAS) and other combustible liquids burned over a 5-year period	o Performed headspace analyses on 3 groundwater samples from existing wells o Drilled and installed 1 shallow monitoring well and 1 deep monitoring well o Collected 5 groundwater samples from the 3 existing wells and the 2 new RI wells o Collected 3 soil samples o Groundwater level measurements taken from all new RI and existing wells
SITE 11: : Fire Training Facility No. 2	early 1960's	Used approximately 10 times during 1 year; precautions were not taken for containing fuel prior to burning	
SITE 12: : Building 850 Drain Storage Yard	1950's – early 1960's	Drums of waste oil and hazardous waste from Bldg. 850 were stored in area. No significant spills were reported	o Drilled 2 soil borings o Collected 6 soil samples
SITE 13: : 4,000 Gallon Underground Tank Pit	1979–1983	A leak was discovered in the tank during removal and analyses performed on adjacent soils yielded organic contamination	o Drilled 2 soil borings o Collected 6 soil samples o Drilled and Installed 4 shallow monitoring wells o Collected 4 groundwater samples o Collected 7 soil samples o Groundwater level measurements taken from all new RI and existing wells o Collected 4 more groundwater samples during the additional RI effort

Table ES-2 summarized, for each site, the contaminant finds for each media, results form risk assessment findings, further investigation recommendations, and remedial recommendations.

TABLE ES-2
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.1 - Bldg. 600 JP-4-Pipeline Leak	Groundwater	<u>INORGANICS</u> o Al,As,Ba,Cr,Co, Fe,Cu,Pb,Mn,Ni,Ag, V and Zn detected but concentrations reported as Total Metals. <u>ORGANICS</u> o Benzene detected above ARAR in one well. o Toluene found below ARAR in one well.	5.69E-01 (Acceptable Range)	2E-05 (Acceptable Range)	Further remedial investigation is required to confirm or deny, and define the possible extent of, groundwater, contamination near this site. The details at the RI will be determined in a separate AF contract.	None at this time	Near downgradient monitoring wells could not be sampled. Unable to confirm or deny groundwater contamination near site.
	Soil	<u>ORGANICS</u> o Methylene Chloride and Acetone detected, but are probable laboratory contaminants.			None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
Site No.2 - POL JP-4 Tank C	Groundwater	<u>INORGANICS</u> o Al,Ba,Cu,Fe,Pb, Mn,Ni, and Zn detected, but concentrations reported as Total Metals <u>ORGANICS</u> o Benzene detected above ARAR in one well. o Toluene found below ARAR in one well.	9.99E-02 (Acceptable Range)	2E-08 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Soil	<u>ORGANICS</u> o Methylene Chloride and Acetone detected, but are probable laboratory contaminants.			None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.4 - BX Mogas Tank Leak Pipeline Leak	Groundwater	INORGANICS o Al,Ba,Co,Fe,Pb, Mn,Ni,V and Zn detected, but concentrations reported as Total Metals. ORGANICS o Benzene detected above ARAR in one well. o Ethylbenzene detected below ARAR in one well.	6.61E-01 (Acceptable Range)	5E-07 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Soil	ORGANICS o Acetone, Benzene, 2-Butanone, Ethyl-Benzene, Methylene Chloride and Total Xylenes detected.	1.[illegible]E-05 (Acceptable Range)	1E-09 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
Site No.6 - POL JP-4 Tank A	Groundwater	INORGANICS o Al,Ba,B,Cu,Fe,Pb, Mn,Ni, & Zn detected but concentrations reported as Total Metals ORGANICS o None	1.12E-01 (Acceptable Range)	None	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Soil	ORGANICS o Methylene chloride and Acetone detected, but are considered laboratory contaminants.			None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)

SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.3 - Landfill	Groundwater	INORGANICS o Al,As,B,Ba,Cd,Cr, Co,Cu,Fe,Pb,Mn,Hg, Mo,Ni,V and Zn detected, but concentrations reported as Total Metals. ORGANICS o Toluene detected below ARAR in two wells. o Vinyl Chloride detected above ARAR in 3 wells. o Benzene and Trichloroethene (TCE) detected above ARAR in one well. o Methylene Chloride detected, but probably is a laboratory contaminant.	9.98E-01 (Acceptable Range)	4E-05 (Acceptable Range)	None	Natural Attenuation With Long Term Monitoring	No contamination was found that would pose any risk to the public health or the environment.
	Soil	INORGANICS o Al,Ba,B,Be,Cd,Cr,Co Cu,Pb,Mn,Mo,Ni,V and Zn detected. ORGANICS o Methylene Chloride detected o Acetone detected but is considered a laboratory contaminant.	5.60E-03 (Acceptable Range)	E-08 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Surface Water	INORGANICS o Al,Ba,B,Fe,Mn,Mo,V and Zn detected, but concentrations reported as Total Metals. ORGANICS o Methylene Chloride detected, but is considered a laboratory contaminant.	NC	NC	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Sediment	INORGANICS o Al,Ba,B,Cd,Cr,Co,Cu, Pb,Mn,Mo,Ni,V and Zn detected ORGANICS o Methylene Chloride and Acetone detected, but are considered laboratory contaminants.	NC	NC	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)

SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS	INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
Site No.7 - JP-4 Tank Truck Spill	Groundwater	<u>INORGANICS</u> o Al,B,Ba,Cr,Co,Cu, Fe,Pb,Mn,Ni,V and Zn detected but concentrations reported as Total Metals. <u>ORGANICS</u> o Benzene detected above the ARAR in one well. o Toluene, Ethylbenzene and Total Xylenes detected below ARAR.	4.49E-00 (Unacceptable Range)	1E-05 (Acceptable Range)	Further Remedial Investigation is required to address levels of contamination found in the downgradient well. o Install additional downgradient monitoirng wells. o Sample all new and existing wells. o Conduct aquifer tests. o Investigate possible contamination along local under ground utilities.	None at this time	Benzene and total xylene contamination was found in MW7-3. Additional investigation is required to gather the data needed to complete a Feasibility Study.
	Soil	<u>INORGANICS</u> o NA <u>ORGANICS</u> o Methylene Chloride and Acetone detected but are considered laboratory contaminants. o Total Xylenes detected.	6.29E-08 (Acceptable Range)	None		No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)

SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 10 - Fire Training Area No. 1	Groundwater	INORGANICS o Al,Ba,Cr,Co,Cu, Fe,Pb,Mn,Mo,Ni,V and Zn detected, but concentrations reported as Total Metals. ORGANICS o Benzene and Trichloroethene detected above ARAR in 4 wells. o Vinyl Chloride detected above ARAR in 2 wells. o Total Xylenes, Toluene, Methylene Chloride, and Ethylbenzene detected below ARARs.	9.77E+00 (Unacceptable Range)	5E-04 (Unacceptable Range)	o Install three monitoring wells (one deep) downgradient of the site. o Sample the 5 existing and new wells o Prior to sampling, inspect new wells for free product. o Conduct aquifer tests on one downgradient well o Collect surface water/ sediment samples from drainage ditch.	o None at this time	Benzene and TCE contamination was found in three monitoring wells (10-2, 10-3, and 10-4). Additional investigation is requried to gather data needed to complete a Feasibility Study.
	Soil	INORGANICS o Al,Ba,Be,B,Cd,Cr,Co, Cu,Pb,Mn,Ni, V and Zn detected. ORGANICS o Trichloroethene and Acetone detected in soils from 2 well borings.	1.33E-02 (Acceptable Range)	5E-08 (Acceptable Range)		No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 3 - NYANG Hazardous Waste Drum Storage Area	Groundwater	<u>INORGANICS</u> o Al,Ba,B,Cr,Co,Cu,Fe, Pb,Mn,Ni,V and Zn detected, but concentrations reported as Total Metals. <u>ORGANICS</u> o Methylene Chloride and Acetone detected, but are considered to be laboratory contaminants. o Trichloroethene and Toluene detected below ARARs.	1.69+00 (Unacceptable Range)	4E-08 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Soil	<u>INORGANICS</u> o Al,Ba,Cr,Co,Cu,Pb,Mn, Ni,Sb,V and Zn detected. <u>ORGANICS</u> o Methylene Chloride and Acetone detected but are considered laboratory contaminants.	6.77E-03 (Acceptable Range)	6E-12 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 8 - Hazardous Waste Drum Storage Yard	Groundwater	<u>INORGANICS</u> o Al,As,Ba,B,Cd,Cr,Co, Cu,Fe,Pb,Mn,Hg,Mo, Ni;V and Zn detected, but concentrations reported as Total Metals. <u>ORGANICS</u> o Trichloroethene detected above ARAR in 2 wells. o 1,1,1-Trichloroethane, 1,1-Dichloroethane, Trans-1,2-dichloroethene, Dichlorodifluoromethane, 1,4-Dichlorobenzene, and Toluene detected below ARARs. o Methylene Chloride detected, but is considered a laboratory contaminant.	4.97E+00 (Unacceptable Range)	5E-05 (Acceptable Range)	o Install additional downgradient monitoring wells. o Sample all existing and new site wells. o Conduct aquifer tests.	o Some data gaps concerning the total extent of contamination and groundwater flow rates will be addressed during the remedial design or immediately prior to the design. o Implementation of subsurface drain groundwater extraction system and off-site treatment/disposal for TCE. Complete remediation is expected to occur in 12 years.	o Some data gaps concerning the total extent of contamination and groundwater flow rates will be addressed during the remedial design or immediately prior to the design.
	Soil (Ingestion & Inhalation for Base Personnel)	<u>INORGANICS</u> o Al,Ba,Cd,Cr,Co,Cu, Pb,Mn,Mo,Ni,V and Zn detected. <u>ORGANICS</u> o Methylene Chloride and Acetone detected but are considered laboratory contaminants	1.54E-02 (Acceptable Range)	2E-12 (Acceptable Range)		No Further Action	No contamination was found that would pose any risk to the public health or the environment.
	Soil (Ingestion & Inhalation for Visiting Children)	<u>INORGANICS</u> o Al,Ba,Cd,Cr,Co,Cu, Pb,Mn,Mo,Ni,V and Zn detected. <u>ORGANICS</u> o Methylene Chloride and Acetone detected but are considered laboratory contaminants	1.50E-01 (Acceptable Range)	2E-07 (Acceptable Range)		No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 8 - Hazardous Waste Drum Storage Yard	Surface Water	<u>INORGANICS</u> o Al,Ba,B,Pb,Mn and Zn detected, but concentrations reported as Total Metals. <u>ORGANICS</u> o Methylene Chloride detected, but is a probable laboratory contaminant.	NC	NC	None	No Futher Action	No contamination was found that would pose any risk to the public health or the environment.
	Sediment (Ingestion for visting children)	<u>INORGANICS</u> o Al,Ba,Be,B,Cd,Cr,Co, Cu,Pb,Mn,Ni,V and Zn detected. <u>ORGANICS</u> o Methylene Chloride and Acetone detected, but are probable laboratory contaminants.	1.02E-01	2E-07	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

NOTES: NC = Not Calculated

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.12 - Building 850 Drum Storage Yard	Soil	<u>INORGANICS</u> o Al,Ba,Be,Cr,Co,Cu, Pb,Mn,Ni,V and Zn detected. <u>ORGANICS</u> o Trans-1,2-Dichloroethene, Trichloroethene, Benzene, Tetrachloroethene, Methylene Chloride, and Acetone detected. o Methylene Chloride and Acetone are considered laboratory contaminants	4.42E-03 (Acceptable Range)	3E-08 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to the public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	SK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONC CINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 9 - Fire Training Area No. 3	Groundwater	INORGANICS o Al,Ba,B,Co,Cu, Fe,Pb,Mn,Mo,Ni and Zn detected, but concentrations reported as Total Metals. ORGANICS o Benzene detected above ARAR in one well. o Total Xylenes, and Ethylbenzene detected. o Methylene Chloride detected, but is a probable laboratory contaminant.	4.49E-01 (Acceptable Range)	8E-07 (Acceptable Range)	None	No Further Actions	Remedial Investigation (RI) indicated that no further action is needed at the Fire Training Area. However, the RI, did indicate a potential upgradient off-base source of contamination.
	Soil	INORGANICS o Al,Ba,Be,Cr,Co, Cu,Pb,Mn,Ni,V and Zn detected. ORGANICS o 2-Butanone, Benzene, Toluene, Ethylbenzene Total Xylenes Methylene Chloride, Acetone and Bis(2-ethylhexl)phthalate detected. o Methlene Chloride and Acetone are considered laboratory contaminants.	4.89E-03 (Acceptable Range)	4E-08 (Acceptable Range)	None	No Further Action	Remedial Investigation (RI) indicated that no further action is needed at the Fire Training Area. However, the RI, did indicate a potential upgradient off-base source of contamination.

TABLE ES-2 (Cont'd)

SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No. 9 - Fire Training Area No. 3	Surface Water	<u>INORGANICS</u> o Al,Be,B,Mn,Hg and Zn detected, but concentrations reported as Total Metals. <u>ORGANICS</u> o 1,1,1-Trichloroethane, 1,1-Dichloroethane and Trichloroethene detected below ARARs. o Methylene Chloride and Chloroform detected, but are probable laboratory contaminants.	NC	NC	None	No Further Action	Remedial Investigation (RI) indicated that no further action is needed at the Fire Training Area. However, the RI did indicate a potential upgradient off-base source of contamination.
	Sediment	<u>INORGANICS</u> o Al,Be,B,Cd,Cr,Co,Cu, Pb,Mn,Hg,Ni,V and Zn detected. <u>ORGANICS</u> o 1,1-Dichloroethane detected. o Methylene Chloride and Acetone detected, but are considered laboratory contaminants.	NC	NC		No Further Action	Remedial Investigation (RI) indicated that no further action is needed at the Fire Training Area. However, the RI did indicate a potential upgradient off-base source of contamination.

NOTES: NC = Not Calculated

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.11 - Fire Training Area No. 2	Soil	INORGANICS o Al,Ba,Be,Cr,Co,Cu, Pb,Mn,Mo,Ni,V and Zn detected. ORGANICS o Methylene Chloride, and Bis(2-ethylhexyl)-phthalate detected, but are probable laboratory contaminants. o Acetone detected.	5.43E-03 (Acceptable Range)	3E-08 (Acceptable Range)	None	No Further Action	No contamination was found that would pose any risk to public health or the environment.

TABLE ES-2 (Cont'd)
SUMMARY OF NIAGARA FALLS IAP RI/FS RECOMMENDATIONS

SITE	MEDIA	CONTAMINANT FINDINGS	RISK ASSESSMENT FINDINGS		INVESTIGATION RECOMMENDATIONS	REMEDIAL RECOMMENDATIONS	RATIONALE
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS			
Site No.13 - 4000 Gallon Underground Tank Pit	Groundwater	INORGANICS o Al,As,Ba,Cr,Co, Cu,Fe,Pb,Mn,Mo, Ni,V and Zn detected, but cooncentrations reported as Total Metals. ORGANICS o Benzene and Trichloroethene detected above ARAR in one well. o Vinyl Chloride detected above ARAR in 2 wells. o 1,2-Dichloroethane, Trans-1,2-Dichloroethene, 1,4-Dichlorobenzene, Chlorobenzene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, Total Xylenes, Toluene, Methylene Chloride and Ethylbenzene detected below ARARs.	3.55E+00 (Unacceptable Range)	2E-03 (Unacceptable Range)	o Install additional downgradient monitoring wells. o Sample all new and existing wells. o Conduct aquifer tests.	o Some data gaps concerning the total extent of contamination and groundwater flow rates will be addressed during the remedial design or immediately prior to the design. o Implementation of subsurface drain groundwater extraction system and offsite treatment/disposal for vinyl chloride and benzene. Complete remediation is expected to occur in 20 years.	o Some data gaps concerning the total extent of contamination and groundwater flow rates will be addressed during the remedial design or immediately prior to the design.
	Soil	INORGANICS o Al,Ba,Cr,Co,Cu,Pb,Mn, Ni,V and Zn detected. o Bis(2-Ethylhexyl)-phthalate detected, but is a probable laboratory contaminants. o Methylene Chloride and Acetone detected, but are considered laboratory contaminants.	4.39E-03 (Acceptable Range)	3E-12 (Acceptable Range)		No Further Action	No contamination was found that would pose any risk to the public health or the environment.

1.0 INTRODUCTION

1.1 AIR FORCE INSTALLATION RESTORATION PROGRAM

The Department of Defense (DoD) Installation Restoration Program (IRP) was implemented to identify and evaluate environmental contamination and associated public health hazards at DoD facilities resulting from past operations and waste handling/disposal. The IRP is the framework under which the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)-mandated activities are conducted at DoD installations. This section summarizes the origin, objectives, and organization of the IRP and describes the relationship between it; CERCLA ; and the National Contingency Plan (NCP).

1.1.1 Program Origins

Evidence accumulated during the 1970's showed that natural resources were being contaminated and the public health threatened by substances migrating from hazardous waste sites located throughout the United States. Because DoD does conduct operations that require the use and disposal of hazardous materials, and in response to the growing national focus on this problem, DoD initiated a program to identify past disposal locations at its facilities, including U.S. Air Force (USAF) installations. Following passage of the Resource Conservation and Recovery Act (RCRA) of 1976 and CERCLA, DoD issued Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6 in June 1980. DEQPPM 80-6 mandated that hazardous waste disposal sites on DoD facilities be identified. The USAF implemented this policy in December 1980. DoD revised and expanded the existing directive through DEQPPM 81-5 in May 1981.

1.1.2 Program Objectives

The objectives of the IRP are to provide a methodical and logical approach to the identification, quantification, and development of feasible remedies for, and resolution of, environmental problems, including related public health hazards caused by hazardous material use or disposal on Air Force facilities. Specifically, the IRP requires the following:

- Identification and evaluation of hazardous material sites on DoD property

- Control of contaminant migration
- Mitigation of hazards to public health or the environment from past DoD activities.

Ideally, remedies selected will meet this objective cost-effectively, while attaining Federal and State potentially applicable or relevant and appropriate requirements (ARARs). While interim responses may be considered, the primary goal of remedy selection will be maximization of on site mitigation using the most practical permanent solutions or technologies.

1.1.3 Program Organization

The IRP, which predates CERCLA, was initiated to provide a methodical approach in identifying potentially contaminated sites, investigating these sites, and evaluating and selecting appropriate remedial actions. The IRP originally was organized into the following four phases:

- Phase I - Records Searches
- Phase II - Confirmation and Quantification Studies
- Phase III - Technology Development
- Phase IV - Remedial Action Plans and Implementation.

Phase I - Records Searches were installation-wide studies that identified and assessed past disposal sites. File material, site visits, and interviews provided the information for these initial assessments. These assessments considered whether or not each site posed hazards to public health or to the environment. If a site presented little or no apparent hazard, subsequent phases were not conducted. If a site presented an imminent threat to public health, an emergency response, which was considered a Phase IV action, was taken. If sampling and evaluation to confirm the suspected hazard was required, Phase II studies were initiated. Sites identified in Phase I were rated by the USAF's Hazard Assessment Rating Methodology (HARM), a system that ranked the site for its potential hazards to the public and/or environmental resources.

Phase II Confirmation and Quantification Studies confirmed the presence or absence of contamination, determined the extent and degree of contamination, and provided the basis for selecting the appropriate type of remedial action. During this phase, groundwater, surface water, soil, and sediment samples were usually collected and analyzed. Geologic profiles were typically determined or confirmed by drilling, and remote sensing techniques were sometimes used to define the size and location of the waste disposal area.

If the Phase II studies revealed no contamination that threatened human health or the environment, then the results were documented and no further action was taken at the site. Although Phase II sampling at some sites did not detect sufficient contamination to justify costly remediation projects, the development of future threats was still a possibility. The approach used for such sites was typically long-term monitoring, which included continued site surveillance by a program of water, soil, or sediment analysis. Sites that were shown to be a threat typically proceeded to Phase IV.

Phase III Technology Development efforts were not undertaken for each site, but were intended to improve site investigation and cleanup technology through research, development, and testing. Phase III was initiated for sites that could not be controlled with proven technology or for sites that were suitable for evaluating new technologies, (i.e. in-situ biodegradation).

Phase IV was not conducted at Niagara Falls International Airport (IAP), but where implemented, was normally conducted in two stages. Phase IVA Remedial Action Plans (RAPs) documented the development, evaluation, and selection of alternatives to control the hazards posed by a waste disposal site. Selection of the best alternative was based on engineering feasibility, cost, environmental effects, public health effects, and compliance with regulatory requirements. Phase IVB was implementation of the selected alternative and normally included design, construction, and management methods (nonstructural control measures). Long-term monitoring was often performed in conjunction with site cleanup to ensure compliance with containment standards or achievement of contaminant cleanup goals.

In October 1986, the President of the United States signed into law the Superfund Amendments and Reauthorization Act (SARA) of 1986. This law not only extends the requirements of CERCLA but modifies the goals of cleanup and the process leading to the selection of a remedy. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to actions that only contain or isolate a contaminant. SARA also provides for greater interaction with the public and state agencies and extends EPA's role in evaluation of the health risks associated with the contamination. Under SARA, early determination of ARARs is required, and consideration of the potential remediation alternatives should be considered at the initiation of a remedial investigation/feasibility study (RI/FS).

In November 1986, in response to SARA and in consideration of various EPA guidance, the USAF modified the IRP to provide for an RI/FS program. To accomplish this, the IRP was expanded to incorporate elements of Phases II and IV. The intent is to conduct the RI/FS in parallel instead of series. The program is now oriented to include ARAR determination, identification and screening of technologies, and development of alternatives. It may include multiple field activities and pilot studies prior to the detailed final analysis of alternatives.

In July 1987, the President of the United States signed Executive Order 12580, which replaced Executive Order 12316. This order delegated responsibility to conduct site investigations and cleanups at Federal facilities to the Secretaries of various agencies, defined relationships between various Federal and State agencies, and provided EPA with a facilitator role in dispute resolutions.

1.1.4 Current Study Objectives

The primary goal of the current study at Niagara Falls IAP is completion of a RI/FS at 13 sites. This will include the generation of a data base for each of the sites to support either: 1) a finding of no adverse impact, where no contaminants or impacts to human health and the environment are identified; or 2) completion of the FS to identify, evaluate, and select optimum remedial alternatives for contaminant mitigation. To achieve this goal, the RI has been scoped to comprehensively identify and quantify the extent and magnitude of contaminants at each site under investigation. The thirteen sites investigated under the RI/FS at Niagara Falls IAP (Figure 1-1) are:

- o Site 1 - Bldg. 600 JP-4 Pipeline Leak
- o Site 2 - POL JP-4 Tank C
- o Site 3 - Landfill
- o Site 4 - BX MOGAS Tank Leak
- o Site 5 - NYANG Hazardous Waste Drum Storage Area
- o Site 6 - POL JP-4 Tank A
- o Site 7 - JP-4 Tank Truck Spill
- o Site 8 - Bldg. 202 Drum Storage Yard
- o Site 9 - Fire Training Facility No. 3
- o Site 10 - Fire Training Facility No. 1
- o Site 11 - Fire Training Facility No. 2
- o Site 12 - Bldg. 850 Drum Storage Yard
- o Site 13 - 4,000 Gallon Underground Tank Pit.

Specific activities proposed for the current IRP RI/FS at Niagara Falls IAP have the following objectives:

- o Develop data to characterize and quantify contaminants present in each medium at each site, determine the pollutant pathways, and calculate the extent of contaminant migration.
- o Establish an understanding of environmental factors impacting remedial alternative assessment.
- o Utilize the above-mentioned information assembled during the RI process to initiate the FS alternative screening and selection process.
- o Develop No Further Action Decision Documents, or their equivalent, for sites that do not adversely impact human health or the environment.

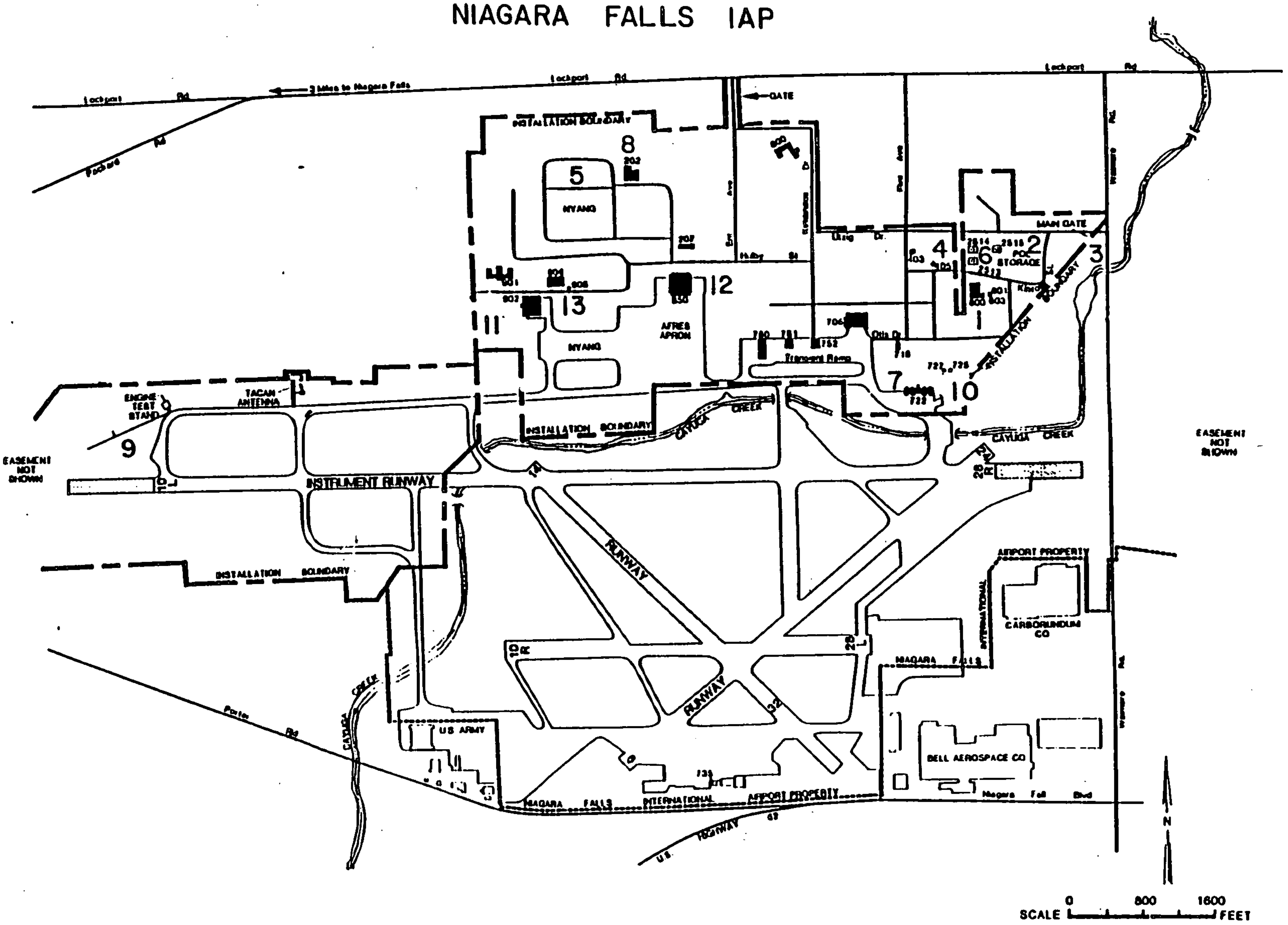
1.2 SUMMARY OF PREVIOUS INVESTIGATIONS

Two previous IRP-approach studies concerned with hazardous waste management and/or environmental quality were conducted at Niagara Falls IAP. The following discussion summarizes those previous investigations.

1.2.1 IRP Phase I - Record Search: December 1983

The Phase I, Initial Assessment/Records Search for Niagara Falls IAP (referenced as Niagara Falls Air Force Reserve Facility (AFRF) in the 1983

NIAGARA FALLS IAP



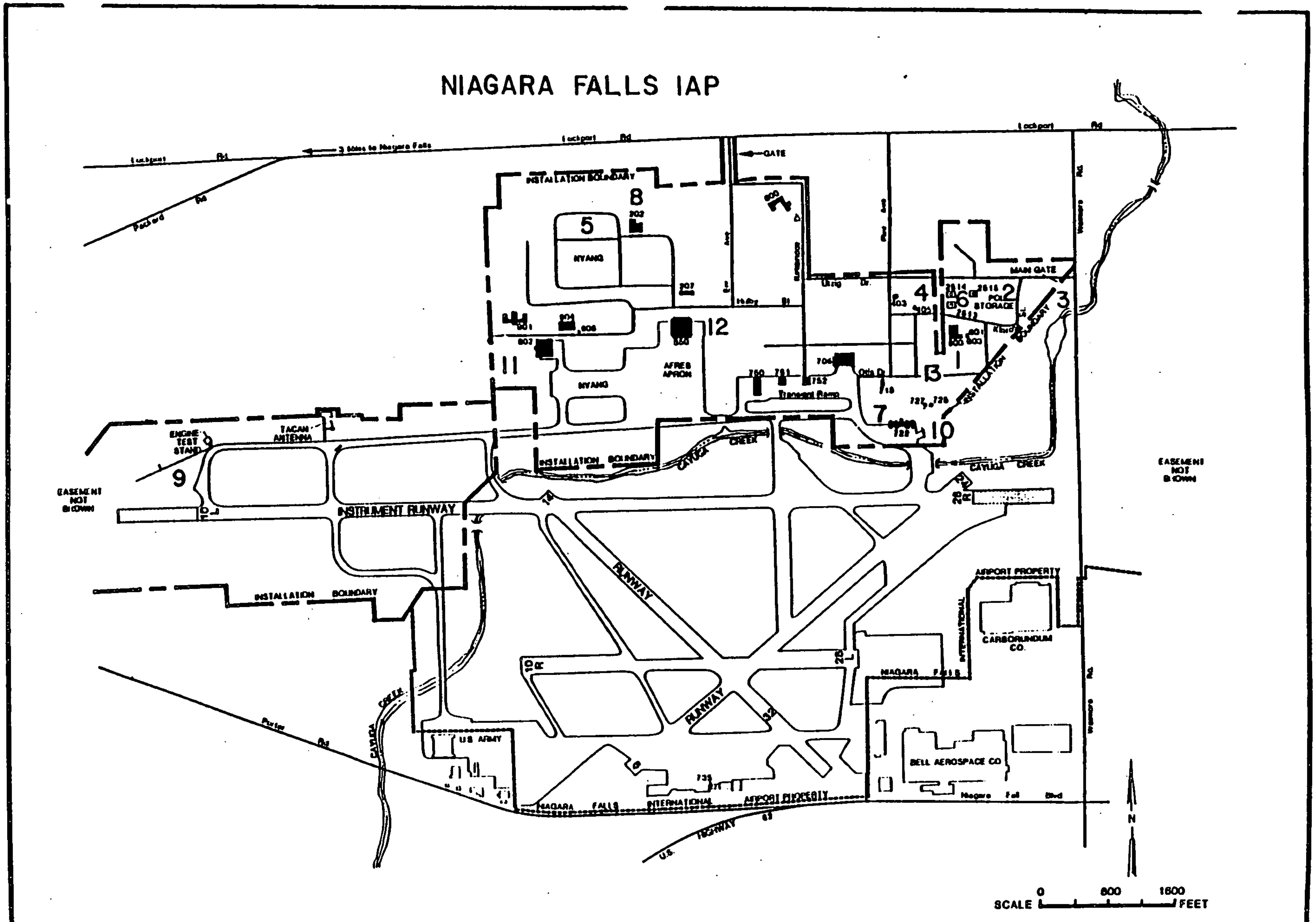
SOURCE: NIAGARA FALLS AFRF INSTALLATION DOCUMENTS

FIGURE 1-1. SITE LOCATIONS AT NIAGARA FALLS IAP report) was conducted by Engineering Science (ES). The objective of the Phase I Record Search was to identify both inactive and active hazardous material management sites, and to assess the potential for environmental contamination and threats imposed by contaminant migration. The methodology utilized in the records search began with a review of past and present industrial operations conducted at the Base. The review was conducted through a series of interviews with Base personnel (past and present) familiar with past waste disposal practices; file searches for past hazardous waste activities; interviews with local, state and federal agencies; and field and helicopter reconnaissance inspections at past hazardous waste activity sites. As a result of this study, thirteen sites were identified as having potentially hazardous contaminant problems, based on scores derived from using the USAF HARM ranking system. Figure 1-2 shows the locations of sites having the potential for environmental contamination. Of the thirteen sites identified, four were determined to have an insufficient potential to create environmental contamination, and consequently no follow-up investigation was recommended. Nine sites were determined to warrant further investigations due to a sufficient potential to create environmental contamination.

1.2.2 IRP Phase II, Stage 1: Confirmation/Quantification, September 1984 - April 1986

Phase II, Stage 1 field activities at Niagara Falls IAP began in April 1984. On the basis of the Phase I findings, the objectives of the Phase II, Stage 1 task were to:

- Determine if environmental contamination had resulted from past waste disposal practices, fuel spills, and fire training activities at Niagara Falls IAP
- Provide estimates of the magnitude and extent of contamination, if present
- Identify potential environmental consequences of migrating pollutants
- Identify additional investigations that may be necessary to delineate the magnitude and extent of contaminants.



SOURCE: NIAGARA FALLS AFRF INSTALLATION DOCUMENTS

FIGURE 1-2. LOCATION OF [illegible] IDENTIFIED BY IRP, PHASE I

The scope of work for Phase II, Stage 1 developed by USAF-OEHL personnel identified 12 sites for specific investigation. Nine of the sites were those mentioned in Section 1.2.1 as requiring additional investigation. Three others that had been eliminated based on relatively low HARM scores were included back into the study at the request of the USAF; a decision document for no further action for the 13th site (Air Force Reserve (AFRES) Hazardous Waste drum storage) was completed in July 1990.

Under the Phase II, Stage 1 effort, thirty-eight (38) monitoring wells were installed in the surficial aquifer and four (4) monitoring wells were installed in the upper bedrock aquifer. Forty-two (42) groundwater, eleven (11) surface water, twelve (12) soil and eleven (11) sediment locations were sampled. Analyses were conducted to determine the concentration of total dissolved solids (TDS), oil and grease (O&G), total organic carbon (TOC), total organic halogens (TOX), phenols and lead in the various matrices of the twelve sites.

Potential contaminants were detected in groundwater samples at each of the 10 sites where monitoring wells were installed. Elevated TOC levels were found at Sites 1 through 10. Elevated TOX levels were found at Sites 3 and 10. Elevated lead concentrations were found at Sites 3, 4, 5 and 8. Oil and grease levels exceeded background levels at Sites 2 and 4. TDS levels exceeded reported naturally occurring levels at Sites 3, 8, and 9.

Elevated concentrations of a number of parameters were detected in surface water/sediment samples at five sites. Elevated TOC and lead levels were detected at Sites 3 and 8. Elevated TOX levels were found at Sites 3, 8, 9, 10 and 12. Oil and grease levels were elevated at Sites 3, 9, 10, and 12.

Potential soil contamination was detected at each of four sites where this media was sampled. Elevated TOC and oil and grease levels were detected at Sites 1, 7, and 12. At Site 11, both TOX and oil and grease levels were elevated.

The Stage 1 results met the objective in determining the presence or absence of potential contamination at the twelve sites investigated. Since

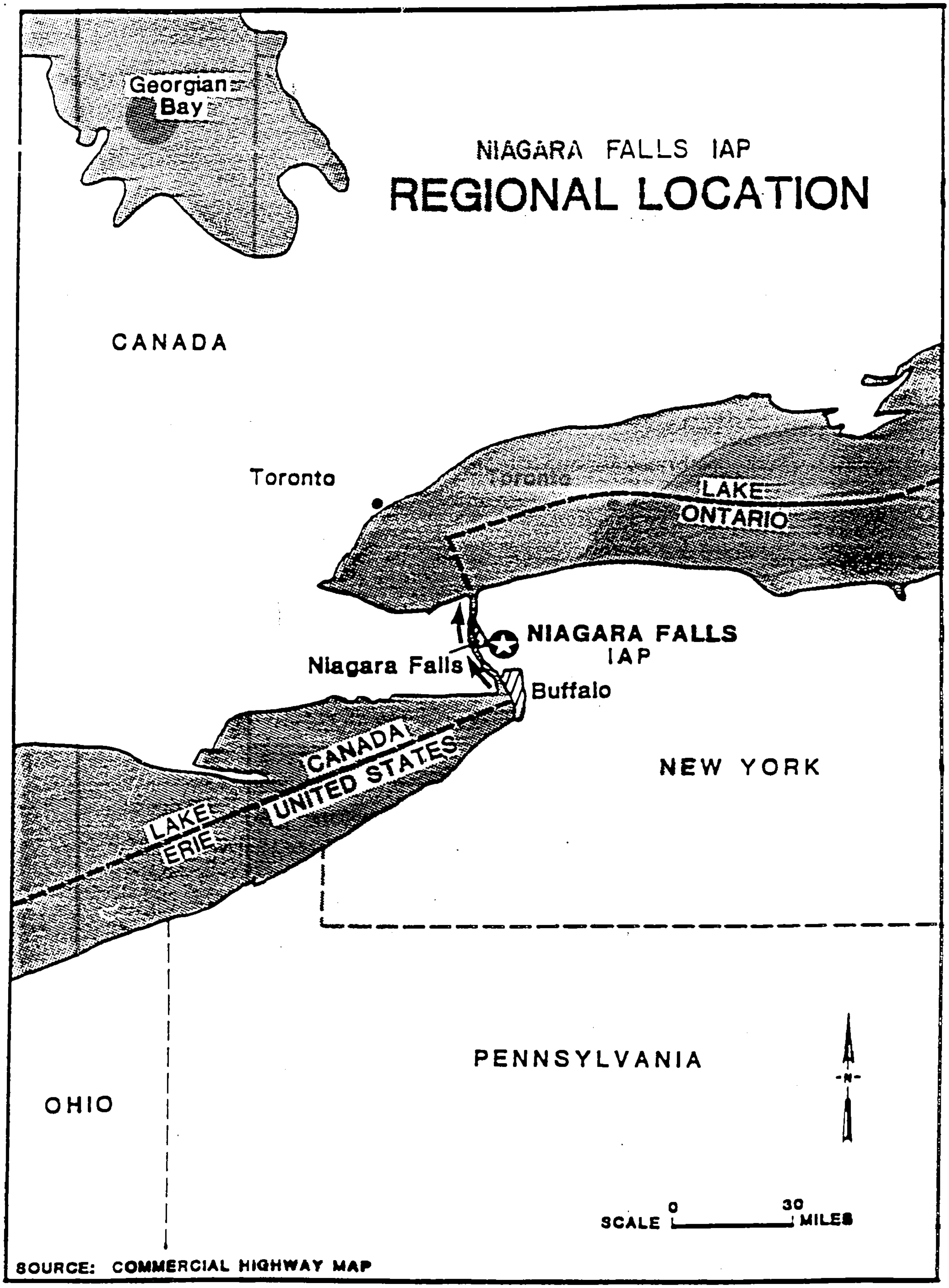
In 1959, a North American Aerospace Defense (NORAD) System CIM-10B Ballistic Operational Missile Air to Ground Radio Controlled (BOMARC) missile complex was constructed at Niagara Falls AFB and the 35th Air Defense Missile Squadron was activated to maintain the missiles. The missile complex was deactivated in the late 1960's and the 107th Tactical Fighter Group (New York Air National Guard) became the tenant organization, currently occupying the western portion of the facility.

In March 1970, Detachment 1, 49th FIS, assumed base responsibility from the 4621st Air Base Group. In December 1970, C-130's replaced the C-119's "Flying Boxcars," which had been on active duty during the Cuban Missile Crisis. In January 1971, the base was transferred from the Aerospace Defense Command to the Air Force Reserve Command and the 914th Tactical Airlift Group assumed the current host duties. The F-4C "Phantom" jet fighters that are presently at the installation are operated and maintained by the New York Air National Guard, 107th Fighter Interceptor Group (formerly the 107th Tactical Fighter Group).

1.3.1 Installation Description

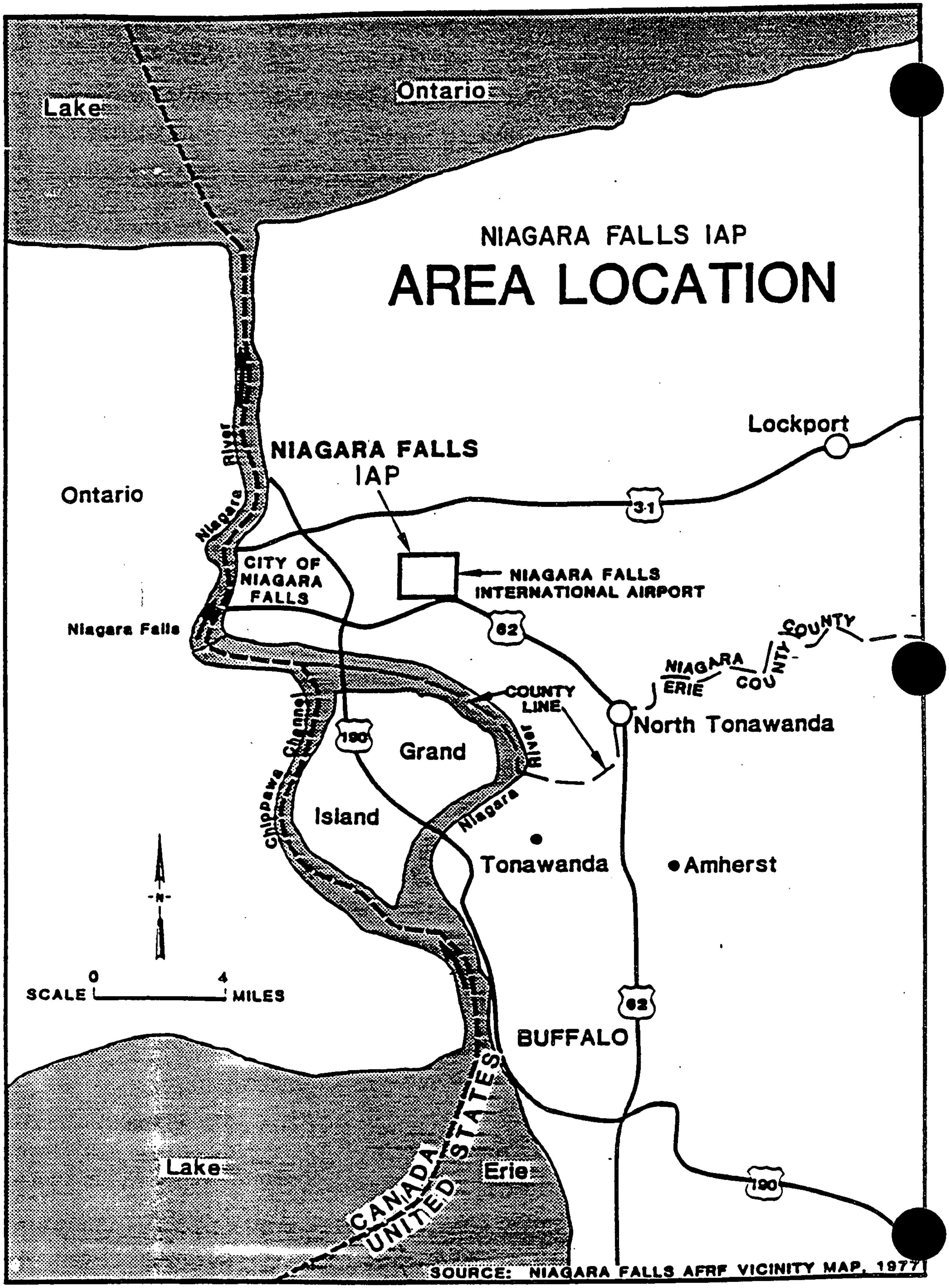
Niagara Falls IAP is located in Niagara County, New York, approximately six miles northeast of the City of Niagara Falls and approximately fifteen miles north of Buffalo. The installation is comprised of 985 acres with a full-time population of approximately 700. An additional 1860 reservists train at the installation for two days each month plus two full weeks each year. Figure 1-3 shows the regional location of Niagara Falls and Figure 1-4 shows the location of the installation within the Niagara Falls area. The installation site plan is shown in Figure 1-5.

The 914th Tactical Airlift Group, the host unit at Niagara Falls IAP, trains the 1860 reserve officers and airmen to combat-ready status for any national emergency that may develop. The installation is manned by civilian personnel and Air Reserve Technicians during normal duty hours. Reserve training is conducted one weekend each month, and during a 15-day duty tour each year. The unit's combat-readiness requirements include airlifting troops, supplies, and equipment into both prepared and unprepared landing zones, providing front-line



SOURCE: COMMERCIAL HIGHWAY MAP

FIGURE 1-3. NIAGARA FALLS IAP REGIONAL LOCATION

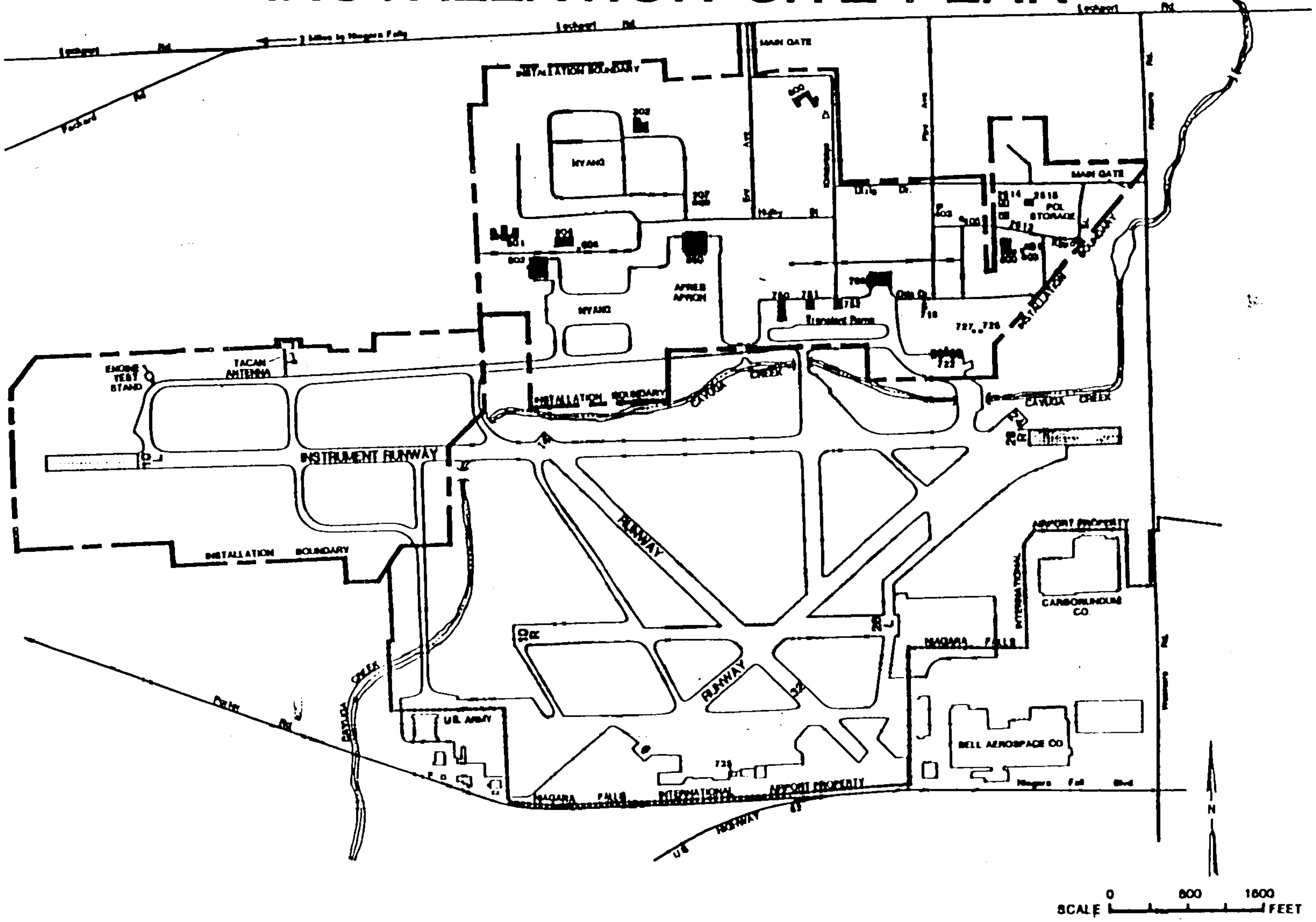


SOURCE: NIAGARA FALLS AFRF VICINITY MAP, 1977

FIGURE 1–4. NIAGARA FALLS IAP AREA LOCATION

NIAGARA FALLS IAP

INSTALLATION SITE PLAN



SOURCE: NIAGARA AFRF INSTALLATION DOCUMENTS

FIGURE 1-5. NIAGARA FALLS IAP INSTALLATION SITE PLAN troops with personnel and logistical support, and providing medical evacuations. Tenant and joint-use organizations at Niagara Falls IAP are listed below.

- 107th Fighter Interceptor Group/NYANG
- DET 1, 1998th Communications Group (AFCG)
- OLD, DET 27, 12th Weather Squadron (AWS)
- 380th Combat Support Group (SAC)
- U.S. Coast Guard Reserve (USCGR)
- New England Area Exchange
- Niagara Falls Air Force Credit Union
- HQ Niagara Group, Civil Air Patrol
- Department of Transportation, Federal Aviation Agency (FAA)
- Niagara Frontier Transportation Authority (NFTA)
- State of New York, Army National Guard
- U.S. Army Corps of Engineering Construction Division

1.3.2 Past Waste Management Activities

The generation and disposal of hazardous or potentially hazardous wastes at Niagara Falls IAP were investigated during the IRP Phase I (Engineering Science, 1983). Most hazardous wastes generated at the Base were produced by the following sources:

- Industrial shops -- Industrial shops provided maintenance support for aircraft flying missions. Wastes generated by these activities were used for fire training exercises, stored on-Base, or disposed of in the Base landfill.

- Fire protection training areas -- Fire training activities have been conducted at Niagara Falls IAP from 1955 to the present. Combustible oils, solvents, and jet fuel (JP-4) have been burned at the fire training sites.

- Pesticide utilization practices -- Herbicides have been applied throughout the history of the Base to control weed growth. Herbicide containers are rinsed with water and disposed of as general refuse.

- Waste storage areas -- A number of waste storage areas have existed at Niagara Falls IAP. Both drum and underground tank storage methods have been used. Since 1978, the majority of wastes have been stored in drums.

- Fuels management areas -- The fuels management system at Niagara Falls IAP has consisted mainly of aboveground and underground storage tanks. Fuels stored in these areas include JP-4, gasoline used in motor vehicles (MOGAS), diesel fuel, fuel oil No. 2, contaminated fuels, and used oils. Tank trucks bring the fuels into the facility.

The hazardous waste sources identified and their attendant waste management practices have produced the following types of sites which are being investigated:

- Landfill area
- Drum storage areas
- JP-4 and MOGAS spills and leaks
- Fire training areas
- Underground storage tank leakage.

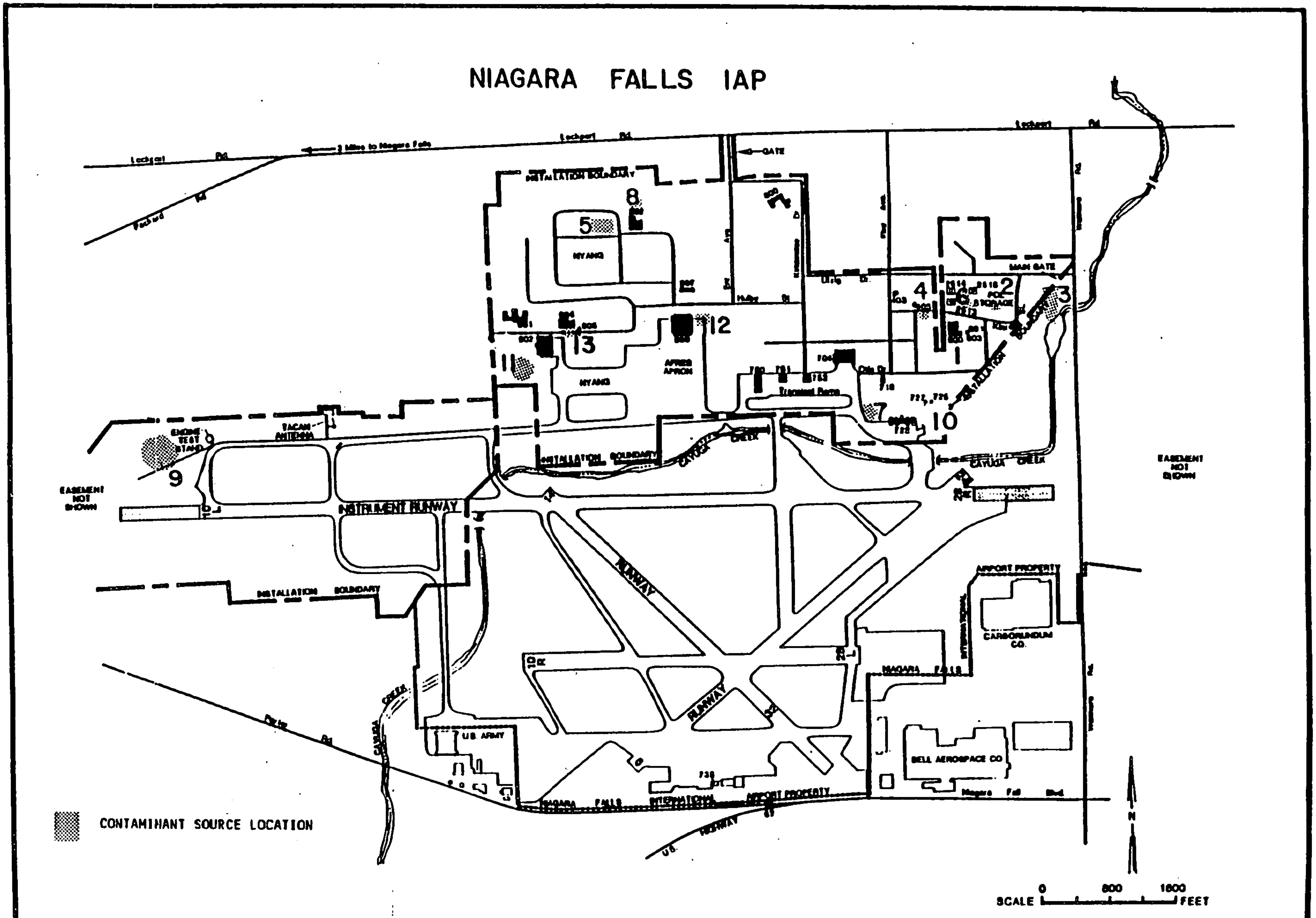
1.4 SITE-SPECIFIC INFORMATION

This section describes the thirteen (13) individual sites that are being investigated under the current IRP RI/FS. The site-specific discussions include the sites' settings and locations, past hazardous materials and wastes disposal, past storage practices, and types of wastes anticipated or detected at these sites during the Phase II, Stage 1 field investigation. Figure 1-6 presents a site location map with contaminant source locations.

1.4.1 Site 1 - Building 600 JP-4 Pipeline Leak

Site 1 is located along McGuire Street, between Kinross Street and Otis Drive. The site encompasses the location of a leak that was discovered in 1969 in an old JP-4 hydrant system. The leak was extensive enough to saturate the soil between McGuire Street and Building 600 with JP-4 (Figure 1-7). The area in question was paved over in 1986.

Elevated levels of TOC were measured in downgradient surficial aquifer wells. TOC levels also were elevated in two wells installed in the underlying bedrock aquifer (Lockport Dolomite). Elevated levels of oil and grease (17.60 ug/g) and TOC (10,000 parts per million [ppm]) were detected in some of the soil samples. It was not determined from the results of this study whether the TOC levels are related to fuel components.



SOURCE: NIAGARA FALLS AFRF INSTALLATION DOCUMENTS

FIGURE 1-6. SITE LO[illegible]ONS AT NIAGARA FALLS IAP

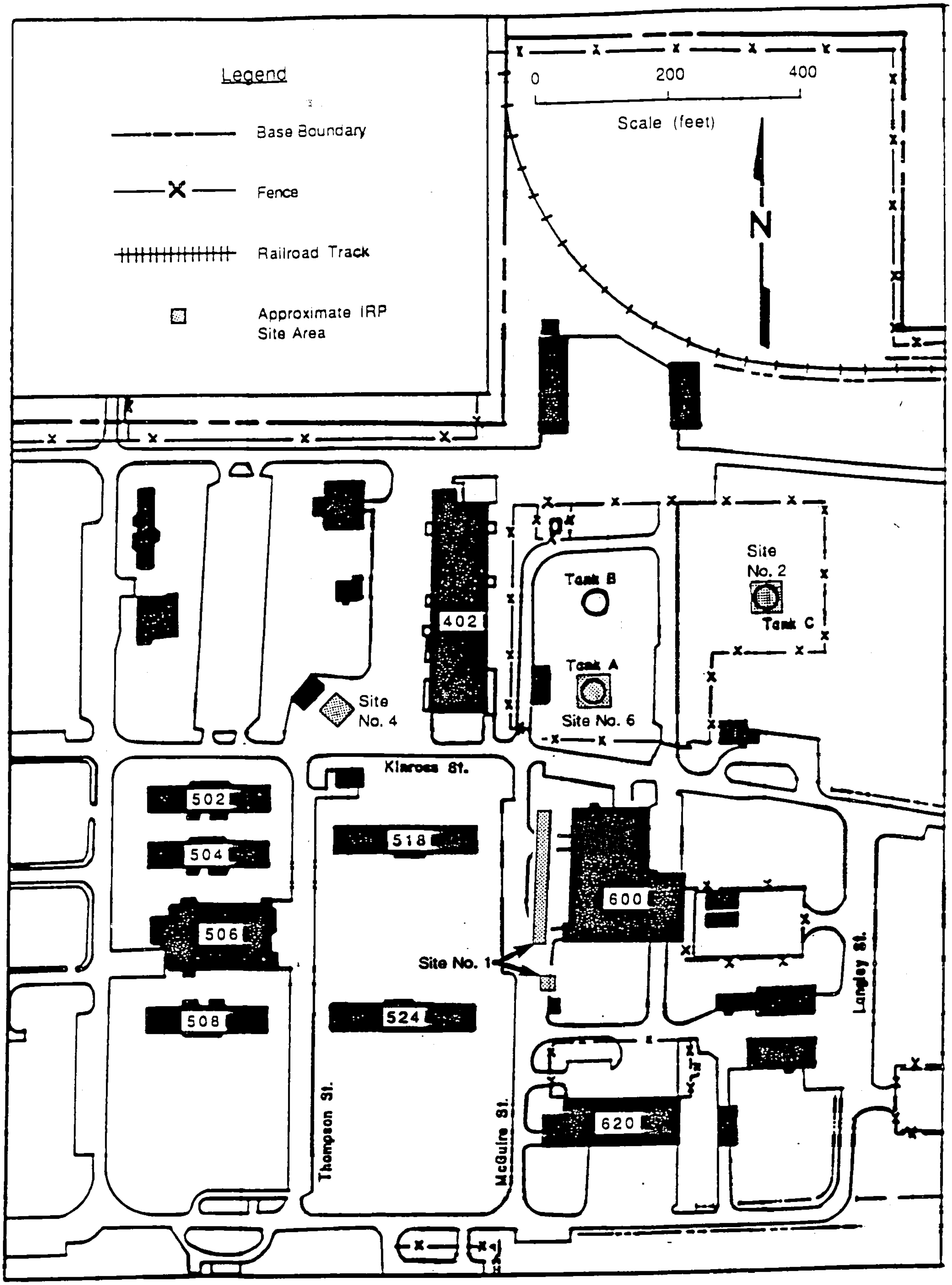


FIGURE 1-7. SITE 1,2,4 AND 6: JP-4 PIPELINE LEAK, POL JP-4 TANK C AND A AND BX MOGAS TANK LEAK

1.4.2 Site 2 - JP-4 Tank C

Site 2 is located within the Petroleum, Oils, and Lubricants (POL) storage yard between Kinross Street and Utzig Drive (Figure 1-7). In 1982, the inlet and outlet pipes to the POL Bulk Storage Tank C began to leak. The leaks were detected when fuel was observed between the dike area and the tank truck loading facilities, and in the oil/water separator. The underground pipes were excavated, and corrosion and leakage were confirmed. At least 4,000 gallons of fuel were estimated to have leaked from the storage tanks.

Elevated oil and grease levels (3.82 mg/L) were observed in one downgradient surficial aquifer well. The upgradient surficial well contained higher TOC and purgeable organic carbon (POC) levels than either of the downgradient wells. Concentrations of TOC, detected in all wells installed at the site, ranged from 20 to 72 mg/L.

1.4.3 Site 3 - Landfill

Site 3 is the closed Base landfill, located between Kinross Street and the east installation boundary (Figure 1-8). The landfill was originally a depressed, marshy area adjoining Cayuga Creek. The landfill and surficial aquifer are in contact with each other. The Cayuga Creek flood-plain encompasses part of the landfill.

The landfill was in operation throughout most of the 1950s and 1960s and was filled to a depth of 8 to 10 feet. It served chiefly as a repository for construction rubble, but additional wastes included trash, garbage, ash from coal stores, waste oil, shop wastes, batteries, scrap electrical parts from Bell Aerospace, car parts, trash from the Navy Station (previously located across the runway), and wastes from Fort Niagara and Model City. The waste material was burned frequently until 1966 when air pollution regulations restricted this meansof waste reduction. Trenches were then dug along the southern edge of the landfill for waste burial.

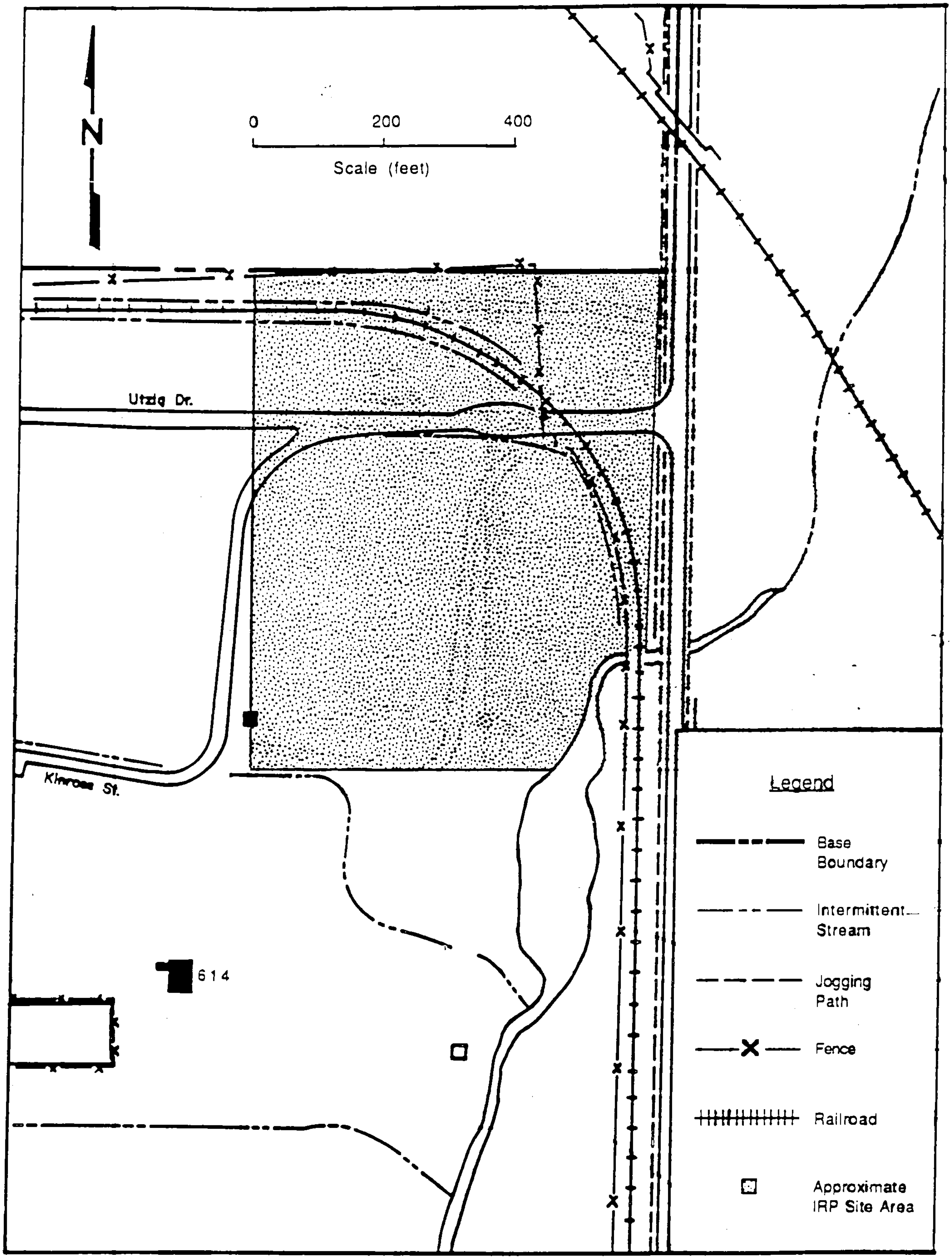


FIGURE 1-8. SITE 3: LANDFILL

Elevated levels of TOC (3.8 to 80 mg/l), POC (1.1 to 12 mg/l), TOX (0.045 to 0.20 mg/l), and lead (4.2 to 1256 mg/l) were detected in both upgradient and downgradient surficial aquifer wells. Water quality data for the downgradient bedrock wells at Site 3 were within applicable standards or criteria. The overall water quality of Cayuga Creek did not substantially change between the upstream and downstream sampling points.

1.4.4 Site 4 - BX MOGAS Tank Leak

The Base Exchange (BX) Gas Station (Building 405) is located at the corner of Kinross and Thompson Streets (Figure 1-7). A pipe leading to an underground MOGAS tank ruptured in 1981, permitting groundwater intrusion into the tank. Water entered the tank and displaced an undetermined volume of MOGAS into the surrounding soil. Gasoline was observed in the storm sewers for a number of weeks following the break, and softened the asphalt pavement in the vicinity of the gas pumps.

Elevated levels of TOC (3.65 to 82 mg/L) and POC were detected in all surficial aquifer wells. The highest levels of oil and grease (3.65 mg/L) and lead (44.5 ug/L) were detected in the upgradient well; these levels are likely to be due to upgradient contamination rather than a result of the gas tank leak.

1.4.5 Site 5 - NYANG Hazardous Waste Drum Storage Area

Site 5 is the New York Air National Guard (NYANG) waste drum storage area, in the abandoned BOMARC missile site. Drums were stored on a concrete pad southwest of Building 202 (Figure 1-9). Phase I investigations reported "visual evidence of minor spills" moving from the pad toward a nearby ditch. During the Stage 1 drilling and sampling effort, additional drums were used for containing tailings generated during that effort. The rapid accumulation of drums necessitated that NYANG store the drums on a second concrete pad, approximately 30 yards south of the original pad.

Elevated levels of TOX (82.9 to 90.9 mg/L) were detected in all surficial aquifer wells installed at the site. Oil and grease levels detected in all

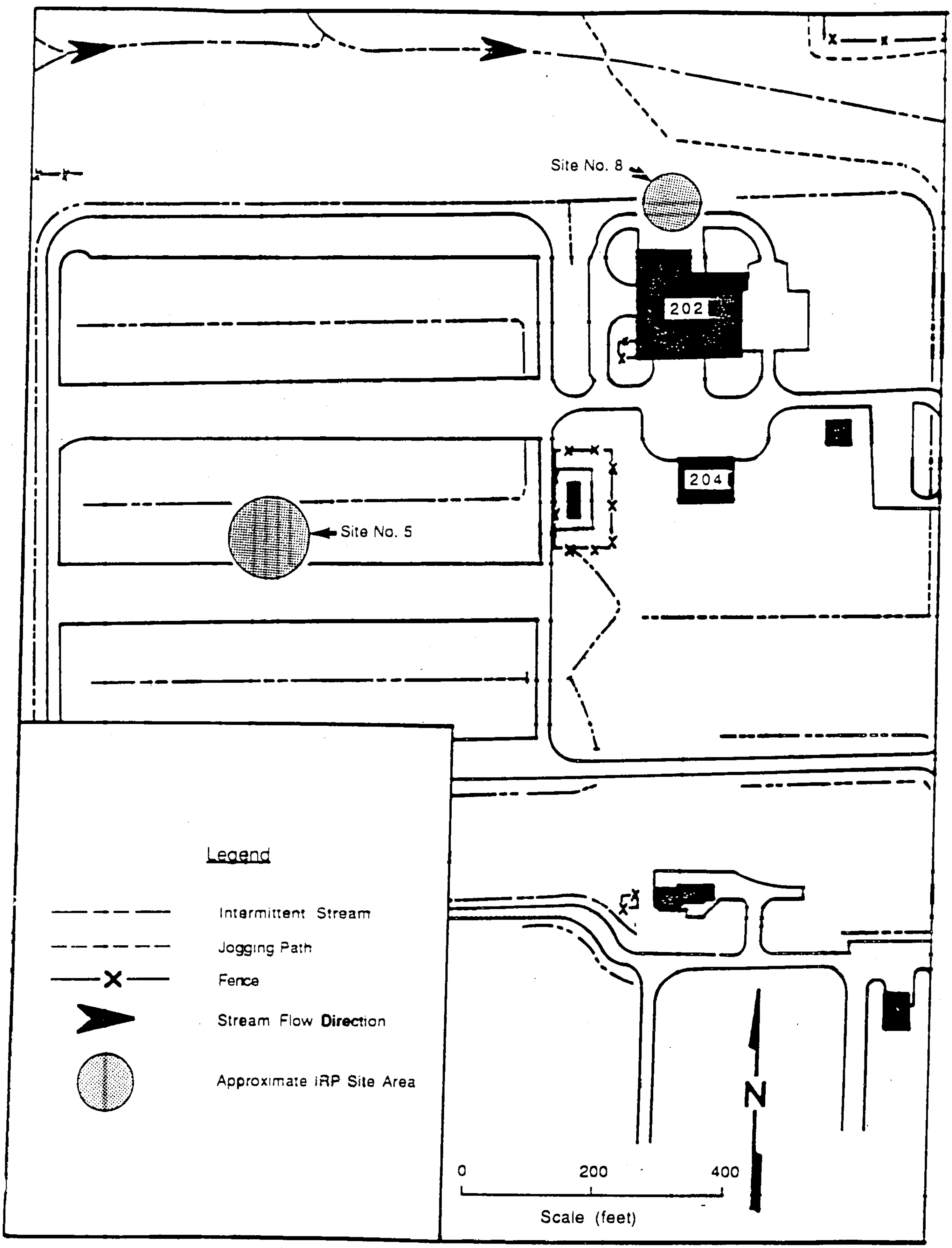


FIGURE 1-9. SITES 5 AND 8: NYANG HAZARDOUS WASTE DRUM STORAGE AREA AND BUILDING 202 DRUM STORAGE YARD

groundwater samples were less than 1 mg/L. Lead concentrations in three groundwater samples exceeded drinking water quality standards.

1.4.6 Site 6 - JP-4 Tank A

Site 6 is located near Site 2 between Kinross Street and Utzig Drive (Figure 1-7). In 1979, fuel was observed inside the dike surrounding the POL Bulk Storage Tank A and was also seen in a nearby storm water drain near the pumphouse. The underground inlet pipe to the tank was excavated and found to be corroded and leaking. A minimum of 4,000 gallons of fuel was estimated to have leaked at this site. Low levels of oil and grease (≤1.52 mg/L) were detected in all of the wells, and elevated levels of TOC (26 mg/L) were detected in one downgradient well.

1.4.7 Site 7 - JP-4 Tank Truck Spill

Site 7 is located at the east edge of the transient ramp, northwest of Building 722 (Figure 1-10). A tank truck overturned at this location in early 1983, spilling JP-4. Temporary dikes were placed in the area to prevent fuel from reaching surface waters. After fuel removal, approximately 2,500 gallons of fuel remained unaccounted for; the majority probably was destroyed when large amounts of contaminated soil were excavated and burned.

Elevated levels of TOC (15.2 to 31.2 mg/L) were found in two surficial aquifer wells. Elevated levels of oil and grease (3.0 to 11.1 ug/g) and TOC were found in soil samples. Elevated TOC values may or may not be related to fuel compounds.

1.4.8 Site 8 - Building 202 Drum Storage Yard

Site 8 was an area north of Building 202 (Figure 1-9) that was used as a hazardous waste drum accumulation point and is currently a repository for construction materials and assorted scrap. The drums were stored on asphalt pavement which was overlaid with new pavement in 1988. Minor spills have been reported in this area and evidence of spills was noted during the Phase I site investigation.

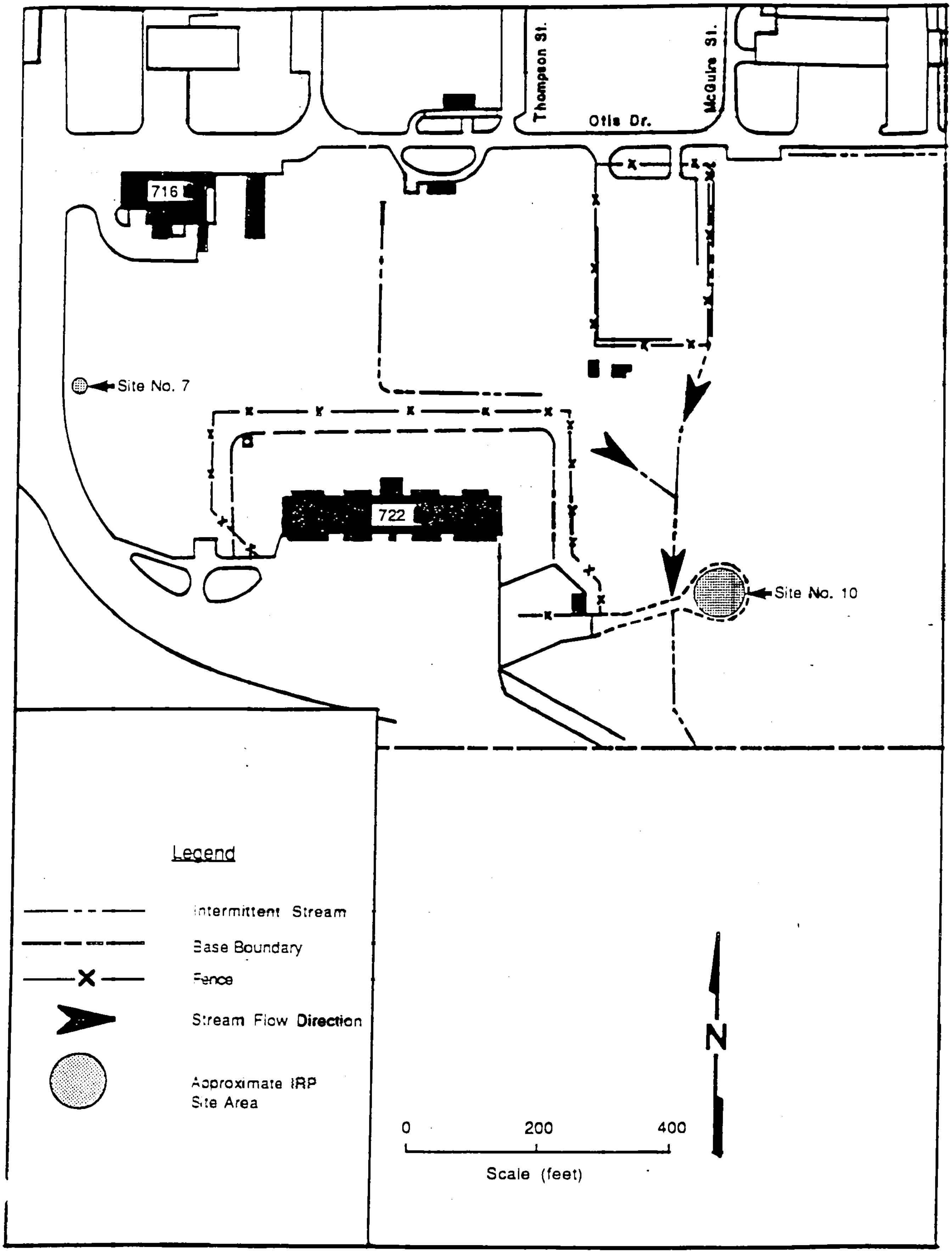


FIGURE 1-10. SITE 7 AND 10: JP-4 TANK TRUCK SPILL AND FIRE TRAINING ARE NO. 1

Elevated levels of TDS, TOC (31.6 to 128.6 mg/L), POC, and lead (119 to 247 ug/L) were detected in all surficial aquifer wells. Elevated lead, oil and grease, and TOC levels were detected in the surface water/sediment samples collected at this site. Lead was detected in the upstream surface water samples with levels ranging from 23.6 to 80.9 ug/L, and in one stream sediment sample with a concentration of 194 ug/g.

1.4.9 Site 9 - Fire Training Area No. 3

Site 9 is located just north of the stabilized overrun at the west end of the instrument runway (Figure 1-11) and has served as the Base fire training area since the early 1960s. The training area consists of a broad, oval area surrounded by a low, earthen berm. The assortment of combustible liquids used at this site prior to 1979 probably included combustible oils, solvents, and JP-4. Since 1979 JP-4 has been the only fuel burned in the pit. During training exercises (one to three times monthly), fires started with these materials were extinguished with Aqueous Film Forming Foam (AFFF) and/or assorted dry chemicals. During the Phase I investigation, surface runoff from the pit was observed to be toward an intermittent creek just north of the site.

Elevated levels of POC and TDS levels were measured in all of the surficial aquifer wells, and TOC at a concentration of 40 mg/L was measured in the downgradient surficial aquifer well. Sediment samples collected downstream from the site contained higher levels of oil and grease (99.9 ug/g) and TOX (5.1 ug/g) than upstream sediment samples (35.2 ug/g and 2.3 ug/g, respectively), indicating that the site is contributing oil and grease and TOX to the stream sediments. Surface water quality did not change between upstream and downstream sampling points, which indicates that the site is not influencing surface water quality.

1.4.10 Site 10 - Fire Training Area No. 1

Site 10, located east of Building 722 (Figure 1-10), served as the Base's principal fire training area during the late 1950s and early 1960s. A variety of combustible liquids and contaminated fuels were burned in the pit during training exercises, and extinguished with fire-fighting foams.

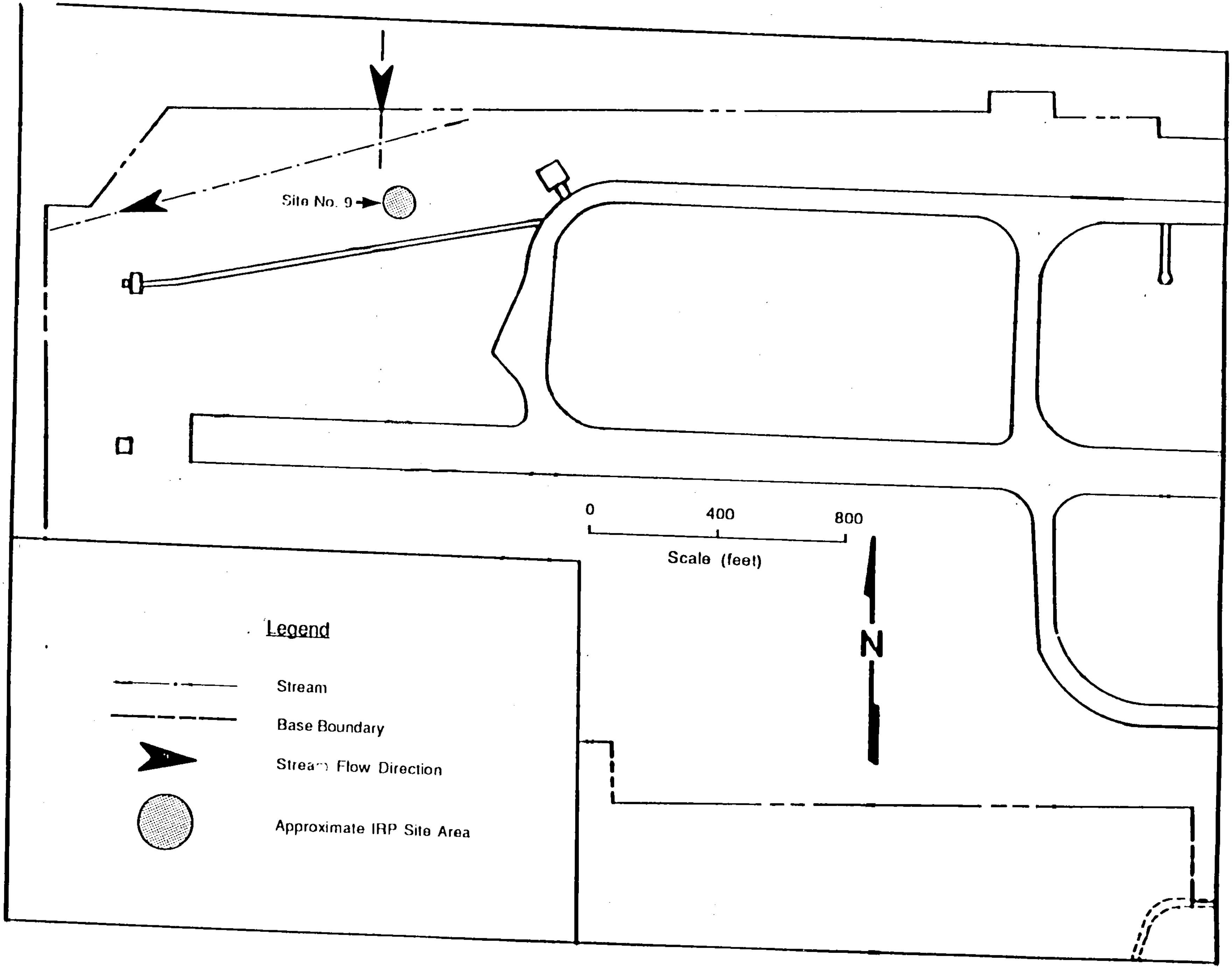


FIGURE 1-11. SITE 9: FIRE TRAINING AREA NO. 3

Elevated levels of TOC (71.2 and 64.2 mg/L) were detected in two groundwater samples, but oil and grease levels in groundwater samples were less than 1 mg/L. TDS and TOX levels in the surface water were higher upstream than downstream. Oil and grease levels in the sediment samples were high both upstream and downstream; however, the concentration downstream was nearly triple the upstream value. Elevated oil and grease levels in the sediment may be attributable to runoff from the hardstand area just west of the stream.

1.4.11 Site 11 - Fire Training Area No. 2

Site 11 reportedly was located by the foundation ruins of an old, stone farmhouse south of Building 900, adjacent to the western edge of the installation boundary (Figure 1-12). The foundation of the farmhouse no longer exists and regrading of the area has complicated any attempts to locate the site. The site was used briefly in the late 1950s as a fire training facility, concurrent with the operation of the Site 10 facility. Fuels were not contained prior to burning at the site.

Soil samples from one of the boreholes at the site exhibited elevated levels of oil and grease (62 to 120 ug/g). TOX values were consistently elevated for all of the soil samples.

1.4.12 Site 12 - Building 850 Drum Storage Yard

Site 12 is an open, grassy area adjacent to the AFRES apron, located east of Building 850 and south of Hulby Street (Figure 1-13). During the 1950s and early 1960s, the site was used as a hazardous waste drum accumulation point. No reports of area spills exist and no evidence of spill was noted during the Phase I site investigation.

Site data indicate environmental contamination; however, the source may not be the storage yard. Surface water quality did not change between upstream and downstream sampling points, which indicates that the site is not influencing the surface water quality. Sediment samples collected upstream of Site 12 contained elevated levels of oil and grease (206 ug/g). Elevated, but identical TOX levels were detected in both upstream and downstream samples. Elevated levels of oil

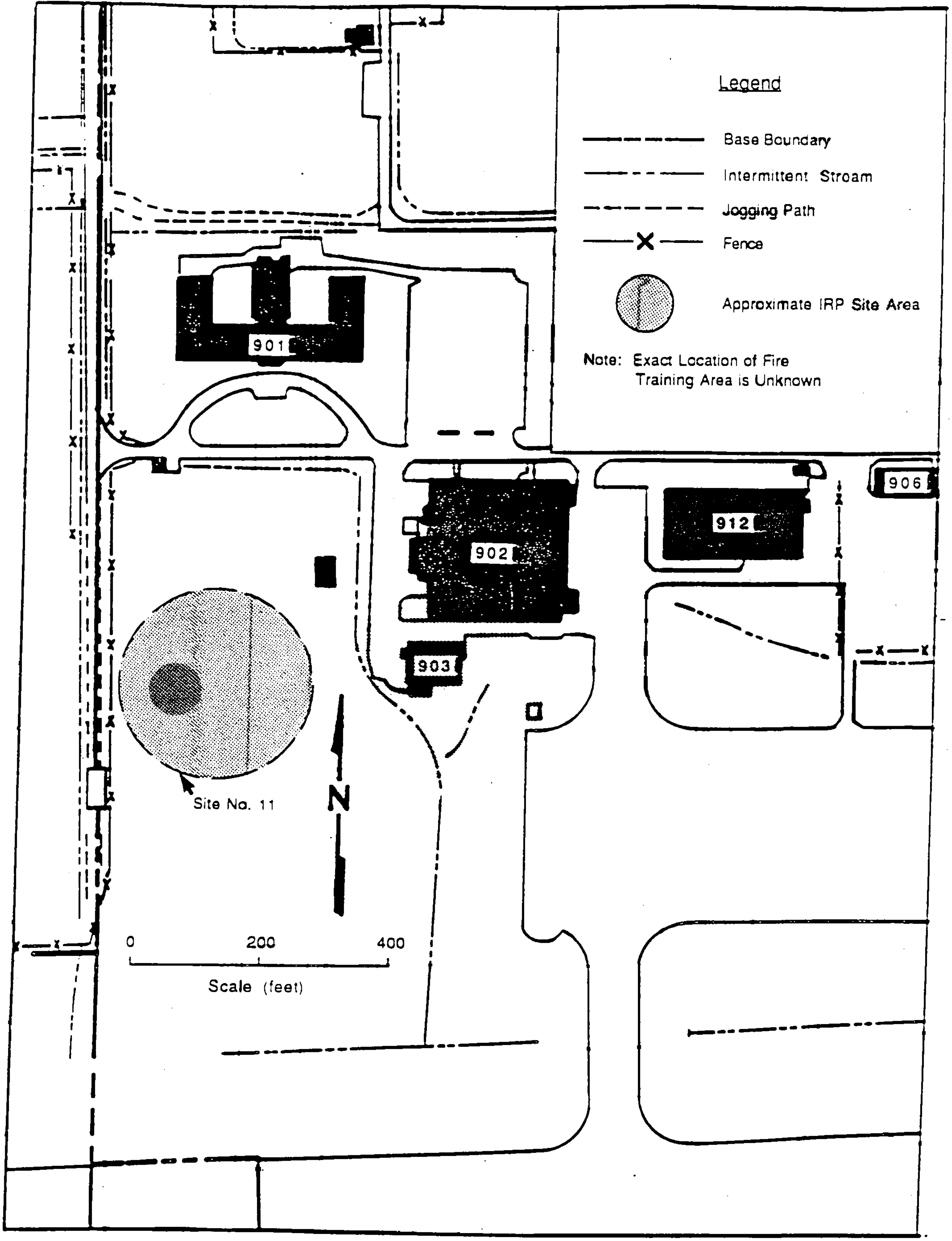


FIGURE 1-12. SITE 11: FIRE TRAINING AREA NO. 2

and grease (45.6 ug/g) and TOC (0.6 ug/g) were detected in some soil samples, but apparently were not related to fuel compounds.

1.4.13 Site 13 - 4,000 Gallon Underground Tank Pit

Site 13 is an underground tank pit located south of Building 904 and west of Building 905 near Site 11 (Figure 1-14). Initially the underground tank was used as a motor fuel tank for a Base gas station, but was used to store general slop waste when the station closed. Since that time, the tank has been pumped out, excavated, and removed; and the excavation pit was backfilled in December 1987. Site 13 was not investigated under the previous IRP Stage 1 program conducted at Niagara Falls IAP but was added under the current IRP RI/FS.

Although Site 13 was not included in the IRP Stage 1 field program, water samples were collected from the tank pit water and soil surrounding the tank on December 8, 1986 at the request of the New York Department of Environmental Conservation (NYDEC) Region 9. Water samples collected previously from the standing water in the tank pit reportedly indicated the presence of tetrachloroethylene and trichloroethylene. Surface soil samples collected near the west edge of the tank pit indicated the presence of tetrachloroethane.

1.4.14 Pathways Affected

Potential pathways existing at Niagara IAP for contaminant migration include groundwater and surface water. Water is carried in ditches and underground drains to storm drains which serve as the primary form of drainage from the installation. Cayuga Creek and an unnamed tributary collect surface water from the installation. These drainage pathways may carry contaminants off-Base, toward the Niagara River. Contaminants in groundwater may flow off-Base through groundwater migration or they may discharge into one of the surface drainage channels.

1.4.15 Summary

The thirteen (13) sites identified at Niagara Falls IAP were considered a potential environmental threat and were recommended for further investigation. All of the sites, except for Site 13, have undergone previous IRP investigations.

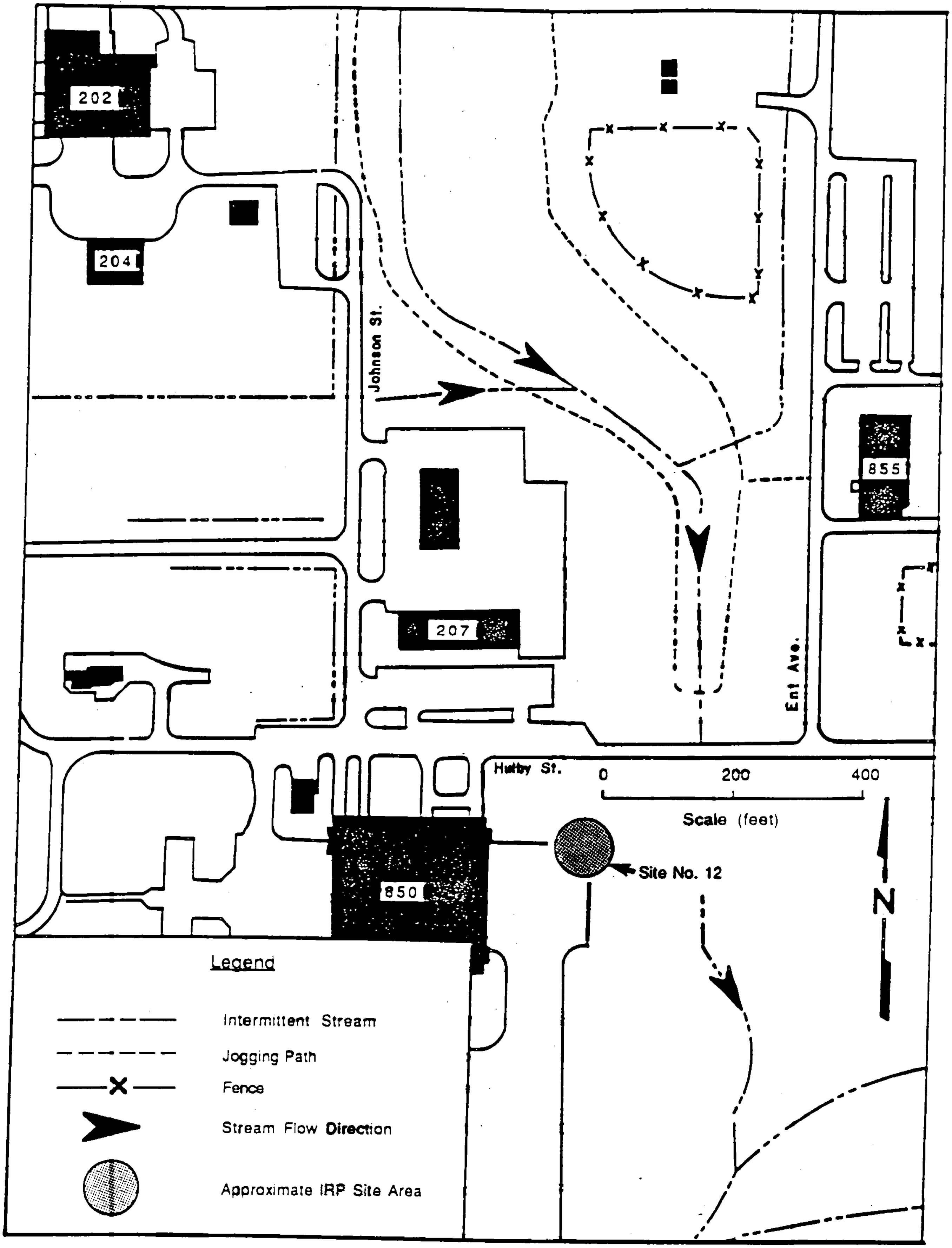


FIGURE 1-13. SITE 12: BUILDING 850 DRUM STORAGE YARD

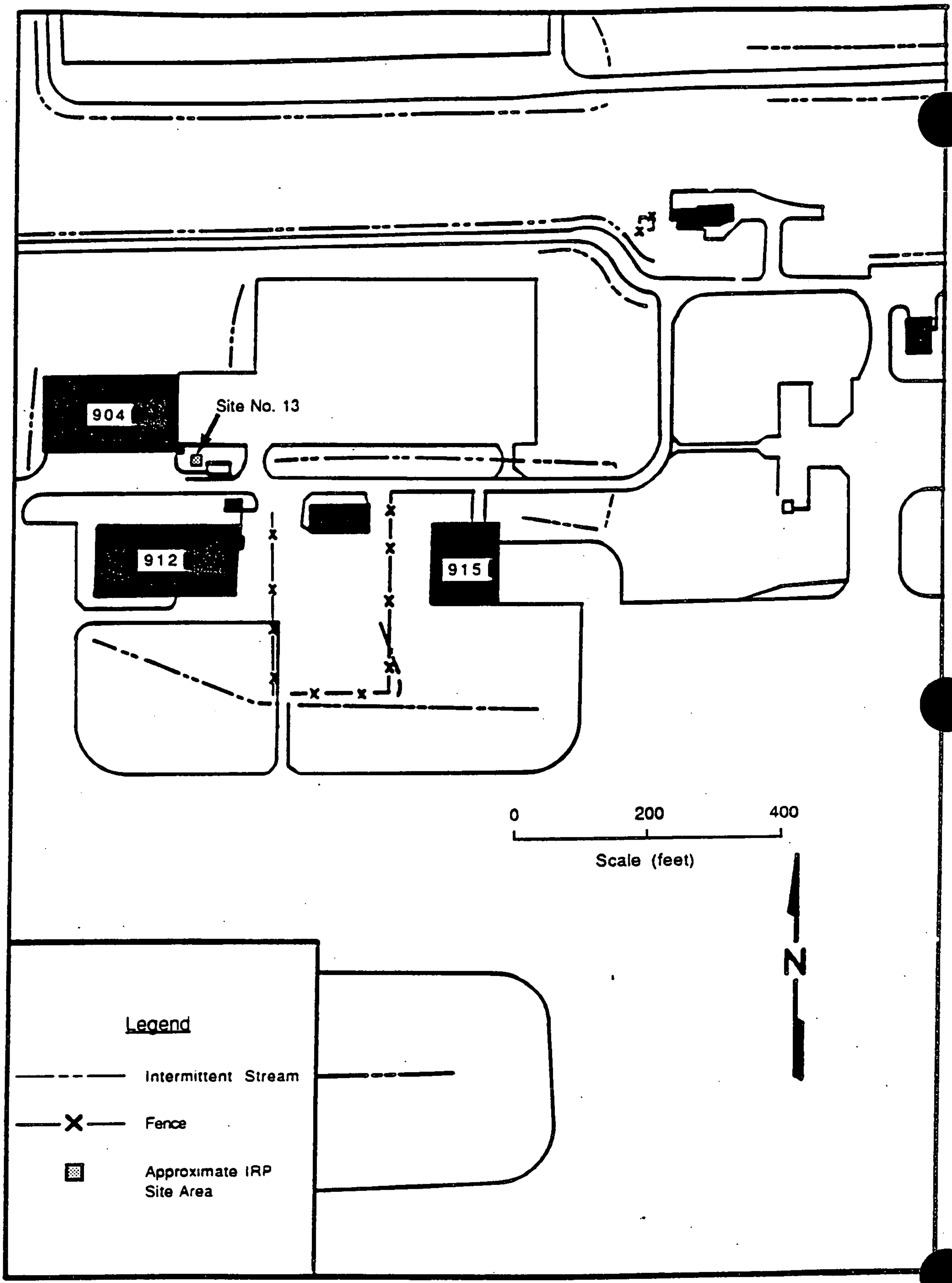


FIGURE 1-14. SITE 13: 4000 GALLON UNDERGROUND TANK PIT

A summary of the Phase II, Stage 1 results for the twelve (12) IRP sites is presented in Table 1-1.

1.5 IDENTIFICATION OF FIELD TEAM

Due to the magnitude and extended duration of the Niagara Falls IAP RI, the Field Investigation Team (FIT) was extensive. A list of the primary members of the field investigation is presented below.

- Field Manager
    - John King -- field program initiation, monitoring well installation, soil borings, well development, well purging, environmental sampling; stream velocity measurements, drum sampling, containerized water sampling, USGS well sampling, field shut-down
- Deputy Field Manager
    - John Vanderslice -- field startup, soil gas, headspace analyses, monitoring well installation, well development, soil borings, well purging, environmental sampling
- Field Geologists
    - Bruce Lin
    - Steve Keller
    - Andy Keim
    - Mike Bolen
    - Laurie Lamb
    - John Carter
- Other Field Staff
    - Rich Gouijn-Stook
    - Chris Arthur
    - Bill Perrin
    - Steve Stavrou
    - Vicky Rothman
    - Meredith Brogdin

TABLE 1-1. SUMMARY OF FINDINGS, IRP PHASE II, STAGE 1 INVESTIGATION, NIAGARA FALL IAP, NEW YORK

	Media Sampled		
	Groundwater	Surface Water/Sediment	Soils
Site 1	• Elevated TOC levels in downgradient surficial Wells 1-3 and 1-4 • Elevated TOC levels in upgradient bedrock Well 1D-1 and bedrock Well 1D-2 • Elevated POC levels in all wells, surficial and bedrock	N/A	• Elevated TOC levels in soil boring samples 1SB-1 and 1SB-4 • Elevated oil and grease levels only in soil boring sample 1SB-3
Site 2	• Elevated oil and grease levels in downgradient surficial Well 2-2 • Elevated TOC levels in all wells, surficial and bedrock • Elevated POC levels in all wells, surficial and bedrock	N/A	N/A
Site 3	• High TDS levels in downgradient surficial Well 3-4 • Elevated TOC levels in downgradient surficial Wells 3-2 and 3-3 • Elevated POC levels in all wells, surficial and bedrock • Elevated TOX levels in downgradient surficial Wells 3-3 and 3-4, and bedrock aquifer Well 3D-1 • Elevated lead levels in surficial upgradient Well 3-1 and downgradient Wells 3-2 and 3-5	• Elevated TOC and POC in sample 3SW-3 • Elevated POC levels in samples 3SW-1 and 3SW-2 • Elevated oil and grease in sample 3SW-3 • Elevated lead levels in samples 3SW-3 and 3SD-3 • Elevated TOX levels in samples 3SW-1, 3SW-2, and 3SW-3	N/A N/A

TABLE 1-1. SUMMARY OF FINDINGS, IRP PHASE II, STAGE 1 INVESTIGATION, NIAGARA FALL IAP, NEW YORK (CONT'D)

	Media Sampled		
	Groundwater	Surface Water/Sediment	Soils
Site 4	• Elevated oil and grease in upgradient surficial Well 4-1 • Elevated lead levels in upgradient surficial Well 4-1 • Elevated TOC and POC levels in all wells	N/A	N/A
Site 6	• Elevated TOC levels in downgradient Well 6-3 • Elevated POC levels in all wells	N/A	N/A
Site 7	• Elevated TOC levels in upgradient surficial Well 7-1 and downgradient Well 7-3 • Elevated POC levels in all wells	N/A	• Elevated oil and grease in soil boring sample 7SB-1 • Elevated TOC in soil boring sample 7SB-2
Site 10	• Elevated TOC levels in upgradient surficial Well 10-3 • Elevated POC levels in all surficial wells • Elevated TOX values in surficial Well 10-2	• Elevated TDS levels in samples 10SW-1 and 10SW-2 • Elevated oil and grease levels in samples 10SD-1 and 10SD-2 • Elevated TOX levels in samples 10SD-1 and 10SD-2	N/A
Site 5	• Elevated TOC levels in all wells • Elevated POC levels in all wells • Elevated lead levels in surficial Wells 5-2, 5-3, and 5-4	N/A	N/A

TABLE 1-1. SUMMARY OF FINDINGS, IRP PHASE II, STAGE 1 INVESTIGATION,
NIAGARA FALL IAP, NEW YORK (CONT'D)

	Media Sampled		
	Groundwater	Surface Water/Sediment	Soils
Site 8	• Elevated TDS levels in all wells • Elevated TOC levels in all wells • Elevated POC levels in all wells • Very high lead levels in all wells	• Elevated TOC levels in sample 8SW-2R • Elevated POC levels in sample 8SW-2 • Elevated TOX levels in samples 8SW-1, 8SD-1, and 8SD-2 • Elevated lead levels in samples 8SW-1R and 8SD-2	N/A
Site 12	N/A	• Elevated TOX levels in samples 12SW-1, 12SD-1, 12SW-2, and 12SD-2 • Elevated oil and grease level in upstream sample 12SW-1	• Elevated oil and grease in 12SB-1 • Elevated TOC levels in 12SB-1 and 12SB-2
Site 9	• Elevated TDS levels in all wells • Elevated TOC levels in downgradient surficial Wells 9-1 and 9-4 • Elevated POC levels in all surficial wells	• Elevated POC levels in samples 9SW-1 and 9SW-2 • Elevated oil and grease level in downstream sample 9SD-2 • Elevated TOX level in downstream sample 9SD-2 • Phenol levels increased in downstream sample 9SD-2	N/A
Site 11	N/A	N/A	• Elevated TOX in all samples • Elevated oil and grease in samples 11SB-3, 11SB-3R, and 11SB-4

2.0 ENVIRONMENTAL SETTING

2.1 INTRODUCTION

An understanding of the environmental setting of Niagara Falls IAP is important for: 1) evaluating previous IRP and other site investigation work completed on the base, 2) scoping and completing an effective remedial investigation (RI) program to quantify the extent and magnitude of environmental contamination at the sites in question, and 3) interpreting the results of the RI as the basis for the Feasibility Study (FS). This section briefly summarizes the geophysical setting, geology, hydrogeology, climatology/air quality, natural resources, and human environmental information that is currently available for Niagara Falls IAP.

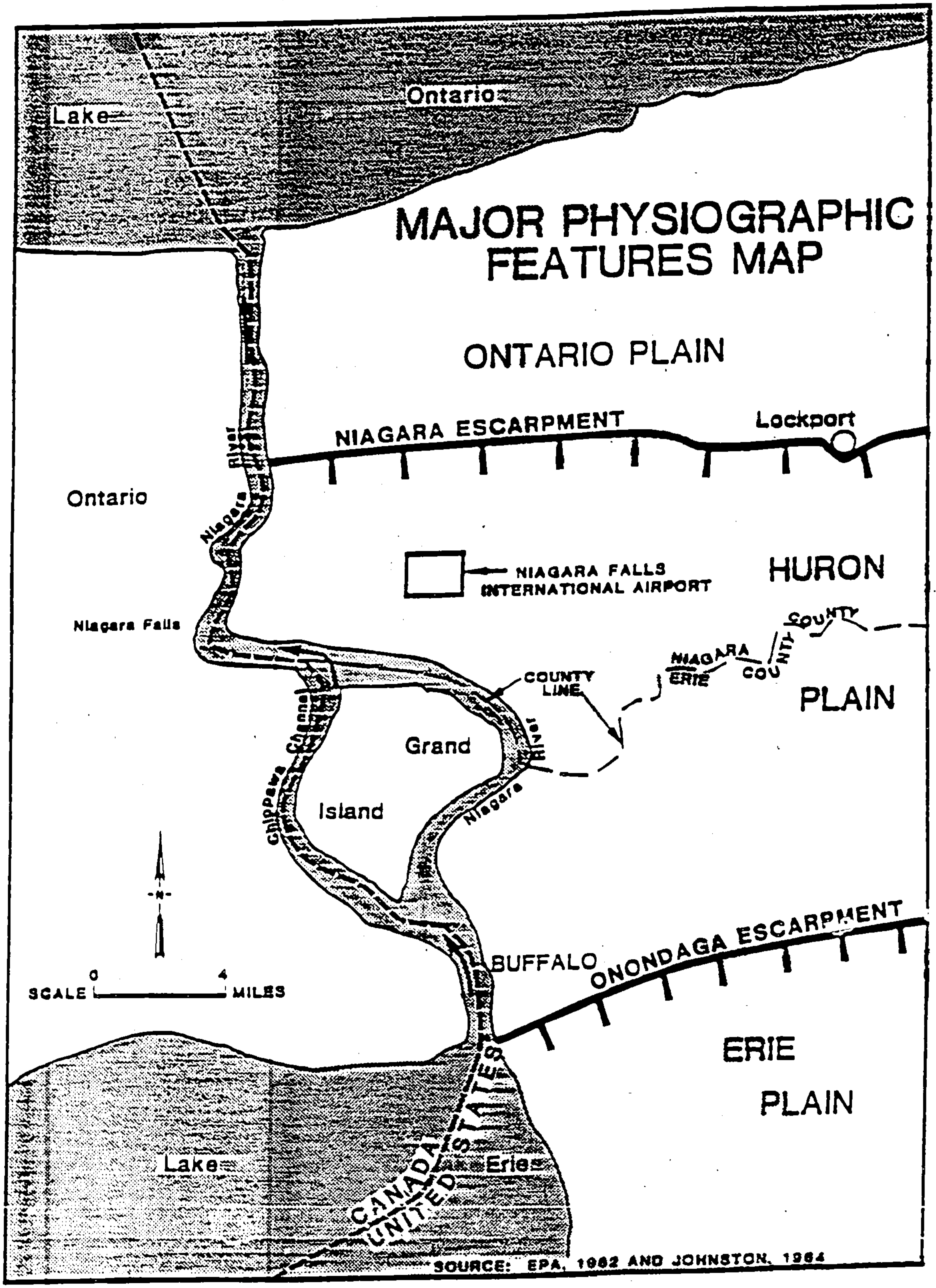
2.2 GEOGRAPHIC SETTING

2.2.1 Physiography

Niagara Falls IAP is located within the Buffalo-Niagara Falls region of the Central Lowland physiographic province. As illustrated in Figure 2-1, three plains comprise the region: Erie, Huron and Ontario. Niagara Falls IAP lies in the Huron Plain of the Central Lowland Province, which is bounded by the Niagara Escarpment to the north and the Onondaga Escarpment to the south. The Huron Plain occupies a portion of western New York State, and extends westward into Ontario, Canada. The plain is nearly flat and extends from the base of the Onondaga Escarpment in the south, to the top of Niagara Escarpment in the north. The Huron Plain is drained by a system of creeks; all of the streams in the Niagara Falls area flow into Lake Ontario either directly or as tributaries to the Niagara River (Johnston, 1964).

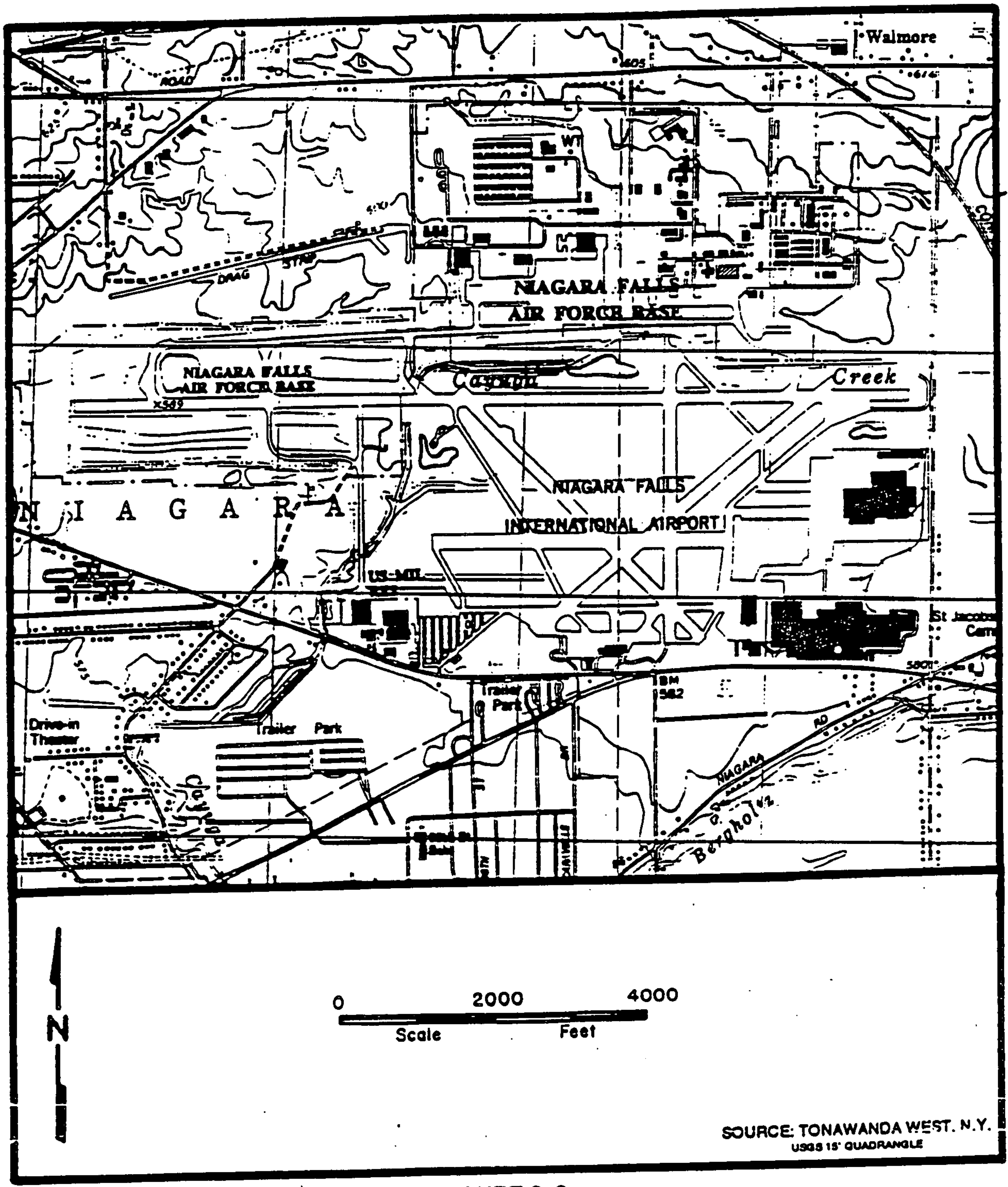
2.2.2 Topography

Surface elevations in the vicinity of the Niagara Falls IAP range between 585 and 600 feet above mean sea level (AMSL). The base and nearby areas are characterized by very low relief (Figure 2-2), as are most land areas located on



SOURCE: EPA, 1982 AND JOHNSTON, 1964

FIGURE 2-1
PHYSIOGRAPHIC LOCATION OF NIAGARA FALLS IAP, NEW YORK



SOURCE: TONAWANDA WEST, N.Y.
USGS 15' QUADRANGLE

FIGURE 2-2.
TOPOGRAPHIC MAP OF NIAGARA FALLS IAP AND VICINITY

the Huron Plain. The escarpments that bound the Huron Plain represent the most pronounced breaks in topography, with the Niagara escarpment showing an abrupt 200 foot drop in elevation. With few exceptions, elevation differences across the Huron Plain greater than 20 feet are rare. The Huron Plain as a whole dips southward towards the Onondaga escarpment, whereas the Ontario Plain dips northward toward Lake Ontario. The majority of topographic features in the Niagara Falls region were created during the Wisconsin Glacial Stage, which occurred approximately 85,000 to 7,000 years ago (Johnston, 1964). After the retreat of the glaciers, the lowland areas were covered by shallow lakes. Lake deposits of silt, clay and fine sand currently dominate the topographic features of the area. As a result, soils that develop on top of these deposits consist of silty clay loams, and are typically poorly drained.

2.2.3 Cultural Geography

Niagara Falls IAP is located in an area of varied land use. Figure 2-3 provides a generalized illustration of land use near the base. The major industrial concentration exists approximately two miles west-southwest of the base, and a minor tract of industry exists along the southeast border of the base. Large residential areas are pervasive throughout the area, while rural and agricultural areas exist to the north, east, and southeast. Commercial tracts are located South and West of the base, along Niagara Falls Boulevard and Military Road.

Since the Niagara Falls IAP straddles the border between the towns of Niagara and Wheatfield all inferences to demographics in the vicinity of the base will be restricted to statistics for those towns. The population of Niagara County stood at 227,354 in 1980, but the estimated 1985 figures show a population loss of 10,000. Starting in 1995, the county population is projected to increase in each five year period, amounting to a total population of 223,922 in 2010. Population growth is predicted to be confined to a few municipalities, namely, the Town of Lockport and the Town of Niagara. Population growth is projected to remain quite stable for other municipalities. Data describing population levels

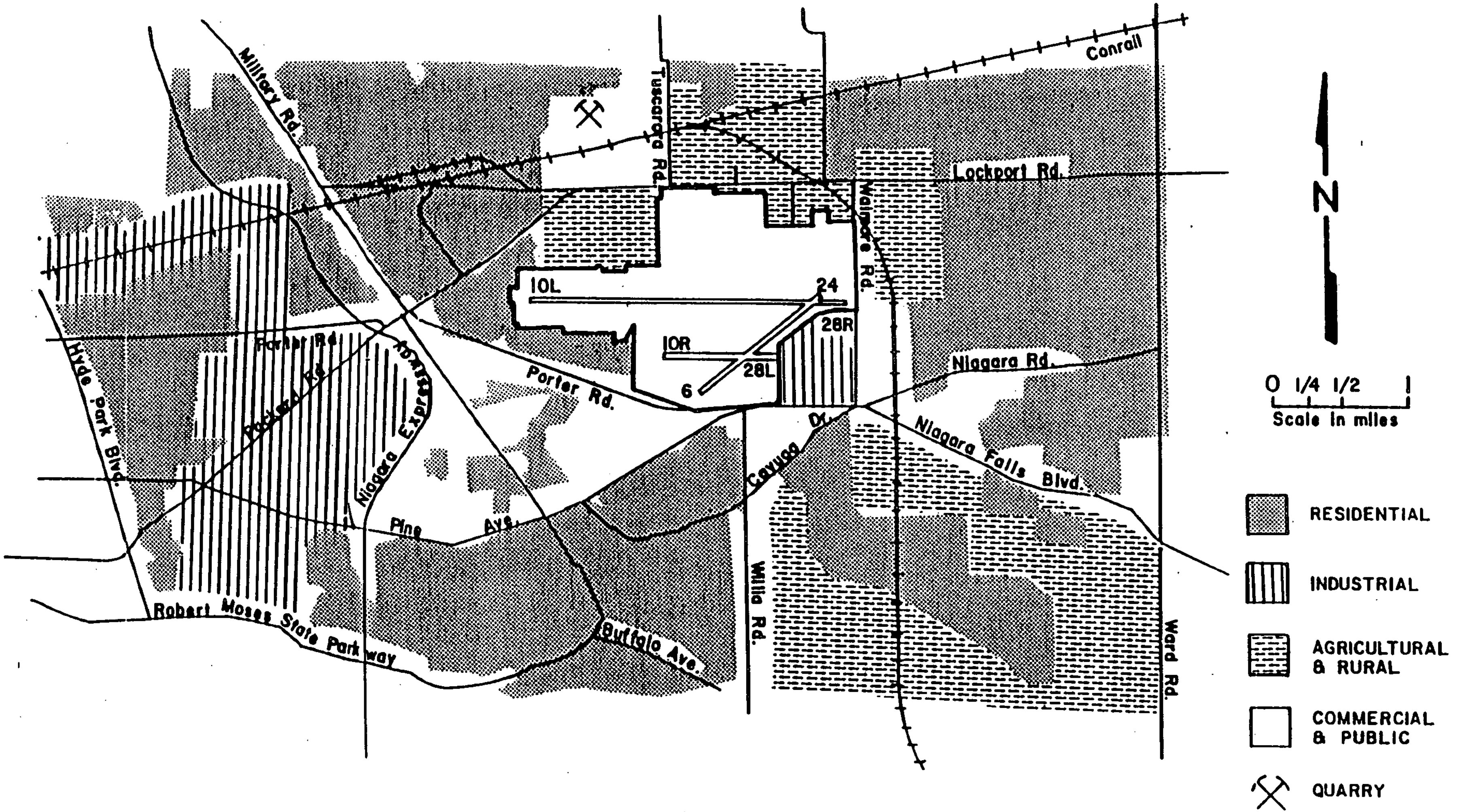


FIGURE 2-3.
LAND USE AROUND NIAGARA FALLS IAP

and age distributions of residents are available from the U.S. Census Bureau for Census tracts around and on the base, as illustrated in Figure 2-4.

The economic outlook for Niagara County is a mixture of growth and decline. Aside from normal business cycle influence, the area is heading toward positive economic and demographic trends for the first time in the past quarter century. Nonagricultural wage and salary jobs are projected to increase by about 8,600 or 1.8 percent by 1990. While the growth rate of the area appears meager compared with rates expected for the state and the nation, this projection is in sharp contrast to the declines of the past. Trade employment is expected to resume a growth pattern following several years of stagnation. Manufacturing employment will continue a secular decline as it did during the 1984 to 1990 period. The factory sector is expected to experience fewer losses (in terms of plant closings) and will become less cyclically sensitive in the future. The resulting stability will benefit the local economy (Erie and Niagara Counties Regional Planning Board, 1987).

Niagara County experienced a per capita income growth rate of 28.4 percent over the period from 1979 to 1983, and is expected to increase from the 1983 figure of $11,398.

Niagara Falls Air Reserve Base has a tremendous impact on the local economy, with an annual payroll in excess of $30 million and contract spending of approximately $4.5 million. It is estimated that secondary jobs created in the area as the result of the Air Base total more than 1,500.

2.3 GEOLOGY AND SOILS

2.3.1 Geology

The geology of the Niagara Falls area has been investigated previously by Grabau (1901), Kindle and Taylor (1913), Cannon (1955), Bolton (1957), Johnston (1964), and Zenger (1965). Data from these reports indicate that there are two geologic units in the Niagara Falls IAP area that are important to this study.

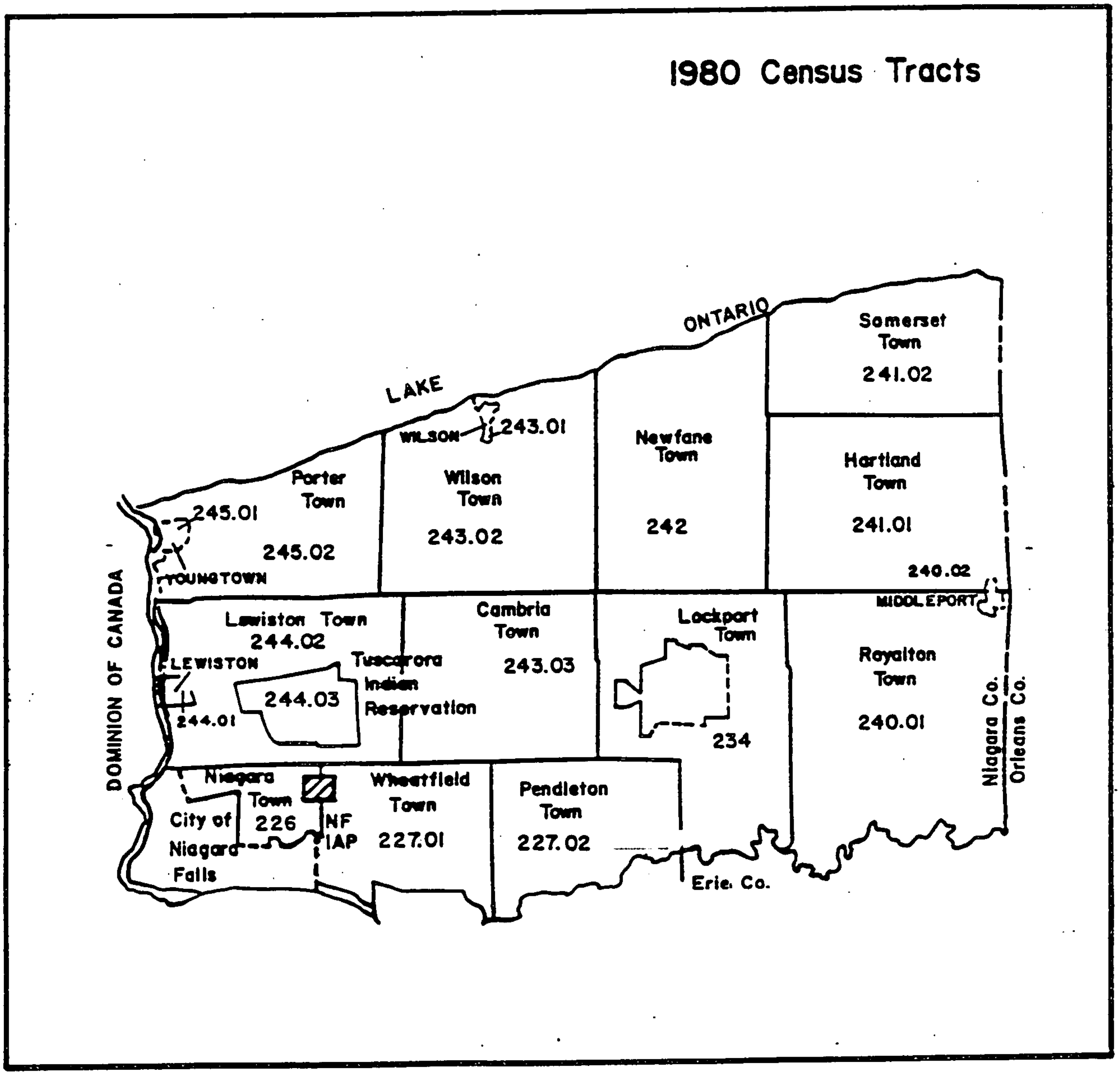


FIGURE 2-4
CENSUS TRACTS FOR NIAGARA COUNTY

These two units are the uppermost bedrock unit and the overlying, unconsolidated, glacial/lacustrine deposits.

A thin cover of unconsolidated deposits overlies carbonate bedrock throughout most of the area. These sediments are the result of several advances and retreats of continental glaciers during the Pleistocene Epoch. Unconsolidated deposits in the Niagara Falls area generally consist of three types:

- Glacial Till - reddish brown, firm, silty clay matrix, surrounding rounded and sub-rounded gravel and cobbles of dolomite, shale and igneous and metamorphic rock fragments.
- Lacustrine Deposits - primarily clays with some silt and local lenses of silty-sand.
- Fluvial Deposits - mostly fairly well sorted sands and gravels.

The glacial till deposits were laid down directly by the glacial ice sheets. The till is generally less than 10 feet thick and overlies bedrock in most areas. The till is often referred to as stony hardpan, as it is particularly compact and locally, may prevent mixing of water between the overlying lake deposits and bedrock. Although the till is characterized as a heterogeneous deposit of cobbles, gravel, sand, silt and clay, it may locally consist of a matrix of sandy clay or a gravel-free, reddish brown, firm silty clay (U.S. Environmental Protection Agency, 1983).

The lacustrine deposits were laid down over the till by glacial lakes that formed along the margins of the ice sheets. These predominantly clay deposits encountered in the Niagara Falls area are the products of glacial lakes Tonawanda and Dana. Although the lacustrine deposits are primarily clay, locally they contain lenses of silty sand, or sand and gravel. This coarser material is a result of sediment reworking caused by networks of meltwater streams. Glacial Lake Tonawanda deposits generally consist of a 3- to 6-foot layer of reddish brown and reddish gray, somewhat moist, firm, silty-clay to clay. The underlying Lake Dana deposits consist of a 2- to 20-foot layer of a reddish brown, very moist to wet, very plastic, very sticky, silty-clay to clay. The boundary between the two lake deposits is indistinct and is based mainly on moisture change. The lacustrine clays are often variegated and varved. The variegated clays, which are primarily shades of red, green, and gray, owe their color to their parent rocks that overlie the Lockport Dolomite to the north of the area. Above the uppermost lacustrine deposits in many areas there are layers of silty sand and clayey silt, and other fill materials that vary in thickness from a few inches to approximately three feet.

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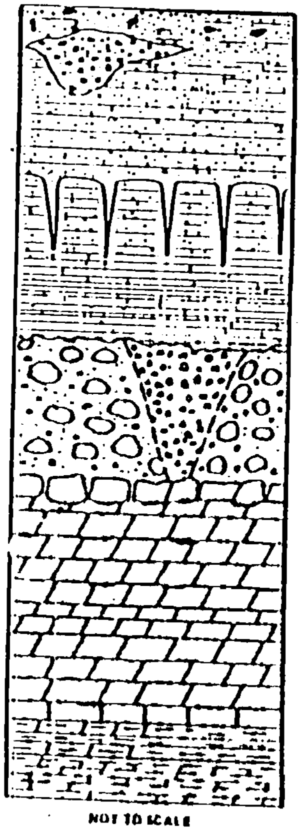
The fluvial sediments scattered throughout the lacustrine deposits are the result of a complex network of streams. These streams were active in the multi-outlet river-lake system that prevailed following the last ice retreat (Calkin and Brett, 1978). Being probably ephemeral in nature, the streams acted to drain and feed the glacial lakes. Remnants of these streams are recognized as thin, disconnected lenses of silty sands, sand, and gravel. The fluvial sands and gravels occur as isolated deposits. Figure 2-5 presents a schematic columnar section of the overburden deposits and the underlying bedrock units.

The bedrock of the Niagara Falls IAP area is the Lockport Dolomite of Middle Silurian age. The Lockport Dolomite is a massive- to thinly-bedded sedimentary rock characterized by vugs, fractures and secondary mineral deposits. The dolomite ranges in color from dark gray to brown over most of its extent. The nearly flat-lying surface of dolomite dips gently to the south at about 28 feet per mile (Reck and Simmons, 1962). The top of the bedrock typically lies 5 to 15 feet below land surface (BLS) (Johnston, 1964). In the Niagara Falls area, the Lockport Dolomite is approximately 180 feet thick (Zenger, 1965). Figure 2-6 illustrates the stratigraphy of the Lockport Formation, extending from the city of Niagara Falls eastward through Tonawanda to Lockport. The Lockport consists of five lithologic units (from youngest to oldest):

Oak Orchard member: brownish-gray, fine- to medium-grained thin- to mostly thick-bedded dolomite; about 120 feet thick.

Eramosa member: medium dark gray to dark gray, fine-grained, thin-to medium-bedded, argillaceous dolomite; from 16 to 18 feet thick.



System		Formation Unit	Thickness (Feet)	General Geologic and Hydrologic Characteristics
Quaternary	Late	Fill	0.1-3	- Covers nearly entire study area - Varies from local soil material to construction rubble and industrial wastes
		Lacustrine Deposits	6-29	- Sand lenses randomly occur as elongated lacustrine deposits throughout region and consist of loamy to sandy clay; sometimes exposed at surface in undisturbed areas - Total thickness of former glacial lake deposits increases from north to south in vicinity of canal - Upper sequence deposited in former Lake Tonawanda (3-8 feet thick) is reddish brown to gray, moist, firm to very firm, varved, silty-clay to clay; dessication cracks reported in selective areas within sequence - Lower sequence (2-20 feet thick) attributable to former Lake Dana is reddish brown, very moist to wet, very plastic, very sticky, silty-clay to clay - Permeability of lacustrine deposits is generally low
		Glacial Till	1-25	- Reddish brown, moist, firm, silty to sandy clay with gravel and cobbles; sandy zones, well-sorted gravel - Two or three ridges of till oriented NE-SW are in Canal Area - Generally low permeability - Approximately 5-20 feet thick in Canal Area
Silurian	Middle	Lockport Dolomite	160-180	- Dark gray to brown, massive to thin bedded dolomite dipping at low angle to south; secondary deposits of sulfides, sulfates, and carbonates occur throughout the formation - Principal aquifer in Niagara Falls area; major producing zones in upper part of formation - Artesian and unconfined water table conditions exist associated with vertical fracture zones, cavities formed by solution of minerals and between bedding planes - Vertical joint system hydraulically connected to Niagara River
	Lower	Rochester Shale	60	- Dark-gray calcareous shale; relatively impermeable

FIGURE 2-5
GENERALIZED COLUMNAR SECTION OF GEOLOGIC UNITS IN THE NIAGARA FALLS IAP AREA

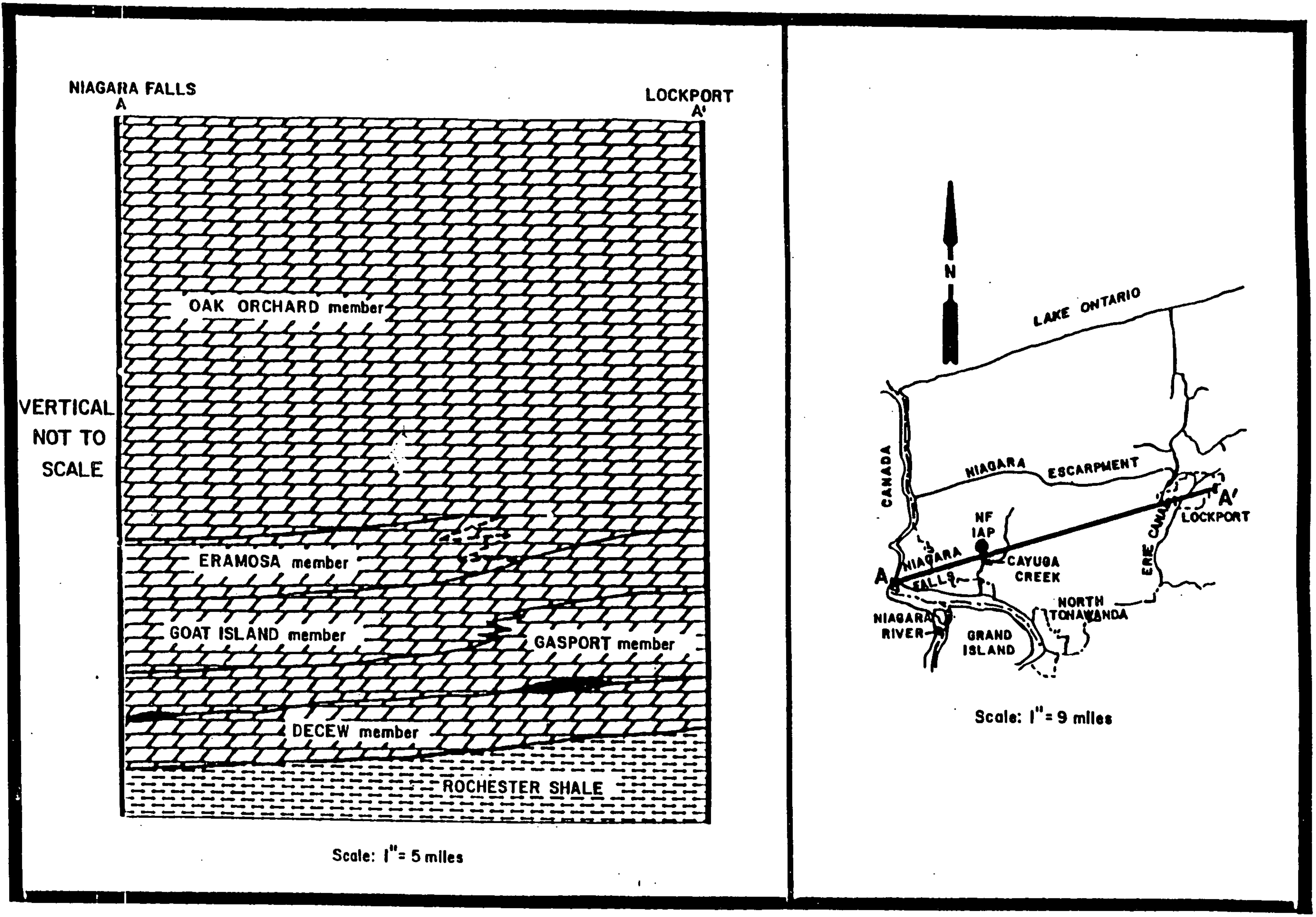


FIGURE 2-6
REGIONAL STRATIGRAPHY [illegible] THE LOCKPORT FORMATION

Goat Island member: light olive-gray to brownish-gray, medium-grained, thick-bedded dolomite; from 19 to 25 feet thick.

Gasport member: olive-gray to brownish-gray, coarse-grained, medium- to thick-bedded limestone or dolomite; from 15 to 23 feet thick.

DeCew member: gray to dark gray, fine-grained, thin- to thick-bedded, and massive, argillaceous dolomite, from 8 to 12 feet thick.

The Lockport Dolomite contains primary and secondary deposits of calcite (calcium carbonate) and gypsum (calcium sulfate) in vugs and fractures. Pyrite (iron sulfide), sphalerite (zinc sulfide), and galena (lead sulfide) particles or zones of mineralization are disseminated throughout the dolomite.

The Lockport Formation is underlain by approximately 60 feet of dark gray calcareous shale known as the Rochester Shale of the Clinton Group. The geologic unit serves as a regional confining unit that limits the downward migration of groundwater.

2.3.2 Soils

Soils at Niagara Falls IAP and vicinity consist of three soil units (Table 2-1 and Figure 2-7): a cut and fill soil unit, the Lakemont unit and the Odessa unit (Higgins and others, 1972). All of these units are part of the Odessa-Lakemont-Ovid association, which is the largest soil association in Niagara County, covering about 21 percent of the county. About 24 percent of this is Odessa soils, 14 percent is Lakemont soils, and 11 percent is Ovid soils. The remaining 51 percent consists of minor soils, including cut and fill soils.

All of these soils, except the cut and fill, formed on level, or nearly level, lake plains south of the limestone escarpment. The soils in the association have a fairly low value for farming. Much of the soil is either idle or is cropland that is not intensively used because of the flatness of the area and the fine texture of the soils. These characteristics cause natural drainage to be poor, creating problems for agricultural development, as well as for town and county planning. The texture of the soil is generally too fine for most

TABLE 2-1

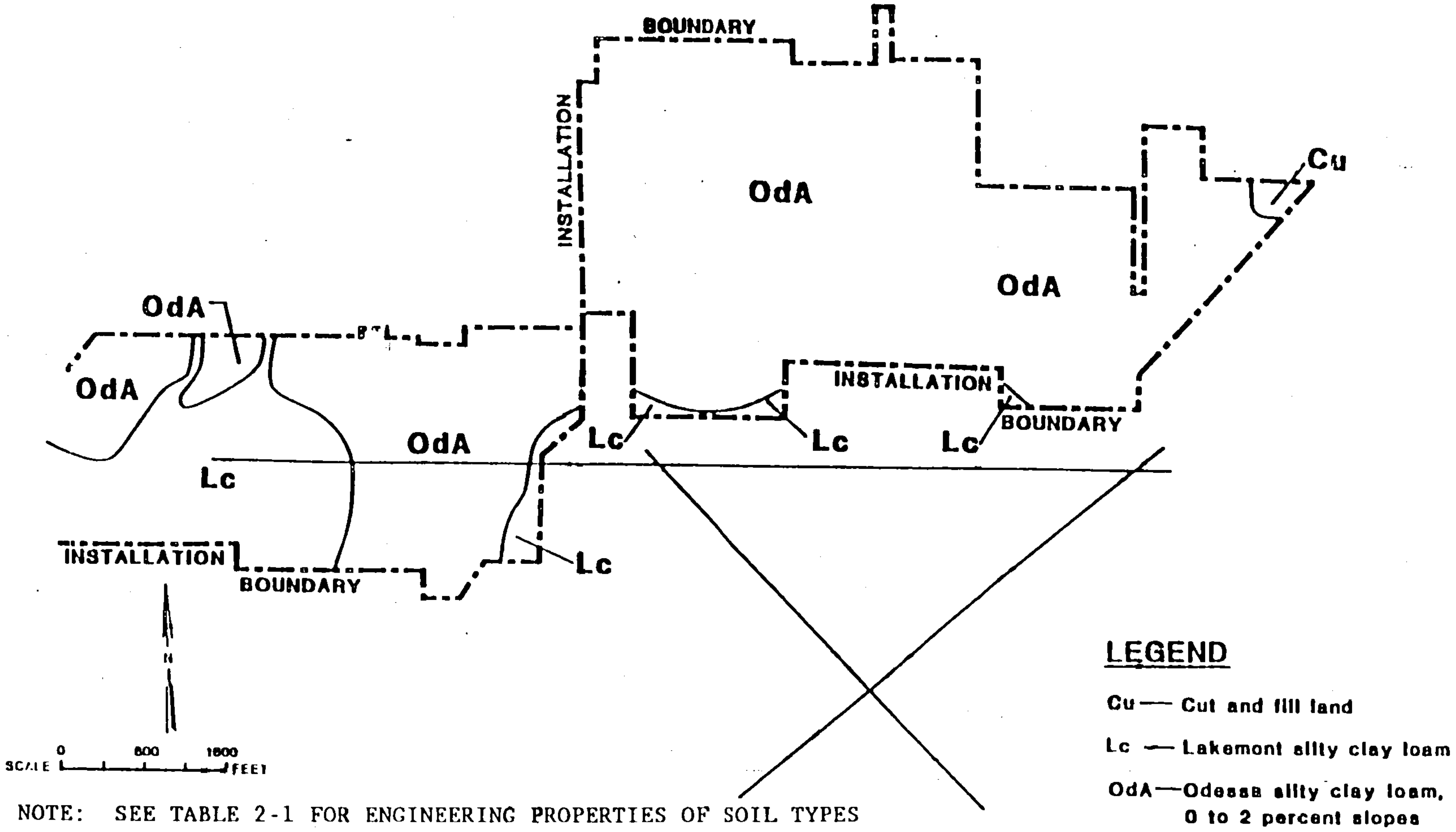
NIAGARA FALLS INTERNATIONAL AIRPORT SOILS

Symbol on Figure 2-7	Unit Description	Depth to Bedrock (Feet)	Depth to Seasonal High Water Table (Feet)	Soil		Septic Tank Use Limitations
				Depth (Inches)	Permeability (Inch/Hour)	
Cu	[1]Cut and fill land	--	--	--	--	--
Lc	Lakemont silty clay loam	6+	0-1/2	0-8 8-26 26-50	0.2-0.63 <0.2 <0.2	Severe: high water table; ponding; slow permeability
OdA	Odessa silty clay loam; 0 to 2 percent slopes	6+	1/2-1	0-8 8-56	0.2-2.0 <0.2	Severe: high water table; slow permeability

Note: 1. Soil unit in which properties vary due to removal of top soil and some subsoil.

Source: USDA, Soil Conservation Service, 1972.

SOILS



NOTE: SEE TABLE 2-1 FOR ENGINEERING PROPERTIES OF SOIL TYPES

SOURCE: USDA, SOIL CONSERVATION SERVICE, 1972

FIGURE 2-7.
NIAGARA FALLS IAP SOILS

vegetable crops, although, if adequately drained, the soils have a good potential to support grain, dairy cattle, and other livestock.

The Lakemont soil unit exists along Cayuga Creek and the western part of Runway 10L/28R. The Lakemont silty clay loam consists of deep, poorly to very poorly drained, moderately fine soils that have a moderately fine- to fine-textured subsoil. The soil forms in level to slightly depressed within large glacial lake basins. Slopes are generally less than 3 percent.

A representative profile of a Lakemont soil shows a surface layer, an upper subsoil layer, a lower subsoil layer, and the substratum. The surface layer is a black, generally neutral (6.1 to 7.6 S.U.) silty clay loam, eight inches thick. The upper subsoil layer is a gray to light-gray, silty clay that has a few prominent reddish-yellow mottles. It is firm, possesses a neutral pH, and is generally 9 inches thick. The lower subsoil layer lies between depths of 18 and 26 inches. It is a firm, pinkish-gray, silty clay that has a few prominent reddish-yellow mottles. The layer generally has a neutral Ph, but the lower four inches are calcareous in places. The substratum is a firm, reddish-gray and reddish-brown, calcareous, silty clay loam (USDA, 1972).

The Lakemont soils have a seasonal high water table that attains levels at or just under the land surface early in spring and during other excessively wet periods. Lakemont soils are normally ponded during wet periods because of their position in the landscape and the low permeability of the subsoil. The depth available for rooting depends on the position of the water table, but roots are confined mainly to a depth of 15 inches. The available moisture capacity is moderate (0.14-0.20 in/in of depth). Permeability is moderately slow in the surface layer and slow in the subsoil (0.20-0.63 in/hr to <0.20 in/hr) (USDA, 1972).

The Odessa silty clay loam consists of deep, rather poorly drained, moderately fine-textured soils. These soils formed in the basins of glacial lakes as lacustrine deposits in which calcareous clay was dominant. They occur where the land is level to gently sloping, with slopes ranging from 0 to 6 percent.

A representative profile of an Odessa soil includes a surface layer, a subsoil, and the substratum. The surface layer is a slightly acidic (6.1-7.3 S.U.), dark grayish-brown silty clay loam, eight inches thick. The subsoil is a firm, brown and light reddish-brown, mottled, silty clay. It is slightly acidic in the upper part and mildly alkaline in the lower part. The substratum is calcareous and consists of very firm, reddish-brown, mottled layers of clay and silt (USDA, 1972). It generally lies at a depth of 33 inches.

The seasonal high water table lies 6- to 12-inches below the surface early in spring and during excessively wet periods. The water table usually is perched above the less permeable subsoil and substratum. Rooting depth is related to the water table and the calcareous substratum and most roots are confined to the uppermost 20 inches of soil. As the water table falls, roots can penetrate to the calcareous substratum. The available moisture capacity is moderate (0.15-0.20 in/in of depth). Permeability is moderately slow in the surface layer and slow in the subsoil (0.20-2.0 in/hr) (USDA, 1972).

Cut and fill soils are found in the extreme northeast corner of the base near the main gate, where the original soil has been removed or covered with other soil materials. The cut and fill soils consist mainly of a mixture of soil materials that have little or no profile development, and are characterized by variable permeability due to the variability of fill materials used (USDA, 1972).

2.4 GROUNDWATER HYDROGEOLOGY

2.4.1 Occurrence and Movement

2.4.1.1 Unconsolidated Surficial Aquifer

The combined unconsolidated deposits in the Niagara Falls IAP area form a minor aquifer in the area, but the fine-grained nature of the unconsolidated units (i.e., till, lacustrine deposits) produces very low hydraulic conductivities. As a result, water wells screened in the unconsolidated deposits reportedly yield less than 100 gallons per day (gpd)(Johnston, 1964). Adequate yields for domestic needs are obtained only when water wells tap into localized sand and gravel deposits. Due to the low permeabilities of the till and lacustrine deposits infiltration rates are low and surface runoff is high. Water movement through these units is fairly restricted, except through sand lenses and dehydration cracks. These cracks are common secondary features that develop in lacustrine clays that are exposed at the surface; the clays periodically dehydrate, resulting in polygonal cracking of the clay to depths of several feet. Some studies claim that these cracks serve as a significant route for groundwater movement in the overburden (EPA, 1983).

The glacial till unit ranges from 1 to 25 feet thick and overlies the bedrock in most places. Overall, the till appears to be a low permeability unit with only localized areas of higher permeability scattered throughout it (EPA, 1983); it reportedly has a measured permeability as low as 7.6 x 10^{-9} cm/sec (EPA, 1983) and as high as 1.08 x 10^{-3} cm/sec (Johnston, 1964). The higher value has been attributed to the presence of sand layers in the till which would influence the water to move more rapidly.

The lower lacustrine silty clay unit, which ranges from 2- to 20-feet in thickness, is generally thin where till deposits are thickest and thick where till deposits are thin. This relationship is not unusual for lake-deposited sediments, and accounts for the absence of any expression of the lower units in the present landscape. According to studies conducted by the USEPA (1983) in the Love Canal Disposal Site several miles south of the Niagara Falls IAP, the lower lacustrine unit was found to have permeabilities only slightly higher than those measured for the underlying till. Permeabilities of 9.7 x 10^{-9} cm/sec and 3.7 x 10^{-8} cm/sec respectively were calculated for the upper and lower half of this unit. These values are lower than those reported by other investigators (Johnston, 1964).

The upper lacustrine silty clay unit, which ranges in thickness from 3 to 6 feet, has a reported permeability range from 2.3 x 10^{-8} cm/sec to 7.6 x 10^{-8} cm/sec (EPA, 1983). However, these values may not be representative of the upper lacustrine unit, because the slug tests were performed on wells where a portion of the screened interval was adjacent to more permeable surface fill materials. As a result, actual permeability values for this unit may be lower. The USEPA values that were obtained are much lower than those determined by other investigators (i.e., 1.8 x 10^{-6} cm/sec)(Johnston, 1964).

The upper surface soils and fill, which are absent in some places and up to 3 feet thick in others, represent the most permeable overburden deposit. Based on the texture of these materials, the permeabilities have been estimated to be 1 x 10^{-2} cm/sec or greater (EPA, 1983).

The overall low permeability of the overburden deposits causes a seasonal water table to form in many places, particularly where fill and coarse-grained material overlie till and lacustrine clays (USGS, 1985). This resulting perched water table reportedly develops mounds that discharge groundwater radially into topographic lows, including drainage ditches and streams. Groundwater movement in the unconsolidated aquifer is generally toward the major surface water bodies (i.e., rivers, creeks, streams) (EPA, 1983). On the installation it was discovered that minor drainage systems, such as ditches and small tributaries, are capable of locally influencing groundwater flow direction in the unconsolidated aquifer.

Groundwater levels in the unconsolidated deposits vary throughout the Niagara Falls area. Test drilling performed by the USGS (1985) reported that groundwater was encountered at 5 to 15 feet BLS. In some areas north and along the Niagara River gorge, where the unconsolidated deposits are thin, no water was encountered (USGS, 1985). On the installation, groundwater was often encountered for the first time at the bedrock/unconsolidated overburden interface, anywhere from 5.2 feet to 17.3 feet BLS. The potentiometric surface of the overburden aquifer on the base ranges from one foot BLS near Building 600 at Site 1, to 13 feet BLS at the NYANG Hazardous Waste Drum Storage Area (Site 5).

The surficial overburden aquifer has been described in the literature as a water table aquifer (Engineering Science, 1983). This is probably true for the uppermost zone during the wetter months when perched water table zones develop, and also in localized areas where more permeable fluvial deposits are not overlain by lacustrine clays. However, artesian conditions will also exist in situations where more permeable silty or sandy zones are overlain or isolated by impermeable clay-rich deposits.

2.4.1.2 Lockport Dolomite Aquifer

The Lockport Dolomite is the major bedrock aquifer in the vicinity of Niagara Falls IAP. The Lockport is a widespread, persistent rock unit and is the first bedrock unit encountered during drilling. Depth to bedrock varies throughout the area but generally ranges from 20 to 40 feet BLS (EPA, 1983). On the base the Lockport Dolomite outcrops along its eastern extremity near Cayuga Creek and occurs at a maximum depth of 15 feet BLS in the vicinity of Site 8, north of Building 202.

Groundwater exists in the Lockport Dolomite under artesian, semi-confined, and unconfined conditions. Artesian conditions appear to predominate in the Niagara Falls area. The till and the lacustrine deposits are less permeable than the fractured, water-bearing zones of the dolomite and thus act as confining beds. Water levels in wells that penetrate these confining units exhibit artesian conditions by rising above the bottom of the overlying clay and silt. Locally, a "washed" till or dirty gravel zone may exist on top of the bedrock surface resulting in a good connection between the bedrock and the overlying till or gravel, thus forming a continuous semi-confined aquifer (Johnston, 1964). Artesian conditions occur exclusively in water-bearing zones in the lower part of the rock, where these zones are surrounded by essentially impermeable crystalline rock.

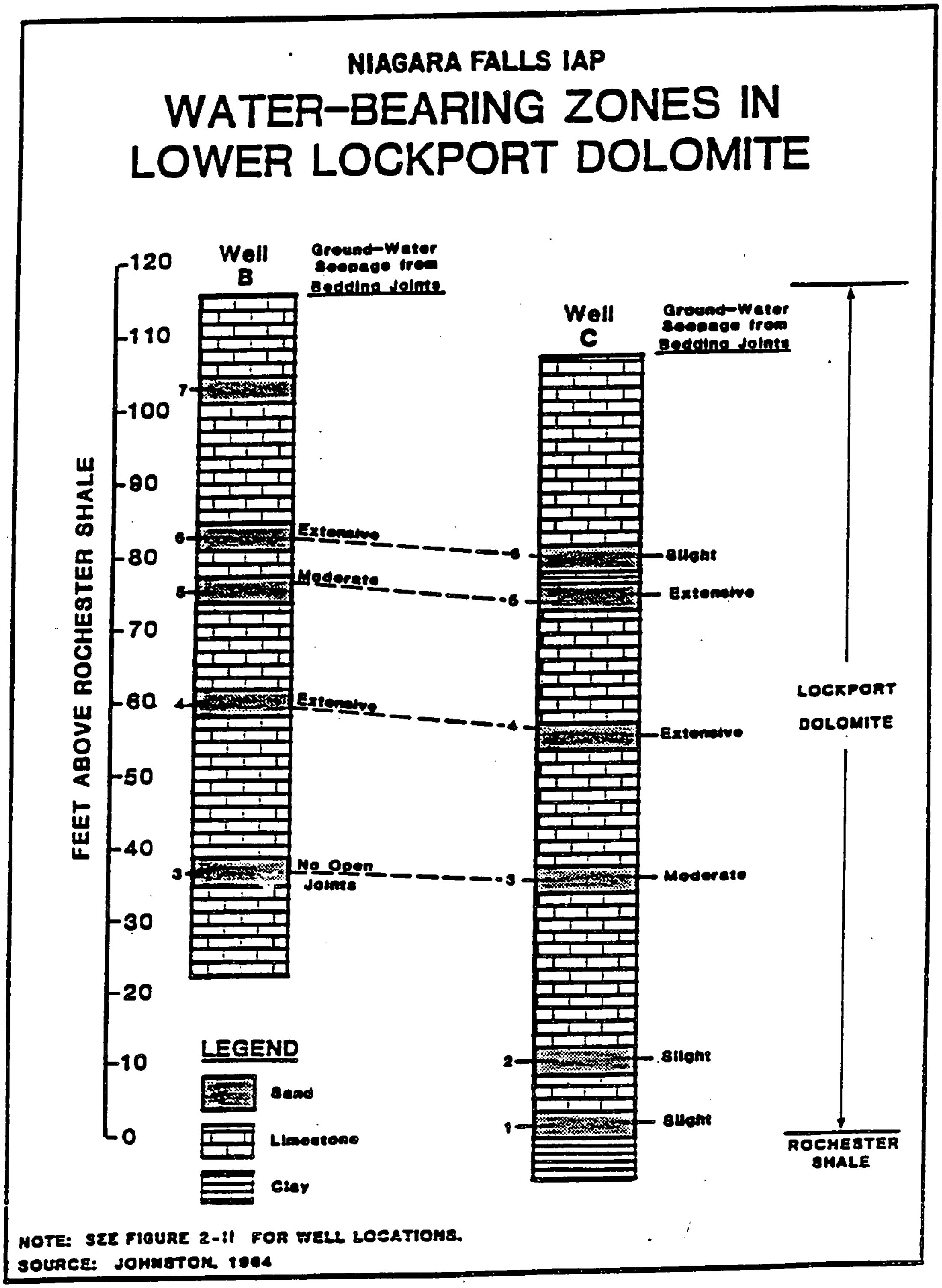
The regional groundwater flow in the vicinity of Niagara Falls is south and west toward the Niagara River. The regional flow in both aquifers is occasionally interrupted in places by such factors as: (1) excessive pumping from wells, (2) openings in the rock which provide paths for water flow in directions other than the regional flow direction, and (3) areas of high recharge (EPA, 1983). The concentration of industrial plants several miles southwest of Niagara Falls IAP, and the attendant drawdown in industrial supply wells, has deflected flow in this area toward those supply wells. The exact area affected by this deflection is not known, but generally extends in a radius of several hundred feet from the most heavily pumped wells. The Niagara River also has a significant effect on the movement of groundwater in the Lockport, particularly in areas adjacent to the upper Niagara River above the Falls.

Groundwater movement within the Lockport Dolomite occurs along several types of water-bearing openings. The literature recognizes bedding-plane joints or separations as being the principal water-bearing feature (Johnston, 1964). Vertical joints, and voids from which gypsum nodules were dissolved, are considered minor water-bearing openings.

Most of the groundwater movement occurs along the horizontal bedding joint zones. Some movement reportedly occurs in other thin-bedded zones (0.5 to 4 inches thick), which tend to be weaker and more likely to fracture than the more massive beds which are 2 to 10 feet thick (USGS, 1985). Open bedding-plane joints can occur at any stratigraphic horizon in the Lockport Dolomite. Concentrations of persistent, closely-spaced joints form major water-bearing zones throughout the formation. Some horizontal joints in a zone have been traced for several miles, although not all joints are water bearing. Joints that are water bearing are widened to some degree by dissolution of the rock by groundwater, with some joints open as much as 1/8 inch (Johnston, 1964). Locally, dissolution along bedding plane joints has been great enough to cause the rock overlying the solution opening to settle. Horizontal joints are probably connected to some extent by vertical fractures, but little information is available to determine the extent of hydraulic connection.

The uppermost water-bearing zone of the Lockport Dolomite, the focus of this remedial investigation, is different from the lower zones, in that groundwater movement is just as likely to occur along a series of vertical fractures/joints as along bedding-plane joints. The uppermost zone is 10 to 15 feet thick, and is commonly referred to as the weathered zone. This zone follows the upper surface of the rock in the outcrop area rather than a stratigraphic horizon. Seven other distinct zones having well-developed bedding plane separations have been identified (Johnson, 1964) in the lower 145 to 170 feet of the Lockport Dolomite (Figure 2-8).

Groundwater elevations within the upper zone of the Lockport Dolomite in the vicinity of the installation range from 586 to 600 feet above MSL (Johnston,



NIAGARA FALLS IAP

WATER-BEARING ZONES IN LOWER LOCKPORT DOLOMITE

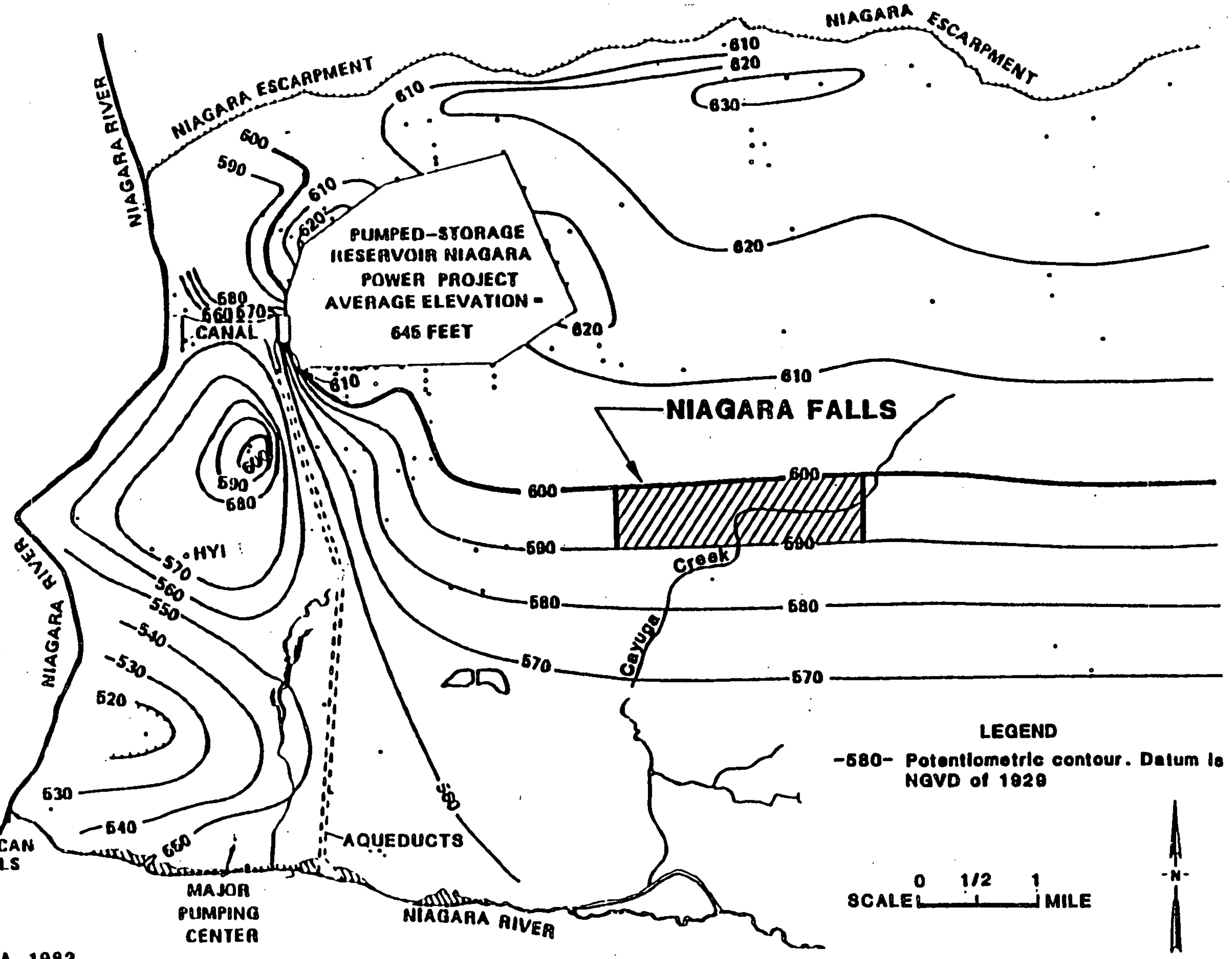
NOTE: SEE FIGURE 2-11 FOR WELL LOCATIONS.
SOURCE: JOHNSTON, 1964

FIGURE 2-8
WATER-BEARING ZONES IN THE LOCKPORT DOLOMITE

1964), with a slight gradient towards the Niagara River. Water levels in bedrock wells on the installation ranged from 0.5 feet above land surface to 13 feet BLS. Figure 2-9 is a generalized potentiometric surface map for the Lockport Dolomite. On the base, the upper water-bearing zone of the Lockport Dolomite is recharged directly by precipitation falling upon outcrops exposed in the landfill area along the eastern perimeter of the installation, and along losing reaches of Cayuga Creek. Surface water in the area is estimated to infiltrate soluble rocks in stream beds at a rate of 2 to 4 million gpd per mile of stream length (Kantrowitz and Snavely, 1982). Groundwater discharge from the Lockport Dolomite, in the vicinity of the installation, reportedly occurs in the Niagara River to the south and in the power plant aqueducts to the southwest (Johnston, 1964). According to recent seepage measurements conducted by the USGS on Cayuga Creek, it appears that the creek is being fed by the Lockport Dolomite near the east side of the installation (USGS, Personal Communication, 1989).

The storage coefficients of the water-bearing zones of the Lockport Dolomite vary mainly with the density of openings in the rocks, which in turn is controlled by the solubility of the rocks. Previous studies have determined that the Lockport Dolomite generally has low coefficients of storage, although the formation is characterized by moderate to high coefficients of transmissivity (Johnston, 1964; La Sala, Jr., 1968). Supply wells installed in permeable zones of the Lockport Dolomite will produce moderate to large yields; however, cones of depression have been observed to develop rapidly and extensively around these wells. Johnston (1964) calculated a coefficient of transmissivity for the upper water-bearing zone to be 3.56×10^{-3} ft^2/s. Pumping tests on other wells in the Niagara Falls area gave transmissivities of 4.64×10^{-4} to 1.55×10^{-3} ft^2/s and coefficients of storage of 0.00001 to 0.0003. The lower end of transmissivity and storage applies to the lowest zones of the Lockport. Pumping tests performed on wells drilled to the base of the Lockport at the Love Canal Waste Disposal Area yielded transmissivity and storage coefficient values of 1.5×10^{-2} ft^2/s and 0.00015, respectively (EPA, 1983).

GENERALIZED POTENTIOMETRIC SURFACE MAP FOR LOCKPORT DOLOMITE



SOURCE: EPA, 1982

FIGURE
GENERALIZED POTENTIOMETRIC SURFACE MAP FOR LOCKPORT DOLOMITE

The yield of a well in the Lockport Dolomite depends mainly upon which water-bearing zone or zones are penetrated, and the degree to which the bedding joints comprising the zones are open to the well. Average yields recorded from wells tapping the upper and middle parts of the Lockport are around 31 gpm (Johnston, 1964) but may range between 2 to 110 gpm (La Sala, Jr., 1968). Even higher yields are reported from wells located adjacent to the Niagara River above the Falls.

2.4.2 Groundwater Uses

Groundwater use in the vicinity of the Niagara Falls IAP is limited. Since the local central water system was installed in 1969, most homes within the vicinity of the installation no longer use their wells, but isolated use of private domestic wells may still exist (Walk, 1983). Most of the domestic wells were completed in the "washed till-top of rock" zone and thus tapped the unconsolidated sediments. The domestic wells generally range between 15 to 20 feet in depth. Well yields are usually less than 100 gpd (Johnston, 1964). The domestic drilled wells tapping the Lockport Dolomite are generally completed within the upper section of the formation and range from 30 to 100 feet deep (Fittante, 1983). The average yield of wells tapping the upper section of the dolomite is 31 gallons per minute (gpm) while the average yield of wells tapping the lower section is 7 gpm (Johnston, 1964). Three wells drilled into the dolomite on the Bell Aerospace property reportedly have yields of 60, 75, and 100 gpm. All three wells were 50 feet deep and the major water-bearing zones were 40 feet BGS (Frey, 1983).

Industrial use of groundwater from the Lockport Dolomite is limited in the vicinity of the installation. One well located at the Carborundum Process Equipment Division Plant northwest of the installation is used for cooling water (Walk, 1983). Other industrial users are located along the Niagara River in the City of Niagara Falls. Wells near the Niagara River reportedly yield as much as 2,000 gpm due to infiltration of water from the Niagara River (Johnston, 1964).

2.4.3 Groundwater Quality

Groundwater quality in the vicinity of the installation has been investigated by EPA (1983), Johnston (1964), the Niagara County Health Department (1983), the Niagara Falls AFRF (1983) and the United States Geological Survey (1985). According to the earlier studies, the groundwater in the vicinity of the base has generally been described as being of poor quality in the unconsolidated sediments and of generally good quality in the Lockport Dolomite. This assessment did not consider the groundwater's high metal content. South and west of the installation the quality of groundwater in the Lockport gradually deteriorates due to the impact of pump induced recharge from the Niagara River, and heavy industrial land use. Historically, groundwater quality has been affected by local septic tank and livestock pond discharges which have caused an increase in the occurrence of elevated fecal coliform levels (Givazdek, 1983). Near the installation, monitoring wells have been installed at Carborundum and Bell Aerospace Textron to assess groundwater quality within the unconsolidated sediments and upper Lockport Dolomite.

Monitoring wells were installed on the installation during the IRP Phase I, Stage 1 study to assess the groundwater quality in the vicinity of a number of hazardous waste management sites. The study's findings are summarized in Section 1.0 of this report. Niagara Falls Air Force Reserve has noted increases in the fecal coliform count in samples taken from Cayuga Creek and base tributaries (Breckenridge, 1983). The increases have been attributed to polluted groundwater discharging into the creek along gaining reaches.

Groundwater in the vicinity of the Carborundum plant was being investigated as a consequence of an open dump used from 1968 to 1976 to dispose of 800 to 1,600 pounds of phenol and 400 tons of solidified resins, floor sweepings, and waste fillers. Groundwater in the vicinity of the dump was found to have varying concentrations of phenol. The Bell Aerospace Textron site was being investigated as a result of a neutralization pond which has been used since the 1950s. Waste generally consisted of rocket fuels, nitric acid, sodium hydroxide neutralizer and plating wastes. Initial studies revealed high concentrations of dichloroethylene, trichloroethylene, methylchloride and vinyl chloride in the groundwater. Within a mile of the southern perimeter of the installation lies the Love Canal site. By 1983 a total of 174 monitoring wells were installed to assess groundwater quality in the vicinity of this 16-acre site used between 1942-1953 for the disposal of industrial toxic materials and municipal wastes. Groundwater from both the shallow unconsolidated, and the deep bedrock aquifer was found to be locally contaminated with numerous organic and inorganic compounds.

The USGS installed three wells in the unconsolidated deposits south and southwest of the installation in an attempt to assess the impact of industrial waste disposal practices of area industries on the groundwater quality (Figure 2-10). This effort was part of an exhaustive study directed at evaluating chemical migration to groundwater and the Niagara River from 138 known hazardous waste disposal sites (USGS, 1985). Water samples from these wells yielded cadmium, lead, and zinc concentrations that exceeded USEPA criteria for drinking water and the New York State groundwater standards. Methylene chloride and toluene were found in significant concentrations along with a number of other organic compounds (Table 2-2). Other USGS wells installed in the unconsolidated deposits along the Robert Moses Parkway adjacent to the upper Niagara River and southwest of the installation have yielded high concentrations of heavy metals, inorganic constituents and organic compounds. These most notably included cyanide, methylene chloride, dichloroethylene, chloroform, trichloroethylene, tetrachloroethane, tetrachloroethylene and toluene (USGS, 1985). The presence of these compounds at these concentrations have been attributed to the disposal practices of the industrial complex bordering the northern part of the Parkway (Figure 2-10).

Groundwater quality within the Lockport Dolomite has generally been described as good, with hydrogen sulfide being the most objectionable constituent. The water is very hard, due to the dissolution of calcium, magnesium and calcium sulfate (gypsum) by groundwater moving through the rock. The range in hardness is from 120 to 2,660 parts per million (ppm) and averages 960 ppm. Softening of this water is often necessary before the water can be used for most purposes. The dissolved solids content of the water from the Lockport Dolomite ranges from 299 to 5,000 ppm and averages 1,400 ppm. Water having dissolved solids concentration greater than 1,000 ppm usually has a detectable mineral

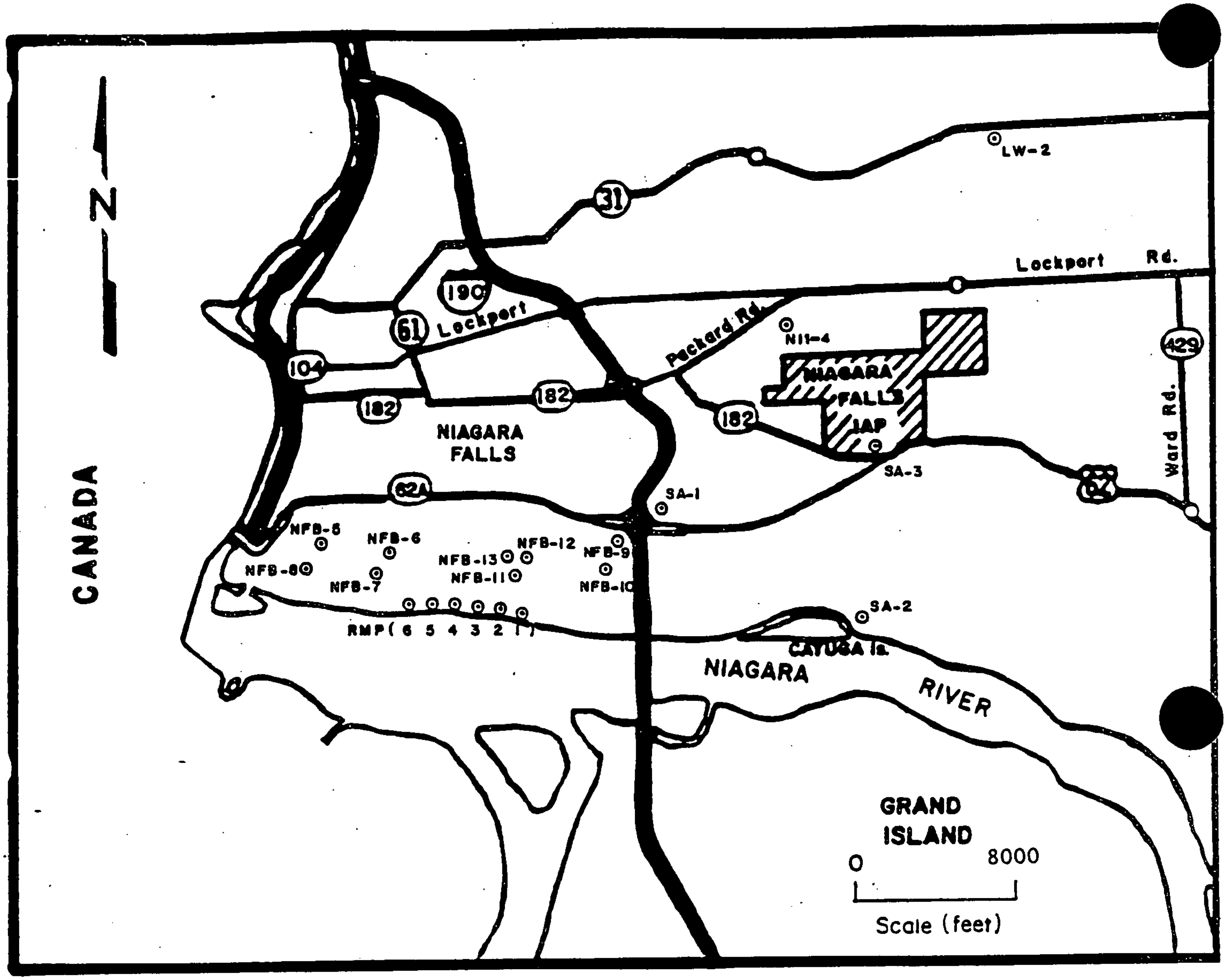


FIGURE 2-10

USGS MONITORING WELLS* IN THE NIAGARA FALLS AREA

*includes unconsolidated deposit wells, Lockport Dolomite wells, and Westbay wells.

TABLE 2-2

Analysis of Groundwater Samples From Wells In Unconsolidated Deposits Along The Niagara River, Niagara Falls, N.Y. November 10, 1983 (Source: USGS, 1985)

	Well number and depth below land surface (ft)		
	(SA-1) I190-I62 Interchange (24.0)	(SA-2) Griffon Park	(SA-3) Airport Triangle (20.0)
pH (S.O.)	7.2		
Specific conductance (umho/cm)	480		
Inorganic Constituents (ug/l)			
Antimony	--	--	4
Arsenic	1	2	4*
Beryllium	--	--	--
Cadmium	13*	17*	100*
Chromium	1	1	8
Copper	39	31	300
Lead	230*	130*	2,200*
Mercury	--	--	--
Nickel	28	14	980
Selenium	--	--	--
Zinc	3,300	8,900*	640,000*
Organic Coumpounds (ug/l)			
Priority pollutants			
Methylene chloride	140	7.1	375
Toluene	150	10	230
Ethylbenzene	5.9	LT	4.5
Chloroform	4.2	--	--
Dibutylphthalate	12	0	2.05
Mirex	--	0.21	--
Trans-1,2-dichloroethylene	--	--	23
Nonpriority pollutants			
Diethylphthalate	LT	7.7	2.5
Methylcyclopentane[1]	4.2	5.6	3.7
1-Methylpentylhydroperoxide[1] (or 1-butanol)	2.0	2.0	--
Hexane	--	12	--
Chlordene	--	--	0.08
1,1-Ethanediol, diacetetate[1]	--	--	44

TABLE 2-2 (Cont'd)

Analysis of Groundwater Samples From Wells In Unconsolidated Deposits Along The Niagara River, Niagara Falls, N.Y. November 10, 1983 (Source: USGS, 1985)

	Well number and depth below land surface (ft)		
	(SA-1) I190-I62 Interchange (24.0)	(SA-2) Griffon Park	(SA-3) Airport Triangle (20.0)
Organic Coumpounds (ug/l)			
Nonpriority pollutants (cont'd)			
heptane[1]	--	--	240
(2,2-Dimethylpropyl)oxiarane[1]	--	--	LT
Methylcyclohexane[1]	--	--	17
Ethylcyclopentane[1]	--	--	7.7
2,3,5-Trimethylpentane[1]	--	--	14
1,2,3-Trimethylcyclopentane[1]	--	--	LT
3-Methyl-2,4-hexadiene[1]	--	--	LT
2,3-Dimethylhexane[1]	--	--	5.8
2-Methylheptane[1]	--	--	44
3,3-Dimethylhexanol[1]	--	--	21
1,4-Dimethyl,cis-cyclohexane[1]	--	--	LT
2,5-Dimethyl-1-hexene[1]	--	--	5.2
2,3,4-Trimethylhexane[1]	--	--	14
(1,1-Dimethylbutyl)oxirane[1]	--	--	2.3
2-Bromohexane[1]	--	--	14
2,6-Dimethylheptane	--	--	18
1,2-Dimethylbenzene[1]	11	--	46
1,4-Dimethylbenzene[1]	5.1	--	15
2,2,4,4-Tetramethyl-3-pentanone[1]	10	--	21
2-Decanone	--	--	57
2-Ethoxybutane[1]	290	--	270
2-Pentanone[1]	--	--	9.1
4-Chloro-trans-cyclohexanol[1]	--	--	LT
1-chloro-2-ethenyl-1-methylcyclopropane	--	--	LT
3-Ethylhexane[1]	11		--
2-Chloronaphthalene[1]	LT	--	--
2,6-Bis(1,1-dimethylproply)-2,5-cyclohexadiene,1,4-dione[1]	5.9	--	--
5-Ethyldihydro-2(3H)-furanone[1]	2.8	--	--
3,5,5-Trimethylhexanoic acid[1]	5.1	--	--
2-(2-Butoxyethoxy)ethanol[1]	93	--	--

TABLE 2-2 (Cont'd)

Analysis of Groundwater Samples From Wells In
Unconsolidated Deposits Along The Niagara River, Niagara Falls, N.Y.
November 10, 1983 (Source: USGS, 1985)

	Well number and depth below land surface (ft)		
	(SA-1) I190-I62 Interchange (24.0)	(SA-2) Griffon Park	(SA-3) Airport Triangle (20.0)
Organic Coumpounds (ug/l)			
Nonpriority pollutants (cont'd)			
Nonanoic acid[1]	85	--	--
1,2-Benzeneidicarboxylic acid[1]	LT	--	--
Decanoic acid[1]	29	--	--
2,5-Bis(1,1-dimethylpropyl)-2,5-cyclohexadiene-1,4-dione[1]	LT	--	--
2-Ethylhexanoic acid[1]	--	31	--
Benzoic anhydride[1]	--	59	--
4-Chlorobenzoic acid[1]	--	13	--
3-Ethylpentene[1]	--	6.7	--
Methylcycledecane[1]	--	LT	--
2-Methylundecane[1]	--	LT	--
4,11-Dimethyltetradecane[1]	--	LT	--
5-Propyltridecane[1]	--	LT	--
1-(2-Butoxyethoxy)ethanol	--	--	8.0
Compounds potentially of natural origin			
Hexanoic acid[1]	13	--	--

[1] Tentative identification based on comparison with the National Bureau of Standards (NBS) library No external standard was available. Concentration reported is semiquantitative and is based only on an internal standard. GC/MS spectra were examined and interpreted by GC/MS analysts.

* Exceeds USEPA criterion for maximum permissible concentration in drinking water or NYS standards for maximum concentration in groundwater.

-- Compound not found

LT Compound found but at less than the quantifiable detection limit taste, but is not necessarily harmful to health (Johnston, 1964). Lower sections of the dolomite may contain brine with a dissolved solid content greater than 35,000 ppm. Table 2-3 summarizes the groundwater quality data in the vicinity of the installation.

Canadian studies on the chemical quality of natural groundwater near the Niagara River have indicated average natural lead and zinc concentrations of 300 ug/l and 800 ug/l respectively, with concentrations increasing with depth (Haynes and Mostaghal, 1982). Literature searches indicate that a certain amount of lead and zinc are believed to be leached from lead and zinc sulfide minerals disseminated through, or locally concentrated in the dolomite. Natural lead concentrations reportedly exceed the USEPA drinking water criterion of 50 ug/l in most places, whereas zinc concentrations are generally less than the Federal and State criteria of 5,000 ug/l (USGS, 1985). To evaluate whether lead and zinc concentrations were natural or man-induced, the USGS (1985) doubled the highest naturally occurring concentration reported in the Canadian studies, producing a value of 1,600 ug/l. Analytical results above 1,600 ug/l were interpreted to be the result of man's activity. Data on the concentration of other heavy metals in groundwater from the Lockport Dolomite is lacking.

Under the same program, the USGS installed a number of monitoring wells in the Lockport Dolomite. Most of these wells were installed in the vicinity of the industrial complex, along the wall of the Niagara River gorge and adjacent to the power plant conduits (Figure 2-10). Heavy metal concentrations were high in shallow bedrock wells along the gorge well. In one well cadmium, lead and zinc exceeded USEPA criteria for drinking water and New York State standards for groundwater (i.e., cadmium 60 ug/l; lead 3,600 ug/l; zinc 8,700 ug/l) (USGS, 1985). The mercury concentration in another well (6.8 ug/l) exceeded both the criterion and standard. The gorge wall wells also showed the presence of several organic compounds. Heptachlor exceeded New York State groundwater standards in four wells and α-BHC exceeded the standard in one well. Heavy metal concentrations were detected in the wells installed next to the power conduits; however, concentrations did not exceed the USEPA drinking water standards. Groundwater from the wells near the conduits showed the largest variety and

TABLE 2-3
GROUNDWATER QUALITY DATA FOR NIAGARA FALLS IAP AND VICINITY

Well ID	Date Sampled	Depth (ft)	pH	Specific Conductance (microhos/cm at 25°C)	Total Dissolved Solids (residue at 180°C)	Chloride (Cl) (ppm)	Iron (Fe) (ppm)	Sulfate (SO_4) (ppm)	Hardness (as $CaCO_3$) (ppm)
3059003	2/27/40	31	7.0	--	3,230	1,000	16	1,140	2,180
3088594	8/23/60	100	--	758	--	18	--	--	--

NOTES:
ppm = parts per million
-- = not tested
Locations are shown on Figure 2-11

Source: Johnston, 1964

highest concentrations of organic compounds, especially on the east side. In one well, toluene, benzene, and trans-1,2 dichloroethylene were detected at 34 ug/l, 180 ug/l and 1,400 ug/l, respectively, and in another well at 5.7 ug/l, 250 ug/l, and 1,400 ug/l, respectively. A total of 56 organic compounds were also found in groundwater sampled from one of these wells (USGS, 1985). Groundwater from wells located on the immediate west side of the conduits contained fewer compounds at generally lower concentrations.

The highest heavy-metal concentrations were detected in groundwater from a bedrock well near the center of the industrial complex, south of the Fall Street Tunnel (Figure 2-10). Cadmium, lead, zinc and selenium were detected at 89 ug/l, 3,500 ug/l, 30,000 ug/l and 760 ug/l respectively, all of which exceeded USEPA drinking water standards. Organic compounds were detected in a number of wells south of the Fall Street Tunnel in the industrial district, but concentrations were less than 9 ug/l for all constituents except for hexane and trans-1,2-dichloroethylene.

In an attempt to establish an upgradient well representative of background water quality conditions for the uppermost water-bearing zone of the Lockport Dolomite, groundwater samples were analyzed from two USGS/Westbay Instruments Ltd. wells located north of Niagara Falls IAP (i.e., USGS Well LW2 and USGS Well NI-1). These samples were collected by SAIC on 13 October, 1989. The location of these wells is shown on Figure 2-10 and a well construction summary representative of these wells is presented in Section 2.4.4.

Table 2-4 presents compounds which were detected in samples collected from both wells. A sulfate concentration of 630 mg/l was detected in USGS Well NI-1 and represented the only value that exceeded the State of New York Drinking Water Standards (250 mg/l). As discussed previously, the average sulfate concentration in the Lockport Dolomite is 104 mg/l (Johnston, 1964). Higher values of inorganics can be expected in zones that are highly mineralized with gypsum. The total dissolved solids (TDS) and chloride concentrations from both wells were below the respective averages of 1,400 mg/l and 100 mg/l for the Lockport Dolomite (Johnston, 1964). Lead and zinc concentrations were lower than the

TABLE 2-4

COMPOUNDS DETECTED IN GROUNDWATER SAMPLES FROM THE USGS/WESTBAY WELLS LOCATED UPGRADIENT FROM NIAGARA FALLS IAP (2)(3)

	USGS Well LW2 Niagara/Wheatfield School Bus Garage Concentration (mg/l)	USGS Well NI-1 Smith Brothers Field Concentration (mg/l)
Inorganics		
Total Dissolved Solids (TDS)	640	1200
Fluoride	0.88	0.84
Chloride	62	38
Sulfate	140	630(1)
Metals		
Boron	0.938	0.222
Barium	0.021	0.021
Calcium	123	28.9
Iron	0.262	0.094
Magnesium	0.042	0.090
Manganese	0.021	0.044
Potassium	10.5	1.32
Silicon	4.02	4.84
Sodium	31.2	26.6
Zinc	1.52	0.034
Organics		
Chlorobenzene	0.33/0.35*	<0.30*

NOTES:

* - ug/l
(1) - Concentration exceeds State of New York drinking water standard.
(2) - Both wells sampled 13 October, 1989.
(3) - Only positive values were reported.

naturally occurring value of 600 ug/l determined for both metals by the USGS in their 1985 study. The only organic compound found to be present was chlorobenzene, measured at a concentration only slightly above the 0.30 ug/l detection limit for the compound.

2.4.4 Well Inventory

A list of wells known to exist within 3 miles of Niagara Falls IAP is provided in Table 2-5 which includes water level depths, total well depths, and the hydrogeologic units in which the wells are screened. The well locations are illustrated in Figure 2-11. According to the Niagara County Department of Health, all residents in the area of the installation are connected to the municipal water supply. Some old domestic wells have been identified in the area but these wells have either been abandoned or are no longer used for potable water supply purposes.

Recently, in an effort to establish a regional groundwater monitoring network around Niagara Falls, New York, the United Stated Geological Survey installed nine monitoring wells in the vicinity of Niagara Falls IAP. The location of these wells is illustrated on Figure 2-10. Suspended in each well borehole is a plastic multi-port system consisting of a string of inflatable packers, measuring ports and pumping ports. Each well borehole is 4-inches in diameter and was diamond cored to a maximum depth of 515 feet. The objective of this installation technique was to acquire specific hydrogeological data through the isolation of specific water producing zones in rock formations underlying the Niagara Falls, New York area. Figures 2-12 and 2-13 present coupling logs for two upgradient wells that were sampled by SAIC with the cooperation of Westbay-trained personnel.

On the installation, a total of fifty-four shallow aquifer and fourteen bedrock monitoring wells were installed to evaluate upgradient and downgradient groundwater quality in the vicinity of 13 inactive hazardous material/waste management sites. Thirty-eight, 2-inch, shallow aquifer wells and four, 4-inch, bedrock aquifer wells were installed during the IRP Phase II, Stage 1 Confirmation/Quantification field program conducted during the Fall of 1984.

TABLE 2-5

WATER WELL DATA FOR NIAGARA FALLS AFRF AND VICINITY

Well ID	Owner &/or Location	Depth (feet)		Hydrogeologic Unit(s) Tapped By Well	Water Level (feet)			Use
		Well	Casing		Below Land Surface	Date mm/dd/yr	Approximate Elevation Above NGVD	
3048571	Wendt Dairy	35	22	Sl	—	—	—	U
3058551	N. Moll	25	—	Sl	7.4	10/20/60	562.6	U
3058552	N. Moll	20	18	Qsg and Sl	11.1	10/20/60	558.9	U
3059003	Union Carbide Chemical Co.	100	6	Sl	28	1940	549.0	A
3068531	E. Lass	49	40	Sl	6.3	10/26/60	573.7	D
3068541	R. Jaeger	19	—	Qsg	—	—	—	D
3068591	C.Swearengen	28	—	Sl	12.1	8/8/60	595.9	U
3068592	W. Mick	49	—	Sl	34.6	8/8/60	589.4	U
3068593	L.Toni	31	—	Sl	13.9	6/2/61	591.1	D
3068594	Haggerty	40	—	Sl	28.4	10/5/60	576.6	U
3078591	—	75	12	Sl	10.3	11/15/62	602.7	O
3078593	W. Lozan	31	15	Sl	12.5	8/8/60	607.5	U
3078594	J. Patterson	34	—	Sl	34.0	8/7/60	575.0	U
3079006	A.W. Nusum	55	10	Sl	12.3	6/2/61	589.7	C
3079007	E. Schul	25	—	Sl	15.8	8/8/60	584.2	U
3079008	Military Road School	45	—	Sl	14.8	6/2/61	596.2	I
3079009	L. Cora	26	—	Sl	17.4	6/2/61	583.6	U
3088541	W. Kroening	38	—	Sl	23.1	10/27/60	606.9	S
3088561	N. Easley	38	—	Sl	27.9	10/27/60	612.1	D
3088571	F. Scholefield	38	—	Sl	13.4	8/7/60	616.6	U
3088572	A. Wittcapp	34	—	Sl	25.6	10/27/60	614.4	D
3088581	Colonial Village School	37	11	Sl	20.8	8/8/60	608.2	U
3088582	E. Heath	44	—	Sl	25.1	8/7/60	612.9	D
3088583	W. Holland	49	—	Sl	12.0	8/8/60	617.0	D
3088584	F. Wagner	33	13	Sl	16.5	11/2/61	613.5	D
3088585	NMPC	45	6	Sl	13.4	11/15/62	620.6	O
3088586	PASNY	61	10	Sl	1.0	11/15/62	620.0	PR
3088587	PASNY	61	10	Sl	2.6	11/15/62	620.4	PR
3088591	NMPC	65	11	Sl	20.0	11/15/62	586.0	O
3088593	NMPC	16	12	Sl	4.1	11/15/62	602.9	O
3088594	NMPC	100	16	Sl	8.4	11/15/62	602.6	O
3088595	NMPC	16	14	Qti	8.3	10/30/62	602.7	O
3088596	NMPC	68	19	Sl	11.7	11/15/62	602.3	O
3088598	PASNY	98	21	Sl	6.5	11/15/62	603.5	O
3088599	PASNY	11	8	Qti	9.8	10/30/62	600.2	O
30885910	—	100	12	Sl	6.0	11/15/62	604.0	O
30885911	—	74	15	Sl	7.7	11/15/62	604.3	O
30885913	J. Williams	24	22	Sl	15.8	8/8/60	597.2	D
B	Corps of Engineers	268	—	Sl, Sr, Sc, Sa	—	—	—	GO
C	Corps of Engineers	238	—	Sl, Sr, Sc, Sa	—	—	—	GO
D1	—	—	—	Sl	—	—	—	D
D2	—	—	—	Sl	—	—	—	D
D3	—	—	—	Sl	—	—	—	D
D4	—	—	—	Sl	—	—	—	D
2897	William Beutel & Sons	1,447	—	—	—	—	—	NG
	Love Canal Area (147 Wells)	—	—	Qd and Sl	—	—	—	O
C1	Carborundum Process Equipment Div. Plant	35	—	Sl	—	—	—	[illegible]
	Carborundum Walmore Road Plant (5 Wells)	—	—	Qd	—	—	—	O
	Bell Aerospace Plant (9 Wells)	—	—	Qd and Sl	—	—	—	O

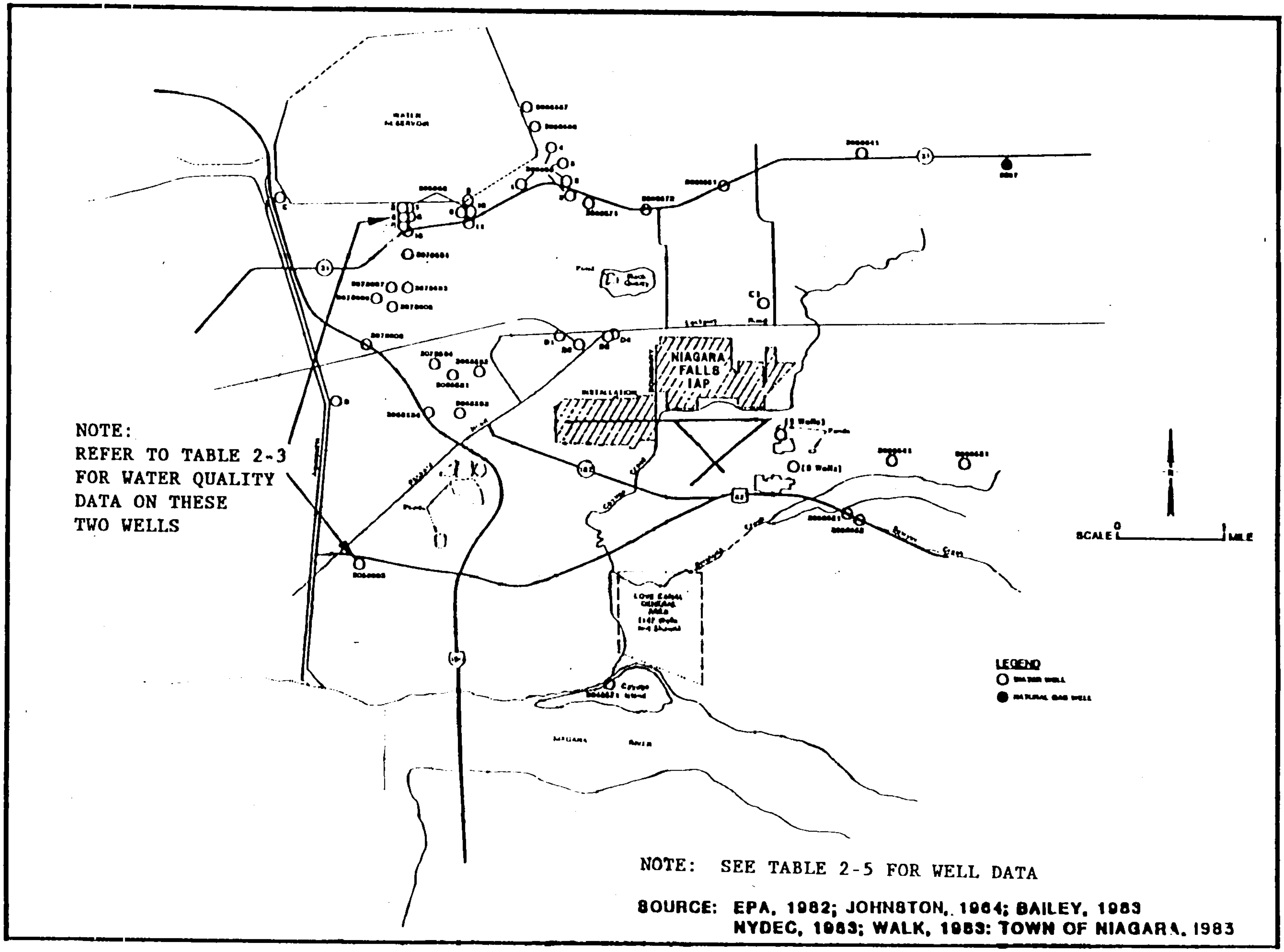
NOTES:

Owner and/or Location
NMPC = Niagara Mohawk Power Corporation
PASNY = Power Authority of the state of New York

Hydrogeologic Unit(s) Tapped By Well
Qd = Pleistocene deposits, undifferentiated
Qsg = Pleistocene sand and gravel
Qt = Pleistocene glacial till
Sa = Albion Group
Sc = Clinton Group
Sl = Lockport Dolomite
Sr = Rochester Shale

Use
A = Abandoned
C = Commercial
D = Domestic
GO = Geological Observation
I = Industrial
NG = Natural Gas
O = Observation
PR = Pressure Relief
U = Unused

Source: Johnston, 1967; EPA, 1982; Bailey, 1983; NYDEC, 1983; Walk, 1983; Town of Niagara, 1983.



NOTE:
REFER TO TABLE 2-3
FOR WATER QUALITY
DATA ON THESE
TWO WELLS

NOTE: SEE TABLE 2-5 FOR WELL DATA

SOURCE: EPA, 1982; JOHNSTON, 1964; BAILEY, 1983
NYDEC, 1983; WALK, 1983: TOWN OF NIAGARA, 1983

FIGURE 2-11
WATER WELL LOCATIONS NEAR NIAGARA FALLS IAP
(Source: Engineering-Science, 1983)

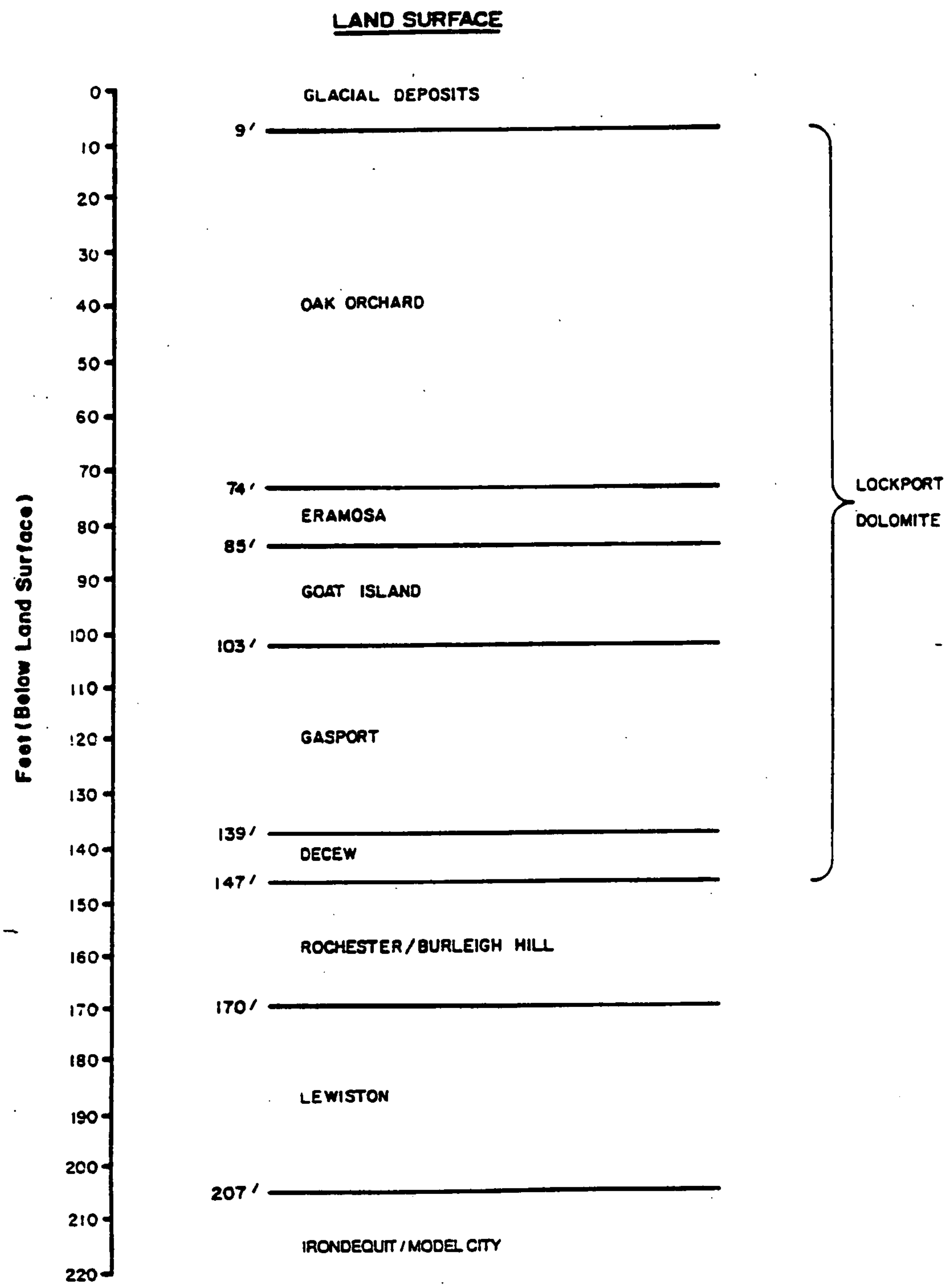


FIGURE 2-12
USGS/WESTBAY COUPLING LOG NI-1

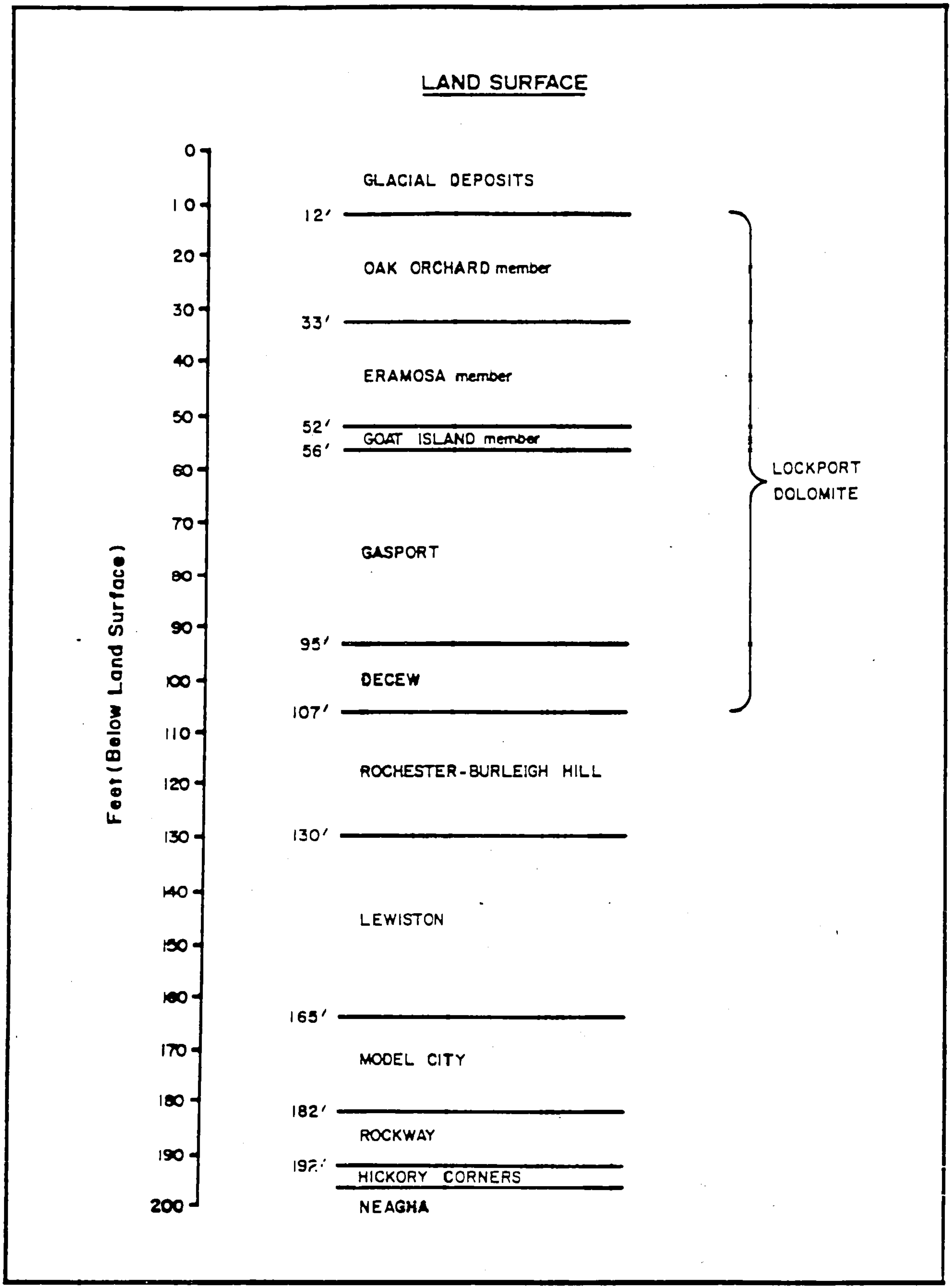


FIGURE 2-13
USGS/WESTBAY COUPLING LOG LW-2

Sixteen, 2-inch, shallow aquifer and ten, 2-inch, bedrock aquifer monitoring wells were installed during the IRP Remedial Investigation (RI) conducted during the summer of 1989. Of the original thirty-eight shallow aquifer wells, six wells could not be sampled as a consequence of being severely damaged or destroyed by base construction, demolition, and grounds maintenance activities. Two shallow aquifer wells sustained severe ice damage and could not be incorporated in the environmental sampling program.

The location of all monitoring wells on Niagara Falls IAP is presented in Figure 2-14. Details on the monitoring well drilling program are presented in Section 3.0 of this report. Specific well construction information is presented in Appendix C. Table 2-6 presents a summary of well construction items presented in Appendix C. The horizontal coordinates and elevations of the monitoring wells are presented in Table 2-7. Water level depth and elevation data collected during the field program are presented in Table 2-8.

2.5 SURFACE WATER HYDROLOGY

2.5.1 Occurrence and Drainage Pattern

Cayuga Creek is the only surface water body that is present on the property of Niagara Falls IAP. The creek enters the installation from the northeast near the main gate to Walmore Road, runs parallel to the southern property boundary, crosses under Runway 10L-28R, and then leaves the installation at its southwest corner. The creek empties into the Little River approximately 4 miles downstream from the base and just north of Cayuga Island. Little River, in turn, empties into the Niagara River approximately five miles upstream of the American and Horseshoe (Canadian) Falls.

Niagara Falls IAP lies partially within the 100-year and 500-year floodplain areas of Cayuga Creek (Figure 2-15). If a 100-year flood occurred, the most affected area of the base would be a 1,000-foot wide area south of Building 722, within the taxiway, and Runway 10L-28R. The least affected area would be a 100- to 400-foot wide area along the tributary of Cayuga Creek from Lockport Road south to the Transient Ramp (NFAFRB, Flood Boundary and Freshwater Wetland Base Map, 1983).

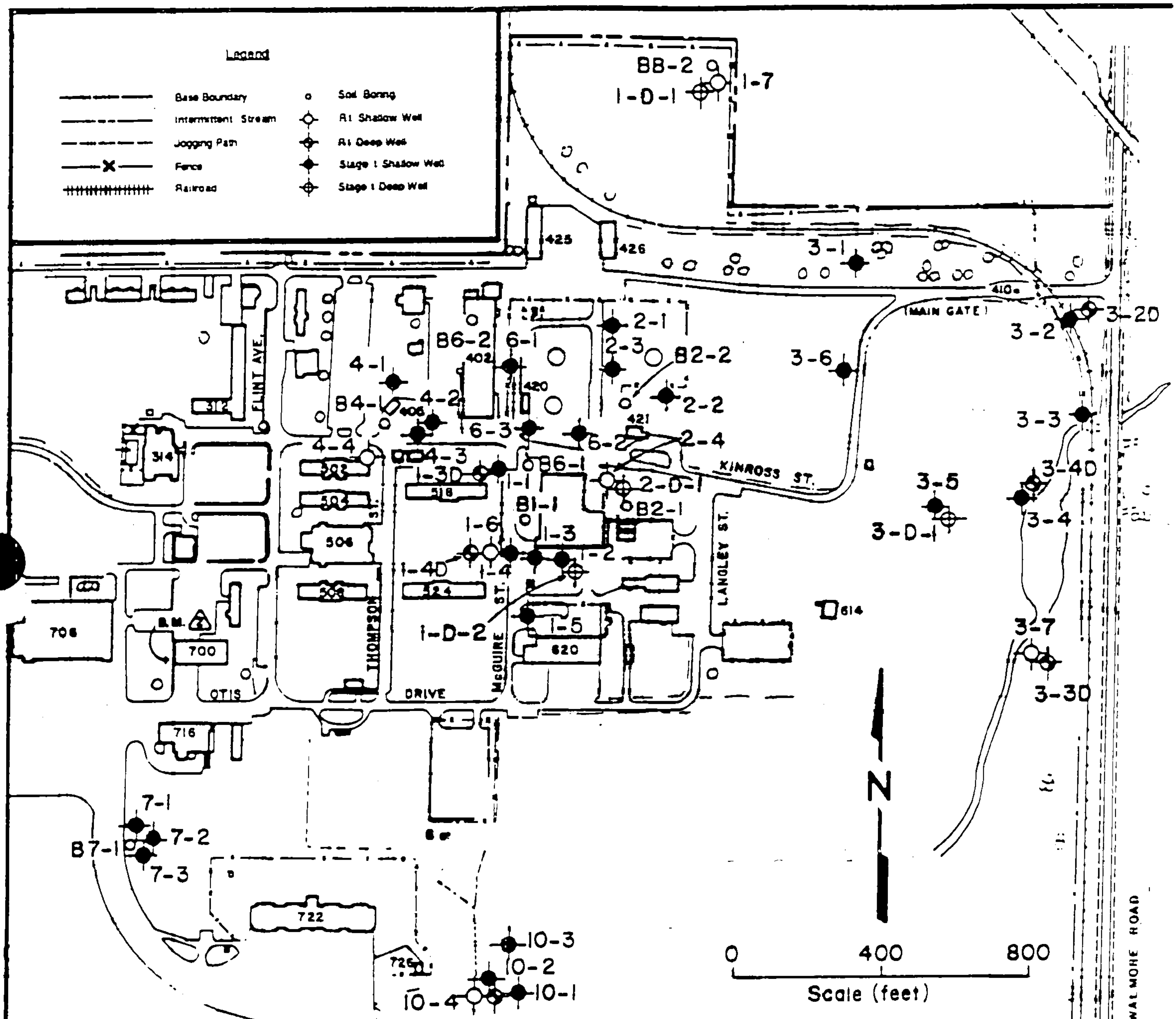


FIGURE 2-14A.
INSTALLATION WELL LOCATION MAP [EAST]

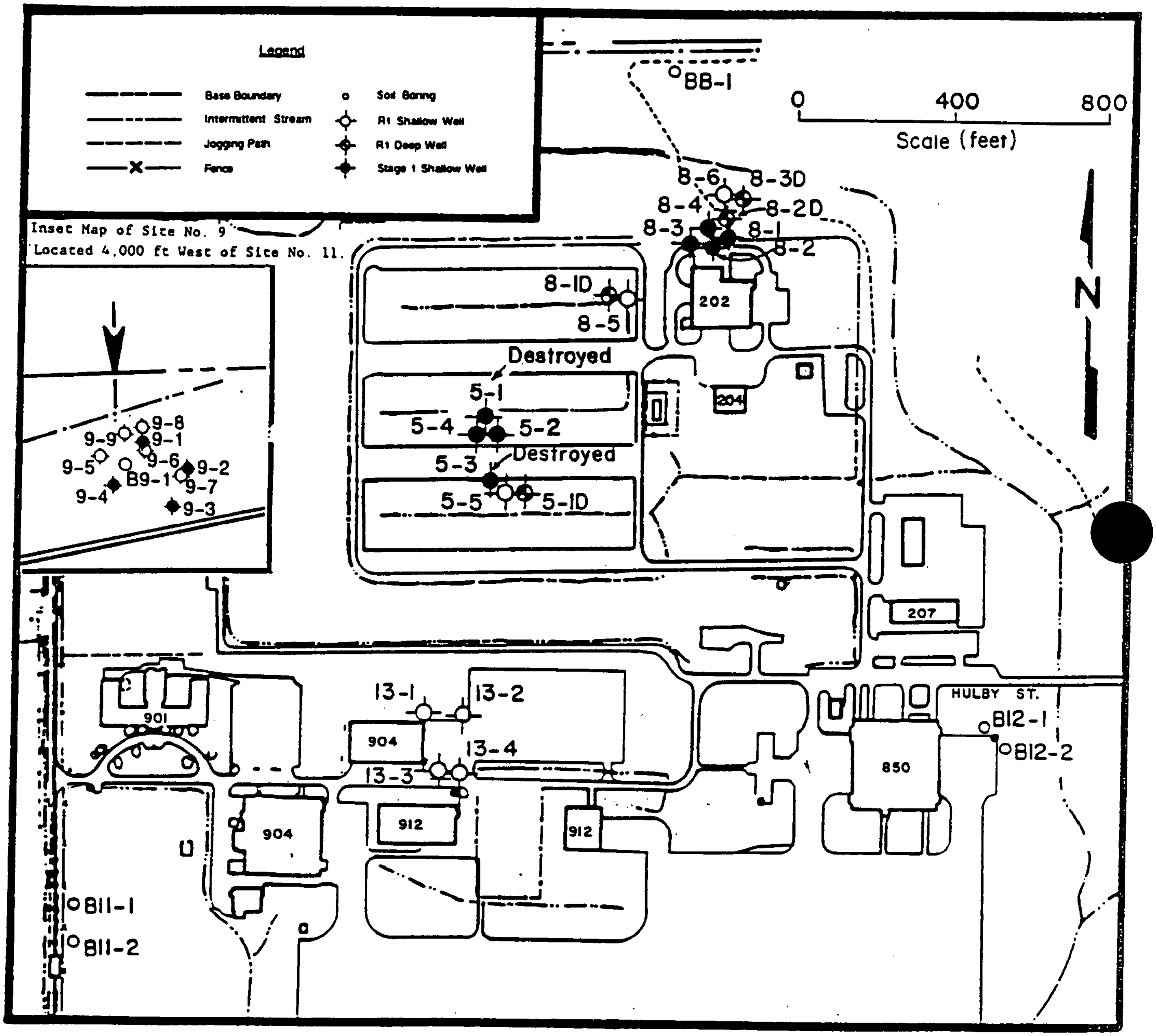


FIGURE 2-14B.
INSTALLATION WELL LOCATION MAP [WEST]

TABLE 2-6. WELL CONSTRUCTION SUMMARY

SITE NO.	WELL NO.	DATE DRILLED AND INSTALLED	DEPTH (ft. BLS)	DRILLING METHOD	SCREENED INTERVAL (ft. BLS)	SAND PACK (ft. BLS)	BENTONITE SEAL (ft. BLS)	RISERS STICK-UP (ft. ALS)
1	MW1-1	10/18 - 19/84	12.0	A	7.0 - 12.0	5.0 - 12.0	3.0 - 5.0	3.50
	MW1-2	10/19/84	6.7	A	4.7 - 6.7	3.7 - 6.7	2.7 - 3.7	0.98
	MW1-3	10/19/84	6.2	A	4.2 - 6.2	3.2 - 6.2	2.2 - 3.2	3.10
	MW1-4	10/19/84	6.0	A	4.0 - 6.0	3.0 - 6.0	2.0 - 3.0	2.55
	MW1-5	10/22/84	5.8	A	3.8 - 5.8	2.8 - 5.8	1.8 - 2.8	2.40
	MW1-6	7/28/89	5.7	A	2.8 - 5.7	2.3 - 5.7	1.3 - 2.3	3.58
	MW1-7	7/18/89	11.7	A	7.2 - 11.7	6.2 - 11.7	4.2 - 6.2	2.80
	MW1D-1	10/30 - 11/5/84	37.0	AR	12.0 - 37.0	0 - 37.0	none	2.00
	MW1D-2	10/19 - 11/5/84	31.0	AR	6.0 - 31.0	0 - 8.4	none	2.00
	MW1-3D	8/17 - 23/89	34.1	AR	13.8 - 34.1	12.0 - 34.1	8.0 - 12.0	2.21
	MW1-4D	8/17 - 24/89	44.60	AR	9.0 - 44.6	7.8 - 44.6	3.8 - 7.8	2.90
2	MW2-1	10/24/84	11.7	A	6.7 - 11.7	4.7 - 11.7	3.7 - 4.7	2.40
	MW2-2	10/24/84	11.3	A	7.3 - 11.3	5.2 - 11.3	3.2 - 5.2	2.68
	MW2-3	10/24/84	12.8	A	7.8 - 12.8	5.8 - 12.8	3.8 - 5.8	2.45
	MW2-4	7/28/89	5.2	A	3.5 - 5.2	2.5 - 5.2	1.5 - 2.5	2.41
	MW2D-1	10/29 - 11/5/84	31.6	AR	6.6 - 31.6	0 - 31.6	none	2.20

TABLE 2-6. WELL CONSTRUCTION SUMMARY (CONT'D)

SITE NO.	WELL NO.	DATE DRILLED AND INSTALLED	DEPTH (ft. BLS)	DRILLING METHOD	SCREENED INTERVAL (ft. BLS)	SAND PACK (ft. BLS)	BENTONITE SEAL (ft. BLS)	RISERS STICK-UP (ft. ALS)
3	MW3-1	10/23/84	12.3	A	7.3 - 12.3	5.3 - 12.3	3.3 - 5.3	2.70
	MW3-2	10/24/84	9.5	A	5.5 - 9.5	3.4 - 9.5	2.5 - 3.4	2.16
	MW3-3	10/26/84	9.4	AR	5.4 - 9.4	4.4 - 9.4	3.4 - 4.4	2.82
	MW3-4	10/25-26/84	8.5	AR	4.5 - 8.4	3.5 - 8.5	2.5 - 3.5	1.41
	MW3-5	10/25/84	8.0	AR	4.0 - 8.0	3.0 - 8.0	2.0 - 3.0	1.14
	MW3-6	10/24/84	8.3	A	4.3 - 8.3	2.8 - 8.3	1.7 - 2.8	1.22
	MW3-7	7/27/89	5.0	A	3.5 - 5.0	2.5 - 5.0	1.5 - 2.5	2.92
	MW3D-1	10/29 - 11/2/84	28.0	AR	3.0 - 28.0	0 - 28.0	none	2.2
	MW3-2D	8/16-22/89	34.8	AR	9.5 - 34.8	8.5 - 34.8	5.0 - 8.5	3.31
	MW3-3D	8/10-17/89	32.4	AR	7.5 - 32.4	6.5 - 32.4	2.25 - 6.5	2.78
	MW3-4D	8/11-21/89	29.0	AR	3.7 - 29.0	3.0 - 29.0	1.0 - 3.0	2.19
4	MW4-1	10/18/89	11.7	A	7.7 - 11.7	5.7 - 11.7	4.7 - 5.7	2.42
	MW4-2	10/18/89	13.0	A	8.0 - 13.0	6.0 - 13.0	4.0 - 6.0	1.83
	MW4-3	10/18/89	12.9	A	7.9 - 12.9	5.9 - 12.9	3.9 - 5.9	1.93
	MW4-4	7/25/89	10.2	A	5.1 - 10.2	4.1 - 10.2	3.1 - 4.1	2.52
5	MW5-1	10/15/89	13.5	A	9.5 - 13.5	6.5 - 13.5	4.5 - 6.5	2.38
	MW5-2	10/16/89	13.0	A	8.0 - 13.0	6.0 - 13.0	4.0 - 6.0	2.38

TABLE 2-6. WELL CONSTRUCTION SUMMARY (CONT'D)

SITE NO.	WELL NO.	DATE DRILLED AND INSTALLED	DEPTH (ft. BLS)	DRILLING METHOD	SCREENED INTERVAL (ft. BLS)	SAND PACK (ft. BLS)	BENTONITE SEAL (ft. BLS)	RISERS STICK-UP (ft. ALS)
5 cont'd	MW5-3	10/16/89	14.1	A	9.1 - 14.1	7.1 - 14.1	5.1 - 7.1	2.47
	MW5-4	10/16/89	13.7	A	8.7 - 13.7	6.7 - 13.7	4.7 - 6.7	2.46
	MW5-5	7/26/89	15.1	A	6.0 - 15.1	5.0 - 15.1	4.0 - 5.0	2.56
	MW5-1D	8/10-24/89	35.4	A	15.0 - 35.4	14.0 - 35.4	11.5 - 14.0	2.63
6	MW6-1	10/25/84	12.0	A	7.0 - 12.0	5.0 - 12.0	3.0 - 5.0	2.42
	MW6-2	10/24/84	12.2	A	7.2 - 12.2	6.2 - 12.2	4.2 - 6.2	2.70
	MW6-3	10/23/84	13.7	A	8.7 - 13.7	6.7 - 13.7	4.7 - 6.7	2.52
7	MW7-1	10/22/84	5.9	A	3.9 - 5.9	2.9 - 5.9	2.0 - 2.9	3.26
	MW7-2	10/22/84	7.0	A	4.0 - 7.0	3.0 - 7.0	2.0 - 3.0	2.97
	MW7-3	10/22/84	8.0	A	5.0 - 8.0	4.0 - 8.0	3.0 - 4.0	2.75
8	MW8-1	10/17/84	14.5	A	9.5 - 14.5	7.5 - 14.5	5.5 - 7.5	2.42
	MW8-2	10/17/84	14.2	A	9.2 - 14.2	7.2 - 14.2	5.2 - 7.2	0.45 (ft. BLS)
	MW8-3	10/17 - 18/84	13.2	A	8.2 - 13.2	6.2 - 13.2	4.2 - 6.2	1.7
	MW8-4	10/17/84	14.1	A	9.1 - 14.1	7.7 - 14.1	5.7 - 7.7	2.26
	MW8-5	7/25/89	12.7	A	6.0 - 12.7	5.0 - 12.7	4.0 - 5.0	2.41
	MW8-6	7/21/89	14.2	A	6.5 - 14.2	5.5 - 14.2	4.5 - 5.5	2.62
	MW8-1D	8/9-15/89	37.47	AR	12.17 - 37.47	11.05 - 37.47	6.6 - 11.05	2.19

TABLE 2-6. WELL CONSTRUCTION SUMMARY (CONT'D)

SITE NO.	WELL NO.	DATE DRILLED AND INSTALLED	DEPTH (ft. BLS)	DRILLING METHOD	SCREENED INTERVAL (ft. BLS)	SAND PACK (ft. BLS)	BENTONITE SEAL (ft. BLS)	RISERS STICK-UP (ft. ALS)
8 cont'd	MW8-2D	8/3-8/89	28.8	AR	13.6 - 28.8	11.7 - 28.8	7.7 - 11.7	2.09
	MW8-3D	8/7-14/89	35.6	AR	15.3 - 35.6	14.3 - 35.6	10.2 - 14.3	2.31
9	MW9-1	10/25/84	8.0	A	5.0 - 8.0	3.0 - 8.0	2.0 - 3.0	3.12
	MW9-2	10/25/84	9.2	A	5.2 - 9.2	3.2 - 9.2	2.2 - 3.2	2.95
	MW9-3	10/24/84	9.1	A	5.1 - 9.1	3.1 - 9.1	2.1 - 3.1	3.0
	MW9-4	10/24/84	9.7	A	5.7 - 9.7	3.7 - 9.7	2.7 - 3.7	3.0
	MW9-5	7/31/89	8.4	A	2.7 - 8.4	2.2 - 8.4	1.2 - 2.2	3.39
	MW9-6	7/31/89	7.3	A	2.7 - 7.3	2.2 - 7.3	1.2 - 2.2	3.20
	MW9-7	7/24/89	9.7	A	4.7 - 9.7	3.7 - 9.7	2.7 - 3.7	3.41
10	MW10-1	10/23/84	8.8	A	5.8 - 8.8	3.8 - 8.8	2.8 - 3.8	2.5
	MW10-2	10/23/84	9.0	A	6.0 - 9.0	4.0 - 9.0	3.0 - 4.0	2.4
	MW10-3	10/23/84	9.9	A	6.9 - 9.9	4.9 - 9.9	3.9 - 4.9	2.3
	MW10-4	7/21/89	7.9	A	4.5 - 7.9	3.5 - 7.9	2.5 - 3.5	2.43
	MW10-1D	8/1/89	32.9	AR	12.66 - 32.9	11.7 - 32.9	6.7 - 11.7	2.55

TABLE 2-6. WELL CONSTRUCTION SUMMARY (CONT'D)

SITE NO.	WELL NO.	DATE DRILLED AND INSTALLED	DEPTH (ft. BLS)	DRILLING METHOD	SCREENED INTERVAL (ft. BLS)	SAND PACK (ft. BLS)	BENTONITE SEAL (ft. BLS)	RISERS STICK-UP (ft. ALS)
13	MW13-1	7/19/89	7.3	A	5.0 - 7.3	4.0 - 7.3	3.0 - 4.0	3.12
	MW13-2	7/19/89	7.5	A	5.0 - 7.5	4.0 - 7.5	3.0 - 4.0	2.62
	MW13-3	7/20/89	9.0	A	5.0 - 9.0	4.0 - 9.0	3.0 - 4.0	2.69
	MW13-4	7/20/89	8.6	A	6.1 - 8.6	5.1 - 8.6	4.1 - 5.1	3.02

A -- Hollow-stem Augering
AR - Auger/Roller
BLS - Below Land Surface
ALS - Above Land Surface

TABLE 2-7. HORIZONTAL COORDINATES AND ELEVATIONS OF MONITORING WELLS INSTALLED AT NIAGARA FALLS IAP (1)

SITE NO	WELL NO	ELEVATION (FT. ASL) TOP OF NOTCH	ELEVATION (FT. ASL) LAND SURFACE	STATE PLANE COORDINATES (FT) NORTH	STATE PLANE COORDINATES (FT) EAST
1	1-1	600.87	597.37	1,135,234.584	406,570.975
	1-2	595.81	594.83	1,134,984.414	406,740.776
	1-3	597.44	594.34	1,134,992.776	406,665.981
	1-4	597.43	594.88	1,135,009.440	406,560.700
	1-5	595.19	592.79	1,134,832.254	406,652.677
	1-6	598.73	595.15	1,135,015.462	406,554.858
	1-7	605.80	603.00	1,136,271.962	407,140.816
	1-D1	605.46	603.46	1,136,273.687	407,125.480
	1-D2	596.88	594.88	1,134,980.934	406,752.997
	1-3D	600.19	597.98	1,135,232.325	406,557.556
	1-4D	597.84	595.10	1,135,014.684	406,542.358
2	2-1	603.55	601.15	1,135,629.644	406,863.067
	2-2	603.54	600.86	1,135,436.236	407,009.782
	2-3	603.08	600.63	1,135,514.660	406,864.120
	2-4	599.71	597.30	1,135,203.505	406,884.320
	2-D1	599.80	597.43	1,135,200.632	406,894.857
3	3-1	604.42	601.72	1,135,789.724	407,522.856
	3-2	598.95	596.79	1,135,626.722	408,103.592
	3-3	593.23	590.41	1,135,371.816	408,119.878
	3-4	590.12	588.71	1,135,150.498	407,965.283
	3-5	593.50	592.36	1,135,135.751	407,734.429
	3-6	601.30	600.08	1,135,499.906	407,485.574
	3-7	590.85	587.93	1,134,719.376	408,019.089
	3-D1	593.46	591.26	1,135,105.356	407,761.465
	3-2D	599.98	596.67	1,135,637.502	408,120.816
	3-3D	590.86	588.08	1,134,710.032	408,034.356
	3-4D	590.73	588.54	1,135,159.979	407,978.091
4	4-1	601.66	599.24	1,135,477.928	406,286.165
	4-2	602.58	600.75	1,135,363.805	406,393.176
	4-3	602.32	600.39	1,135,342.001	406,355.893
	4-4	600.87	598.35	1,135,271.366	406,236.984
5	5-1	599.43	597.05	1,136,172.072	402,409.376
	5-2	598.70	596.32	1,136,123.807	402,434.808
	5-3	599.06	596.59	1,135,996.080	402,433.553
	5-4	599.42	596.96	1,136,124.182	402,385.651
	5-5	600.37	597.81	1,135,978.964	402,436.767
	5-1D	600.33	597.70	1,135,978.928	402,447.518
6	6-1	602.59	600.17	1,135,511.485	406,604.202
	6-2	602.03	599.33	1,135,331.132	406,786.664
	6-3	601.98	599.46	1,135,345.160	406,651.139
7	7-1	592.31	589.05	1,134,262.934	405,630.248
	7-2	591.91	588.94	1,134,216.242	405,654.989
	7-3	592.10	589.35	1,134,194.128	405,628.393

ASL = Above Sea Level

(1) = Damaged wells at Site No. 3 and 1 were resurveyed

TABLE 2-7. HORIZONTAL COORDINATES AND ELEVATIONS OF MONITORING WELLS INSTALLED AT NIAGARA FALLS IAP (1) (CONT'D)

SITE NO	WELL NO	ELEVATION (FT. ASL) TOP OF NOTCH	LAND SURFACE	STATE PLANE COORDINATES (FT) NORTH	EAST
8	8-1	600.05	597.63	1,136,653.593	403,049.234
	8-2	597.25	597.70	1,136,637.867	403,023.558
	8-3	599.06	597.36	1,136,648.698	402,959.125
	8-4	600.86	598.60	1,136,683.254	403,025.696
	8-5	600.20	597.79	1,136,500.592	402,754.005
	8-6	601.21	598.59	1,136,795.024	403,069.895
	8-1D	599.90	597.71	1,136,497.692	402,768.155
	8-2D	600.57	598.48	1,136,688.638	403,035.454
	8-3D	601.14	598.83	1,136,789.644	403,081.967
9	9-1	588.65	585.53	1,134,053.304	397,324.281
	9-2	588.72	585.77	1,133,984.867	397,433.903
	9-3	588.68	585.68	1,133,888.734	397,394.222
	9-4	588.59	585.59	1,133,948.374	397,248.145
	9-5	588.80	585.41	1,134,030.935	397,220.580
	9-6	588.64	585.44	1,134,055.305	397,333.770
	9-7	588.88	585.47	1,133,982.874	397,424.979
	9-8	587.86	585.51	1,134,090.620	397,330.103
	9-9	587.63	585.18	1,134,079.683	397,284.665
10	10-1	589.88	587.43	1,133,823.793	406,643.815
	10-2	590.40	588.00	1,133,853.055	406,571.930
	10-3	590.67	588.37	1,133,949.156	406,618.965
	10-4	589.39	586.96	1,133,804.635	406,563.118
	10-1D	589.64	587.09	1,133,805.763	406,571.706
13	13-1	598.91	595.79	1,135,368.599	402,262.472
	13-2	597.99	595.37	1,135,367.348	402,380.496
	13-3	598.67	595.98	1,135,217.733	402,303.392
	13-4	598.38	595.36	1,135,211.071	402,351.638

ASL = Above Sea Level

(1) = Damaged wells at Site No. 5 and 1 were resurveyed

TABLE 2-8

Groundwater Levels at Niagara Falls IAP

		05–31–89 Water Levels		09–12–89 Water Levels		10–4–89 Water Levels		04–11–90 Water Levels	
Site No.	Well No.	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet RLS
1	1–1	593.51	3.86	592.28	5.09	593.38	3.99	594.82	2.55
	1–2	591.35	3.48	591.31	3.52	591.66	3.17	594.21	0.62
	1–3	592.64	1.70	591.10	3.24	591.42	2.92	593.86	0.48
	1–4	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
	1–5	590.90	1.89	589.75	3.04	590.02	2.77	591.43	1.36
	1–6	NI	NI	590.62	4.53	589.91	5.24	593.18	1.97
	1–7	NI	NI	594.20	8.80	593.99	9.01	599.89	3.11
	1–D1	594.90	8.56	593.71	9.75	593.00	10.46	595.41	8.05
	1–D2	593.07	1.81	591.29	3.59	591.72	3.16	594.04	0.84
	1–3D	NI	NI	592.59	5.39	592.70	5.28	595.35	2.63
	1–4D	NI	NI	585.42	9.68	586.87	8.23	592.85	2.25
2	2–1	599.03	2.12	596.38	4.77	596.07	5.08	600.22	0.93
	2–2	598.24	2.62	595.41	5.45	595.16	5.70	599.98	0.88
	2–3	599.54	1.09	593.39	7.24	596.09	4.54	600.49	0.14
	2–4	NI	NI	590.55	6.75	593.88	3.42	596.68	0.62
	2–D1	594.13	3.30	591.10	6.33	590.56	6.87	593.15	4.28
3	3–1	599.36	2.36	596.74	4.98	597.43	4.29	599.92	1.80
	3–2	593.03	3.76	591.57	5.22	592.27	4.52	595.41	1.38
	3–3	589.06	1.35	587.24	3.17	588.15	2.26	590.30	0.11
	3–4	587.17	1.54	587.24	1.47	586.89	1.82	587.36	1.35
	3–5	589.95	2.41	589.26	3.10	589.36	3.00	592.21	0.15
	3–6	596.02	4.06	594.60	5.48	594.35	5.73	599.49	[illegible]
	3–7	NI	NI	583.52	4.41	584.06	3.87	587.75	[illegible]
	3–D1	590.14	1.12	588.92	2.34	589.01	2.25	591.05	0.21
	3–2D	NI	NI	589.10	7.57	589.06	7.61	591.03	5.64
	3–3D	NI	NI	588.08	(0.86)	585.78	2.30	590.89	(2.81)
	3–4D	NI	NI	588.54	(0.46)	588.97	(0.43)	590.88	(2.34)
4	4–1	593.91	5.33	592.65	6.59	592.77	6.47	594.91	4.33
	4–2	595.77	4.98	594.17	6.58	594.15	6.60	596.84	3.91
	4–3	595.10	5.29	593.52	6.87	593.56	6.83	596.17	4.22
	4–4	NI	NI	592.06	6.29	592.22	6.13	592.95	5.40
5	5–1	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
	5–2	591.01	5.[illegible]	585.25	11.07	585.12	11.20	593.29	3.03
	5–3	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
	5–4	591.01	5.95	585.23	11.73	585.11	11.85	593.32	3.64
	5–5	NI	NI	585.17	12.64	585.01	12.80	592.12	5.69
	5–1D	NI	NI	585.14	12.56	584.90	12.80	592.68	5.02

ASL = Above Sea Level
BLS = Below Land Surface
NI = Not Installed
NT = Not Taken
( ) = Above Land Surface

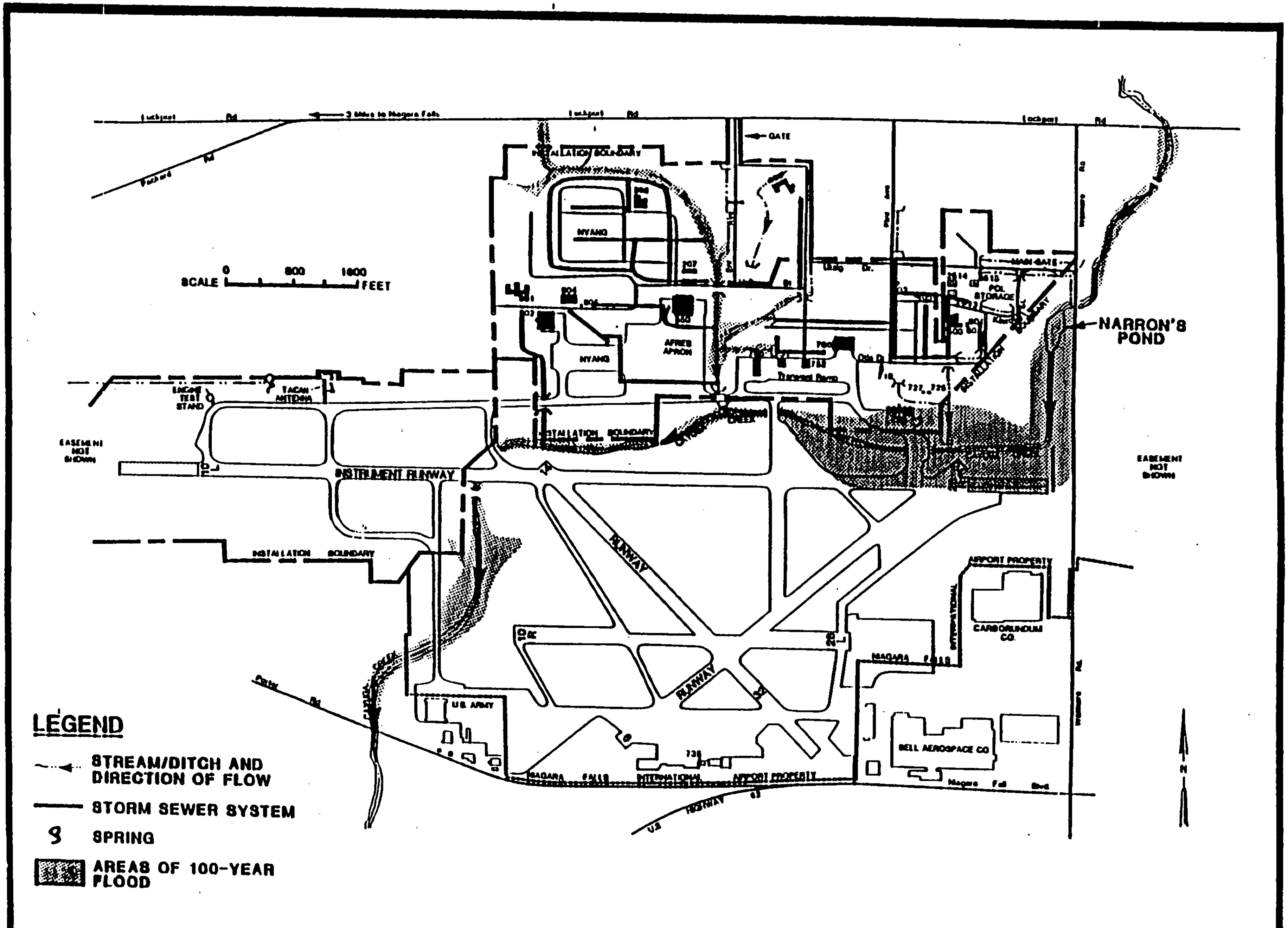
TABLE 2-8 (CONT'D)

Groundwater Levels at Niagara Falls IAP

		05-31-89		09-12-89		10-4-89		04-11-90	
		Water Levels		Water Levels		Water Levels		Water Levels	
Site No.	Well No.	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet BLS	Elevation feet ASL	Depth feet BLS
	6-1	598.28	1.89	592.91	7.26	595.84	4.33	598.40	1.77
6	6-2	596.47	2.86	594.87	4.46	595.39	3.94	597.27	2.06
	6-3	595.89	3.57	594.93	4.53	594.81	4.65	596.65	2.81
	7-1	587.11	1.94	584.35	4.70	584.36	4.69	588.48	0.57
7	7-2	587.15	1.79	583.49	5.45	583.48	5.46	588.11	0.83
	7-3	583.48	5.87	582.62	6.73	582.55	6.80	585.96	3.39
	8-1	590.59	7.04	588.34	9.29	585.78	11.85	592.48	5.15
	8-2	NT	NT	NT	NT	586.18	11.52	NT	NT
	8-3	590.57	6.79	586.41	10.95	586.17	11.19	590.49	6.87
	8-4	590.59	8.01	586.48	12.12	586.23	12.37	592.49	6.11
8	8-5	NI	NI	586.68	11.11	586.49	11.30	Destroyed	Destroyed
	8-6	NI	NI	586.55	12.04	586.33	12.26	593.35	5.24
	8-1D	NI	NI	586.16	11.55	585.92	11.79	592.22	5.49
	8-2D	NI	NI	586.41	12.07	586.23	12.25	592.52	5.96
	8-3D	NI	NI	586.44	12.39	586.21	12.62	592.52	6.31
	9-1	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
	9-2	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
	9-3	NT	NT	581.52	4.16	581.07	4.61	583.32	2.36
	9-4	NT	NT	581.26	4.33	580.79	4.80	585.59	NT
9	9-5	NI	NI	581.32	4.09	581.01	4.40	581.63	3.78
	9-6	NI	NI	582.27	3.17	581.93	3.51	583.99	1.45
	9-7	NI	NI	581.88	3.59	581.44	4.03	583.19	2.28
	9-8	NI	NI	NI	NI	NI	NI	581.39	6.47
	9-9	NI	NI	NI	NI	NI	NI	583.44	4.19
	10-1	585.07	2.36	582.28	5.15	582.12	5.31	586.03	1.40
	10-2	584.80	3.20	582.20	5.80	582.29	5.71	585.45	2.55
10	10-3	585.69	2.68	582.93	5.44	582.87	5.50	586.43	1.94
	10-4	NI	NI	581.88	5.08	581.95	5.01	584.81	2.15
	10-1D	NI	NI	581.98	5.11	582.16	4.93	585.28	1.81
	13-1	NI	NI	589.29	6.50	589.32	6.47	NT	NT
13	13-2	NI	NI	587.78	7.59	587.91	7.46	589.09	6.28
	13-3	NI	NI	590.52	5.46	590.58	5.40	591.72	4.26
	13-4	NI	NI	589.12	6.24	589.07	6.29	590.98	4.38

ASL = Above Sea Level
BLS = Below Land Surface
NI = Not Installed

NT = Not Taken
() = Above Land Surface



SOURCE: NIAGARA FALLS AFRF STORM DRAINAGE SYSTEM, 1977 AND FLOOD BOUNDARY & FRESHWATER WETLAND MAP, 1983

FIGURE 2-15
NIAGARA FALLS IAP SURFACE DRAINAGE MAP
(Source: Engineering-Science, 1983)

Surface drainage on the Niagara Falls IAP flows into Cayuga Creek and three tributaries which transect the base (Figure 2-15). A storm drainage system consisting of aboveground ditches and underground pipes controls the surface-water drainage from the base to Cayuga Creek and its tributaries. A small pond (Narron's Pond) has been constructed on Cayuga Creek just south of the main gate. The three tributaries enter the base on the northern side from Lockport Road. One tributary enters the base in the extreme northwestern corner of the base within the New York Air National Guard area, a second tributary enters the base near the main gate to Lockport Road, and a third tributary enters the base along Flint Avenue.

2.5.2 Surface Water Quality

Surface-water quality of major streams in the vicinity of the Niagara Falls IAP has been affected by pollution related to the industrial development in the Niagara Falls area (Reck and Simmons, 1952). The American side of the Niagara River has in the past contained elevated levels of phenols and fecal coliform. (NFARFF, TAB A-1, 1977). Sampling of Cayuga Creek sediment downstream and west of the Love Canal area in Niagara Falls indicated elevated levels of gamma-emitting radionuclides (EPA, 1982). On the base, limited sampling of Cayuga Creek has found elevated levels of fecal coliform (Breckenridge, 1983). Cayuga Creek water is not used for drinking, industrial, or primary contact recreational purposes. Cayuga Creek enters the Little River approximately four miles downstream of the base. Little River, in turn, empties into the Niagara River approximately five miles upstream of the Falls. The City of Niagara Falls municipal water intakes are located in the Niagara River approximately three miles downstream of the mouth of Cayuga Creek.

Formal water-quality sampling stations, for monitoring Cayuga Creek water quality, were proposed on the installation at six permanent locations. According to the base-Civil Engineering, the program was never activated.

2.5.3 Surface Water Use

Cayuga Creek is not used for drinking or industrial make-up water. Cayuga Creek is classified as a Class "D" stream. A Class "D" stream categorically has water quality suitable for primary and secondary contact recreation, although other factors may limit the use for that purpose. The classification also means that the waters are suitable for fishing, although waters under this classification will not support fish propagation, due to such natural conditions as intermittency of flow. Specifications for Class "D" waters include a Ph range between 6.0 and 9.5 Standard Units and a dissolved oxygen concentration not less than 3 mg/l at any time (NYDEC, 1986).

2.6 AIR QUALITY

2.6.1 Ambient Quality

The Niagara Falls IAP is located within the Niagara Frontier Air Quality Control Region of the State of New York. Air quality in the vicinity of the base is within federal and state standards for all pollutants measured (AFRES, 1989). Due to the inactivation of the base air sampling station all airport air quality is based on data obtained from the Girard St. air monitoring station, located approximately 2 1/2 miles southwest of the base. Standards are met for sulfur dioxide, total suspended particulates (TSP), and carbon monoxide. Oxides of nitrogen, ozone, and lead are not suspected to be in violation of the standards; therefore they are not measured. Table 2-9 compares ambient air quality data measured in the town of Niagara Falls in 1987 with federal and state standards. State standards were not exceeded for any of the pollutants measured. The area around the airport has been designated as in attainment for each of the pollutants in Table 2-9 (AFRES, 1989).

2.7 NATURAL RESOURCES

2.7.1 Mineral Resources

No mineral or metal ores are mined in the vicinity of the base. Limestone is mined throughout Niagara and Erie counties. Two limestone mining operations exist in the vicinity of the base, one located approximately 1-1/2 miles north of the base boundary and the other in the town of Lockport (AFRES, 1989). Glacial sand and gravel are also mined in the region, although no extraction operations are located within the immediate vicinity of the base.

TABLE 2-9

Comparison of Ambient Air Quality Measurements in the Niagara Falls Area with Federal and New York State Standards

Pollutant	Averaging Time	Federal Standard Primary	Federal Standard Secondary	New York Standard	1987 Ambient Value[a]
Sulfur dioxide (ppm)	1 yr	0.03	-	0.03	0.012
	24 h	0.14	-	0.14	0.110
	3 h	-	0.50	0.50	0.059
Total suspended particulates[b] (ug/m^3)	1 yr	75	60	75	50
	24 h	260	150	260	130
Carbon monoxide (ppm)	8 h	10	10	9	4.9
	2 h	40	40	35	8.7
Ozone (ppm)	1 h	0.12	0.12	0.12	Not Measured
Nitrogen oxides (ug/m^3)	1 yr	100	100	100	Not Measured
Lead (ug/m^3)	3 months	1.5	-	1.5	Not Measured

[a] The values used are the highest values reported for each year, except for SO_2, TSP, and CO, for which the second-highest values are given.

[b] As of July 31,1987, the TSP standard was replaced at the federal level by the PM_{10} standard. PM_{10} - particulate matter, particles with a diameter of less than 10 microns.

Source: AFRES, 1989.

2.7.2 Environmental Resources

The agricultural districts located north and east of the base are considered a valued natural resource in the region; principal crops grown include hay, corn, small grains, and a variety of fruits and vegetables.

Other resources in the region include hydro-electric power. Niagara County is one of the principal manufacturing centers of hydro-electricity for the state. The Niagara Power Reservoir, located three miles northwest of the base, is the largest inland surface water body used for hydro-electricity.

2.8 CULTURAL RESOURCES

No existing or potential archeological sites or historic structures listed in the State files or in the National Register of Historic Places are located within the vicinity of the Niagara Falls IAP (AFRES, 1989).

2.9 BIOLOGY AND ECOLOGY

2.9.1 Communities and Habitats

The Niagara Falls IAP occupies approximately 624 acres, of which 226 acres are improved, 237 acres are semi-improved grounds and 161 acres are under facilities. No unimproved grounds exist at the base (AFRES, 1989).

The majority of base land is classified as grassland-type vegetative cover with scattered shrubs and trees. Most of the land is actively mowed and landscaped. Natural habitat is limited at the base. Wildlife habitats are restricted to expanses of mowed grassy fields, areas associated with drainage ditches, and Cayuga Creek. The typical wildlife found at the base include hawks, mice, rabbits, foxes, deer, pheasants, sparrows, rock doves, robins and gulls. Occasionally migratory species, such as waterfowl, shorebirds and some predatory birds, also are sighted at the base. Cayuga Creek provides the only aquatic habitat on the base, but due to the intermittent flow and poor water quality of the stream, populations of fish are absent. (AFRES, 1989).

2.9.2 Sensitive Areas

A 72 acre freshwater wetland exists southwest of the stabilized overrun of runway 10L-28R; 14 acres of this wetland are on base property. The NYDEC has classified this wetland as a Class II wetland (i.e. an emergent Marsh with Moderate Value as a wetland protection area) (AFRES, 1989).

2.9.3 Endangered Species

No federal- or state-listed threatened or endangered species are reported to exist at the Niagara Falls IAP, and no critical on-site habitats exist for listed species that might potentially occur at the base.

2.10 CLIMATOLOGY/METEOROLOGY

2.10.1 Precipitation (Seasonal Variation)

The humid continental climate of the Niagara Falls IAP area is characterized by moderate annual precipitation. The main circulation of air is generally dry along the path of the prevailing westerly winds. Secondary circulation systems from the Gulf of Mexico in the summer and from Canada in the winter provide additional precipitation. The proximity to Lakes Erie and Ontario has a moderating effect on temperature, and provides additional moisture to the region. Annual distribution of precipitation in the area is relatively even, with heavy snowfall occurring frequently during the winter. Mean annual precipitation, recorded from 1871 to 1981, was 35.58 inches per year. Net precipitation (precipitation minus evaporation) is + 8.6 inches (Engineering Science, 1987). Average monthly temperature, precipitation, and snowfall data for the Niagara Falls IAP are presented in Table 2-10.

TABLE 2-10

CLIMATIC CONDITIONS FOR NIAGARA FALLS IAP

Months	Temperature (°F) Mean Average Monthly *(1987-1989)	Precipitation (IN) Mean Monthly (1871-1981)	Precipitation (IN) Mean Monthly *(1987-1989)	Snowfall (IN) Mean Monthly (1944-1981)	Snowfall (IN) Mean Monthly *(1987-1989)
Jan	27.6	3.09	1.68	23.8	6.15
Feb	23.8	2.69	3.30	18.0	30.75
Mar	33.5	2.75	3.07	11.9	8.1
Apr	43.8	2.70	2.42	3.1	1.65
May	56.5	2.86	4.27	0.1	4.0
Jun	64.9	2.79	4.06	T	0.0
Jul	72.2	2.94	3.4	0.0	0.0
Aug	69.9	3.21	2.58	0.0	0.0
Sep	62.1	3.07	3.75	T	0.0
Oct	47.4	3.05	4.35	0.3	0.3
Nov	42.8	3.21	3.90	12.4	0.8
Dec	32.2	3.22	2.46	22.4	10.3
		35.58	39.24		

NOTE: T = Trace
(Modified from Engineering Science 1983)
*(Jan 87 to Sept 89) Period

3.0 FIELD INVESTIGATION PROGRAM

3.1 ORGANIZATION AND DEVELOPMENT

The field investigation program for the Niagara Falls International Airport (IAP) was organized according to the objectives of the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study (RI/FS). These objectives are as follows:

- o Confirm and quantify the extent and magnitude of contamination to all media traceable to documented historical base activities, such as fire training, accidental spills, and the handling/disposal of hazardous waste
- o Identify pathways and the potential impact of this contamination upon public health and the environment
- o Formulate remedial technologies/alternatives to resolve the problems of contamination according to Federal, State, and local regulations and guidelines.

The remedial investigation and feasibility study are interdependent, and the activities comprising these two projects are generally performed concurrently rather than sequentially. However, it should be noted that since the remedial investigation emphasizes data collection and site characterization, and the feasibility study emphasizes data analysis and evaluation of alternatives, certain portions of work are accomplished sequentially.

3.1.1 Remedial Investigation

The remedial investigation consisted of numerous field operation episodes which focused on the following tasks:

- o Site inspections
- o Groundwater level measurements
- o Soil gas survey
- o Headspace analysis of groundwater and soil
- o Subsurface soil sampling using hollow-stem auger drilling techniques

- Installation of shallow and deep groundwater monitoring wells
- Groundwater, surface water, and surface sediment sampling
- Surface water discharge measurements along Cayuga Creek and its tributaries
- Water tank sampling (well development and purge water)
- Drum sampling of suspected contaminated borehole cuttings
- Surveying of new wells, boreholes and surface sampling points.

Tasks performed during the RI generated field and analytical data to support the RI/FS. In addition, a literature search was performed to update background information concerning Niagara Falls IAP and the surrounding area. Consequently, such data and literature collection efforts were evaluated, finalized and used to create this report.

Task protocols used in the field effort at Niagara Falls IAP are summarized in this section and are presented in detail in the Niagara Falls IAP IRP RI/FS Work Plan and Quality Assurance Project Plan (QAPP).

3.1.2 Risk Assessment

As indicated in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (Interim Final Report: October 1988), the evaluation of risk to public health and the environment is a critical component of site characterizations and assessment. A baseline risk evaluation is conducted to assess site conditions in the absence of remedial actions. In general, the objective of the baseline evaluation is to provide as complete a picture as possible of the magnitude of problems associated with given sites. The baseline risk assessment determines whether or not remedial action is necessary and whether an immediate and direct threat to health and the environment exists.

For Niagara Falls IAP the baseline assessment was tailored to fit the particular circumstances of the site. The appropriate level of detail was determined for the base by site-specific factors (e.g., the number, concentrations, and types of chemicals under investigation, the number and complexity of the sources of release, the number of significant exposure pathways, the nature of the hydrogeology, the establishment of ARARs, and the adequacy of the available monitoring data). Data collected during the RI were evaluated to determine if they were sufficient to develop remedial alternatives. If the data are proven insufficient, additional data gathering would be necessary. The feasibility study used this available RI data to develop remedial response objectives for each site.

3.1.3 Feasibility Studies

The feasibility study provides a comprehensive site-by-site evaluation of remedial alternatives basis which protect human health and the environment; it is conducted as outlined in SARA and the NCP. The feasibility study is interdependent with the remedial investigation. Preliminary alternative remedial actions were developed using data gathered during the RI and judgments based on the risk assessment. Only those hazardous waste disposal and spill sites at which contaminant levels have been quantified and which have defined sources were selected for remedial action. Hence, "No Further Action" sites were excluded from FS completion. Decision Documents supporting no further action for those sites will be completed by AFRES.

In the process of developing alternatives, SAIC identified general response actions and possible remedial technologies for each such action identified. General response actions selected each include the "No Action" alternative as a baseline against which other alternatives can be measured.

3.2 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) were specified for each data collection activity or task included in the remedial investigation. In addition, the feasibility study included data gathering activities based on RI data. Niagara Falls IAP's QAPP provided the IRP team with guidelines for all field and laboratory operations to pursue the project's primary goal. That goal was to produce data of known and acceptable quality to allow the IRP team to assess fully the impact of past and present hazardous waste practices; to identify, quantify, and delineate the extent of any contamination; and to develop preliminary alternative action plans. During the course of this investigation, all activities and analyses were conducted using standard procedures so that known and acceptable levels of accuracy, precision, completeness, representativeness, and comparability were documented.

3.3 SUMMARY OF FIELD PROGRAM ACTIVITIES

Table 3-1 provides a summary of the IRP RI activities completed at Niagara Falls IAP, and Table 3-2 summarizes the overall RI analytical program at Niagara Falls IAP. In addition, Figures 3-1 through 3-11 display the location of RI environmental monitoring stations (i.e., monitoring wells, soil borings and stream sampling points).

3.3.1 Program Scheduling

The IRP RI/FS program at Niagara Falls IAP proceeded in the following chronology:

Notice to proceed	9/87
Work Plan preparation	9/87 - 6/89
QAPP preparation	9/87 - 6/89
Health and Safety Plan preparation	9/87 - 7/89
RI Field Program (see Table 3-3 for detail)	4/89 - 4/90
Data Analysis: Informal Technical Information Report	9/89 - 8/90
Final RI/FS Report	10/89 - 10/90

3.3.2 Identification and Role of Subcontractors

The following subcontractors were utilized to complete the Niagara Falls IAP IRP RI/FS activities documented in this report:

- Ecology and Environment, Inc., Buffalo, New York -- laboratory analytical services

Summary of Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name	Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 1: Building 600 **JP-4** Pipeline Leak*	1969	Leak in underground JP-4 hydrant system saturated ground with JP-4; fuel appeared in surface drainage after heavy rains	o Conducted a 2-day soil gas survey at Site 1 (6 sampling points) o Performed headspace analyses on 14 groundwater samples and 6 soil samples o Drilled and installed 4 shallow monitoring wells and 2 deep monitoring wells o Drilled 6 soil borings o Collected 18 soil samples o Collected 20 groundwater samples from the 15 existing wells and the 5 new RI wells o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 2: POL JP-4 Tank C*	1982	Approximately 9,000 gallons of JP-4 leaked from underground inlet and outlet pipes leading to Tank C; fuel appeared in stormwater drainage.	
SITE NO 4: BX MOGAS Tank Leak*	1981	Undetermined amount of gasoline leaked from underground pipe, persisted for several weeks in storm sewers	
SITE NO 6: POL JP-4 Tank A*	1979	An underground inlet pipe from Tank A leaked greater than 4,000 gallons of JP-4, due to pipe corrosion. The leak appeared at the ground surface inside the dike and in nearby stormdrains	

*Activities listed represent the collective effort at Sites No. 1, 2, 4 and 6.

Tab 1 (Cont'd)
Summary of Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name		Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 3:	Landfill	1952-1969	A disposal site for construction rubble, trash, garbage, ash from coal stoves, waste oil, shop wastes, batteries, scrap electrical parts from Bell Aerospace, car parts, trash from the Navy station, Fort Niagara and Model City	o Drilled and installed 1 shallow monitoring well and 3 deep monitoring wells o Collected 10 groundwater samples from the 6 existing wells and the 4 new RI wells o Collected 3 surface water/sediment samples and took discharge measurements at the upstream point o Collected 7 soil samples o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 5:	NYANG Hazardous Waste Drum Storage**	1983	Drums containing wastes from shop operations stored since 1983; visual evidence of spill migration to surface drainage.	o Conducted a maximum 1-day soil gas survey at Site 8 (13 sampling points) o Performed headspace analyses on 6 groundwater samples from existing wells o Drilled and installed 3 shallow monitoring wells and 4 deep monitoring wells o Collected 13 groundwater samples from the 6 existing wells and the 7 new RI wells. o Collected 3 surface water and 4 sediment samples and took discharge measurements at each point o Collected 8 soil samples o Groundwater level measurements taken from all new RI and existing monitoring wells
SITE NO 8:	Building 202 Drum Storage Yard**	1978-1983	Drums containing waste oils and hazardous waste storage area. History of small spills evident	

**Activities at this site represent the combined effort at Sites No. 5 and [illegible]

Tab ont'd)
Summary o agara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name		Date of Operation or Occurrence	Description	IRP RI Activities
SITE NO 7:	JP-4 Tank Truck Spill	1983	Tank truck overturned; approximately 2,500 gallons of JP-4 unaccounted for after cleanup	o Performed headspace analyses on 3 groundwater samples from existing wells o Collected 3 groundwater samples from existing wells o Drilled 1 soil boring o Collected 3 soil samples o Groundwater level measurements taken from all existing monitoring wells
SITE NO 9:	Fire Training Facility No. 3	1963–1983	In operation from the early 1960's to present; burned JP-4 and possibly other combustible liquids (oils, solvent, etc.); runoff to Cayuga Creek evident	o Performed headspace analyses on 1 groundwater sample from existing wells and 3 soil samples o Drilled 1 soil boring o Collected 3 soil samples o Drilled and installed 3 shallow monitoring wells o Collected 4 soil samples o Collected 4 groundwater samples from the 1 existing well and the 3 new RI wells o Collected 3 surface water/sediment samples o Groundwater level measurements taken from all new RI and existing wells o Drilled and installed 2 shallow monitoring wells during additional RI effort o Collected 6 groundwater samples from the 1 Stage 1 well and the 5 RI wells during the additional RI effort

Tab 1 (Cont'd)
Summary of Niagara Falls IAP
IRP Remedial Investigation (RI) Activities

Site Number/Name		Date of Operation or Occurrence	Description	IRP RI Activities
SITE 10:	: Fire Training Facility No. 1	1955–1963	Contaminated fuel (AVGAS) and other combustible liquids burned over a 5-year period	o Performed headspace analyses on 3 groundwater samples from existing wells o Drilled and installed 1 shallow monitoring well and 1 deep monitoring well o Collected 5 groundwater samples from the 3 existing wells and the 2 new RI wells o Collected 3 soil samples o Groundwater level measurements taken from all new RI and existing wells
SITE 11:	: Fire Training Facility No. 2	early 1960's	Used approximately 10 times during 1 year; precautions were not taken for containing fuel prior to burning	
SITE 12:	: Building 850 Drain Storage Yard	1950's – early 1960's	Drums of waste oil and hazardous waste from Bldg. 850 were stored in area. No significant spills were reported	o Drilled 2 soil borings o Collected 6 soil samples
SITE 13:	: 4,000 Gallon Underground Tank Pit	1979–1983	A leak was discovered in the tank during removal and analyses performed on adjacent soils yielded organic contamination	o Drilled 2 soil borings o Collected 6 soil samples o Drilled and installed 4 shallow monitoring wells o Collected 4 groundwater samples o Collected 7 soil samples o Groundwater level measurements taken from all new RI and existing wells o Collected 4 more groundwater samples during the additiona[illegible]ffort

TABLE 3-2
NUMBER OF SAMPLES BY SITE

PARAMETER (Groundwater)	ANALYTICAL METHOD	SITES											
		1,2,4, & 6	3	7	10	5 & 8	12	9	11	13	CONT. WATER	USGS WELLS	TOTAL
		GW SW	GW SW	GW SW	GW SW	GW SW	GW SW	GW SW	GW SW	GW SW			
Alkalinity - Carbonate Bicarbonate & Hydroxide (Field Test)	A403	20/-	10/3	3/-	5/-	13/3	-/-	6/3	-/-	4/-	-	2	67
Common Anions (Chloride, Fluoride, Nitrate, Sulfate, Orthophosphate)	A429	20/-	10/3	3/-	5/-	13/2	-/-	4/3	-/-	4/-	-	2	67
Specific Conductance (Field Test)	E120.1	20/-	10/3	3/-	5/-	13/3	-/-	6/3	-/-	4/-	-	2	67
pH (Field Test)	E150.1	20/-	10/3	3/-	5/-	13/3	-/-	6/3	-/-	4/-	-	2	67
Total Dissolved Solids	E160.1	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Temperature (Field Test)	E170.1	20/-	10/3	3/-	5/-	13/3	-/-	6/3	-/-	4/-	-	2	67
Metal Screen (25 Metals)	E200.7	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Arsenic	E206.2	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Lead	E239.2	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Mercury	E245.1	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Selenium	E270.2	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	-	2	67
Petroleum Hydrocarbons	E418.1	20/-	10/3	3/-	5/-	13/3	-/-	4/3	-/-	4/-	9	2	79
Purgeable Halocarbons*	E601*	-/-	10/3	-/-	5/-	13/3	-/-	6/3	-/-	4/-	9	2	56
Organochlorine Pesticides and PCB's	E608	-/-	10/3	-/-	-/-	-/-	-/-	-/-	-/-	4/-	-	-	16
Extractable Priority Pollutants	E625	-/-	10/3	-/-	-/-	13/3	-/-	-/-	-/-	-/-	-	-	30
Purgeable Aromatics*	SW5030/ SW8020*	20/-	10/3	3/-	5/-	13/3	-/-	6/3	-/-	4/-	9	-	-

TABLE 3-2 (Cont'd)
NUMBER OF SAMPLES BY SITE

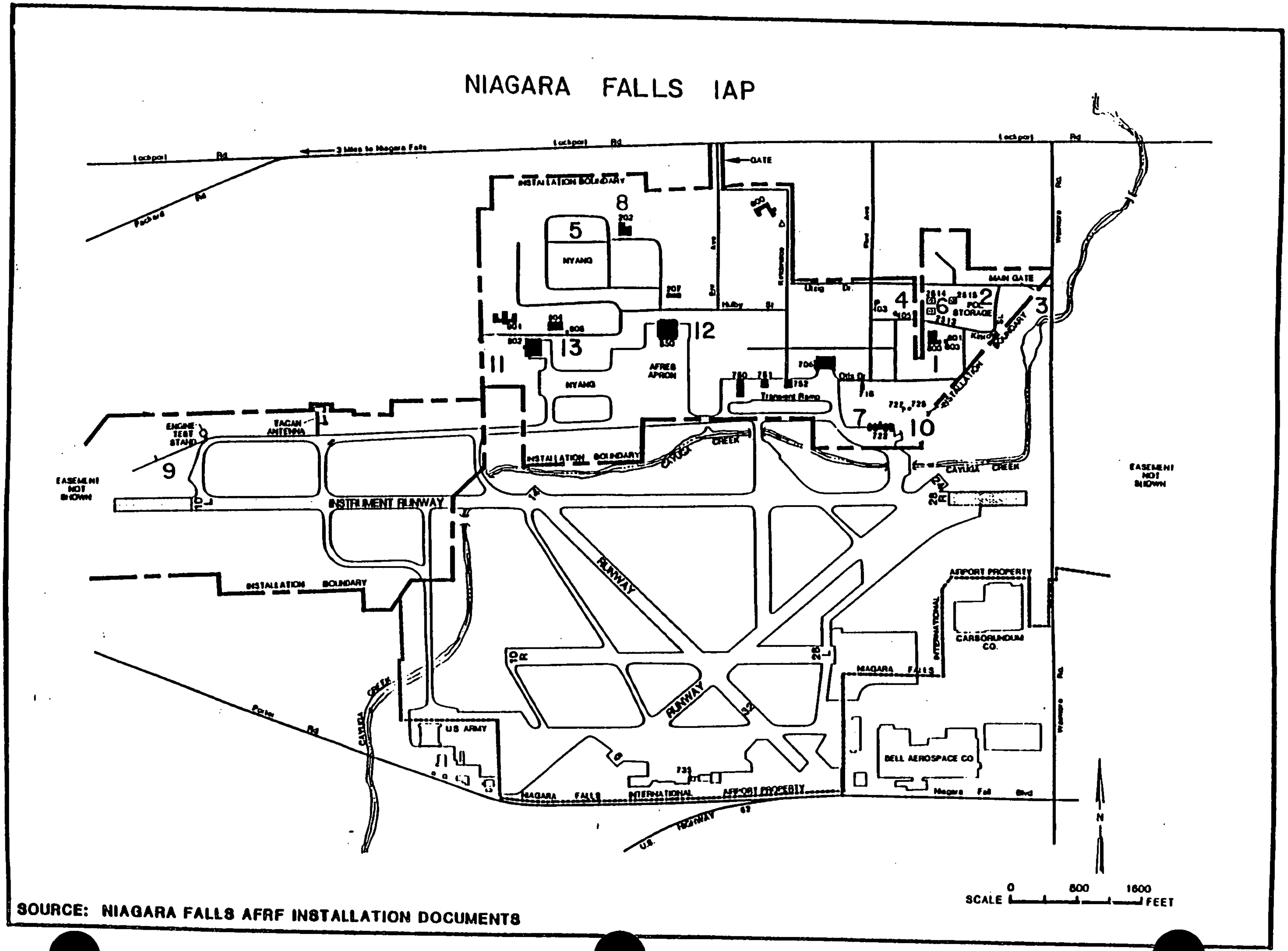
PARAMETER	ANALYTICAL METHOD	1.2.4. & 6	3	7	10	5 & 8	12	9	11	13	Background	Tox	SOIL
Soil Samples		Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb Sd	Sb	Ss	TOTAL
Petroleum Hydrocarbons	SW3550/ E418.1	17/-	7/3	3/-	3/-	9/4	6/-	7/3	6/-	7/-	6	-	81
Metal Screen (25 Metals)	SW3050/ SW6010	-/-	7/3	-/-	3/-	9/4	6/-	7/3	6/-	7/-	6	-	61
Lead	SW3050/ SW7420	-/-	7/3	-/-	3/-	-/-	-/-	7/3	6/-	7/-	-	-	36
Mercury	SW7471	-/-	7/3	-/-	-/-	9/4	6/-	-/3	-/-	-/-	6	-	38
Volatile Organic Compounds	SW5030/ SW8240	-/-	7/3	-/-	3/-	-/4	6/-	7/3	6/-	7/-	6	4	56
Semivolatile Organic Compounds	SW3550/ SW8270	-/-	-/3	-/-	3/-	9/4	6/-	7/3	6/-	7/-	6	4	58
*Soil Moisture Content	ASTM D2216	18/-	8/-	4/-	3/-	10/4	6/-	7/3	6/-	7/-	6	-	82
Aromatic Volatile Organics	SW5030/ SW8020	17/-	-/-	3/-	-/-	9/-	-/-	-/-	-/-	-/-	6	-	35
Extraction Procedure Toxicity	40 CFR 261/24	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-	4	4
Total Organic Carbon	SW9060	1/-	1/-	1/-	-/-	1/-	-/-	-/-	-/-	-/-	-	-	4

TABLE 3-2 (Cont'd)
NUMBER OF SAMPLES BY SITE

PARAMETER Soil Samples	ANALYTICAL METHOD	1.2.4. & 6 Sb Sd	3 Sb Sd	7 Sb Sd	10 **Sb Sd**	5 & 8 Sb Sd	12 Sb Sd	9 Sb Sd	11 Sb Sd	13 Sb Sd	Background Sb	Tox **Ss**	SOIL TOTAL
Engineering Property Characteristics:													
Density	ATSM D854	1/-	1/-	1/-	-/-	1/-	-/-	-/-	-/-	-/-	-	-	4
Grain Size	ASTM D422	1/-	1/-	1/-	-/-	1/-	-/-	-/-	-/-	-/-	-	-	4
Plasticity Index	ASTM D424	1/-	1/-	1/-	-/-	1/-	-/-	-/-	-/-	-/-	-	-	4

Sb - Soil Borings   Sd - Sediment   Ss - Soil

* Includes one additional sample at sites 1,2,4 and 6,3,7 and 5&8 for engineering property characteristics



SOURCE: NIAGARA FALLS AFRF INSTALLATION DOCUMENTS

FIGURE 3-1.
IRP RI/FS SITE LOCATIONS AT NIAGARA FALLS IAP

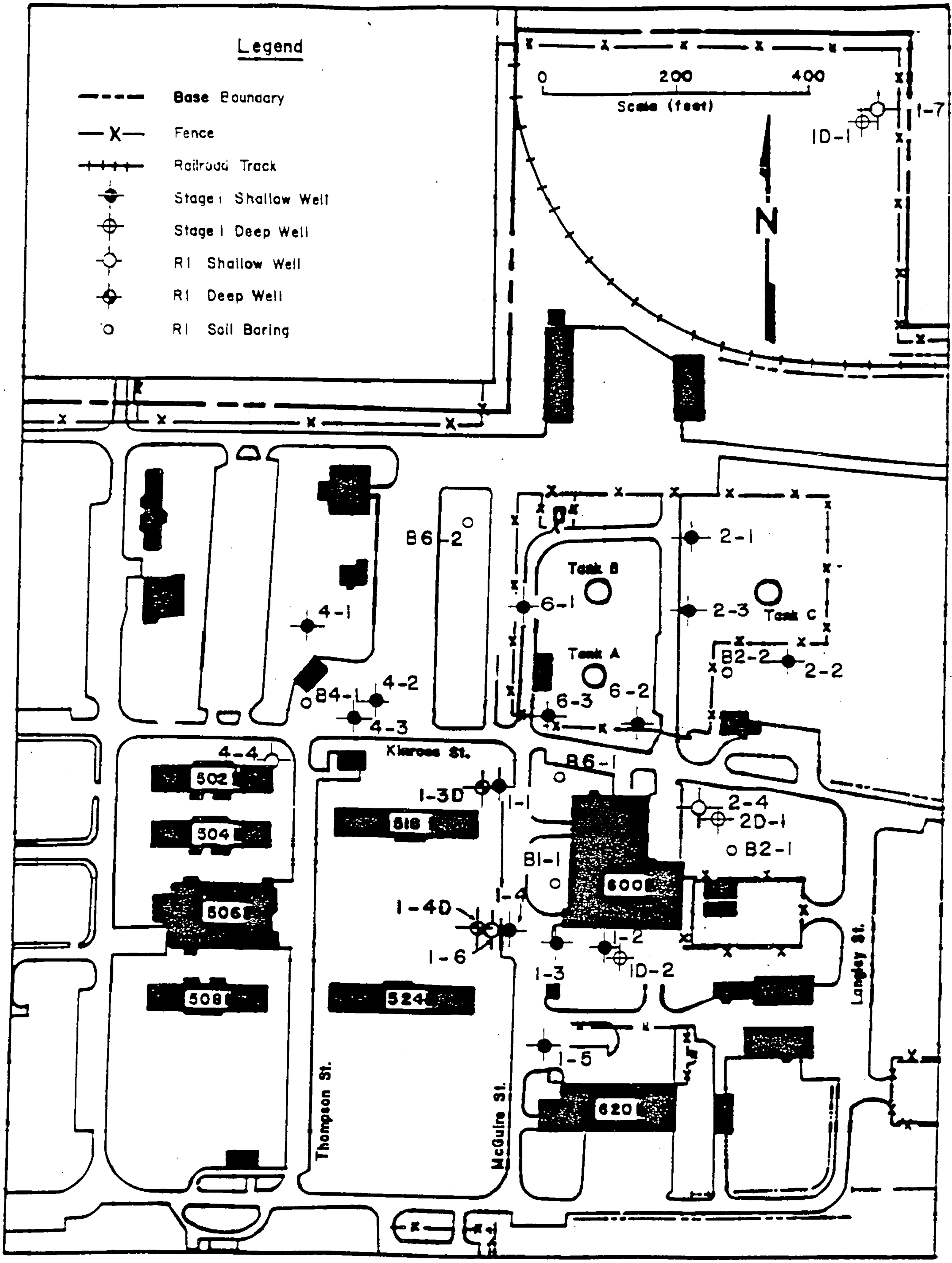


FIGURE 3-2.
SITE NOS. 1,2,4 AND 6: IRP RI ENVIRONMENTAL MONITORING STATIONS

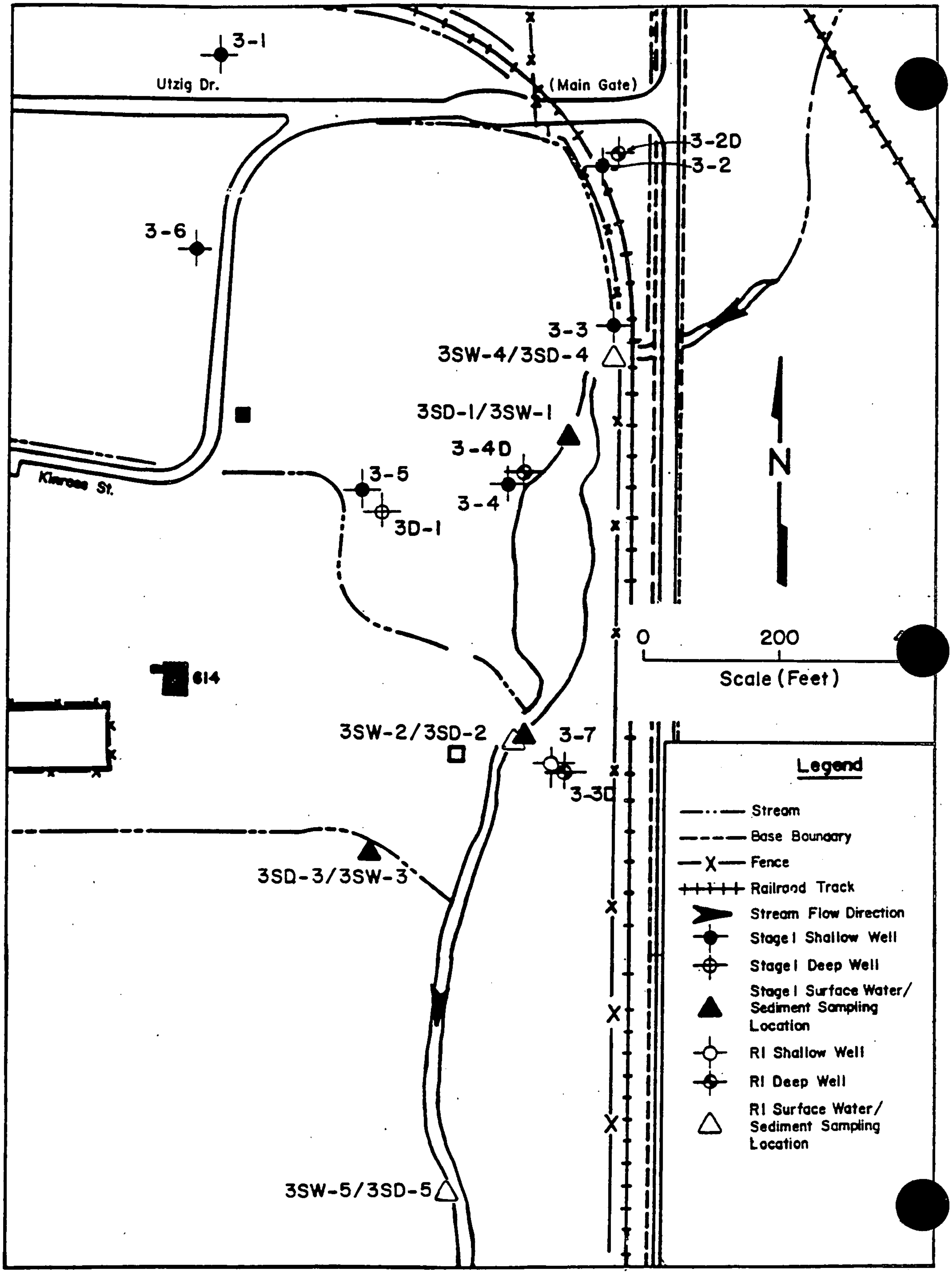


FIGURE 3-3.
SITE NO. 3: IRP RI ENVIRONMENTAL MONITORING STATIONS

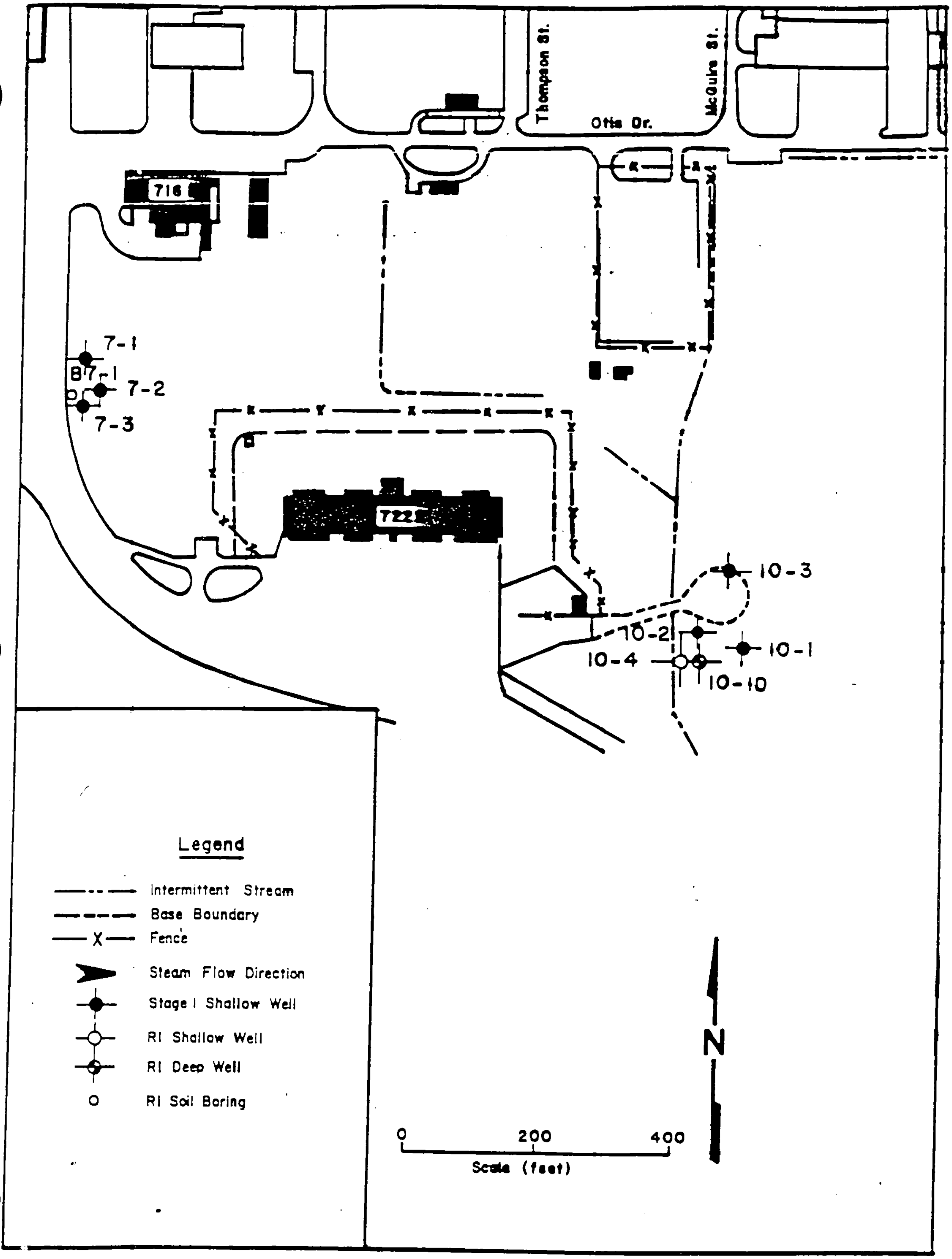


FIGURE 3-4.
SITE NOS. 7 AND 10: IRP RI ENVIRONMENTAL MONITORING STATIONS

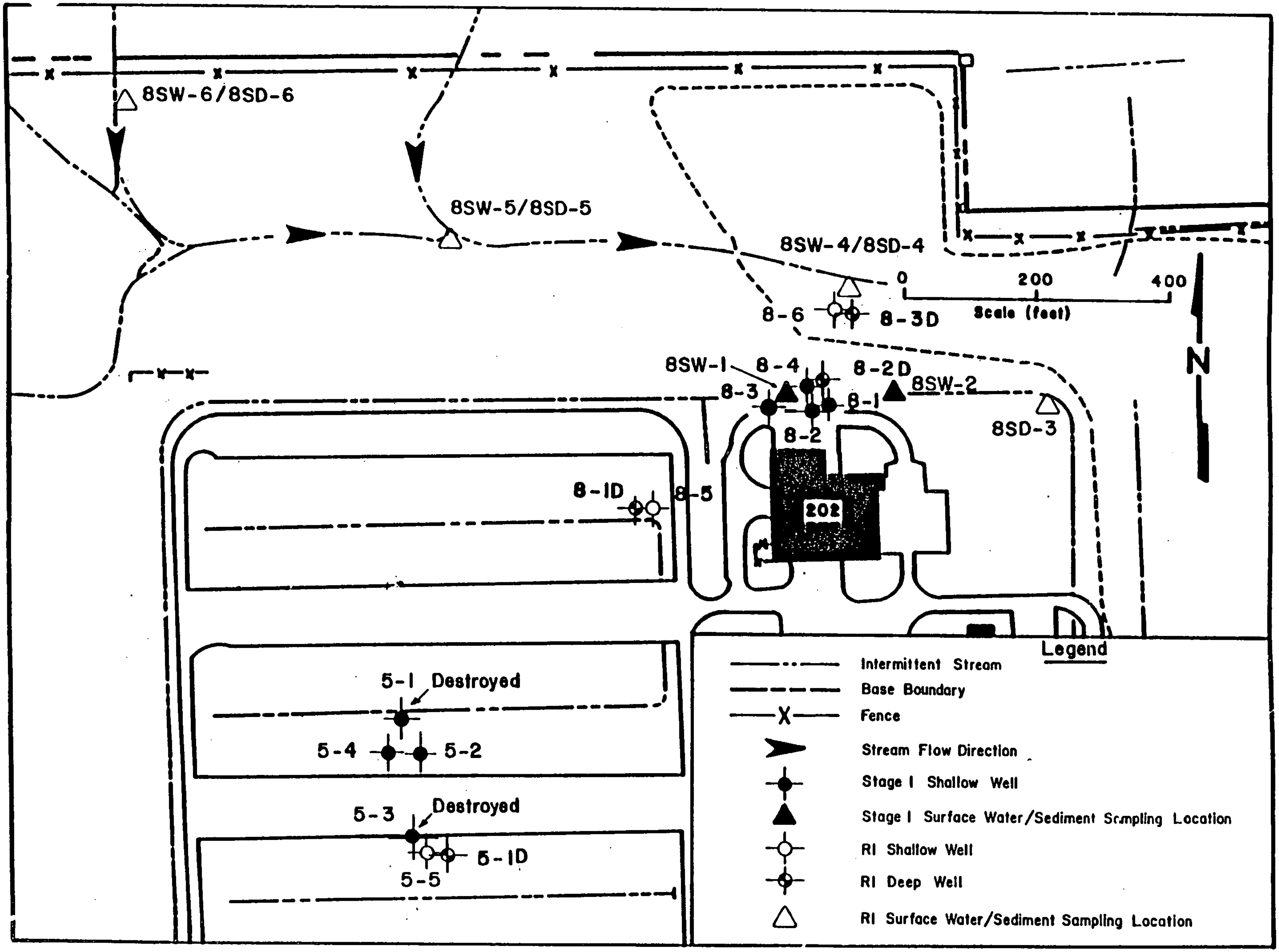


FIGURE 3-5
SITE NOS. 5 AND 8: IRP RI ENVIRONMENTAL MONITORING STATIONS

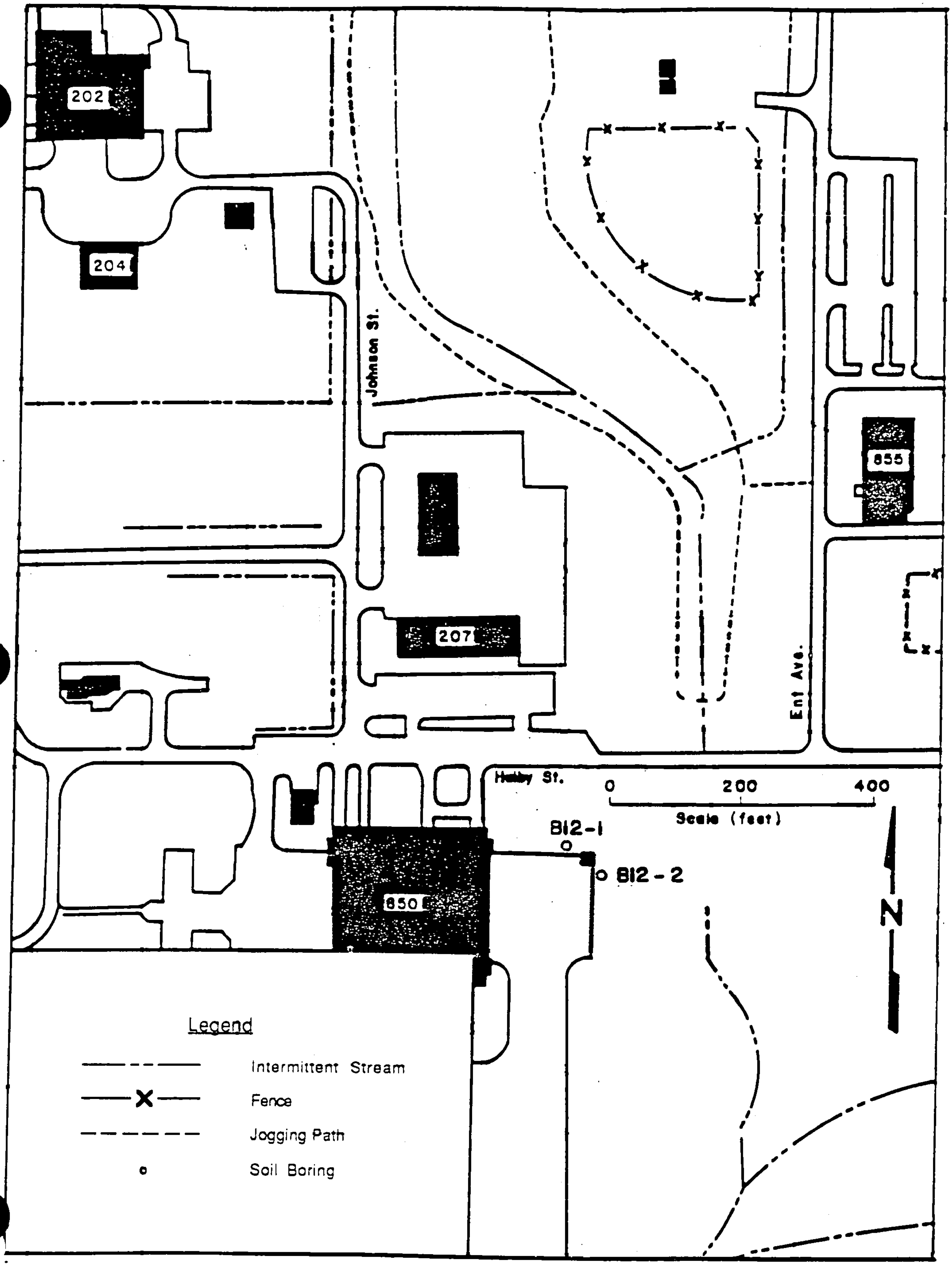


FIGURE 3-6.
SITE NO. 12: IRP RI ENVIRONMENTAL MONITORING STATIONS

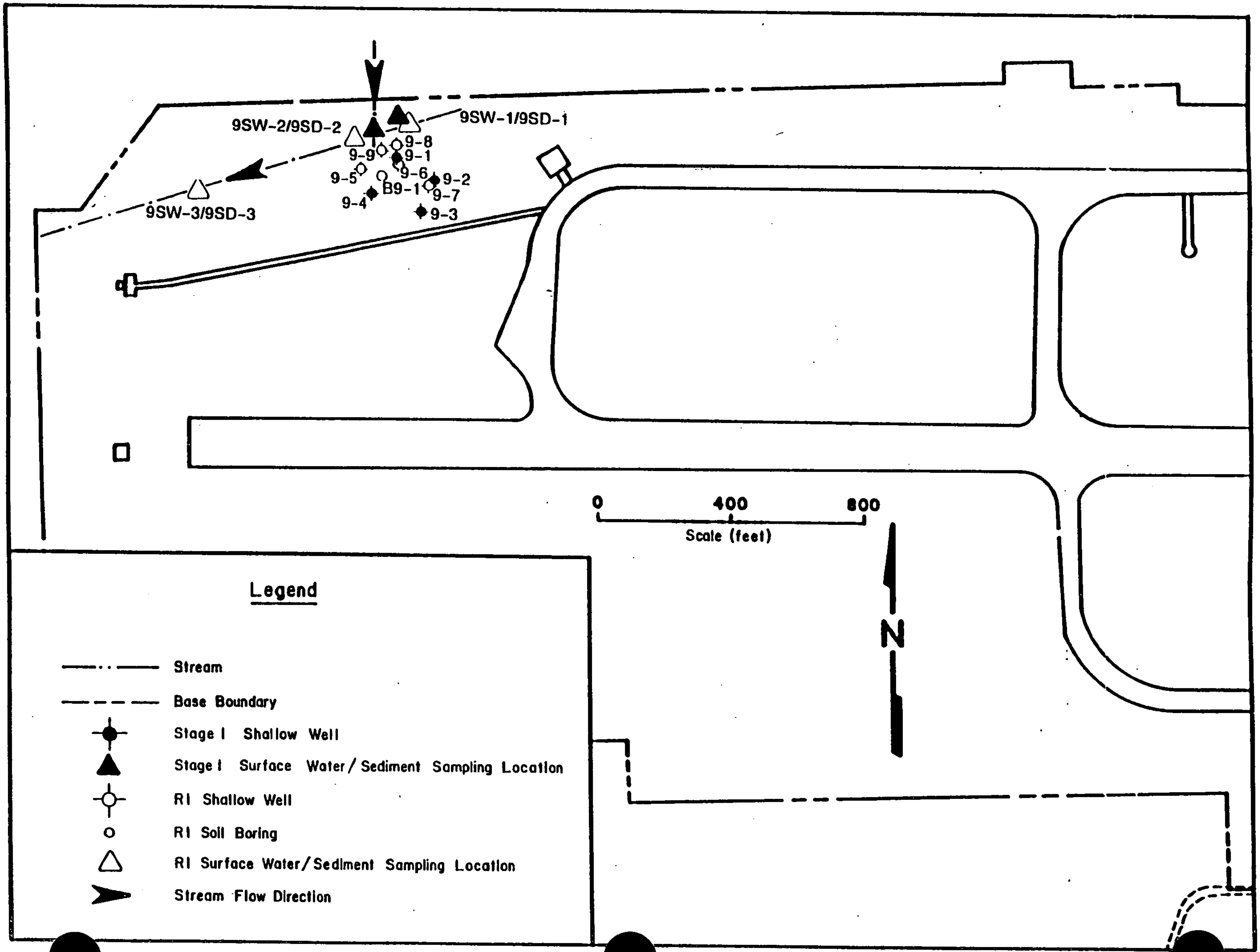


FIGURE 3-7.
SITE NO. 9: IRP RI ENVIRONMENTAL MONITORING STATIONS

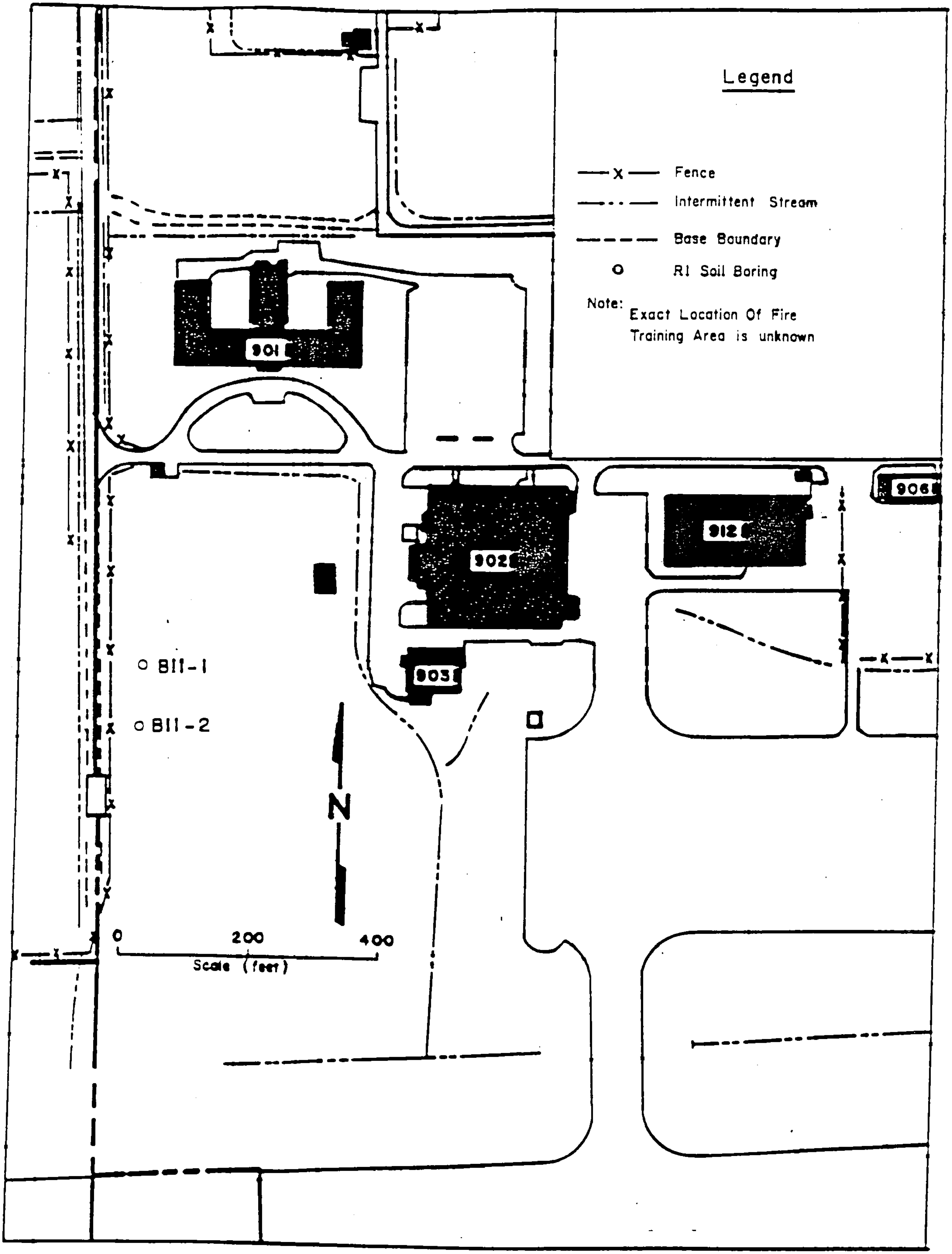


FIGURE 3-8.
SITE NO. 11: IRP RI ENVIRONMENTAL MONITORING STATIONS

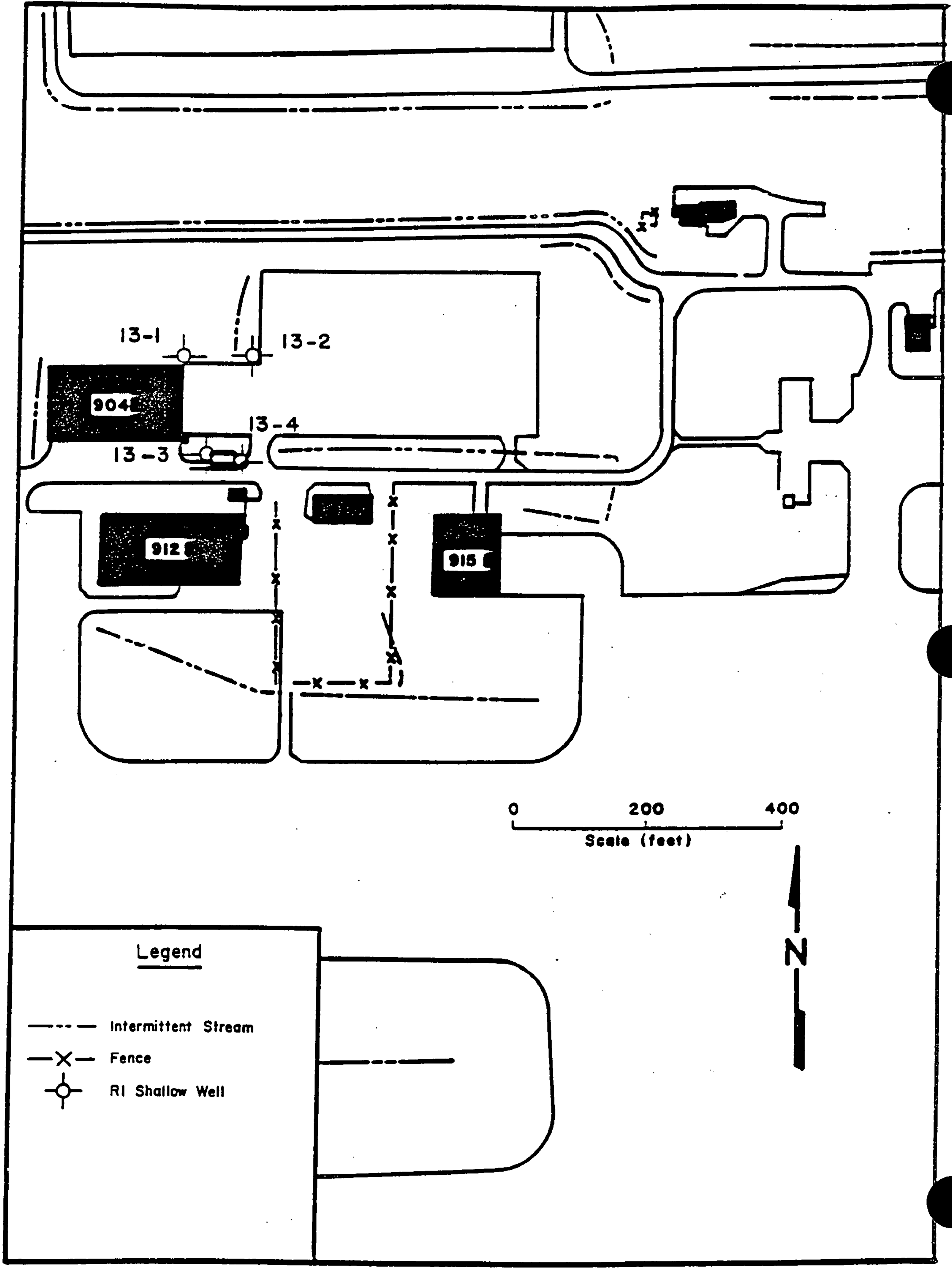


FIGURE 3-9.
SITE NO. 13: IRP RI ENVIRONMENTAL MONITORING STATIONS

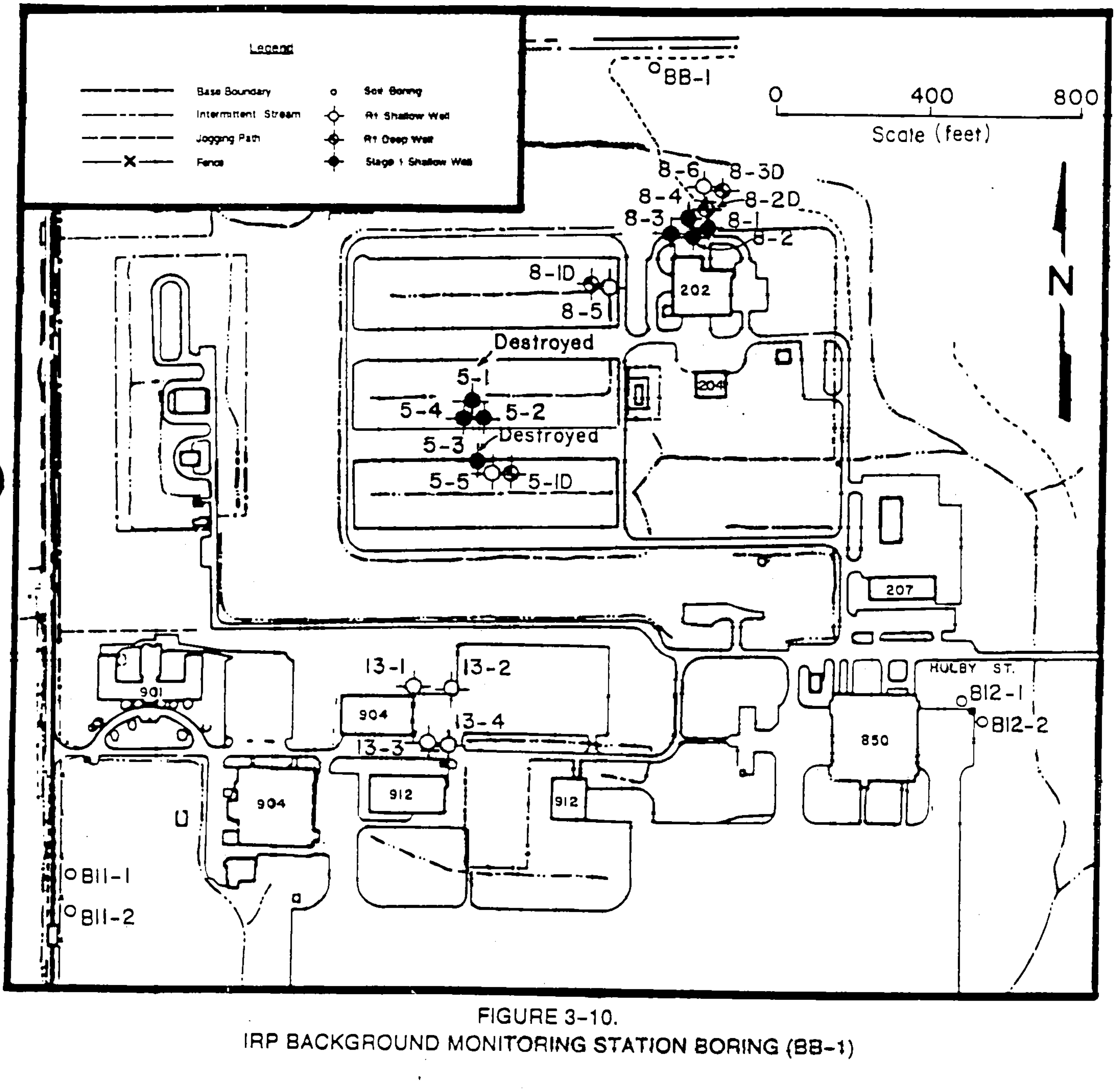


FIGURE 3-10.
IRP BACKGROUND MONITORING STATION BORING (BB-1)

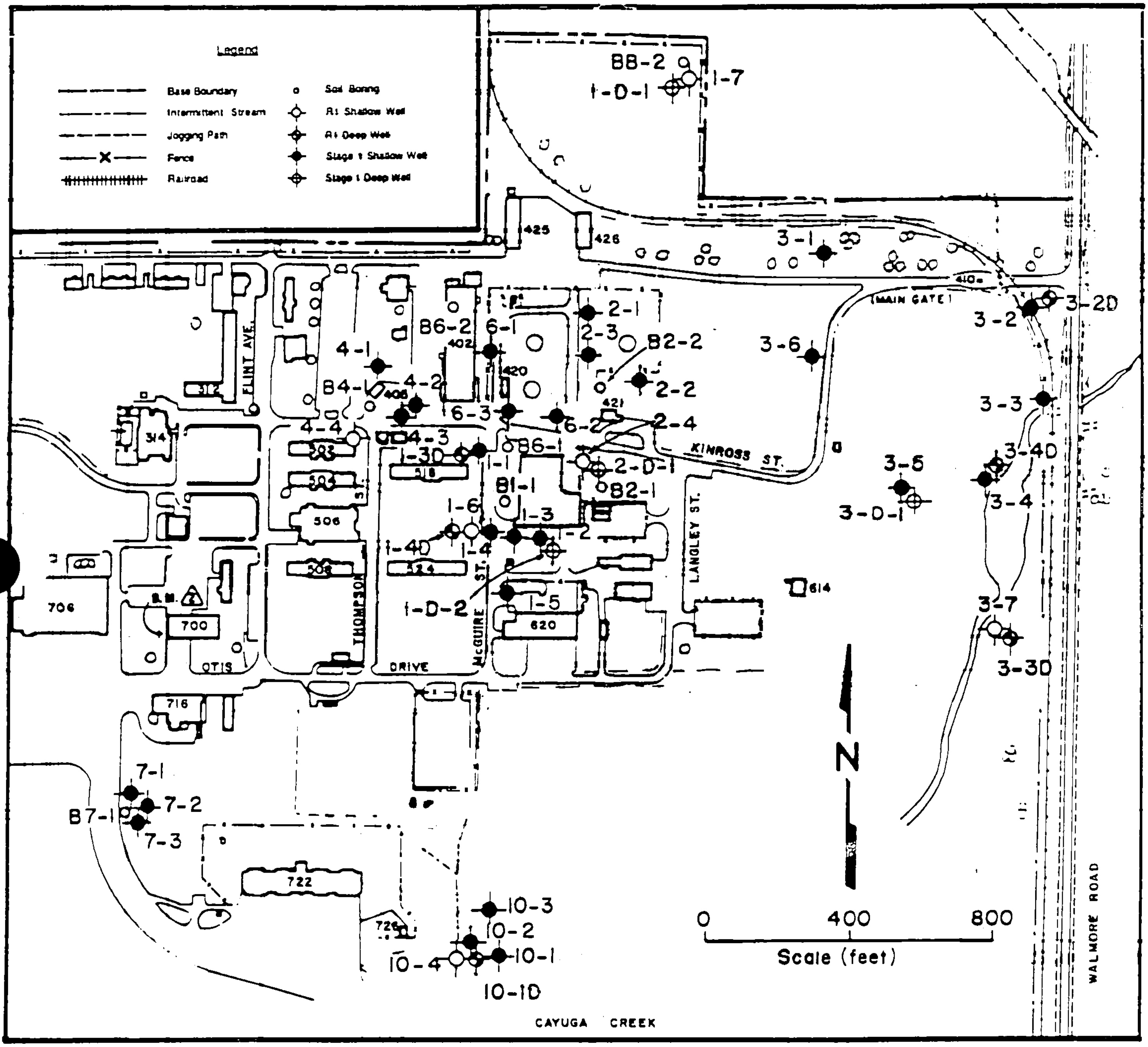


FIGURE 3-11.
IRP BACKGROUND MONITORING STATION BORING (BB-2)

TABLE 3-3

CHRONOLOGY OF RI FIELD INVESTIGATION PROGRAM
NIAGARA FALLS IAP

TASK	PERIOD OF PERFORMANCE	TOTAL # OF DAYS
Soil Gas Surveys	4/18/89 to 4/20/89	3 days
Site Inspection	5/31/89 to 6/02/89	3 days
Headspace Analysis	6/03/89 to 6/06/89	4 days
Subsurface Soil Borings/ Soil Sampling	7/10/89 to 7/18/89	7 days
Installation of Shallow Wells	7/18/89 to 7/31/89 and 4/13/90	11 days
Installation of Deep Wells	8/01/89 to 8/25/89	20 days
Groundwater Level Measurements	5/31/89 9/12/89 10/04/89 4/11/90	3 days
Groundwater Sampling on Base	9/11/89 to 9/29/89 and 4/13/90 to 4/19/90	17 days
Surveying	9/12/89 to 9/15/89 and 4/17/90	4 days
Surface Water/Surface Sediment Sampling	9/27/89 to 9/29/89	3 days
Discharge Measurements	9/27/89 to 9/28/89	2 days
Water Tank Sampling	10/03/89	1 day
Drum Sampling	10/03/89	1 day
USGS Wells-Groundwater Sampling	10/13/89	1 day

- Empire Soils Investigations, Inc., Hamburg, New York -- soil boring and shallow/deep monitoring well installations
- Tracer Research Corporation, Tucson, Arizona -- soil gas survey and headspace analysis
- McIntosh and McIntosh, P.C., Lockport, New York -- surveying.

3.4 INVESTIGATIONS, TESTS, AND SURVEYS

3.4.1 Site Inspections

Numerous site inspections were conducted at Niagara Falls IAP prior to field activities for the following reasons:

- Re-acquaint SAIC with the study sites
- Carry on literature search with State and Local agencies
- Take groundwater level measurements to establish hydraulic gradient and water table positions
- Determine placement of monitoring wells and soil borings
- Coordinate with IAP base personnel.

The location of the 1989 RI/FS monitoring wells and soil borings were selected based upon the results of the groundwater level measurements, soil gas surveys, headspace analyses, and existing site data.

3.4.2 Soil Gas Survey

Shallow soil gas surveys were performed at Niagara Falls IAP at Site 1 (JP-4 pipeline leak), Site 8 (drum storage yard) and Site 13 (underground storage tank). Soil gas surveys were originally scheduled for Sites 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13. However, because of elevated and/or perched water table conditions and saturated soils during the April 1989 soil gas survey inhibited attempts to acquire representative soil gas samples at 11 of these sites only Sites 1, 8 and 13 were tested.

The main objective of the soil gas survey was to detect the subsurface distribution of volatile organic compounds in an effort to define soil contamination resulting from past hazardous waste handling practices and to optimize RI borehole and well placements at the sites. The sampling strategy was to sample gases at a point of suspected contamination and progress in the general direction of contaminant detection to points of no contaminant detection at 10 to 50 foot spacings.

SAIC subcontracted Tracer Research Corporation (TRC) to conduct the survey for three days in April, 1989. The company provided an analytical field van equipped with one Varian 3300 gas chromatograph, two Spectra Physics SP 4270 computing integrators, two built-in gas-powered generators, and specialized hydraulic mechanisms to drive and withdraw sampling probes. A total of 42 soil gas samples were collected and analyzed for some or all of the following compounds:

- 1,1,1-trichloroethane (TCA)
- trichloroethene (TCE)
- tetrachloroethene (PCE)
- benzene
- toluene
- ethylbenzene
- xylenes
- total hydrocarbons

Soil gas samples were collected by driving a hollow steel probe (7 feet long and 3/4 inches in diameter) to a depth less than 3 feet into the ground. The above-ground end of the sampling probe was fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum pump. During the evacuation of soil gas, samples were collected by inserting a syringe needle through a silicone rubber segment in the evacuation line and down into the steel probe. The sample was then subsampled in volumes ranging from 1 µl to 2 ml to provide for duplicate injections. TCA, TCE, and PCE were analyzed using the electron capture detector (ECD) of the gas chromatograph. The flame ionization detector (FID) from the same gas chromatograph was used to analyze for benzene, toluene, ethylbenzene, xylenes, and total hydrocarbons. Compounds were separated on a 3' and 6' by 1/8" OD packed column with OV-101 as the stationary phase. Nitrogen was used as the carrier gas.

Cross contamination was prevented by purging the syringe with nitrogen carrier gas prior to sampling, and checking for contamination by injection into the gas chromatograph. System blanks were run periodically to confirm that no contamination was present in the probes, adapters and syringes. All soil gas probes, adapters, and syringes were used only once during the course of a working day and then thoroughly cleaned before use on the subsequent day. Analytical instruments were continually checked for calibration by use of chemical standards prepared in water from commercially available analytical chemicals.

3.4.3 Headspace Analyses of Groundwater and Soil

Since site conditions proved to be unfavorable and impaired the usefulness of soil gas techniques, headspace analysis of groundwater from existing Stage 1 monitoring wells and soils from sites that required more control (i.e., those with high HARM scores, damaged wells) was conducted. Headspace analysis replaced soil gas techniques at Sites 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. The objective of the combined soil gas surveys and headspace technique was to determine, to the best extent possible, the relative distribution and extent of volatile organic contamination in the subsurface as a basis for establishing locations for the RI/FS soil borings and monitoring wells.

The headspace analyses program included the collection of groundwater samples from all existing IRP Stage 1 monitoring wells and soil samples collected from closely spaced borings around known contaminant source areas. Only the areas that required more control included soil sampling.

SAIC retained TRC to conduct the survey for four days in June, 1989. TRC used an on-site Varian 3300 gas chromatograph with two Spectra Physics Chromjet SP4400 computing integrators. A total of 11 soil samples and 27 groundwater samples were collected by SAIC and analyzed in the field by TRC. Samples were analyzed for either most or all of the following compounds:

- 1,1,1 - trichloroethane (TCA)
- trichloroethene (TCE)
- tetrachloroethene (PCE)
- benzene
- toluene
- ethylbenzene
- xylenes
- total hydrocarbons

Prior to collecting groundwater samples, a static water level measurement was taken, and each well was purged (3 to 5 well casing volumes). Groundwater samples were collected by the SAIC field team within 24 hours of purging. A point-source teflon bailer was used to retrieve the groundwater samples and the samples were dispensed into appropriate, prelabeled teflon-lined septum vials. Vials were filled to allow no headspace. The vials were then given to the GC operator for analysis.

At those sites that required more control, soil samples were collected from tightly spaced borings around specific contaminant source areas. A hand operated stainless steel auger was used to collect the soil samples from intervals of one to three feet below the ground surface. In order to minimize the soils' exposure to the air, samples were immediately transferred from the sampler into appropriately labeled, 6 ounce, lab-prepared jars. Each of the sample jars were then refrigerated until analyzed by the GC operator.

Groundwater and soil samples for headspace analyses were analyzed using a Varian 3300 gas chromatograph equipped with a flame ionization detector (FID) and an electron capture detector (ECD). The ECD analyzed TCA, TCE, and PCE. The FID analyzed for benzene, toluene, ethylbenzene, xylenes, and total hydrocarbons. Compounds were separated by running the samples on 1/8-inch OD packed columns with OV-101 as the stationary phase. Nitrogen was used as the carrier gas.

Halocarbon and hydrocarbon compounds detected in the headspace samples were identified by chromatographic retention time. Quantification of compounds in the headspace were achieved by comparing the detector response for the sample with the response measured for headspace calibration standards (external standardization). Instrument calibration checks were completed periodically throughout the day.

Groundwater samples were contained in 40 ml, teflon-lined, septum vials in order to exclude any air. Any sediments in the aqueous sample were allowed to settle. The samples were maintained at an equal temperature so as not to bias sample results. Approximately 20 ml of the sample were decanted off, then the vial was resealed and shaken vigorously for 30 seconds. This allowed for the partitioning of compounds into the headspace of the vial. The headspace vapor was subsampled (duplicate injections) in volumes ranging from 1 µl to 2 ml.

Soil samples were analyzed using the following methodology. Approximately 10 grams of soil and 10 ml of reagent-grade water were placed in a 40-ml, teflon-lined, septum vial, leaving approximately 20 ml of headspace. Each vial was then shaken vigorously for 30 seconds before analysis. This allowed for the desorption of volatile organic compounds from the soil into the water, and the partitioning of these compounds into the headspace of the vial. The headspace vapor was subsampled (duplicate injections) in volumes ranging from 1 µl to 2 ml.

Analytical instruments were calibrated each day by the use of chemical standards prepared in water by serial dilution from commercially available pure chemicals. Standards were maintained at the same temperature as the samples. A headspace Response Factor (RF) was generated for each analysis. The RF was generated by decanting 20 ml off of the aqueous standard, leaving approximately the same amount of headspace that existed in the samples. The bottle was then resealed and shaken for 30 seconds. An analysis of the headspace in the bottle yielded the headspace RF. The value of the RF was then used to accurately estimate the total mass of the analysis in the original water sample.

Detection limits for the compounds of interest were a function of the injection volume, as well as the detector sensitivity for individual compounds. Thus, the detection limits varied with the sample size and larger injection volumes improved the detection limit. Peaks for compounds of interest were kept within the linear range of the analytical instrument. The detection limits ranged from 0.002 µg/kg for halocarbon compounds to 0.4 µg/kg for hydrocarbon compounds, depending on the conditions of the measurement (e.g., sample size). If any component analyzed was not detected, the detection limit for that compound in the analysis was given as a "less than" value (e.g., < 0.003 µg/kg). This number was calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that was visible under the conditions of the measurement.

The following Quality Assurance/Quality Control procedures were followed in order to prevent any cross-contamination of soil or groundwater samples.

oGlass syringes were used for only one sample per day and were washed and baked out at night. If they were used twice, they were purged with carrier gas (nitrogen) and baked out between sampling.

- Septa through which samples were injected into the chromatograph were replaced on a daily basis to prevent possible gas leaks from the chromatographic column.
- Analytical instruments were calibrated each day by the use of chemical standards prepared in water by serial dilution from commercially available pure chemicals. Calibration checks were run after every five samples.
- Prior to sampling each day, system blanks were run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to a concurrently sampled air analysis.
- All sampling and 2 cc subsampling syringes were decontaminated each day, and such equipment were not reused before being decontaminated. Microliter size subsampling syringes were reused only after a nitrogen carrier gas blank was run to insure it was not contaminated by the previous sample.

3.4.4 Hydrogeologic Assessment

Evaluation of the hydrogeology of the area underlying Niagara Falls IAP and the designated potentially hazardous waste sites was based upon information previously collected at the site, in addition to the information collected during the IRP 1989 RI/FS. Data pertinent to the hydrogeologic assessment included groundwater level measurements, surface water level measurements (if warranted), surface water discharge measurements, detailed lithologic descriptions of the aquifer materials, and the locations and integrity of potential confining (or relatively impermeable) boundary layers. The lithologic information necessary to evaluate the hydrogeologic conditions at Niagara Falls IAP resulted from field logging conducted by SAIC geologists during the drilling of monitoring wells and borings at the Base. Field logging consisted of detailed visual descriptions for the encountered subsurface materials with delineation of a site-specific hydrogeologic framework and potential contaminant transport pathways based on the interpreted field logs. Evaluation of these data permitted the assessment of groundwater flow directions and rates within the affected aquifer. The hydrogeologic evaluation was integral to the interpretation of contaminant transport directions and rates and to the evaluation of potential hazards associated with the contaminant migration.

Groundwater level measurements were taken at all existing wells at Niagara Falls IAP during four independent 24-hour periods. The first 24-hour period was prior to initiating 1989 RI well installations at Niagara Falls IAP during the May 1989 site inspection. The second and third periods were prior to and following the September-October 1989 groundwater sampling activity. The last was taken during the April 1990 additional RI effort. Groundwater level measurements were taken from the twenty-eight (28) 1989 RI wells and the thirty-seven (37) existing Phase II, Stage 1 wells on the base. The SAIC field team used both an electronic well sounder (Slope Indicator Co. - model 51453) and a Lietz-Eslon fiberglass tape measure with a stainless steel popper to measure the static water level in the well. The elevation of the water table at a given well was calculated by subtracting the depth to water in a non-flowing well from the surveyed altitude of the top of the PVC casing at the notch. In this manner, an extensive and well-documented data base was established that enhanced the interpretation of groundwater flow directions and hydraulic gradients.

3.4.5 Surface Water Discharge Measurements

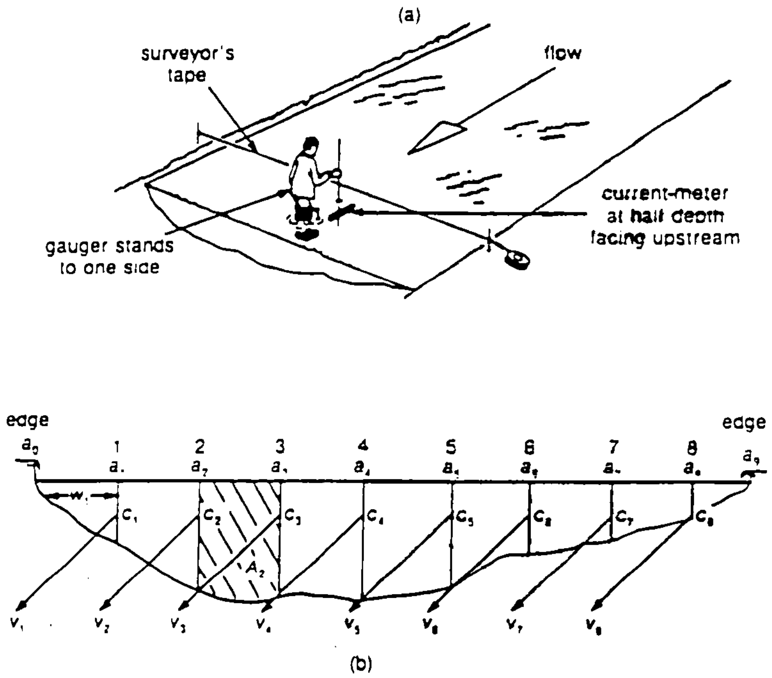
In conjunction with surface water sampling activities at monitoring locations along Cayuga Creek and its tributaries, discharge measurements were taken using the "USGS Discharge Measurements at Gauging Stations, Technique of Water Resources Investigation, Book 3, 1989." Discharge flow measurements were taken at five (5) surface water sampling locations along Cayuga Creek at Site 3, and along a drainage ditch at Site 8. No discharge measurements were taken at Site 9 due to poor conditions for measurement. In order to determine the amount of surface water discharged at each sampling location, flow velocities were measured using a current meter suspended in the creek, pointing in an upstream direction (Figure 3-12). A Marsh-McBirney, Inc. Model 201D portable water flow meter was used which measures the velocity in one direction from an electromagnetic sensor, when placed in a conductive liquid, such as water.

3.4.6 Surveying of Wells

All newly constructed monitoring wells, soil borings, sampling points and any previously unsurveyed wells from which samples were collected/analyzed during this study were surveyed by McIntosh and McIntosh, P.C. (State Certified Surveyor). The damaged wells that were repaired at Site Nos. 1 and 3 were also resurveyed. A notch was made on the top of the riser casing to establish well elevations. The ground surface next to the well was also surveyed. The soil borings were surveyed to the center point of the grouted borehole at the ground surface. The surface water/surface sediment sampling points were surveyed to steel stakes identifying the sampling point. The surveys were completed to a vertical accuracy of 0.01 feet and a horizontal accuracy of one foot. All surveys were referenced to U.S. Geological survey elevation datum and the New York State Coordinate System. All bench marks were clearly identified on the base map. Well and borehole positions were recorded on project and site-specific maps.

3.5 WELL DRILLING AND BOREHOLE PROGRAM

In order to obtain data necessary for the hydrogeologic assessment and the risk assessment of each study site, twenty eight (28) groundwater monitoring wells and fourteen (14) boreholes were installed at Niagara Falls IAP, during the 1989 RI. Two additional wells were installed in April 1990. The program was divided into three activities: shallow soil borings, shallow groundwater monitoring well installations, and deep groundwater monitoring well installations. But the shallow soil borings and the shallow groundwater monitoring wells were drilled/installed/screened in the surficial sediments on the base. The deep groundwater monitoring wells were screened in the Lockport Dolomite. The following subsections detail these activities.



Stream flow is often measured by means of a current-meter gauging, where stream-flow velocities are measured at regular intervals across the stream as shown in (b) The gauger faces upstream and stands to one side of the instrument so that turbulence around his legs does not affect the readings.

FIGURE 3-12.
FLOW MEASUREMENT TECHNIQUES

3.5.1 Location and Number of Wells and Boreholes Installed

The location of wells and boreholes installed during the 1989 RI for each site can be found on Figures 3-2 through 3-11. In general, the placement rationale was based upon: IRP RI/FS Statement of Work specifications, locations and spacing of existing wells, site configuration, previous studies and analyses, water level measurements, groundwater gradients, flow direction determinations, clearance of base utilities, and headspace and soil gas studies.

The number of wells and boreholes varied from site to site. Table 3-4 presents the total number of wells and boreholes, as well as a summary of the drilling and borehole program.

3.5.2 Footage Summary

Table 3-5 provides a drilling footage summary for each site, well and borehole during the 1989 RI.

3.5.3 Drill Rig(s) and Drilling Technique Utilization

Various drill rigs and techniques were used at Niagara Falls IAP during the RI. Table 3-6 summarizes the utilization of all drill rigs and techniques per site. Empire Soils Investigation, Inc. of Hamburg, New York, a New York state licensed drilling company was subcontracted to perform the RI drilling work under the supervision of one SAIC supervisory geologist per rig. Empire Soils Investigations Inc. was also the drilling subcontractor during the previous IRP Stage 1 investigation. The following drilling techniques were used by the drillers during the RI:

- Hollow-stem augering
- Air-Rotary.

3.5.4 Well Design and Well Construction Details

Boreholes were drilled using hollow-stem auger or air rotary methods. The

Table 3-4
Drilling Program Summary
Niagara Falls IAP RI/FS

Site	Number	Total # of Installed Monitoring Wells	Total # of Installed Boreholes	Drilling Type	Auger (ID/OD)	Total Footage Drilled	Total # of California Ring Samples	Total # of 2" ID Split Spoon Samples	Personnel Protection Level
SITE NO 1:	Building 600 JP-4 Pipeline Leak.	2 shallow 2 deep	1	HSA	4.25"/8"	101.0	3	19	D
SITE NO 2:	POL JP-4 Tank C	1 shallow	2	HSA	4.25"/8"	21.7	11	3	D
SITE NO 4:	BX MOGAS Tank Leak	1 shallow	1	HSA	4.25"/8"	19.7	6	6	D
SITE NO 6:	POL JP-4 Tank A	0	2	HSA	4.25"/8"	19.5	13	0	D
SITE NO 3:	Landfill	1 shallow 3 deep	0	HSA AR	4.25"/8" *3 7/8"	101.4	14	1	D
SITE NO 5:	NYANG Hazardous Waste Drum Storage	1 shallow 1 deep	0	HSA AR	4.25"/8" *3 7/8"	50.8	7	3	D
SITE NO 8:	Building 202 Drum Storage Yard	2 shallow 3 deep	0	HSA AR	4.25"/8" *3 7/8"	128.4	24	7	D

Table 3-4 (Cont'd)
Drilling Program Summary
Niagara Falls IAP RI/FS

Site Number	Total # of Installed Monitoring Wells	Total # of Installed Boreholes	Drilling Type	Auger (ID/OD)	Total Footage Drilled	Total # of California Ring Samples	Total # of 2" ID Split Spoon Samples	Personnel Protection Level
SITE NO 7: JP-4 Tank Truck Spill	0		HSA	4.25"/8"	6.0	4	0	C
SITE NO 9: Fire Training Facility No. 3	5 shallow	1	HSA	4.25"/8"	50.2	25	9	D
SITE NO 10: Fire Training Facility No. 1	1 shallow 1 deep	0	HSA AR	4.25"/8" *3 7/8"	41.2	7	3	D
SITE NO 11: Fire Training Facility No. 2	0	2	HSA	4.25"/8"	18.0	15	0	D
SITE NO 12: Building 850 Drum Storage Yard	0	2	HSA	4.25"/8"	18.0	14	0	D
SITE NO 13: 4,000 gal underground Tank Pit	4 shallow	0	HSA	4.25"/8"	33.0	23	1	D
Background Borings	0	2	HSA	4.25"/8"	22.5	17	0	D
TOTAL	28	14			631.4	183	42	

NOTES:

shallow - screened in the overburden
deep - screened in Bedrock Aquifer
C - respiratory and dermal protection
D - dermal protection

AR - air rotary
HSA - hollow stem auger
* - tricone bit (deep wells)

Table 3-5
Drilling Footage Summary for RI Borehole And Well Installations, Niagara Falls IAP

Site/Name	Well #	Borehole #	Depth Drilled in Feet (BLS)	Total Footage-Drilled per Site
SITE NO 1: Building 600 JP-4 Pipeline Leak		B1-1	4.6	101
	MW 1-6		5.7	
	MW 1-7		12.0	
	MW 1-3D		34.1	
	MW 1-4D		44.6	
SITE NO 2: POL JP-4 Tank C		B2-1	6.0	21.7
		B2-2	10.5	
	MW 2-4		5.2	
SITE NO 4: BX MOGAS Tank Leak		B4-1	9.0	19.7
	MW 4-4		10.7	
SITE NO 6: POL JP-4 Tank A		B6-1	9.0	19.5
		B6-2	10.5	
SITE NO 3: Landfill	MW 3-7		5.0	101.4
	MW 3-2D		35.0	
	MW 3-3D		32.4	
	MW 3-4D		29.0	
SITE NO 5: NYANG Hazardous Waste Drum Storage	MW 5-5		15.4	50.8
	MW 5D-1		35.4	

Table 3-5 (Cont'd)
Drilling Footage Summary for RI Borehole And Well Installations, Niagara Falls IAP

Site/Name	Well #	Borehole #	Depth Drilled in Feet (BLS)	Total Footage-Drilled per Site
SITE NO 8: Building 202	MW 8-5		12.3	128.4
Drum Storage Yard	MW 8-6		14.2	
	MW 8-1D		37.5	
	MW 8-2D		28.8	
	MW8-3D		35.6	
SITE NO 7: JP-4 Tank		B7-1	6.0	6.0
Truck Spill				
SITE NO 9: Fire Training		B9-1	9.3	50.2
Facility No. 3	MW 9-5		8.4	
	MW 9-6		7.3	
	MW 9-7		9.7	
	MW 9-8		8.0	
	MW 9-9		7.5	
SITE NO 10: Fire Training	MW 10-4		7.9	41.2
Facility No. 1	MW 10-1D		33.3	
SITE NO 11: Fire Training		B11-1	9.0	18.0
Facility No. 2		B11-2	9.0	
SITE NO 12: Building 850		B12-1	10.5	18.0
Drum Storage Yard		B12-2	7.5	
SITE NO 13: 4,000 gal Underground Tank Pit	MW 13-1		7.5	33.0
	MW 13-2		7.5	
	MW 13-3		9.4	
	MW 13-4		8.6	
Background Borings		BB-1	12.0	22.5
		BB-2	10.5	

Table 3-6
Drill Rig and Drilling Technique Utilization
Niagara Falls IAP RI/FS

Site Number/Name	Shallow Monitoring Well Installation Using Hollow Stem Auger Technique	Deep Monitoring Well Installation Using Hollow-Stem Auger and Air Rotary Techniques	Subsurface Soil Borings Using Hollow Stem Auger Technique
SITE No 1: Building 600 JP-4 Pipeline Leak	CME-55 ATV Failing F-6	Failing F-6	CME-45 Trailer
SITE No 2: POL JP-4 Tank C			CME-55 ATV
SITE No 4: BX MOGAS Tank Leak	Failing F-6		CME-45 Trailer
SITE No 6: POL JP4 Tank A			CME-55 ATV
SITE No 3: Landfill	Failing F-6	Failing F-6	
SITE No 5: NYANG Hazardous Waste Drum Storage	CME-45 Trailer Failing F-6	Failing F-6	
SITE No 8: Building 202 Drum Storage Yard	CME-45 Trailer	Failing F-6	
SITE No 7: JP-4 Tank Truck Spill			CME-55 ATV

Table 3-6 (Cont'd)
Drill Rig and Drilling Technique Utilization
Niagara Falls IAP RI/FS

Site Number/Name	Shallow Monitoring Well Installation Using Hollow Stem Auger Technique	Deep Monitoring Well Installation Using Hollow-Stem Auger and Air Rotary Techniques	Subsurface Soil Borings Using Hollow Stem Auger Technique
SITE No 9: Fire Training Facility No. 3	CME-55 ATV Failing F-6		CME-55 ATV
SITE No 10: Fire Training Facility No. 1	CME-45 Trailer	Failing F-6	
Site No 11: Fire Training Facility No. 2			CME-55 ATV
SITE No 12: Building 850 Storage Yard			CME-55 ATV
SITE No 13: 4,000 gal Underground Tank Pit			CME-55 ATV CME-45 Trailer
Background Borings			CME-55 ATV

auger stem opening was a minimum of 4 1/4-inch inside diameter (I.D.) to permit installation of 2-inch ID PVC Schedule 40 screen and riser pipe for shallow wells (Figure 3-13). Shallow wells ranged in depth from 6 to 15 feet. Total depth of each deep well ranged from 40 to 50 feet BLS (Figure 3-14). Split-spoon samples were collected on a continuous basis when collecting soils for laboratory analysis, and at 5-foot intervals when collecting soils for lithologic descriptions only.

Shallow Monitoring Wells

Procedures for shallow monitoring well installation using hollow-stem auger methods are described as follows:

1. Base clearance was obtained. Sites were cleared by Base personnel prior to drilling to ensure that no underground utilities were present.
2. Set up rig over the staked location; leveled the rig.
3. The plugged hollow-stem auger was advanced to the top of the interval to be sampled.
4. The plug was removed and a sample was collected using either a California Ring Sampler or a standard split-spoon. The plug was then replaced.
5. Steps 3 and 4 were repeated until the assigned depth was reached.
6. Once the borehole was drilled to completion depth, the auger plug was removed and a 2- to 5-foot length of PVC well screen with a bottom plug and an appropriate length of riser was installed (2-inch ID, PVC Schedule 40). All screens and risers were threaded flush joint. The well screen and casing were steam cleaned prior to installation in the borehole. The screen interval was set at a depth to allow for fluctuation in the water table elevation and to allow any free-floating petroleum, oils, and lubricants to enter the well during sampling. The top of the casing extended at least 2-3 feet above ground elevation.
7. The augers were raised in 2-foot increments, and silica sand of a grain-size distribution compatible with the screen and the formation was tremied in place. This process was continued until the sand pack extended at least 2 feet above the top of the screen.

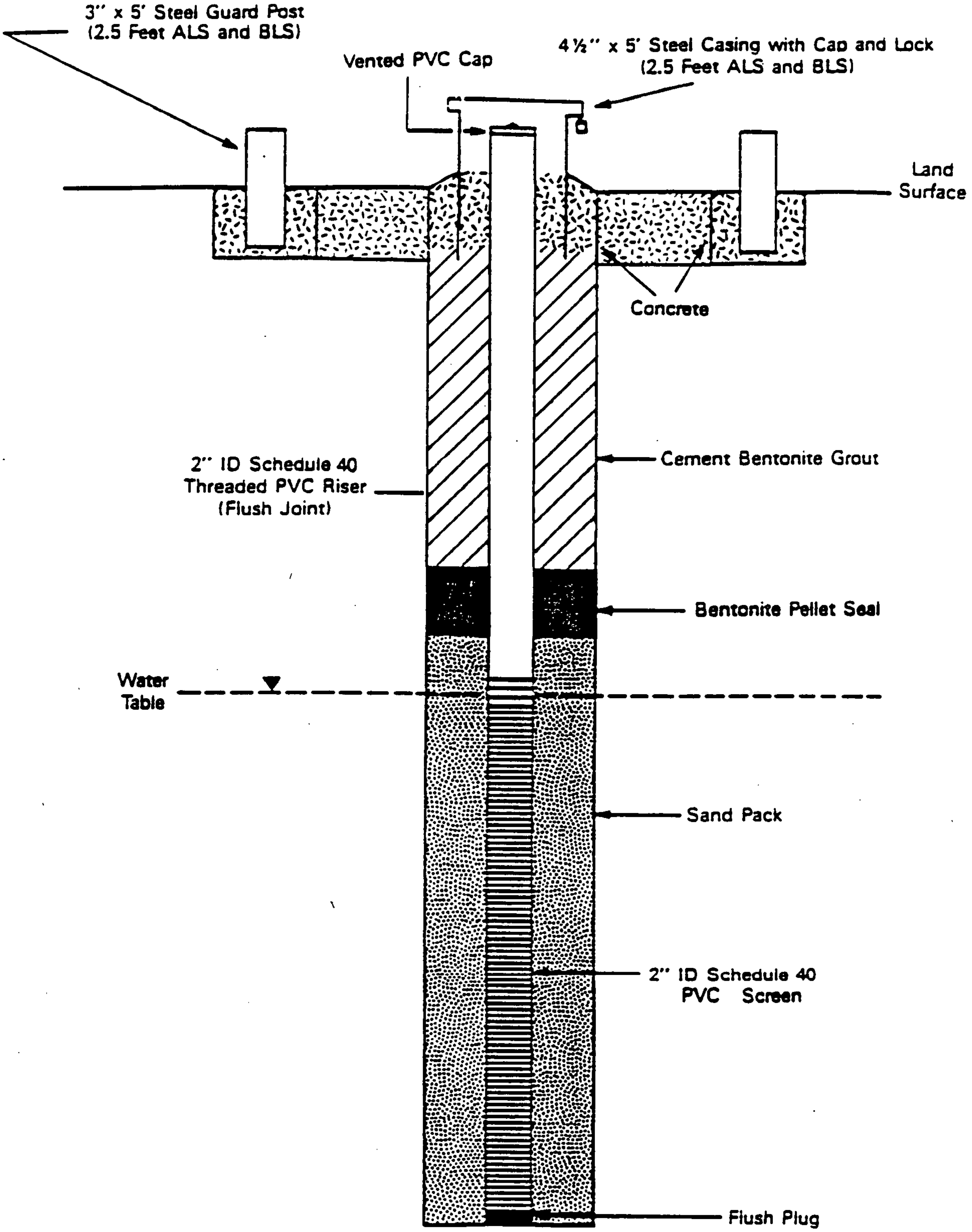


FIGURE 3-13
SCHEMATIC DIAGRAM OF A SHALLOW MONITORING WELL

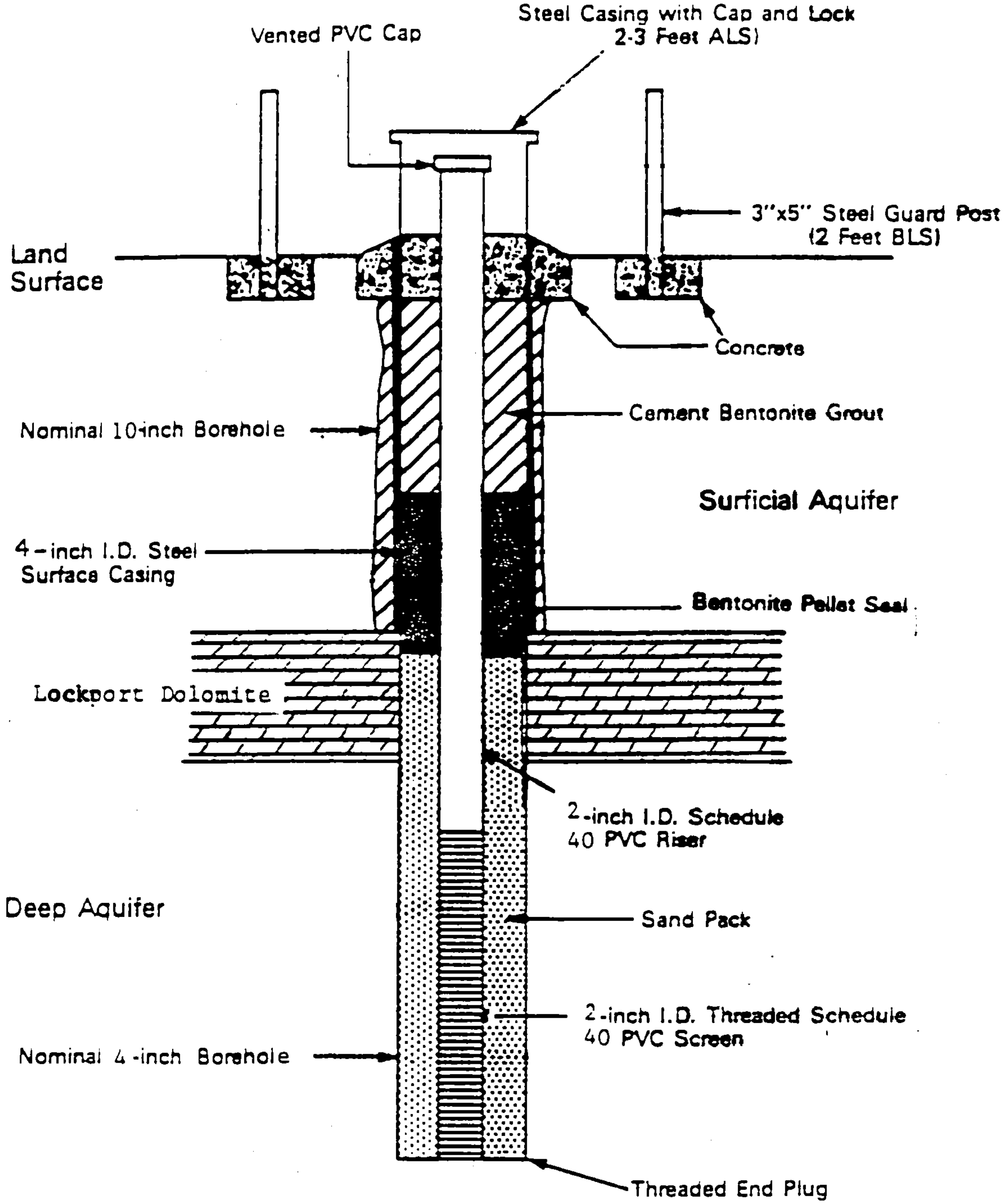


FIGURE 3-14
SCHEMATIC DIAGRAM OF A DEEP, DOUBLE-CASED MONITORING WELL

8. After the sand pack was tremied in place and measurements were taken to ensure the proper location of the sand pack, a 2-foot bentonite pellet seal was tremied on top of the sand pack.

9. After the bentonite seal was in place, the bentonite was allowed to hydrate, and measurements were taken to ensure its proper location, a cement and bentonite grout was tremied in place from the top of the seal to the land surface. This was accomplished in such a manner that a tight, continuous grout seal was ensured through the entire interval. Cement and bentonite grout mixtures consisted of potable water, bentonite, and Type I and II Portland cement with 94 pounds of cement and 5 pounds of bentonite per 6.5 gallons of water.

10. The depth of well screen placement was determined based on where the water table was encountered. The well screen generally extended to the top of the bedrock.

11. Each well was developed by bottom-filling bailer, surging, and pumping until the supervisory geologist determined that the well water was acceptable in clarity and conductivity (i.e., where clarity and conductivity stabilized and showed no further improvement or reduction with continued development). The total volume of removed water was measured and recorded. All development water was containerized and disposed of in a manner acceptable to the State of New York and Niagara Falls IAP personnel. Conditions and observations noted during development were recorded on development forms (Appendix D).

12. A blank pump, with an outside diameter (OD) of 1 7/8 inches, was lowered into the well to see if it could travel throughout the entire length of the well prior to well acceptance.

13. A protective casing equipped with a hinged, loose-fitting cap capable of being locked to prevent unauthorized entry, was installed within 24-hours of well installation. A crowned concrete pad was built around the protective casing to secure the casing and to allow surface runoff. In order to minimize the deleterious effects of frost action, the concrete pads were constructed with galvanized steel reinforcing fibers which imparted a greater durability to the well pads. A hole was drilled in the side of the protective casing near the concrete pad to allow drainage. The drilling subcontractor provided and installed keyed-alike locks.

14. An identification number was painted on the side and top of the protective casing.

15. Three 3-inch by 6-foot steel guard posts were installed radially around the concrete pad in areas where wells had the potential of being damaged by mowers or other vehicles. These guard posts extended approximately 3 to 4 feet above land surface (ALS).

Well construction summary sheets and borehole logs are provided in Appendix C for each borehole drilled or well installed. The logs and summary sheets describe the lithology and summarize details of the well construction (i.e., screened interval, water level). Daily log forms were completed for tracking the progress of well drilling and installation. No wells were abandoned.

3.5.5 Field Measurements and Data Acquisition

Boring Logs

Boring logs found in Appendix C were prepared based on the field log book notes taken by the SAIC supervisory geologist. The geologist recorded split spoon sample descriptions according to the "Standard Practice for Description and Identification of Soils." Lithologic descriptions contain the following elements:

- Interval depth below ground surface
- Sample number
- Organic vapor monitoring results (OVA meter)
- Recovery
- Lithology
- Grain size (visual)
- Color (Munsell Chart)
- Consistency
- Texture
- Relative density
- Moisture (visual)
- Fabric/bedding
- Standard penetration test values (blow counts)
- Soil classification (Unified Classification System)
- Other distinctive features

Well Construction Summary

Well construction summaries found in Appendix C were prepared based on the field log book notes taken by the SAIC supervisory geologist. Table 3-7 displays the type of information compiled to complete a well construction summary.

Table 3-7
Monitoring Well Construction Data
Niagara Falls, IAP RI/FS

Site Number	Groundwater Monitoring Well No.	Notch in Top of Casing/Ground Elevation (MSL)	Well Depth (ft. BLS)	Screened Interval (ft. BLS)	Sand Pack (ft. BLS)	Bentonite Seal (ft. BLS)	Grout (ft. BLS)
Site No 1	MW 1-6	598.73/597.15	5.7	2.8 - 5.7	2.3 - 5.7	1.3 - 2.3	0.0 - 1.3
	MW 1-7	605.80/603.00	11.7	7.2 - 11.7	6.2 - 11.7	4.2 - 6.2	1.2 - 4.2
	MW 1-3D	600.19/597.98	34.1	13.8 - 34.1	12.0 - 34.1	8.0 - 12.0	0.0 - 8.0
	MW 1-4D	597.84/595.10	44.6	9.0 - 44.6	7.8 - 44.6	3.8 - 7.8	0.0 - 3.8
Site No 2	MW 2-4	599.71/597.30	5.2	3.5 - 5.2	2.5 - 5.2	1.5 - 2.5	0.0 - 1.5
Site No 3	MW 3-7	590.85/587.93	5.0	3.5 - 5.0	2.5 - 5.0	1.5 - 2.5	0.0 - 1.5
	MW 3-2D	599.98/596.67	34.8	9.5 - 34.8	8.5 - 34.8	5.0 - 8.5	0.0 - 5.0
	MW 3-3D	590.86/588.08	32.4	7.5 - 32.4	6.5 - 32.4	2.25 - 6.5	0.0 - 6.5
	MW 3-4D	590.73/588.54	29.0	3.7 - 29.0	3.0 - 29.0	1.0 - 3.0	0.0 - 1.0
Site No 4	MW 4-4	600.87/598.35	10.2	5.1 - 10.2	4.1 - 10.2	3.1 - 4.1	0.0 - 3.1
Site No 5	MW 5-5	600.37/597.81	15.1	6.0 - 15.1	5.0 - 15.1	4.0 - 5.0	2.0 - 4.0
	MW 5-1D	600.33/597.70	35.4	15.0 - 35.4	14.0 - 35.4	11.5 - 14.0	0.0 - 11.5
Site No 8	MW 8-5	600.20/597.79	12.7	6.0 - 12.7	5.0 - 12.7	4.0 - 5.0	2.0 - 4.0
	MW 8-6	601.21/598.59	14.2	6.5 - 14.2	5.5 - 14.2	4.5 - 5.5	1.5 - 4.5
	MW 8-1D	599.90/597.71	37.5	12.2 - 37.5	11.1 - 37.5	6.6 - 11.1	0.0 - 6.6
	MW 8-2D	600.57/598.48	28.8	13.6 - 28.8	11.7 - 28.8	7.7 - 11.7	0.0 - 7.7
	MW 8-3D	601.14/598.83	35.6	15.3 - 35.6	14.3 - 35.6	10.2 - 14.3	0.0 - 10.2
Site No 9	MW 9-5	588.80/585.41	8.4	2.7 - 8.4	2.2 - 8.4	1.2 - 2.2	0.0 - 1.2
	MW 9-6	588.64/585.44	7.3	2.7 - 7.3	2.2 - 7.3	1.2 - 2.2	0.0 - 1.2
	MW 9-7	588.88/585.47	9.7	4.7 - 9.7	3.7 - 9.7	2.7 - 3.7	1.7 - 2.7
	MW 9-8	587.86/585.51	8.0	3.0 - 8.0	2.0 - 8.0	1.0 - 2.0	0.0 - 1.0
	MW 9-9	587.63/585.18	7.5	2.5 - 7.5	2.0 - 7.5	1.0 - 2.0	0.0 - 1.0

Table 3-7 (Cont'd)
Monitoring Well Construction Data
Niagara Falls, IAP RI/FS

Site Number	Groundwater Monitoring Well No.	Notch in Top of Casing/Ground Elevation (MSL)	Well Depth (ft. BLS)	Screened Interval (ft. BLS)	Sand Pack (ft. BLS)	Bentonite Seal (ft. BLS)	Grout (ft. BLS)
Site No 10	MW 10-4	589.39/586.96	7.9	4.5 - 7.9	3.5 - 7.3	2.5 - 3.5	1.5 - 2.5
	MW 10-1D	589.64/587.09	32.9	12.66 - 32.9	11.7 - 32.9	6.7 - 11.7	0.0 - 6.7
Site No 13	MW 13-1	598.91/595.79	7.3	5.0 - 7.3	4.0 - 7.3	3.0 - 4.0	2.0 - 3.0
	MW 13-2	597.99/595.37	7.5	5.0 - 7.5	4.0 - 7.5	3.0 - 4.0	2.0 - 3.0
	MW 13-3	598.67/595.98	9.0	5.0 - 9.0	4.0 - 9.0	3.0 - 4.0	2.0 - 3.0
	MW 13-4	598.36/595.36	8.6	6.1 - 8.6	5.1 - 8.6	4.1 - 5.1	2.0 - 4.1

Measurements During Well Development

During well development several field measurements were taken and recorded by the SAIC supervisory geologist both on well development forms, and in the field log book. The measurements are as follows:

Measurement	Instrument
pH	Omega PHH80
Conductivity	Omega PHH80
Temperature	Calibrated Thermometer
Discharge Rate	Calibrated Bucket and Stopwatch

Field calibration was performed at the start of each day according to Section 3.6.4. In addition, other observations were recorded, such as clarity, odor, and the amount of sediment present in the discharge.

Air Monitoring

During all drilling, well installation operations, and sampling activities, air measurements were monitored using a Century OVA 128 portable organic vapor analyzer and a MSA Combustible Gas and Oxygen Alarm, Model 261. The OVA 128 was used to identify potential hazardous and/or toxic airborne materials harmful to personnel. The MSA Combustible Gas and Oxygen Alarm was used to monitor for combustible gas emissions and/or deficient oxygen levels during drilling. Measurements were made both upwind and downwind of the site, in the workers breathing zone, above the borehole, and over fresh soil and water samples. Calibrations were performed at the start of each day according to Section 3.6.4.

3.6 SAMPLING PROGRAM

3.6.1 Summary of Sample Types/Numbers

Four media were sampled as part of the Niagara Falls IAP RI/FS: soil, surface sediment, surface water, and groundwater. The types and numbers of samples taken per site, per analytical parameter are displayed in Table 3-2.

3.6.2 Sampling Methodology and Protocols

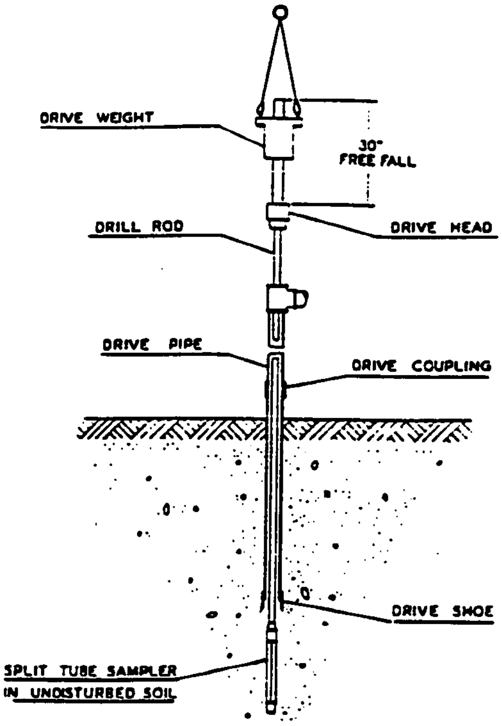
3.6.2.1 Soil Sampling

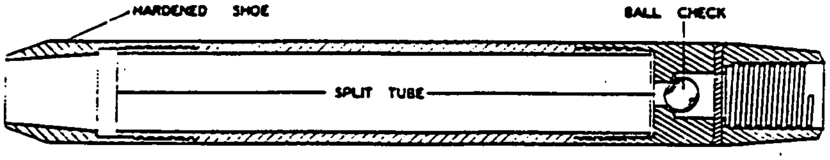
Subsurface

Soil samples for analysis were collected during the drilling of soil borings and certain well installation activities using a "California" ring-type sampler (see Figure 3-15). Each sample consisted of a 2.0-foot section of soil, of which 1.5 feet was contained in three, 6-inch sleeves. The extra 0.5 feet of soil was contained in the spoon's shoe. The sleeves were constructed of either stainless steel or brass. The stainless steel sleeve was always loaded in front of the brass sleeve when sampling for metals. The contents of the stainless steel sleeve (Sleeve A) were reserved for metals and semivolatile analyses. The contents of the brass sleeve (Sleeve B) were reserved for volatile organic compounds, aromatic volatile compounds, petroleum hydrocarbons, soil moisture, and in those few cases, total organic carbon. The third brass sleeve (Sleeve C) was reserved for engineering physical property parameters (i.e., soil moisture, density, grain size, and plasticity index). Continuous sampling was performed until the groundwater table was encountered.

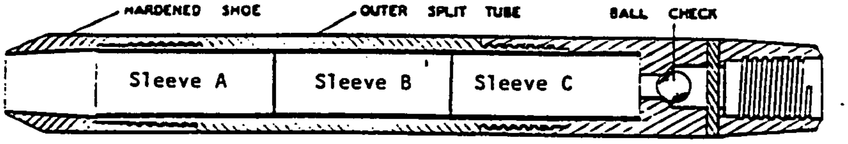
The soil sampling procedures and protocols were as follows:

- Each "California" ring-type sampler and its brass and stainless steel sleeves were decontaminated prior to use. Decontamination included the following: Steam-cleaning with laboratory-grade detergent/potable water; ASTM Type II water rinse; pesticide-grade methanol rinse; pesticide-grade hexane rinse; air dry prior to use.
- Each "California" ring-type sampler was loaded with sleeves in the following order: (bottom to top) first Sleeve A, the stainless steel sleeve, followed by Sleeves B and C, both brass sleeves.
- Each sleeve was handled and prepared as an actual sample, with the sleeve acting as the sample container, to be sent to the contract analytical laboratory.
- Once the "California" ring sampler was pulled from the borehole, the sampler was placed on a clean stainless steel tray.





Standard Split-Spoon Sampler



California Ring-Type Sampler

FIGURE 3-15
SOIL SAMPLING DEVICES

- Once the sampler was opened, an immediate scan for volatile organic vapors was performed with an OVA 128 meter. All readings were recorded in the log book.
- All sleeves were then removed from the sampler and both ends of the sleeves were covered with teflon sheeting, followed by aluminum foil, and then sealed with plastic caps. Each cap was secured with duct tape. Sleeve B for volatile organic contaminants was sealed first and was immediately placed in the sampling cooler.
- The sleeves were handled using clean Solvex gloves and decontaminated stainless steel tools.
- Replicate samples were taken in the laboratory from specially marked sleeves since the sampling method did not allow for the collection of field replicates.
- Each sleeve was marked with the proper sample label, placed in a ziplock bag and stored at <4°C in a thermally insulated cooler.
- After the last sample was collected, the sample log in the field book was reviewed to decide what samples would be shipped for analyses. The decision was based on OVA readings, abnormal odors and discoloration. A maximum of three soil samples per borehole were allowed for analysis. If none of the samples satisfied the criteria, only one sample was sent from the soil/water interface in the borehole.
- The intervals for engineering property analysis was from an interval not selected for chemical analyses.
- All equipment and tools were decontaminated between sample collections.

In addition, soil samples were examined for various characteristics as follows:

- Internal depth below ground surface
- Sample number
- Organic vapor monitoring results (OVA meter)
- Recovery
- Lithology
- Grain size (visual)
- Color (Munsell chart)
- Consistency
- Texture
- Relative density
- Moisture
- Fabric/bedding

- Standard penetration test values (blow counts)
- Soil classification (Unified Classification System)
- Other distinctive features

These characteristics complement the analytical results for each sample.

Drummed Cuttings

Soil samples were taken of drummed soil cuttings from drilling operations. A total of four (4) drums were sampled, each of which contained suspected hazardous drill cuttings.

Sampling procedures and protocols were as follows:

- Selected drums were sampled on the basis of OVA meter readings, discoloration, odor and soil boring log.
- Samples were extracted from each drum using a stainless steel auger. Three samples were collected at different depths within the drums.
- The three samples were mixed on a stainless steel sheet to form one composite sample for analysis. This composite was placed in the appropriately labeled containers.
- All sampling tools were decontaminated between each drum.

3.6.2.2 Groundwater Sampling

Wells

Groundwater samples were collected within 24 hours of purging each well using either a hand pump or a bailer. At least three borehole volumes of water were removed from each well. Groundwater samples were retrieved with a 3 foot by 1-7/8 inch point-source Teflon bailer. The decontaminated bailer was lowered to 2.5 feet below the measured static water level in the well to collect representative groundwater at the surface of the aquifer. The wells were purged and sampled from least- to most-suspected for the presence of contamination, based on HARM scores and the Stage 1 sampling effort results. It generally worked out that the wells at the individual sites were sampled from upgradient to downgradient. Each bailer was equipped with a removable Teflon stop-cock at the tip of the bailer which dispensed the sample directly into an appropriate prelabeled sample container with samples dispersed in order of volatilization sensitivity. All required preservatives were added to the sample containers in the field (see Section 3.6.3). Each sample container was wrapped in an impact insulating packing material and placed immediately in coolers containing sufficient ice to quickly reduce and maintain the sample temperature at 4°C or below. Samples were delivered via lab courier within 24 hours of collection to the laboratory for analysis. The bailers were decontaminated between each well.

Storage Tanks

In order to determine if purge and development waters containerized during the field effort should be disposed of as hazardous waste, a water sample from each tank was collected and analyzed. Each tank was sampled using a decontaminated 3 foot by 1-7/8 inch point-source Teflon bailer. The sample was dispensed into the appropriate prelabeled sample container, in order of volatilization sensitivity. All required preservatives were added to the sample containers in the field. The bailers were decontaminated between each tank. Each sample container was wrapped in an impact insulating packing material and placed immediately in coolers containing sufficient ice to quickly reduce and maintain the sample temperature at 4°C or below. Samples were delivered via lab courier within 24 hours of collection to the laboratory for analysis.

3.6.2.3 Surface Water Sampling

Surface water samples were collected from individual sampling locations, at each of three sites. Surface water samples were collected using grab sampling techniques, starting downstream and proceeding upstream to each sampling location. Sample bottles were filled with sample water by holding the container below the water surface. Care was taken not to disturb and incorporate bottom sediments into the water sample. Sample containers were labeled, preserved, packed and shipped to the laboratory via courier in insulated coolers at a storage temperature of 4°C or less.

3.6.2.4 Surface Sediment Sampling

Surface sediment samples were collected from the same location as, but after the collection of surface water samples using a stainless steel trowel. All tools were decontaminated between sampling locations. The sediments were placed directly into the appropriate prelabeled sample containers which were packed and shipped to the laboratory via courier in insulated coolers at a storage temperature of 4°C or less.

3.6.3 Sample Preservation, Containers, Holding Times

Table 3-8 presents the analytical methods, sample containers, preservatives, and required holding times for all samples collected during the 1989 Niagara Falls IAP RI/FS field effort.

3.6.4 Field Quality Assurance/Quality Control Program

Prior to soil sample collection at Niagara Falls IAP, a quality assurance project plan (QAPP) specific to the RI at this base was prepared and approved. This document described in detail all procedures used in the field to ensure that the data quality objectives were achieved. A summary of the field QA/QC program is presented in Table 3-9. Specific points addressed in the QAPP include:

- Project description
- Organization and responsibilities
- Quality assurance objectives
- Sample handling procedures
- Sample custody
- Calibration procedures and frequencies
- Analytical procedures
- Data reduction, validation, and reporting
- Internal quality control checks
- Performance and system audits
- Preventive maintenance of equipment and instrumentation
- Data assessment procedures
- Corrective action
- Quality assurance reports to management.

Table 3-8

Analytical Methods, Sample Containers, Preservatives, and Required Holding Times for Samples Collected at Niagara Falls IAP

Parameter	Method	Sample Container Type	Preservative	Max. Holding Time After Collection (before Extraction & Analysis)
Soil/Sediment Samples/Drill Cuttings				
o Petroleum Hydrocarbons	SW3550/418.2	Soil: brass sleeve with Teflon lined end caps Sediment: 500 ml wide mouth glass jar, Teflon lined I-CHEM Protocol B preparation Soil: Stainless steel sleeve with Teflon lined end caps	Refrigeration <4°C	28 day
o Total Metals				
- ICP screen	SW3050/6010	Sediment: 500 ml wide mouth glass jar, Teflon lined I-CHEM Protocol A preparation	Refrigeration <4°C	6 months (mercury - 28 days)
- Mercury	SW7471			
- Lead	SW3050/7421			
o Volatile Organic Compounds	SW 5030/8240	Soil: brass sleeve with Teflon lined end caps Sediment: 500 ml wide-mouth glass jar, Teflon-lined I-CHEM Protocol B preparation	Refrigeration <4°C	14 days
o Semi-volatile Organic Compounds	SW3550/8270	Soil: brass sleve with Teflon lined end caps Sediment: 500 ml wide-mouth glass jar, Teflon lined I-CHEM Protocol A preparation	Refrigeration <4°C	14 days - extraction 40 days - analysis
o Extraction Procedure Toxicity (metals only)	40 CFR 261/24	500 ml wide-mouth glass jar, Teflon lined I-CHEM Protocol A preparation	Refrigeration <4°C	6 months
o Aromatic Volatile Compounds	SW5030/8020	Soil: brass sleeve with Teflon lined end caps	Refrigeration <4°C	14 days
o Total Organic Carbon	SW9060	Soil: brass sleeve with Teflon lined end caps	Refrigeration <4°C	28 days

Table 3-8 (Continued)

Analytical Methods, Sample Containers, Preservatives, and Required Holding Times
for Samples Collected at Niagara Falls IAP

Parameter	Method	Sample Container Type	Preservative	Max. Holding Time After Collection (before Extraction & Analysis)
o Physical & Chemical Parameters				
- Soil moisture content	ASTM D2216	Soil: 2 brass sleeves with Teflon lined end caps	None	None
- Grain size including hydrometer	ASTM D422	32 oz wide-mouth glass jar		
- Density	ASTM D854			
- Plasticity Index	ASTM D4318			
Groundwater/Surface Water Containerized Water Samples				
o Common Anions	Std. Methods 429	500 ml plastic bottle I-CHEM Protocol B preparation	Refrigeration <4°C	28 days
o Total Dissolved Solids	E160.1	1.0 liter plastic bottle I-CHEM Protocol B preparation	Refrigeration <4°C	7 days
o Total Metals				
- ICP screen	E200.7	1.0 liter plastic bottle	HNO_3 to pH <2	6 months
- Arsenic	E206.2	I-CHEM Protocol C	Refrigeration <4°C	(mercury - 28 days)
- Mercury	E245.1	preparation		
- Lead	E239.2			
- Selenium	E270.2			
o Total Petroleum Hydrocarbons	E418.1	1.0 liter glass bottle, Teflon lined I-CHEM Protocol B preparation	H_2SO_4 to pH <2 Refrigeration <4°C	28 days
o Extractable Priority Pollutants	E625	1.0 liter glass bottle, Teflon-lined I-CHEM Protocol A preparation	Refrigeration <4°C	7 days - extraction 40 days - analysis
o Purgeables Halocarbons/ Aromatics	SW5030/8021	2-40 ml glass vials, Teflon-lined, septa I-CHEM Protocol B preparation	HCl to pH <2 Refrigeration <4°C	14 days
o Non-halogenated Volatile Organics	SW5030/8015	2-40 ml glass vials, Teflon lined, septa	HCl to pH <2 Refrigeration <4°C	14 days
o Purgeable Aromatics	SW5030/8020	2-40 ml glass vials, Teflon lined, septa	HCl to pH <2 Refrigeration <4°C	14 days

Table 3-8 (Continued)

Analytical Methods, Sample Containers, Preservatives, and Required Holding Times
for Samples Collected at Niagara Falls IAP

Parameter	Method	Sample Container Type	Preservative	Max. Holding Time After Collection (before Extraction & Analysis)
o Ethylene Dibromide	E504.1	2-40 ml glass vials, Teflon lined, septa	Refrigeration <4°C	28 days
o Organochlorine Pesticides and PCB's	E608	1.0 liter glass, Teflon liner	Refrigeration <4°C	7 days - extraction 40 days-analysis
o Hardness	E130.1	250-500 ml glass	HNO_3 to pH <2 Refrigeration <4°C	6 months
o pH	E150.1	500 ml plastic beaker	None required	Analyzed immediately
o Temperature	E170.1	500 ml plastic beaker	None required	Analyzed immediately
o Specific Conductance	E120.1	500 ml plastic beaker	None required	Analyzed immediately
o Alkalinity	Std. Method 403	500 ml plastic beaker	None required	Analyzed immediately

TABLE 3-9 FIELD QA/QC PROGRAM SUMMARY

USEPA QA/QC Elements	June 1989 QAPP Elements	Corresponding QAPP Sections
o Sampling Procedures	<u>Sample Handling Procedures</u>	
	o References	o 1.5.1
	o Soils, sediments, and cuttings	o 1.5.2
	- Volatile organics	- 1.5.2.1
	- Extractable organics	- 1.5.2.2
	- Metals	- 1.5.2.3
	o Water	o 1.5.3
	- Volatile organics	- 1.5.3.1
	- Extractable organics	- 1.5.3.2
	- Metals	- 1.5.3.3
	- General chemical analyses	- 1.5.3.4
	o Replicate soil sampling procedure	o 1.5.4
	o Duplicate water sampling procedure	o 1.5.5
	o Sample shipment preparation	o 1.5.6
	o Decontamination procedure	o 1.5.7
o Sample Custody	<u>Sample Custody</u>	o 1.6
	o Chain-of-Custody	o 1.6.1
	- Sample labels	- 1.6.1.1
	- Chain-of-Custody record	- 1.6.1.2
	- Transfer of custody and shipment	- 1.6.1.3
	o Documentation	o 1.6.2
	- Sample identification	- 1.6.2.1
	- Daily logs	- 1.6.2.2
	- Corrections to documentation	- 1.6.2.3
	- Photographs	- 1.6.2.4
	- Disposition of documentation	- 1.6.2.5
	o Sample packaging and shipping	o 1.6.3
	- Sample packaging	- 1.6.3.1
	- Shipping containers	- 1.6.3.2
	- Marking and labeling	- 1.6.3.3

TABLE 3-9 FIELD QA/QC PROGRAM SUMMARY (Cont'd)

USEPA QA/QC Elements	June 1989 QAPP Elements	Corresponding QAPP Sections
o Calibration Procedures and Frequency	Calibration Procedures and Frequency	o 1.7
	o Field Equipment	o 1.7.1
	- HNU photoionization analyzer	- 1.7.1.1
	- MSA combustible gas indicator	- 1.7.1.2
	- Specific conductance meter	- 1.7.1.3
	- pH meter	- 1.7.1.4
	- Water and level indicator	- 1.7.1.5
	- Digital thermometer	- 1.7.1.6
	- Field alkalinity analyzer	- 1.7.1.7
o Analytical Procedures	Analytical Procedures	o 1.8
	o Field Testing and Screening	o 1.8.1
	- pH measurements	- 1.8.1.1
	- Specific conductance	- 1.8.1.2
	- Temperature	- 1.8.1.3
	- Air monitoring measurements	- 1.8.1.4
	- Alkalinity measurements	- 1.8.1.5
o Data Reduction, Validation, and Reporting	Data Reduction, Validation, and Reporting	o 1.9
	o Field and Technical Data	o 1.9.1
	- Field and technical data reduction	- 1.9.1.1
	- Field and technical data validation	- 1.9.1.2
	- Field and technical data reporting	- 1.9.1.3
o Internal Quality Control Checks	Internal Quality Control Checks	o 1.10
	o Internal Field Quality Control Checks	o 1.10.1
o Performance and System Audits	Performance and System Audits	o 1.11
	o Field Performance Audits	o 1.11.1
	o Field System Audits	o 1.11.2

TABLE 3-9 FIELD QA/QC PROGRAM SUMMARY (Cont'd)

USEPA QA/QC Elements	June 1989 QAPP Elements	Corresponding QAPP Sections
o Preventive Maintenance	Preventive Maintenance of Equipment and Instruction	o 1.12
	o Field Equipment	o 1.12.1
	- HNU photoionization analyzer	- 1.12.1.1
	- MSA combustible gas indicator	- 1.12.1.2
	- pH meter	- 1.12.1.3
	- Specific conductance meter	- 1.12.1.4
	- Thermometer	- 1.12.1.5
	- Field alkalinity analyzer	- 1.12.1.6
o Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness	Data Assessment Procedures	o 1.13
	o Field Data	o 1.13.1
	- Precision	- 1.13.1.1
	- Accuracy	- 1.13.1.2
	- Completeness	- 1.13.1.3
o Corrective Action	Corrective Action	o 1.14
	o Field Corrective Action	o 1.14.1
o Quality Assurance Reports to Management	Quality Assurance Reports to Management	o 1.15
	o Field Quality Assurance Reports	o 1.15.1
	o Special Notifications	o 1.15.3

In addition to these 14 elements that comprise the quality assurance/quality control (QA/QC) section of the QAPP, Section 2, Method Protocols, provides specific instructions for performing soil gas surveys; headspace analyses; installing boreholes and wells; sample collection; and equipment decontamination. Each member of the Niagara Falls IAP field team was issued a copy of the approved QAPP in addition to the Work Plan.

This section will discuss field quality control checks performed during sample collection at Niagara Falls IAP. Collection and analysis of field blanks, trip blanks, field duplicates, and equipment washes are intended as QC checks on the integrity of sample collection and handling procedures and equipment decontamination procedures.

Field blanks, equipment blanks, and trip blanks were prepared using ASTM Type II reagent water and sample bottles randomly selected from the bottles prepared for environmental samples. ASTM Type II reagent water was used to prepare these field check samples, regardless of the environmental medium being sampled, because:

- It mimics the physical characteristics of groundwater and surface water
- It mimics a reproducible fraction (moisture) of soils and sediments
- No reproducible, affordable material is available that mimics the clay and organic portion of soils and sediments.
- An organic or aqueous reservoir is necessary for the absorption, dissolution, or solvation of organic and inorganic contaminants.

The following QC samples were collected for each day of sampling:

- One trip blank per container per sampling team for every batch of soil and water samples to be analyzed for VOCs.
- One field blank per field sampling team for each day water samples were collected for VOC analysis at a particular site or zone.
- One set of equipment blanks for every day of groundwater sampling. All parameters were analyzed.

- One field replicate for every 10 soil/sediment samples was collected at a preselected monitoring point. Field replicates were collected at the same time and in the same manner as the other samples. Field replicates were separate samples, obtained from the same monitoring point. Results of the field replicate analyses were used to assess the precision of the field sampling techniques, not that of the analytical techniques.

- One field duplicate for every 10 water samples were collected at preselected monitoring points. Duplicate samples were collected independently at a sampling location during a single act of sampling. Field duplicates were labeled in a manner indistinguishable from other samples, so that personnel performing the analyses were not able to determine which samples were duplicates. Field duplicates were used to evaluate the precision of sampling techniques.

Results of all field QC check samples are presented with the applicable environmental sample results in the following section.

Trip Blanks -- Trip blanks were prepared prior to the beginning of the sampling trip by pouring ASTM Type II reagent-grade water into prepared sample bottles. These sample bottles were randomly selected from the supply of prepared sample bottles. Sample containers were filled and preserved to yield a representative blank for each type of VOC analysis, resulting in a complete trip blank for the sampling event. These trip blanks were prepared at the laboratory, shipped to Niagara Falls IAP, stored with the unused sample bottles, transported to the site or zone, and then shipped for analysis with the samples collected during the sampling event. The trip blanks remained unopened throughout the sampling event. The analytical results of trip blanks will be used to assess contamination of sample containers during transport to and storage at the site, contamination of samples during transport back to the laboratory, and to make an overall judgement as to whether the contaminants detected in the environmental samples were contributed during transport or by the sample containers, or are representative of conditions at Niagara Falls IAP. One trip blank was included in each shipment of samples for VOC analysis.

Field Blanks -- Field blanks (ambient conditions blanks) were prepared at the beginning of each groundwater sampling event at each discrete sampling site by pouring ASTM Type II reagent-grade water into prepared sample bottles. These sample bottles were randomly selected from the supply of prepared sample bottles received from I-CHEM Research, Inc. A sample container was selected, filled, and preserved in a manner that was appropriate for each type of VOC analysis for which environmental samples were collected. The field blanks were then handled and analyzed in the same manner as the environmental samples particular to that site or zone. Because field blanks and environmental samples are collected under the same conditions, the results of the field blank analyses were used to indicate the presence of external contaminants (drill rig or aircraft exhaust, dust particles) that may have been introduced into samples during collection, and to make an overall judgement as to whether the contaminants detected in the environmental samples were contributed by conditions independent of the formation sampled or are representative of conditions at Niagara Falls IAP. Field blanks contaminated during transport will be assessed by the simultaneous evaluation of trip blank results.

Equipment Blanks -- Equipment blanks (bailer washes) were prepared for manual and small automated sampling equipment used to collect environmental samples (i.e., equipment blanks were not prepared for drill rig sampling equipment). Equipment blanks were collected during the sampling day by pouring ASTM Type II reagent-grade water into/through/over a clean piece of sampling equipment, such as bailers, shovels, and trowels, and then dispensing it into prepared sample bottles. These sample bottles were randomly selected from the supply of prepared sample bottles received from I-CHEM Research, Inc. The results of the analyses of bailer washes were used to assess the efficiency of equipment decontamination procedures in preventing cross-contamination between samples and to make an overall judgement as to whether the contaminants detected in the environmental samples were contributed by the sampling equipment or are representative of conditions at Niagara Falls IAP.

Field Replicates/Duplicates -- Field replicates were collected in quantities equal to 10 percent of the total number of environmental samples. These samples were collected at the same time and using the same techniques as the planned environmental samples. Replicate locations were either pre-selected prior to the daily sampling activities or selected based upon an abnormal instrument reading or an unforeseen field condition (i.e, floating product or strong fuel odor). The identification of each replicate was coded to prevent external laboratory bias. A suffix of "R" was added to each replicate soil sample.

Replicate soil samples were collected as a means of assessing the precision of the sampling effort at Niagara Falls IAP. One replicate sample was taken per ten sampling locations. Field replicates did not release the laboratory from its own QC requirements for duplicate analyses. A significant problem that arises during soil sampling from a borehole is accurately duplicating the sample interval. To alleviate this problem, samples were collected using a 3-inch "California" ring-type sampler. This sampler provided adequate sample volume so that the lab could obtain a replicate sample.

Duplicate water samples were collected as a means of assessing the precision of the sampling effort at Niagara Falls IAP. One duplicate was taken for every ten wells sampled, or one duplicate sample per site or zone, if that site of zone was scheduled for less than ten samples. Duplicate samples were coded in a manner to prevent laboratory personnel from recognizing them as quality control samples. For the purposes of this project, water samples were designated as duplicates even through several bailer volumes were needed to fill the sample containers. Field duplicates did not release the laboratory from its own QC requirements for duplicate analyses. The procedures for collecting and containerizing field duplicate water samples are described below.

The volatile fraction was collected first to minimize loss of analyte through volatilization. The first bailer volume was used to fill the sample vials. The next bailer volume was used to fill the replicate sample vials. Sample collection, preservation, and containerization procedures were those described in Section 3.6.3. After the volatile fractions had been collected, the sample volumes for the remaining analyses were collected in the manner described above. Sample collection, preservation and containerization procedures were those described in Section 3.6.3 for the applicable analysis. After collection, all sample bottles were labeled properly and stored on-site at less than 4°C until they were packed and delivered to the laboratory for analyses.

3.7 LABORATORY PROGRAM

3.7.1 Identification of Laboratory

All analyses conducted as part of the IRP RI/FS at Niagara Falls IAP were performed by Ecology and Environment Inc., Buffalo, New York. SAIC's primary contact was Marcia Meredith of Ecology and Environment, Inc.

3.7.2 Description of Analytical Parameters

The descriptions of all field and laboratory parameters, instrumentation used, and sources of likely interference are presented in Table 3-10.

3.7.3 Laboratory Quality Assurance/Quality Control Program

An overview of the Ecology and Environment Inc. laboratory QA/QC program is presented in Table 3-11.

3.7.3.1 Establishment of Method Limits of Detection

Method detection limits and sample detection limits are presented in Appendix F following the technical report. Method detection limits are presented with the method blank data for each analysis. Detection limits are also presented with each sample analysis corrected for matrix interference, dilution factors, and, in the case of soil results, moisture content.

Organic Analyses -- Seven replicate reagent blanks are prepared with laboratory standards to contain method analytes at a concentration between one and five times the estimated method detection limit. The replicate samples are then analyzed and the results calculated. The method detection limit of each analyte is equal to three times the standard deviation of the seven replicate analyses. This procedures is repeated for each sample matrix (e.g., groundwater, surface water, sediment, and soil.)

TABLE 3-10 NIAGARA FALLS IAP RI ANALYTICAL PARAMETER DESCRIPTION

PARAMETER	METHOD	INSTRUMENTATION TYPE	ANALYTE TYPES	INTERFERENCE TYPES
<u>Field Analyses and Tests</u>				
o Alkalinity	Standard Method 403	Hach Field Alkalinity Analyzer	Carbonate, bicarbonate, and hydroxide alkalinity as mg/L $CaCO_3$	o Sample turbidity o Exposure to air o Incomplete temp. equilibration o Inadequately cleaned or maintained equipment o Operator error
o Specific Conductance	EPA Method 120.1	Omega pH 80	Soluble species as a function of the ability of the sample to conduct an electric current	o Nonstandardized to 25°C o Sample turbidity o Exposure to air o Inadequately maintained equipment o Operator error
o pH	EPA Method 150.1	Omega pH 80	Hydrogen ion concentration	o Incomplete temp. equilibration o Sample aeration, oxidation, and/or degassing o Inadequately maintained equipment o Operator error
o Temperature	EPA Method 170.1	Fischer NBS-traceable thermometer	---	o Improperly calibrated equipment o Measurement delay o Operator error

TABLE 3-10 NIAGARA FALLS IAP RI ANALYTICAL PARAMETER DESCRIPTION (Cont'd)

PARAMETER	METHOD	INSTRUMENTATION TYPE	ANALYTE TYPES	INTERFERENCE TYPES
Laboratory Analyses and Tests				
o Petroleum Hydrocarbons	Extraction Modified SW846 Method 3550 (soil)	Extraction Ultrasonic cell disruptor	o Fluorocarbon - 113 extractable petroleum hydrocarbons	o Biodegradable animal greases and vegetable oils
	Analysis EPA Method 418.1 (soil and water)	Analysis Infrared spectrophotometer		o Cross-contamination between samples or between samples and standards
				o Light hydrocarbon volatilization
o ICP Metal Screen	Digestion SW846 Method 3050 (soil)		o Aluminum, arsenic antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silica, silver, sodium, thallium, vanadium, zinc	o Anionic (chlorides, phosphates, and sulfates) and cationic (aluminum, calcium, iron, and magnesium) interference that affects arsenic, antimony, selenium, and thallium
	Analysis SW846 Method 6010 (soil) EPA Method 200.7 (water)	Analysis Inductively coupled argon plasma (ICP) spectroscopy		o Sample turbidity o Spectal Interferences (e.g., aluminum and arsenic)
o Graphite Furnace Atomic Absorption Spectrophotometry	Digestion Same as above (soil)			
	Analysis o SW846 Method 7421 - lead (soil) o EPA Method 206.2 - Arsenic (water) o EPA Method 239.2 - Lead (water) o EPA Method 270.2 - Selenium (water)	Analysis Graphite furnace atomic absorption spectrophotometer	o Arsenic, lead, and selenium	o Sulfate Interference (lead)

TABLE 3-10 NIAGARA FALLS IAP RI ANALYTICAL PARAMETER DESCRIPTION (Cont'd)

PARAMETER	METHOD	INSTRUMENTATION TYPE	ANALYTE TYPES	INTERFERENCE TYPES
o Total Dissolved Solids	o EPA Method 160.1	o None, gravimetric determination	o Undifferentiated dissolved solutes	o Highly mineralized water containing significant concen. of calcium, magnesium, chloride and/or sulfate may be hygroscopic and may require prolonged drying. o Samples containing high concen. of bicarbonate require careful and prolonged drying to ensure that all bicarbonate is converted to carbonate. o Samples highly concentrating will form a crust and trap water beneath
o Extraction Procedure Toxicity (metals only)	40 CFR 261/24	<u>Analysis</u> o Inductively coupled argon plasma (ICP) spectroscopy and graphite furnace atomic absorption spectrophotometer	o Silver, barium, arsenic, cadmium, chromium, mercury, lead, and Selenium	o Anionic (chlorides, phosphates, and sulfates) and cationic (aluminum, calcium, iron, and magnesium) interference that effects arsenic, antimony, Selenium and thallium. o Sample turbidity o Spectral interferences (e.g., aluminum and arsenic) o Sulfate interference (lead)
o Soil Moisture Content	ASTM D2216	o Oven, balance	o Water Content	o None
o Density	ASTM D854	o Compactor	o Density vs. water content	o None
o Grain Size Incl. Hydrometer	ASTM D422	o Sieve & shaker	o Particle size	o None
o Purgeable Aromatics	<u>Preparation</u> SW846 Method 5030 <u>Analysis</u> SW846 Method 8020	<u>Preparation</u> Purge-and-trap <u>Analysis</u> Gas chromatograph with PID	o Purgeable aromatic compounds	o Memory effect from highly concentrated samples o Cross-contamination during sample shipment and storage

TABLE 3-10 NIAGARA FALLS IAP RI ANALYTICAL PARAMETER DESCRIPTION (Cont'd)

PARAMETER	METHOD	INSTRUMENTATION TYPE	ANALYTE TYPES	INTERFERENCE TYPES
o Mercury Analysis	o SW846 Method 7471 (soil) o EPA Method 245.1 (water)	Cold-vapor atomic absorption spectrophotometer	o Mercury	o Incomplete sample digestion o Volatile organic material may absorb at the wavelength specified for mercury analyses
o Volatile Organics	o SW846 Method 8240 (soil)	o Gas Chromatography/mass spectrometer	o Volatile chlorinated hydrocarbons o Volatile aromatic hydrocarbons	o Matrix - floating product - concentration of other analytes - concen. of non-8240 list analytes o Circulating contaminates (e.g., methylene chloride, acetone, and hexanes)
o Extractable Priority Pollutants	<u>Extraction</u> o SW846 Method 3550 (soil) <u>Analysis</u> o SW846 Method 8270 (soil) o EPA Method 625 (water)	<u>Analysis</u> Gas chromatography/ mass spectrometer	o Polynuclear aromatics hydrocarbons o Nitroaromatic hydrocarbons o Chlor. hydrocarbons o Phenolic hydrocarbons	o Sample pH o Matrix - floating product - concentration of other analytes - concen. of non-8270 list analytes (e.g., JP-4 + MOGAS compounds) o Circulating contaminants (e.g., phthalates)
o Common Anions	o Std. Method 429 (water)	o Ion chromatograph	o Orthophosphate o Chlorides o Sulfates o Fluoride o Nitrate	o Matrix-Interference from high concentrations of other analytes

TABLE 3-10 NIAGARA FALLS IAP RI ANALYTICAL PARAMETER DESCRIPTION (Cont'd)

PARAMETER	METHOD	INSTRUMENTATION TYPE	ANALYTE TYPES	INTERFERENCE TYPES
o Purgeable Halocarbons	Preparation SW846 Method 5030	Preparation Purge-and-trap	o Volatile chlorinated hydrocarbons	o Memory effect from highly concentrated samples
	Analysis SW846 Method 8021	Analysis Gas chromatograph with PID/ HECD in series	o Volatile aromatic hydrocarbons	o Cross-contamination during sample shipment and storage
				o Common laboratory solvent, especially methylene chloride
o Non-halogenated Volatile Organic Compounds	Preparation SW846 Method 5030	Preparation Purge-and-trap	o Ketones, ethers, alcohols	o Memory effect from highly concentrated samples
	Analysis SW846 Method 8015	Analysis Gas chromatograph		o Cross-contamination during sample shipment and storage
o Ethylene Dibromide	EPA Method 504.1	Gas chromatograph	o Ethylene dibromide	o Chlorinated co-eluting compounds
o Pesticides and PCBs	EPA Method 608	Gas chromatograph with ECD	o Organochlorine pesticides and polychlorinated bi-phenyls	o Phthalate esters non-target co-extrated co-eluting compounds
o Hardness	EPA Method 130.1	Autoanalyzer	o Calcium and/or other cations as $CaCO_3$	o None

TABLE 3-11. LABORATORY QA/QC PROGRAM SUMMARY

PARAMETER	METHOD	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Volatile Organics	SW846 Method 8240	Mass scale calibration using PFTBA	Daily, prior to sample analyses	Refer to method	Repeat calibration
		Check of mass spectral ion intensities using BFB	Every 12 hours	Refer to method	Retune instrument Repeat BFB analysis
		System performance check compounds	Every 12 hours	$\overline{RF} \geq 0.300$ (0.250 for bromoform)	1) Evaluate system 2) Repeat calibration
		Calibration check compounds	Every 12 hours	RPD <25 percent	1) Evaluate system 2) Repeat calibration
		Surrogate spikes	Every sample	Refer to method	1) Evaluate system 2) Recalculate data and/or reanalyze sample 3) Flag data
		Internal standard	Every sample	Refer to method	Flag data
		Method blank	Every 12 hours	Target Compounds (except common solvents) <MDL	1) Clean system 2) Repeat blank analysis
		Matrix spike	5 percent	Refer to method	1) Run check standard 2) Correct problem 3) Flag data
		Matrix spike duplicate	5 percent	Lab control limits	Flag data
Extractable Priority Pollutants	SW846 Method 8270/ EPA Method 625	Mass scale calibration using PFTBA	Daily, prior to sample analyses	Refer to method	Repeat calibration
		Check of mass spectral ion intensities using DFTPP	Every 12 hours	Refer to method	Retune instrument Repeat DFTPP analysis
		System performance check compounds	Every 12 hours	$\overline{RF} \geq 0.050$	1) Evaluate system 2) Repeat calibration

TABLE 3-11. LABORATORY QA/QC PROGRAM SUMMARY (Cont'd)

PARAMETER	METHOD	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Extractable Priority Pollutants (Cont'd)	SW846 Method 8270/EPA Method 625	Calibration check compounds	Every 12 hours	RPD <30 percent	1) Evaluate system 2) Take corrective action 3) Repeat test 4) See lab manager
		Surrogate spikes	Every sample	Refer to method	1) Evaluate system 2) Recalculate data and/or reanalyze extract 3) Re-extract and re-analyze sample or flag data
		Internal standards	Every sample	Refer to method	Flag data
		Extraction blank	5 percent	<5 x MDL	1) Run solvent blank 2) Evaluate system
		Matrix spike	5 percent	Refer to method	1) Run check standard 2) Correct problem 3) Flag data
		Matrix spike duplicate	5 percent	Lab control limits	Evaluate system
Metals	EPA Method 200.7 SW846 Method 6010	Mixed standard calibration verification	Daily	Measured value for high standard within 10 percent of expected value	Repeat calibration
		Calibration check	10 percent	Measured value within 10 percent of true value for element of interest	Repeat calibration
		Method blank	10 percent	≤5 x MDL	1) Evaluate system 2) Recalibrate
		Matrix spike	5 percent	±25 percent error	1) Post spike analysis 2) Flag data

TABLE 3-11. LABORATORY QA/QC PROGRAM SUMMARY (Cont'd)

PARAMETER	METHOD	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Metals (Cont'd)	EPA Method 200.7 SW846 Method 6010	Matrix spike duplicate	5 percent	RPD <20 percent	1) Check interelement correction factor and background correction points 2) Flag data
		ICP interference check	Run at beginning, middle, and end of daily run	80-120 percent of true value for EPA check sample elements	1) Repeat calibration 2) See lab manager
		ICP linear range check	Daily	Measured value within ±5 percent of expected value	Tests upper limit of ICP linear range
		Limit of detection (LOD) check	Quarterly	None	Used to verify current LOD
Metals - Arsenic - Selenium - Mercury - Lead	SW7060/E206.2 SW7740/E270.2 SW7420/E239.2 SW7471/E245.1	Multipoint calibration	Daily prior to analyses	r ≥0.995	Repeat calibration
		Calibration check	10 percent	±15 percent error	Recalibrate
		Method blank	10 percent	≤5 x MDL	Will be used to indicate analytical contaminants
		Matrix spike analysis	5 percent	±25 percent error	Post spike analysis
		Matrix spike duplicate	5 percent	RPD <20 percent	Post spike analysis
current LOD		LOD check	Quarterly	None	Used to verify
Common Anions - - Chloride - Sulfate - Fluoride - Orthophosphate - Nitrate	Std. Method A429	Multipoint calibration	Daily	r ≥0.995	Repeat calibration
		QC check sample	Every 15 samples	±5 percent error	Repeat calibration

TABLE 3-11. LABORATORY QA/QC PROGRAM SUMMARY (Cont'd)

PARAMETER	METHOD	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Common Anions (continued)	Std. Method 429 (continued)	Method blank	One per batch	None	Used to assess memory effects
		Duplicate analyses	5 percent	RPD <10 percent	1) Obtain third value, 2) Flag data
		Matrix spike	5 percent	±15 percent error	Flag data
Petroleum Hydrocarbons	EPA Method 418.1	Multipoint calibration	Daily	r >0.995	Repeat calibration
		Control sample/calibration check std.	1) Following calibration 2) 10 percent	80 - 120% recovery	Repeat calibration
		Calibration blank	One per batch	<5 x MDL	Used to assess analytical contamination
Purgeable Aromatics, Purgeable Halocarbons, Non-Halogenated volatile ogranics	SW846 Methods 5030/8020, 5030/8021	Multipoint Calibration	Start of Analyses	RSD<20%	Check system recalibrate
		Calibration verification	Daily	RSD<20%	Perform multipoint calibration
		Method blank	Every 20 samples	Compounds <5 MDL	Repeat analyses check system
		Matrix spike	5%	Lab control limits	Flag data
		Matrix spike duplicate	5%	Lab control limits	Flag data
Pesticides/PCBs	EPA Method 608	Multipoint Calibration	Start of analyses	RSD <20%	Check system recalibrate
		Calibration Verification	Daily	RPD <20%	Perform multipoint calibration
		Method Blank	Each batch of samples extracted	Compounds <5 MDL	Repeat analyses check system
		Matrix spike	5%	Lab control limits	Flag data
		Matrix spike duplicate	5%	Lab control limits	Flag data
		PCB Reference Standard	Monthly	Lab control limits	Flag data

TABLE 3-11. LABORATORY QA/QC PROGRAM SUMMARY (Cont'd)

PARAMETER	METHOD	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Hardness	EPA Method 130.1	Blank	Each Batch	Used as reference	None
		$CaCO_3$ Ref Standard	Each Batch	Used as reference	None
Ethylene Dibromide	EPA Method 504.1	Multipoint Calibration	Start of analyses	RSD<20%	Check system, recalibrate
		Calibration Verification	Daily	RPD<20%	Recalibrate
		Method Blank	Every 10 samples	Compound <5 MDL	Re-analyze
		Matrix Spike	Every 10 samples	Lab control limits	Flag data

ICP Metals Analyses -- Instrument detection limits (IDLs) are determined by multiplying by three the average of the standard deviation(s) obtained on 3 nonconsecutive days from the analysis of a standard solution (each analyte in reagent water) at a concentration of three to five times the estimated IDL, with seven consecutive measurements per day. Each measurement is performed as though it were a separate analytical sample (i.e., each measurement is followed by a rinse and/or other procedure normally performed between the analysis of separate samples). IDLs are determined and reported for each wavelength in the analysis of the samples.

GFAA Metals Analyses -- IDLs (in µg/L) are determined by multiplying by three the average of the standard deviation(s) obtained on 3 nonconsecutive days from the analysis of a standard solution (each analyte in reagent water) at a concentration of three to five times the estimated IDL, with seven consecutive measurements per day. Each measurement is performed as though it were a separate analytical sample (i.e., each measurement is followed by a rinse and/or other procedure normally performed between the analysis of separate samples). IDLs are determined and reported for each wavelength used in the analysis of the samples.

Inorganic Analyses -- Detection limits for general chemistry parameters are determined by an evaluation of the signal-to-noise ratio, or by the response of the lowest concentration standard.

3.7.3.2 QA/QC Control Limits

Control limits for QC samples are used to indicate variability in results due to systematic or assignable causes as opposed to random or unassignable causes. Warning limits provide a reference point two-thirds the magnitude of action limits.

Action limits corresponding to specific acceptance criteria given in the referenced EPA analytical methods are used for QC check samples. Published acceptance criteria are used for matrix and surrogate spike recoveries where sufficient historical data are not available. Method QC acceptance criteria are shown in Table 3-11. Where sufficient data are available, control limits are calculated as described below.

Limits are derived as a function of variability (expressed in terms of the range or standard deviation) among a group of measurements taken when the system is in control. Control charts for individual measurements are used to track analytical control in terms of percent recoveries for spikes, surrogates or control samples. Individual, rather than average (subgroup), values are plotted. Control limits for recoveries are calculated from the last 30 recorded values as specified in the EPA methods.

Action limits for surrogate spike recoveries are calculated as specified in SW-846, 3rd ed.:

$$UCL_x = X + \overline{2}s$$

$$LCL_x = X - \overline{2}s$$

where $\overline{X}$ and s represent the mean and standard deviation, respectively, for a set of recoveries for a given matrix. The calculated limits will not exceed the published limits in the referenced methods, where any are cited.

Range charts are used to track repeatability of duplicate results. The upper control limit is calculated using the standard deviation of the last 30 relative percent differences ($UCL = \overline{X}+25$) for duplicate pairs. The lower control limit is zero.

Control limits are presented with each applicable QC check analysis in Section 4.0 and in Appendix F following the technical report.

INSTALLATION RESTORATION PROGRAM (IRP)

RI/FS

VOLUME IIA

Section 4

Niagara Falls International Airport
Niagara Falls, New York

Science Applications International Corporation (SAIC)
One Sears Drive
Paramus, New Jersey 07652

May 1991

Remedial Investigation/Feasibility Study (RI/FS) Report 1987-1990

PREPARED FOR

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098-6001

UNITED STATES AIR FORCE
HUMAN SYSTEMS DIVISION (AFSC)
IRP PROGRAM OFFICE (HSD/YAQI)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

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IV RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 DISCUSSION OF RESULTS

4.1.1 Discussion of Results for Sites No. 1, 2, 4 and 6: Building 600 JP-4 Pipeline Leak, POL JP-4 Tank C and A, and BX Mogas Tank Leak

4.1.1.1 Presentation of Results

4.1.1.1.1 Site Geology

The geology of the combined Sites 1, 2, 4, and 6, as interpreted from the Stage 1 and RI well and soil boring logs, consists of a fine grained veneer of glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. Figure 4-1 presents the locations of the Site Nos. 1, 2, 4 and 6 soil borings and monitoring wells. The thickness of the unconsolidated deposits ranges from a maximum of 14 feet in the vicinity of POL Bulk Storage Tanks A and B to a minimum of 5.5 feet near building 620 just south of Site No. 1 well, MW1-5. According to the literature, the thickness of the dolomitic bedrock (Lockport Dolomite) is estimated to be 180 feet in this area. Figure 4-2 presents a generalized geologic cross-section of the combined site area.

The soils in the vicinity of the combined sites belong to the Odessa Series and are characterized by gently sloping, poorly drained, silty clay loams. The surface soils are generally eight inches thick and consist of grayish-brown clay loam which grades into a firm, brown and light reddish-brown, mottled silty clay. The substratum consists of a very firm, reddish-brown layer of clay and silt.

The lacustrine deposits form the uppermost unconsolidated unit in the combined site area. A silty clay glacial till forms the lowermost unit, which rests directly on the bedrock surface. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. The contact between the two units is indistinct. The lacustrine deposits generally consist of thin bedded to laminated, grayish-brown to reddish-brown, mottled silty clay with intercalations of silt and fine sand. The intercalations are inferred to be of fluvial derivation.

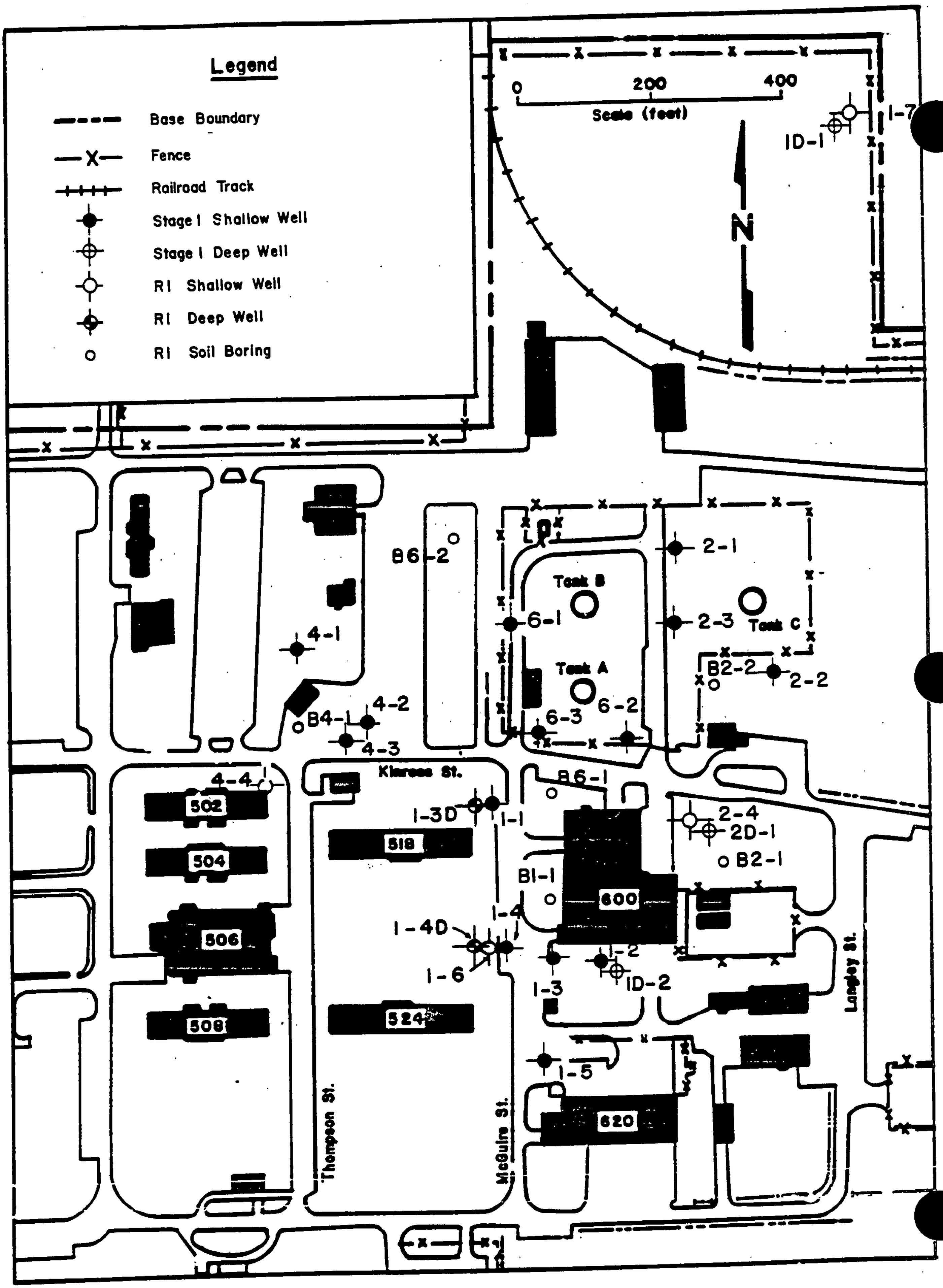


FIGURE 4-1.
SITE NOS. 1,2,4, AND 6: SOIL BORING AND MONITORING WELL LOCATION MAP

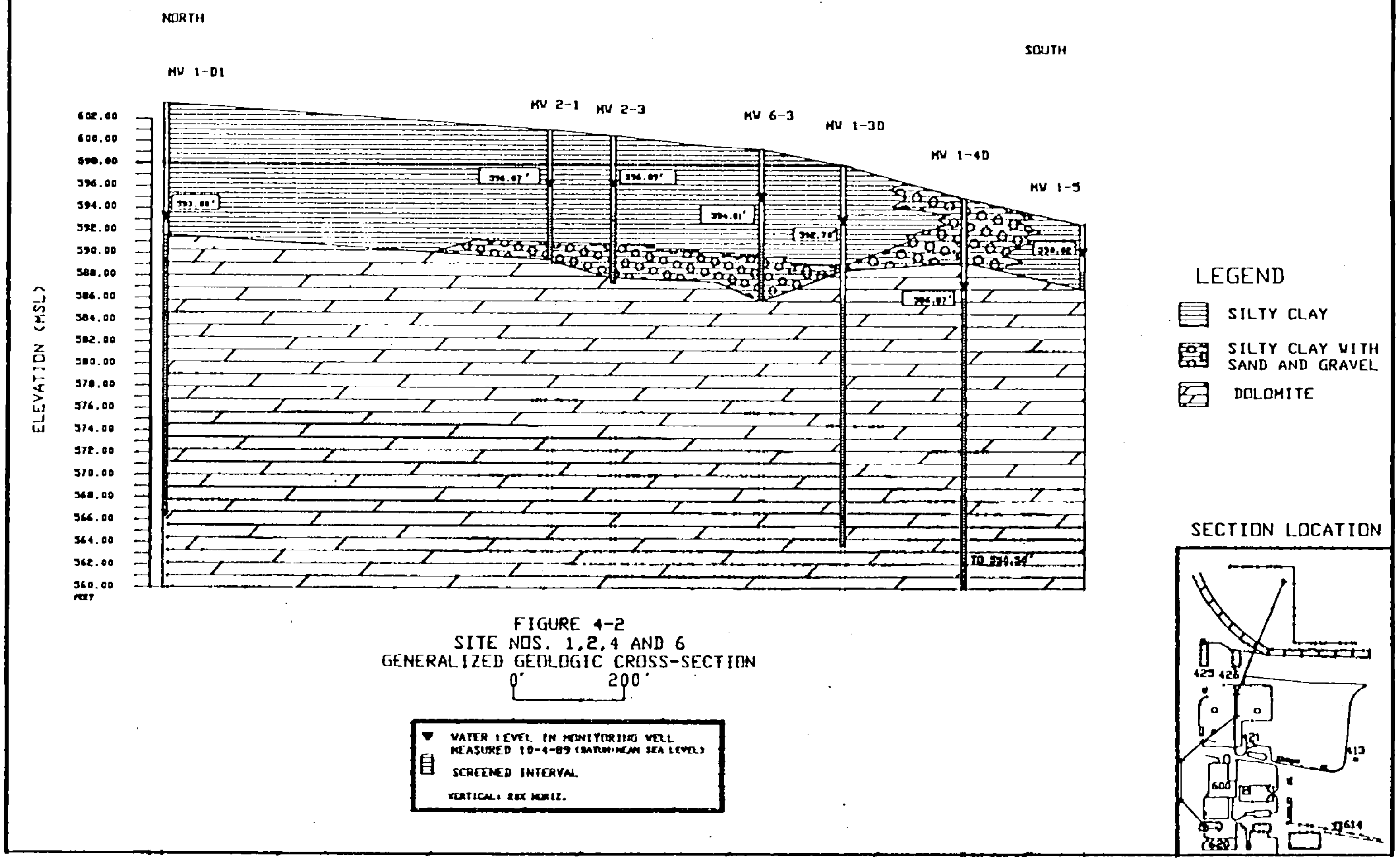


FIGURE 4-2
SITE NOS. 1,2,4 AND 6
GENERALIZED GEOLOGIC CROSS-SECTION

Glacial till consists of a reddish-brown matrix of silty clay. The till can be distinguished from the lacustrine deposits by the presence of trace to minor amounts of gravel and the absence of bedding plane laminations. Gravel in the glacial till consists of subrounded to subangular clasts of dolomite, shale and metamorphic material. Due to inherent problems associated with distinguishing between these units, and the limited number and discontinuous nature of the Stage 1 soil sampling, thickness variations of the till and lacustrine deposits beneath the combined site study area could not be ascertained. Well and soil boring logs do suggest that the lacustrine deposits may be absent in a small area south of shallow aquifer wells MW1-6 and MW1-3 owing to the presence of gravel throughout the sediment column. In this area till probably occurs as a surface deposit.

Minor intercalations of fluvial sediments occur sporadically throughout the combined site study area. At soil boring B-2-2, a 1.5 foot lens of sandy silt occurs 6.5 feet below the land surface. Fluvial sediments may also be mixed in with the basal till deposits at soil boring B-6-2.

The bedrock surface, as interpreted by well boring logs and depicted in the structural contour map, (Figure 4-3), is uneven and slopes radially away from the center of the combined site study area. The uneven bedrock surface, depicted in the cross-section, is inferred to be the result of differential erosion as a consequence of preglacial drainage. Subsequent ice scouring associated with continental glaciation likely subdued all but the major erosional features. One significant feature, inferred to be a paleochannel, exists in the vicinity of shallow monitoring well MW6-3. The extent of this "channel" is unknown. As a general observation, gravel appears to be locally concentrated in this depressional feature. The concentration of gravel is best explained by reworking of the basal till deposits due to subsurface drainage, since it is doubtful if preglacial lag gravel deposits could have survived continental glaciation.

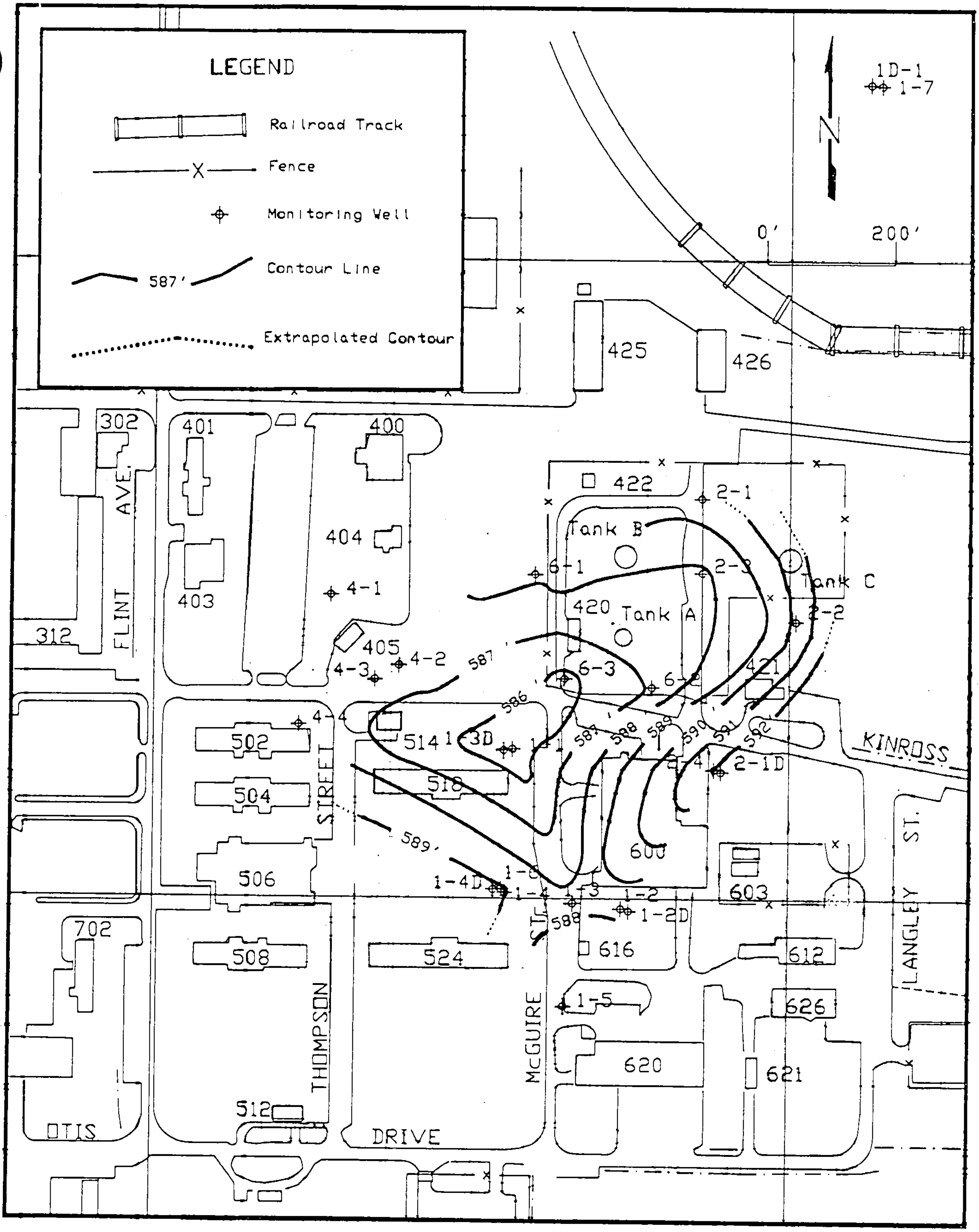


Figure 4-3
Site Nos. 1,2,4 and 6: Structural Contour Map of the Bedrock Surface

Information was obtained on the dolomitic bedrock beneath the study area during the RI bedrock drilling program though it was not complete. General lithologic and structural logs of the upper dolomite were determined. Air rotary drilling was somewhat successful in detecting horizons of incompetent bedrock, interpreted as fracture zones or localized pockets of vugs or solution cavities. Some of these horizons function as water-bearing zones due to enhanced permeability. As is the case with the upper bedrock geology at all of the IRP sites, incompetent zones tend to be concentrated within the upper 10-15 feet of the dolomite. Approximately 15 feet below the bedrock surface, incompetent zones are less prominent.

4.1.1.1.2 Site Hydrogeology

Both the shallow unconsolidated aquifer and the deep upper bedrock aquifer were evaluated at Site Nos. 1, 2, 4 and 6. In all cases, the first water bearing zone encountered in the shallow aquifer was a horizon of silty clay containing some gravel and sand, which occurred at the bedrock-unconsolidated overburden interface. This horizon represents a zone of glacial till materials that has been reworked by groundwater travelling along this interface. All of the other till and lacustrine materials observed lack sufficient permeability to function as viable water-bearing formations and collectively function as an aquitard. This geologic arrangement results in a predominantly confined shallow aquifer system.

Between May 1989 and April 1990, the water levels in the shallow unconsolidated aquifer occurred at an average depth 4.09 feet. During April 1990 water levels exhibited a range in elevation from 599.89 feet MSL at MW 1-7 to 591.43 feet MSL at MW 1-5. The maximum head differential was 8.46 feet and the hydraulic gradient was 0.0055. The hydraulic gradient inferred for the combined sites is consistent with the 0.0036 gradient reported in a comprehensive groundwater flow modeling study sponsored by the USEPA at the nearby Love Canal site (Mercer et. al., 1983). A maximum average water level fluctuation of 2.80 feet was observed in the shallow monitoring wells of the combined site area between October 1989 and April 1990. As a general trend, water levels tended to be lowest in October and highest in April. Table 4-1 presents all the hydrogeologic data collected in the field. Figures 4-4 and 4-5 present potentiometric surface

TABLE 4-1

Site Nos. 1,2,4 and 6 - Hydrogeologic Data

Static Water Level Results

	05-31-89 Water Levels		09-12-89 Water Levels		10-4-89 Water Levels		04-11-90 Water Levels	
Monitor Well No.	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS
1-1	593.51	3.86	592.28	5.09	593.38	3.99	594.82	2.55
1-2	591.35	3.48	591.31	3.52	591.66	3.17	594.21	0.62
1-3	592.64	1.70	591.10	3.24	591.42	2.92	593.86	0.48
1-4	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
1-5	590.90	1.89	589.75	3.04	590.02	2.77	591.43	1.36
1-D1	594.90	8.56	593.71	9.75	593.00	10.46	595.41	8.05
1-D2	593.07	1.81	591.29	3.59	591.72	3.16	594.04	0.84
1-3D	NI	NI	592.59	5.39	592.70	5.28	595.35	2.63
1-4D	NI	NI	585.42	9.68	586.87	8.23	592.85	2.25
1-6	NI	NI	590.62	4.53	589.91	5.24	593.18	1.97
1-7	NI	NI	594.20	8.80	593.99	9.01	599.89	3.11
2-1	599.03	2.12	596.38	4.77	596.07	5.08	600.22	0.93
2-2	598.24	2.62	595.41	5.45	595.16	5.70	599.98	0.88
2-3	599.54	1.09	593.39	7.24	596.09	4.54	600.49	0.14
2-D1	594.13	3.30	591.10	6.33	590.56	6.87	593.15	4.28
2-4	NI	NI	590.55	6.75	593.88	3.42	596.68	0.62
4-1	593.91	5.33	592.65	6.59	592.77	6.47	594.91	4.33
4-2	595.77	4.98	594.17	6.58	594.15	6.60	596.84	3.91
4-3	595.10	5.29	593.52	6.87	593.56	6.83	596.17	4.22
4-4	NI	NI	592.06	6.29	592.22	6.13	592.95	5.40
6-1	598.28	1.89	592.91	7.26	595.84	4.33	598.40	1.77
6-2	596.47	2.86	594.87	4.46	595.39	3.94	597.27	2.06
6-3	595.89	3.57	594.93	4.53	594.81	4.65	596.65	2.81

NOTES:

NI = Not Installed
ft.BLS = feet below land surface
ft.MSL = feet in reference to mean sea level

TABLE 4-1 (Cont'd)

Site Nos. 1,2,4 and 6 - Hydrogeologic Data

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW 4-3	3.28×10^{-6} ft/sec	5.0 ft	1.64×10^{-5} ft^2/sec
MW 1D-2	1.50×10^{-5} ft/sec	25 ft	3.75×10^{-4} ft^2/sec

Notes:

NI = Not Installed
ft.BLS = feet below land surface
ft.MSL = feet in reference to mean sea-level
Transmissivity was

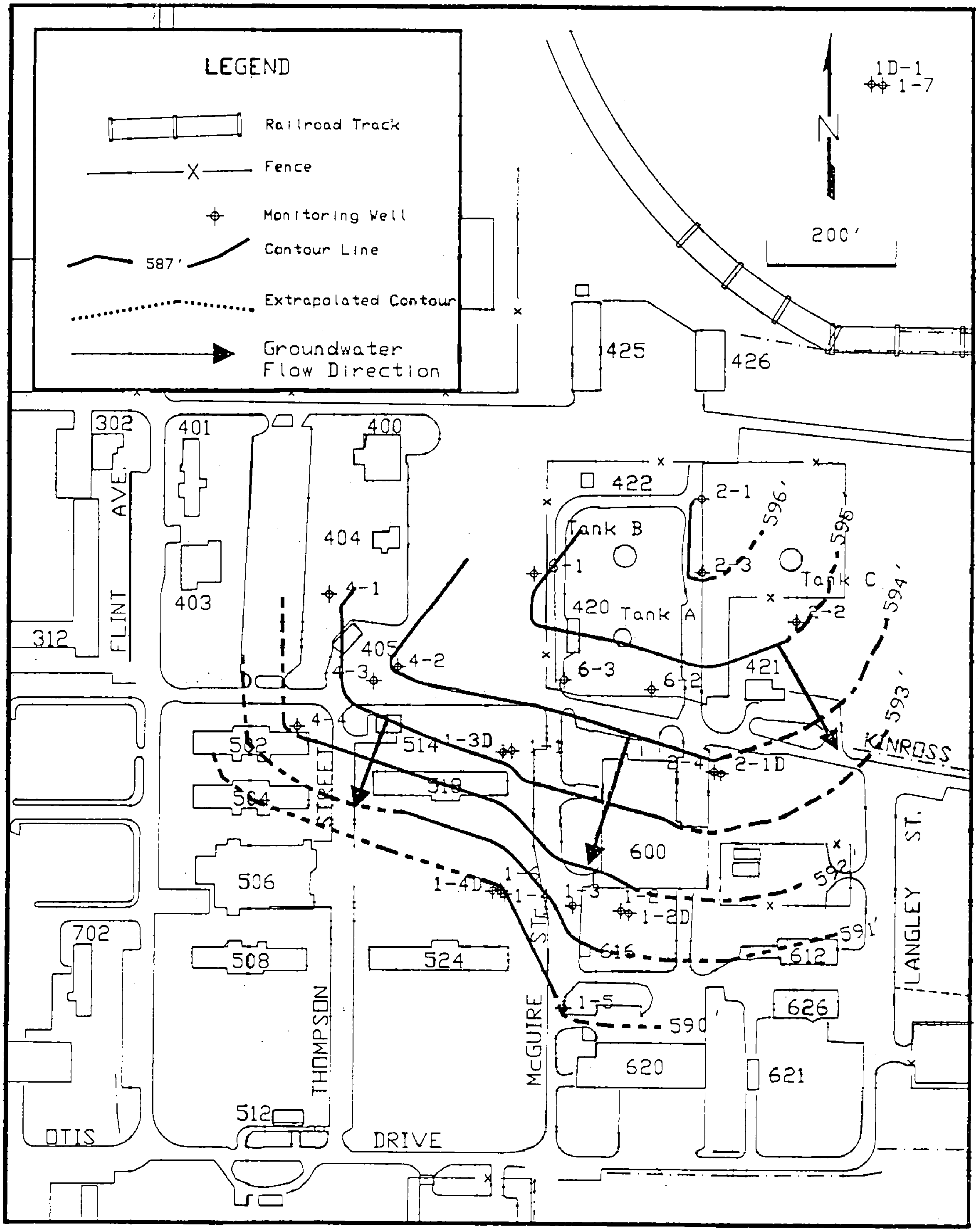


Figure 4-4
Site Nos. 1,2,4 and 6: Shallow Aquifer Potentiometric Surface Map
(October, 1989)

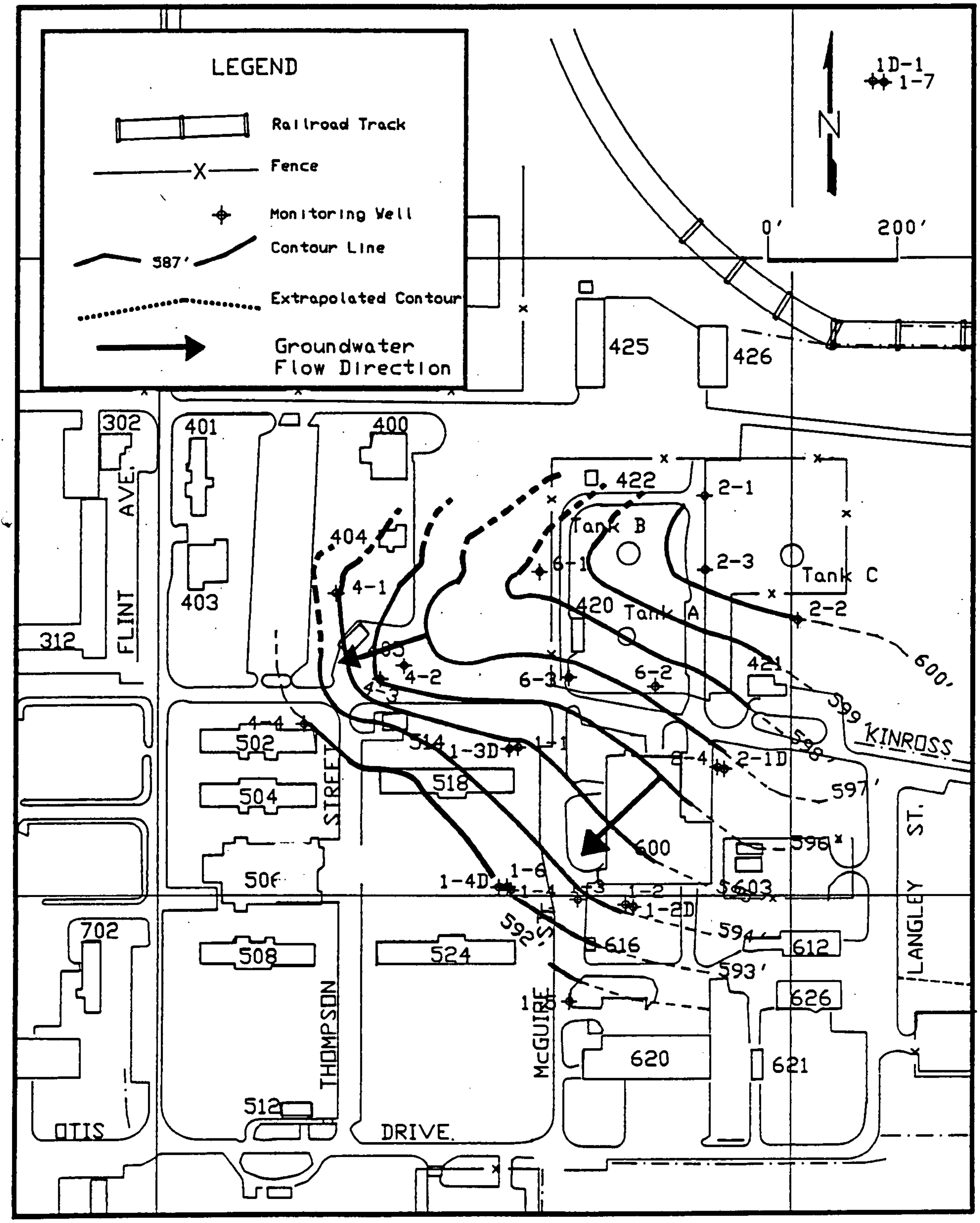


Figure 4-5
Site Nos. 1,2,4 and 6: Shallow Aquifer Potentiometric Surface Map
(April, 1990)

maps constructed from the October 1989 and April 1990 water level measurements taken at the shallow aquifer monitoring wells. The direction of groundwater flow in the shallow aquifer varies throughout the combined sites. In the vicinity of Site No. 2 located along the eastern edge of the study area, groundwater flow in the shallow system is southeast. In the vicinity of Site No. 4 and Site No. 1 located along the western edge of the study area, groundwater flow in the shallow aquifer is toward the southwest. As illustrated on the maps, slight variations in groundwater flow direction occur throughout the year.

Water bearing zones in the upper portions of the Lockport Dolomite were generally assessed during air rotary drilling. Several zones of incompetent bedrock were encountered in the upper 15 feet of the dolomite during the Stage 1 and RI drilling efforts conducted at the combined site study area. These incompetent zones, interpreted as regions of fractured bedrock or concentrations of interconnected solution cavities or vugs, are the most likely water-bearing structures in the upper-portions of the dolomite. Most of the zones encountered are less than 6-inches thick. Between May 1989 and April 1990, water levels in the upper bedrock aquifer occurred at an average depth of 5.58 feet. During April 1990, water levels exhibited a range in elevation from 595.41 feet MSL at MW 1D-1 to 592.85 feet MSL at MW 1-4D (Table 4-1). The maximum head differential was 2.56 feet and the hydraulic gradient was 0.0019. A maximum average water level fluctuation of 3.19 feet was observed in the combined site deep wells between October 1989 and April 1990. Figures 4-6 and 4-7 are potentiometric surface maps constructed from the October 1989 and April 1990 water level measurements taken at Site Nos. 1, 2, 4 and 6 upper bedrock monitoring wells. In certain locations, where vertical fractures in the upper bedrock connect the bedrock aquifer with the main water-bearing unit of the unconsolidated aquifer, the dense silty clays of the till and lacustrine deposits act to confine the bedrock aquifer. As depicted in Figures 4-6 and 4-7, horizontal groundwater flow in the upper bedrock aquifer is generally inferred to range between southeast and southwest.

Water level measurements collected between September 1989 and April 1990 showed that shallow-deep well pairs in the combined site study area have differential head potentials (Table 4-1). In all but one shallow-deep well pair

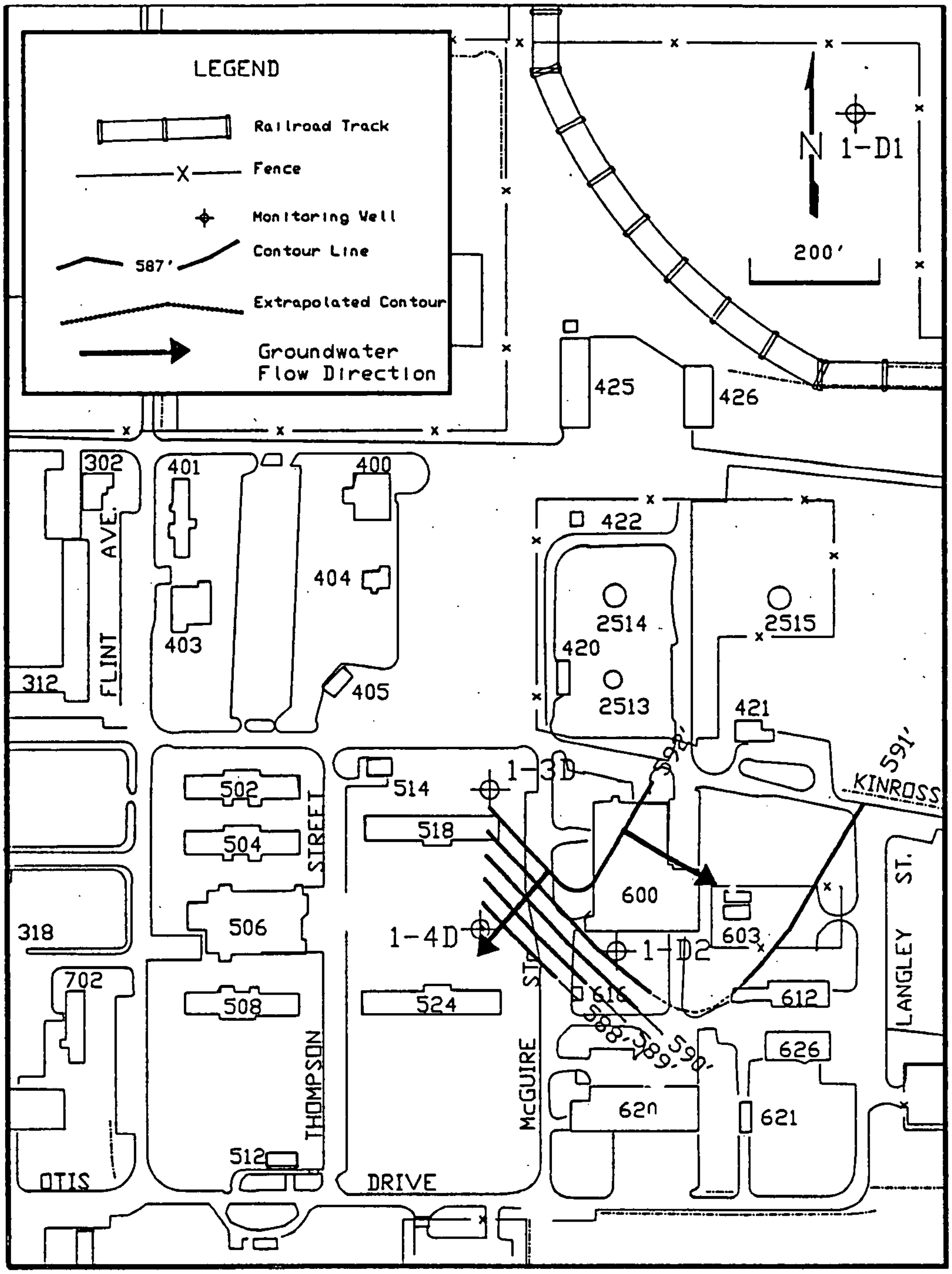


Figure 4-6
Site Nos. 1,2,4 and 6: Upper Bedrock Aquifer Potentiometric Surface Map
(October, 1989)

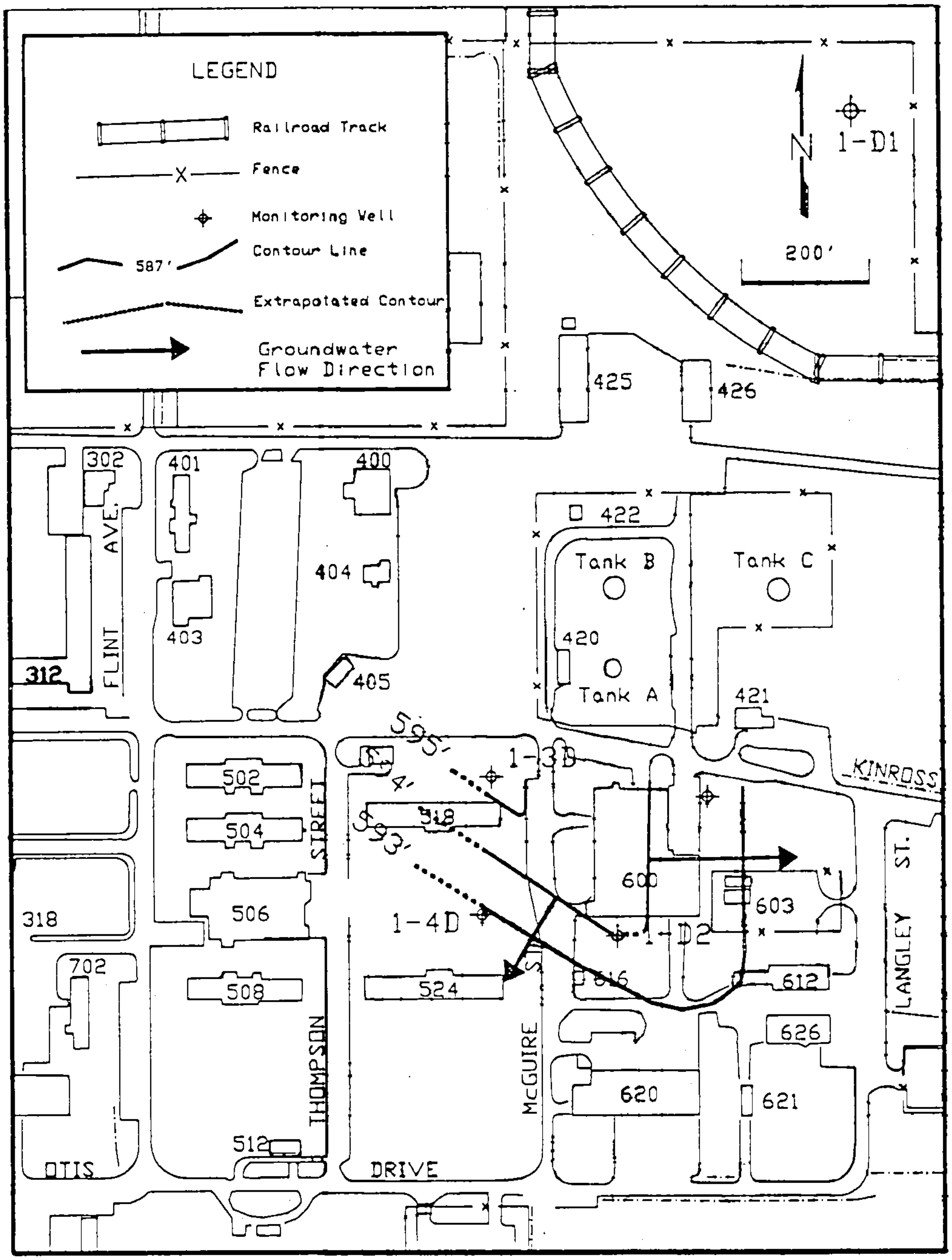


Figure 4-7
Site Nos. 1,2,4 and 6: Upper Bedrock Aquifer Potentiometric Surface Map
(April, 1990)

the shallow wells exhibited a greater head potential suggesting a downward migration of groundwater from the unconsolidated aquifer into the upper bedrock aquifer. The greatest head potential differences between well pairs occur during the wetter times of the year, usually Spring. Shallow wells exhibit a greater response than the paired deep wells to seasonal fluctuations in precipitation. The response factors for the shallow wells generally average 3.2 times that of the paired deep wells. Head potential differences as of April 1990 between shallow-deep well pairs exhibiting this tendency ranged from 0.08 feet at well pair MW 1-1/MW 1-3D to 6.26 feet at well pair MW 1-6/MW1-4D. Interaquifer exchange likely occurs between the unconsolidated shallow aquifer and the upper bedrock aquifer at locations were vertical fractures in the dolomite extend to the bedrock surface and intercept the coarser grained water-bearing till deposits at the base of the unconsolidated materials. The hydrostatic condition observed between the two aquifers may be a function of season.

No aquifer testing was conducted during the RI. During the Stage 1 study, slug tests were performed on monitoring wells MW 4-3 and MW 1D-2. Head levels were recorded using a weighted graduated line with an attached float. A hydraulic conductivity value of 3.3×10^{-6}ft/sec (1×10^{-4} cm/sec) was calculated for Site No. 4 shallow monitoring well, MW 4-3, and a hydraulic conductivity value of 1.5×10^{-5} ft/sec (4.5×10^{-4} cm/sec) was derived from the Site No. 1 bedrock well, MW1D-2.

Point source well testing methods conducted during a remedial investigation at Love Canal (EPA, 1985) yielded conductivity values for the unconsolidated aquifer on the order of 2.5×10^{-10} ft/s (7.6×10^{-9} cm/s). An earlier regional investigation conducted by Johnston (1964) reported hydraulic conductivities in the unconsolidated aquifer as high as 3.28×10^{-5} ft/s (1.0×10^{-3} cm/s). The higher conductivity value was attributed to the presence of higher conductive sand layers within the sediments. According to the USGS (1985), horizontal groundwater velocities at a nearby industrial property ranged from 0.02 to 0.06 ft/year. During a comprehensive groundwater investigation at Love Canal (Mercer et. al., 1983), groundwater modeling results were compared against actual groundwater extraction systems. Hydraulic conductivities from the glacial till material from point source well testing (i.e., slug tests) yielded values that were in accordance with previous studies (10^{-10} to 10^{-11} ft/s) (EPA, 1983; Glaubinger et. al., 1979). As a result of the flow modeling study, it was discovered that the presence of more permeable swales and sand bodies can effectively increase the hydraulic conductivity of the unconsolidated aquifer. Due to the influence of these areas of localized higher conductivity, the average conductivity of the unconsolidated groundwater system is somewhat higher than values determined from point source well testing methods (i.e., slug tests). Based on extensive modeling and comparisons with French drain flow, the shallow aquifer was characterized as having hydraulic conductivities in the range of 10^{-6} to 10^{-7} ft/s (10^{-4} to 10^{-5} cm/s), with an effective porosity of 10 to 15% and an average gradient of 0.0036. Using the bulk hydraulic conductivity and effective porosity value from the flow modeling study, coupled with the 0.0055 hydraulic gradient calculated for the combined site study area, horizontal groundwater flow velocities of 3×10^{-4} to 3×10^{-3} ft/day are predicted. These values equate to annual flow velocities of 1.2×10^{-1} to 1.2 feet/year.

According to the Stage 1 slug test results, and assuming an effective porosity of **26%** (Brassington, 1988) for dolomite, coupled with the 0.0019 hydraulic gradient deduced from the April 1990 round of water level measurements, horizontal velocities of groundwater in the upper bedrock aquifer are calculated as 9.5×10^{-3} ft/day or 3.47 ft/year. Based upon transmissivities and the average thickness reported for the uppermost water bearing zone of the Lockport Dolomite at a nearby hazardous waste disposal site (EPA, 1983) and the gradient and porosity values discussed in this section, horizontal groundwater velocities on the order of 1.5×10^{-1} ft/day or 6.31×10^{-1} ft/day are calculated. Horizontal groundwater velocities in the upper aquifer are considerably greater than those predicted for the unconsolidated aquifer.

4.1.1.1.3 Analytical Results for Site No. 1,2,4 and 6: Soil Gas Survey/ Headspace Analyses

A total of 26 soil gas samples were collected and analyzed in the vicinity of Site No. 1 (JP-4 Pipeline Leak). Soil gas techniques were not applied at the other sites. Samples were analyzed for the following volatile organic compounds:

- o benzene
- o toluene
- o ethylbenzene

- xylenes
- total hydrocarbons.

These compounds were chosen because of their suspected presence in the subsurface as a result of the fuel system leak and the amenability of these compounds to soil gas detection.

Saturated soil conditions and near surface perched water tables interfered with the implementation of soil gas techniques. Since probes could only be driven one to two feet below land surface, an adequate seal could not be ensured which would prevent surface air from cross-contaminating most samples. Data produced from the soil gas survey at this site are more likely to reflect ambient air quality rather than the composition of soil pore gas. The soil gas data for Site No. 1 is presented as Table 4-2. Figure 4-8 presents a soil gas sample location map for Site No. 1. Despite the limiting factors encountered at Site No. 1, subsurface contamination was suggested at a few locations. A potential hot spot, perhaps representing residual fuel contamination from the hydrant system leak was detected beneath the paved area adjacent to the loading dock to Building 600. The potential contamination appears to be limited to the paved area adjacent to Building 600's loading dock.

Headspace analyses were conducted on groundwater samples collected from fourteen (14) Stage 1 monitoring wells previously installed at the Sites 1,2,4 and 6 study area. An isoconcentration contour map could only be constructed for total hydrocarbons(Figure 4-9). Due to the localized concentrations and limited data generated for benzene, xylenes and trichloroethene (TCE), isoconcentration contour maps were not constructed for these compounds. TCE was found in only one well in the combined site study area (i.e., 96 ug/l at MW2D-1). Benzene concentrations of 400 ug/l, and 5 ug/l were detected in groundwater from monitoring wells MW4-3 and MW6-2 respectively. Xylene concentrations of 14 ug/l and 4 ug/l were found in groundwater samples from monitoring wells MW4-1 and MW4-2 respectively. Concentrations of 1,1,1-trichloroethane (TCA), tetrachloroethene (PCE), toluene and ethylbenzene occurred near or below the instrument's detection limit. The headspace analytical data for Sites 1,2,4 and 6 are presented in Table 4-3.

Table 4-2

Site Nos. 1,2,4 and 6: Soil Gas Analytical Data

Sample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
Ambient Air		4/18/89	0.03	<0.008	<0.01	<0.01	0.03
SG-1-1	1'	4/18/89	0.08	<0.02	<0.02	<0.02	0.08
SG-1-2	1'	4/18/89	0.04	<0.02	<0.02	<0.02	0.04
SG-1-3	2'	4/18/89	0.03	<0.02	<0.02	<0.02	0.04
SG-1-4	2.5'	4/18/89	0.04	0.02	<0.02	<0.02	0.04
SG-1-5	3'	4/18/89	0.01	<0.02	<0.02	<0.02	0.01
SG-1-6	3'	4/18/89	0.02	<0.02	<0.02	<0.02	0.02
SG-1-7	3'	4/18/89	0.5	0.2	<0.02	0.02	2
SG-1-8	1'	4/18/89	0.01	0.02	<0.02	<0.02	0.1
SG-1-9	1.5'	4/18/89	0.04	0.02	<0.02	<0.02	0.08
SG-1-10	1'	4/18/89	0.5	0.4	<0.02	0.2	2
SG-1-11	2'	4/18/89	0.4	0.4	0.8	0.6	2
Ambient Air		4/18/89	0.01	<0.02	<0.02	<0.02	0.01
Ambient Air		4/19/89	0.007	0.004	<0.01	<0.01	0.01
SG-1-12	2'	4/19/89	0.01	<0.02	<0.03	<0.03	<0.01
SG-1-13	2'	4/19/89	0.08	<0.02	<0.03	<0.03	0.08
SG-1-14	2'	4/19/89	0.04	0.02	<0.03	<0.03	0.08
SG-1-15	2'	4/19/89	0.02	<0.02	<0.03	<0.03	0.02
SG-1-16	2'	4/19/89	0.04	0.04	<0.03	0.03	0.2
SG-1-17	3'	4/19/89	0.02	0.02	<0.03	<0.03	0.04
SG-1-18	3'	4/19/89	0.2	0.1	0.1	<0.03	2
SG-1-19	2'	4/19/89	0.05	<0.02	<0.03	<0.03	0.05
SG-1-20	2.5'	4/19/89	1	0.5	0.1	<0.03	4
SG-1-21	2.5'	4/19/89	17	27	<0.02	<0.02	58
SG-1-22	2.5'	4/19/89	2	1	0.3	<0.03	6
SG-1-23	3'	4/19/89	0.02	<0.02	<0.03	<0.03	0.02
SG-1-24	2.5'	4/19/89	0.05	0.05	<0.03	<0.03	0.4
SG-1-25	2'	4/19/89	64	21	<0.4	<0.3	196
SG-1-26	1.5'	4/19/89	8	3	<0.08	<0.08	26
Ambient Air		4/19/89	0.01	<0.008	<0.008	<0.008	0.01

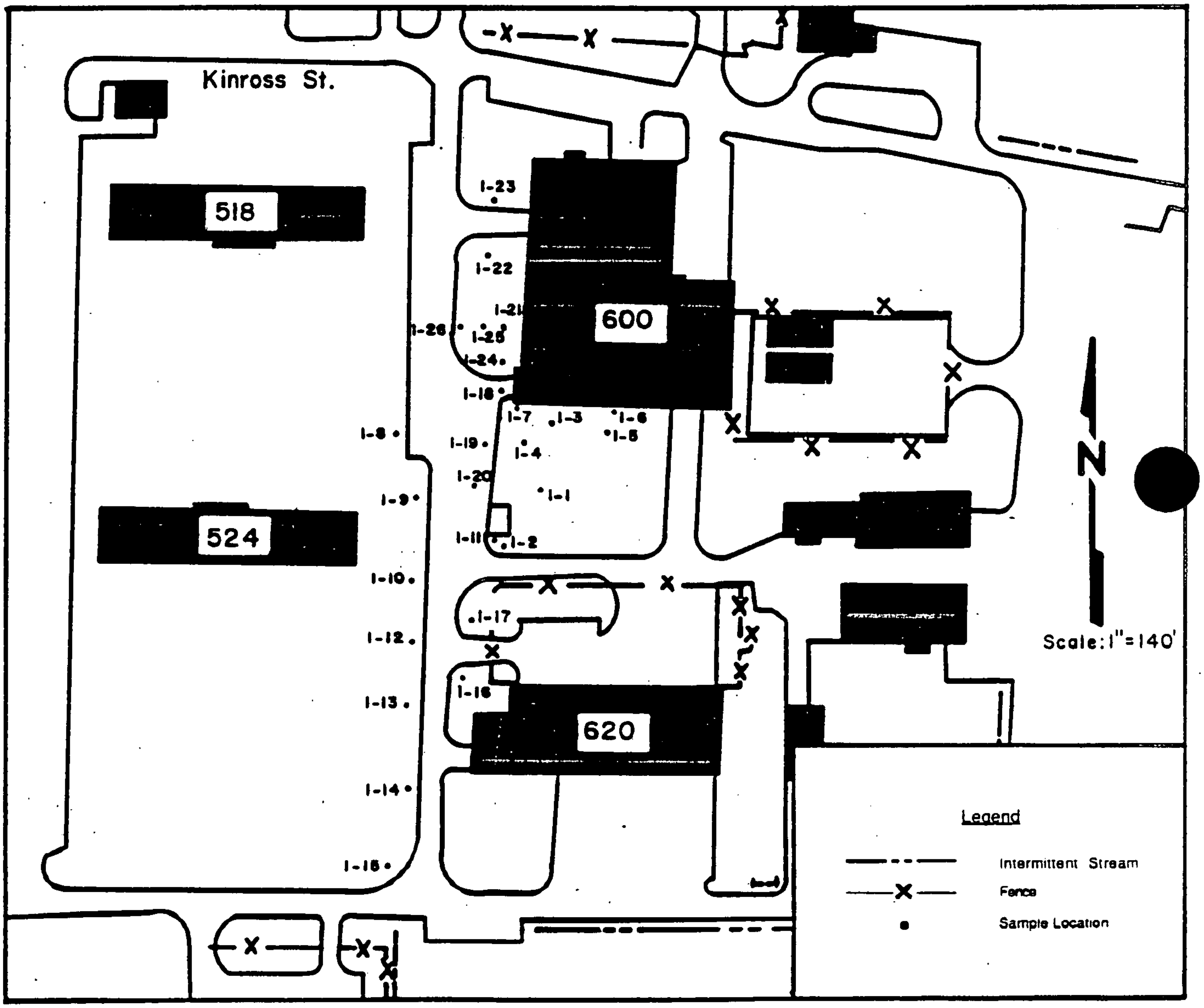


FIGURE 4-8.
SITE NOS. 1,2,4, AND 6: SOIL GAS SAMPLE LOCATIONS

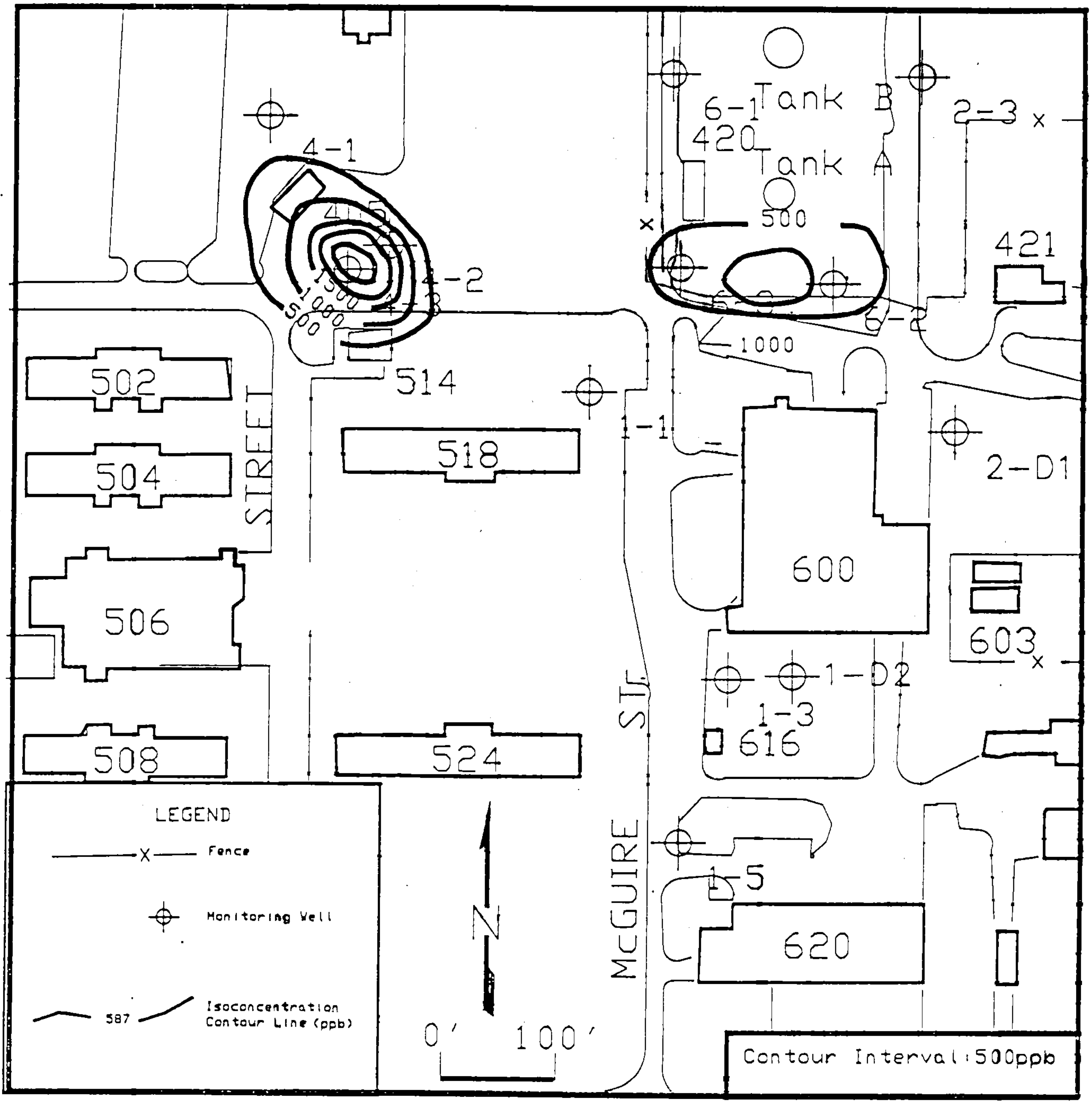


Figure 4-9
Site Nos. 4 and 6: Total Hydrocarbon Isoconcentration Contour Map (Groundwater Headspace Analyses)

Table 4-3
Site Nos. 1,2,4 and 6: Summary of Headspace Analytical Results for Groundwater

Sample	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
MW4-1	06/05/89	0.02	0.02	0.007	<0.3	<0.8	<0.7	14	400
MW4-2	06/05/89	0.02	0.02	0.007	<0.3	<0.8	<0.7	4	50
MW4-3	06/05/89	0.05	<0.004	<0.0006	400	<0.8	<0.7	<10	2,700
MW6-1	06/05/89	0.03	0.04	0.006	<0.4	<0.4	<0.3	<0.5	90
MW6-2	06/05/89	0.01	<0.002	0.007	5	<0.4	<0.3	<0.5	850
MW6-3	06/05/89	0.006	0.02	0.003	<0.4	<0.4	<0.3	<0.5	820
MW2-D1	06/06/89	<0.003	96	<0.0004	<0.4	<0.4	<0.4	<0.7	60
MW2-1	06/06/89	0.01	<0.0003	0.008	<0.4	<0.4	<0.4	<0.7	32
MW2-2	06/06/89	0.005	<0.003	0.007	<0.4	<0.4	<0.4	<0.7	8
MW2-3	06/06/89	0.02	<0.003	0.0009	<0.4	<0.4	<0.4	<0.7	6
MW1-D2	06/07/89	<0.0006	0.009	<0.05	<0.6	<0.6	<0.4	<0.7	60
MW1-1	06/07/89	0.01	0.06	<0.05	<0.6	<0.6	<0.4	<0.7	90
MW1-3	06/07/89	<0.006	<0.001	<0.05	<0.6	<0.6	<0.4	<0.7	7
MW1-5	06/07/89	<0.006	<0.001	<0.05	<0.6	<0.6	<0.4	<0.6	7

Figure 4-9 illustrates the inferred pattern of total hydrocarbons contamination in groundwater in the vicinity of Site Nos. 4 and 6. The highest total hydrocarbon concentrations (i.e., 2,700 ug/l, 850 ug/l and 820 ug/l) were found at the downgradient wells MW4-3, MW6-2 and MW6-3 of Sites No. 4 and 6 respectively.

Headspace analyses were conducted on six soil samples collected from shallow hand auger borings in the combined site study area. An isoconcentration map was constructed from the total hydrocarbon data (Figure 4-10). Total hydrocarbon levels as high as 38,000 ug/kg and 5,600 ug/kg were detected in soils from boring SB1-1 and SB6-1. A benzene concentration of 20,000 ug/kg was also detected in boring SB1-1. Concentrations of all other compounds occurred at or below the instrument's detection limit. The headspace analyses for soils in the combined site area are presented in Table 4-4.

4.1.1.1.4 Analytical Results for Site No. 1,2,4 and 6: Contract Laboratory

Matrix-specific results by site are presented for each individual sample in Tables 4-5 through 4-12; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-13. Engineering property characteristics of soils in the combined site study area are presented in Table 4-14.

Organic Analyses: A total of 18 soil boring samples were analyzed for volatile organics. (Only purgeable aromatic compound analysis was required at these sites; however, due to laboratory configuration all soil samples were analyzed for full scan volatile organics by GC/MS). Twenty-two groundwater samples from the four sites, and associated field QC blanks, were analyzed for purgeable aromatics. The seven groundwater samples from Sites 4 and 6 were also analyzed for ethylene dibromide. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- o Volatile organic analysis for soil sample B-1-1-2 resulted in one surrogate recovery value which exceeded the control limit; toluene-d8 recovery was 122% (upper control limit = 117%).

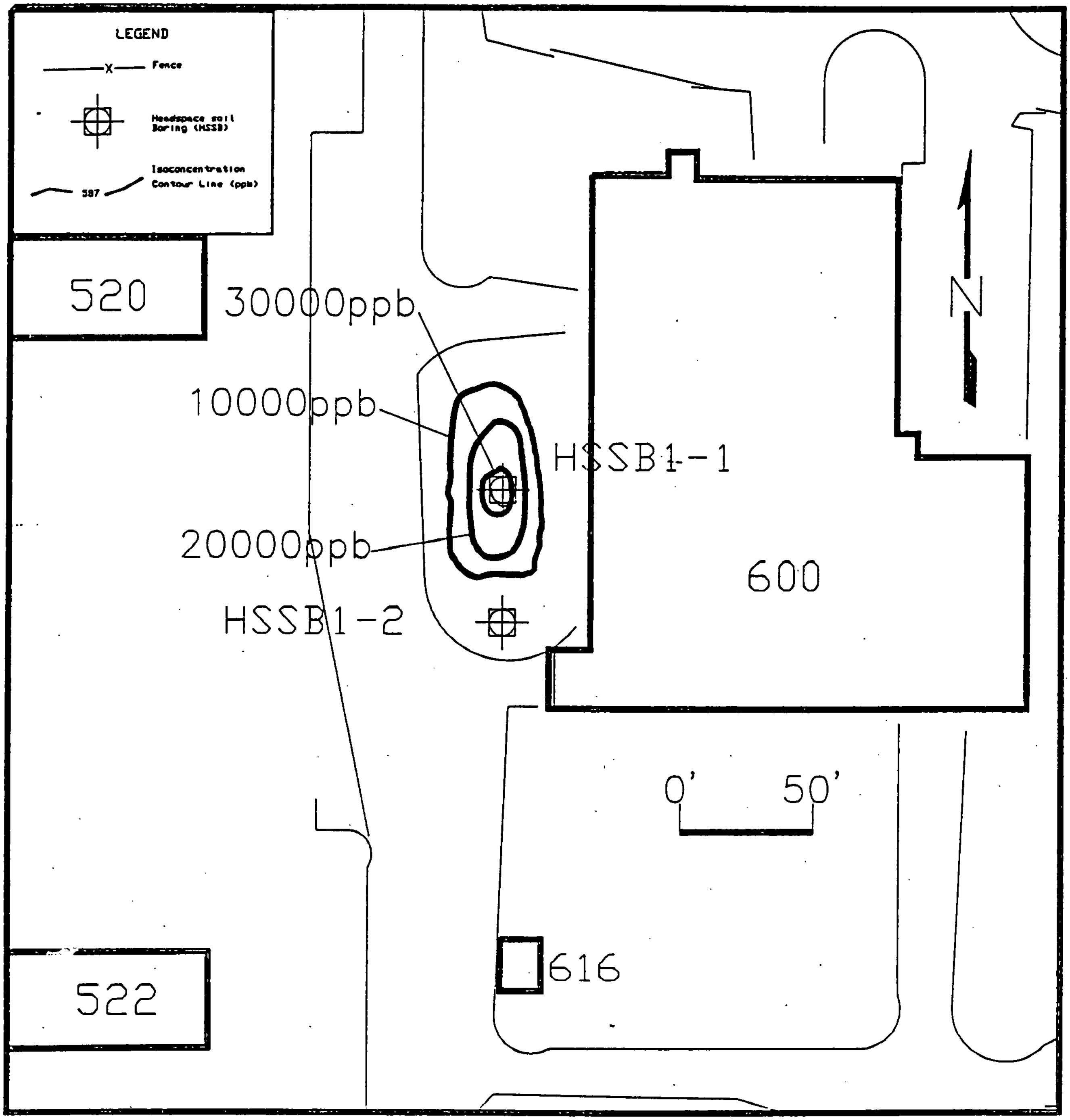


Figure 4–10
Site No. 1: Total Hydrocarbon Isoconcentration-
Contour Map
Soil Headspace Analyses

Table 4-4
Site Nos. 1,2,4 and 6: Summary of Headspace Analytical Results for Soils

Sample	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
SB6-1	06/05/89	<0.02	<2	<0.01	<0.4	<1	<0.8	<1	5,600
SB6-2	06/05/89	<0.02	<0.005	<0.009	<2	<0.5	<0.4	<0.6	230
SB4-1	06/05/89	<0.03	<2	<0.01	<0.4	<1	<0.9	<1	400
SB2-1	06/06/89	<0.1	<0.2	<0.02	<0.5	<0.5	<0.4	<1	14
SB2-2	06/06/89	<0.08	<0.1	<0.02	<0.4	<0.4	<0.4	<0.6	40
SB2-3	06/06/89	<0.08	<0.1	<0.01	2	<0.4	<0.3	<0.5	24
SB1-2	06/07/89	0.02	<0.002	<0.06	<4	<4	<3	<4	230
SB1-1	06/07/89	0.001	<0.003	0.05	20,000	<130	<90	<150	38,000

TABLE 4-5

SITE NO. 1: ANALYTICAL RESULTS: SOILS

Parameter (units)	Detection Limits	Sample Field ID (Sample Description) B-1-1-2 (3.1'-4.6')	 B-1-1-3 (4.6'-5.7')
EPA Method SW8240			
Volatile Orgainics (mg/Kg)			
Methylene Chloride	0.005	ND[a,b,c]	0.010[c]
Acetone	0.010	0.025[a,b,c]	0.150[b,c]
Others	See Appendix F	ND	ND
EPA Method SW3550/E418.1			
Total Petroleum Hydrocarbons (mg/kg)	5.0	18000	1100

Footnotes:

a = One surrogate (toluene-d8) had recoveries above the upper control limit.
b = Compound also detected in associated method blank.
c = Associated field duplicate analyses exceeded 35% RPD for this parameter.

TABL

SITE NO. 1: ANALYTICA ULTS: GROUNDWATER

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description)														
		GW86 (MW-1-2)	GW87 (MW-1-5)	GW88 (MW-1D-2) Duplicate	GW89 (MW-1-1)	GW90 (MW-1-7)	GW91 (MW-1D-1)	GW92 (MW-1D-2)	GW95 (MW-1-3D)	GW96 (MW-1-4D)	TB-25 Trip Blank	TB27 Trip Blank	GW85 Field Blank	GW94 Field Blank	GW93 Equip. Wash	GW97 Equip. Wash
EPA Method SW5030/8020																
Purgeable Aromatics (µg/l)		ND	ND	ND	ND		ND	ND^{a}	ND^{a}	ND^{a}	ND^{a}	ND^{a}	ND	ND^{a}	ND^{a}	ND^{a}
Benzene	0.3					0.92										
Tolune	0.3					1.0										
Others	See Appendix F					ND										
EPA Method 200.7*																
Total Metals (mg/L)											NA	NA	NA	NA		
Aluminum	0.10	20.8^{c,f}	3.86^{c,f}	0.437^{c,f}	21.7^{c,f}	2.97^{c,f}	0.152^{c,f}	0.170^{c,f}	0.245^{f}	0.216^{f}					ND^{c,f}	ND^{f}
Arsenic	0.05	ND^{f}	ND^{f}	ND^{f}	ND^{f}	0.72^{f}	ND^{f}	0.051^{f}	ND^{f}	ND^{f}					ND^{f}	ND^{f}
Arsenic (E206.2)	0.005	ND	ND	ND	0.0053	ND	ND	ND	ND	ND					ND	ND
Barium	0.010	0.219^{d}	0.062^{d}	0.098^{d}	0.263^{d}	0.042^{d}	0.045^{d}	0.090^{d}	0.048	0.047					ND^{d}	ND
Boron	0.010	0.192^{b}	0.161^{b}	0.109^{b}	0.148^{b}	0.083^{b}	0.094^{b}	0.112^{b}	0.061^{b,e}	0.058^{b,e}					0.087^{b}	ND^{b,e}
Calcium^{c}	0.20	128	130	106	500	253	213	101	395	134					ND	ND
Chromium	0.010	0.022	ND	ND	0.022	ND	ND	ND	ND	ND					ND	ND
Cobalt	0.010	0.013	ND	ND	ND	ND	ND	ND	ND	ND					ND	ND
Copper	0.010	0.113	0.049	ND	0.055	ND	ND	ND	ND	ND					ND	ND
Iron	0.025	28.1^{c}	5.78^{c}	3.40^{c}	30.5^{c}	6.18^{c}	0.960^{c}	2.93^{c}	2.18	1.27					0.049^{c}	ND
Lead	0.05	ND^{e,f}	ND^{e,f}	0.069^{e,f}	0.321^{e,f}	ND^{e,f}	ND^{e,f}	ND^{e,f}	ND^{f}	ND^{f}					ND^{e,f}	ND^{f}
Lead (E239.2)	0.005	0.057^{f}	0.023^{f}	0.096^{f}	NA+	0.0086^{f}	ND^{f}	0.029^{f}	ND^{f}	ND^{f}					ND^{f}	ND^{f}
Magnesium^{c}	0.20	69.0	74.2	47.8	335	281	94.7	48.1	308	44.0					ND	ND
Manganese	0.005	1.23^{d}	0.907^{d}	0.128^{d}	1.64^{d}	1.81^{d}	0.071^{d}	0.0132^{d}	0.599	0.569					ND^{d}	ND
Molybdenum	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND					0.012	ND
Nickel	0.015	0.046^{e}	ND^{e}	ND^{e}	0.033^{e}	ND^{e}	ND^{e}	ND^{e}	ND	ND					ND^{e}	ND
Potassium^{c}	0.40	3.56^{e}	1.03^{e}	1.12^{e}	6.61^{e}	3.34^{e}	2.09^{e}	0.910^{e}	1.54	1.94					ND^{e}	ND
Silicon^{c}	0.020	30.0^{b}	11.0^{b}	6.18^{b}	31.6^{b}	10.9^{b}	7.47^{b}	5.64^{b}	8.09^{b,e}	4.74^{b,e}					0.093^{b}	[illegible]^{b,e}
Silver	0.010	ND	ND	ND	ND	ND	ND	ND	0.521	ND					ND	ND
Sodium^{c}	0.20	27.8	60.2	29.2	68.8	90.5	33.9	29.2	60.2	25.1					ND	ND
Vanadium	0.01	0.038	ND	ND	0.036	ND	ND	ND	ND	ND					ND	ND
Zinc	0.01	0.463^{f}	0.309^{f}	0.206^{f}	1.04^{f}	0.089^{f}	0.026^{f}	0.089^{f}	0.027^{f}	0.420^{f}					ND^{f}	ND^{f}
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND	ND					ND	ND
EPA Method E418.1 (mg/L)																
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND	1.6	ND	ND	ND	ND	ND				ND	ND
Miscellaneous Inorganics (mg/L)											NA	NA	NA	NA		
Total Dissolved Solids (E160.1)	1.0	520	820	520	2000	2400	1300	480	3200	690					ND	1.0
Anions (A429):																
Fluoride	0.1	1.2	0.8	0.71	0.61	1.4	0.74	0.69	0.88	0.42					ND	ND
Chloride	0.5	34	84	42	87	31	41	44	74	65					ND	ND
Nitrate-Nitrogen	0.5	ND	ND	ND	ND	0.64	ND	ND	ND	ND					ND	ND
Sulfate	0.5	120	220	120	1600	1900	640	120	2000	170					ND	ND
Total Hardness (E130.1)	1.0	700	720	480	2800	2000	1100	530	2400	580					ND	ND

TABLE 4-6 (Cont'd)
SITE NO. 1: ANALYTICAL RESULTS: GROUNDWATER

Footnotes:

a = Associated MS/MSD analyses resulted in recoveries (for one or both of the spikes) below the applicable control limit.
b = Compound also detected in associated method blank.
c = Accuracy data unavailable; compound not routinely included in spiking solution.
d = Associated matrix spike analysis inidcated low recovery (below lower control limit).
e = Associated lab matrix replicate analysis resulted in RPD values above control limits.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.

NA+ = Not analyzed by GFAA (E239.2) due to elevated concentration which could be adequately determined by ICP (E200.7).

TABLE 4-7

SITE NO. 2: ANALYTICAL RESULTS: SOILS

Parameter (units)	Detection Limits	B-2-1-1 (0-1.5')	B-2-1-3 (3.0'-4.5')	B-2-1-4 (4.5'-6.0')	B-2-2-1 (0-1.5')	B-2-2-4 (4.5-6.0')	B-2-2-7 (9.0'-10.5')
		Sample Field ID (Sample Description)					
EPA Method SW8240 Volatile Organics (mg/kg)							
Methylene Chloride	0.005	<0.0081[*,a,b]	0.025[a,b]	0.026[a,b]	0.022[a,b]	0.0081[a,b]	0.014[a,b]
Acetone	0.010	0.047[a,b]	0.017[a,b]	0.018[a,b]	0.013[a,b]	0.017[a,b]	0.018[a,b]
Others	See Appendix F	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 Total Petroleum Hydrocarbons (mg/kg)	5.0	290[c]	9.4[c]	8.8[c]	6.6[c]	ND[c]	9.4[c]

Footnotes:

* = Compound present below measurable detection limit
a = Compound also detected in associated method blank
b = Associated field duplicate analyses exceeded 35% RPD of this parameter associated
c = Associated laboratory precision measurement exceeded RPD control limit.

TABLE 4-8

SITE NO. 2: ANALYTICAL RESULTS: GROUNDWATER

Parameter (units)	Detection Limits	GW75 (MW-2-1)	GW76 (MW-2-3)	GW77 (MW-2-2)	GW78 (MW-2-4)	GW71 (MW-2D-1) Dup.	GW72 (MW-2D-1)	TB24 Trip Blank	TB23 Trip Blank	GW73 Field Blank	GW74 Field Blank	GW79 Equip. Wash	GW70 Equip. Wash
		Sample Field ID (Sample Description)											
EPA Method SW5030/8020													
Purgeable Aromatics (µg/L)													
Benzene	0.3	ND[b]	ND[b]	ND[b]	0.33[a,b]	ND	ND	ND[b]	ND	ND	ND[b]	ND[b]	ND
Toluene	0.3	ND[b]	ND[b]	ND[b]	0.52a,b	ND	ND	ND[b]	ND	ND	ND[b]	ND[b]	ND
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E200.7													
Total Methods (mg/L)													
								NA	NA	NA	NA		
Aluminum	0.1	0.188	2.02	0.444	1.07	ND	ND					ND	ND
Barium	0.01	ND	0.036	0.018	0.054	0.062	0.067					ND	ND
Boron	0.01	0.116[c]	0.054[c]	0.056[c]	0.108[c]	0.074[c]	0.090[c]					0.038[c]	0.013[c]
Calcium[d]	0.20	532	537	333	139	152	158					ND	0.074
Copper	0.010	0.011	ND	0.013	ND	ND	ND					ND	0.011
Iron	0.025	0.676[f]	3.82[f]	1.11[f]	4.43[f]	1.10[d,f]	4.13[d,f]					ND[f]	ND[d,f]
Lead	0.05	ND	ND	ND	ND	ND	ND					ND	ND
Lead (E239.2)	0.005	ND[f]	0.005[f]	ND[f]	ND[f]	ND[e,f]	0.004[e,f]					ND[f]	ND[e,f]
Magnesium[d]	0.20	408	466	319	84.4	55.7	57.6					ND	ND
Manganese	0.005	1.84	0.723	0.526	1.74	0.224	0.260					ND	ND
Nickel	0.015	0.016	0.026	ND	ND	ND	ND					ND	ND
Potassium[d]	0.4	1.67[f]	2.58[f]	1.61[f]	1.07[f]	0.620[e,f]	0.926[e,f]					ND[f]	ND[e,f]
Silicon[d]	0.020	10.3[c]	11.3[c]	8.86[c]	8.09[c]	5.67[c]	6.02[c]					0.084[c]	0.079[c]
Sodium[d]	0.200	67.6	74.2	66.3	84.3	61.6	64.4					ND	ND
Zinc	0.01	0.184	0.456	0.042	0.036	0.172	0.186					ND	ND
Others	ND	ND	ND	ND	ND	ND	ND					ND	ND
EPA Method SW3550/E418.2													
Total Petroleum Hydrcarbons	1.0	1.2	ND	ND	1.3	ND	ND	NA	NA	NA	NA	ND	ND
Miscellaneous Inorganics (mg/L)								NA	NA	NA	NA		
Total Dissolved Solids (E160.1)	1.0	4000	4100	2900	1000	960	800					5.0	ND
Anions (A429):													
Fluoride	0.1	1.4	1.4	0.66	1.2	0.9	0.8					ND	ND
Chloride	0.5	16	19	25	140	150	140					ND	ND
Sulfate	0.5	2600	2900	2100	300	170	160					ND	ND
Total Hardness (E130.1)	1.0	3400	3400	2600	720	620	630					ND	ND

Footnote:

a = Surrogate recovery below control limit for this analysis.
b = Associated MS/MSD analyses had low recovery for this compound for one of the spikes and RPD values exceeded the control limit.
c = Compound also detected in associated method blank.
d = Accuracy data unavailable; compound not included in matrix spiking solution.
e = Associated lab matrix replicate analysis resulted in RPD values which exceeded the control limit.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.

TABLE 4-9
SITE NO. 4: ANALYTICAL RESULTS: SOILS

Parameter (units)	Detection Limits	B-4-1-3 (4.5'-6.0')	B-4-1-3R (4.5'-6.0',Rep)	B-4-1-4 (6.0'-7.5')	B-4-1-5 (7.5'-9.0')
		Sample Field Identification (Sample Description)			
EPA Method SW8240 Volatile Organics(mg/kg)					
Methylene chloride	0.005	1.400[a,b,c]	2.600[a,b,c]	1.600[a,b,c]	0.011[b,c]
Acetone	0.010	4.400[a,b,c]	6.900[a,b,c]	3.400a,b,c	0.082[b,c]
2-Butanone	0.010	ND[a]	ND[a]	ND[a]	0.019
Benzene	0.005	ND[a]	ND[a]	ND[a]	0.013
Ethybenzene	0.005	<1.20[*,a]	<1.20[*,a]	3.100[a]	0.087
Total Xylenes	0.005	<1.20[*,a]	<1.20[*,a]	3.100[a]	0.087
Others	See Appendix F	ND	ND	ND	
EPA Method SW3550/E418.1 Total Petroleum Hydrocarbons (mg/kg)	5.0	21	20	120	6.2
EPA Method SW9060 Total Organic Carbon (mg/kg)	NR	NA	NA	>10,000	NA

Footnote:

* = Compound present below measurable detection limit.
a = Volatile organic compound analysis performed using methanol extraction; detection limit approximately 200 times higher than normal.
b = Compound also detected in associated method blank.
c = Field duplicate analyses exceeded 35% RPD.

NR= Not Reported

TABLE 4-10
SITE NO. 4: ANALYTICAL RESULTS: GROUNDWATER

Parameter Units	Detection Limits	Sample Field Identification (Sample Description)						
					TB23	GW65	GW70	
		GW66 (MW-4-1)	GW67 (MW-4-2)	GW68 (MW-4-3)	GW69 (MW-4-4)	(Trip Blank)	(Field Blank)	(Equip. Wash)
EPA Method SW5030/8020								
Purgeable Aromatics (µg/l)								
Benzene	0.3	ND	ND	23	ND	ND	ND	ND
Ethylbenzene	0.3	ND	ND	2.3	ND	ND	ND	ND
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method E504.1								
Ethylene Dibromide (µg/l)	0.3	ND	ND	ND	ND	ND	ND	ND
EPA Method 200.7*								
Total Metals (mg/L)						NA	NA	
Aluminum	0.1	6.79	1.37	4.35	1.70			ND
Barium	0.01	0.100	0.060	0.237	0.037			ND
Boron	0.01	0.146^{a}	0.093^{a}	0.113^{a}	0.333^{a}			0.13^{a}
Calcium^{b}	0.20	53.3	48.3	270	189			0.074
Cobalt	0.01	ND	ND	0.017	ND			ND
Copper	0.10	0.024	0.013	0.022	0.011			0.011
Iron	0.025	13.4^{d}	3.46^{d}	9.44^{d}	3.76^{d}			ND^{d}
Lead	0.05	0.076	ND	0.078	ND			ND
Lead (E239.2)	0.005	0.078$_{c,d}$	0.031$_{c,d}$	0.060$_{c,d}$	0.010$_{c,d}$			ND$_{c,d}$
Magnesium^{b}	0.20	45.6	31.7	181	125			ND
Manganese	0.005	1.16	1.21	1.92	1.36			ND
Nickel	0.015	0.031	0.015	0.51	ND			ND
Potassium^{b}	0.4	3.08^{c,d}	2.23^{c,d}	2.28^{c,d}	2.07^{c,d}			ND^{c,d}
Silicon^{b}	0.020	18.6^{a}	10.7^{a}	16.4^{a}	10.8^{a}			0.079^{a}
Sodium	0.200	73.5	76.4	74.3	76.9			ND
Vanadium	0.01	0.011	ND	ND	ND			ND
Zinc	0.01	0.701	0.189	0.388	0.131			ND
Others	See Appendix F	ND	ND	ND	ND			ND
EPA Method E418.1 (mg/L)								
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND	NA	NA	ND
Miscellaneous Inorganics (mg/L)						NA	NA	
Total Dissolved Solids (E160.1)	1.0	4300	3400	1100	1700			ND
Anions (A429):								
Fluoride	0.1	1.4	0.5	1.1	1.9			ND
Chloride	0.5	220	130	140	49			ND
Sulfate	0.5	2300	1860	480	560			ND
Total Hardness (E130.1)	1.0	3100	2320	1360	1140			ND

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not routinely included in seeking solution.
c = Associated matrix replicate analysis resulted in RPD values above control limits.
d = Associated field duplicate analyses exceeded 35% RPD.
* = Or as indicated for those metals analyzed by alternate methods.

TABLE 4-11
SITE NO. 6: ANALYTICAL RESULTS: SOILS

Parameter (units)	Detection Limits	B-6-1-1 (0-1.5')	B-6-1-3 (3.0'-4.5')	B-6-1-6 (7.5'-9.0')	B-6-2-1 (0-1.5')	B-6-2-4 (4.5'-6.0')	B-6-2-7 (9.0'-10.5')
		Sample Field ID (Sample Description)					
EPA Method SW8240 **Volatile Organics(mg/kg)**							
Methylene chloride	0.005	<0.0055[*,a,b]	0.0095[a,b]	0.0093[a,b]	ND[b]	ND[b]	ND[b]
Acetone	0.010	0.015[a,b]	<0.012[*,a,b]	0.015[a,b]	0.014[b]	0.016[b]	0.059[b]
Others	See Appendix F	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg) Total Petroleum Hydrocarbons	5.0	79	8.8	6.5	ND[c]	ND[c]	ND[c]

Footnote:

a = Compound also detected in associated method blank.
b = Associated field blank analyses exceeded 35% RPD.
c = Associated matrix spike had recoveries above control limit.

TABLE 4-12
SITE NO. 6: ANALYTICAL RESULTS: GROUNDWATER

		Sample Field Identification (Sample Description)					
Parameter (units)	**Detection Limits**	**GW81 (MW-6-1)**	**GW82 (MW-6-2)**	**GW83 (MW-6-3)**	**TB24 Trip Blank**	**GW80 Field Blank**	**GW84 Equip. Wash**
EPA Method SW5030/8020							
<u>Purgeable Aromatics (μg/L)</u>	ND	ND	ND	ND	ND	ND	ND
EPA Method E504.1							
<u>Ethylene Dibromide (μg/L)</u>	ND	ND	ND	ND	ND	ND	ND
EPA Method 200.7*							
<u>Total Metals (mg/L)</u>					NA	NA	
Aluminum	0.1	0.667	2.27	0.792			ND
Barium	0.01	0.016	0.037	0.022			ND
Boron	0.01	0.079[a]	0.049[a]	0.052[a]			0.020[a]
Calcium[b]	0.20	436	334	313			ND
Copper	0.010	0.028	0.029	0.011			ND
Iron	0.025	2.63[c]	3.94[c]	1.33[c]			0.025[c]
Lead	0.050	ND	ND	ND			ND
Lead (E239.2)	0.005	0.007[c]	0.008[c]	0.008[c]			ND[c]
Magnesium[b]	0.20	665	251	280			ND
Manganese	0.005	0.642	0.257	0.322			ND
Nickel	0.015	0.017	ND	ND			ND
Potassium[b]	0.4	1.97[c]	2.35[c]	2.69[c]			ND[c]
Silicon[b]	0.020	8.62[a]	12.1[a]	10.2[a]			0.102[a]
Sodium	0.200	126	71.3	64.2			ND
Zinc	0.01	0.292	0.204	0.724			ND
Others	See Appendix F	ND	ND	ND			ND
EPA Method E418.1 (mg/L)							
<u>Total Petroleum Hydrocarbons</u>	1.0	ND	ND	ND	NA	NA	ND
<u>Miscellaneous Inorganics (mg/L)</u>					NA	NA	
Total Dissolved Solids (E160.1)	1.0	5400	2200	2300			33
Anions (A429):							
Fluoride	0.1	1.5	1.5	1.1			ND
Chloride	0.5	43	210	150			ND
Sulfate	0.5	3900	1000	1200			ND
Total Hardness (E130.1)	1.0	6000	1700	2000			ND

<u>Footnotes</u>:

a = Compound also detected in associated method blank.
b = Accuracy data not available; compound routinely not included in spiking solution.
c = Associated field duplicate analyses exceeded 35% RPD.
* = On as indicated for metals analyzed by alternate methods.

TABLE 4-13
Field Water Quality Data
Niagara Falls IAP
Site Nos. 1, 2, 4 and 6
9/26 to 9/29/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 1-1	12°	6.52	1970	320	0	0	320	Background	cloudy
MW 1-1D1	9°	7.01	1150	335	0	0	335	Background	clear
MW 1-3	11°	6.92	590	470	0	0	470	Background	cloudy
MW 1-3D	11°	6.73	2180	370	0	0	370	Background	clear
MW 1-4D	12°	6.98	720	400	0	0	400	Background	clear
MW 1-5	11°	7.02	880	400	0	0	400	Background	cloudy
MW 1-7	10°	7.27	2010	250	0	0	250	Background	cloudy
MW 1D-2	11°	7.26	617	300	0	0	300	Background	clear
MW 2-1	11°	7.79	2610	535	0	0	535	Background	clear
MW 2-2	12°	8.13	2040	475	0	0	475	Background	clear
MW 2-3	12°	8.05	2700	395	0	0	395	Background	clear
MW 2-4	10°	7.32	1060	440	0	0	440	Background	clear
MW 2D-1	12°	7.99	880	340	0	0	340	Background	clear
MW 4-1	11°	7.20	2530	460	0	0	460	Background	cloudy
MW 4-2	13°	7.60	2290	395	0	0	395	Background	clear
MW 4-3	13°	7.59	1410	555	0	0	555	Background	cloudy
MW 4-4	12°	7.87	1080	310	0	0	310	Background	clear
MW 6-1	11°	7.89	3320	500	0	0	500	Background	clear
MW 6-2	12°	7.90	1910	490	0	0	490	Background	clear
MW 6-3	12°	8.30	1850	475	0	0	475	Background	clear

TABLE 4-14

SITE NOS. 1,2,4 AND 6: ENGINEERING PROPERTY CHARACTERISTICS FOR SOILS

Parameter	ASTM Method	Sample Number B-4-1-4C
Soil Moisture	D2216	10.0%
Density	D4287	2.68
Plasticity Index	D4318	4
Grain Size	D422	--- See Appendix D ---

- Three out of four soil samples from Site 4 (B-4-1-3/3R/4) were analyzed for volatile organics using a methanol extraction dilution technique. These samples (identified in Table 4-9) have elevated detection limits, approximately 200 times higher than routine MDLs.

- Methylene chloride and acetone were detected in most soil samples from all four sites. These were not target compounds. However, it should be noted that laboratory contamination may have elevated the reported concentrations of these compounds. (This is also the case for those samples which were methanol extracted; after taking into consideration the dilution factor, sample concentrations are similar to the method blank concentrations.) In cases where the concentration reported in the soil exceeded the method blank concentration by an order of magnitude, the compounds were treated as site contaminants.

- The field duplicate pair associated with the soil samples was collected at Site 4 (B-4-1-3/3R). This was one of the samples analyzed for volatile organics using the methanol extraction technique. Target compounds were not reported for the pair at concentrations above the detection limit. (Methylene chloride and acetone were reported in both samples and had elevated RPDs = 60% and 44%, respectively, although these were not target compounds)

- One groundwater sample from Site 2, GW-78, had an outlier surrogate recovery for the analysis of purgeable aromatics. (α, α, α - trifluorotoluene recovery = 68%, lower control limit = 69%)

- The matrix spike/matrix spike duplicate (MS/MSD) pairs associated with the purgeable aromatics analysis of groundwater samples from Site 1 had several recoveries which were outside of control limits. The MS/MSD for GW-92, GW-93 and TB-25 had low recoveries for both spikes for toluene and ethylbenzene. The laboratory attributed the low recoveries to either matrix effect or the spiking solution; matrix effect is unlikely since the spikes were performed on GW-93, which was the equipment wash blank. Recoveries for toluene were MS = 49%/MSD = 49%, and ethylbenzene = 50%/49% (lower control limit for toluene and ethylbenzene = 80%). The MS/MSD for GW-94, GW-95, GW-96, GW-97 and TB-27 also had low MSD recovery for toluene (= 75%), and elevated RPDs for benzene = 81% and toluene = 29% (RPD control limit = 20%).

- The MS/MSD analyses for several Site 2 groundwater samples (GW-74, GW-75, GW-76, GW-77, GW-78, GW-79, TB24) and the Site 6 well samples had low MSD recoveries for benzene and toluene of 24% and 60%, respectively, (lower control limits for benzene = 41%, toluene = 80%). The RPD between the MS and MSD exceeded the 20% control limit for benzene (RPD = 117%) and toluene (= 45%).

Inorganic Analyses: Eighteen soil boring samples from all four sites were analyzed for total petroleum hydrocarbons (TPH). Twenty-two groundwater samples and associated field QC blanks were analyzed for metals, TPH, total dissolved solids (TDS), common anions and hardness. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The laboratory matrix duplicate TPH analysis associated with the soil samples from Site 2 exceeded the control limit for RPD; the duplicate samples (from a non-OEHL laboratory project) had an RPD=75% (control limit = 28%).

- Two groundwater samples from Site 2 (GW-71, GW-72) and all the groundwater samples from Site 4 (GW-66, GW-67, GW-68, GW-69, GW-70) exceeded the mercury holding time by one day; the samples were analyzed 29 days after sample collection.

- The metals laboratory method blank associated with groundwater samples from Sites 2, 4 and 6 had a boron concentration of 0.171 mg/L and silicon = 0.088 mg/L. Sample concentrations for boron for these sites ranged from 0.013 - 0.146 mg/L except for GW-69 (Site 4) which had a boron concentration of 0.333 mg/L. All reported boron concentrations, except possibly GW-69, are therefore considered to be biased high. Silicon concentrations for the sites ranged from 5.67 - 18.6 mg/L for the groundwater samples, and 0.079 - 0.102 mg/L for the equipment washes. Therefore, the sample concentrations were not significantly affected by background laboratory contamination.

- Two laboratory method blanks were associated with the metals analysis of groundwater samples from Site 1. The method blank for samples GW86-GW93 had boron = 0.035 mg/L and silicon = 0.103 mg/L. The equipment wash for this sample set (GW-93) had boron = 0.087 mg/L and silicon = 0.093 mg/L. Groundwater sample concentrations ranged from 0.083 - 0.192 mg/L for boron and 5.64 - 31.6 mg/L silicon. The method blank for samples GW-95, GW-96 and GW-97 had boron = 0.497 mg/L and silicon = 0.032 mg/L. The equipment wash for this sample set (GW-97) had boron non-detected and silicon = 0.113 mg/L. Groundwater sample concentrations for boron = 0.058-0.061 mg/L and silicon = 4.74-8.09 mg/L. Therefore all boron concentrations for samples from Site 1 are suspected of being biased high and silicon concentrations were not affected by background levels.

- The following spike analyses were outside of the control limits by more than 5% for detected metals for the indicated samples. Manganese recovery was 58% for the spike associated with GW86-93. No assessment of accuracy could be made for calcium, magnesium, potassium, silicon and sodium. In addition, aluminum and iron recovery could not be calculated for the spike associated with Site 1 (GW86-93) due to elevated levels native to the sample.

- Precision measurements exceeded the control limits (RPD=20%) by more than 5% for the following duplicate sample analysis. Nickel (RPD=44%) for GW86-93; boron (detected in one of the samples, and not the other) and silicon (=51%) for GW95-97; lead by graphite furnace (=28%) and potassium (=55%) for GW70 - GW72 and GW66-70.

- The field duplicate pair for Site 1 was GW88/92; analyses exceeded 35% RPD for aluminum (RPD = 88%), arsenic by ICP (detected in one sample, and not the other), lead by ICP (detected only in one sample), lead by graphite furnace (=107%) and zinc (=79.3%).
- The field duplicate pair for Sites 2, 4 and 6 was GW71/72; analyses exceeded 35% RPD for iron (RPD=116%), lead by graphite furnace (detected in one sample and not the other) and potassium (=40%).

4.1.1.2 Significance of Findings

4.1.1.2.1 Significance of Findings: Sites No. 1,2,4 and 6 - JP-4 Pipeline Leak, POL JP-4 Tank C and A, and BX MOGAS Tank Leak

Groundwater and soils were investigated at Sites No. 1,2,4 and 6 to characterize the environmental impact of various fuel leaks that occurred throughout the study area. Tables 4-15 through 4-22 present analyses versus ARARs and/or background levels for all contaminants found in soil and groundwater during the RI.

During the drilling of one soil boring at Site No. 1, soil samples were collected for analysis. Since no ARARs have been established for soils, the analytical soil data was compared to the installations's background concentrations. The background levels established for the installation's soils were based upon the analytical results from two upgradient background borings. It should be noted in the following discussion that the full range of possible background concentrations common to the Niagara Falls soils has not been determined:

- Soil samples from the single Site 1 boring (B-1-1) yielded high levels of total petroleum hydrocarbons (TPH). TPH levels of 18,000 mg/kg and 1,100 mg/kg were measured in soil from the 3.1 to 4.6-foot interval and the 4.6 to 5.7-foot interval, respectively. These concentrations are not surprising, since soil gas results, despite the area-wide limitations imposed on this technology, yielded significant levels of fuel component contamination in this area. Headspace analyses on soils from this area also confirmed the presence of fuel contamination. With this information, the boring was precisely positioned in what was believed to be the source of the JP-4 hydrant system leak. Despite the careful positioning of the soil boring B-1-1, the TPH levels may be biased by the presence of asphalt aggregates in the road base and soil, which were incorporated in the soil samples. If the TPH results were representative of contamination resulting from the JP-4 hydrant system leak, correspondingly high levels of certain volatile organics found in

TABLE 4-15

SITE NO.1: ANALYTICAL RESULTS VS BACKGROUND CONCENTRATIONS: SOIL

Parameter (units)	Detection Limits	Background[d] (mg/kg)	Selected Average for Soils[f] (mg/kg)	Sample Field ID (Sample Description) B-1-1-2 (3.1'-4.6')	B-1-1-3 (4.6'-5.7')
EPA Method SW8240 **<u>Volatile Orgainics (mg/Kg)</u>**					
Methylene Chloride	0.005	0.0056-0.0091	--	ND[a,b,c]	0.010[c]
Acetone	0.010	ND-0.056	--	0.025[a,b,c]	0.150[b,c]
Others	See Appendix F			ND	ND
EPA Method SW3550/E418.1 **<u>Total Petroleum Hydrocarbons (mg/kg)</u>**	5.0	ND	--	18000	1100

<u>Footnotes</u>:

a = One surrogate (toluene-d8) had recoveries above the upper control limit.
b = Compound also detected in associated method blank.
c = Associated field duplicate analyses exceeded 35% RPD for this parameter.
d = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
NA Not Analyzed
ND Not Detected

TABLE 4-16

SITE NO. 1: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

			Sample Field Identification (Sample Description)							
Parameter (Units)	Detection Limits	ARAR[g]	GW86 (MW-1-2)	GW87 (MW-1-5)	GW89 (MW-1-1)	GW90 (MW-1-7)	GW91 (MW-1D-1)	GW92 (MW-1D-2)	GW95 (MW-1-3D)	GW96 (MW-1-4D)
EPA Method SW5030/8020										
Purgeable Aromatics (µg/l)			ND	ND	ND		ND	ND[a]	ND[a]	ND[a]
Benzene	0.3	ND[h]				0.92				
Toluene	0.3	5[i]				1.0				
Other	See Appendix F	-				ND				
EPA Method 200.7*										
Total Metals (mg/L)										
Aluminum	0.10	No ARAR	20.8[c,f]	3.86[c,f]	21.7[c,f]	2.97[c,f]	0.152[c,f]	0.170[c,f]	0.245[f]	0.216[f]
Arsenic	0.05	0.025[i]	ND[f]	ND[f]	ND[f]	0.72[f]	ND[f]	0.051[f]	ND[f]	ND[f]
Arsenic (E206.2)	0.005	0.025[i]	ND	ND	0.0053	ND	ND	ND	ND	ND
Barium	0.010	1.0[i]	0.219[d]	0.062[d]	0.263[d]	0.042[d]	0.045[d]	0.090[d]	0.048	0.047
Boron	0.010	1.0[i]	0.192[b]	0.161[b]	0.148[b]	0.083[b]	0.094[b]	0.112[b]	0.061[b,e]	0.058[b,e]
Calcium[c]	0.20	No ARAR	128	130	500	253	213	101	395	134
Chromium	0.010	0.050[i]	0.022	ND	0.022	ND	ND	ND	ND	ND
Cobalt	0.010	No ARAR	0.013	ND	ND	ND	ND	ND	ND	ND
Copper	0.010	0.200[i]	0.113	0.049	0.055	ND	ND	ND	ND	ND
Iron	0.025	0.300[i]	28.1[c]	5.78[c]	30.5[c]	6.18[c]	0.960[c]	2.93[c]	2.18	1.27
Lead	0.05	0.025[i]	ND[e,f]	ND[e,f]	0.321[e,f]	ND[e,f]	ND[e,f]	ND[e,f]	ND[f]	ND[f]
Lead (E239.2)	0.005	0.025[i]	0.057[f]	0.023[f]	NA+	0.0086[f]	ND[f]	0.029[f]	ND[f]	ND[f]
Magnesium[c]	0.20	No ARAR	69.0	74.2	335	281	94.7	48.1	308	44.0
Manganese	0.005	0.300[i]	1.23[d]	0.907[d]	1.64[d]	1.81[d]	0.071[d]	0.0132[d]	0.599	0.569
Molybdenum	0.010	No ARAR	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	0.015	0.0154[j]	0.046[e]	ND[e]	0.033[e]	ND[e]	ND[e]	ND[e]	ND	ND
Potassium[c]	0.40	No ARAR	3.56[e]	1.03[e]	6.61[e]	3.34[e]	2.09[e]	0.910[e]	1.54	1.94
Silicon[c]	0.020	No ARAR	30.0[b]	11.0[b]	31.6[b]	10.9[b]	7.47[b]	5.64[b]	8.09[b,e]	4.74[b,e]
Silver	0.010	0.050[i]	ND	ND	ND	ND	ND	ND	0.521	ND
Sodium[c]	0.20	20[i]	27.8	60.2	68.8	90.5	33.9	29.2	60.2	25.1
Vanadium	0.01	No ARAR	0.038	ND	0.036	ND	ND	ND	ND	ND
Zinc	0.01	0.300[i]	0.463[f]	0.309[f]	1.04[f]	0.089[f]	0.026[f]	0.089[f]	0.027[f]	0.420[f]
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E418.1 (mg/L)										
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	1.6	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)										
Total Dissolved Solids (E160.1)	1.0	500[m]	520	820	2000	2400	1300	480	3200	690
Anions (A429):										
Fluoride	0.1	1.5[i]	1.2	0.8	0.61	1.4	0.74	0.69	0.88	0.42
Chloride	0.5	250[i]	34	84	87	31	41	44	74	65
Nitrate-Nitrogen	0.5	10[i]	ND	ND	ND	0.64	ND	ND	ND	ND
Sulfate	0.5	250[i]	120	220	1600	1900	640	120	2000	170
Total Hardness (E130.1)	1.0	No ARAR	700	720	2800	2000	1100	530	2400	580

TABLE 4-16 (Cont'd)
SITE NO. 1: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Footnotes:

a = Associated MS/MSD analyses resulted in recoveries (for one or both of the spikes) below the applicable control limit.
b = Compound also detected in associated method blank.
c = Accuracy data unavailable; compound not routinely included in spiking solution.
d = Associated matrix spike analysis inidcated low recovery (below lower control limit).
e = Associated lab matrix replicate analysis resulted in RPD values above control limits.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.
g = Applicable or relevant or appropriate requirements
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F
NA+ = Not analyzed by GFAA (E239.2) due to elevated concentration which could be adequately determined by ICP (E200.7).

TABLE 4-17

SITE NO. 2: ANALYTICAL RESULTS VS BACKGROUND CONCENTRATIONS: SOIL

Parameter (units)	Detection Limits	Background[d] (mg/kg)	Selected Average for Soils[f] (mg/kg)	Sample Field ID (Sample Description)		
				B-2-1-1 (0-1.5')	B-2-1-3 (3.0'-4.5')	B-2-1-4 (4.5'-6.0')
EPA Method SW8240 Volatile Organics (mg/kg)						
Methylene Chloride	0.005	0.0056 - 0.0091	--	<0.0081[*,a,b]	0.025[a,b]	0.026a,b
Acetone	0.010	ND - 0.056	--	0.047[a,b]	0.017[a,b]	0.018a,b
Others	See Appendix F			ND	ND	ND
EPA Method SW3550/E418.1 Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	--	290[c]	9.4[c]	8.8[c]

Footnotes:

* = Compound present below measurable detection limit
a = Compound also detected in associated method blank
b = Associated field duplicate analyses exceeded 35% RPD of this parameter associated
c = Associated laboratory precision measurement exceeded RPD control limit.
d = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected

TABLE 4-17 (Cont'd)

SITE NO. 2: ANALYTICAL RESULTS VS BACKGROUND CONCENTRATIONS: SOIL

Parameter (units)	Detection Limits	Background[d] (mg/kg)	Selected Average for Soils[f] (mg/kg)	Sample Field ID (Sample Description)		
				B-2-2-1 (0-1.5')	B-2-2-4 (4.5'-6.0')	B-2-2-7 (9.0'-10.5')
EPA Method SW8240						
Volatile Organics (mg/kg)						
Methylene Chloride	0.005	0.0056 - 0.0091	--	0.022a,b	0.0081[a,b]	0.014a,b
Acetone	0.010	ND - 0.056	--	0.013[a,b]	0.017[a,b]	0.018a,b
Others	See Appendix F			ND	ND	ND
EPA Method SW3550/E418.1						
Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	--	6.6[c]	ND[c]	9.4[c]

Footnotes:

* = Compound present below measurable detection limit
a = Compound also detected in associated method blank
b = Associated field duplicate analyses exceeded 35% RPD of this parameter associated
c = Associated laboratory precision measurement exceeded RPD control limit.
d = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected

TABL
SITE NO.2:ANALYTICAL RESU . ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR^{g}	Sample Field Identification (Sample Description)				
			GW75 (MW-2-1)	GW76 (MW-2-3)	GW77 (MW-2-2)	GW78 (MW-2-4)	GW72 (MW-2D-1)
EPA Method SW5030/8020							
Purgeable Aromatics (μg/L)							
Benzene	0.3	ND^{h}	ND^{b}	ND^{b}	ND^{b}	0.33^{a,b}	ND
Toluene	0.3	5^{i}	ND^{b}	ND^{b}	ND^{b}	0.52^{a,b}	ND
Others	See Appendix F	-	ND	ND	ND	ND	ND
EPA Method 200.7*							
Total Metals (mg/L)							
Aluminum	0.1	No ARAR	0.188	2.02	0.444	1.07	ND
Barium	0.01	1.0^{i}	ND	0.036	0.018	0.054	0.067
Boron	0.01	1.0^{i}	0.116^{c}	0.054^{c}	0.056^{c}	0.108^{c}	0.090^{c}
Calcium^{d}	0.20	No ARAR	532	537	333	139	158
Copper	0.010	0.200^{i}	0.011	ND	0.013	ND	ND
Iron	0.025	0.300^{i}	0.676^{f}	3.82^{f}	1.11^{f}	4.43^{f}	4.13^{d,f}
Lead	0.05	0.025^{i}	ND	ND	ND	ND	ND
Lead (E239.2)	0.005	0.025^{i}	ND^{f}	0.005^{f}	ND^{f}	ND^{f}	0.004^{e,f}
Magnesium^{d}	0.20	No ARAR	408	466	319	84.4	57.6
Manganese	0.005	0.300^{i}	1.84	0.723	0.526	1.74	0.260
Nickel	0.015	0.0154^{j}	0.016	0.026	ND	ND	ND
Potassium^{d}	0.40	No ARAR	1.67^{f}	2.58^{f}	1.61^{f}	1.07^{f}	0.926^{e,f}
Silicon^{d}	0.020	No ARAR	10.3^{c}	11.3^{c}	8.86^{c}	8.09^{c}	6.02^{c}
Sodium^{d}	0.20	20^{i}	67.6	74.2	66.3	84.3	64.4
Zinc	0.01	0.300^{i}	0.184	0.456	0.042	0.036	0.186
Others	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.2							
Total Petroleum Hydrocarbons	1.0	No ARAR	1.2	ND	ND	1.3	ND
Miscellaneous Inorganics (mg/L)							
Total Dissolved Solids (E160.1)	1.0	500^{m}	4000	4100	2900	1000	800
Anions (A429):							
Fluoride	0.1	1.5^{i}	1.4	1.4	0.66	1.2	0.8
Chloride	0.5	250^{i}	16	19	25	140	140
Sulfate	0.5	250^{i}	2600	2900	2100	300	160
Total Hardness (E130.1)	1.0	No ARAR	3400	3400	2600	720	630

Footnotes:

a = Surrogate recovery below control limit for this analysis.
b = Associated MS/MSD analyses had low recovery for this compound for one of the spikes and RPD values exceeded the control limit.
c = Compound also detected in asociated method blank.
d = Accuracy data unavailable; compound not included in matrix spiking solution.
e = Associated lab matrix replicate analysis resulted in RPD values which exceeded the control limit.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.
g = Applicable or relevant or appropriate requirements
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water
m = Federal Secondary Drinking Water Standard

TABLE 4-19
SITE NO. 4: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (units)	Detection Limits	Background[d] (mg/Kg)	Selected Average for Soils[f] (mg/Kg)	Sample Field Identification (Sample Description) B-4-1-3 (4.5'-6.0')	B-4-1-4 (6.0'-7.5')	B-4-1-5 (7.5'-9.0')
EPA Method SW8240 **Volatile Organics(mg/kg)**						
Methylene chloride	0.005	0.0056-0.0091	--	1.400[a,b,c]	1.600[a,b,c]	0.011[b,c]
Acetone	0.010	ND-0.56	--	4.400[a,b,c]	3.400a,b,c	0.082[b,c]
2-Butanone	0.010	ND	--	ND[a]	ND[a]	0.019
Benzene	0.005	ND	--	ND[a]	ND[a]	0.013
Ethybenzene	0.005	ND	--	<1.20[*,a]	3.100[a]	0.087
Total Xylenes	0.005	ND	--	<1.20[*,a]	3.100[a]	0.087
Others	See Appendix F			ND	ND	
EPA Method SW3550/E418.1 **Total Petroleum Hydrocarbons (mg/kg)**	5.0	ND	--	21	120	6.2
EPA Method SW9060 **Total Organic Carbon (mg/kg)**	NR	ND	--	NA	>10,000	NA

Footnote:

* = Compound present below measurable detection limit.
a = Volatile organic compound analysis performed using methanol extraction; detection limit approximately 200 times higher than normal.
b = Compound also detected in associated method blank.
c = Field duplicate analyses exceeded 35% RPD.
d = Associated matrix spike recovery exceeded upper control limit.
e = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA= Not Analyzed
ND= Not Detected
NR= Not Reported

TABLE 4-20
SITE NO. 4: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample Field Identification (Sample Description) GW66 (MW-4-1)	GW67 (MW-4-2)	GW68 (MW-4-3)	GW69 (MW-4-4)
EPA Method SW5030/8020						
Purgeable Aromatics (μg/l)						
Benzene	0.3	ND[h]	ND	ND	23	ND
Ethylbenze	0.3	5[i]	ND	ND	2.3	ND
Others	See Appendix F	-	ND	ND	ND	ND
EPA Method E504.1						
Ethylene Dibromide (μg/l)	0.3	-	ND	ND	ND	ND
EPA Method 200.7*						
Total Metals (mg/L)						
Aluminum	0.1	No ARAR	6.79	1.37	4.35	1.70
Barium	0.01	1.0[i]	0.100	0.060	0.237	0.037
Boron	0.01	1.0[i]	0.146[a]	0.093[a]	0.113[a]	0.333[a]
Calcium[b]	0.20	No ARAR	53.3	48.3	270	189
Cobalt	0.010	No ARAR	ND	ND	0.017	ND
Copper	0.010	0.200[i]	0.024	0.013	0.022	0.011
Iron	0.025	0.300[i]	13.4[d]	3.46[d]	9.44[d]	3.76[d]
Lead	0.05	0.025[i]	0.076	ND	0.078	ND
Lead (E239.2)	0.005	0.025[i]	0.078[c,d]	0.031[c,d]	0.060[c,d]	0.010[c,d]
Magnesium[b]	0.20	No ARAR	45.6	31.7	181	125
Manganese	0.005	0.300[i]	1.16	1.21	1.92	1.36
Nickel	0.015	0.0154[j]	0.031	0.015	0.51	ND
Potassium[b]	0.40	No ARAR	3.08[c,d]	2.23[c,d]	2.28[c,d]	2.07[c,d]
Silicon[b]	0.020	No ARAR	18.6[a]	10.7[a]	16.4[a]	10.8[a]
Sodium	0.200	20[i]	73.5	76.4	74.3	76.9
Vanadium	0.01	No ARAR	0.011	ND	ND	ND
Zinc	0.01	0.300[i]	0.701	0.189	0.388	0.131
Others	See Appendix F	-	ND	ND	ND	ND
EPA Method E418.1 (mg/L)						
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)						
Total Dissolved Solids (E160.1)	1.0	500[m]	4300	3400	1100	1700
Anions (A429):						
Fluoride	0.1	1.5[i]	1.4	0.5	1.1	1.9
Chloride	0.5	250[i]	220	130	140	49
Sulfate	0.5	250[i]	2300	1860	480	560
Total Hardness (E130.1)	1.0	No ARAR	3100	2320	1360	1140

Footnotes:
a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not routinely included in spiking solution.
c = Associated matrix replicate analysis resulted in RPD values above control limits.
d = Associated field duplicate analyses exceeded 35% RPD.
* = Or as indicated for those metals analyzed by alternate methods.
g = Applicable or relevant or appropriate requirements
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F
NA+ = Not analyzed by GFAA (E239.2) due to elevated concentration which could be adequately determined by ICP (E200.7).

TABLE 4-21
SITE NO. 6: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

				Sample Field ID (Sample Description)					
Parameter (units)	Detection Limits	Background[d] (mg/Kg)	Selected Average for solids[e] (mg/Kg)	B-6-1-1 (0-1.5')	B-6-1-3 (3.0'-4.5')	B-6-1-6 (7.5'-9.0')	B-6-2-1 (0-1.5')	B-6-2-4 (4.5'-6.0')	B-6-2-7 (9.0'-10.5')
EPA Method SW8240 Volatile Organics(mg/kg)									
Methylene chloride	0.005	0.0056 - 0.0091	--	<0.0055[*,a,b]	0.0095[a,b]	0.0093[a,b]	ND[b]	ND[b]	ND[b]
Acetone	0.010	ND - 0.056	--	0.015[a,b]	<0.012[*,a,b]	0.015[a,b]	0.014[b]	0.016[b]	0.059[b]
Others	See Appendix F	ND ND	 --	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 **(mg/kg)**									
Total Petroleum Hydrocarbons	5.0			79	8.8	6.5	ND[c]	ND[c]	ND[c]

Footnote:

a = Compound also detected in associated method blank.
b = Associated field blank analyses exceeded 35% RPD.
c = Associated matrix spike had recoveries above control limit.
d = The range of the background concentrations are based on the combined analytical results of the two background borings installed during the RI.
e = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
ND= Not Detected.

TABLE 4-22
SITE NO. 6: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample Field Identification (Sample Description)		
			GW81 (MW-6-1)	GW82 (MW-6-2)	GW83 (MW-6-3)
EPA Method SW5030/8020					
Purgeable Aromatics (μg/l)	ND	-	ND	ND	ND
EPA Method E504.1					
Ethylene Dibromide (μg/l)	ND	-	ND	ND	ND
EPA Method 200.7*					
Total Metals (mg/L)					
Aluminum	0.1	No ARAR	0.667	2.27	0.792
Barium	0.01	1.0[i]	0.016	0.037	0.022
Boron	0.01	1.0[i]	0.079[a]	0.049[a]	0.052[a]
Calcium[b]	0.20	No ARAR	436	334	313
Copper	0.010	0.200[i]	0.028	0.029	0.011
Iron	0.025	0.300[i]	2.63[c]	3.94[c]	1.33[c]
Lead	0.05	0.025[i]	ND	ND	ND
Lead (E239.2)	0.005	0.025[i]	0.007[c]	0.008[c]	0.008[c]
Magnesium[b]	0.20	No ARAR	665	251	280
Manganese	0.005	0.300[i]	0.642	0.257	0.322
Nickel	0.015	0.0154[j]	0.017	ND	ND
Potassium[b]	0.40	No ARAR	1.97[c]	2.35[c]	2.69[c]
Silicon[b]	0.020	No ARAR	8.62[a]	12.1[a]	10.2[a]
Sodium	0.200	20[i]	126	71.3	64.2
Zinc	0.01	0.300[i]	0.292	0.204	0.724
Others	See Appendix F	-	ND	ND	ND
EPA Method E418.1 (mg/L)					
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND
Miscellaneous Inorganics (mg/L)					
Total Dissolved Solids (E160.1)	1.0	500[m]	5400	2200	2300
Anions (A429):					
Fluoride	0.1	1.5[i]	1.5	1.5	1.1
Chloride	0.5	250[i]	43	210	150
Sulfate	0.5	250[i]	3900	1000	120
Total Hardness (E130.1)	1.0	No ARAR	6000	1700	2000

TABLE 4-22 (Continued)
SITE NO. 6: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not routinely included in spiking solution.
c = Associated field duplicate analysis exceeded 35% RPD.
* = Or as indicated for those metals analyzed by alternate methods.
g = Applicable or relevant or appropriate requirements
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F
NA+ = Not analyzed by GFAA (E239.2) due to elevated concentration which could be adequately determined by ICP (E200.7).

fuel should also be expected. TPH was not detected in any of the background boring samples.

- Methylene chloride and acetone reportedly found in the soil samples from boring B-1-1 are probably laboratory contaminants based upon similar concentrations found in the volatile organic method blank. Low levels of methylene chloride and acetone were also found in the background soil sample. No additional volatile organics were detected in the Site No. 1 soils.

- Site No. 1 soils were not analyzed for metals, so no information is available for comparison to background metal levels.

Eight Site No. 1 monitoring wells including the two background wells were sampled. The RI/FS background wells, MW1-7 and MW1D-1, have Site No. 1 designations. The presence of organic contamination in the shallow background well casts doubt on the suitability of this well as a background well. Two wells (MW1-3 and MW1-4) could not be sampled due to damage sustained during the intervening period between the 1986 Stage 1 and 1989 RI/FS studies. One new shallow monitoring well (MW1-6) which was installed to replace one of these damaged wells could not be sampled due to a lack of water in the well. The following presents a discussion comparing the levels of compounds measured in the Site No. 1 wells to ARARs and background information:

- Volatile organic compounds were only detected in one well. Low levels of benzene (0.71 ug/L) and toluene (1.0 ug/l) were found in shallow monitoring well MW1-7. The benzene concentration in MW1-7 exceeds the "non-detectable" New York State Water Quality ARAR. Monitoring well MW1-7 serves as the shallow aquifer background well for the RI/FS. Monitoring well MW1D-1, serves as the upper bedrock background well. The presence of benzene and toluene in MW1-7 more likely suggests an upgradient/off-base source, rather than a regional upgradient condition in the shallow aquifer system, since these compounds are detected in only a number of shallow wells throughout the base. Possible off-base, upgradient sources of contamination include an abandoned scrapyard located on Flint Avenue and an adjacent automotive garage.

- TPH's were also found in the shallow background well at 1.6 mg/l.

Nineteen inorganic metals were detected above instrument detection limits in the groundwater at Site No. 1. Only those metal species that can potentially cause adverse health effects on elevated concentrations are discussed. A number of metals consistently exceeded the promulgated ARARs. The elevated metal values, particularly iron, manganese, lead, zinc and even nickel in groundwater from the Site Nos 1, 2, 4 and 6 monitoring wells can be correlated to metal contributions from particulate clastic and carbonate sources rather than dissolved species. Since the total sample was digested as part of the analysis, the results include any chemical species or trace element comprising the suspended particles in the groundwater. There is, therefore, a strong correlation between samples with high metal content and visual observations of high turbidity recorded during field sampling. As a result, there is a considerable range in the concentrations of metals from well to well. Although metal levels were elevated in the background wells, the concentrations were not as high as groundwater from some of the other wells due to less turbidity. In addition, total metal concentrations (sum of all individual measurements) exceed, by as much as an order of magnitude, the analyses for total dissolved species. Based upon this and the regional groundwater quality reported by other investigators (See Section 2.4.3) it is concluded that the high values of metals were not introduced into the groundwater through activities associated with Base operations, but reflect a natural condition. A more detailed examination of the origin of elevated metals found in the installation's groundwater is presented in Section 4.3. The following presents a comparison of metal levels measured in groundwater at Site No. 1 with ARARs and background values:

- Arsenic was detected in MW1-1 at a concentration of 0.0053 mg/l. This concentration occurs within the 0.025 mg/l ARAR set for arsenic in the New York State Water Quality Standards. Analysis by ICP indicated the presence of arsenic in MW1-7 and MW1D-2, but this was not confirmed by the more sensitive furnace method.

- Iron and manganese were elevated in nearly all wells and in many cases exceeded the 0.300 mg/l State Water Quality ARAR for both metals, even in groundwater from the shallow background well MW1-7. Iron concentrations that exceeded the State Standard occurred in MW1-2 (28.1 mg/l), MW1-5 (5.78 mg/l), MW1-1 (30.5 mg/l), MW 1D-1 (0.960), MW1-7 (6.18 mg/l), MW1D-2 (2.93 mg/l), MW1-3D (2.18 mg/l), and MW1-4D (1.27 mg/l). Manganese concentrations that exceeded the State standard occurred in MW1-2 (1.23 mg/l), MW1-3D (0.599 mg/l), MW1-4D (0.569 mg/l), MW1-5 (0.907 mg/l), MW1-1 (1.64 mg/l) and MW1-7 (1.81 mg/l).

- Groundwater from wells MW1-2, MW1-1, and MW1D-2 yielded lead concentrations of 0.057 mg/l, 0.321 mg/l and 0.029 mg/l. These levels exceeded the 0.025 mg/l State Water Quality ARAR set for lead.

- Silver was detected is MW1-3D at 0.521 mg/l. This value exceeded the State Drinking Water Standard for that compound set at 0.050 mg/l. The presence of silver in this one well can not be linked to any reported hazardous material management activity conducted at the combined site area.

- A nickel concentration of 0.046 mg/l in MW1-2 and 0.033 mg/l in MW1-1 exceeded the 0.0154 mg/l ARAR established under the Federal Ambient Water Quality Criteria (FWQC) for human health and aquatic life.

- Barium levels in groundwater at Site No. 1 ranged from 0.042 mg/l in MW1-7 to 0.263 mg/l in MW1-1. The lowest concentration was reported for the shallow background well. All of the barium concentrations occur within the ARAR established in the State Water Quality Standards.

- Chromium was detected in some of the Site No. 1 wells, but at levels below the ARARs.

- Cobalt was only found in one well (MW1-2) at 0.013 mg/l. Although cobalt was not detected in the shallow background well, no ARAR presently exists for this metal.

- Zinc found in the groundwater of Site No. 1 ranged from 0.026 mg/l in MW 1D-1 to 0.463 mg/l in MW1-1. Three groundwater samples indicated zinc levels slightly above the 0.3 mg/l ARAR promulgated in the New York State Water Quality Standards.

- Copper was detected in only a few of the Site No. 1 wells. All of the detected levels of copper were well below the ARAR.

- Vanadium was only detected in groundwater from MW1-2 (0.038 mg/l) and MW1-1 (0.036 mg/l). No ARAR presently exists for this metal. Vanadium was not detected in either the shallow nor deep background monitoring wells.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Total dissolved solids (TDS) in groundwater samples from all Site No. 1 wells except MW1D-2 exceeded the 500 mg/l Secondary Drinking Water Standards. The highest levels were recorded at monitoring well MW1-3D and MW1-7 where values of 3,200 mg/l and 2,400 mg/l, respectively, were measured.

- Sulfate levels exceeded the 250 mg/l standard set in New York State Water Quality Regulations in MW1-1 (1,600 mg/l), MW1-7 (1,900 mg/l), MW1D-1 (640 mg/l) and MW1-3D (2,000 mg/l).

- Chloride and fluoride levels ranged from 31.0 mg/l to 87.0 mg/l and 0.42 mg/l to 1.4 mg/l respectively.

- Sodium levels exceeded the 20 mg/l standard set in New York State Water Quality Regulations in all Site 1 monitoring wells. The condentrations ranged from 25.1 mg/l to 90.5 mg/l.

- Groundwater at Site No. 1 is very hard. Hardness values ranged from 480 mg/l to 2800 mg/l.

The generally poor water quality of the groundwater is explained in the literature (Johnston, 1964). Groundwater from the Lockport Dolomite is described as very hard and moderately to highly mineralized. The average hardness and chloride concentrations reported for the Lockport Dolomite are 960 mg/l and 234 mg/l respectively. Typical groundwater from the Lockport is also characterized by high calcium and magnesium, and high sulfate and bicarbonate. According to the literature, water from the unconsolidated deposits is also very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate crystals (gypsum) in the soil and bedrock.

The following presents a discussion of the organic analytical soil data yielded by the two Site No. 2 soil borings compared to the background soil data. As mentioned in the discussion of the Site No. 1 soil data, the background levels established for the installation's soils were based upon the analytical results from two upgradient background borings. The full range of possible background concentrations for Niagara Falls soils has not been determined:

- Soils from the two Site No. 2 soil borings yielded levels of petroleum hydrocarbon contamination. In boring B-2-1, TPH concentrations of 290 mg/kg, 9.4 mg/kg and 8.8 mg/kg were measured in soils from the 0.0 to 1.5 foot, 3.0 to 4.5 foot and 4.5 to 6.0-foot intervals respectively. In boring B-2-2, TPH levels of 6.6 mg/kg and 9.4 mg/kg were found in soils from the 0.0 to 1.5 foot and 9.0 to 10.5-foot intervals, respectively. No other fuel components were detected in the soil samples above measurable detection limits. Since no ARARs have been established for soils the TPH concentrations can only be compared to levels measured in the background borings. In the case of TPH, the compound was not detected in any background soil samples.

- The only volatile organic compounds found in Site No. 2 soils were methylene chloride and acetone. The low levels of methylene chloride and acetone found in the soil samples of B-2-1 and B-2-2 are probably laboratory contaminants. Similar concentrations were also measured in laboratory method blanks. These compounds are also reported in soils from the background soil borings.

All of the five Site No. 2 monitoring wells were sampled during the RI groundwater sampling program. The following presents a discussion comparing organic compounds found in the Site No. 2 monitoring wells to ARARs and background levels.

- Volatile organic compounds were detected in only one well. Benzene and toluene were respectively detected at 0.33 ug/l and 0.52 ug/l in the groundwater from new well MW2-4. The benzene level exceeds the "non-detect" New York State Water Quality ARAR. The benzene and toluene concentrations are generally half those found in the shallow background well MW1-7. Since no volatile organic components were found in the shallow Stage 1 wells which are much closer to and surround the inlet and outlet pipes of POL Tank C, the source of the 1982 leak, the presence of these contaminants in MW2-4 must be the result of contaminated runoff infiltration.

- MW2-4 also had a TPH concentration of 1.3 mg/l. This concentration was slightly less than the TPH concentration found in shallow background well. A total petroleum hydrocarbon concentration of 1.2 mg/l was recorded also in well MW2-1. The presence of TPH in this well is likely related to infiltration of contaminated runoff from the POL driveway.

Thirteen inorganic metals were detected above instrument detection limits in groundwater at Site No. 2. Only those metal species that can potentially cause adverse health effects at elevated concentrations are discussed. Iron, manganese, nickel, and zinc were the only metals found in groundwater samples at Site No. 2 which exceeded the established ARARs. For reasons discussed in the Site No. 1 section, the elevated levels of metals found in groundwater at Site No. 2 are not considered to be linked to site operations. The following presents a comparison of metal levels measured in groundwater at Site No. 2 with ARARs and background values.

- The 0.300 mg/l New York State Water Quality ARAR set for iron was exceeded in all of the Site 2 wells; however, groundwater from the shallow background well also exceeded the State standard. Iron ranged from 0.676 mg/l at MW2-1 to 4.43 mg/l at MW2-4. These iron concentrations are lower than the iron levels found in the shallow background well MW1-7.

- The 0.300 mg/l New York State Water Quality ARAR promulgated for manganese was exceeded in four out of the five Site 2 wells. Manganese levels ranged from a low of 0.260 mg/l in MW2D-1, the only value that did not exceed the standard, to a high of 1.84 mg/l at MW2-1. The relatively high manganese concentration obtained at MW2-1 is nearly identical to the manganese concentration from the shallow background well.

- Nickel concentrations of 0.016 mg/l and 0.026 mg/l detected in MW2-1 and MW2-3 respectively, exceeded the 0.0154 mg/l FWQC Human Health ARAR.

- Barium was detected in groundwater from most of the Site No. 2 wells. Barium levels generally matched the concentrations established by both background wells. None of the levels exceeded the ARARs.

- Copper, although not detected in the background wells, was detected in several wells at Site No. 2. The levels of copper measured were within the limits set by the ARARs.
- Lead was detected in MW2-3 (0.005 mg/l)and MW 2D-1 (0.004 mg/l). This concentration were also within the ARAR established in the State Water Quality Standards.
- Zinc levels measured in groundwater at Site No. 2 ranged from 0.036 mg/l to 0.456 mg/l. Only MW2-3 (0.456 mg/l) concentration was above the New York State Water Quality ARAR of 0.300 mg/l.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- The Secondary Drinking Water Standard of 500 mg/l for total dissolved solids (TDS) was exceeded in all Site No. 2 wells. TDS ranged from 800 mg/l in MW2D-1 to 4,100 mg/l in MW2-3.
- Sulfate levels exceeded the State Water Quality ARAR of 250 mg/l in all but one well. Sulfate concentrations of 2,600 mg/l, 2,900 mg/l, 2,100 mg/l and 300 mg/l were measured in MW2-1, MW2-3, MW2-2 and MW2-4 respectively. Although sulfate concentrations in the shallow background well also exceeds the State ARAR, the average sulfate concentration in groundwater at Site No. 2 tends to be slightly higher than the base background level.
- Chloride and fluoride levels ranged from 16.0 mg/l to 140 mg/l and 0.66 mg/l to 1.4 mg/l respectively.
- Sodium levels exceeded the 20 mg/l standard set in New York Water Quality Regulations in the five site monitoring wells. The concentrations ranged from 64.4 mg/l to 84.3 mg/l.
- Total hardness ranged from 630 mg/l to 3400 mg/l.

The following presents a comparison of the organic analytical data yielded by the Site No. 4 soil boring with background levels. As mentioned in the discussion of the Site No. 1 soil data, the background levels established for the installation's soils were based upon the analytical results from two upgradient background borings. The full range of possible background concentrations for Niagara Falls soils has not been determined:

- The three soil samples collected from the single Site No.4 boring B-4-1 contained levels of total petroleum hydrocarbons (TPH). TPH was not detected in soils of the background soil borings. A relatively high concentration of 120 mg/kg was measured in the soil sample collected from the 6.0 to 7.5-foot interval.

- 2-Butanone, benzene, ethylbenzene and xylenes were detected in soil from the 7.5 to 9.0-foot interval at 0.019 mg/kg, 0.013 mg/kg, 0.087 mg/kg and 0.087 mg/kg respectively. Soils from the 6.0 to 7.5-foot interval contained ethylbenzene and xylenes both at 3.100 mg/kg.

None of these compounds were detected in soil samples collected from the two background soil borings. The presence of these compounds in the soil samples from the one soil boring are most likely related to the MoGas fuel leak.

- Methylene chloride and acetone levels measured in the soil samples of Site No. 4 occurred significantly above the concentrations yielded by the trip blanks. Even though these compounds are typical laboratory contaminants, their reported concentrations suggest that they may be site contaminants. The low levels of methylene chloride and acetone measured in soils of the background borings are considered laboratory artifacts.

All of the four Site No. 4 monitoring wells were sampled during the RI groundwater sampling program. A comparison of organic compounds measured in Site No. 4 monitoring wells with ARARs and background levels is presented below:

- Benzene and ethylbenzene were detected in MW4-3 at concentrations of 23 ug/l and 2.3 ug/l respectively. The benzene concentration in MW4-3 not only exceeds the "non-detect" State ARAR, but is also considerably greater than the background concentration obtained in shallow background well MW1-7. The ethylbenzene concentration is lower than the most stringent ARAR for this compound. Due to the downgradient position of the well and the presence of chemical constituents commonly found in fuel, the presence of these compounds is being attributed to residual contamination from the fuel leak.

Sixteen inorganic metals were detected above instrument detection limits in the groundwater at Site No. 4. Only those metal species considered to pose a health risk at elevated concentrations are considered in the discussion. For reasons discussed under the Site No. 1 section, the elevated levels of metals found in groundwater are not being linked to specific site problems. The following presents a comparison of metal levels measured in groundwater at Site No. 4 with ARARs and background levels:

- Groundwater from all four Site No. 4 monitoring wells exceeded the State's 0.300 mg/l ARAR promulgated for iron and manganese. Iron levels ranged from 3.46 mg/l in MW4-2 to 9.44 mg/l in MW4-3. Manganese levels ranged from 1.16 mg/l in MW4-1 to 1.92 mg/l in MW4-3. Manganese and iron levels were also exceeded in groundwater from the shallow background well. Levels reported for the background well for these two metals fall within the respective ranges established at Site No. 4.

- Groundwater from three of the four monitoring wells yielded lead levels higher than the 0.025 mg/l State of New York Water Quality ARAR. Lead levels of 0.078 mg/l, 0.031 mg/l and 0.060 mg/l were measured in MW4-1, MW4-2, and MW4-3, respectively.

- Nickel levels of 0.031 mg/l and 0.51 mg/l from MW4-1 and MW4-3 respectively exceed the 0.0154 mg/l FWQC Human Health ARAR.
- Barium levels measured in most Site No. 4 wells were higher than concentrations measured in the background wells. Groundwater at Site No. 4 exhibited a barium range of 0.037 mg/l to 0.237 mg/l. All levels were below the 1.0 mg/l ARAR set in the New York State Water Quality Standards.
- Low levels of vanadium and cobalt were detected in two separate wells at Site No. 4. A cobalt concentration of 0.017 mg/l was reported for MW4-3 and a vanadium concentration of 0.011 mg/l was found in MW4-1. Vanadium and cobalt were not detected in the background wells and no ARARs presently exist for these metals.
- Groundwater from two Site No. 4 wells exceeded the State's 0.300 mg/l ARAR promulgated for zinc. Zinc levels were 0.388 mg/l in MW4-3 and 0.701 in MW4-1. Other levels detected below ARAR's were 0.131 mg/l and 0.189 mg/l in MW4-4 and MW4-2 respectively.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- The total dissolved solids (TDS) levels in all Site No. 4 wells exceeded Secondary Drinking Water Standards. TDS ranged from 1,100 mg/l in MW4-3 to 4,300 mg/l in MW4-1.
- The State Water Quality Standard for sulfate was also exceeded in all wells. Sulfate levels ranged from 1,480 mg/l in MW4-3 to 2,300 mg/l in MW4-1. Sulfate levels which also exceeded the State ARAR were measured in the shallow background well.
- Chloride and fluoride levels ranged from 49.0 mg/l to 220 mg/l and 0.5 mg/l to 1.9 mg/l respectively.
- Sodium levels exceeded the 20 mg/l standard set in New York State Water Quality Regulations in all Sit No. 4 monitoring wells. The concentrations ranged from 73.5 mg/l to 76.9 mg/l.
- Total hardness ranged from 1140 mg/l to 3100 mg/l. As predicted by the literature, the groundwater is very hard and mineralized (Johnston, 1964).

Soil samples were collected for analyses from two soil borings drilled in the Site No. 6 study area. A comparison of the organic analytical data yield by the Site No. 6 soil samples with background levels is presented below. As mentioned in the discussion of the Site No. 1 soil data, the background levels established for the installation's soils were based upon the analytical results from two upgradient background borings. The full range of possible background concentrations for Niagara Falls soils has not been determined:

- Total petroleum hydrocarbon (TPH) levels ranged from 6.5 mg/kg to 79.0 mg/kg in soil samples from Site No. 6 soil boring B-6-1. The highest concentration was measured in soil from the 0.0 to 1.5-foot interval. This compound was not detected in soils from B-6-2. The presence of TPH in the soil at B-1-6 is best explained by infiltration of contaminated runoff from the adjacent parking lot rather than the fuel leak near POL Bulk Storage Tank A. TPH was not detected in soils from the background borings.

- Methylene chloride and acetone were the only volatile organic compounds detected in the Site No. 6 soils. Methylene chloride and acetone concentrations in the Site No. 6 soils were comparable to concentrations found in associated method blanks. Methylene chloride and acetone are therefore considered to be laboratory contaminants. [As a general rule, common laboratory pollutants (i.e., methylene chloride and acetone) are only considered contaminants when sample concentrations exceed the highest blank concentration by an order of magnitude.]

A total of three monitoring wells were sampled at Site No. 6. No volatile organic compounds were detected in the groundwater from these monitoring wells.

Fourteen inorganic metals were detected above instrument detection limits in groundwater from Site No. 6. Only those metal species considered to pose an adverse health risk at elevated concentrations were discussed. As discussed in the Site No. 1 section, the elevated levels of metals found in the groundwater at Site No. 6 are not being attributed to the site problem. The following presents a comparison of metal levels measured in groundwater at Site No. 6 with ARARs and background levels:

- Water from wells MW6-1, MW6-2, and MW6-3 yielded iron concentrations that exceeded the 0.300 mg/l ARAR established under the New York State Water Quality Standards. Two of these wells yielded manganese concentrations that exceeded the State ARAR. The lowest iron concentrations were recorded in MW6-3 at 1.33 mg/l and the highest concentrations were found in MW6-2 at 3.94 mg/l. Manganese was found in wells MW6-1 and MW6-3 at levels of 0.642 mg/l and 0.322 mg/l respectively. Iron and manganese levels in the shallow background well also exceeded the State ARARs.

- Barium levels encountered in groundwater at Site No. 6 were generally lower than the background levels, and all levels at this site occurred well within the ARAR.

- Copper, which was not detected in any of the background wells, was found in all three wells at Site No. 6. All of the concentrations were well below the promulgated ARAR for copper.
- Lead levels measured in groundwater from all Site No. 6 wells were also well within the State ARAR.
- Nickel was only found in MW6-1 at a concentration of 0.017 mg/l. This concentration exceeds the 0.0154 mg/l FWQC Human Health ARAR. Nickel was not detected in groundwater from the background wells. Zinc found in groundwater at Site No. 6 was considerably higher than levels reported for the background wells.
- Zinc ranged from 0.204 mg/l in MW6-2 to 0.724 mg/l in MW6-3. Only the zinc level encountered at Site No. 6 (MW6-3) was above the ARAR of 0.300 mg/l established in the State Water Quality Standards.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Total dissolved solids (TDS) in groundwater from Site No. 6 ranged from 2,200 mg/l in MW6-2 to 5,400 mg/l in MW6-1. TDS in all wells at Site No. 6 exceeded the 500 mg/l Secondary Drinking Water Standard.
- Sulfate levels range from 1,000 mg/l in MW6-2 to 3,900 mg/l in MW6-1. Sulfate levels in all wells exceeded the 250 mg/l ARAR promulgated in the New York State Water Quality Standards.
- Chloride and fluoride levels ranged from 43.0 mg/l to 210 mg/l and 1.1 mg/l to 1.5 mg/l respectively.
- Sodium levels exceeded the 20 mg/l standard set in New York State Water Quality Regulations in all Site No. 6 monitoring wells. The concentrations ranged from 64.2 mg/l to 126 mg/l.
- Total hardness ranged from 1700 mg/l to 6000 mg/l. As expected from the literature, water from the shallow aquifer is hard and mineralized.

4.1.1.2.2 Zones of Contamination

Soil and groundwater contamination detected at each of the combined site study areas is of an isolated nature. Figures 4-11 and 4-12 illustrate the contaminants found in the soil and groundwater at each monitoring station. Zones of contamination are therefore generally restricted to small areas immediately adjacent to identified contaminant sources or some other unrelated source. No isoconcentration contour maps were generated due to the isolated nature of contamination. As mentioned in Section 4.1.1.2.1, the elevated levels of metals measured in groundwater of the combined site study area are not being attributed to site related contamination problems but rather naturally occurring metals found in suspended particulate clastic materials.

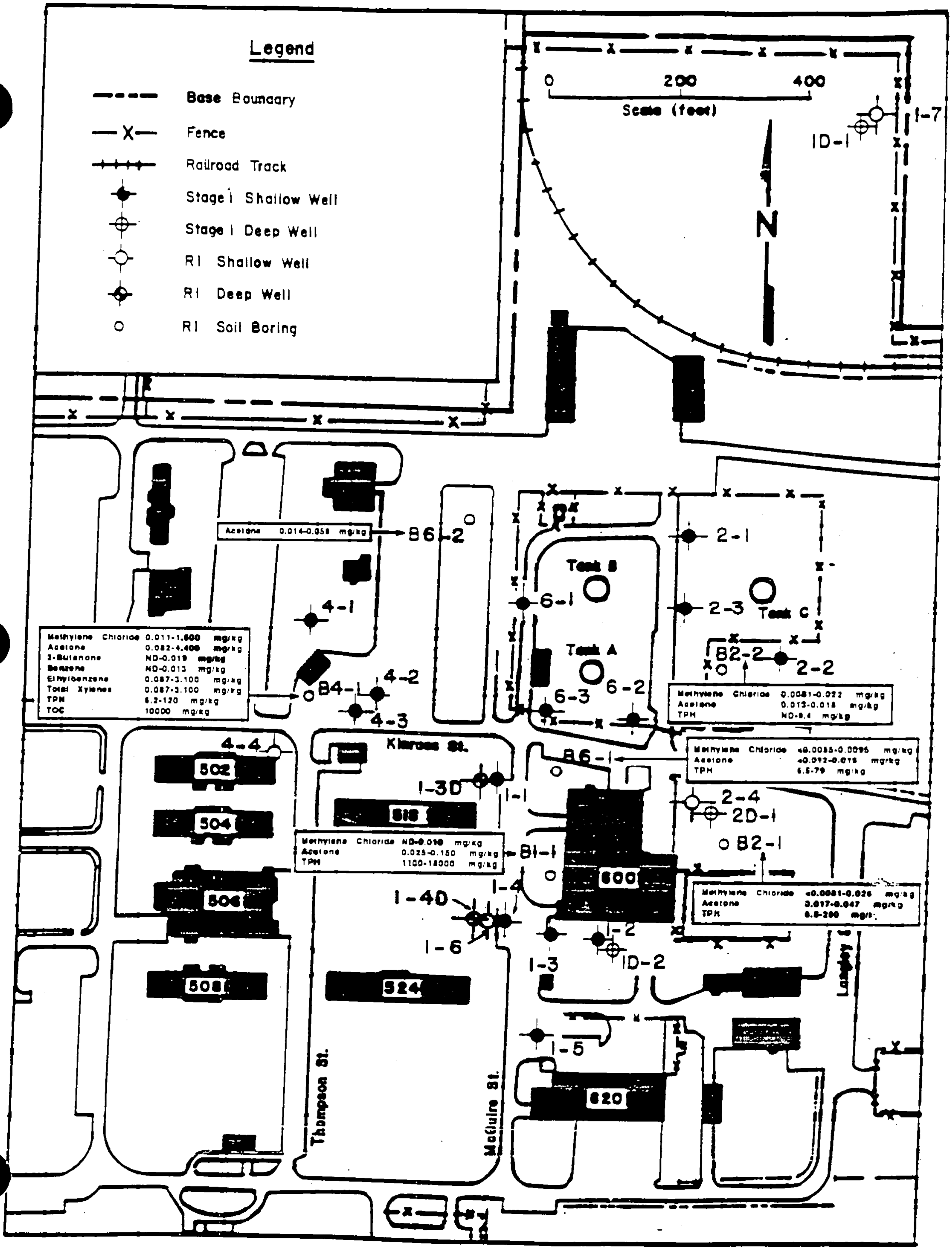


FIGURE 4-11.
SITE NOS. 1,2,4, AND 6: ZONES OF CONTAMINATION - SOIL

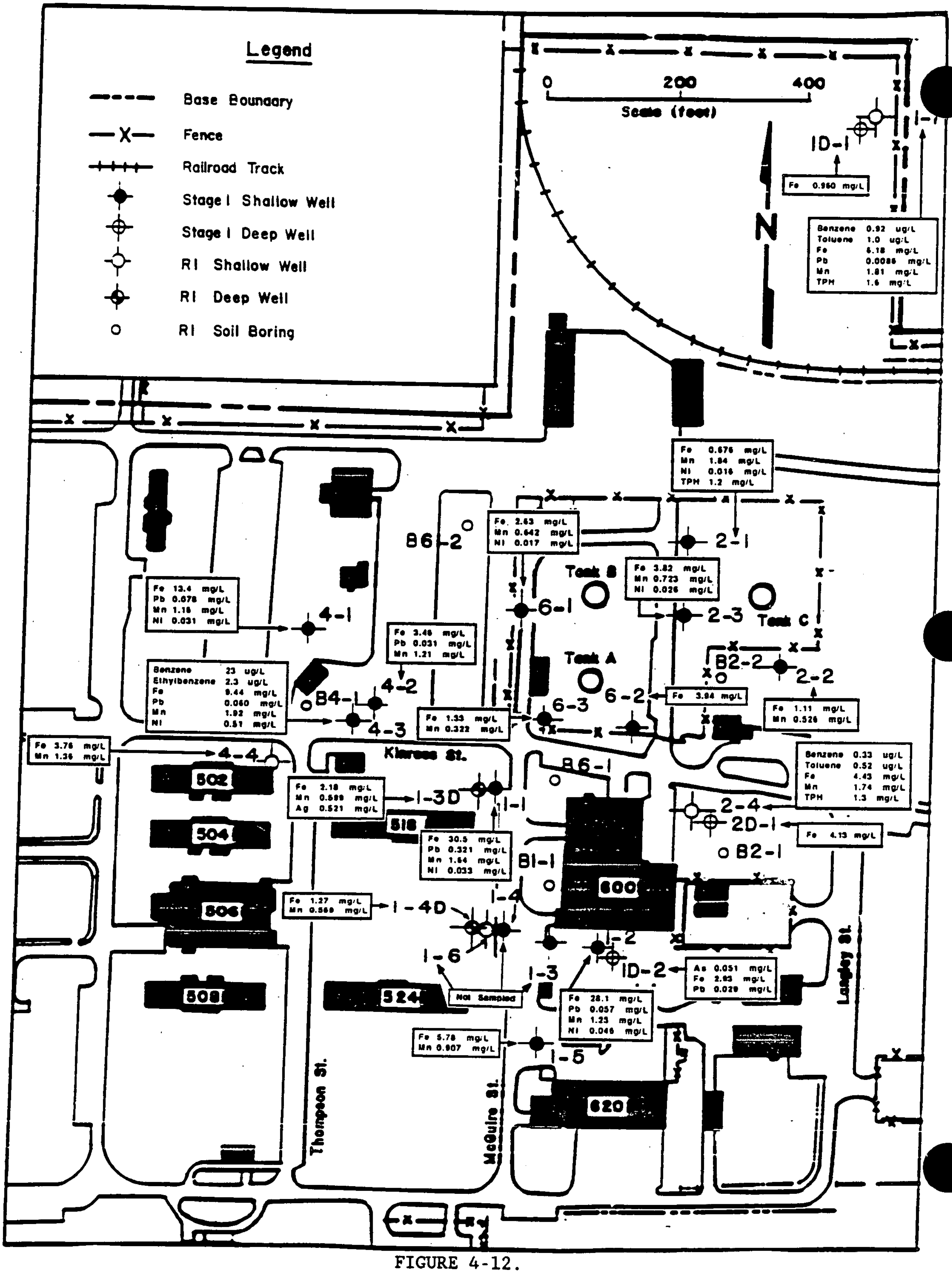


FIGURE 4-12.

SITE NOS. 1,2,4, AND 6: ZONES OF CONTAMINATION - GROUNDWATER

At Site No. 1 contamination appeared to be limited to the soils in the immediate vicinity of the JP-4 pipeline leak near the loading dock of Building 600. No fuel related chemicals were found in groundwater sampled from monitoring wells situated hydrogeologically downgradient from this leak. The presence of benzene and toluene detected in groundwater from shallow background well (MW1-7) is not related to any of the base's hazardous waste/material management areas and likely originates off-base.

At Site No. 2 no contaminants were detected in groundwater in the immediate vicinity of the inlet and outlet pipes of the POL Storage Tank C. Benzene, toluene and TPH found in the most downgradient monitoring well (MW2-4) is probably related to the infiltration of contaminated runoff originating from the driveway just west of this well. Although the well is in a downgradient position to the intake leaks, the absence of contamination in downgradient wells proximal to the source of the Site No. 2 leak does not substantiate Site No. 2 as being the source of the contaminants found in MW2-4. TPH detected in soil from the boring located just east of Building 600 is probably linked to contaminated surface drainage originating from the paved area just south of the boring.

At Site No. 4 residual soil and groundwater contamination is restricted to the area where the former pipe leading to the MoGas tank leaked. Benzene and ethylbenzene were only found in the shallow downgradient well (MW4-3) situated proximal to the source of the fuel leak. These fuel components were not detected in the other downgradient well (MW4-4) located 150 feet southwest of MW4-3. Soil from the soil boring located near the west side of the former MoGas tank also yielded fuel related contaminants.

The only contaminant found at Site No. 6 during the RI occurred at soil boring B-6-1. TPH was found in the soil from this boring; the highest concentration was found near the surface. Contamination of the surface soil is probably the result of contaminated runoff from the parking lot located several feet north of the boring. If the contamination was the result of the 1979 leak found in the inlet pipe of POL Tank A contamination would be highest at the groundwater/soil interface as a result of contamination migrating through the groundwater system. Organic fuel constituents were not detected in groundwater from the wells located around POL Tank A.

4.1.1.2.3 Contaminant Migration

The isolated nature of soil and groundwater contamination at some of the combined site study areas implies that only minor if any migration of contaminants has occurred. Migration of contaminants through the shallow groundwater system, considering the hydrogeologic data yielded by the flow modeling study at Love Canal (Mercer et. al., 1983) and the USGS (1985) study both discussed in Section 4.1.1.1.2, are expected to range between 3.0 x 10^{-3} ft/day to 5.48 x 10^{-5} ft/day. Higher migration rates occur locally in non-connective stringers of sand. In consideration of the age of the various fuel leaks of the combined site study areas and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, the following migration distance ranges for sites where site related contamination was detected should be expected:

Site No. 1	- (Minimum)	4.2 x 10^{-1}feet
	- (Maximum)	23 feet
Site No. 4	- (Minimum)	1.8 x 10^{-1}feet
	- (Maximum)	9.8 feet

Given the most conservative estimates for contaminant migration at Site Nos. 1 and 4, which do not consider contaminant attenuation effects, it would take another 70 years and 104 years, respectively, before contaminants originating from Site Nos. 1 and 4 reach the nearest downgradient monitoring well at each site (i.e., MW1-4 and MW4-4)

Cultural features, such as sewer line and underground utility lines and pipes may have some affect on patterns and speed of contaminant transport within the subsurface. The area around Sites 1, 2 , 4, and 6 contains many unconnected underground utilities as shown in Section 4 Attachment A. The effect of these utilities on contaminant transport patterns, although, is expected to be limited due to the natural geologic and hydraulic conditions of the site and the location of the utility lines above the shallow water table of the area.

Although no site related contaminants were detected in groundwater from the upper water bearing zone of the Lockport Dolomite at Sites No. 1,2,4 and 6, migration rates have nonetheless calculated. Based upon the discussion presented in Section 4.1.1.1.2, migration rates would most likely be between 1.5 x 10^{-1} ft/day to 6.31 x 10^{-1} ft/day. If contamination did spread to the upper bedrock aquifer, migration rates would be considerably greater than that predicted for the unconsolidated aquifer. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.1.2.4 Baseline Risk Assessment: Sites No. 1,2,4 and 6

4.1.1.2.4.1 Baseline Risk Assessment for Site No. 1

This section presents the baseline risk assessment for Site 1. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 1 - Data Analysis and Hazard Identification

For the sites under investigation at Niagara Falls IAP (i.e., Sites 1 through 13), all chemicals positively identified in the groundwater which were not excluded during the QA/QC review or due to the absence of verified reference doses (RfDs), were included in the baseline assessment of risks to human health. Monitoring data from environmental media were collected, evaluated using the QA/QC criteria developed by the U.S. EPA (1989), and were summarized for use in the baseline risk assessment. The chemicals retained for use in the evaluation are referred to as "chemicals of concern".

Current EPA guidance for risk assessment (USEPA 1989) specifies that chemicals should not be eliminated from evaluation at a site because they are present in background samples. EPA no longer advocates selection of indicator compounds and recommends that all chemicals identified at the site should be evaluated in the baseline risk assessment if possible. The exception would be those chemicals eliminated on the basis of blank contamination, and nutrient substances of low toxicity (e.g., calcium, magnesium, iron).

A "representative" environmental concentration was determined for each chemical of concern at each site. In addition, the range of observed values was also delineated. The representative concentration was calculated as the arithmetic mean of the sampling data sets. At all sites, the mean concentrations were used as the basis of the risk assessment. "Not detected" values (i.e., sampling results at, or below the detection limit) were treated as one half the detection limit and included in the calculation of the arithmetic mean.

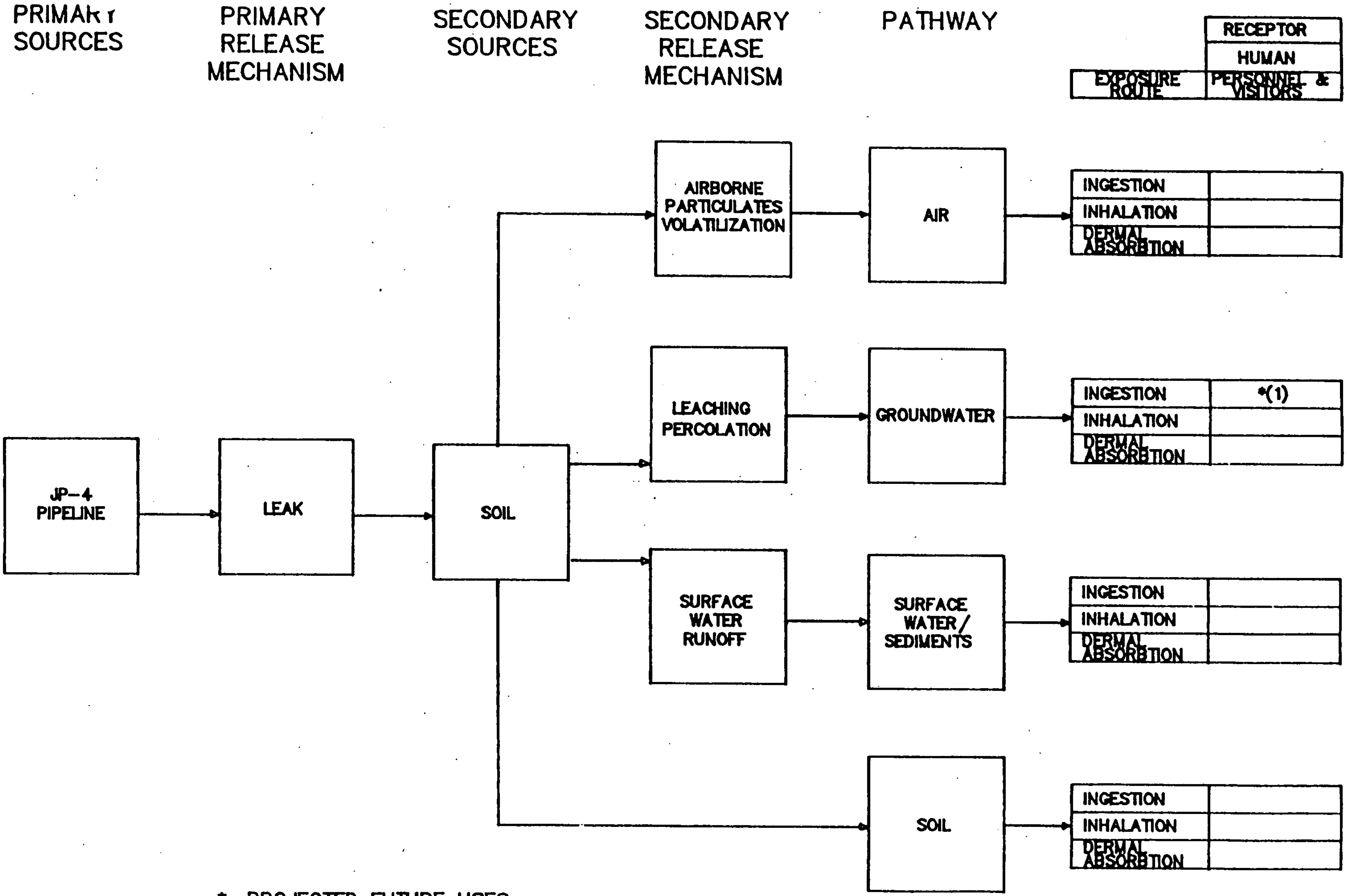
A quantitative risk assessment of exposure to total petroleum hydrocarbons (TPH) as a class of compounds is not possible. TPH is a complex mixture whose component chemicals have not been identified. There are no verified EPA toxicity measures available for TPH as a class of compounds for use in risk characterization. At best, levels of TPH can only be qualitatively evaluated by comparison with measured levels of identified hydrocarbons. Levels of TPH in soils at Site 1 were elevated (mean concentrations equal to 9550 mg/kg) indicating the presence of aliphatic and olefinic hydrocarbons in subsurface soils that have not been incorporated into the listing of chemicals of concern. As noted in the sections that follow however, exposure to soil is not a pathway of concern at Site 1. Concentrations of TPH in groundwater were considerably lower than that in soil; in the parts per billion range.

Site No. 1 - Exposure Assessment

The primary objectives of the exposure assessment at each site are to identify the receptors at potential risk, and to develop an estimate of the "reasonable maximum exposure" (RME) expected to occur at each site under investigation. Base personnel are assumed to be the receptor group at greatest risk of exposure. No one is currently using water from the aquifer beneath the site as a source of drinking water. Consequently, there is no actual risk of exposure. However, for the purpose of evaluating the significance of observed levels of chemicals in groundwater, a hypothetical exposure scenario has been developed and evaluated here. The conceptual site model for Site 1 is presented in Figure 4-13. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 1 is provided in Appendix G.

Soil

In 1969, a leak which saturated the soils at the site was discovered in an old JP-4 hydrant system near Building 600. The contaminated area is now paved thus eliminating potential for exposure to soils (i.e., via ingestion, inhalation or dermal contact).



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie. AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-13.
CONCEPTUAL SITE MODEL
SITE 1 - BUILDING 600 JP-4
PIPELINE LEAK

Surface Water/Sediment

The nearest surface water body (Cayuga Creek) is approximately 1200 feet to the southeast of Site 1 and there are no drainage ditches in close proximity to the site. Therefore exposure of Base personnel to surface water has been eliminated as a pathway of concern for Site 1.

Groundwater

According to the Niagara County Health Department, the Base and surrounding communities have been supplied with a municipal water system since 1969. The Niagara County Health Department (1983) also confirmed that inactive or abandoned private wells (shallow, dug wells) exist for a number of the older off-base residences. Several studies (Engineering Science, 1983) evaluating the groundwater in the vicinity of the Niagara Falls IAP have described the quality as poor in the unconsolidated sediments. The domestic use of these wells as occasional potable water sources is unlikely due to the poor quality of the water in the shallow aquifer.

Horizontal flow in the shallow unconsolidated aquifer is to the south and southwest (Section 4.1.1.1.2 of this report) with reported velocities less than 0.06 ft/yr (USGS, 1985). Most of the private wells are upgradient of the site with a few old industrial (5 wells within a quarter mile of the site) and old residential (4 wells within 1 1/3 miles of the site) wells located southeast of the facility (Engineering Science, 1983). It is considered unlikely that contaminated groundwater originating at this site would reach offsite wells located across the Cayuga Creek. Due to the low horizontal velocity of the groundwater (long travel time), and the projected interception of the groundwater by Cayuga Creek, the contaminants are likely to be attenuated or transported in surface water prior to reaching the wells to the southeast of the facility.

Although the base and surrounding communities are currently provided with a municipal water supply (i.e., there is no complete exposure pathway), it was assumed that Base personnel hypothetically ingest groundwater having contaminant concentrations equal to that detected in the shallow aquifer directly below the site. This assumption was made to provide a screening level risk evaluation of the groundwater in the vicinity of the site and may be used as an interpretive tool for assessing groundwater data.

The onsite occupational exposure assumptions used were very conservative. Due to the natural attenuation of the contaminants and the interception of the contaminant plume by the Creek, it is unlikely that potential offsite exposures (i.e., if private wells were in use) would be greater than the estimated onsite exposures. Therefore, only onsite exposures were evaluated.
A list of assumptions for hypothetical exposures to groundwater is presented below.

- Base personnel (70 kg adults) are assumed, hypothetically, to ingest one liter of groundwater per day, everyday for 20 years of a 70 year lifetime. The ingestion rate was adopted to reflect the time spent by Niagara personnel at the Base each day, and the potential use of groundwater for drinking water. A detailed evaluation of the assumptions used and the derivation of these assumptions are included in Appendix G.
- Chemicals in groundwater at the site are conservative (i.e., do not degrade or transform over time).
- The risk assessment for the sites which have both soil exposure and groundwater exposure evaluated does not combine exposure across pathways (i.e., consumption of groundwater, and ingestion of soil). Because no one is actually using groundwater as a source of potable water, it would be extremely unrealistic to evaluate combined exposure from all environmental media.
- The risk assessment for the sites which have detected contamination within both shallow and deep aquifers combined exposure across aquifers (i.e., consumption of groundwater from both aquifers) in order to provide the most conservative estimate of site risk.

Site No. 1 - Toxicity Assessment

The toxicity measures used in the risk assessment were obtained primarily from the EPA Integrated Risk Information System (IRIS) data base, and the EPA Health Effects Assessment Summary Tables (USEPA 1989c). Reference doses (RfDs) are used in evaluating the potential for adverse noncarcinogenic effects. Carcinogenic potency factors (q_1^*) are used in cancer risk estimates. A listing of these toxicity measures, and a more detailed explanation of their use is presented in Appendix G. In the absence of verified reference doses, toxicity measures may be adopted based upon structural and toxicological similarities between compounds.

Toxicity values for noncarcinogenic and carcinogenic effects are commonly derived from critical effect data based on administered rather than absorbed dose. Dose estimates developed for the risk assessment of Site 1 are therefore based upon direct intake rather that absorbed dose to ensure comparability. All toxicity measures for noncarcinogenic effects are reported together with a listing of the key target organ at risk for chronic exposure. Carcinogenic potency factors are reported together with the Weight of Evidence classification indicating the uncertainty in the toxicological data base. Toxicity profiles and a summary of toxicity measures are provided in Appendix G.

Site No. 1 - Risk Characterization

The results of risk characterization for exposure to groundwater at the Site 1 are presented in Table 4-23. The hazard index for combined exposure across compounds is approximately 5.7×10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater at Site 1. The excess lifetime cancer risk of hypothetical exposure to groundwater was calculated to be approximately 2×10^{-5}. This is within the acceptable range established by EPA for waste site remediation. The magnitude of this risk estimate is attributable to levels of arsenic detected in groundwater. Note however, that arsenic is found to occur at naturally high concentrations in the Niagara Falls area (Litten, 1986). See Section 4.3 for a detailed discussion of background concentrations of inorganic chemicals.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Silver (70 ug/L) was the only chemical for which the mean concentrations in groundwater exceeded the Federal MCL (50 ug/L). Mean levels of manganese (870 ug/L) exceeded the New York State numerical groundwater limits (300 ug/L) and mean levels of zinc (307 ug/L) exceeded the New York State numerical groundwater limits (300 ug/L) . The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

The only monitoring well containing quantifiable concentrations of TPH (1.6 mg/L) was MW-1-7 which was initially designated as the background well. Water samples from this well also contained benzene (0.92 ug/L) and toluene (1.0 ug/L).

TABLE 4-23

RISK CHARACTERIZATION FOR SITE NO. 1: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Concarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	6280.00			
Arsenic	5.00	4.91E-02	Skin, Lung	2.45E-05
Barium	102.00	2.00E-02	Hypertension	
Chromium	9.00	1.77E-02	Skin	
Cobalt	6.00		Thyroid, Heart	
Copper	30.00	7.96E-03	GI Tract, Blood	
Lead	22.00	1.54E-01	CNS, Kidney	
Manganese	870.00	4.27E-02	CNS, Reproductive	
Nickel	16.00	7.85E-03	Skin, Lung	
Silver	70.00	2.29E-01	Liver, Kidney, CNS	
Vanadium	13.00	1.82E-02	Respiratory Effects	
Zinc	315.00	1.55E-02	GI Tract	
ORGANICS				
Benzene	0.25	6.81E-03	Hematopoietic Sys.	2.03E-08
Toluene	0.26	8.50E-06	CNS	
Hazard Index: Combined Exposure		5.69E-01		
Excess Lifetime Cancer Risk: Combined Exposure				2E-05

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

The unidentified hydrocarbons present at this location cannot be evaluated due to the lack of human health guidelines for TPH as a class of compounds.

Site No. 1 - Uncertainty in the Risk Assessment

It is important to recognize the uncertainty inherent in the risk assessment process. None of the results presented are point estimates. In actuality all estimates of potential risks should be considered distributions of potential outcomes that reflect the range of possible values of all component variables (i.e., the range of values for exposure and toxicity factors). As conducted, the baseline risk assessment of Site 1 at Niagara Falls IAP yields conservative, upper-bound estimates of the potential for adverse health effects.

The major factors that lead to an overestimation of potential risks include; (1) use of one half the detection limit for "not detected" results in calculation of the arithmetic means that were used as the basis of exposure and dose estimates; (2) the assumption that all chemicals are conservative in the environment and do not transform or degrade over the period of exposure; (3) the assumption that all chemicals are 100 percent bioavailable for uptake and absorption; and (4) the adoption of conservative ingestion rates for exposure to contaminated groundwater and soils.

Given the hypothetical, conservative nature of the baseline risk assessment, it is unlikely that the potential risks to human health have been underestimated. Although ingestion exposure of Base personnel to groundwater is an incomplete pathway, there is no more plausible alternate pathway to use as the basis of the risk assessment or for comparison in the evaluation of uncertainty. As discussed above, exposure of offsite receptors to site-related contaminants in groundwater is not occurring. Note that any of groundwater contamination originating at Site 1 that might hypothetically reach old offsite dug wells would result in concentrations at these locations, orders of magnitude below that detected on Base.

4.1.1.2.4.2 Baseline Risk Assessment for Site No. 2

This section presents the baseline risk assessment for Site 2. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 2 - Data Analysis and Hazard Identification

Chemicals of concern for Site 2 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

Mean levels of TPH in soils at Site 2 were 54.45 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons in subsurface soils that have not been incorporated into the listing of chemicals of concern. As noted in the sections that follow however, exposure to soil is not a pathway of concern at Site 2. The concentrations of TPH in groundwater at the site was considerable lower; mean value equal to 0.8 mg/L.

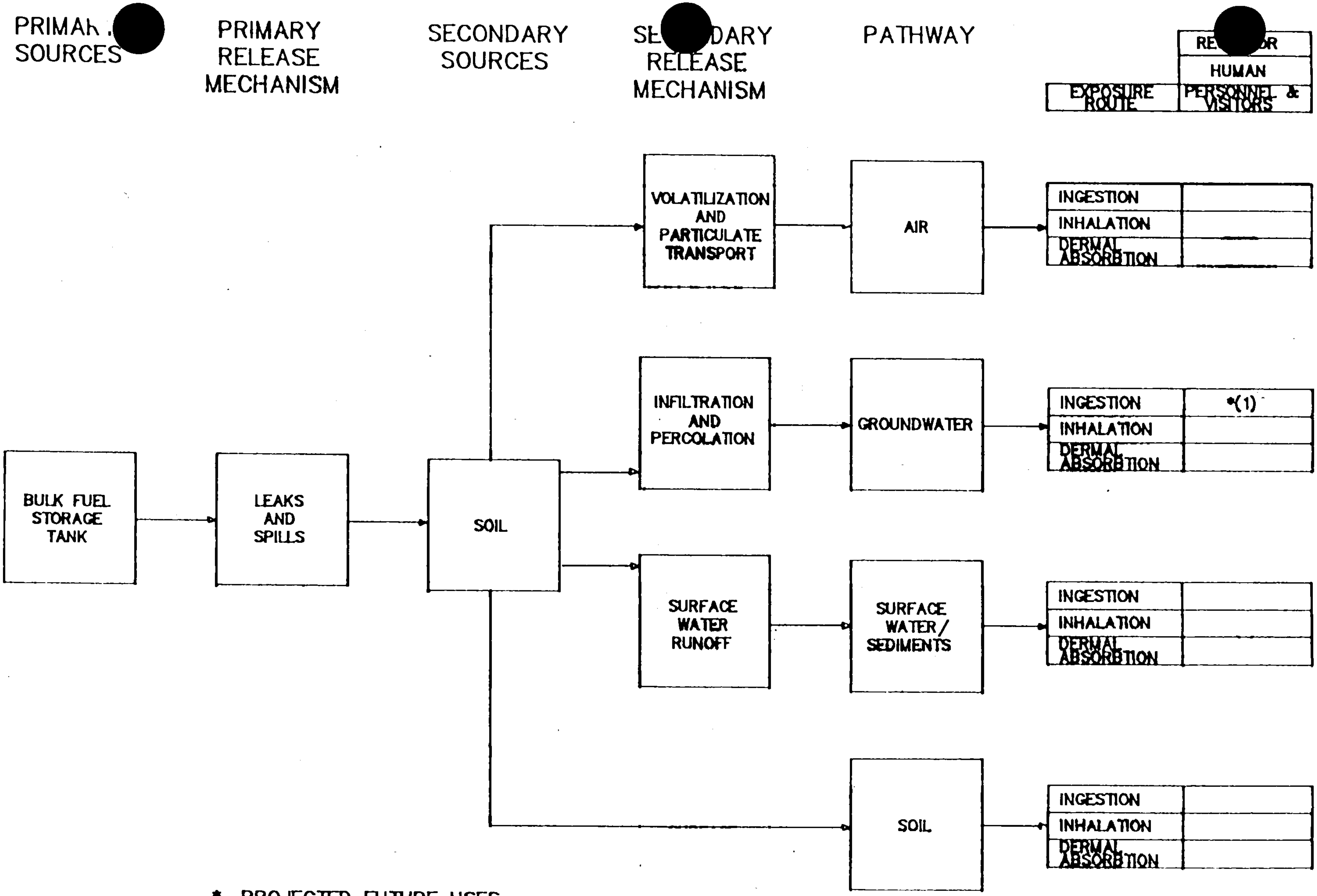
Site No. 2 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater at the site are presented in Section 4.1.1.2.4.1, Exposure Assessment. Please refer to this section for a detailed presentation.

A leaking pipe connected to the bulk fuel storage Tank C was discovered in 1982. At this time, underground pipes at the site were excavated and replaced. Approximately 4,000 gallons of fuel leaked from the storage tank however, before repair and pipe replacement was completed. The conceptual site model for exposure to chemicals released from the storage tank at Site 2 is presented in Figure 4-14.

Soil

Site No. 2 (JP-4 Tank C) is fenced within the Petroleum, Oil, and Lubricants storage yard and access is limited (i.e., this is a higher security area). The site is partially covered with asphalt. Given the limited access and the existence of paved areas, exposure to soil (inhalation of particulates, ingestion, and dermal contact) was not evaluated.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie, AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-14
CONCEPTUAL SITE MODEL
SITE 2 - JP-4 TANK C

Surface Water/Sediments

The area around Tank C is diked preventing surface water runoff from the site. Tank C is approximately 1000 ft from Cayuga Creek, with no drainage ditches providing access to the creek. Transport of chemicals in runoff and exposure to surface water and sediments was not evaluated at Site 2.

Groundwater

The rationale for assessing exposure to groundwater as a pathway of concern at Site 2 is presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). This section presents a discussion of all exposure assumptions. A detailed evaluation of the exposure pathways is provided in Appendix G.

Site No. 2 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 2 - Risk Characterization

The results of risk characterization for exposure to groundwater at the Site 2 are presented in Table 4-24. The hazard index for combined exposure across compounds is approximately 1.0×10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater at Site 2. The excess lifetime cancer risk of hypothetical exposure to groundwater was calculated to be approximately 2×10^{-8}. This is within the acceptable range established by EPA for waste site remediation. Benzene was the only potentially carcinogenic compound detected in groundwater at the site.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. No Federal MCLs were exceeded at Site 2. The mean concentration of manganese (1010 ug/L) exceeded the numerical groundwater limit established by the state of New York (300 ug/L). New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

TABLE 4-24

RISK CHARACTERIZATION FOR SITE NO. 2: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Excess Noncarcinogenic Effects: Target Organ System	Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	754.00			
Barium	35.00	6.87E-03	Hypertension	
Copper	8.00	2.12E-03	GI Tract, Blood	
Lead	3.00	2.10E-02	CNS, Kidney	
Manganese	1010.00	4.95E-02	CNS, Reproductive	
Nickel	13.00	6.38E-03	Skin, Lung	
Zinc	179.00	8.78E-03	GI Tract	
ORGANICS				
Benzene	0.19	5.18E-03	Hematopoietic Sys.	1.54E-08
[illegible]uene	0.22	7.20E-06	CNS	
Hazard Index: Combined Exposure		9.99E-02		
Excess Lifetime Cancer Risk: Combined Exposure				2E-08

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

Site No. 2 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater is presented in Section 4.1.1.2.4.1, Uncertainty in the Risk Assessment. The reader is referred to this section for a complete discussion.

4.1.1.2.4.3 Baseline Risk Assessment for Site No. 4

This section presents the baseline risk assessment for Site 4. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

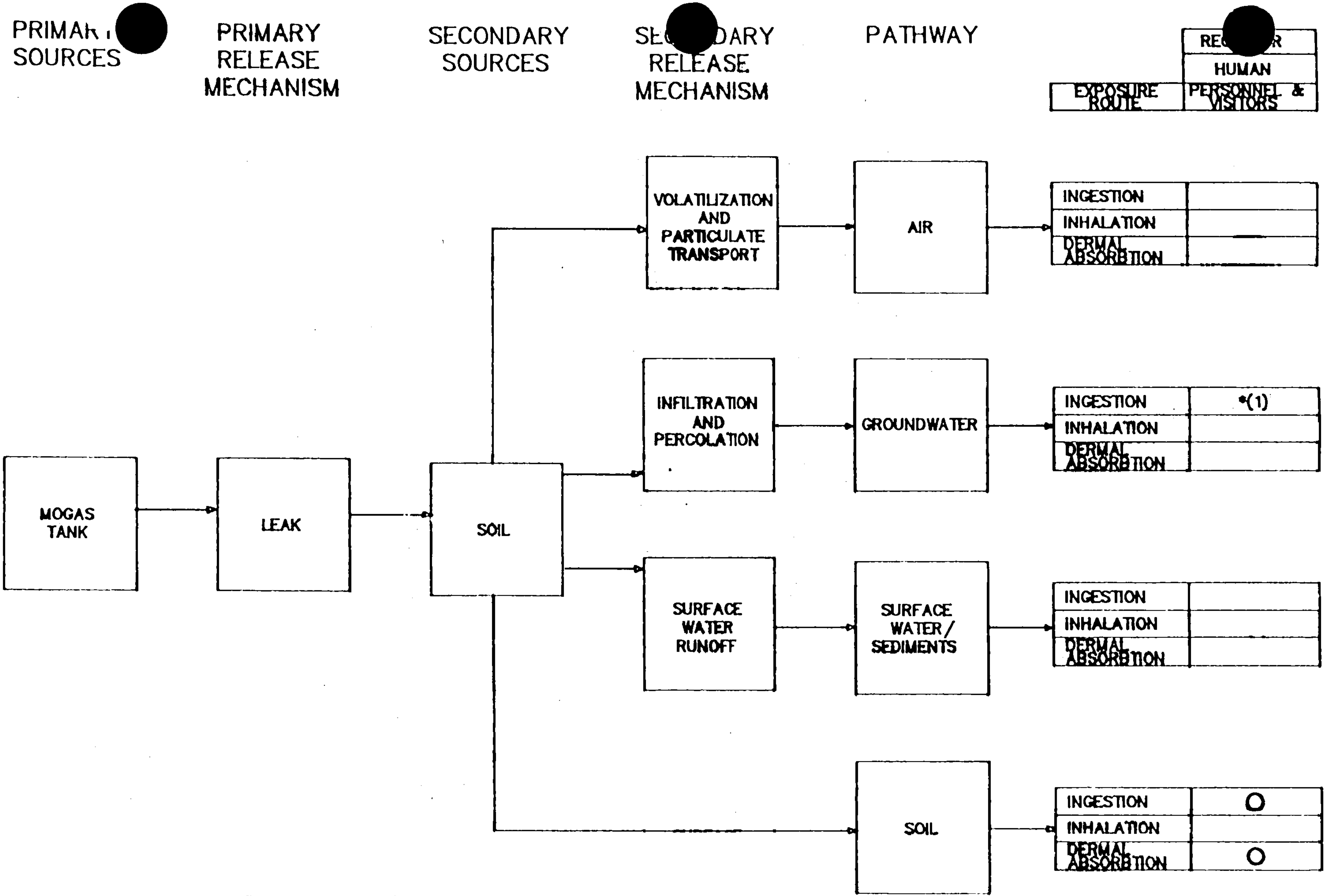
Site No. 4 - Data Analysis and Hazard Identification

Chemicals of concern for Site 4 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

Levels of TPH in soils at Site 4 were elevated (mean concentrations equal to 48.9 mg/kg) indicating the presence of aliphatic and olefinic hydrocarbons in subsurface soils that have not been incorporated into the listing of chemicals of concern. These chemicals likely reflect the presence of residual fuel-related compounds. TPH was not detected in groundwater at the site.

Site No. 4 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater at the site are presented in Section 4.1.1.2.4.1, Exposure Assessment. Please refer to this section for a detailed presentation. The conceptual site model for Site 4 is presented in Figure 4-15. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at the site is provided in Appendix G.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (Ie. AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-15
CONCEPTUAL SITE MODEL
SITE 4 - BX MOGA TANK LEAK

Soil

A pipe leading to the underground MOGAS tank ruptured in 1981 permitting groundwater intrusion into the tank. An undetermined amount of fuel was dispersed in the surrounding soil. The area of contamination currently consists of improved grounds and is highly trafficked (i.e., it is closely located to the base's main buildings of operation). Surface soil may be exposed in areas, thus presenting a pathway for exposure. The assumptions for exposure of base personnel to soils are described below and are documented further in Appendix G.

- Base personnel come into direct contact with soils at Site 4 and inadvertently ingest 0.1 grams of soil per day, two days per week, 20 weeks per year, for 20 years out of a 70 year lifetime. Note that monitoring results for the entire soil column were used in calculation of the arithmetic mean. Field screening did not indicate contamination of surface soils. Consequently, an evaluation was conducted of hypothetical chronic exposure to contamination in the soil column. This assessment is designed to provide a measure of the significance of observed levels of chemicals in the subsurface environment.
- Chemicals in the ingested soil are assumed to be completely bioavailable for uptake and absorption.
- Chemicals in soil at the site are assumed to be conservative (i.e., do not degrade or transform over time).
- The following evaluation of site risk, using the above assumptions, is functionally equivalent to a site specific quantitative assessment of site risk as required by OSWER Directive 9502.00-6D. The specific health-based soil criteria presented in OSWER Directive 9502.00-6D do not strictly apply to sites at this base due to variances in exposure assumption. Sites which demonstrate excess risk from exposure assessments will be targeted for further action, including the calculation of specific quantitative health-based criteria for site remediation.

Groundwater

The rationale for assessing exposure to groundwater as a pathway of concern at Site 4 is presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). This section presents a discussion of all exposure assumptions. A detailed evaluation of the exposure pathways is provided in Appendix G.

Site No. 4 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 4 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at the Site 4 are presented in Table 4-25. The hazard index for combined exposure across compounds is approximately 6.6 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater. The excess lifetime cancer risk was estimated to be approximately 5 x 10^{-7}. This result falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The cancer risk is attributable to the presence of benzene in groundwater.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Benzene was the only compound for which the mean concentration exceeded the MCL (5.86 ug/L at Site 4 vs. an MCL of 5.0 ug/L). Mean concentrations of lead (45 ug/L), manganese (1410 ug/L) and zinc (352 ug/L) were greater than the groundwater limits established by the state of New York (25 ug/L, 300 ug/L, and 300 ug/l respectively). The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

Soil Pathway

The results of risk characterization for exposure to soil at the Site 4 are presented in Table 4-26. The hazard index for combined exposure across compounds is approximately 1.3 x 10^{-5}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils at Site 4 is 1 x 10^{-9}. This result falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation under the Superfund Program.

Site No. 4 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and is presented in Section 4.1.1.2.4.1, Uncertainty in the Risk Assessment. The reader is referred to this section for a complete discussion.

TABLE 4-25

RISK CHARACTERIZATION FOR SITE NO. 4: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	3550.00			
Barium	109.00	2.14E-02	Hypertension	
Cobalt	8.00		Thyroid, Heart	
Lead	45.00	3.15E-01	CNS, Kidney	
Manganese	1410.00	6.92E-02	CNS, Reproductive	
Nickel	141.00	6.92E-02	Skin, Lung	
Vanadium	6.00	8.41E-03	Respiratory Effects	
Zinc	352.00	1.73E-02	GI Tract	
ORGANICS				
Benzene	5.86	1.60E-01	Hematopoietic Sys.	4.76E-0
Ethylbenzene	0.69	6.77E-05	Skin, Liver, Kidney	
Hazard Index: Combined Exposure		6.61E-01		
Excess Lifetime Cancer Risk: Combined Exposure				5E-07

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a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-26

RISK CHARACTERIZATION FOR SITE NO. 4: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Acetone	3.70	5.80E-06	Liver, Kidney	
Benzene	0.45		Hematopoietic Sys	5.81E-10
2-Butanone	0.88	2.76E-06	CNS, Fetotoxicity	
Ethylbenzene	0.69	1.08E-06	Skin, Liver, Kidney	
Methylene Chloride	1.40	3.67E-06	Liver, Kidney, CNS	4.72E-10
Xylenes	1.10	8.61E-08	CNS	
Hazard Index: Combined Exposure		1.34E-05		
Excess Lifetime Cancer Risk: [illegible]mbined Exposure				1E-09

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

No surveys have been conducted on frequency of contact of Base personnel with soils at this site. However, as conducted, the baseline risk assessment of exposure to soils at Site 4 is believed to yield conservative, upper-bound estimates of the potential for adverse health effects. The major factors that lead to an overestimation of potential risks include; (1) use of one half the detection limit for "not detected" results in calculation of the arithmetic means that were used as the basis of exposure and dose estimates; (2) the assumption that all chemicals are conservative in the environment and do not transform or degrade over the period of exposure; (3) the assumption that all chemicals are 100 percent bioavailable for uptake and absorption; (4) evaluation of hypothetical exposure to higher levels of contamination in subsurface soils; and (5) the adoption of conservative ingestion rates for exposure to soils.

Note that intake values for soil ingestion were based on data for the full soil column, not surface soils (insufficient data were available for concentrations in surface soil). Further it has been assumed that all inadvertent soil ingestion for an individual takes place on Site 4. The 100 ug/day value for soil contact was calculated as a total ingestion rate (i.e. from all exposures throughout the day). Even using these very conservative assumptions, the risk estimates were within the acceptable range established by EPA.

4.1.1.2.4.4 Baseline Risk Assessment for Site No. 6

This section presents the baseline risk assessment for Site 6. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 6 - Data Analysis and Hazard Identification

Chemicals of concern for Site 6 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

Mean levels of TPH in soils at Site 6 were 17.2 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. As discussed in the following sections however, exposure to soils at Site 6 is not a pathway of concern. TPH was not detected in groundwater at the site.

Site No. 6 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater at the site are presented in Section 4.1.1.2.4.1, Exposure Assessment. Please refer to this section for a detailed presentation.

The conceptual site model for Site 6 is presented in Figure 4-16. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 6 is provide in Appendix G.

Soils

Site No. 6 (JP-4 Tank A) is fenced within the Petroleum, Oil, and Lubricants storage yard and access is limited (i.e., this is a higher security area). The site is partially covered with asphalt. Given the limited access at the site and the presence of paved areas, exposure to soil (inhalation of particulates, ingestion, and dermal contact) was not evaluated as a pathway of concern.

Surface Water/Sediments

The area around Tank A is diked preventing surface water runoff. Tank A is approximately 1000 ft from Cayuga Creek, with no drainage ditches providing access to the creek. Exposure of Base personnel to surface water and sediments was not evaluated as pathways of concern for Site 6.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 6 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

Site No. 6 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 6 - Risk Characterization

The results of risk characterization for exposure to groundwater at Site 6 are presented in Table 4-27. The hazard index for combined exposure across compounds is approximately 1.1×10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater at Site 6. No potentially carcinogenic compounds were detected in groundwater at the site.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean levels of none of the chemicals present in groundwater at Site 6 exceeded MCLs. New York State groundwater limits (300 ug/L each) were exceeded by mean concentrations of manganese (407 ug/L) and zinc (407 ug/L).

Site No. 6 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater is presented in Section 4.1.1.2.4.1. The reader is referred to this section for a more complete discussion.

4.1.2. Discussions of Results for Site No. 3: Landfill

4.1.2.1. Presentation of Results

4.1.2.1.1. Site Geology

The geology of Site No. 3 as interpreted from the Stage 1 and RI well boring logs is similar to that encountered at the combined site study area (e.g. Sites 1, 2, 4 and 6): a predominantly fine grained veneer of glacial till and lacustrine deposits resting upon a massive to thinly bedded dolomite. The location of all IRP monitoring wells in the vicinity of Site No. 3 is presented in Figure 4-17. The unconsolidated materials achieve a maximum thickness in the northern and northeastern portions of the study area and thin rapidly to the south. The unconsolidated overburden was measured at 12.3 feet north of Utzig

TABLE 4-27

RISK CHARACTERIZATION FOR SITE NO. 6: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	1240.00			
Barium	25.00	4.91E-03	Hypertension	
Copper	23.00	6.10E-03	GI Tract, Blood	
Lead	8.00	5.61E-02	CNS, Kidney	
Manganese	407.00	2.00E-02	CNS, Reproductive	
Nickel	11.00	5.40E-03	Skin, Lung	
Zinc	407.00	2.00E-02	GI Tract	
Hazard Index: Combined Exposure		1.12E-01		
cess Lifetime Cancer Risk: mbined Exposure				

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

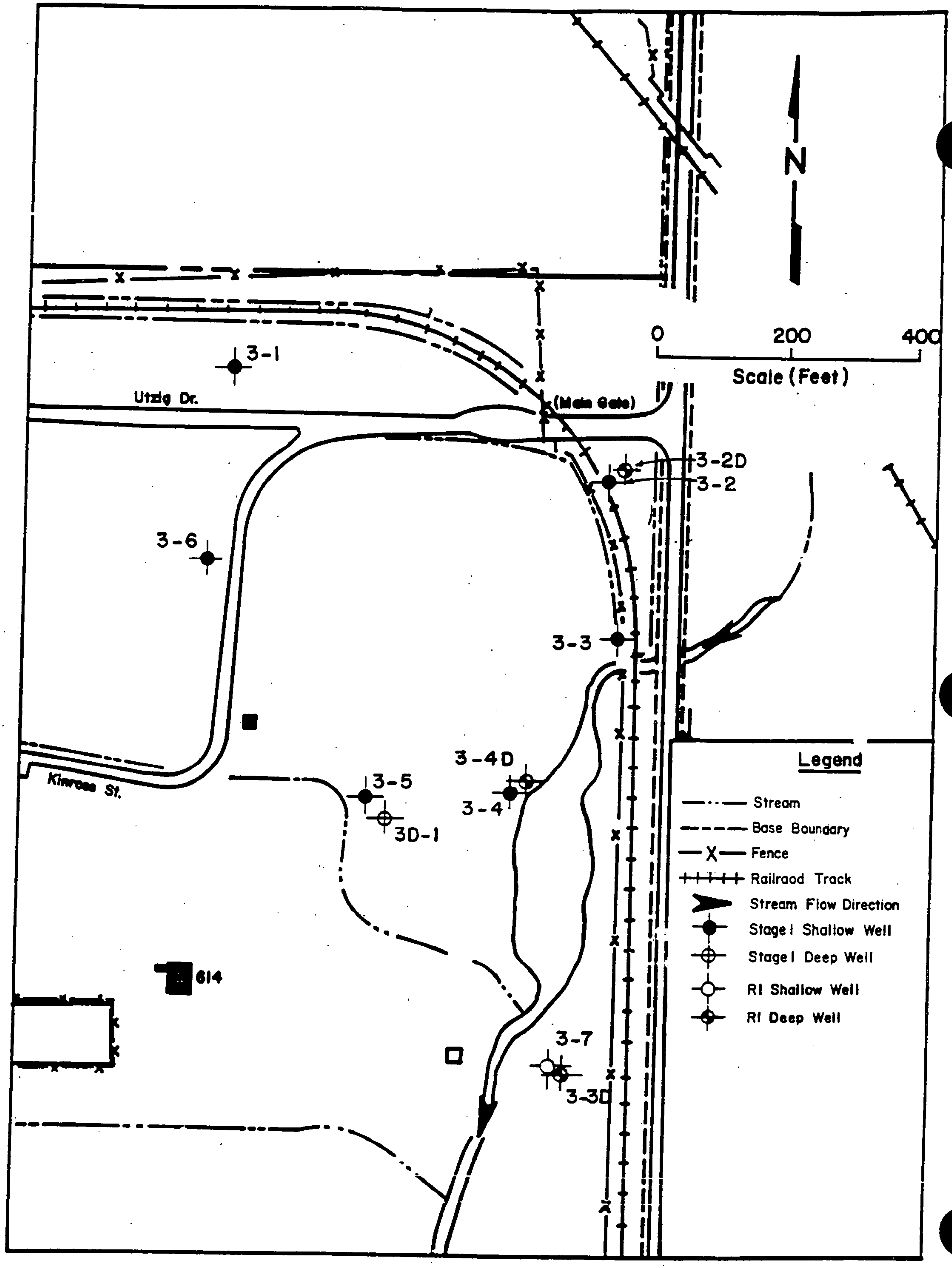


FIGURE 4-17
SITE NO. 3: MONITORING WELL LOCATION MAP

Drive at monitoring well MW3-1 and 3.0 feet at the shallow-deep well pair MW3-5/MW3D-1. The bedrock outcrops in several areas south of the drainage ditch located due south of this well pair. The dolomite also forms the stream bed of Cayuga Creek which flows south-southwest along the eastern margin of the Site No. 3 study area. The Lockport Dolomite reportedly achieves a maximum thickness of 180 feet beneath the installation. A generalized geologic cross-section of the Site No. 3 study area is presented in Figure 4-18.

Nearly all soils in the vicinity of Site No. 3 belong to the Odessa Series. This soil type was encountered in the Site Nos 1, 2, 4 and 6 study area and is described in Section 4.1.1.1.1. A minor soil group in the Site 3 study area are the cut and fill materials in the extreme northeast corner of the facility and a narrow strip of Wayland silt loam along the banks of Cayuga Creek. The cut and fill soils consist of a heterogeneous mixture of soil materials that have little or no profile development. The Wayland silt loam has a very dark grayish-brown silt loam surface layer approximately 8-inches thick. The upper part of the subsoil is friable, mottled, dark-gray silt loam. The lower part of the subsoil consists of firm, mottled brown silt loam. Those wells close to Cayuga Creek (i.e. MW3-2D, MW3-2, MW3-3, MW3-4D, MW3-4, MW3-7 and MW3-3D) are installed in the Wayland silt loam.

As at other sites, the lacustrine deposits form the uppermost deposits when present. Lacustrine materials are inferred to be absent along the eastern edge of the site. In those areas where lacustrine materials are present, it overlies a deposit of clay rich till which rests directly on the bedrock. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. Both of these units were described previously in Section 4.1.1.1.1. Glacial till deposits are present at the surface along the eastern margin of Site No. 3 and form a subsurface deposit at all other locations within the Site No. 3 study area. As was the case at Site Nos. 1, 2, 4 and 6, the average thickness of each unit could not be ascertained due to the limited number and discontinuous nature of soil samples collected during the Stage 1 drilling effort and the inherent problems associated with their similarities. The use of sample sleeves during the drilling of the RI well borings also

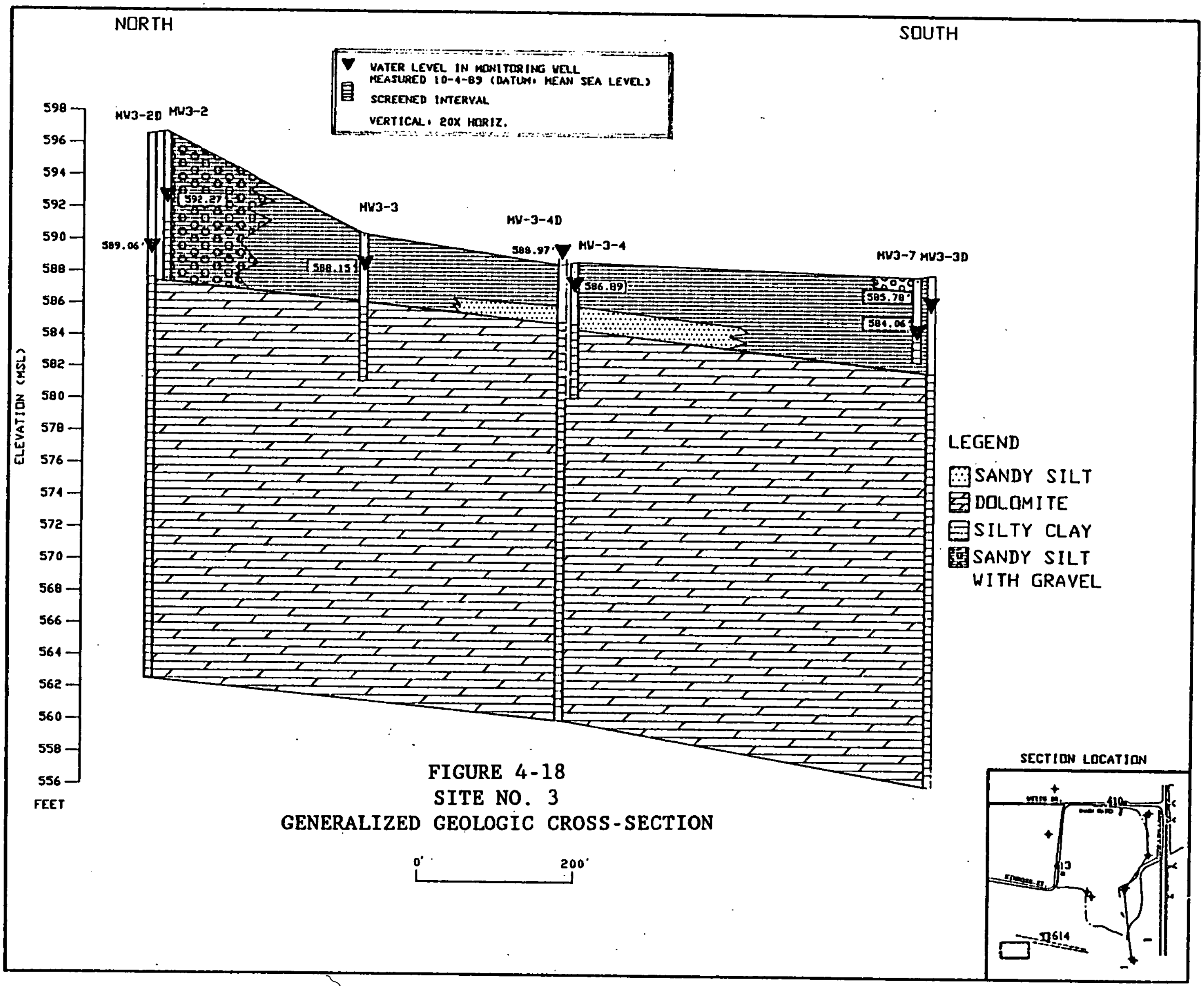


FIGURE 4-18
SITE NO. 3
GENERALIZED GEOLOGIC CROSS-SECTION

obstructed efforts to obtain subsurface control at this site, since the metal sleeves concealed all but the top and bottom portions of the soil samples.

Intercalations of fluvial sediments occur sporadically throughout the Site No. 3 study area. Fluvial materials occur at the surface in the vicinity of MW3-4D which implies that portions of Cayuga Creek occasionally meander.

The bedrock surface beneath the Site No. 3 study, area as interpreted from well boring logs, is generally smooth to slightly irregular. Irregularities are interpreted to be the result of preglacial erosion processes. Glacial processes probably subdued most of the irregular features. The bedrock surface slopes generally toward the east-southeast as depicted in the structural contour map constructed for Site No. 3 (Figure 4-19).

A general log of the upper Lockport Dolomite was determined. Air rotary drilling was somewhat successful in detecting zones of incompetent bedrock. Zones of incompetent bedrock, interpreted as fractured or thinly bedded zones, or localized concentrations of vugs or solution cavities, probably serve as the principal water bearing zones in the upper Lockport Dolomite. Most zones of incompetent bedrock occur within the upper 10-15 feet of bedrock. Fifteen feet below the bedrock surface incompetent zones were only rarely detected. This pattern is consistent with the upper bedrock geology across the installation.

4.1.2.1.2. Site Hydrogeology

The shallow unconsolidated aquifer and the upper bedrock aquifer, referenced as the shallow and deep aquifer respectively, were investigated at Site No. 3. Cayuga Creek, which flows along the eastern site boundary, was also investigated.

The principal water-bearing interval of the shallow aquifer identified during the Stage 1 and RI well drilling programs is a thin 1 to 1.5 foot saturated horizon of silty clay till containing some gravel and sand. This horizon which occurred at the bedrock - unconsolidated overburden interface. The

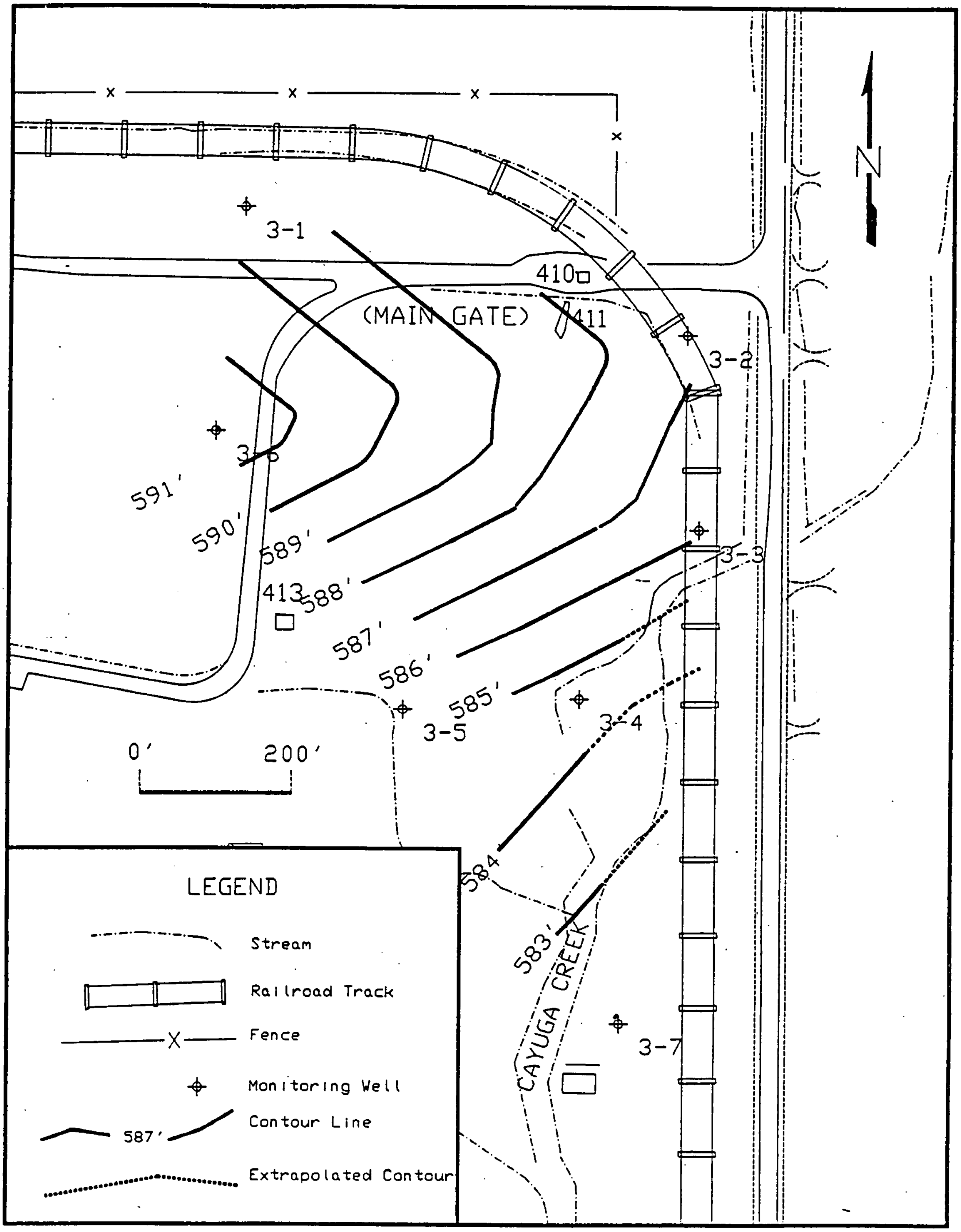


FIGURE 4-19
SITE NO. 3: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

overlying units of till and lacustrine silty clay probably function as an aquitard, resulting in a confined water table. Between May 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 2.76 feet. During April 1990 water levels exhibited a range in elevation from 599.92 feet MSL at MW3-1 to 587.36 feet MSL at MW3-4. The maximum head differential is 12.56 feet and the hydraulic gradient is 0.0161. According to the groundwater flow modeling study (Mercer et. al., 1983) conducted at Love Canal, a hydraulic gradient of 0.0036 is more typical of the unconsolidated aquifer. The steeper gradient interpreted from the Site No. 3 shallow monitoring wells is probably a hydrogeologic anomaly that exists only during the wetter Spring months.

A maximum average water level fluctuation of 2.85 feet was observed in the shallow Site No. 3 monitoring wells between October 1989 and April 1990. As a general trend, water levels seem to be lowest in October and highest in April. Table 4-28 presents all the hydrogeologic data collected in the field. Figures 4-20 and 4-21 present potentiometric surface maps constructed for the shallow unconsolidated aquifer from the October 1989 and April 1990 water-level measurements at Site No. 3. Groundwater flow in the shallow system exhibit some variation between the Fall and Spring months, but is generally southeast toward Cayuga Creek.

During the Stage 1 effort, three shallow wells were installed five feet into the bedrock (i.e. MW3-3, MW3-4 and MW3-5) because of the thin nature of the overburden deposits in these areas and the high likelihood that the shallow aquifer is in communication with the bedrock aquifer as a consequence of the cut and fill techniques used in land-filling. Due to this well construction, water level measurements from MW3-3, MW3-4 and MW3-5 are not entirely representative of shallow aquifer conditions in the vicinity of these wells.

The locations of water bearing zones in the upper portions of the Lockport Dolomite beneath Site No. 3 were inferred to be zones of incompetent bedrock. Zones of incompetent bedrock are characterized by isolated or extensive intervals of abundant bedding plane separations, joints, fractures, vugs or solution cavities. It is not likely that all zones encountered are water-bearing. In

TABLE 4-28

Site No. 3 - Hydrogeologic Data

Static Water Level Results

Monitor Well No	05-31-89 Water Levels Elevation feet MSL	05-31-89 Water Levels Depth feet BLS	09-12-89 Water Levels Elevation feet MSL	09-12-89 Water Levels Depth feet BLS	10-04-89 Water Levels Elevation feet MSL	10-04-89 Water Levels Depth feet BLS	04-11-90 Water Levels Elevation feet MSL	04-11-90 Water Levels Depth feet BLS
3-1	599.36	2.36	596.74	4.98	597.43	4.29	599.92	1.80
3-2	593.03	3.76	591.57	5.22	592.27	4.52	595.41	1.38
3-3	589.06	1.35	587.24	3.17	588.15	2.26	590.30	0.11
3-4	587.17	1.54	587.24	1.47	586.89	1.82	587.36	1.35
3-5	589.95	2.41	589.26	3.10	589.36	3.00	592.21	0.15
3-6	596.02	4.06	594.60	5.48	594.35	5.73	599.49	0.59
3-D1	590.14	1.12	588.92	2.34	589.01	2.25	591.05	0.21
3-2D	NI	NI	589.10	7.57	589.06	7.61	591.03	5.64
3-3D	NI	NI	588.08	0.86	585.78	2.30	590.89	2.81
3-4D	NI	NI	588.54	0.46	588.97	0.43	590.88	2.34
3-7	NI	NI	583.52	4.41	584.06	3.87	587.75	0.18

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW3-2 (1)	$\geq 10^{-3}$ ft/s	4.0 ft	4.00×10^{-3} ft^2/s
MW3-6 (1)	$\geq 10^{-3}$ ft/s	4.0 ft	4.00×10^{-3} ft^2/s
MW3-4 (2)	3.00×10^{-7} ft/s	4.0 ft	1.20×10^{-6} ft^2/s
MW3-5 (1)(2)	$\geq 10^{-3}$ ft/s	4.0 ft	4.00×10^{-3} ft^2/s

Notes:

NI = Not Installed
(1) Estimated value; injected water could not be added quick enough to maintain a head for measurement of decline
(2) Wells installed 5 feet into bedrock
ft.BLS = feet below land surface
ft.MSL = feet in reference to mean sea level
ALS = above land surface
Transmissivity was calculated as follows: $K \cdot B = T$.
Saturated Thickness was determined by measuring the length of screen below the static water level.

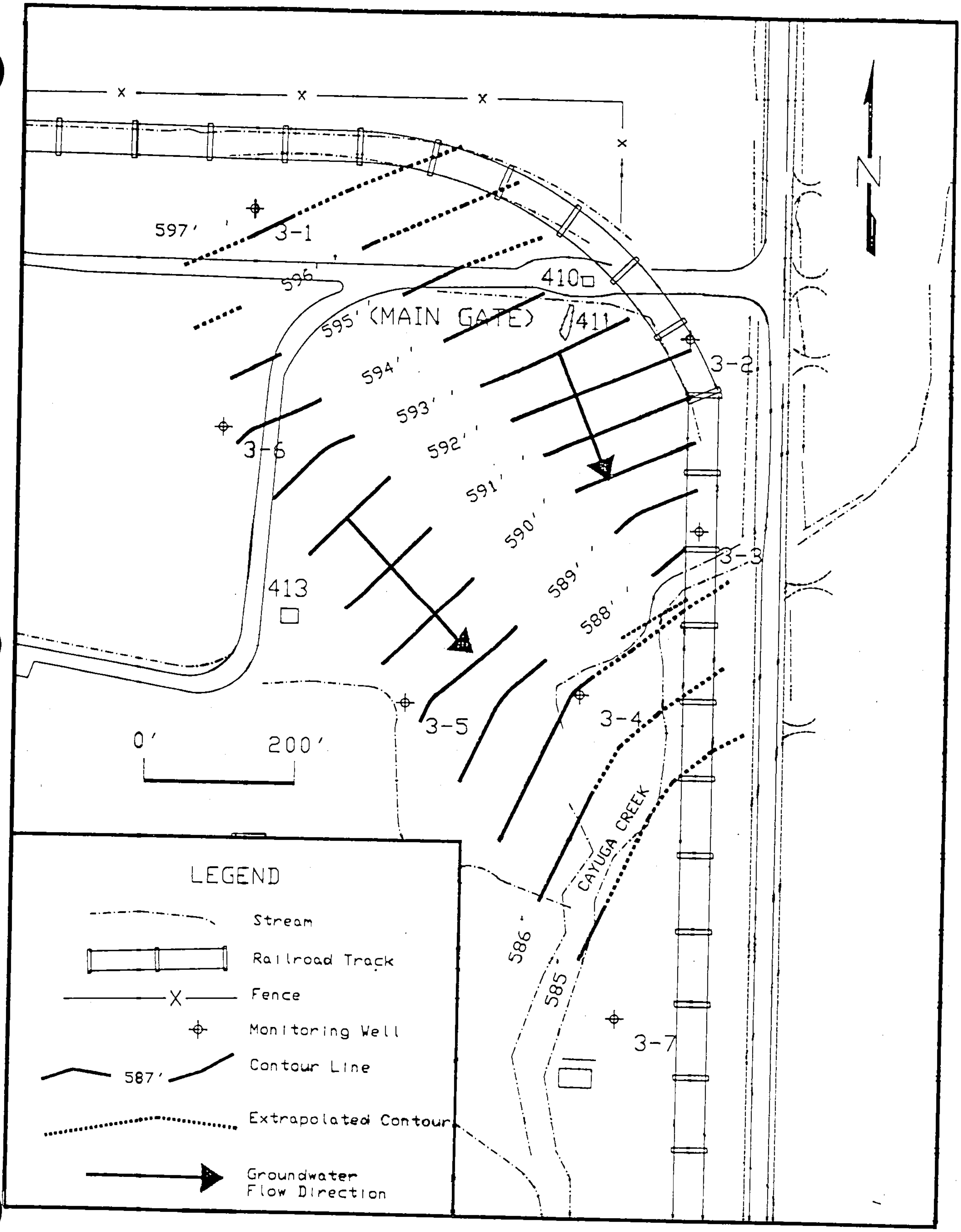


FIGURE 4-20
SITE NO. 3: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

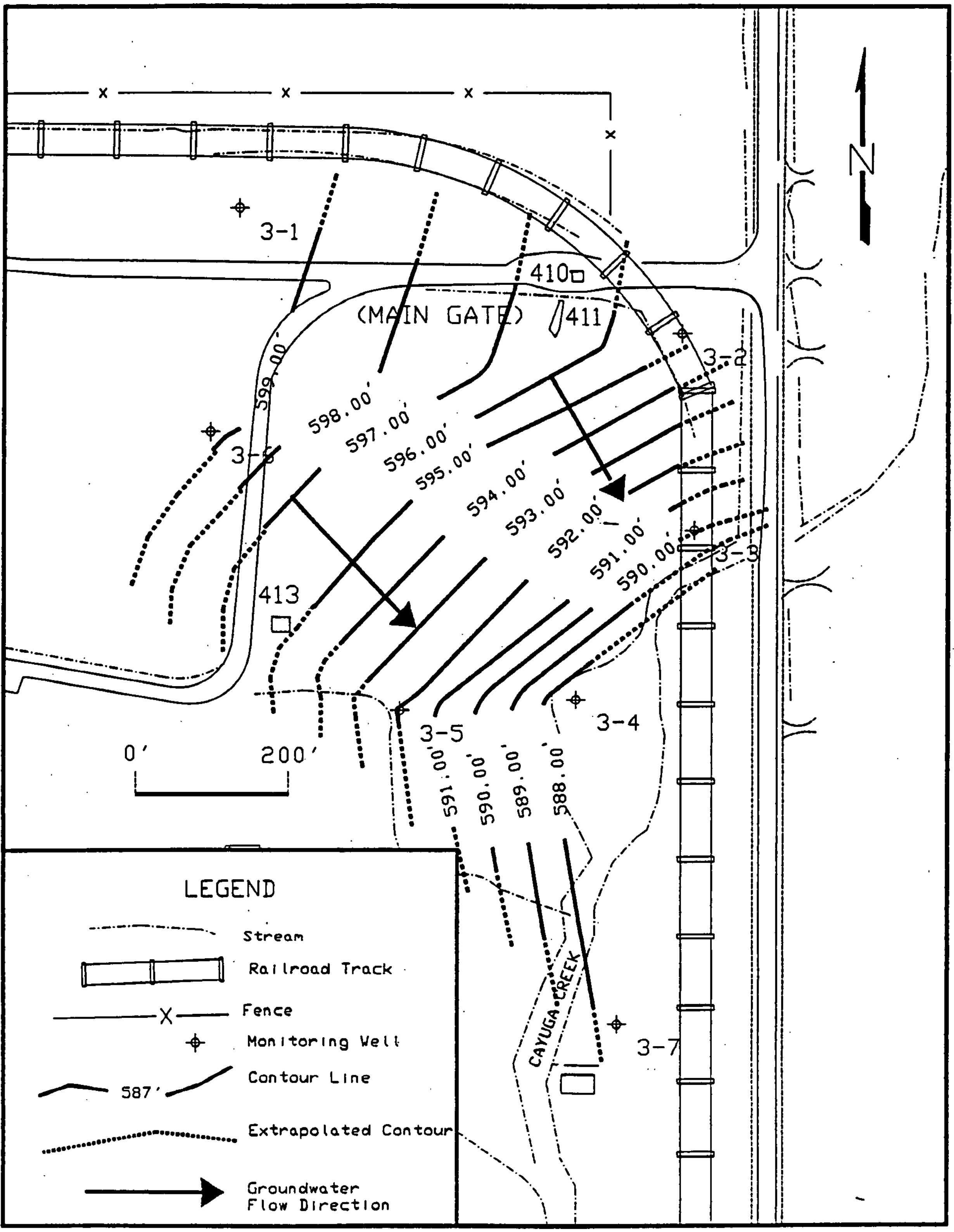


FIGURE 4-21
SITE NO. 3: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

areas where vertical fractures connect the upper bedrock aquifer to the principal water bearing zone of the unconsolidated aquifer, the overlying glacial till and lacustrine deposits act to confine the aquifer. Between May 1989 and April 1990, water levels measured in the upper bedrock wells, not including the shallow monitoring wells that extend five feet into the bedrock, averaged 1.72 feet below land surface. During April 1990, water levels exhibited a range in elevation of 591.05 feet MSL at MW3-D1 to 590.88 feet MSL at MW3-4D. Monitoring wells MW3-4D and MW3-3D, located along the west and east bank of Cayuga Creek, respectively, are flowing artesian wells; the water levels respectively stand 1.08 feet and 0.46 feet above land surface. The maximum head differential of the upper bedrock aquifer across Site No. 3 is 0.17 feet and the hydraulic gradient is 0.0007. A maximum average water level fluctuation of 2.76 feet was observed in the Site No. 3 bedrock wells between October 1989 and April 1990. Due to the very slight hydraulic gradient interpreted from the April 1990 water level measurements a meaningful potentiometric surface map could not be constructed. Figure 4-22 presents a potentiometric surface map of the upper bedrock aquifer at Site No. 3 constructed from the October 1989 water level measurements. Groundwater flow in the bedrock aquifer is interpreted to be to the south-southeast. Cayuga Creek has been identified by the USGS as a gaining system and appears to exert a local influence on the groundwater flow pattern of the upper bedrock aquifer. Cayuga Creek is interperted to act as a local hydraulic barrier to groundwater flow within the upper unconsolidated aquifer. Shallow groundwater moving across the landfill site is expected to discharge, through natural groundwater seepage, into Cayuga Creek.

During the Stage 1 effort, an attempt was made to measure the hydraulic conductivity of the shallow unconsolidated aquifer. The hydraulic conductivity of the upper bedrock aquifer was not measured during the Stage 1 effort. Slug test were performed on shallow monitoring wells MW3-2 and MW3-6. Head levels were recorded using a weighted graduated line with an attached float. Unfortunately, hydraulic conductivities could only be estimated since injected water could not be added quick enough to maintain a head for measurement of decline. Nonetheless, the estimated hydraulic conductivity for both MW3-2 and MW3-6 was $\geq 10^{-3}$ ft/s ($\geq 10^{-2}$ cm/s). Slug tests were also performed on two shallow monitoring wells that were installed five (5) feet into bedrock (i.e. MW3-4 and MW3-5). Hydraulic conductivities calculated for MW3-4 and MW3-5 were 3.0×10^{-7} ft/s (9.0×10^{-6} cm/s) and $\geq 10^{-3}$ ft/s ($\geq 10^{-2}$ cm/s) (estimated) respectively.

As discussed in Section 4.1.1.1.2, the extensive groundwater flow modeling study of the shallow aquifer at Love Canal (Mercer et. al., 1983) reported hydraulic

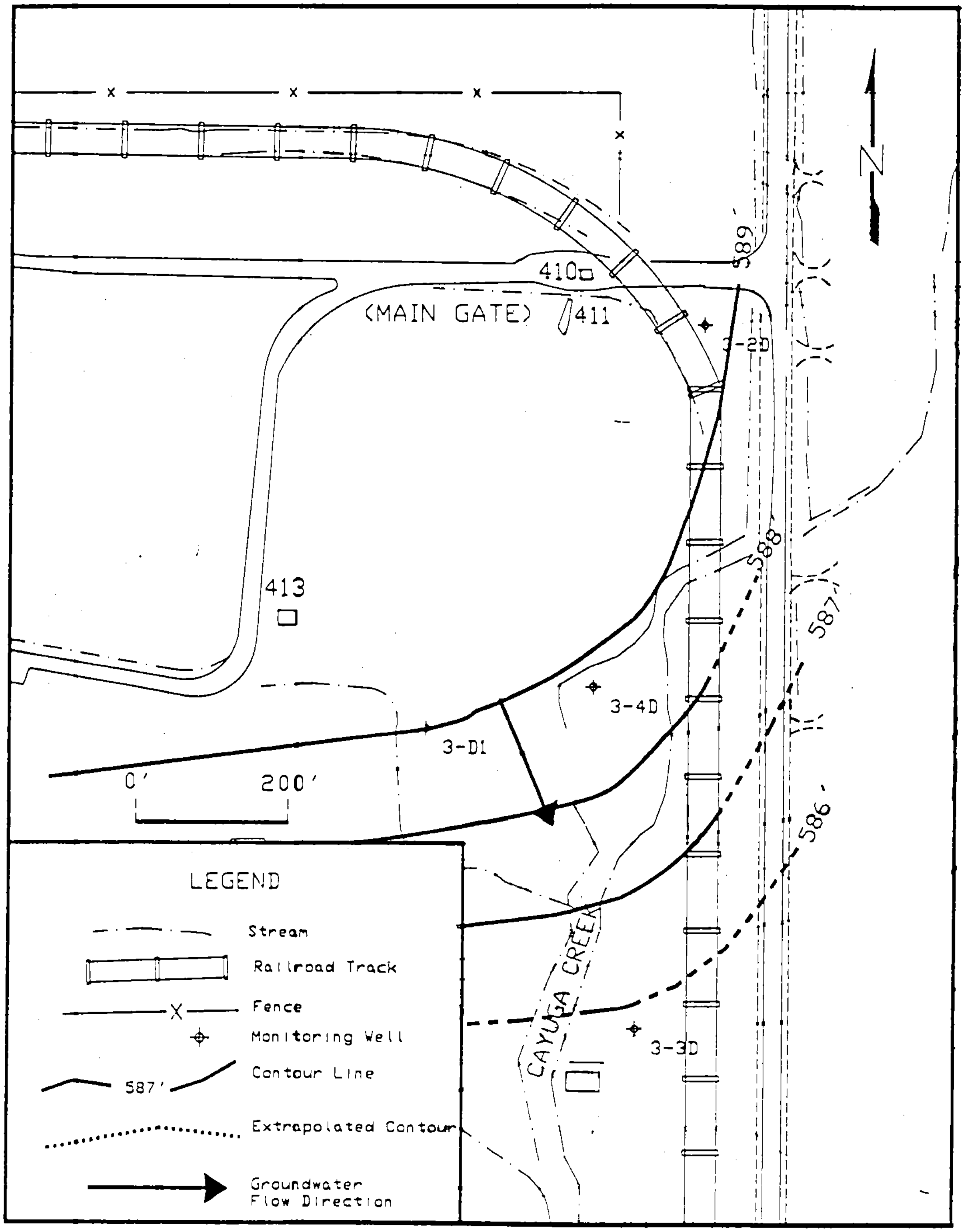


FIGURE 4-22
SITE NO. 3: UPPER BEDROCK AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

conductivities in the range of 10^{-6} to 10^{-7} ft/s, an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. The hydraulic conductivity yielded by the Stage 1 slug test on MW3-4 was consistent with the Love Canal values, despite the fact that a portion of this well is screened in the upper bedrock aquifer. Using the hydrogeologic data from the flow modeling study, horizontal groundwater flow velocities of 2.1×10^{-4} to 2.1×10^{-3} ft/day are predicted for the unconsolidated aquifer at Site No. 3. These velocity values equate to a flow of 7.7×10^{-2} to 7.7×10^{-1} ft/year. According to the USGS (1985), groundwater flow in the shallow aquifer at an industrial property located nearby ranged from 2.0×10^{-2} to 6.0×10^{-2} ft/year.

Based upon transmissivities and the average thickness reported for the uppermost water bearing zone of the Lockport Dolomite at a nearby hazardous waste disposal site (EPA, 1983), a 26% effective porosity value (Brassington, 1988) and the hydraulic gradient discussed in this section, horizontal groundwater velocities on the order of 2.3×10^{-1} ft/day or 84 ft/year are predicted for upper bedrock aquifer at Site No. 3. Horizontal groundwater velocities of the upper bedrock aquifer are considerably greater than those predicted for the unconsolidated aquifer.

Cayuga Creek flows along the eastern boundary of the site. The creek enters the base at a point near shallow monitoring well MW3-3 and flows south-southwest along the eastern extremity of the landfill. A portion of Site No. 3 is located within the 100-year and 500-year floodplain. The creek opens up into a small man-made pond (Narron's Pond) in the vicinity of monitoring well pairs MW3-4/MW3-4D. Figure 4-23 shows the Site No. 3 sampling locations along Cayuga Creek. Table 4-29 displays the average depth, mean velocity and flow at the one monitoring station where discharge measurements could be taken (i.e. 3SW-4/3SD-4). The calculated discharge of 0.30 ft^3/s is probably representative of low flow conditions.

The USGS conducted seepage and discharge measurements along the creek in early August 1989 and one of their stations was situated on the east side of Walmore Road, just upstream from the IRP station. The USGS reported a discharge of 0.735 ft^3/s at the Walmore Road station (Personal Communication, 1989). The

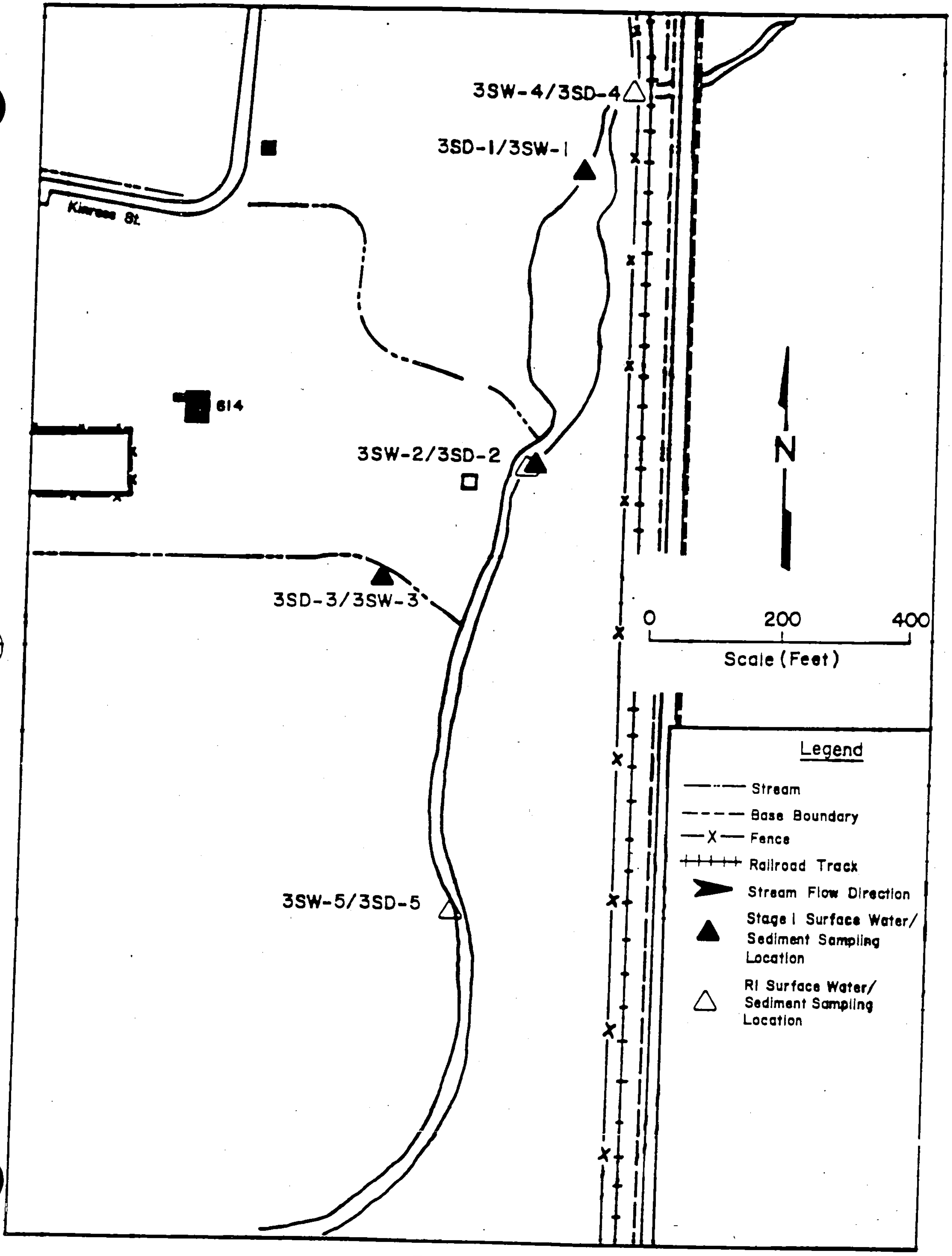


FIGURE 4-23
SITE NO. 3: SURFACE WATER/SEDIMENT SAMPLING STATIONS

TABLE 4-29

Site No. 3: SURFACE WATER DISCHARGE MEASUREMENT DATA

Site/Station No.	Avg. Depth <ft.>	Mean Velocity <ft./sec>	Discharge <CFS>
SITE 3			
3SW-4/3SD-4	0.63	0.04	0.30

ft = feet
ft/sec = feet per second
CFS = cubic feet per second

* Discharge is the total flow of water through the stream channel cross-sectional area.

USGS took another series of measurements further downstream. Of interest to the Site No. 3 study area are the data from a station located near the first taxiway crossing in the man-made channel of Cayuga Creek. A discharge of 0.707 ft^3/s was calculated for this station which suggests the creek is losing some of its flow to the surficial and bedrock aquifer along this reach and possibly gaining flow along the Walmore Road section. The IRP station 3SW-4/3SD-4 is situated along this gaining reach. Along most of the length of Cayuga Creek in the vicinity of Site No. 3, the stream bed consists of exposed dolomitic bedrock with occasional thin patches of lag sands and gravels.

4.1.2.1.3. Analytical Results For Site No. 3: Headspace Analyses

Attempts to perform headspace analyses on groundwater from the Stage 1 monitoring wells previously installed around Site No. 3 were abandoned after discovering that the well casings of four wells were damaged. The damage, believed to be caused by ice build up between the PVC riser and the protective steel casing, prevented the collection of groundwater samples. With one exception (MW3-5), these wells were eventually repaired and were incorporated into the RI groundwater sampling effort.

4.1.2.1.4 Analytical Results for Site No 3: Contract Laboratory

Matrix-specific results are presented for each individual sample in Tables 4-30 through 4-33; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-34. Engineering property characteristics for the Site No. 3 soils are presented in Table 4-35.

Organic Analyses: Nine soil boring samples were analyzed for volatile organics. Eleven groundwater and four surface water samples were analyzed for purgeable halocarbons, purgeable aromatics, pesticides/PCBs, and semivolatile organics. The groundwaters were also analyzed for ethylene dibromide. Four surface sediments were collected and analyzed for volatile organics and semivolatile organics. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

TABLE 4-30
SITE NO. 3: ANALYTICAL RESULTS: SOILS

		Sample Field Identification (Sample Description)								
Parameter (Units)	**Detection Limits**	**WB-3-2D-4 (4.5'-6.0')**	**WB-3-2D-4R (4.5'-6.0') Duplicate**	**WB-3-2D-5 (6.0'-7.5')**	**WB-3-2D-6 (7.5'-9.0')**	**WB-3-3D-1 (4.0'-5.5')**	**WB-3-4D-1 (0-1.5')**	**WB-3-4D-1R (0-1.5') Duplicate**	**WB-3-4D-2 (1.5'-3.0')**	**WB-3-7-4 (4.5'-6.0')**
EPA Method SW8240 (mg/kg) <u>Volatile Organics</u>			NA					NA		
Methylene Chloride	0.005	ND^{b}		0.015^{b}	0.014^{b}	0.07^{b}	0.012^{b}		ND^{b}	<0.006^{*,b}
Acetone	0.010	0.016^{a,b}		0.023^{a,b}	0.021^{a,b}	0.022^{a,b}	0.017^{a,b}		<0.011^{*,a,b}	0.013^{a,b}
Others	See Appendix F	ND		ND	ND	ND	ND		ND	ND
EPA Method SW3050/6010* <u>Total Metals (mg/kg)</u>										
Aluminum^{c}	10.0	12000	13200	14000	4260	7160^{a}	9530^{b}	18500^{b}	12500^{b}	14400
Barium	1.0	66.9^{d}	78.6^{d}	137^{d}	55.2^{d}	58.4^{d}	88.1	80.3	76.0	102
Beryllium	0.2	ND^{d}	ND^{d}	ND^{d}	ND^{d}	ND^{d}	ND^{b}	0.31^{b}	ND^{b}	0.596
Boron	1.0	ND	ND	ND	ND	ND	ND	ND	ND	81.7
Cadmium	0.5	ND	ND	ND	1.4	ND	1.1^{b,d}	2.8^{b,d}	0.91^{b,d}	1.66
Calcium^{c}	50.0	25400	29000	39600	105000	62300	3770	3240	1990	13000
Chromium	1.0	18.3^{d}	17.8^{d}	20.4^{d}	5.8^{d}	11.2^{d}	19.3	18.1	12.6	15.4
Cobalt	1.0	12.5^{d}	10.8^{d}	10.3^{d}	2.0^{d}	7.16^{d}	8.4	8.6	5.9	12.3
Copper	1.0	20.0^{d}	18.3^{d}	20.6^{d}	8.4^{d}	13.7^{d}	8.3^{d}	8.6^{d}	6.6^{d}	28.8
Iron^{c}	2.5	26600	28300	34500	11600	17300^{a}	14500^{b}	51700^{b}	15100^{b}	34200
Lead	5.0	15.4^{b}	25.5^{b}	28.2^{b}	23.2^{b}	17.9^{b}	25.9^{b}	39.6^{b}	15.1^{b}	60.7
Magnesium^{c}	50.0	13400	12900	13700	39100	18500	4420	3990	3290	7780
Manganese	0.5	457^{a}	413^{c}	525^{c}	542^{c}	801^{c}	414^{d}	565^{d}	279^{d}	692
Molybdenum	1.0	ND^{b,d}	2.8^{b,d}	ND^{b,d}	ND^{b,d}	3.31^{d}	ND	ND	ND	ND
Nickel	1.5	27.6^{d}	24.8^{d}	27.9^{d}	7.1^{d}	16.4^{d}	13.8	13.0	11.8	20.0
Potassium^{c}	50.0	1770	1770	2410	796	1130	1540	1400	952	766
Silicon^{c}	100.0	711	677	796	740	884^{a}	461	428	392	1670
Sodium^{c}	50.0	154	152	169	127	129	105	96.4	952	71.1
Vanadium	1.0	25.5^{d}	24.8^{d}	26.9^{d}	9.0^{d}	15.5^{d}	28.3	37.2	18.2	30.1
Zinc	1.0	66.1^{d}	59.9^{d}	187^{d}	206^{d}	295^{d}	426	409	548	687
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 Total Petroleum <u>Hydrocarbons (mg/kg)</u>	5.0	ND	ND	ND	ND	ND	8.9^{b}	ND^{b}	ND^{b}	ND

TABLE 4-30 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	WB-3-2D-4 (4.5'-6.0')	WB-3-2D-4R (4.5'-6.0') Duplicate	WB-3-2D-5 (6.0'-7.5')	WB-3-2D-6 (7.5'-9.0')	WB-3-3D-1 (4.0'-5.5')	WB-3-4D-1 (0-1.5')	WB-3-4D-1R (0-1.5') Duplicate	WB-3-4D-2 (1.5'-3.0')	WB-3-7-4 (4.5'-6.0')
		Sample Field Identification (Sample Description)								
EPA Method SW9060 Total Organic Carbon (mg/kg)	NR	NA	NA	NA	NA	NA	NA	NA	2300	NA

Footnotes:

a = Compound also detected in associated method blank
b = Associated field duplicate analysis exceeded 35% RPD for this parameter. (Note that there is not a field duplicate assoicated with sample WB-3-7-4.)
c = Accuracy data unavailable; this compound was not routinely spiked, or spike recoveries could not be calculated.
d = Matrix spike recovery was below the control limit for this parameter.
* = Or as indicated for those metals analyzed by alternate methods.

NA = Not Analyzed
NR = Not Reported

TABLE 4-31
SITE NO. 3: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description)									
		GW50 (MW-3-1)	GW51 (MW-3-2)	GW52 (MW-3-2D) Duplicate	GW53 (MW-3-2D)	GW54 (MW-3-6)	GW55 (MW-3-3)	GW57 (MW-3-1D)	GW59 (MW-3-4)	GW-60 (MW-3-4D)	GW61 (MW-3-3D) Duplicate
EPA Method SW5030/8021 (µg/l) **Volatile Organics/** **<u>Purgeable Halocarbons</u>**				NA							
Methylene Chloride	0.8	3.7[a]	3.9[a]		3.6[a]	3.3[a]	18[a]	4.7[a]	5.8[a]	8.2[a]	9.4[a]
Vinyl Chloride	0.8	ND	ND		ND	ND	3.6	20	ND	3.1	ND
Trichloroethene	1	ND	ND		ND	ND	55	ND	ND	ND	ND
Others	See Appendix F	ND	ND		ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 **<u>Purgeable Aromatics (µg/L)</u>**		ND		NA				ND		ND	ND
Benzene	0.3		ND[b]		ND[b]	ND[b]	0.96[b]		ND[h]		
Toluene	0.3		ND[b]		ND[b]	0.39[b]	0.36[b]		ND[h]		
Others	See Appendix F		ND		ND	ND	ND		ND		
EPA Method E504.1 **<u>Ethylene Dibromide (µg/L)</u>**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E608 **<u>Pesticides/PCB's (µg/L)</u>**	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]
EPA Method E625 **<u>Semivolatile Organics (µg/L)</u>**				NA							
Bis(2-ethylhexyl)phthalate	10	<10[*,a,d]	ND[a,d]		<10[*a,d]	<10[*a,d]	<10[*a,d]	<10[*a,d]	62[a,d]	ND[a,d]	<10[*a,d]
Di-n-butylphthalate	10	<10*	<10*		<10*	<10*	<10*	<10*	ND	<10*	<10*
Others	See Appendix F	ND	ND		ND	ND	ND	ND	ND	ND	ND
EPA Method E200.7** **<u>Total Metals (mg/L)</u>**				NA							
Aluminum	0.1	31.4[d]	14.2[d]		0.760[d]	48.2[d]	0.106[d]	1.40[d]	18.9[a,d]	ND[a,d]	ND[a,d]
Arsenic	0.05	ND	ND		ND	ND	ND	ND	ND	ND	ND
Arsenic (E206.2)	0.005	0.012	0.008		ND	0.013	ND	ND	ND	ND	ND
Barium	0.01	0.744	0.160		0.057	0.533	0.141	0.089	0.137[g]	0.067[g]	0.049[g]
Boron	0.01	1.27[a,g,d]	0.168[a,g,d]		0.078[a,g,d]	0.509[a,g,d]	0.739[a,g,d]	0.087[a,g,d]	0.129[a,e,g,d]	0.098[a,e,g,d]	0.318[a,e,g,d]
Cadmium	0.005	0.064	ND		ND	0.006	ND	ND	ND	ND	ND
Calcium[f]	0.20	603	220		315	44.9	221	196	553[a]	203[a]	301[a]

TABLE 4-[illegible]nt'd)
SITE NO. 3: ANALYTICAL RESULTS: GROUNDWATER

		Sample Field Identification (Sample Description)									
Parameter (Units)	Detection Limits	GW50 (MW-3-1)	GW51 (MW-3-2)	GW52 (MW-3-2D) Duplicate	GW53 (MW-3-2D)	GW54 (MW-3-6)	GW55 (MW-3-3)	GW57 (MW-3-1D)	GW59 (MW-3-4)	GW60 (MW-3-4D)	GW61 (MW-3-3D) Duplicate
EPA Method 200.7**											
Total Metals (mg/L) (Cont'd)				NA							
Chromium	0.010	0.127	0.15		ND	0.060	ND	ND	0.035	ND	ND
Cobalt	0.010	0.015	ND		ND	0.038	ND	ND	0.012	ND	ND
Copper	0.010	0.857	0.058		ND	0.162	ND	ND	0.021	ND	ND
Iron	0.025	61.4^{d}	23.6^{d}		5.05^{d}	91.0^{d}	1.47^{d}	3.13^{d}	$23.4^{a,e,g,d}$	$0.905^{a,e,g,d}$	$0.723^{a,e,g,d}$
Lead	0.05	0.841	0.378		0.051	0.121	ND	ND	0.154	ND	ND
Lead (E239.2)	0.005	NA^{+}	NA^{+}		0.082	NA^{+}	0.027	0.014	NA^{+}	ND	ND
Magnesium^{f}	0.20	87.9	120		69.4	173	100	59.8	65.6^{d}	56.6^{a}	87.0^{a}
Manganese	0.005	1.69^{d}	0.952^{d}		0.208^{d}	4.41^{d}	1.07^{d}	0.143^{d}	0.513^{d}	0.065^{d}	0.050^{d}
Mercury (E245.1)	0.0002	0.0002	ND		ND	ND	ND	ND	ND^{e}	ND^{e}	ND^{e}
Molybdenum	0.01	ND	ND		0.032	ND	ND	ND	ND	ND	ND
Nickel	0.015	0.233	0.024		0.035	0.103	ND	ND	0.016	ND	ND
Potassium^{f}	0.4	29.4^{d}	4.57^{d}		3.65^{d}	11.1^{d}	2.57^{d}	2.69^{d}	$3.73^{a,d}$	$3.51^{a,d}$	$2.53^{a,d}$
Silicon^{f}	0.20	$38.1^{a,g}$	$29.0^{a,g}$		$47.8^{a,g}$	$57.8^{a,g}$	$9.41^{a,g}$	$65.9^{a,g}$	25.6^{a}	4.31^{a}	5.38^{a}
Sodium^{f}	0.0	214	67.2		37.1	36.3	69.7	23.2	30.0^{a}	43.6^{a}	29.2^{a}
Vanadium	0.01	0.051	0.023		ND	0.074	ND	ND	0.029	ND	ND
Zinc	0.01	2.77	0.822		1.50	1.93	0.346	0.051	0.493	ND	ND
Others	See Appendix F	ND	ND		ND	ND	ND	ND	ND	ND	ND
EPA Method E418.1 (mg/L)											
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)				NA							
Total Dissolved Solids (E160.1)	1.0	2500	780		1200	780	1300	1000	2400	1000	1500
Common Anions (A429)											
Fluoride	0.1	0.22	0.91		1.1	0.46	1.0	0.70	0.97	0.74	0.81
Chloride	0.5	200	120		84	55	100	43	55	77	35
Sulfate	0.5	1600	170		510	38	370	420	1600	400	820
Total Hardness (E130.1)	1.0	1800	1100		1100	1600	1000	800	1900	770	1000

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis resulted in recoveries below lower control limit for one of the spikes, and high RPD values for this parameter.
c = One of the target pesticides (endrin) was not recovered in 2 out of 4 spike analyses associated with these samples due to breakdown; this suggests potential bias in reporting this compound as not detected.
d = Associated field duplicate analysis exceeded 35% RPD.
e = Associated matrix spike had recoveries below control limit.
f = Accuracy data unavailable; compound is not routinely included in the spiking solution
g = Associated lab matrix replicate analyses resulted in RPD values above the control limit.
h = Analysis required a re-extraction (initial low surrogate recoveries); re-extraction performed past holding time.

NA+ = Not analyzed by GFAA due to levels being adequately determined by ICP.
** = Or as indicated for metals analyzed by an alternate method.

TABLE 4-31 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Sample Field Identification (Sample Description)							
	GW62 (MW-3-7)	GW63 (MW-3-3D)	TB21 Trip Blank	TB22 Trip Blank	GW49 Field Blank	GW58 Field Blank	GW56 Equip. Wash	GW64 Equip. Wash
EPA Method SW5030/8021 (ug/L)								
Volatile Organics/Purgeable Halocarbons								
Methylene Chloride	9.4^{a}	11^{a}	4.6^{a}	5.1^{a}	5.7^{a}	6.0^{a}	5.2^{a}	11^{a}
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
Others	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020								
Purgeable Aromatics (µg/L)	ND	ND	ND	ND	ND	ND		ND
Benzene							ND^{b}	
Toluene							ND^{b}	
Others							ND	
EPA Method E504.1								
Ethylene Dibromide (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E608								
Pesticides/PCB's (µg/L)	ND^{c}	ND^{c}	NA	NA	NA	NA	ND	ND
EPA Method E625								
Semivolatile Organics (µg/L)			NA	NA	NA	NA		
Bis(2-ethylhexyl)phthalate	$<10^{*,a,d}$	$10^{a,d}$					ND	$<10^{*,a,d}$
Di-n-butylphthalate	<10*	17					<10*	ND
Others	ND	ND					ND	ND
EPA Method 200.7**								
Total Metals (mg/L)			NA	NA	NA	NA		
Aluminum	$5.53^{a,d}$	0.211^{d}					ND^{d}	ND^{d}
Arsenic	ND	ND					ND	ND
Arsenic (E206.2)	ND	ND					ND	ND
Barium	0.067^{g}	0.043					ND	ND
Boron	$0.092^{a,e,g,d}$	$0.088^{a,d}$					$0.029^{a,g,d}$	$0.036^{a,d}$
Cadmium	ND	ND					ND	ND
Calcium^{f}	167^{a}	262					ND	ND
Chromium	0.01	ND					ND	ND
Cobalt	ND	ND					ND	ND

TABLE 4-31 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS: GROUNDWATER

	Sample Field Identification (Sample Description)							
Parameter (Units)	GW62 (MW-3-7)	GW63 (MW-3-3D)	TB21 Trip Blank	TB22 Trip Blank	GW49 Field Blank	GW58 Field Blank	GW56 Equip. Wash	GW64 Equip. Wash
EPA Method 200.7[**]								
Total Metals (mg/L) (Cont'd)			NA	NA	NA	NA		
Copper	ND	ND					ND	ND
Iron	8.67[a,e,g,d]	1.75					ND[d]	ND[d]
Lead	ND	ND					ND	ND
Lead (E239.2)	0.013	ND					ND	ND
Magnesium[f]	58.4[a]	91.1					ND	ND
Manganese	1.05[d]	0.073[d]					ND[d]	ND[d]
Mercury (E245.1)	ND[e]	ND[e]					ND	ND[e]
Molybdenum	ND	ND					ND	ND
Nickel	ND	ND					ND	ND
Potassium[f]	1.83[a,d]	1.74[d]					ND[d]	ND[d]
Silicon[f]	10.3[a]	5.41					0.195[a,g]	0.090
Sodium[f]	80.1[a]	24.8[a]					ND	ND[a]
Vanadium	ND	ND					ND	ND
Zinc	0.207	ND					ND	0.018
Others	ND	ND					ND	ND
EPA Method E418.1 (mg/L)								
Total Petroleum Hydrocarbons	ND	ND	NA	NA	NA	NA	ND	ND
Miscellaneous Inorganics (mg/L)			NA	NA	NA	NA		
Total Dissolved Solids (E160.1)	1100	1400					10	ND
Common Anions (A429)								
Fluoride	0.18	0.78					ND	ND
Chloride	41	34					ND	ND
Sulfate	540	820					ND	ND
Total Hardness (E130.1)	730	1100					ND	ND

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis resulted in recoveries below lower control limit for one of the spikes, and high RPD values for this parameter.
c = One of the target pesticides (endrin) was not recovered in 2 out of 4 spike analyses associated with these samples due to breakdown; this suggests potential bias in reporting this compound as not detected.
d = Associated field duplicate analysis exceeded 35% RPD.
e = Associated matrix spike had recoveries below control limit.
f = Accuracy data unavailable; compound is not routinely included in the spiking solution
g = Associated lab matrix replicate analyses resulted in RPD values above the control limit.
h = Analysis required a re-extraction (initial low surrogate recoveries); re-extraction performed past holding time.

** = Or as indicated for metals analyzed by an alternate method.

TABLE 4-32
SITE NO. 3: ANALYTICAL RESULTS: SURFACE WATERS

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description)					
		SW-7 (3SW-4)	SW-8 (3SW-2)	SW-9 (3SW-5)	SW-10 (3SW-5 Duplicate)	TB-26 Trip Blank	SW-6 Field Blank
EPA Method SW5030/8021 (ug/L)							
Volatile Organics/Purgeable Halocarbons							
Methylene Chloride	0.8	1.2[b,c]	1.0[b,c]	1.0[b,c]	0.9[a,b,c]	1.0[b,c]	3.7[b,c]
Others	See Appendix F	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (µg/L)							
Purgeable Aromatic Organics	See Appendix F	ND	ND	ND	ND	ND	ND
EPA Method E608 (µg/L)							
Pesticides and PCB's	See Appendix F	ND[e]	ND[e]	ND[e]	ND[a,e]	NA	NA
EPA Method E625 (µg/L)							
Semivolatile Organics	See Appendix F	ND	ND	ND	ND	NA	NA
EPA Method E200.7*							
Total Metals (mg/L)						MA	MA
Aluminum	0.1	ND	0.168	ND	ND		
Arsenic	0.5	ND	0.052	ND	ND		
Arsenic (EPA Method E206.2)	0.005	ND	ND	ND	ND		
Barium	0.01	0.075	0.079	0.071	0.075		
Boron	0.01	0.102[b]	0.111[b]	0.085[b]	0.085[b]		
Calcium[f]	0.20	204	226	199	196		
Iron	0.025	0.144[g]	0.338[g]	0.108[g]	0.134[g]		
Magnesium[f]	0.20	56.5	41.1	41.8	43.9		
Manganese	0.005	0.033[d]	0.054[d]	0.069[d]	0.017[d]		
Molybdenum	0.010	ND[d,g]	0.014[d,g]	0.013[d,g]	ND[d,g]		
Potassium[f]	0.4	3.31	3.08	2.94	3.16		
Silicon[f]	0.020	3.77[b]	3.87[b]	3.65[b]	3.78[b]		
Sodium[f]	0.200	35.2	34.5	32.7	34.1		
Vanadium	0.01	ND[d,g]	0.014[d,g]	ND[d,g]	0.014[d,g]		
Zinc	0.01	1.32	0.978	0.551	0.566		
Others	See Appendix F	ND	ND	ND	ND		
EPA Method E418.1 (mg/L)							
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND		

TABLE 4-32 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description)					
		SW-7 (3SW-4)	SW-8 (3SW-2)	SW-9 (3SW-5)	SW-10 (3SW-5 Duplicate)	TB-26 Trip Blank	SW-6 Field Blank
Miscellaneous Inorganics (mg/L)						NA	NA
Total Dissolved Solids (E160.1)	1.0	800	740	720	680		
Common Anions (A429)							
Fluoride	0.1	0.68	0.66	0.65	0.64		
Chloride	0.5	57	67	59	63		
Nitrate-Nitrogen	0.5	ND	0.65	ND	ND		
Sulfate	0.5	250	260	240	250		
Hardness (E130.1)	1.0	620	580	590	570		

Footnote:

a = Surrogate recovery was above upper control limit for this analysis.
b = Compound also found in associated method blank
c = Associated MS/MSD had recovery below control limit for this compound in one or both spikes.
d = Associated field duplicate analysis exceeded 35% RPD
e = No assessment of precision could be made; data unavailable
f = No assessment of accuracy could be made; compounds not included in spiking solution.
g = Associated lab matrix replicate had RPD value above control limit.
h = Associated matrix spike had recovery below control limit.
i = Associated matrix spike had recovery above control limit.
* = Or as indicated for those metals analyzed by alternate methods.

TABLE 4-33
SITE NO. 3: ANALYTICAL RESULTS: SURFACE SEDIMENTS

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description) SD-7 (3SD-4)	SD-8 (3SD-2)	SD-9 (3SD-5)	SD-10 (3SD-5, Duplicate)
EPA Method SW8204 (mg/kg) **Volatile Organics**					
Methylene Chloride	0.005	0.011	0.0096	0.018	0.0097
Acetone	0.010	0.016^{b,d}	0.026^{b,d}	0.018^{b,d}	0.018^{b,d}
Others	See Appendix F	ND	ND	ND	ND
EPA Method SW3550/8270 **Semivolatile Organics (mg/kg)**	See Appendix F	ND^{a,e}	ND^{e}	ND^{e}	ND^{e}
EPA Method SW3050/6010* **Total Metals (mg/kg)**					
Aluminum^{f}	10.0	2620	5260	3790	2940
Barium	1.0	228^{d,g}	111^{d,g}	30.4^{d,g}	21.1^{d,g}
Boron	1.0	35.6	71.5	19.2	18.3
Cadmium	0.5	3.45	4.36	1.25	1.09
Calcium^{f}	50.0	891^{d}	692^{d}	14500^{d}	67.2^{d}
Chromium	1.0	3.06^{d}	6.32^{d}	5.76^{d}	3.28^{d}
Cobalt	1.0	4.35^{d}	11.3^{d}	2.29^{d}	ND^{d}
Copper	1.0	9.29	6.99	4.92	4.07
Iron^{f}	2.5	11300	23000	6480	6150
Lead	5.0	13.8^{d,g}	23.4^{d,g}	11.4^{d,g}	ND^{d,g}
Magnesium^{f}	50.0	44400^{d}	15800^{d}	5240^{d}	12800^{d}
Manganese	0.5	26.9^{i}	22.8^{i}	189^{i}	351^{i}
Molybdenum	1.0	ND^{d}	ND^{d}	ND^{d}	1.39^{d}
Nickel	1.5	8.24	12.5	9.38	7.35
Potassium^{f}	50.0	368	636	497	454
Silicon^{f}	100.0	388^{d}	505^{d}	547^{d}	164^{d}
Sodium^{f}	50.0	108^{d}	1210^{d}	135^{d}	81.9^{d}
Vanadium	1.0	5.23	11.2	3.77	5.25
Zinc	1.0	872^{d}	19.2^{d}	1070^{d}	743^{d}
Others	See Appendix F	ND	ND	ND	ND
EPA Method SW3550/E418.1 **Total Petroleum Hydrocarbons (mg/kg)**	5.0	ND^{d}	ND^{d}	82^{d}	22^{d}

TABLE 4-33 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS: SURFACE SEDIMENTS

Footnote:

a = Surrogate recovery was above upper control limit for this analysis.
b = Compound also found in associated method blank.
c = Associated MS/MSD had recovery below control limit for this compound in one or both spikes.
d = Associated field duplicate analysis exceeded 35% RPD.
e = No assessment of precision could be made; data unavailable.
f = No assessment of accuracy could be made; compounds not included in spiking solution.
g = Associated lab matrix replicate had RPD value above control limit.
h = Associated matrix spike had recovery below control limit.
i = Associated matrix spike had recovery above control limit.

* = Or as indicated for metals above analyzed by an alternate method.

TABLE 4-34
Field Water Quality Data
Niagara Falls IAP
Site No. 3
9/22 & 9/23/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 3-1	13°	8.30	1960	105	0	0	105	Background	cloudy
MW 3-1D	15°	7.65	920	300	0	0	300	Background	clear
MW 3-2	13°	7.70	820	335	0	0	355	Background	cloudy
MW 3-2D	15°	7.52	970	300	0	0	300	Background	clear
MW 3-3	14°	8.14	1180	600	0	0	600	Background	clear
MW 3-3D	10°	7.39	1200	290	0	0	290	Background	clear
MW 3-4	10°	7.4	1750	305	0	0	305	Background	clear
MW 3-4D	10°	7.80	970	275	0	0	275	Background	clear
MW 3-6	16°	7.99	900	700	0	0	700	Background	cloudy, muddy
MW 3-7	8°	7.21	920	240	0	0	240	Background	clear

TABLE 4-35

SITE NO. 3: ENGINEERING PROPERTY CHARACTERISTICS FOR SOILS

Parameter	ASTM Method	Sample Number WB-3-7-4C
Soil Moisture	D2216	27.5%
Density	D4287	2.67
Plasticity Index	D4318	14
Grain Size	D422	--- See Appendix D ---

- Volatile organic method blanks associated with the analysis of the soil boring samples were all contaminated with acetone at concentrations ranging from <0.010* - 0.013 mg/L, (where <0.010* mg/l refers to the presence of the compound but at a concentration below the reported detection limit). Sample concentrations of acetone ranged from <0.011*-0.023 mg/kg, and should be considered biased high.

- The field duplicate associated with the soil boring samples was collected from a different site during the same period as Site 3 samples. The duplicate pair, WB-5-1D-1/1R, exceeded 35% RPD for volatile organic analysis of methylene chloride (RPD = 125%) and acetone (= 123%).

- Method blanks associated with the purgeable halocarbon analysis of groundwater samples had methylene chloride concentrations ranging from 1.8-3.1 ug/L; confirmation analysis method blanks were contaminated with the compound at levels from 4.1-11 ug/L. Sample concentrations of methylene chloride ranged from 3.3-18 ug/L; field QC blanks were contaminated at concentrations of 4.6-11 ug/L. All sample methylene chloride concentrations should be considered to be biased high.

- Precision and accuracy measurements (MS/MSD analyses) associated with the purgeable halocarbons analysis of the groundwater samples were within control limits for the detected compounds. Other non-detected compound recoveries and RPD values may have exceeded control limits, but no significant bias was indicated.

- One of the matrix spikes associated with the purgeable aromatic analysis of groundwater samples GW-51, GW-53, GW-54, GW-55 and GW-56 had recoveries below the control limits for benzene (recovery = 32%, lower control limit = 41%) and toluene (recovery = 65%, lower control limit = 80%). The RPD values between the MS and MSD also exceeded the control limit (RPD = 20%) for benzene (RPD = 95%) and toluene (=32%).

- Two of four MS/MSD analyses for pesticides exhibited endrin breakdown. Recovery of endrin could not be calculated since the compound broke down to endrin ketone and endrin aldehydes. All samples had all pesticide compounds, including endrin aldehyde, as non-detected, so this potential endrin breakdown has no significant impact on the sample data.

- One groundwater sample, GW59, had semivolatile organic surrogate recoveries below control limits and required re-extraction. The re-extraction was performed 25 days after sample collection. This sample was the only groundwater with any semivolatile organic compound reported above the detection limit; bis(2-ethylhexyl)phthalate was reported at 62 ug/L. However, the method blank associated with this sample extraction/analysis had bis(2-ethylhexyl)phthalate at 68 ug/L. Several other samples had bis(2-ethylhexyl)phthalate at levels just at or below the detection limits; in all cases, the compound concentrations could be considered suspect as laboratory contamination. (This also explains the discrepancy between field duplicate pair GW-61 and GW-63).

- The MS/MSD analysis for the semivolatile organic analysis of groundwater samples exceeded the precision control limits for all the base-neutral spiked compounds. Since all samples had non-detected concentrations for all compounds (except bis(2-ethylhexyl)phthalate) the potential impact is minimal. The laboratory did not perform any re-analysis as the method does not provide RPD control limit guidelines, and doesn't require re-analyses.

- One surface water sample, SW-10, had a purgeable halocarbon recovery above the control limit: bromochloromethane recovery = 149%, upper control limit = 140%.

- Primary and confirmation method blanks associated with the purgeable halocarbon analysis of the surface waters had methylene chloride concentrations ranging from 5.1-11 ug/L. Therefore all sample and field QC concentrations (0.9-3.7 ug/L) should be considered suspect.

- The purgeable halocarbons MS/MSD analysis had methylene chloride recoveries below the control limit: recovery for both spikes = 60%, lower control limit = 80%.

- The pesticide/PCB analysis of surface water sample SW-10 had dibutylchlorendate surrogate recovery (=180%) above control limits (= 154%).

- Only a matrix spike (not an MS/MSD) was associated with the pesticide/PCB analysis of the surface waters; therefore no assessment of precision could be made.

- The MS/MSD recovery of pentachlorophenol associated with the semivolatile organic analysis of the surface waters indicated potential low bias. Recoveries were 3 and 8%; since sample concentrations were non-detected, the impact is limited to the detection limit which may be higher than reported.

- The method blanks associated with the volatile organic analysis of the sediment samples had acetone present at levels below the detection limits. Sample concentrations (0.016-0.026 mg/kg) may be biased high.

- The analysis of methylene chloride exceeded 35% RPD for the field duplicate pair SD-10/SD-9, with an RPD=60%.

- The recovery of surrogate compound phenol-d5 (recovery = 118%), for the semivolatile organic analysis of SD-7 exceeded the upper control limit (= 113%).

- Only a matrix spike (not an MS/MSD pair) was analyzed with the sediment samples for semivolatile organics; therefore no assessment of precision could be made.

<u>Inorganic Analyses</u>: Nine soil boring and four surface sediment samples were analyzed for metals and total petroleum hydrocarbons (TPH). One soil boring sample was analyzed for total organic carbon. Eleven groundwater and four surface water samples were analyzed for metals, TPH, total dissolved solids (TDS), common anions and hardness. The following is a discussion of data which may be biased as result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The metals method blank for WB-3-3D-1 contained aluminum (20.3 mg/l), boron (1.49 mg/L), iron (13.8 mg/L) and silicon (30 mg/L). Boron was not detected in the sample, but the other metals were present at much higher concentrations than in the blank.

- Several matrix replicate/matrix spike (MR/MS) samples were associated with the metals analysis of soil boring samples. No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium; these compounds were not included in the spiking solution. In addition, all spikes had recoveries below control limits for antimony; recoveries ranged from 19-54% (lower control limit = 75%). Therefore the potential for significant bias for antimony indicates that, at a minimum, the detection limits should be higher than reported.

- The following spike recoveries or RPD values for compounds detected in the associated soil boring samples were more than 5% outside of the control limits of 75-125% recovery and 30% RPD, unless noted otherwise. The MR/MS associated with WB-3-3D-1, WB-2D-4/4R/5/6 had the following compounds outside control limits: barium (recovery = 63%), cobalt (=64%), copper (=69%), molybdenum (=64%), nickel (=66%), vanadium (=67%), zinc (=64%) and lead was detected in one sample, but not the other. The MR/MS for WB-3-4D-1/1R/2 had a copper recovery =67% and manganese = 32%.

- Three field duplicate pairs were associated with the metals analysis of the soil boring samples. All lead measurements exceeded 35% RPD, with values ranging from 42-200% RPD (when lead was detected in one sample, but not the other). In addition pair WB-3-2D-4/4R, associated with WB-3-2D-4/5/6, had molybdenum detected in only one of the samples. Pair WB-3-4D-1/1R, associated with WB-3-4D-1/2, exceeded 35% RPD for aluminum (RPD = 64%), beryllium (detected only in one sample), cadmium (= 87%), and iron (= 112%).

- The metals method blanks associated with the groundwater samples all had boron (concentrations = 0.062-0.407 mg/L) and silicon (0.032-0.184 mg/L). Field blank concentrations for boron were 0.029-0.036 mg/L and silicon = 0.090-0.195 mg/L. Groundwater concentrations ranged from 0.078-1.27 mg/L for boron and 4.31-65.9 mg/l for silicon. Therefore, most sample concentrations for boron (B) should be considered potentially biased, with the exception of GW-50 (B=1.27 mg/L), GW-54 (B=0.509 mg/l), GW55 (B=0.739 mg/l) and GW-61 (B=0.318 mg/l) where the impact is questionable, due to the varying background levels. Silicon concentrations reported for the groundwater samples are not considered to be affected by method contamination, since the levels are significantly higher than the blanks.

In addition, the method blank for GW59-62 contained aluminum (0.102 mg/l), calcium (=14.4 mg/l), iron (=0.052 mg/l), magnesium (=3.50 mg/l), potassium (=0.501 mg/l), and sodium (=5.48 mg/l). These levels were generally less than the sample concentrations and should have minimal impact. In addition, a re-analysis of this blank several days later indicated that only aluminum was present (0.142 mg/L), making the original higher results suspect.

- Several matrix replicate/matrix spike (MR/MS) samples were associated with the metals analysis of groundwater samples. The following spike recoveries or RPD values for compounds detected in the associated samples were more than 5% outside of control limits (75-125% recovery, 20% RPD, unless noted). The RPD for the replicate analysis of GW56, associated with GW-50, 51, 53-57, was 51% for silicon and boron was detected in one sample but not the other. Boron RPD was also high for the replicate analysis of GW-61, associated with GW59-62 (RPD=111%); the spike associated with these samples had low recovery for boron (70%) iron (68%) and mercury (73%; lower control limit=80%)

- The field duplicate pair, GW61/GW63, exceeded 35% RPD for aluminum (detected only in one sample), boron (113%), iron (83%), manganese (37%) and potassium (37%).

- The metals method blank associated with the analyses of the surface waters samples contained boron at 0.061 mg/l and silicon = 0.092 mg/l. Sample concentrations ranged from boron=0.085-0.111 mg/l and silicon = 3.65-3.87 mg/l.

- The MR/MS for the metals analysis of the surface waters was performed on SW10. Calcium, magnesium, potassium, silicon and sodium were not spiked; therefore no assessment of accuracy could be made. Molybdenum and vanadium were detected in one sample but not the other.

- The field duplicate pair, SW9/SW10, also had molybdenum and vanadium detected only in one sample; this indicates that the precision for these metals at concentrations close to the detection limit may not be well defined. Manganese also exceeded 35% RPD (121%).

- The MR/MS analyses associated with the metals determinations for the surface sediments exceeded the control limit for RPD (30%) for barium (160%) and lead by ICP (60%). No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium since these metals were not spiked. Recovery was low for antimony (30%) and silver (24%), indicating potential bias which may impact the reported detection limit. Recovery was also above the control limit for manganese at 148%.

- The field duplicate pair SD9/SD10 exceeded 35% RPD for barium (RPD=36%), calcium (=198%), chromium (=55%), cobalt and lead (detected in only one sample), magnesium (=84%), manganese (=60%), molybdenum (detected only in one sample), silicon (=108%), sodium (=49%) and zinc (=36%).
- The field duplicates analyzed for TPH for the soil borings (WB-3-4D-1/1R) and sediments (SD9/SD10) exceeded 35% RPD; the RPD values were 200% (detected only in one sample) and 115%, respectively.

4.1.2.2 Significance of Findings

4.1.2.2.1 Significance of Findings: Site No. 3 - Landfill

Groundwater, soils, surface water/sediments were investigated at Site No. 3 to characterize the environmental impact of materials disposed of in the landfill during the 1950s and 1960s. Tables 4-36 through 4-38 present analyses versus ARARs and/or background levels for all contaminants found in the matrices studied.

During the drilling of four well borings, soil samples were collected for analysis. A total of twenty metals were detected at various concentrations in soils from the four well borings. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed. Since no ARARs have been established for soils, the following presents a discussion comparing the analytical data to background concentrations and normal trace element averages published for soils:

- In soil samples from WB-3-2D, and WB-3-7, cadmium was measured at 1.4 mg/kg (7.5 to 9.0-foot interval) and 1.66 mg/kg (4.5 to 6.0-foot interval) respectively. A cadmium range of 0.91 mg/kg to 1.1 mg/kg was established in soils from WB-3-4D (1.5 to 3.0 foot and 0.0 to 1.5-foot interval respectively). The normal average cadmium concentration reported for soils is 0.06 mg/kg. Cadmium was not detected in any of the soils from the background soil borings.
- A beryllium level of 0.596 mg/kg was measured in the single soil sample collected from well boring WB-3-7 (4.5 to 6.0-foot interval). The normal average beryllium concentration reported for soils is 6 mg/kg. Beryllium was not detected in any of the soils from the background soil borings.

TABLE 4-36
SITE NO.3: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (Units)	Detection Limits	Background[e] (mg/Kg)	Selected Average for soils[f] (mg/Kg)	Sample Field Identification (Sample Description) WB-3-2D-4 (4.5'-6.0')	WB-3-2D-5 (6.0'-7.5')	WB-3-2D-6 (7.5'-9.0')	WB-3-3D-1 (4.0'-5.5')	WB-3-4D-1 (0-1.5')	WB-3-4D-2 (1.5'-3.0')	WB-3-7-4 (4.5'-6.0')
EPA Method SW8240 (mg/kg) Volatile Organics										
Methylene Chloride	0.005	0.0056-0.0091	--	ND[b]	0.015[b]	0.014[b]	0.07[b]	0.012[b]	ND[b]	<0.006[*,b]
Acetone	0.010	0.016[a,b]	--	0.023[a,b]	0.021[a,b]	0.022[a,b]	0.017[a,b]	<0.011[*,a,b]		0.013[a,b]
Others	See Appendix F	ND		ND	ND	ND	ND	ND	ND	
EPA Method SW3050/6010* Total Metals (mg/kg)										
Aluminum[c]	10.0	2,300-15,600	71,000	12000	14000	4260	7160[a]	9530[b]	12500[b]	14400
Barium	1.0	28.4-163	430	66.9[d]	137[d]	55.2[d]	58.4[d]	88.1	76.0	102
Beryllium	0.2	ND	6	ND[d]	ND[d]	ND[d]	ND[d]	ND[b]	ND[b]	0.596
Boron	1.0	ND	10	ND	ND	ND	ND	ND	ND	81.7
Cadmium	0.5	ND	0.06	ND	ND	1.4	ND	1.1[b,d]	0.91[b,d]	1.66
Calcium[c]	50.0	2,120-213,000	13,700	25400	39600	105000	62300	3770	1990	13000
Chromium	1.0	3.29-19.6	100	18.3[d]	20.4[d]	5.8[d]	11.2[d]	19.3	12.6	15.4
Cobalt	1.0	2.10-11.3	8	12.5[d]	10.3[d]	2.0[d]	7.16[d]	8.4	5.9	12.3
Copper	1.0	9.92-21.0	30	20.0[d]	20.6[d]	8.4[d]	13.7[d]	8.3[d]	6.6[d]	28.8
Iron[c]	2.5	5,060-31,700	38,000	26600	34500	11600	17300[a]	14500[b]	15100[b]	34200
Lead	5.0	9.96-26.0	10	15.4[b]	28.2[b]	23.2[b]	17.9[b]	25.9[b]	15.1[b]	60.7
Magnesium[c]	50.0	4,050-51,900	5,000	13400	13700	39100	18500	4420	3290	7780
Manganese	0.5	386-801	600	457a	525[c]	542[c]	801[c]	414[d]	279[d]	692
Molybdenum	1.0	ND	2	ND[b,d]	ND[b,d]	ND[b,d]	3.31[d]	ND	ND	ND
Nickel	1.5	4.41-25.1	40	27.6[d]	27.9[d]	7.1[d]	16.4[d]	13.8	11.8	20.0
Potassium[c]	50.0	496-2,300	8,300	1770	2410	796	1130	1540	952	766
Silicon[c]	100.0	223-345	320,000	711	796	740	884[a]	461	392	1670
Sodium[c]	50.0	49.6-154	6,300	154	169	127	129	105	952	71.1
Vanadium	1.0	5.30-320	100	25.5[d]	26.9[d]	9.0[d]	15.5[d]	28.3	18.2	30.1
Zinc	1.0	53.3-864	50	66.1[d]	187[d]	206[d]	295[d]	426	548	687
Others	See Appendix F	ND	--	ND	ND	ND	ND	ND		
EPA Method SW3550/E418.1 Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	--	ND	ND	ND	ND	8.9[b]	ND[b]	ND

TABLE 4-36 (CONT'D)
SITE NO.3: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

		Sample Field Identification (Sample Description)								
Parameter (Units)	Detection Limits	Background[e] (mg/Kg)	Selected Average for soils[f] (mg/Kg)	WB-3-2D-4 (4.5'-6.0')	WB-3-2D-5 (6.0'-7.5')	WB-3-2D-6 (7.5'-9.0')	WB-3-3D-1 (4.0'-5.5')	WB-3-4D-1 (0-1.5')	WB-3-4D-2 (1.5'-3.0')	WB-3-7-4 (4.5'-6.0')
EPA Method SW9060 Total Organic Carbon (mg/kg)	NR			NA	NA	NA	NA	NA	2300	NA

Footnotes:

a = Compound also detected in associated method blank
b = Associated field duplicate analysis exceeded 35% RPD for this parameter. (Note that there is not a field duplicate assoicated with sample WB-3-7-4.)
c = Accuracy data unavailable; this compound was not routinely spiked, or spike recoveries could not be calculated.
d = Matrix spike recovery was below the control limit for this parameter.
e = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
* = Or as indicated for those metals analyzed by alternate methods.
NA = Not Analyzed
NR = Not Reported

TABL

SITE NO. 3: ANALYTICAL RES VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	Sample Field Identification (Sample Description)							
			GW50 (MW-3-1)	GW51 (MW-3-2)	GW53 (MW-3-2D)	GW54 (MW-3-6)	GW55 (MW-3-3)	GW57 (MW-3D-1)	GW59 (MW-3-4)	GW-60 (MW-3-4D)
EPA Method SW5030/8021 (μg/l)										
Volatile Organics/										
Purgeable Halocarbons										
Methylene Chloride	0.8	0.19[k]	3.7[a]	3.9[a]	3.6[a]	3.3[a]	18[a]	4.7[a]	5.8[a]	8.2[a]
Vinyl Chloride	0.8	2.0[i]	ND	ND	ND	ND	3.6	20	ND	3.1
Trichloroethene	1	5.0[i]	ND	ND	ND	ND	55	ND	ND	ND
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020										
Purgeable Aromatics (μg/L)			ND					ND		ND
Benzene	0.3	ND[h]		ND[b]	ND[b]	ND[b]	0.96[b]		ND[***]	
Toluene	0.3	5[i]		ND[b]	ND[b]	0.39[b]	0.36[b]		ND[***]	
Others	See Appendix F	-		ND	ND	ND	ND		ND	
EPA Method E504.1										
Ethylene Dibromide (μg/L)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E608										
Pesticides/PCB's (μg/L)	ND[c]	-	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]
EPA Method E625										
Semivolatile Organics (μg/L)										
Bis(2-ethylhexyl)phthalate	10	50[i]	<10[*a,d]	ND[a,d]	<10[*a,d]	<10[*a,d]	<10[*a,d]	<10[*a,d]	62[a,d]	ND[a,d]
Di-n-butylphthalate	10	No ARAR	<10*	<10*	<10*	<10*	<10*	<10*	ND	<10*
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E200.7**										
Total Metals (mg/L)										
Aluminum	0.1	No ARAR	31.4[d]	14.2[d]	0.760[d]	48.2[d]	0.106[d]	1.40[d]	18.9[a,d]	ND[a,d]
Arsenic	0.05	0.025[i]	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (E206.2)	0.005	0.025[i]	0.012	0.008	ND	0.013	ND	ND	ND	ND
Barium	0.01	1.0[i]	0.744	0.160	0.057	0.533	0.141	0.089	0.137[g]	0.067[g]
Boron	0.01	1.0[i]	1.27[a,g,d]	0.168[a,g,d]	0.078[a,g,d]	0.509[a,g,d]	0.739[a,g,d]	0.087[a,g,d]	0.129[a,e,g,d]	0.098[a,e,g,d]
Cadmium	0.005	0.010[i]	0.064	ND	ND	0.006	ND	ND	ND	ND
Calcium[f]	0.20	No ARAR	603	220	315	44.9	221	196	553[a]	203[a]

TABLE 4-37 (Cont'd)

SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	GW50 (MW-3-1)	GW51 (MW-3-2)	GW53 (MW-3-2D)	GW54 (MW-3-6)	GW55 (MW-3-3)	GW57 (MW-3D-1)	GW59 (MW-3-4)	GW60 (MW-3-4D)
			Sample Field Identification (Sample Description)							
EPA Method 200.7**										
Total Metals (mg/L) (Cont'd)										
Chromium	0.010	0.050[i]	0.127	0.15	ND	0.060	ND	ND	0.035	ND
Cobalt	0.010	No ARAR	0.015	ND	ND	0.038	ND	ND	0.012	ND
Copper	0.010	0.200[i]	0.857	0.058	ND	0.162	ND	ND	0.021	ND
Iron	0.025	0.300[i]	61.4[d]	23.6[d]	5.05[d]	91.0[d]	1.47[d]	3.13[d]	23.4[a,e,g,d]	0.905[a,e,g,d]
Lead	0.05	0.025[i]	0.841	0.378	0.051	0.121	ND	ND	0.154	ND
Lead (E239.2)	0.005	0.025[i]	NA[+]	NA[+]	0.082	NA[+]	0.027	0.014	NA[+]	ND
Magnesium[f]	0.20	No ARAR	87.9	120	69.4	173	100	59.8	65.6[d]	56.6[a]
Manganese	0.005	0.300[i]	1.69[d]	0.952[d]	0.208[d]	4.41[d]	1.07[d]	0.143[d]	0.513[d]	0.065[d]
Mercury (E245.1)	0.0002	0.002[i]	0.0002	ND	ND	ND	ND	ND	ND[e]	ND[e]
Molybdenum	0.01	No ARAR	ND	ND	0.032	ND	ND	ND	ND	ND
Nickel	0.015	0.0154[j]	0.233	0.024	0.035	0.103	ND	ND	0.016	ND
Potassium[f]	0.4	No ARAR	29.4[d]	4.57[d]	3.65[d]	11.1[d]	2.57[d]	2.69[d]	3.73[a,d]	3.51[a,d]
Silicon[f]	0.20	No ARAR	38.1[a,g]	29.0[a,g]	47.8[a,g]	57.8[a,g]	9.41[a,g]	65.9[a,g]	25.6[a]	4.31[a]
Sodium[f]	0.0	20[i]	214	67.2	37.1	36.3	69.7	23.2	30.0[a]	43.6[a]
Vanadium	0.01	No ARAR	0.051	0.023	ND	0.074	ND	ND	0.029	ND
Zinc	0.01	0.30[i]	2.77	0.822	1.50	1.93	0.346	0.051	0.493	ND
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E418.1 (mg/L)										
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	ND	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)										
Total Dissolved Solids (E160.1)	1.0	500[m]	2500	780	1200	780	1300	1000	2400	1000
Common Anions (A429)										
Fluoride	0.1	1.5[i]	0.22	0.91	1.1	0.46	1.0	0.70	0.97	0.74
Chloride	0.5	250[i]	200	120	84	55	100	43	55	77
Sulfate	0.5	250[i]	1600	170	510	38	370	420	1600	400
Total Hardness (E130.1)	1.0	No ARAR	1800	1100	1100	1600	1000	800	1900	770

TABLE 4-37 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

<u>Footnotes</u>:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis resulted in recoveries below lower control limit for one of the spikes, and high RPD values for this parameter.
c = One of the target pesticides (endrin) was not recovered in 2 out of 4 spike analyses associated with these samples due to breakdown; this suggests potential bias in reporting this compound as not detected.
d = Associated field duplicate analysis exceeded 35% RPD.
e = Associated matrix spike had recoveries below control limit.
f = Accuracy data unavailable; compound is not routinely included in the spiking solution.
g = Associated lab matrix replicate analyses resulted in RPD values above the control limit.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for Class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
L = Applicable or Relevant or Appropriate Requirements.
m = Federal Secondary Drinking Water Standards

ITIR = Informal Technical Information Report - Appendix F.
NA+ = Not analyzed by GFAA due to levels being adequately determined by ICP.
** = Or as indicated for metals analyzed by an alternate method.
*** = Analysis required a re-extraction (initial low surrogate recoveries); re-extraction performed past holding time.

TABLE 4-37 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

	Sample Field Identification (Sample Description)		
Parameter (Units)	**ARAR[L]**	**GW62 (MW-3-7)**	**GW63 (MW-3-3D)**
EPA Method SW5030/8021 (ug/L)			
Volatile Organics/Purgeable Halocarbons			
Methylene Chloride	0.19[k]	9.4[a]	11[a]
Vinyl Chloride	2.0[i]	ND	ND
Trichloroethene	5.0[i]	ND	ND
Others	-	ND	ND
EPA Method SW5030/8020			
Purgeable Aromatics (μg/L)		ND	ND
Benzene	ND[h]		
Toluene	5[i]		
Others	-		
EPA Method E504.1			
Ethylene Dibromide (μg/L)	-	ND	ND
EPA Method E608			
Pesticides/PCB's (μg/L)	-	ND[c]	ND[c]
EPA Method E625			
Semivolatile Organics (μg/L)			
Bis(2-ethylhexyl)phthalate	50[i]	<10[*,a,d]	10[a,d]
Di-n-butylphthalate	No ARAR	<10*	17
Others	-	ND	ND
EPA Method 200.7[**]			
Total Metals (mg/L)			
Aluminum	No ARAR	5.53[a,d]	0.211[d]
Arsenic	0.025[i]	ND	ND
Arsenic (E206.2)	0.025[i]	ND	ND
Barium	1.0[i]	0.067[g]	0.043
Boron	1.0[i]	0.092[a,e,g,d]	0.088[a,d]
Cadmium	0.010[i]	ND	ND
Calcium[f]	No ARAR	167[a]	262
Chromium	0.050[i]	0.014	ND
Cobalt	No ARAR	ND	ND

TABLE [illegible] Cont'd)

SITE NO. 3: ANALYTICAL [illegible]TS VS. ARARs: GROUNDWATER

Parameter (Units)	ARAR[L]	GW62 (MW-3-7)	GW63 (MW-3-3D)
EPA Method 200.7**			
Total Metals (mg/L) (Cont'd)			
Copper	0.200[i]	ND	ND
Iron	0.300[i]	8.67[a,e,g,d]	1.75
Lead	0.025[i]	ND	ND
Lead (E239.2)	0.025[i]	0.013	ND
Magnesium[f]	No ARAR	58.4[a]	91.1
Manganese	0.300[i]	1.05[d]	0.073[d]
Mercury (E245.1)	0.002[i]	ND[e]	ND[e]
Molybdenum	No ARAR	ND	ND
Nickel	0.0154[j]	ND	ND
Potassium[f]	No ARAR	1.83[a,d]	1.74[d]
Silicon[f]	No ARAR	10.3[a]	5.41
Sodium[f]	20[i]	80.1[a]	24.8[a]
Vanadium	No ARAR	ND	ND
Zinc	0.300[i]	0.207	ND
Others	-	ND	ND
EPA Method E418.1 (mg/L)			
Total Petroleum Hydrocarbons	No ARAR	ND	ND
Miscellaneous Inorganics (mg/L)			
Total Dissolved Solids (E160.1)	500[m]	1100	1400
Common Anions (A429)			
Fluoride	1.5[i]	0.18	0.78
Chloride	250[i]	41	34
Sulfate	250[i]	540	820
Total Hardness (E130.1)	No ARAR	730	1100

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis resulted in recoveries below lower control limit for one of the spikes, and high RPD values for this parameter.
c = One of the target pesticides (endrin) was not recovered in 2 out of 4 spike analyses associated with these samples due to breakdown; this suggests potential bias in reporting this compound as not detected.
d = Associated field duplicate analysis exceeded 35% RPD.
e = Associated matrix spike had recoveries below control limit.
f = Accuracy data unavailable; compound is not routinely included in the spiking solution.
g = Associated lab matrix replicate analyses resulted in RPD values above the control limit.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for Class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
l = Applicable or Relevant or Appropriate Requirements.
m = Federal Secondary Drinking Water Standards
ITIR = Informal Technical Information Report - Appendix F.
NA+ = Not analyzed by GFAA due to levels being adequately determined by ICP.
** = Or as indicated for metals analyzed by an alternate method.
*** = Analysis required a re-extraction (initial low surrogate recoveries); re-extraction performed past holding time.

TABLE 4-38
SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

			Sample Field Identification (Sample Description)		
Parameter (Units)	Detection Limits	ARAR[J]	SW-7 (3SW-4)	SW-8 (3SW-2)	SW-9 (3SW-5)
EPA Method SW5030/8021 (ug/L)					
Volatile Organics/Purgeable Halocarbons					
Methylene Chloride	0.8	0.19[K]	1.2[b,c]	1.0[b,c]	1.0[b,c]
Others	See Appendix F	-	ND	ND	ND
EPA Method SW5030/8020 (µg/L)					
Purgeable Aromatic Organics	See Appendix F	-	ND	ND	ND
EPA Method E608 (µg/L)					
Pesticides and PCB's	See Appendix F	-	ND[e]	ND[e]	ND[e]
EPA Method E625 (µg/L)					
Semivolatile Organics	See Appendix F	-	ND	ND	ND
EPA Method E200.7*					
Total Metals (mg/L)					
Aluminum	0.1	No ARAR	ND	0.168	ND
Arsenic	0.5	0.050[L]	ND	0.052	ND
Arsenic (EPA Method E206.2)	0.005	0.050[L]	ND	ND	ND
Barium	0.01	1.0[L]	0.075	0.079	0.071
Boron	0.01	No ARAR	0.102[b]	0.111[b]	0.085[b]
Calcium[f]	0.20	No ARAR	204	226	199
Iron	0.025	1.0[M]	0.144[g]	0.338[g]	0.108[g]
Magnesium[f]	0.20	No ARAR	56.5	41.1	41.8
Manganese	0.005	0.05[N]	0.033[d]	0.054[d]	0.069[d]
Molybdenum	0.010	No ARAR	ND[d,g]	0.014[d,g]	0.013[d,g]
Potassium[f]	0.4	No ARAR	3.31	3.08	2.94
Silicon[f]	0.020	No ARAR	3.77[b]	3.87[b]	3.65[b]
Sodium[f]	0.200	No ARAR	35.2	34.5	32.7
Vanadium	0.01	No ARAR	ND[d,g]	0.014[d,g]	ND[d,g]
Zinc	0.01	0.047[M]	1.32	0.978	0.551
Others	See Appendix F	-	ND	ND	ND
EPA Method E418.1 (mg/L)					
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND

TABLE 4-38 (Cont'd)
SITE NO. 3: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	ARAR[J]	Sample Field Identification (Sample Description) SW-7 (3SW-4)	SW-8 (3SW-2)	SW-9 (3SW-5)
Miscellaneous Inorganics (mg/L)					
Total Dissolved Solids (E160.1)	1.0	No ARAR	800	740	720
Common Anions (A429)					
Fluoride	0.1	No ARAR	0.68	0.66	0.65
Chloride	0.5	No ARAR	57	67	59
Nitrate-Nitrogen	0.5	10[L]	ND	0.65	ND
Sulfate	0.5	No ARAR	250	260	240
Hardness (E130.1)	1.0	No ARAR	620	580	590

Footnote:

a = Surrogate recovery was above upper control limit for this analysis.
b = Compound also found in associated method blank
c = Associated MS/MSD had recovery below control limit for this compound in one or both spikes.
d = Associated field duplicate analysis exceeded 35% RPD
e = No assessment of precision could be made; data unavailable
f = No assessment of accuracy could be made; compounds not included in spiking solution.
g = Associated lab matrix replicate had RPD value above control limit.
h = Associated matrix spike had recovery below control limit.
i = Associated matrix spike had recovery above control limit.
J = Applicable or Relevant and Appropriate Requirements.
K = Federal Ambient Water Quality Criteria - for Human Health (FWQC-HH): Adjusted for Drinking Water Only.
L = Maximum Contaminant Level (MCL) established under the Safe Drinking Water Act.
M = Federal Ambient Water Quality Criteria - Fresh Chronic Value for Aquatic Life.
N = Secondary Maximum Contaminant Level (SMCL) established under the Safe Drinking Water Act - Not an ARAR.

* = Or as indicated for those metals analyzed by alternate methods.

- Boron, a potential lab contaminant, was detected at 81.7 mg/kg in soil from the 4.5 to 6.0-foot interval of well boring WB-3-7 and molybdenum was detected at 3.31 mg/kg in the soil sample from the 4.0 to 5.5-foot interval at well boring WB-3-3D. Both of these compounds were not detected in soils from the background soil borings. The boron concentration in WB-3-7 is eight times the normal concentration reported for soils. Boron is not known to be a product of any current or past Air Force activity at this installation.

- The molybdenum concentration in the soil sample from WB-3-3D is slightly over the normal level reported for soils.

- A lead concentration of 60.7 mg/kg was found in the single soil sample from WB-3-7 (4.5 to 6.0-foot interval). This value is more than double the highest lead level recorded from the background soil borings and exceeds the average lead level reported for most soils by a factor of six.

- Barium and chromium levels measured in soils from Site 3 were not only below the average concentration reported for most soils, but within the range established by soils from the background soil boring.

- Copper levels measured in most Site No. 3 soils occurred within the range established by the background soil boring. A copper value of 28.8 mg/kg found in soil from the 4.5 to 6.0-foot interval of WB-3-7 was the only value that occurred outside the background range. The concentration of copper in most soils averages 30.0 mg/kg.

- The concentrations of manganese in soils of Site No. 3 occur within the range derived from the background soils boring.

- With the exception of a few values, nickel levels found in soil at Site No. 3 fall within the range established by the background boring. Nickel levels of 27.6 mg/kg and 27.9 mg/kg measured in soils from the 4.5 to 6.0-foot and 6.0 to 7.5-foot intervals of WB-3-2D respectively were slightly outside this upper limit of this range. Nickel levels across the site are below the 40 mg/kg average reported for typical soils.

- Vanadium concentrations found in soils from Site No. 3 were generally similar to the background range. These concentrations were still well below the 100 mg/kg average reported for most soils.

- Zinc levels found in soils of Site No. 3 were also similar to the range established by the background soil boring. Like the background soil boring, concentrations were considerably higher than the 50 mg/kg average reported for most soils. The elevated zinc levels detected across the base are believed to be caused by zinc sulfide minerals derived from the bedrock being locally concentrated in the soil.

The following presents a comparison of the organic analytical data yielded by the Site No. 3 well borings with background levels:

- Total petroleum hydrocarbons (TPH) were detected at 8.9 mg/kg in the soil sample collected from the 0.0 to 1.5-foot interval of well boring WB3-4D. TPH was not detected in any of the soil samples analyzed from the background soil borings.

- Methylene chloride and acetone were the only volatile organic compounds detected in Site No. 3 soils. The acetone reported in the Site No. 3 soils is considered a laboratory contaminant since comparable concentrations were found in the volatile organic method blank for soils. Methylene chloride was not reported in the method blank, therefore its reported presence in the Site No. 3 soils cannot be dismissed as a laboratory contaminant.

Groundwater samples were collected from ten of the eleven wells at Site No. 3. One well (MW3-5) could not be sampled due to irreparable damage caused by ice damage. The following presents a comparison of organic compounds measured in the Site No. 3 monitoring wells with ARARs and background levels:

- Toluene was detected in shallow aquifer wells MW3-6 and MW3-3 at 0.39 ug/l and 0.36 ug/l, respectively. The toluene concentrations did not exceed any of the published ARARs. The toluene values were also lower than that reported in groundwater from the shallow background well.

- Benzene was measured in groundwater from shallow aquifer well MW3-3 at 0.96 ug/l. The benzene concentration exceeds the "non-detect" New York State Water Quality ARAR, but is only slightly higher than the 0.93 ug/l value found in the shallow background well.

- Trichloroethene was also detected in shallow aquifer well MW3-3 at 55 ug/l. The TCE level reported for MW3-3 exceeds the 5.0 ug/l New York State Water Quality ARAR by an order of magnitude. TCE was not detected in the shallow background well.

- A vinyl chloride concentration of 20 ug/l yielded by MW3-1D exceeds the State Water Quality ARAR by one order of magnitude. Vinyl chloride was also reported in MW3-3 at 3.6 ug/l. This concentration is just above the State Water Quality ARAR set for this compound. A similar concentration of vinyl chloride was found in MW3-4D (i.e., 3.1 ug/l). Vinyl chloride was not detected in the background wells.

- The low levels of methylene chloride detected in the Site No. 3 groundwater samples are probably the result of laboratory contamination based upon similar concentrations found in the laboratory method blanks and various field blanks.

- In bedrock aquifer well MW3-3D di-n-butyl phthalate and bis (2-ethylhexyl) phthalate were measured at 17 ug/l and 10 ug/l, respectively. Bis (2-ethylhexyl) phthalate was measured in MW3-4 at 62 ug/l above the New York State Water Quality ARAR of 50 ug/L.

Since similar concentrations were found in the various blanks, these compounds are considered to be laboratory contaminants.

Twenty one inorganic metals were detected above instrument detection limits in the groundwater at Site No. 3. A number of the metals consistently exceed the promulgated ARARs. As discussed in Section 4.1.1.2.1, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in groundwater at Site No. 3 with ARARs and background values:

- Lead was detected above the New York State Water Quality ARAR in MW3-1, MW3-2, MW3-2D, MW3-6, MW3-3 and MW3-4 at concentrations of 0.841 mg/l, 0.378 mg/l, 0.082 mg/l, 0.121 mg/l, 0.027 mg/l, and 0.154 mg/l, respectively. The lead levels found in MW3-1 and MW3-2 exceeded the 0.025 mg/l standard by more than an order of magnitude.

- Iron levels in all wells exceeded the 0.300 mg/l ARAR set in the State Water Quality Standards. Iron concentrations of 61.4 mg/l, 23.6 mg/l, 5.05 mg/l, 91.0 mg/l, 1.47 mg/l, 3.13 mg/l, 23.4 mg/l, 0.905 mg/l, 8.67 mg/l and 1.75 mg/l were measured at MW3-1, MW3-2, MW3-2D, MW3-6, MW3-3, MW3-1D, MW3-4, MW3-4D, MW3-7 and MW3-3D respectively.

- Manganese exceeded the State Standard in MW3-1 (1.69 mg/l), MW3-2 (0.952 mg/l), MW3-6 (4.41 mg/l), MW3-3 (1.07 mg/l), MW3-4 (0.513 mg/l) and MW3-7 (1.05 mg/l). Although the ARAR for manganese and iron were also exceeded in groundwater from the shallow background well some of the iron levels reported from the Site No 3 wells were an order of magnitude higher.

- Cadmium and chromium were detected in shallow aquifer wells MW3-1 at 0.064 mg/l and 0.127 mg/l, respectively. Concentrations for both these metals exceeded the promulgated New York Water Quality ARARs.

- The 0.0154 mg/l FWQC Human Health ARAR for nickel was exceeded in MW3-1 (0.233 mg/l), MW3-2 (0.024 mg/l), MW3-2D (0.035 mg/l), MW3-6 (0.103 mg/l) and MW3-4 (0.016 mg/l).

- Arsenic was found in the groundwater from MW3-1, MW3-2 and MW3-6 but below the 0.025 mg/l New York State Water Quality ARAR.

- Barium found in groundwater at Site No. 3 ranged from 0.043 mg/l in MW3-3D to 0.744 mg/l in MW3-1. Barium was found to be more concentrated in groundwater collected from the shallow wells. Although some of the levels, particularly those found in the shallow wells, exceeded background barium values by an order of magnitude, none of the levels at Site No. 3 exceeded the State ARAR.

- Boron levels in groundwater of Site No. 3 ranged from 0.078 mg/l in MW3-2D to 1.27 mg/l in MW3-1. Once again, the boron levels encountered in the shallow wells tended to be much higher than the established background levels. Only MW3-1 at 1.27 mg/l exceeded the New York State Quality ARAR of 1.0 mg/l. Boron is not known to be a product of any current or past Air Force activity at this installation.

- Copper was measured in MW3-1 (0.857 mg/l), MW3-2 (0.058 mg/l), MW3-6 (0.162 mg/l) and MW3-4 (0.021 mg/l). Copper did not occur above the measurable detection limit in any of the upper bedrock wells. Only MW3-1 at the concentration of 0.857 mg/l exceeded the 0.2 mg/l ARAR promulgated under the New York State Water Quality Standards. Copper was not detected in groundwater from the background wells.

- Mercury was measured in MW3-1 at the detection limit (0.0002 mg/l). This level occurred within the 0.002 mg/l ARAR set in the State Water Quality Standards.

- Molybdenum was found above the measurable detection limit in MW3-2D (0.032 mg/l). Vanadium was measured in a number of the Site No. 3 monitoring wells. Vanadium concentrations of 0.051 mg/l, 0.023 mg/l, 0.074 mg/l and 0.029 mg/l were yielded by MW3-1, MW3-2, MW3-6 and MW3-4 respectively. Molybdenum and vanadium were not found in groundwater from the background wells and no ARARs presently exists for these metals.

- Zinc was measured in most wells at Site No. 3. Concentrations of 2.77 mg/l, 0.822 mg/l, 1.50 mg/l, 1.93 mg/l, 0.346 mg/l, 0.051 mg/l, 0.493 mg/l and 0.207 mg/l were found in MW3-1, MW3-2, MW3-2D, MW3-6, MW3-3, MW3-1D, MW3-4 and MW3-7 respectively. The established New York State Water Quality ARAR for zinc of 0.30 mg/l was exceeded in six Site 3 wells. Some of these zinc levels were considerably higher than the background levels.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Total dissolved solids (TDS) in all of the Site No. 3 groundwater samples were above the 500 mg/l Secondary Drinking Water Standard. TDS ranged from 780 mg/l in MW3-2 and MW3-6 to 2,500 mg/l in MW3-1.

- The New York State Water Quality ARAR for sulfate was exceeded in MW3-1 (1,600 mg/l), MW3-2D (500 mg/l), MW3-3 (370 mg/l), MW3-1D (420 mg/l), MW3-4 (1,600 mg/l), MW3-4D (400 mg/l), MW3-7 (540 mg/l) and MW3-3D (820 mg/l). Sulfate levels were also exceeded in both the shallow and deep background wells.

- Chloride and fluoride levels ranged from 43 mg/l to 200 mg/l and 0.18 mg/l to 1.1 mg/l respectively.

- o Sodium levels exceeded the 20mg/1 standard set in New York State Quality Water Regulations.
- o Total hardness in groundwater from Site No. 3 ranged from 730 mg/l to 1900 mg/l. The groundwater at Site No. 3 is hard and mineralized.

The generally poor water quality of the groundwater is explained in the literature (Johnston, 1964). Groundwater from the Lockport Dolomite is described as very hard and moderately to highly mineralized. The average hardness and chloride concentrations reported for the Lockport Dolomite are 960 mg/l and 234 mg/l respectively. Typical groundwater from the Lockport is also characterized by high calcium and magnesium, and high sulfate and bicarbonate. According to the literature, water from the unconsolidated deposits is also very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate crystals (gypsum) in the soil and bedrock.

Surface water and sediment samples were collected at three monitoring locations along Cayuga Creek to determine the environmental impact of groundwater infiltration and surface drainage on the water quality of the creek. One monitoring station was located at the point where Cayuga Creek enters the installation as a means to determine the quality of the surface water prior to traversing the eastern margin of the landfill. The remaining two monitoring points were situated downstream and downgradient of Site No. 3, north and south of an intermittent tributary which conveys stormwater drainage to the creek. The purpose of these two points was to assess the effect that the stormwater tributary has on the creek's water quality. Table 4-38 presents a comparison of surface water analytical results to the established ARARs. None of the compounds detected in the surface water and sediment were employed in a risk-based evaluation.

No volatile organic compound were detected in the sediment samples, other than methylene chloride and acetone which, because of their low levels and presence in the various blanks, are considered to be laboratory contaminants. No semivolatile contaminants were found in the sediments. Total petroleum hydrocarbons (TPH) were only found in sediment collected from the most downstream monitoring station, 3SD-5 (82 mg/kg). The source of TPH in the sediments at this station might be the drainage ditch located approximately 400 feet upstream.

A total of nineteen metals were detected at various concentrations in sediments from the three monitoring station. Since no ARARs have been established for stream sediments and no background values were established, the metals are discussed with reference to the normal trace element averages published for soils. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed here:

- Boron levels appeared to be elevated in the creek sediments. Boron levels ranged from 19.2 mg/kg at 3SD-5 to 71.5 mg/kg at 3SD-2. The average boron concentration reported in soils in 10 mg/kg.
- Cadmium levels in the stream sediments ranged from 1.25 mg/kg at 3SD-5 to 4.36 mg/kg at 3SD-2. The average cadmium concentration reported for normal soils is 0.06 mg/kg.
- One cobalt value was elevated above the 8 mg/kg average reported for soils. A cobalt concentration of 11.2 mg/kg was measured in 3SD-2.
- Lead found in the sediments was elevated slightly above the 10 mg/kg average for soils. Lead levels ranged from 11.4 mg/kg at 3SD-5 to 23.4 mg/kg at 3SD-2. Very high concentrations of zinc were found in sediments from two of the monitoring stations. Concentrations of 872 mg/kg and 1070 mg/kg measured in sediments from 3SD-4 and 3SD-5 respectively exceeded the 50 mg/kg average documented for most soils by an order of magnitude. The elevated levels of lead and zinc, and possibly cadmium, in the creek sediments at Site No. 3 probably corresponds to the dissolution of metallic complexes occurring naturally in the bedrock and the unconsolidated overburden.

Except for methylene chloride, which is believed to be a laboratory contaminant based upon low levels and its presence in the field blanks, no volatile organic compounds were detected above instrument detection limits in the surface water samples collected at Site No. 3. The surface water did not yield any semivolatile, pesticide or PCB compounds.

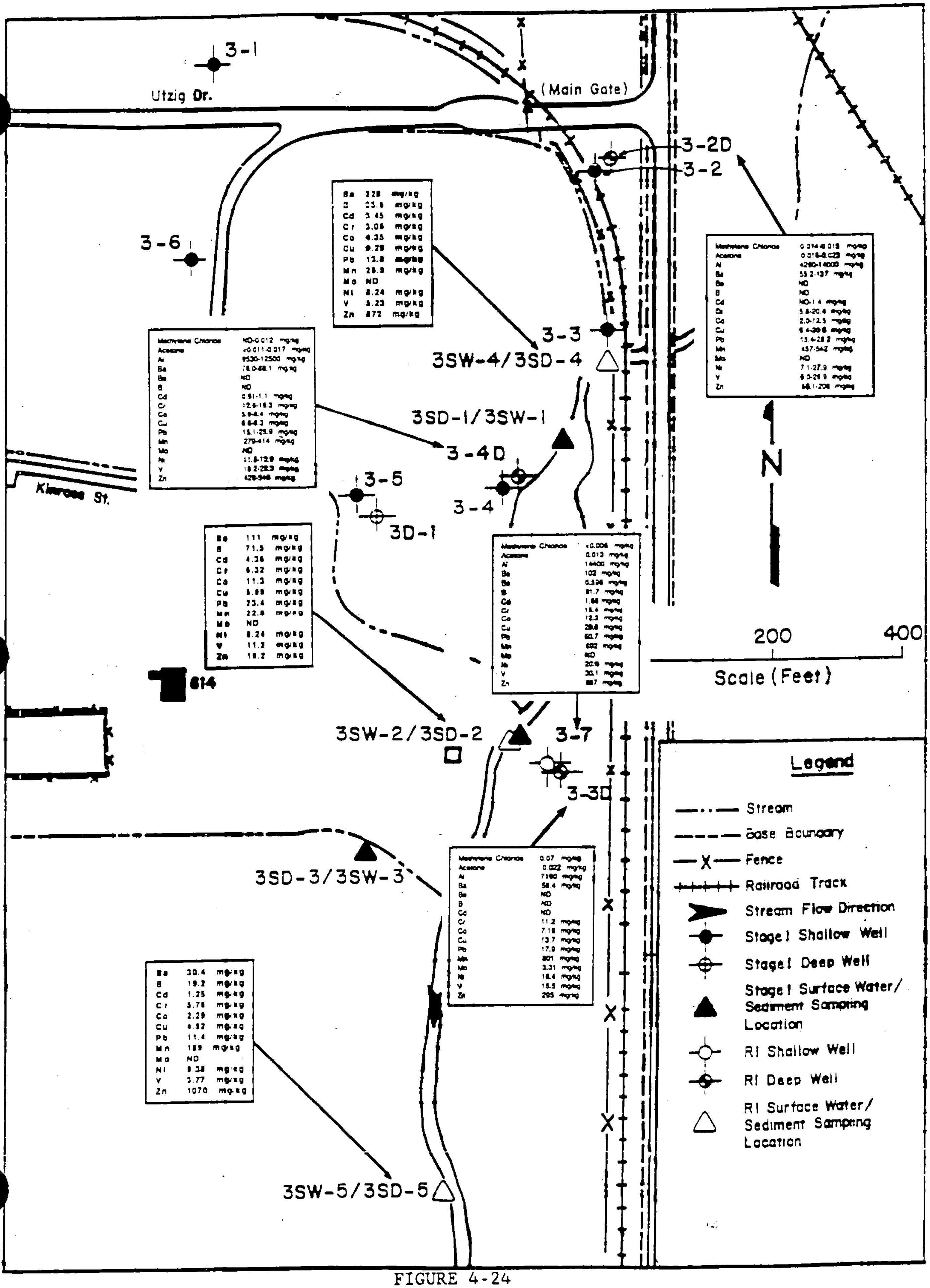
A total of fourteen metals were detected in the three surface water samples. Only those metal species that exceed established ARARs are discussed:

- Zinc levels found in surface water from each monitoring station exceeded the 0.047 mg/l ARAR established under the Federal Ambient Water Quality Criteria (FWQC) chronic value for fresh water aquatic life. Zinc levels ranged from 0.551 mg/l at 3SW-5 to 1.32 mg/l at 3SW-4. Zinc levels found in the surface are believed to be natural due to derived from the dissolution of zinc sulfide minerals present in the dolomite of the upper bedrock aquifer. The bedrock is exposed in several sections along the course of the creek and has been documented by the USGS (Personal Communication, 1989) to be discharging to the creek near upstream steam monitoring station.

4.1.2.2.2 Zones of Contamination

A number of contaminants were found in the soil and groundwater along the eastern downgradient margin of the landfill. Figures 4-24 and 4-25 illustrate the levels of contaminants found at each monitoring station. Elevated levels of cadmium found in the soils along the eastern margin of the landfill and southeast across the creek may represent naturally elevated concentrations found in the soil and may not necessarily be related to the types of wastes (i.e., batteries) disposed of in the landfill. According to the literature, various metallic mineral complexes, especially those containing zinc, lead, arsenic, chromium, copper and nickel are disseminated throughout the Lockport Dolomite and various shales located north of the installation (Litten, 1986). These bedrock units were the source of the glacial and lacustrine sediments deposited throughout the Niagara Falls area. The elevated levels of metals found in the Site No. 3 soils are believed to be indicative of natural background soil conditions.

A number of volatile organic compounds occurred in groundwater from the unconsolidated and upper bedrock aquifer downgradient of the landfill. Varying levels of vinyl chloride were found in three wells along the southern portion of the landfill. The vinyl chloride in the groundwater at Site No. 3 is considered to be a degradation product of trichloroethene (TCE), since vinyl chloride was never used as a raw material on the base. TCE was found in one downgradient shallow well (MW3-3). Benzene and toluene also occurred in this well. Due to the proximity of this well to the Cayuga Creek, it was originally thought that the creek may have introduced contaminants into this well. Since these contaminants were not found in the surface water samples collected from the creek and since the USGS has identifieid this reach at the creek as a gaining stream, there is little support for this theory. Shallow groundwater at this site discharges, through natural seepage, to the surface water of Cayuga Creek.



Ba	228	mg/kg
B	33.6	mg/kg
Cd	3.45	mg/kg
Cr	3.06	mg/kg
Co	4.35	mg/kg
Cu	8.29	mg/kg
Pb	13.8	mg/kg
Mn	26.8	mg/kg
Mo	ND	
Ni	8.24	mg/kg
V	5.23	mg/kg
Zn	872	mg/kg

Methylene Chloride	ND-0.012 mg/kg
Acetone	<0.011-0.017 mg/kg
Al	9530-12500 mg/kg
Ba	78.0-88.1 mg/kg
Be	ND
B	ND
Cd	0.91-1.1 mg/kg
Cr	12.6-18.3 mg/kg
Co	5.9-8.4 mg/kg
Cu	6.8-8.3 mg/kg
Pb	15.1-25.9 mg/kg
Mn	279-414 mg/kg
Mo	ND
Ni	11.8-13.9 mg/kg
V	18.2-28.3 mg/kg
Zn	429-548 mg/kg

Methylene Chloride	0.014-0.015 mg/kg
Acetone	0.018-0.023 mg/kg
Al	4280-14000 mg/kg
Ba	55.2-137 mg/kg
Be	ND
B	ND
Cd	ND-1.4 mg/kg
Cr	5.8-20.4 mg/kg
Co	2.0-12.5 mg/kg
Cu	8.4-20.8 mg/kg
Pb	15.4-28.2 mg/kg
Mn	457-542 mg/kg
Mo	ND
Ni	7.1-27.9 mg/kg
V	8.0-25.9 mg/kg
Zn	68.1-206 mg/kg

Ba	111	mg/kg
B	71.5	mg/kg
Cd	4.36	mg/kg
Cr	6.32	mg/kg
Co	11.3	mg/kg
Cu	6.88	mg/kg
Pb	23.4	mg/kg
Mn	22.8	mg/kg
Mo	ND	
Ni	8.24	mg/kg
V	11.2	mg/kg
Zn	19.2	mg/kg

Methylene Chloride	<0.006 mg/kg
Acetone	0.013 mg/kg
Al	14400 mg/kg
Ba	102 mg/kg
Be	0.596 mg/kg
B	81.7 mg/kg
Cd	1.66 mg/kg
Cr	18.4 mg/kg
Co	12.3 mg/kg
Cu	28.8 mg/kg
Pb	60.7 mg/kg
Mn	682 mg/kg
Mo	ND
Ni	20.9 mg/kg
V	30.1 mg/kg
Zn	887 mg/kg

Methylene Chloride	0.07 mg/kg
Acetone	0.022 mg/kg
Al	7190 mg/kg
Ba	58.4 mg/kg
Be	ND
B	ND
Cd	ND
Cr	11.2 mg/kg
Co	7.16 mg/kg
Cu	13.7 mg/kg
Pb	17.9 mg/kg
Mn	801 mg/kg
Mo	3.31 mg/kg
Ni	18.4 mg/kg
V	15.5 mg/kg
Zn	295 mg/kg

Ba	30.4	mg/kg
B	18.2	mg/kg
Cd	1.25	mg/kg
Cr	5.76	mg/kg
Co	2.29	mg/kg
Cu	4.92	mg/kg
Pb	11.4	mg/kg
Mn	189	mg/kg
Mo	ND	
Ni	9.38	mg/kg
V	3.77	mg/kg
Zn	1070	mg/kg

FIGURE 4-24
SITE NO. 3: ZONES OF CONTAMINATION - SOIL AND SEDIMENTS

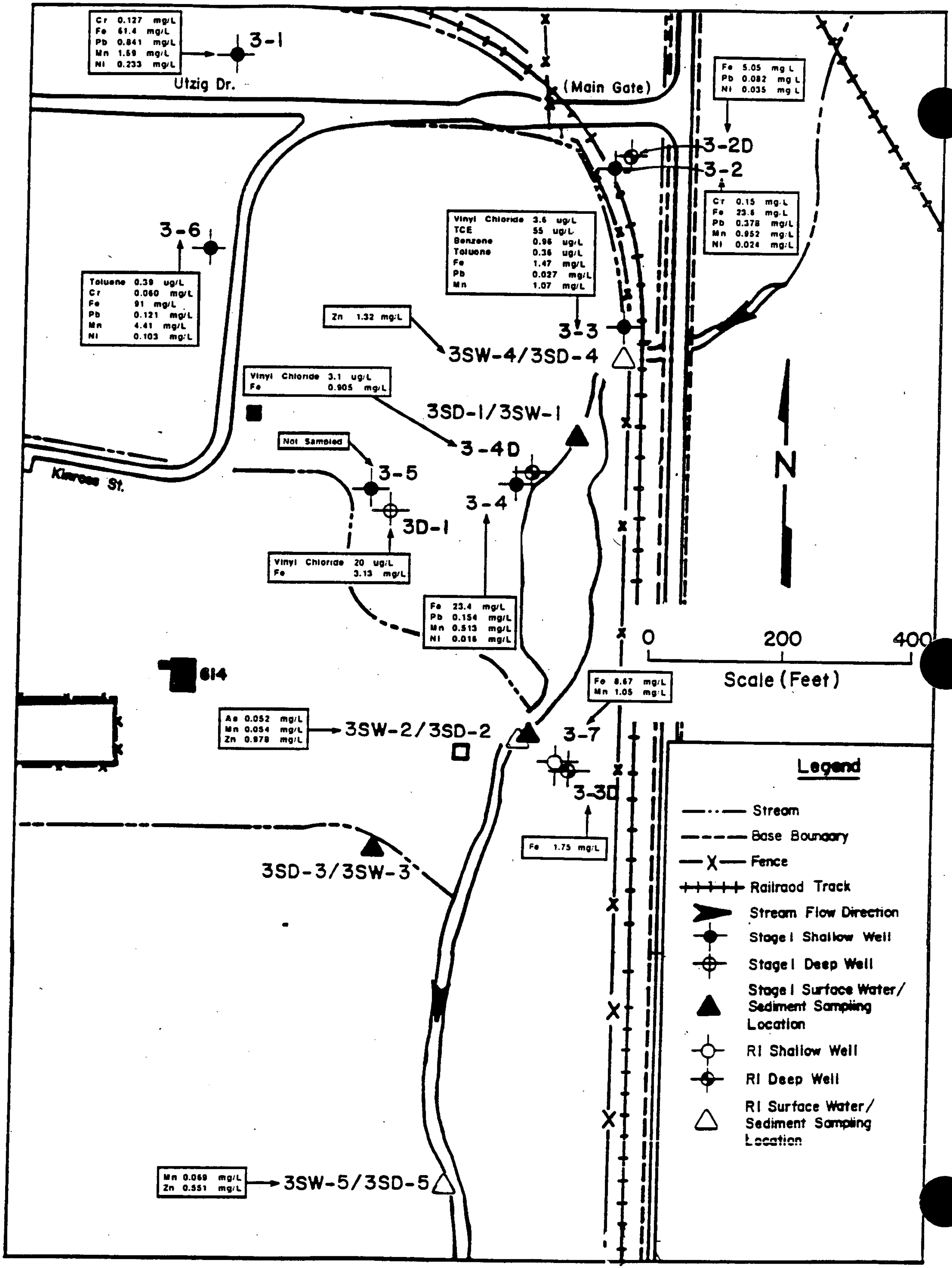


FIGURE 4-25
SITE NO. 3: ZONES OF CONTAMINATION - GROUNDWATER AND SURFACE WATER

Contaminant transport for the surface water to the groundwater is therefore not a pathway of concern. The volatile organics in this well are likely derived from an adjacent upgradient area of the landfill. Toluene found in upgradient well MW3-6 is probably derived from the infiltration of contaminated runoff from the adjacent unpaved road.

As discussed in Section 4.1.1.2.1, elevated metal levels yielded by the Site No. 3 groundwater samples are believed to be indicative of naturally occurring metals found in the suspended particulate clastic materials rather than site induced contamination.

4.1.2.2.3 Contaminant Migration

As evidenced by the presence of contaminants found in several shallow downgradient wells, contaminants are migrating through and away from the landfill. Since the downgradient eastern edge of the landfill borders Cayuga Creek, contaminants migrate a short distance before being intercepted and carried off by the creek. Considering the hydrogeologic data yielded by the extensive flow modeling study at Love Canal (Mercer et. al., 1983) and the USGS (1985) study discussed in Section 4.1.1.1.2, the migration rate of contaminants in the shallow groundwater system are expected to range between 5.48×10^{-5} to 2.1×10^{-3} ft/day. Higher migration rates occur locally in regions containing nonconnective stringers of sand. In consideration of the landfill's age and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, the following migration distance ranges have been estimated:

Site No. 3 - (Minimum) 7.6×10^{-1} feet
- (Maximum) 29 feet

Migration of contaminants through the upper bedrock aquifer, based upon the discussion presented in Section 4.1.2.1.2 are predicted to occur at a more rapid rate of 2.3×10^{-1} ft/day. The contaminant migration direction in the upper bedrock aquifer, as interpreted from the potentiometric surface maps, is south to southeast, towards Cayuga Creek. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

Cultural features, such as sewer line and underground utility lines and pipes may have some affect on patterns and speed of contaminant transport within the subsurface. The area around Site 3 does not contain any underground utilities (as shown in Section 4 Attachment A), therefore abnormal contaminant transport patterns, as a result of cultural features in this area, are not expected.

According to the USGS (Personnel Communication, 1989) the upper bedrock aquifer appears to be discharging to Cayuga Creek along the stream bed bordering the landfill. If this is the case, contaminants migrating via the uppermost water bearing zone of the Lockport Dolomite are probably released to the creek along the stream bed. The creek likely acts as a hydrological barrier, inhibiting contaminant migration beyond the creek. Off base contaminant exposure via the groundwater pathway is therefore remote. At this time there is no evidence to suggest that contaminants are migrating across the creek. None of these contaminants were detected in the shallow/deep well pair (MW3-7/MW3-3D) located on the opposite side of the creek downgradient from the landfill. Since contaminants were not detected in the surface water at Site No. 3, contaminant dilution has eliminated possible off-base exposure via this surface water pathway.

4.1.2.2.4 Baseline Risk Assessment for Site No. 3

This section presents the baseline risk assessment for Site 3. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 3 - Data Analysis and Hazard Identification

Chemicals of concern for Site 3 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

TPH was detected in soils at Site 3 in a single sample out of seven: 3.4 mg/kg. This indicates the localized presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment. TPH was not detected in groundwater at the site.

Site No. 3 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation. The conceptual site model for Site 3 is presented in Figure 4-26. The exposure pathways are discussed in detail below. Additional documentation for the exposure assumptions adopted at Site 3 are provided in Appendix G.

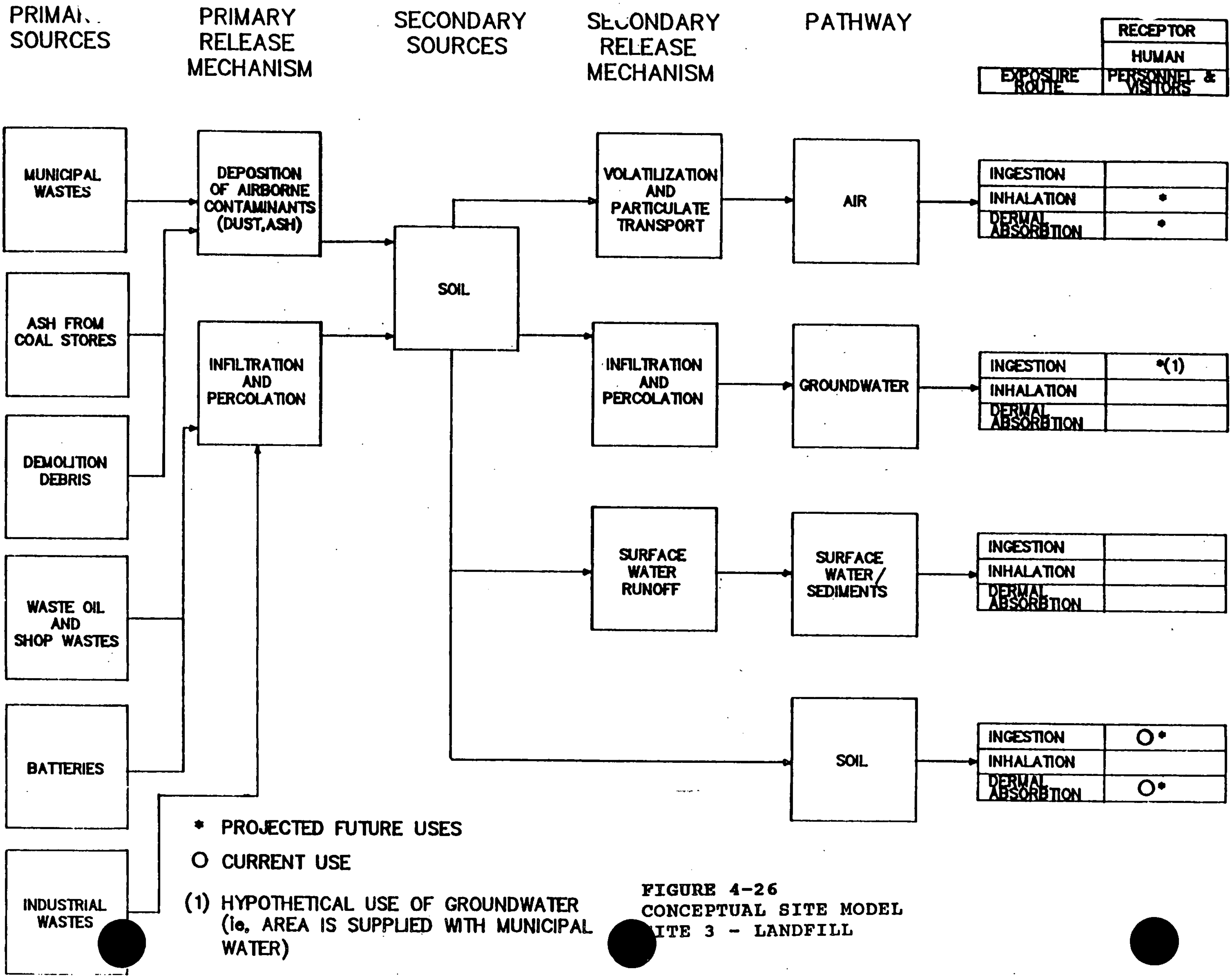
Soil

The landfill is presently inactive and encompasses an area of less than 5 acres. The landfill area currently consists of a flat open grass field with scattered deciduous trees. The boundaries of the Base are fenced but access to the landfill itself is not restricted (i.e., is not fenced). Therefore, soil exposure (i.e., inadvertent ingestion) to Base personnel who may occasionally visit the site was evaluated. The exposure assumptions used for Site 4 soil exposure were also adopted for use in exposure assessment at Site 3 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Surface Water/Sediments

A risk-based evaluation has not been conducted for exposure to surface water or sediments in the vicinity of Niagara Falls IAP Site 3. The significance of concentrations of contaminants in surface water is evaluated only by comparison with ARARs. Cayuga Creek is located south and east of the base boundaries and, due to its intermittent nature, cannot support game fish. Thus, no onsite recreational activity (i.e., fishing) takes place in this surface water body. As there is no exposure to sediments or surface waters on base, sediment contamination is not considered in the risk assessment. In addition, no Federal criteria or standards are currently available for sediment contamination. Section 4.1.2.2.1 presents a qualitative discussion and evaluation of concentrations of chemicals in sediment samples.

Note that there is unrestricted access to the Cayuga Creek as it exits off base in the vicinity of a trailer park and children may play in the creek.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie, AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-26
CONCEPTUAL SITE MODEL
[illegible]ITE 3 - LANDFILL

Exposure to children offsite may occur through inadvertent ingestion of surface water/sediments and dermal contact. Surface water and groundwater from the Base appears to discharge into Cayuga Creek. No surface water or sediment samples were collected offsite (i.e., near the residential area).

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 3 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

Site No. 3 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 3 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at Site 3 are presented in Table 4-39. The hazard index for combined exposure across compounds is approximately 9.98×10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater. The excess lifetime cancer risk of hypothetical exposure to groundwater was calculated to be approximately 4×10^{-5}. This is within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The magnitude of the cancer risk was attributable to the presence of arsenic (LCR = 2.45×10^{-5}), and vinyl chloride (LCR = 1.93×10^{-5}). As discussed previously, arsenic is found at naturally high concentrations in the Niagara Falls area.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. At Site 3, mean concentrations of TCE (6 ug/L) and vinyl chloride (3 ug/L) exceeded Federal MCLs (5 ug/L and 2 ug/L, respectively). Mean levels of manganese (1020 ug/L) exceeded the New York State groundwater limits (300 ug/L)and mean levels of zinc (840 ug/l) exceeded the New York State groundwater limits (300 ug/l). The New York state groundwater

TABLE 4-39

RISK CHARACTERIZATION FOR SITE NO. 3: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	13400.00			
Arsenic	5.00	4.91E-02	Skin, Lung	2.45E-05
Barium	204.00	4.00E-02	Hypertension	
Boron	318.00	3.47E-02	CNS, GI Tract, Skin	
Cadmium	9.00	1.77E-01	Kidney	
Chromium	28.00	5.49E-02	Skin	
Cobalt	10.00		Thyroid, Heart	
Copper	113.00	3.00E-02	GI Tract, Blood	
Lead	24.00	1.68E-01	CNS, Kidney	
Manganese	1020.00	5.00E-02	CNS, Reproductive	
Mercury	0.10	3.27E-03	CNS	
Molybdenum	8.00			
Nickel	45.00	2.21E-02	Skin, Lung	
Vanadium	210.00	2.94E-01	Respiratory Effects	
Zinc	813.00	3.99E-02	GI Tract	
ORGANICS				
Benzene	0.23	6.27E-03	Hematopoietic Sys.	1.87E-08
Toluene	0.21	6.87E-06	CNS	
Trichloroethylene	6.00	5.89E-03	Liver, Kidney, CNS	1.85E-07
Vinyl Chloride	3.00	2.26E-02	Blood, Liver, CNS	1.93E-05
Hazard Index: Combined Exposure		9.98E-01		
Excess Lifetime Cancer Risk: Combined Exposure				4E-05

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

Soil Pathway

The results of risk characterization for exposure to soil at Site 3 are presented in Table 4-40. The hazard index for the combined exposure across compounds is approximately 5.6×10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils at Site 3 is approximately 4×10^{-8}. EPA has established an acceptable excess lifetime cancer risk range of 10^{-6} to 10^{-4} for waste site remediation under the Superfund Program. Given this guidance, the results for Site 3 would be considered acceptable.

Surface Water Pathway

As noted previously, a risk assessment was not conducted for chemicals in surface water. However, mean concentrations in surface water were compared with Federal ambient water quality criteria (FWQC). None of the mean concentrations of chemicals in surface waters at this location exceeded the FWQC adjusted for drinking water only.

Site No. 3 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.1.3 Discussion of Results for Site No. 7: JP-4 Tank Truck Spill

4.1.3.1 Presentation of Results

4.1.3.1.1 Site Geology

The geology of Site No. 7, as interpreted from the Stage 1 and RI well and soil boring logs, consists of a fine grained veneer of glacial till and

TABLE 4-40

RISK CHARACTERIZATION FOR SITE NO. 3: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	11276.00			
Barium	83.60	2.62E-04	Hypertension	
Beryllium	0.20	6.34E-06	Lung, Skin, Heart	3.90E-08
Boron	12.17	2.12E-05	CNS, GI Tract, Skin	
Cadmium	0.88	2.76E-04	Kidney	
Chromium	14.60	4.58E-04	Skin	
Cobalt	8.30		Thyroid, Heart	
Copper	15.10	6.41E-05	GI Tract, Blood	
Lead	28.30	3.17E-03	CNS, Kidney	
Manganese	538.00	4.22E-04	CNS, Reproductive	
Molybdenum	2.52			
Nickel	17.50	1.37E-04	Skin, Lung	
Vanadium	22.50	5.05E-04	Respiratory Effects	
Zinc	343.00	2.69E-04	GI Tract	
ORGANICS				
Acetone	0.009	1.41E-08	Liver, Kidney	
Methylene Chloride	0.022	5.76E-08	Liver, Kidney, CNS	7.40E-12
Hazard Index: Combined Exposure		5.60E-03		
Excess Lifetime Cancer Risk: Combined Exposure				4E-08

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

lacustrine sediments overlying massive to thinly bedded dolomite. The location of all Site No. 7 monitoring wells is presented in Figure 4-27. Due to the proximity of Site No. 10, most maps referenced for Site No. 7 will also contain Site No. 10 information. Since only a small area was investigated, the thickness of the unconsolidated deposits exhibit little variation. The sediments achieve a minimum thickness of 5.9 feet at shallow monitoring well MW7-1 and a maximum thickness of 8.0 feet at shallow monitoring well MW7-3. Bedrock (i.e., Lockport Dolomite) is estimated to be 180 feet thick. A generalized geologic cross-section of the Site No. 7 study area is presented as Figure 4-28.

Soils encountered at Site No. 7 belong to the Odessa Series. This soil type was encountered in the Site Nos. 1, 2, 4 and 6 study area and is described in Section 4.1.1.1.1.

The lacustrine sediments form the uppermost unit of the unconsolidated deposits. The lacustrine sediments grade into glacial till sediments at depth. Both of these sediment types are similar in texture, consistency and appearance, which complicates efforts to distinguish one from the other. Both of these units were described previously in Section 4.1.1.1.1 of this report.

Thin intercalations of fluvial sediments were encountered at soil boring B-7-1. A 0.9 foot thick layer of silty sand was logged 3 feet below land surface and another layer of silty sand (0.5 feet thick) was encountered 5 feet below land surface. Due to the limited and discontinuous soil sampling conducted during the Stage 1 effort, other lenses of fluvial sediments may have been missed.

Topographic features occurring on the bedrock surface could not be discerned due to the limited number and close spacing of wells at the site. It is likely, however, that the bedrock surface in the vicinity of Site No. 7 has features similar to those found at combined Site Nos. 1, 2, 4 and 6. The character and stratigraphy of the dolomite at Site No. 7 are unknown, since no bedrock wells were installed. A structural contour map of the Lockport Dolomite surface at Site No. 7 has been constructed and is presented as Figure 4-29.

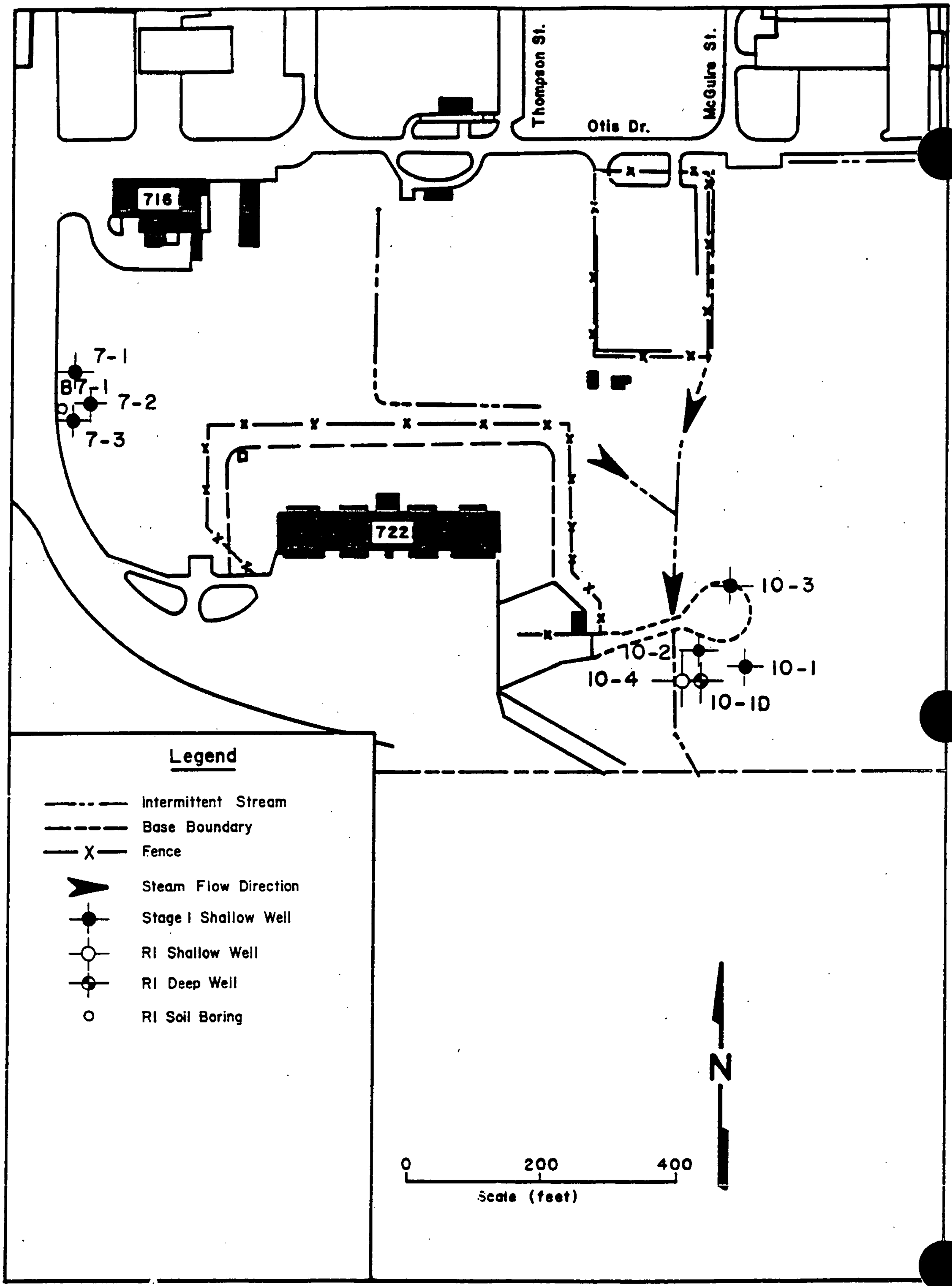


FIGURE 4-27.
SITE NO. 7: MONITORING WELL AND SOIL BORING LOCATION MAP

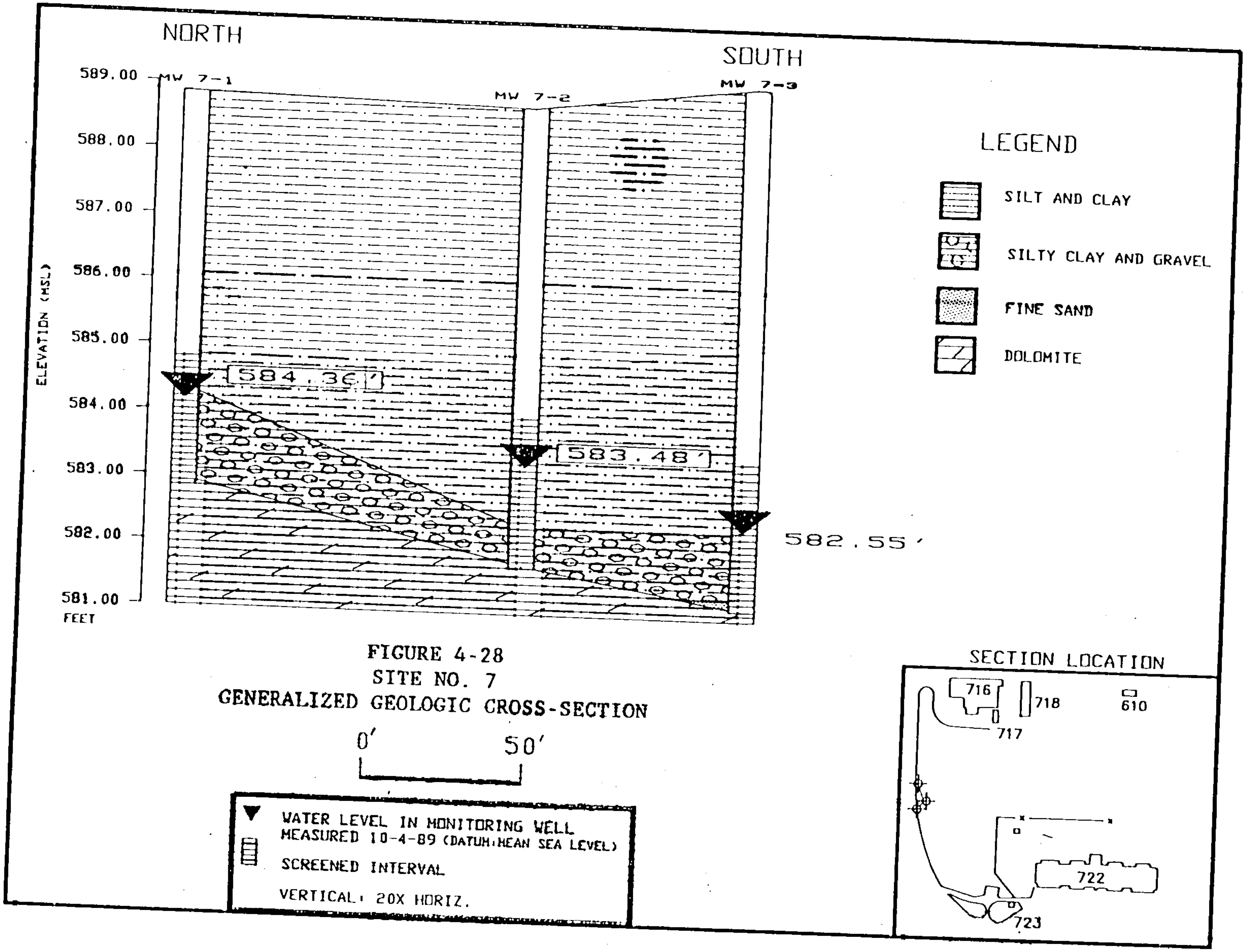


FIGURE 4-28
SITE NO. 7
GENERALIZED GEOLOGIC CROSS-SECTION

4.1.3.1.2 Site Hydrogeology

Only the shallow unconsolidated aquifer was evaluated at Site No. 7. Based upon the Stage 1 well boring logs, the first potential water-bearing zone encountered in the shallow aquifer is a moist horizon of silty-clay containing some gravel, which rests directly on the bedrock surface. This horizon is believed to represent a slightly more permeable layer of glacial till. Aside from the thin intercalations of silty sand, all of the other till and lacustrine material penetrated generally lacked sufficient permeability to serve as viable water-bearing formations and collectively function as an aquitard. This geologic arrangement results in a predominantly confined shallow aquifer system. Between May 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 4.02 feet and ranged in elevation from 588.48 feet MSL at MW7-1 to 585.96 feet MSL at MW7-3. The maximum head differential across Site No. 7 is 2.52 feet and the hydraulic gradient is 0.0336. This is an unusually steep hydraulic gradient and is atypical for the unconsolidated aquifer in the Niagara Falls area. According to the groundwater flow modeling study (Mercer et. al., 1983) conducted at Love Canal, a hydraulic gradient of 0.0036 is more typical of the unconsolidated aquifer. The steeper gradient interpreted from the Site No. 7 shallow monitoring wells is probably a hydrogeologic anomaly that exist only during the wetter Spring months, or is an apparent condition facilitated by a hydrogeologically isolated or damaged downgradient well.

A maximum average water level fluctuation of 4.05 feet was observed in the Site No. 7 monitoring wells between October 1989 and April 1990. Table 4-41 presents all the hydrogeologic data collected at Site No. 7. Figures 4-30 and 4-31 present potentiometric surface maps of the shallow unconsolidated aquifer constructed from the October 1989 and April 1990 water level measurements at Site No. 7. Groundwater flow in the shallow system is interpreted to be generally southwest.

A curious hydrogeologic relationship was noted during the RI field effort at Site No. 7. During the wetter months of spring, a very steep hydrogeologic gradient occurs across the site. A maximum gradient of 4.08 feet over a horizontal distance of 35 feet was observed during the May 1989 round of water

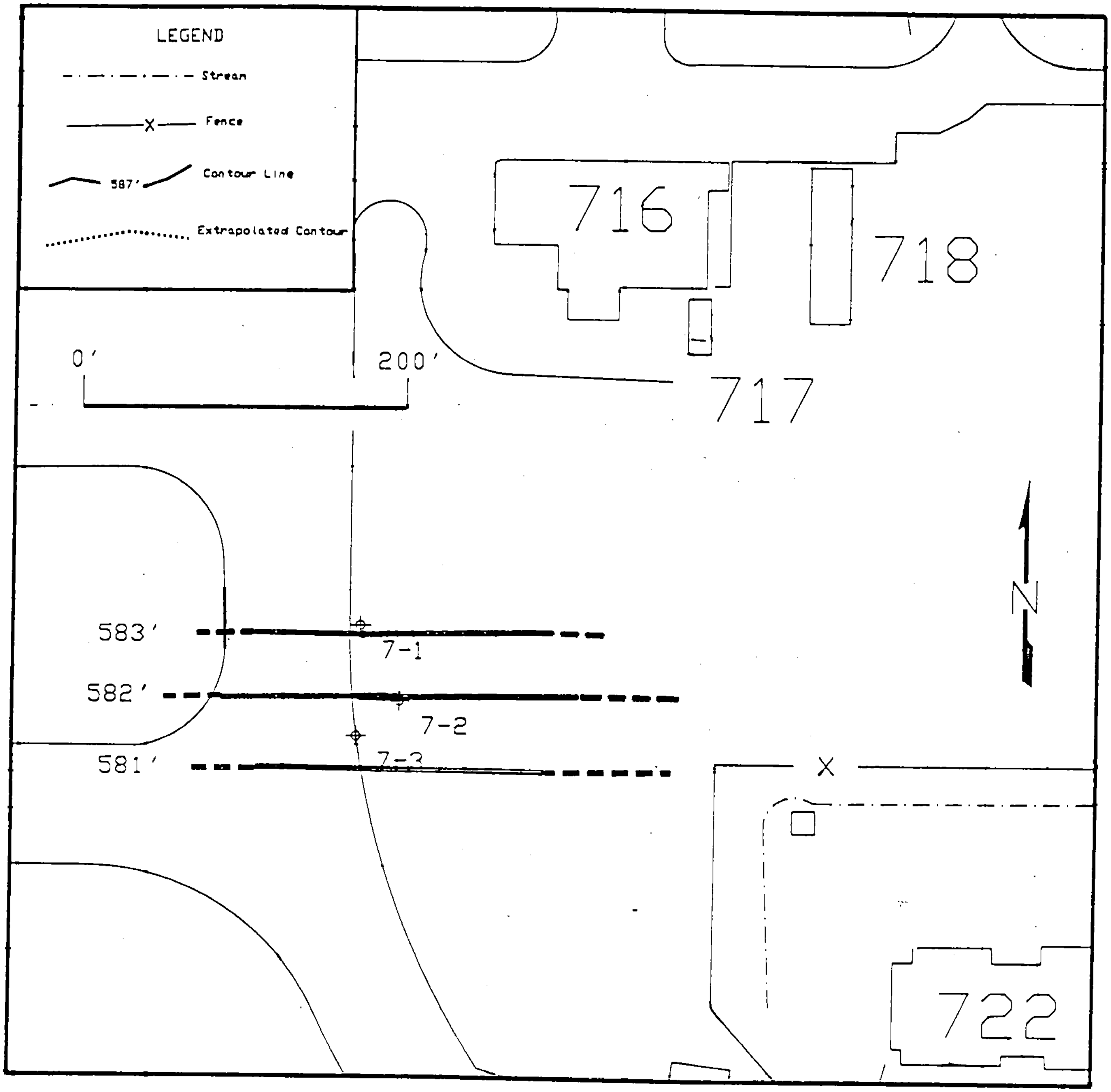


FIGURE 4-29
SITE NO. 7: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

TABLE 4-41

Site No. 7 - Hydrogeologic Data

Static Water Level Results

	05-31-89 Water Levels		09-12-89 Water Levels		10-04-89 Water Levels		04-11-90 Water Levels	
Monitor Well No	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**
7-1	587.11	1.94	584.35	4.70	584.36	4.69	588.48	0.57
7-2	587.15	1.79	583.49	5.45	583.48	5.46	588.11	0.83
7-3	583.48	5.87	582.62	6.73	582.55	6.80	585.96	3.39

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW7-1	2.50×10^{-6} ft/sec	2.0 ft	5.00×10^{-6} ft^2/sec

Notes:

ft.BLS = Feet below land surface
ft.MSL = Feet in reference to mean sea level
Transmissivity was calculated as follows: $K \cdot B = T$.
Saturated Thickness was determined by measuring the length of screen below the static water level.

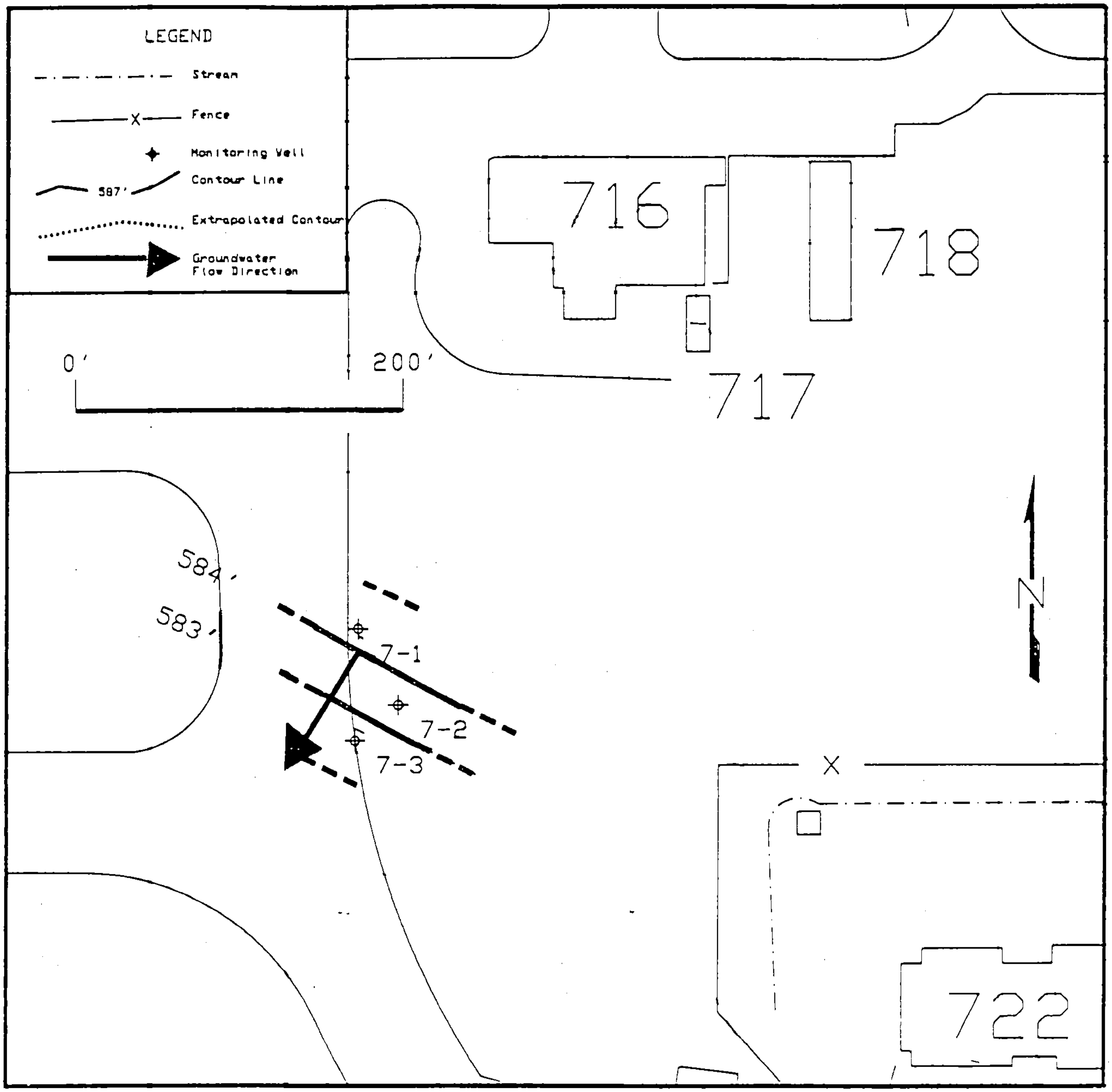


FIGURE 4-30
SITE NO. 7: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1988)

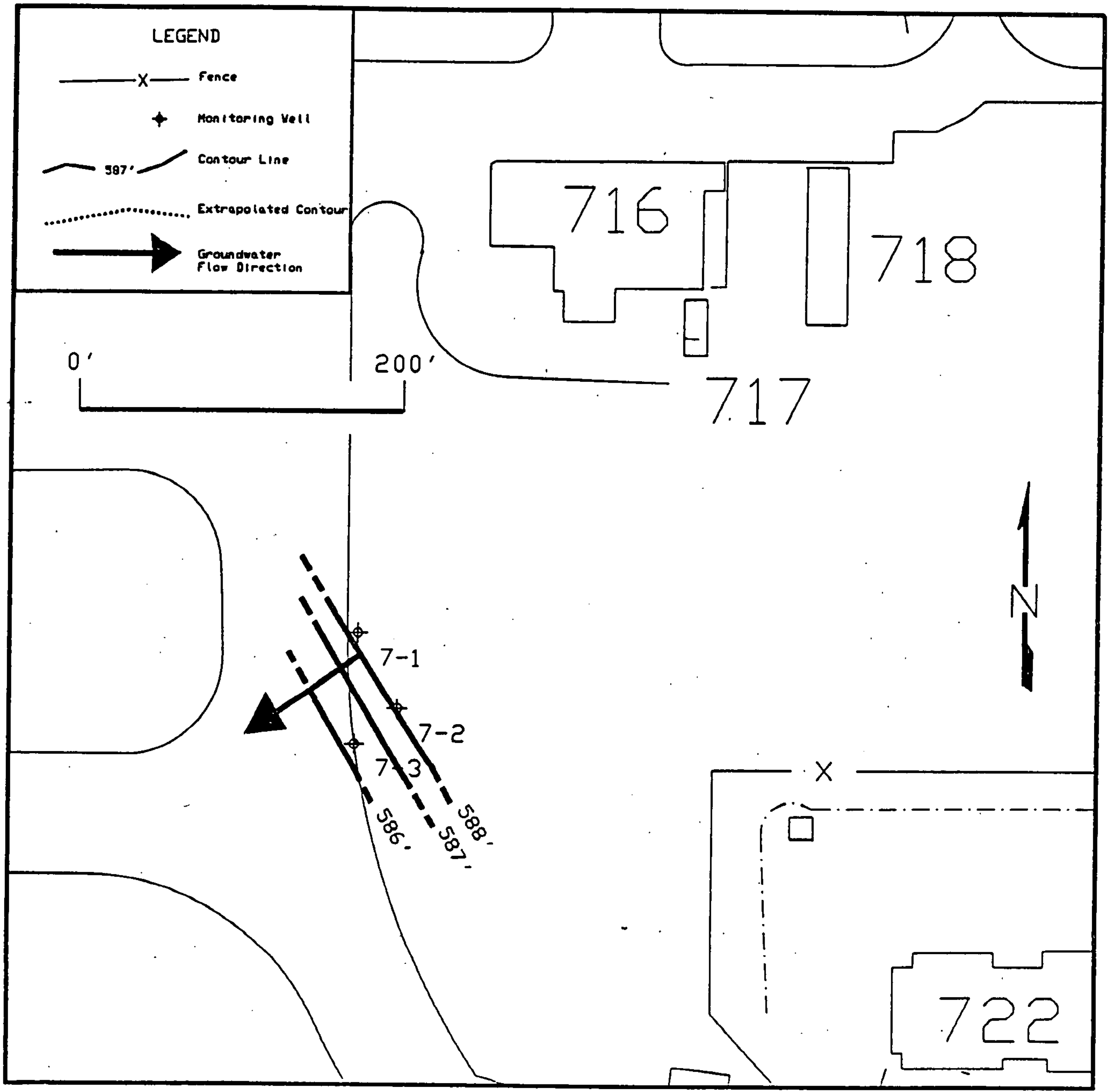


FIGURE 4-31
SITE NO. 7: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

level measurements. During the drier summer months, the gradient is less distinct, amounting to 2.11 feet over a horizontal distance of 75 feet. Like most of the shallow monitoring wells across the installation, MW7-1 and MW7-2 respond fairly quickly to seasonal rainfall fluctuations. Typically the highest water levels in the wells are experienced during early spring, when more rainfall occurs across the area; the lowest water levels are encountered at the end of summer which marks the end of an extended period of only sporadic short duration rainfall events (i.e., thunderstorms). Between spring (May 1989) and the end of summer (October 1989), water level fluctuations of 3.67 feet and 2.75 feet were observed in monitoring wells MW7-2, and MW7-1 respectively, while a water level fluctuation of only 0.93 feet was observed in monitoring well MW7-3. Monitoring well MW7-3 appears to be hydrogeologically isolated from the two upgradient wells. The slow water-level response in MW7-3 is possibly explained by a less permeable water-bearing zone, the lack of vertical fractures in the upper bedrock near this well or a silted filter pack around the well screen.

During the Stage 1 effort, an attempt was made to measure the hydraulic conductivity of the shallow unconsolidated aquifer in the vicinity of Site No. 7. A single slug test was performed on shallow monitoring well MW7-1. Head level responses were recorded using a weighted graduated line with an attached float. As a result of the Stage 1 slug test, a hydrogeologic conductivity value of 2.5 x 10^{-6} ft/sec (7.5 x 10^{-5} cm/sec) was calculated for MW7-1. As discussed in Section 4.1.1.1.2, the extensive groundwater flow modeling study of the shallow aquifer at the Love Canal site (Mercer et. al, 1983) reported hydraulic conductivities in the range of 10^{-6} to 10^{-7} ft/s, an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. The hydraulic conductivity yielded by the Stage 1 slug test is therefore consistent with those of the flow modeling study. Using the hydrogeologic data from the flow modeling study, horizontal groundwater flow velocities of 2.1 x 10^{-4} to 2.1 x 10^{-3} ft/day are predicted. These velocity values equate to 7.7 x 10^{-2} to 7.7 x 10^{-1} ft/year. At a nearby industrial property, the USGS (1985) reported a groundwater velocity range of 2.0 x 10^{-2} to 6.0 x 10^{-2} ft/year in the shallow aquifer.

4.1.3.1.3. Analytical Results For Site No. 7: Headspace Analyses

Headspace analyses were conducted on groundwater samples collected from three (3) Stage 1 monitoring wells previously installed at Site No. 7. Isoconcentration contour maps were constructed for trichloroethene (TCE) and total hydrocarbons (Figures 4-32 and 4-33). Due to the isolated occurrences of tetrachloroethene (PCE), benzene, toluene and xylenes, isoconcentration contour maps were not constructed for these compounds. TCE, PCE, benzene, toluene and total hydrocarbons concentrations of 0.2 ug/l, 0.4 ug/l, 780 ug/l, 130 ug/l and 3,400 ug/l were respectively found in the groundwater from downgradient well MW7-3. Xylene concentrations of 16 ug/l and 4 ug/l were detected in groundwater from MW7-1 and MW7-2 respectively. Xylene was not detected in the downgradient well MW7-3. 1,1,1-trichloroethane (TCA) and ethylbenzene occurred at or below the instrument's detection limit. The headspace analytical data for Site No. 7 is presented in Table 4-42.

Figure 4-32 illustrates the inferred pattern of TCE contamination in the shallow unconsolidated aquifer beneath Site No. 7. The contamination pattern suggests that levels of TCE increase upgradient from the JP-4 fuel truck spill area. Groundwater from monitoring well MW7-1 registered the highest concentration of TCE at 1 ug/l. TCE was not detected in any of the wells during the RI groundwater sampling effort.

Figure 4-33 illustrates the inferred pattern of total hydrocarbons in groundwater of the shallow unconsolidated aquifer across the Site No. 7 study area. The maps generally depict an increase in the levels of total hydrocarbons in a downgradient direction. Total hydrocarbon concentrations of 3,400 ug/l, 16 ug/l and 90 ug/l were measured in MW7-3, MW7-2 and MW7-1 respectively.

4.1.3.1.4 Analytical Results for Site No. 7: Contract Laboratory

Matrix-specific results are presented for each individual sample in Tables 4-43 and 4-44; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-45. Engineering property characteristics for soils at Site No. 7 are presented in Table 4-46.

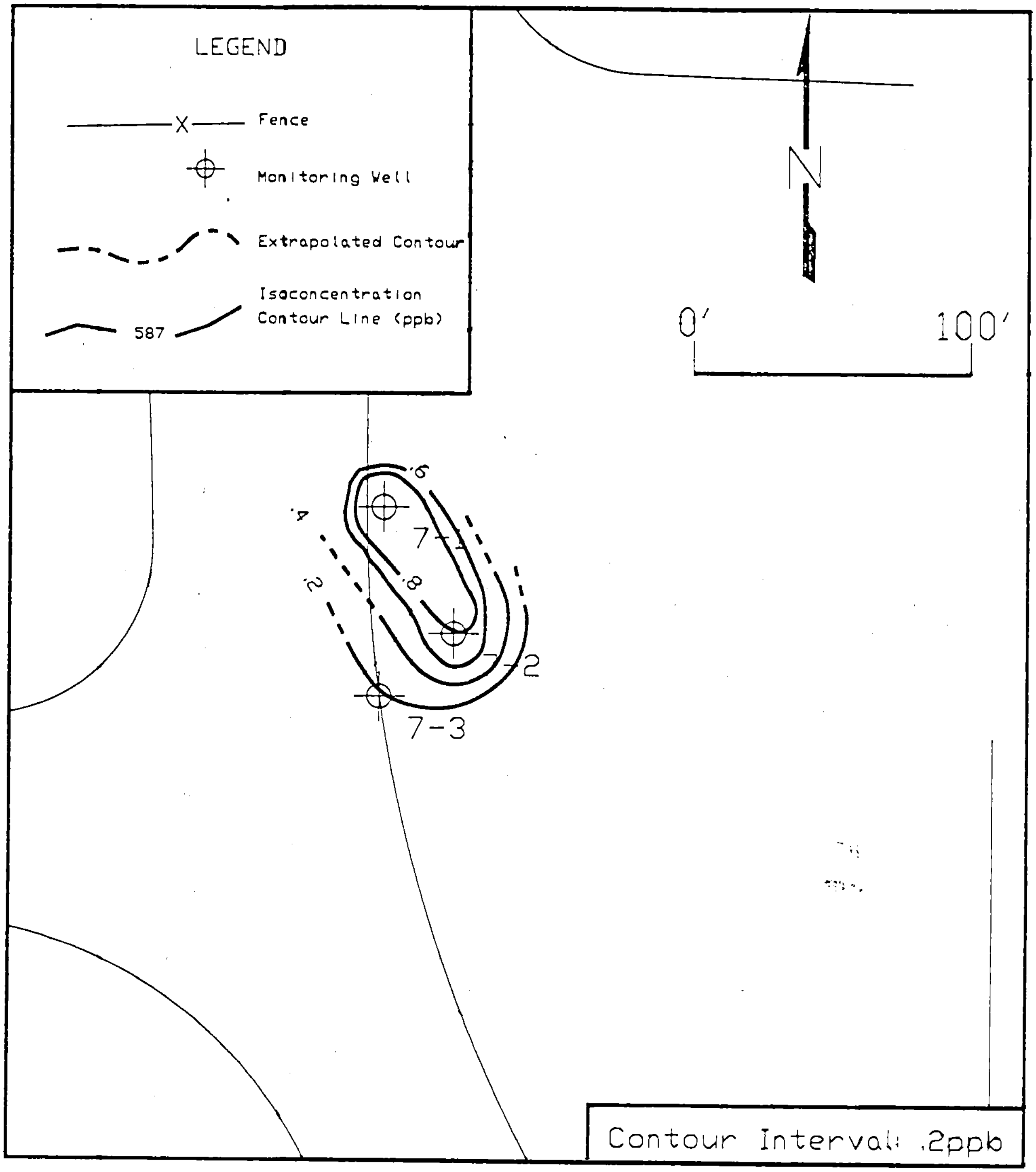


FIGURE 4-32
SITE NO. 7: TRICHLOROETHENE (TCE) ISOCONCENTRATION CONTOUR MAP
GROUNDWATER HEADSPACE ANALYSES

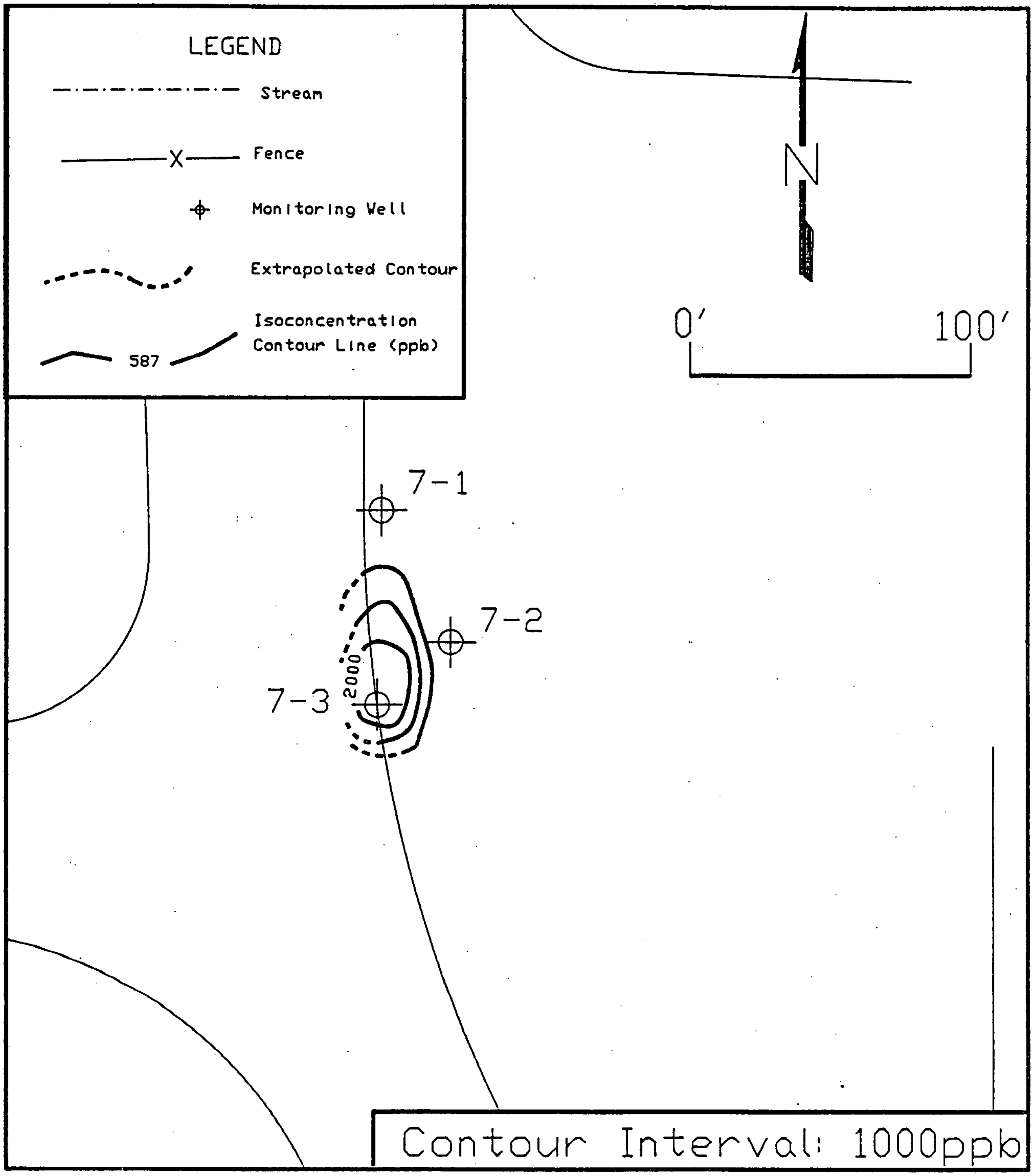


FIGURE 4-33
SITE NO. 7: TOTAL HYDROCARBON ISOCONCENTRATION CONTOUR MAP
GROUNDWATER HEADSPACE ANALYSES

Table 4-42

Site No. 7: Summary of Headspace Analytical Results for Groundwater

Sample	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
MW7-1	06/04/89	<0.0003	1	<0.0002	<0.5	<0.7	<0.5	16	90
MW7-2	06/04/89	0.009	0.8	<0.0002	19	<0.3	<0.3	4	16
MW7-3	06/04/89	0.003	0.2	0.4	780	130	<0.5	<0.8	3,400

TABLE 4-43
SITE NO. 7: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	Sample Field Identification (Sample Description) B-7-1-1 (0-1.5')	 B-7-1-3 (3.0-4.5')	 B-7-1-4 (4.5'-6.0')
EPA Method SW8240 (mg/kg) **Volatile Organics**				
Methylene Chloride	0.005	<0.0060[*,b]	4.1[b,c]	3.8[a,b,c]
Acetone	0.010	<0.0115[*,b]	7.5[b,c]	5.4[a,b,c]
Total Xylenes	0.005	ND	1.800[c]	<1.200[*,a,b,c]
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg) **Total Petroleum Hydrocarbons**	5.0	11[d]	570[d]	230[d]
EPA Method SW9060 **Total Organic Carbon (mg/kg)**	NR	NA	NA	2600

Footnotes:

* Compound present below measurable detection limit.

a = Surrogate recovery (4-bromoflurobenzene) exceeded upper control limit.
b = Compound also detected in associated method blank.
c = Volatile organic analysis performed using methanol extraction; detection limit approximately 200 times higher than routine MDLs.
d = Associated matrix spike had recovery above control limits.

NR = Not reported

TABLE 4-44
SITE NO. 7: ANALYTICAL RESULTS: GROUNDWATER

		Sample Field Identification (Sample Description)									
Parameter (Units)	**Detection Limits**	**GW22 (MW-7-1)**	**GW23 (MW-7-2)**	**GW25 (MW-7-2) Duplicate**	**TB17 Trip Blank**	**GW21 Field Blank**	**GW26 Equip. Wash**	**GW110 (MW-7-3)**	**GW111 Equip. wash**	**GW108 Trip Blank**	**GW109 Field Blank**
EPA **Method** SW5030/8020											
Purgeable Aromatic (ug/L)									ND	ND	ND
Benzene	0.3	ND	ND	ND	ND	ND	ND	460			
Toluene	0.[illegible]	ND^{a,b}	1.1^{a,b}	0.59^{a,b}	ND^{a,b}	ND^{a,b}	ND^{a,b}	260			
Ethylbenzene	0.3	ND	ND	ND	ND	ND	ND	190			
Total Xylenes	1.0	ND	ND	ND	ND	ND	ND	850			
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND			
EPA Method E$^{200.7*}$											
Total Metals (mg/L)					NA	NA				NA	NA
Aluminum	0.1	1.90^{b}	20.5^{b}	9.30^{b}			ND^{b}	0.610	ND		
Barium	0.01	0.074^{b}	0.213^{b}	0.112^{b}			ND^{b}	0.052	ND		
Boron	0.01	0.270^{b,c}	0.128^{b,c}	0.087^{b,c}			0.026^{b,c}	0.160	0.084		
Calcium^{d}	0.20	96.8^{b,c}	352^{b,c}	130^{b,c}			ND^{b,c}	89.0	0.740		
Chromium	0.010	ND^{b}	0.036^{b}	0.018^{b}			ND^{b}	ND	ND		
Cobalt	0.010	ND^{b}	0.012^{b}	ND^{b}			ND^{b}	ND	ND		
Copper	0.010	0.013^{b}	0.073^{b}	0.030^{b}			ND^{b}	0.017	ND		
Iron	0.025	3.36^{b}	24.4^{b}	10.3^{b}			ND^{b}	4.80	ND		
Lead	0.05	ND^{b}	0.076^{b}	ND^{b}			ND^{b}	NR	ND		
Lead (E239.2)	0.005	0.022^{b}	0.076^{b}	0.030^{b}			ND^{b}	0.0064	ND		
Magnesium^{d}	0.20	62.3^{b}	202^{b}	65^{b}			ND^{b}	45.0	ND		
Manganese	0.005	0.577^{b}	0.912^{b}	0.466^{b}			ND^{b}	0.600	ND		
Nickel	0.15	ND	0.041^{b}	0.018^{b}			ND^{b}	ND	ND		
Potassium^{d}	0.4	0.610^{b}	2.54^{b}	1.64^{b}			ND^{b}	0.680	ND		
Silicon^{d}	0.020	8.23^{b,c}	56.5^{b,c}	18.2^{b,c}			0.124^{b,c}	5.70	0.260		
Sodium^{d}	0.200	14.1	7.79	7.96			0.207	8.60	ND		
Vanadium	0.01	ND^{b}	0.028^{b}	ND^{b}			ND^{b}	ND	ND		
Zinc	0.01	0.244^{b,c}	3.40^{b,c}	1.36^{b,c}			ND^{b,c}	0.086	ND		
Others	See Appendix F	ND	ND	ND			ND	ND	ND		
EPA Method E418.1 (mg/L)											
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	NA	NA	ND	45	ND	NA	NA
Miscellaneous Inorganics (mg/L)					NA	NA				NA	NA
Total Dissolved Solids (E160.1)	1.0	500	450	NA			NA	390	19		
Common Anions (A429)											
Fluoride	0.1	0.89	0.81	NA			NA	2.5	ND		
Chloride	0.5	19	11	NA			NA	9.0	ND		
Sulfate	0.5	110	99	NA			NA	0.93	ND		
Total Hardness (E130.1)	1.0	610	530	570			ND	350	ND		

TABLE 4-44 (Cont'd)
SITE NO. 7: ANALYTICAL RESULTS: GROUNDWATER

Footnotes:

a = Associated MS/MSD analyses had high recovery (above control limits) for this and other compounds for one of the spikes; RPD values were above control limits for 6 out of 7 compounds.
b = Associated field duplicate analysis exceeded 35% RPD.
c = Compound also detected in associated method blank.
d = Accuracy data not available; compound not included in spiking solution.
* = Or as indicated for those metals analyzed by alternate methods.
NA = Not analyzed.

TABLE 4-45
Field Water Quality Data
Niagara Falls IAP
Site No. 7
9/16/89

Well No.	Temperature	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 7-1	59.5°F	7.34	600	375	0	0	375	Background	clear
MW 7-2	58°F	7.32	450	150	0	0	150	Background	slightly cloudy

TABLE 4-46

SITE NO. 7: ENGINEERING PROPERTY CHARACTERISTICS FOR SOILS

Parameter	ASTM Method	Sample Number B-7-1-3C
Soil Moisture	D2216	19.1%
Density	D4287	2.97
Plasticity Index	D4318	29
Grain Size	D422	--- See Appendix D ---

Note that during the additional RI field effort (April, 1990) a groundwater sample, MW-7-3, was collected which was not sampled originally. The results for this sample are included in all tables and discussions.

Organic Analyses: Three soil boring samples were analyzed for volatile organics. (Only purgeable aromatic compound analysis was required at this site; however, due to laboratory configuration all soil samples were analyzed for full scan volatile organics by GC/MS). Four groundwater samples and associated field QC blanks were analyzed for purgeable aromatics. (One sample, GW-110, was also analyzed for purgeable halocarbons; this was not required for this site and the results are not included in Table 4-44. All method compounds, however, were non-detected.) The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- One soil sample (B-7-1-4) analyzed for volatile organics had a surrogate recovery slightly above the control limit: p-bromofluorobenzene recovery =125%, upper control limit =121%.
- Although not target compounds, methylene chloride and acetone were detected in the soil samples and the laboratory method blanks. The volatile organic methanol extraction blank had methylene chloride = 1.7 mg/kg and acetone = 3.6 mg/kg. The method blank associated with B-7-1-1 had methylene chloride = 0.006 mg/kg and acetone present but below the detection limit.
- It should be noted that for the volatile organics analysis of B-7-1-3 by methanol extraction, xylenes were detected at 1.80 mg/kg with a corresponding detection limit value of 1.05 mg/kg.
- The associated soil field duplicate pair was collected from another site during the same time period as the Site 7 samples. The sample pair (B-4-1-3/3R) exceeded 35% RPD for methylene chloride (RPD=60%) and acetone (=44%); volatile organic analysis was performed by methanol extraction for these samples.
- The MS/MSD pair associated with the purgeable aromatic analysis of groundwater samples GW21-26 had an elevated toluene recovery = 140% (upper control limit = 120% recovery), and 29% RPD (control limit = 20%). Other spiked compounds, which were not detected in the samples also had elevated recovery values and RPDs.
- The field duplicate pair (GW23/25) associated with groundwater samples GW21-26, exceeded 35% RPD for toluene (RPD = 60%).

<u>Inorganic Analyses</u>: Three soil boring samples were analyzed for total petroleum hydrocarbons (TPH); one of these samples was also analyzed for total organic carbon. Four groundwater samples were analyzed for metals, TPH, total dissolved solids, common anions, and total hardness. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The matrix spike associated with the TPH analysis of the soil samples had recovery just slightly above the control limits; recovery =145%, upper control limit =142%.

- The laboratory metals method blank associated with groundwater samples GW-22, GW-23, GW-25 and GW-26 contained boron =0.029 mg/L, calcium =0.386 mg/L, silicon = 0.083 mg/L, and zinc =0.037 mg/L. The equipment wash blank, GW-26, had boron = 0.026 mg/L, calcium =ND, silicon =0.124 mg/L and zinc =ND. Sample concentrations for all metals except boron were significantly higher than the blank concentrations and were probably not biased. Boron concentrations ranged from 0.087-0.270 mg/l and the presence of background concentrations may have slightly elevated the reported values.

- The matrix replicate/matrix spike associated with the metals analysis of groundwater samples GW-22, GW-23, GW-25 and GW-26 resulted in 0% recovery for antimony and silver, indicating significant bias in the analysis. These elements were not detected in any samples, however the actual detection limits may be significantly higher than reported.

- The field duplicate pair, GW23/25, had greater than 35% RPD for all detected elements (except sodium). The sample (GW23) had concentrations approximately twice that of the duplicate (GW25). [Note: This was also true of the toluene concentrations observed for the pair.]

4.1.3.2 Significance of Findings

4.1.3.2.1 Significance of Findings: Site No. 7 - JP-4 Tank Truck Spill

Groundwater and soils were investigated at Site No. 7 to characterize the environmental consequences of the 1983 JP-4 tank truck spill. Tables 4-47 and 4-48 present analyses versus ARARs and/or background levels for all contaminants found in the matrices studied.

TABLE 4-47
SITE NO. 7: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

		Sample Field Identification (Sample Description)				
Parameter (Units)	**Detection Limits**	**Background[e] (mg/Kg)**	**Selected Average for soils[f] (mg/Kg)**	**B-7-1-1 (0-1.5')**	**B-7-1-3 (3.0-4.5')**	**B-7-1-4 (4.5'-6.0')**
EPA Method SW8240 (mg/kg) **Volatile Organics**						
Methylene Chloride	0.005	0.0056-0.0091	--	<0.0060[*,b]	4.1[b,c]	3.8[a,b,c]
Acetone	0.010	ND-0.056	--	<0.0115[*,b]	7.5[b,c]	5.4[a,b,c]
Total Xylenes	0.005	ND	--	ND	1.800[c]	<1.200[*,a,b,c]
Others	See Appendix F			ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg) **Total Petroleum Hydrocarbons**	5.0	ND	--	11[d]	570[d]	230[d]
EPA Method SW9060 **Total Organic Carbon (mg/kg)**	NR			NA	NA	2600

Footnotes:

* Compound present below measurable detection limit.

a = Surrogate recovery (4-bromoflurobenzene) exceeded upper control limit.
b = Compound also detected in associated method blank.
c = Volatile organic analysis performed using methanol extraction; detection limit approximately 200 times higher than routine MDLs.
d = Associated matrix spike had recovery above control limits.
e = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
* = Or as indicated for those metals analyzed by alternate methods.
NA = Not Analyzed
NR = Not Reported

TABLE 4-48
SITE 7: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	Sample Field Identification (Sample Description) GW22 (MW-7-1)	 GW23 (MW-7-2)	 GW110 (MW-7-3)
EPA Method SW5030/8021					
Purgeable Aromatic (ug/L)					
Benzene	0.3	ND[h]	ND	ND	460
Toluene	0.3	5[i]	ND[a,b]	1.1[a,b]	260
Ethylbenzene	0.3	5[i]	ND	ND	190
Total Xylenes	1.0	15[i]	ND	ND	850
Others	See Appendix F	-	ND	ND	ND
EPA Method E200.7*					
Total Metals (mg/L)					
Aluminum	0.1	No ARAR	1.90[b]	20.5[b]	0.610
Barium	0.01	1.0[i]	0.74[b]	0.213[b]	0.052
Boron	0.01	1.0[i]	0.270[b,c]	0.128[b,c]	0.160
Calcium[d]	0.20	No ARAR	96.8[b,c]	352[b,c]	89.0
Chromium	0.010	0.050[i]	ND[b]	0.036[b]	ND
Cobalt	0.010	No ARAR	ND[b]	0.012[b]	ND
Copper	0.010	0.200[i]	0.013[b]	0.073[b]	0.017
Iron	0.025	0.300[i]	3.36[b]	24.4[b]	4.80
Lead	0.05	0.025[i]	ND[b]	0.076[b]	NR
Lead (E239.2)	0.005	0.025[i]	0.022[b]	0.076[b]	0.0064
Magnesium[d]	0.20	No ARAR	62.3[b]	202[b]	45.0
Manganese	0.005	0.300[i]	0.577[b]	0.912[b]	0.600
Nickel	0.15	0.0154[j]	ND	0.041[b]	ND
Potassium[d]	0.4	No ARAR	0.610[b]	2.54[b]	0.680
Silicon[d]	0.20	No ARAR	8.23[b,c]	56.5[b,c]	5.70
Sodium[d]	0.20	20[i]	14.1	7.79	8.60
Vanadium	0.01	No ARAR	ND[b]	0.028[b]	ND
Zinc	0.01	0.300[i]	0.244[b,c]	3.40[b,c]	0.086
Others	See Appendix F	-	ND	ND	ND
EPA Method E418.1 (mg/L)					
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	45
Miscellaneous Inorganics (mg/L)					
Total Dissolved Solids (E160.1)	1.0	500[m]	500	450	390
Common Anions (A429)					
Fluoride	0.1	1.5[i]	0.89	0.81	2.5
Chloride	0.5	250[i]	19	11	9.0
Sulfate	0.5	250[i]	110	99	0.93
Total Hardness (E130.1)	1.0	No ARAR	610	530	350

TABLE 4-48 (Cont'd)
SITE NO. 7: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

<u>Footnotes</u>:

a = Associated MS/MSD analyses had high recovery (above control limits) for this and other compounds for one of the spikes; RPD values were above control limits for 6 out of 7 compounds.
b = Associated field duplicate analysis exceeded 35% RPD.
c = Compound also detected in associated method blank.
d = Accuracy data not available; compound not included in spiking solution.
g = Associated lab matrix replicate analyses resulted in RPD values above the control limit.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for Class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
L = Applicable or Relevant or Appropriate Requirements
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F.
NA = Not analyzed.
* = Or as indicated for those metals analyzed by alternate method.

During the drilling of one soil boring at Site No.7, soil samels were collected for analyses. Since not ARARs have been established for soils, the following discussion compares the site No. 7 analytical soil data to background levels.

- Soils from the single boring at Site No. 7 yielded a total petroleum hydrocarbon(TPH) range from 11 mg/kg to 570 mg/kg. The highest concentrations were detected from the 3.0 to 4.5 foot (570 mg/kg) and4.5 to 6.0 foot (230 mg/kg) intervals. TPH was not detected in any of the soils analyzed from the background soil borings. The presence of TPH at the levels reported in soils at Site 7 is likely related to the fuel spill.

- Total xylenes were measured in soils from the 3.0 to 4.5-foot interval at 1.80 mg/kg (compared to an elevated detection limit of 1.05 mg/kg); otherwise this compound was not detected or present below the measurable detection limit.

- The low levels of methylene chloride and acetone reported in the soil samples at Site No. 7 are probably laboratory contaminants since similar levels were found in the method blank. These compounds are also reported in soils from the background soil borings.

Three Site No. 7 monitoring wells were sampled. MW7-1 and MW7-2 were sampled during the main RI effort in September 1989. amd MW7-3 was sampled during the additional RI conducted in April 1990. MW7-3 could not be sampled during the main RI effort due to a depressed water column and slow recharge. The following discussion presents a comparison of organic compounds measured in the Site No. 7 monitoring wells with ARARs and background levels.

- Toluene was detected in groundwater from across gradient shallow aquifer well MW7-2 at 1.1 ig/l. Toluene was not detedted in upgradient MW7-1. In the shallow downgradient well, MW7-3, toluene was detected at 260 ug/l. Toluene in MW7-3 exceeds the concentration in the shallow background well by a factor of 260, and the New York State Water Quality ARAR of 5 ug/l.

- Benzene was detected in the shallow downgradient well (Mw7-3) at 460 ug/l. This benzene levle does not satisfy the "non-detectable" New York Water Quality ARAR and exceeds the background level by nearly three orders of magnitude.

- Xylenes and ethylbenzeme were detected in the downgradient shallow well, MW7-3, at 850 ug/l, and 190 ug/l above the New York State Water Quality ARARs of 15 ug/l and 5 ug/l respectively. Xylene and ethylbenzene were not detected in groundwater from the background well.

- MW7-3 had a TPH concentration of 45 mg/l which is considerably higher than that observed in the shallow background well.

The presence of benzene, toluene, xylenes, ethylbenzene and TPH in groundwater from downgradient well MW7-3 can only be linked o the 1983 JP-4 fuel spill, since all of these compounds are commonly found in fuel.

Eighteen inorganic metals were detected above instrument detection limits in groundwater at Site No. 7. As discussed in Section 4.1.1.2.1, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in the Site No. 7 groundwater with ARARs and background values:

- Lead exceeded the 0.025 mg/l ARAR set by the State Water Quality Standard in shallow aquifer well MW7-2. A lead concentration of 0.076 mg/l was measured in this well.
- Iron and manganese levels in all three Site No. 7 monitoring wells exceeded the 0.300 mg/l State ARAR promulgated for these metals. Iron and manganese concentrations in the shallow background well also exceeded the State ARAR. Iron concentrations in groundwater from Site No. 7 ranged from 3.36 mg/l to 24.4 mg/l in MW7-1 and MW7-2 respectively. Manganese concentrations in groundwater from Site No. 7 ranged from 0.577 mg/l to 0.912 mg/l in the same wells respectively.
- The 0.0154 mg/l FWQC Human Health ARAR promulgated for nickel was exceeded in MW7-2 (0.041 mg/l).
- Barium levels found in groundwater at Site No. 7 ranged from 0.052 mg/l to 0.213 mg/l. None of the concentrations exceeded the New York State ARAR for barium, but the barium level recorded in MW7-2 (0.213 mg/l) was substantially higher than the background levels.
- Boron levels in MW7-1 (0.270 mg/l), MW7-2 (0.128 mg/l) and MW7-3 (0.160 mg/l) were also considerably higher than background levels, but below the New York State Water Quality ARAR of 1.0 mg/l. Boron is not known to be a product of any current or past Air Force activity .
- Chromium was found in MW7-2 (0.036 mg/l) but the concentration did not exceed the 0.050 mg/l New York State Water Quality ARAR.
- Levels of copper found in groundwater from MW7-1 (0.013 mg/l), MW7-2 (0.073 mg/l) and MW7-3 (0.017 mg/l) occurred below the State ARAR promulgated for this metal. Copper was not detected in groundwater from the background wells.

- Zinc levels in groundwater at Site No. 7 ranged from 0.086 mg/l to 3.40 mg/l. The highest concentration was found in MW7-2 and this level exceeded the zinc concentration obtained from the shallow background well by a factor of 38, and was the only concentration above the New York State Water Quality ARAR of 0.300 mg/l.

- Other metals detected in MW7-2 included vanadium and cobalt (0.012 mg/l and 0.029 mg/l respectively). Presently, no ARARs exist for these metals.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Groundwater from all Site No. 7 wells occurred within the 500 mg/l Secondary Drinking Water Standard for total dissolved solids (TDS).

- Sulfate in groundwater from all the wells occurred at levels below the 250 mg/l New York State Water Quality ARAR. Groundwater analyzed across most of the installation exceeds both of TDS and sulfate standards.

- The groundwater from the Site No. 7 wells is hard; hardness values ranged from 350 mg/l to 610 mg/l. The average hardness reported for groundwater of the unconsolidated deposits is 545 mg/l.

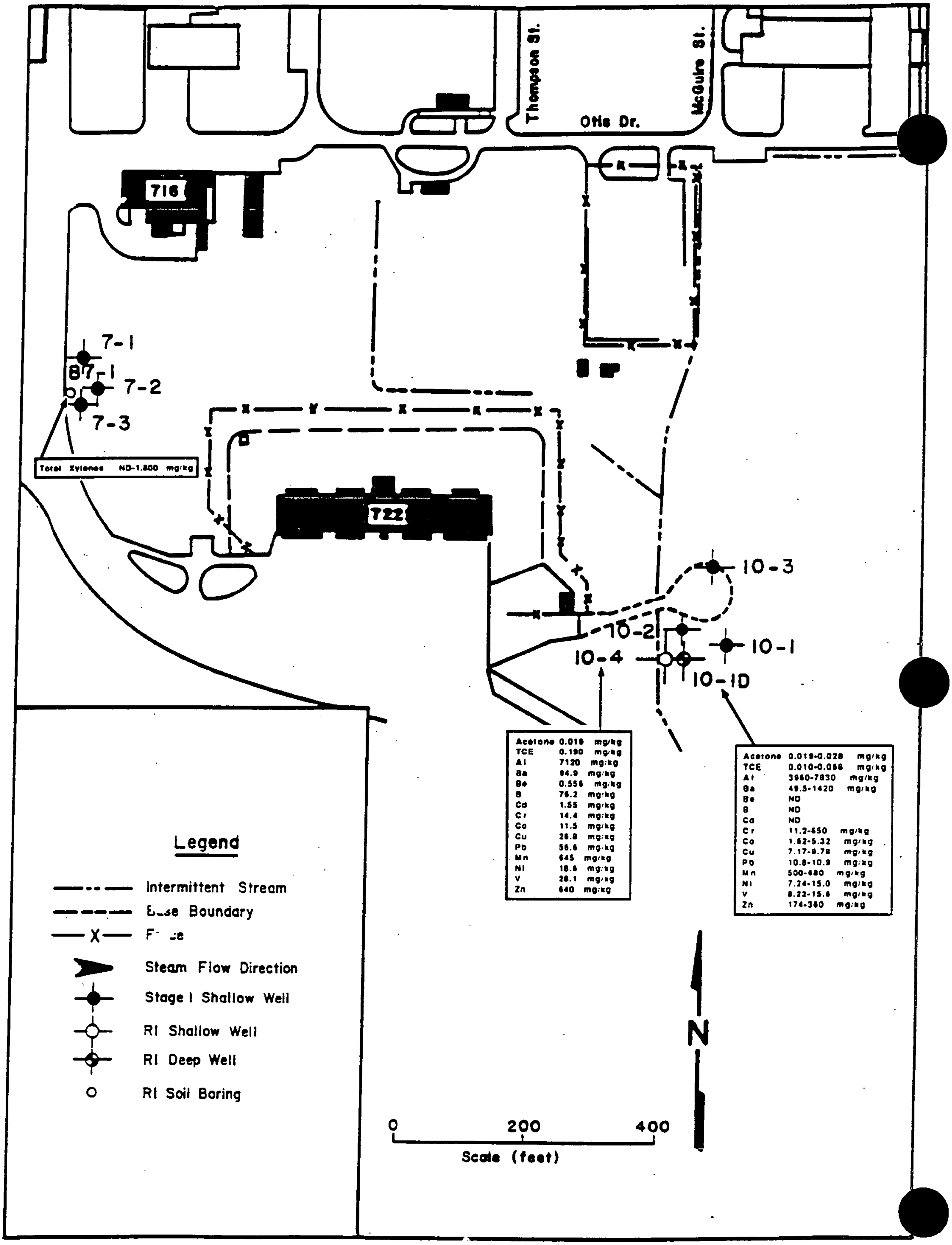
- Chloride levels in groundwater from Site No 7 ranged from 9.0 mg/l to 19 mg/l. Fluoride levels ranged from 0.81 mg/l to 2.5 mg/l.

According to the literature, water from the unconsolidated deposits is not so highly mineralized as that from the bedrock (Johnston, 1964). The water is noted as having a moderately high chloride content (118 mg/l).

4.1.3.2.2 Zones of Contamination

Due to the limited number of wells and borings at Site No. 7 it is not possible to fully establish zones of contamination. Despite the lack of monitoring stations at this site, it is likely that the zones of contamination are generally restricted to the area of the JP-4 fuel truck spill. Figures 4-34 and 4-35 depict the levels of contamination found at each monitoring station. The highest concentrations of fuel type contamination are found in the soil at the vicinity of the actual fuel spill and in the downgradient monitoring well(MW7-3) located several feet south of the spill area. Levels of TPH and xylenes were measured in the soils where the spill occurred. Fairly high levels of benzene, xylenes, toluene and ethylbenzene were found in the groundwater of

MW7-3. In across gradient well MW7-2, toluene was also found but at a much lower concentration. As discussed in Section 4.1.1.2.1, elevated metal levels yielded by the Site No. 7 groundwater samples are believed to be indicative of naturally occurring metals found in the suspended particulate clastic materials rather than site induced contamination.



Acetone	0.019	mg/kg
TCE	0.190	mg/kg
Al	7120	mg/kg
Ba	94.9	mg/kg
Be	0.556	mg/kg
B	76.2	mg/kg
Cd	1.55	mg/kg
Cr	14.4	mg/kg
Co	11.5	mg/kg
Cu	26.8	mg/kg
Pb	56.6	mg/kg
Mn	645	mg/kg
Ni	18.6	mg/kg
V	28.1	mg/kg
Zn	640	mg/kg

Acetone	0.019-0.028	mg/kg
TCE	0.010-0.068	mg/kg
Al	3960-7830	mg/kg
Ba	49.5-1420	mg/kg
Be	ND	
B	ND	
Cd	ND	
Cr	11.2-650	mg/kg
Co	1.62-5.32	mg/kg
Cu	7.17-9.78	mg/kg
Pb	10.8-10.9	mg/kg
Mn	500-680	mg/kg
Ni	7.24-15.0	mg/kg
V	8.22-15.6	mg/kg
Zn	174-360	mg/kg

FIGURE 4-34
SITE NO. 7: ZONES OF CONTAMINATION - SOIL

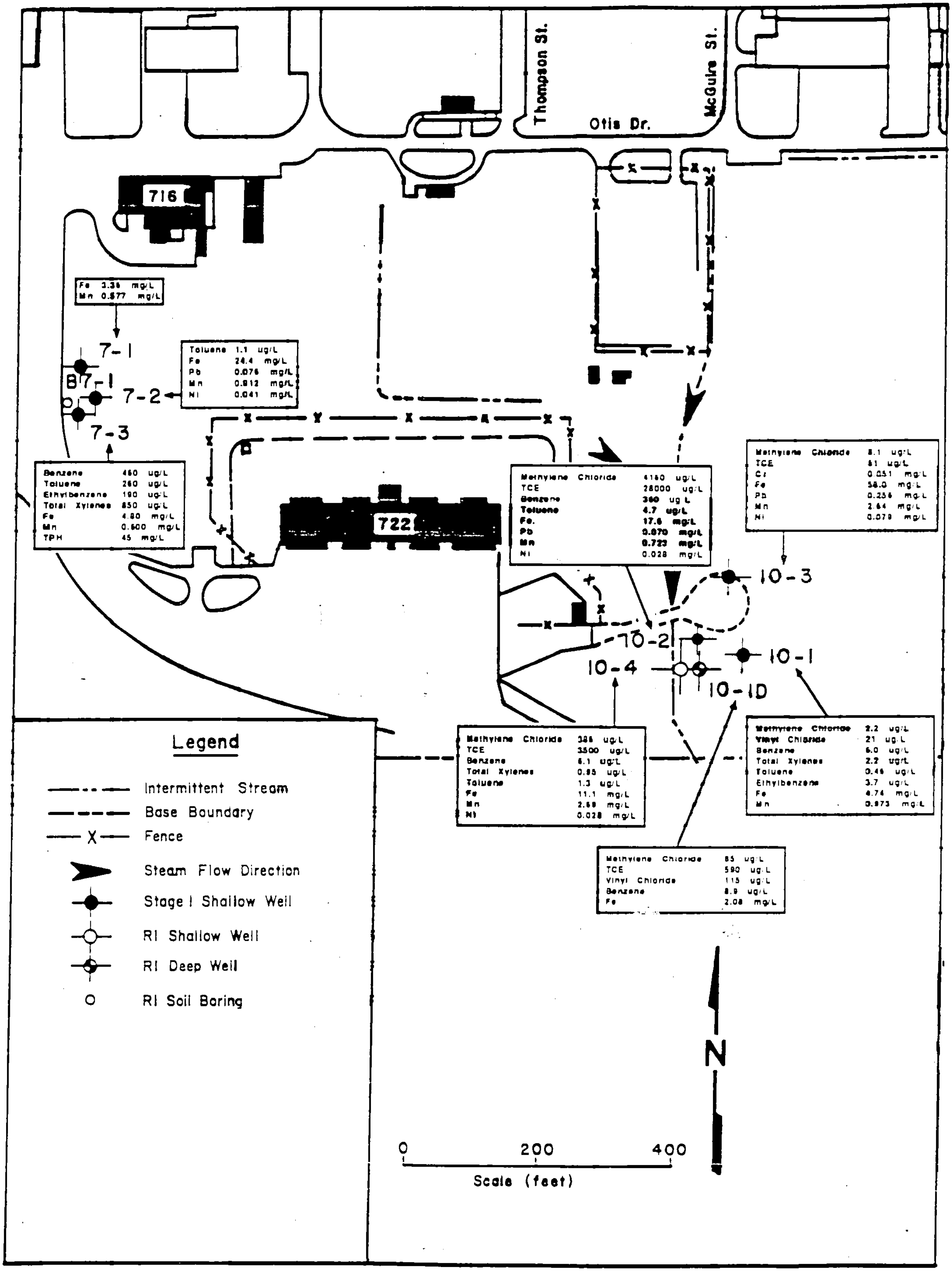


FIGURE 4-35
SITE NO. 7: ZONES OF CONTAMINATION - GROUNDWATER

4.1.3.2.3 Contaminant Migration

Migration of contaminants through the groundwater system appears to be the only viable pathway identified at Site No. 7. Migration of contaminants via the unconsolidated aquifer is estimated, as the exact contaminant plume limits are not known. Utilizing the hydrogeologic data yielded by the flow modeling study conducted at the Love Canal site (Mercer et. al., 1983) and the USGS (1985) study discussed in Section 4.1.1.1.2, contaminant migration rates are predicted to range between 5.48×10^{-5} to 2.1×10^{-3} ft/day. Higher migration rates might occur locally in nonconnective stringers of sand. In consideration of the age of the JP-4 spill and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, the following migration distance ranges have been estimated:

Site No. 7 - (Minimum) 1.4×10^{-1} feet
- (Maximum) 5.4 feet

Cultural features, such as sewer lines and underground utility lines and pipes may have some affect patterns and speed of contaminant transport within the subsurface. The area around Site 7 contains a single abandoned underground fuel line as shown in Section 4 Attachment A. The effect of this utility on contaminant transport patterens, although, is expected to be limited due to the natural geologic and hydraulic conditions of the site and the location of the utility line above the shallow water table of the area. Future investigatory work at this site will include sampling along this utility to confirm the absence of lateral contaminant migration along this route.

Based upon the most conservative contaminant migration projections, little migration has occurred over the past seven years since the fuel spill. Migration of contaminants would generally be to the south, as interpreted from the potentiometric surface maps. Due to the very slow migration rates that are predicted, it is unlikely if the contaminants would ever reach off-base human receptors before natural attenuation processes substantially reduced the levels of contamination. In any event, Cayuga Creek, which is located approximately 1000 feet south of the site, would act as a hydrologic barrier, inhibiting off-base contact via the groundwater pathway. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.3.2.4 Baseline Risk Assessment for Site No. 7

This section presents the baseline risk assessment for Site 7. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 7 - Data Analysis and Hazard Identification

Chemicals of concern for Site 7 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

The monitoring well (MW-1-7) which was initially designated as the background well for the Base was found to contain detectable concentrations of benzene (0.92 ug/L), toluene (1.0 ug/L), and TPH (1.6 mg/L), thus making it difficult to compare volatile organic values to background levels. In a USGS study (1985), ethylbenzene ranged from 4.5 to 5.9 ug/L and toluene ranged from 10 to 230 ug/L in water samples taken from the unconsolidated deposits along the Niagara River. In groundwater samples collected at Site 7, the mean values for ethylbenzene and toluene were 63 ug/L and 87 ug/L, respectively. One inorganic chemical (chromium at 16 ug/L) in the groundwater samples was above the range (1 to 8 ug/L) found in the USGS study (See Section 2.4.3 of this report for more detail).

Mean levels of TPH in soils at Site 7 were elevated (270 mg/kg) indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis however, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment. TPH was detected in one of three groundwater samples at the site: concentration of 45 mg/L.

Site No. 7 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation.

The conceptual site model for Site 7 is presented in Figure 4-36. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 7 is provided in Appendix G.

Soil

Site 7 is the location of a tank truck spill of JP-4 fuel. At the time of the spill temporary dikes were constructed to prevent fuel from reaching surface water (i.e., drainage ditches). Access to this area is not limited or fenced. The possibility exists for Base personnel to be exposed to surface soils at this location. The exposure assumptions used for Site 4 soil exposure have been adopted to assess exposure at Site 7 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 7 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

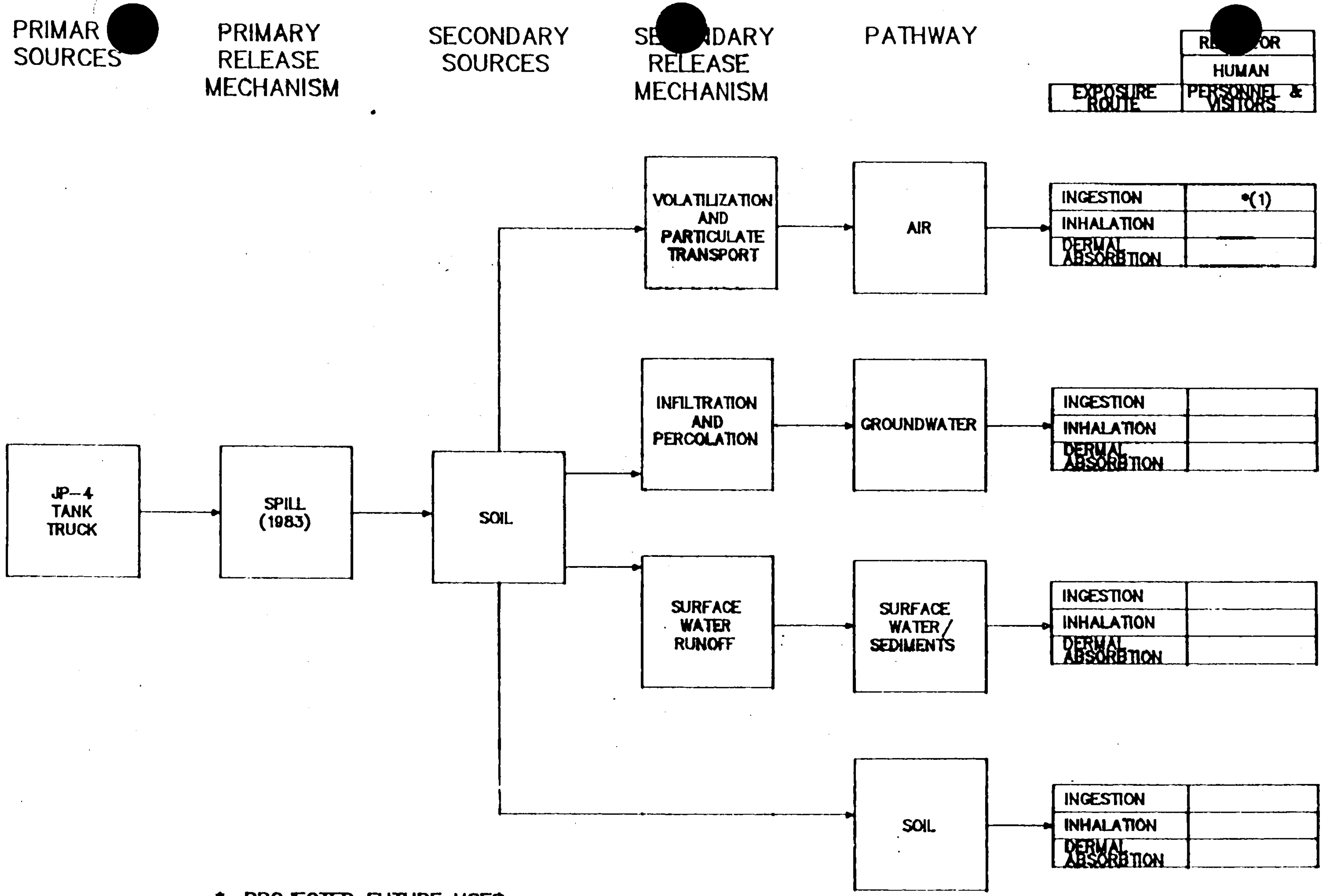
Site No. 7 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 7 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at the Site 7 are presented in Table 4-49. The hazard index for combined exposure across compounds is approximately 4.5. This value exceeds unity (1.0) and adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a source of drinking water. Benzene is the principal chemical of concern.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie. AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-36
CONCEPTUAL SITE MODEL
SITE 7 - JP-4 TANK TRUCK SPILL

TABLE 4-49

RISK CHARACTERIZATION FOR SITE NO. 7: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	5800.00			
Barium	96.00	1.88E-02	Hypertension	
Boron	179.00	1.95E-02	CNS, GI Tract, Skin	
Chromium	16.00	3.14E-02	Skin	
Copper	0.03	7.19E-06	GI Tract, Blood	
Lead	27.00	1.89E-01	CNS, Kidney	
Manganese	622.00	3.05E-02	CNS, Reproductive	
Nickel	19.00	9.32E-03	Skin, Lung	
Vanadium	8.80	1.23E-02	Respiratory Effects	
Zinc	0.90	4.43E-05	GI Tract	
ORGANICS				
Benzene	153.00	4.17E+00	Hematopoietic Sys	1.24E-05
Ethylbenzene	63.00	6.18E-03	Skin, Liver, Kidney	
Toluene	87.00	2.85E-03	CNS	
Xylenes	284.00	1.39E-03	CNS	
Hazard Index: Combined Exposure		4.49E+00		
Excess Lifetime Cancer Risk: Combined Exposure				1E-05

a. Arithmetic mean of groundwater sampling set (9/89 and 4/90). "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

Only one carcinogenic compound was detected in groundwater at Site 7. The excess lifetime cancer risk of exposure to benzene in groundwater is projected to be approximately 1 x 10^{-5}. Benzene is classified as a Group A carcinogen (i.e., known human carcinogen).

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean concentrations of benzene at Site 7 exceed the MCL of 5 ug/L. New York State groundwater limits were exceeded by mean levels of lead (27 ug/L), manganese (622 ug/L), and zinc (124 ug/l). The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

Soil Pathway

The results of risk characterization for exposure to soil at the Site 7 are presented in Table 4-50. Only a small quantity of xylenes was found in soils. The hazard quotient for xylenes in soil is approximately 6.3 x 10^{-8}. No adverse noncarcinogenic effects would be anticipated for chronic ingestion exposure to this environmental medium. No carcinogenic compounds were detected in soils at the site.

Site No. 7 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.1.4 Discussion of Results for Site No. 10: Fire Training Area No. 1

4.1.4.1 Presentation of Results

4.1.4.1.1 Site Geology

The geology of Site No. 10, as interpreted by the Stage 1 and RI well boring logs, consists of a veneer of fine grained glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The location of all Site

No. 10 monitoring wells is presented in Figure 4-37. Due to the proximity of Site No. 7, most maps referenced for Site No. 10 will also contain Site No. 7 information. The unconsolidated deposits at Site No. 10 exhibit a tendency to thicken in a north to north-east direction across the site. The unconsolidated materials achieve a minimum thickness of 7.9 feet at shallow monitoring well MW10-4 and a maximum thickness of 9.9 feet at shallow monitoring well MW10-3. The Lockport Dolomite in this area of Niagara Falls is estimated to be 180 feet thick. A generalized geologic cross-section of the Site No. 10 study area is presented as Figure 4-38.

As at most of the IRP sites, the soils encountered at Site No. 10 belong to the Odessa Series. These soils were discussed previously in Section 4.1.1.1.1. As observed at most of the sites, the lacustrine sediments generally form the uppermost unit of the unconsolidated deposits at Site No. 10. Glacial till forms the lowermost unit and rests directly on the dolomite surface. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. Both of these units were described previously in Section 4.1.1.1.1 of this report. For the same reasons discussed in Section 4.1.2.1.1 the average thickness of both these units could not be ascertained.

Intercalations of fluvial sediments probably occur sporadically throughout the site area but went undetected during the Stage 1 and RI drilling programs. As is the case with the majority of the IRP sites, these deposits are volumetrically insignificant, but often serve as significant routes for subsurface water movement.

Due to the limited number and relative close spacing of the wells at the Site No. 10 study area, significant topographic features on the bedrock surface could not be discerned. Due to the site's proximity to the combined site study area (Sites No. 1, 2, 4 and 6), it is likely that the bedrock surface in the vicinity of Site No. 10 also bears the mark of differential erosion from both preglacial drainage and glacial ice scouring. A structural contour map of the Lockport Dolomite surface at Site 10 is presented as Figure 4-39.

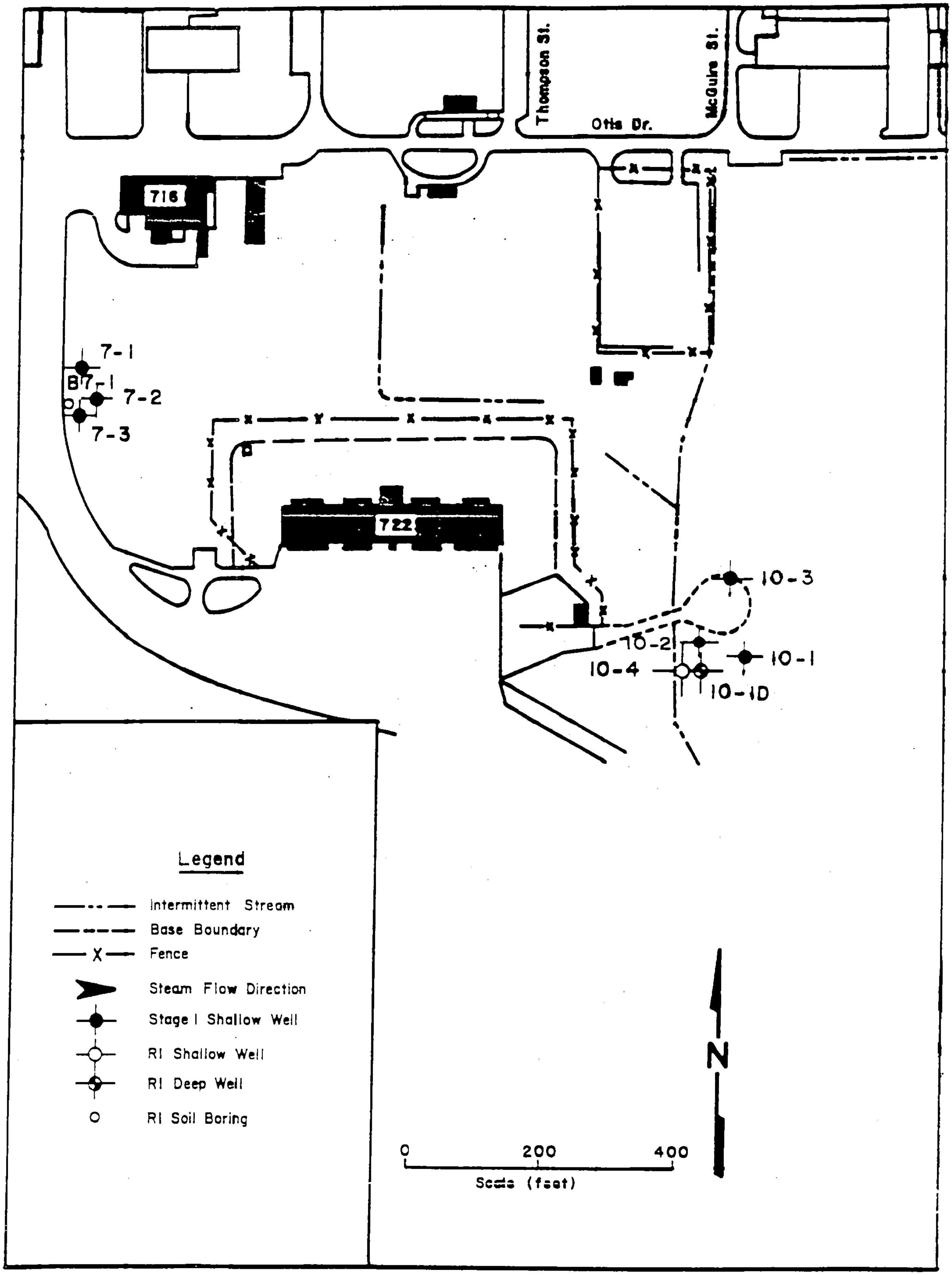


FIGURE 4-37
SITE NO. 10: MONITORING WELL LOCATION MAP

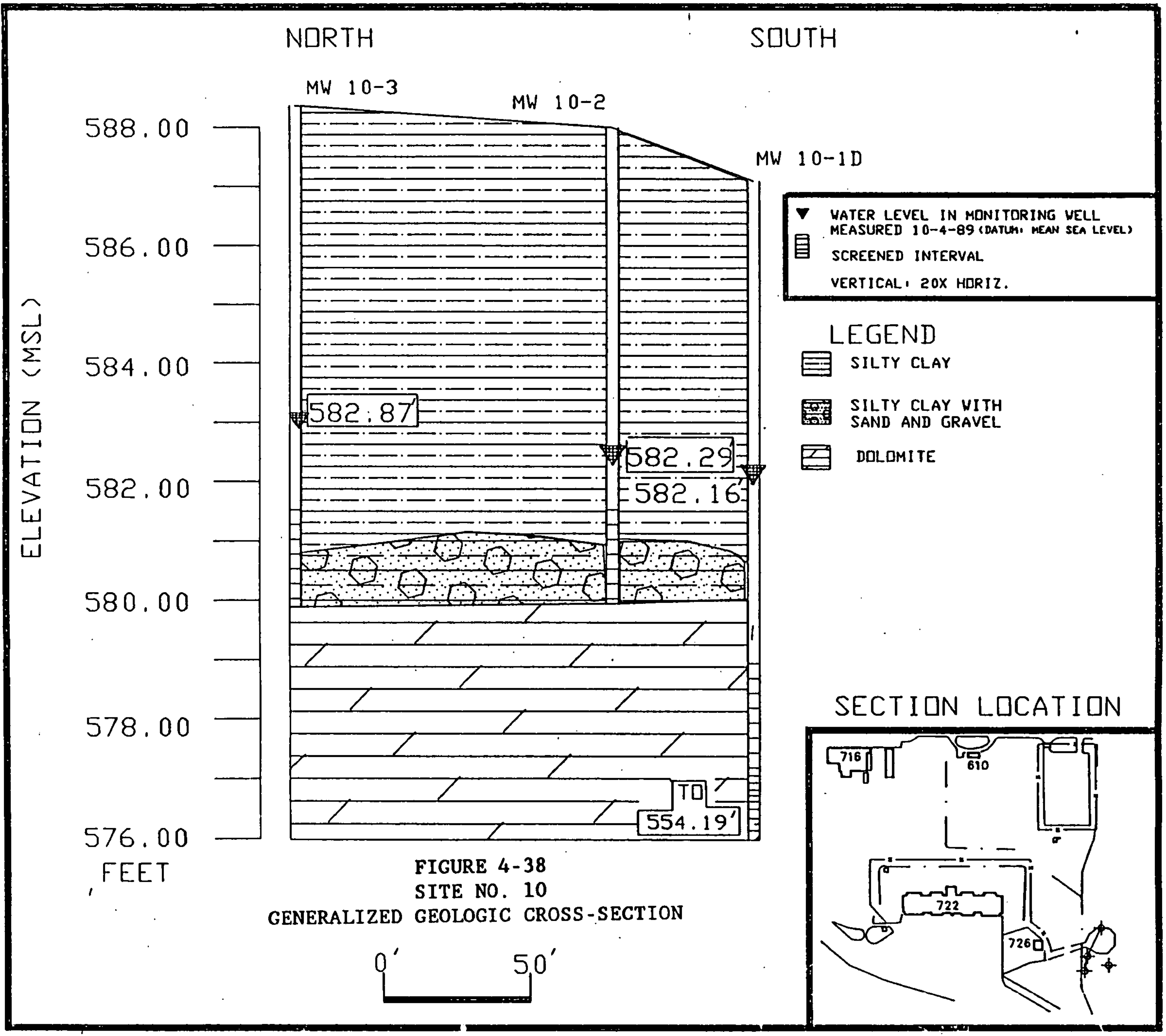


FIGURE 4-38
SITE NO. 10
GENERALIZED GEOLOGIC CROSS-SECTION

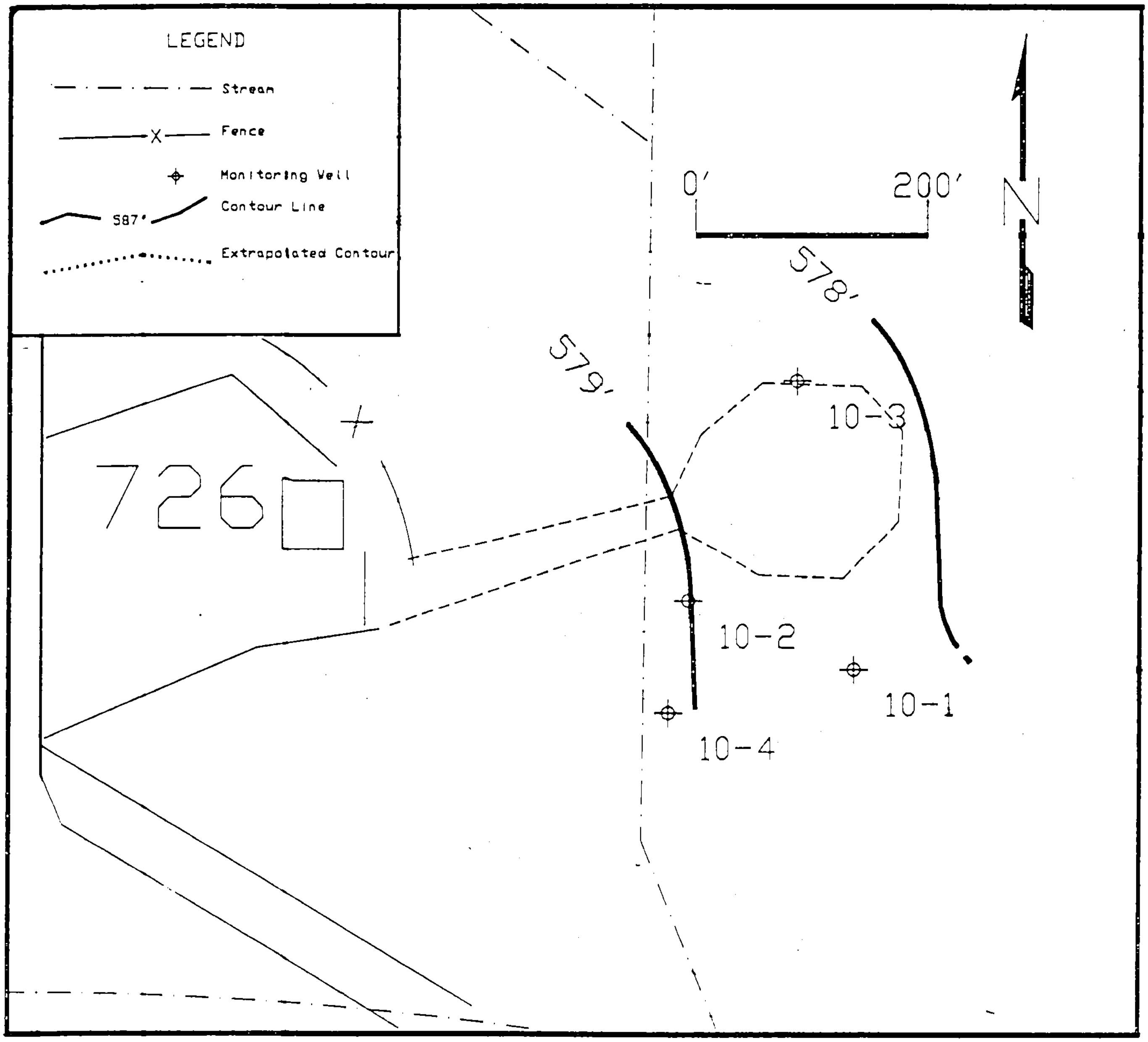


FIGURE 4-39
SITE NO. 10: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

Some general information on the upper Lockport Dolomite was obtained during the drilling of the single upper-bedrock well installed during the RI field effort. Air rotary drilling was somewhat successful in the detection of incompetent zones in the upper 25-feet of bedrock. These zones of incompetent bedrock are interpreted as fractured or thinly bedded zones, or regions of localized concentrations of vugs or solution cavities. Some of these incompetent bedrock zones are water-bearing. Most of the incompetent bedrock zones tend to be concentrated within the upper 10 to 15 feet of the dolomite. Fifteen (15) feet below the bedrock surface incompetent zones are seldom detected. This pattern is consistent with the upper-bedrock geology at all the IRP sites on the installations.

4.1.4.1.2 Site Hydrogeology

The shallow unconsolidated aquifer and the upper bedrock aquifer, referenced as the shallow and deep aquifer respectively, were investigated at Site No. 10. Based upon the Stage 1 and RI well boring logs, the first potential water-bearing zone encountered in the shallow aquifer was a thin silty-clay horizon containing some gravel which rests directly on the bedrock surface. This horizon represents a slightly more permeable section of till. All other materials penetrated generally lacked sufficient permeability to serve as viable water-bearing formations and collectively function as an aquitard. Between May 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 3.96 feet. During April 1990, water levels of the shallow aquifer exhibited a range in elevation from 586.43 feet MSL at MW10-3 to 584.81 feet MSL at MW10-4. The maximum head differential across Site No. 10 is 1.62 feet and the hydraulic gradient is 0.0101. According to the groundwater flow modeling study discussed previously (Mercer et. al., 1983), a hydraulic gradient of 0.0036 was determined to be more typical of the unconsolidated aquifer. The steeper gradient interpreted at Site No. 10 and several other sites across the installation is probably a seasonal abnormality that exist only during the wetter Spring months. A maximum average water-level fluctuation of 3.37 feet was observed in the Site No. 10 shallow monitoring wells between October 1989 and April 1990. Table 4-51 presents all the hydrogeologic data collected at Site No. 10. Figures 4-40 and 4-41 present potentiometric surface maps of the shallow

TABLE 4-51

Site No. 10 - Hydrogeologic Data

Static Water Level Results

Monitor Well No	05-31-89 Water Levels Elevation feet MSL	05-31-89 Water Levels Depth feet BLS	09-12-89 Water Levels Elevation feet MSL	09-12-89 Water Levels Depth feet BLS	10-04-89 Water Levels Elevation feet MSL	10-04-89 Water Levels Depth feet BLS	04-11-90 Water Levels Elevation feet MSL	04-11-90 Water Levels Depth feet BLS
10-1	585.07	2.36	582.28	5.15	582.12	5.31	586.03	1.40
10-2	584.80	3.20	582.20	5.80	582.29	5.71	585.45	2.55
10-3	585.69	2.68	582.93	5.44	582.87	5.50	586.43	1.94
10-1D	NI	NI	581.98	5.11	582.16	4.93	585.28	1.81
10-4	NI	NI	581.88	5.08	581.95	5.01	584.81	2.15

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW10-3	6.2×10^{-5} ft/sec	3.0 ft	1.86×10^{-4} ft^2/sec

Notes:

NI - Not Installed
ft.BLS = Feet below land surface
ft.MSL = Feet in reference to mean sea-level
Transmissivity was calculated as follows: $K \cdot B = T$.
Saturated Thickness was determined by measuring the length of screen below the static water-level.

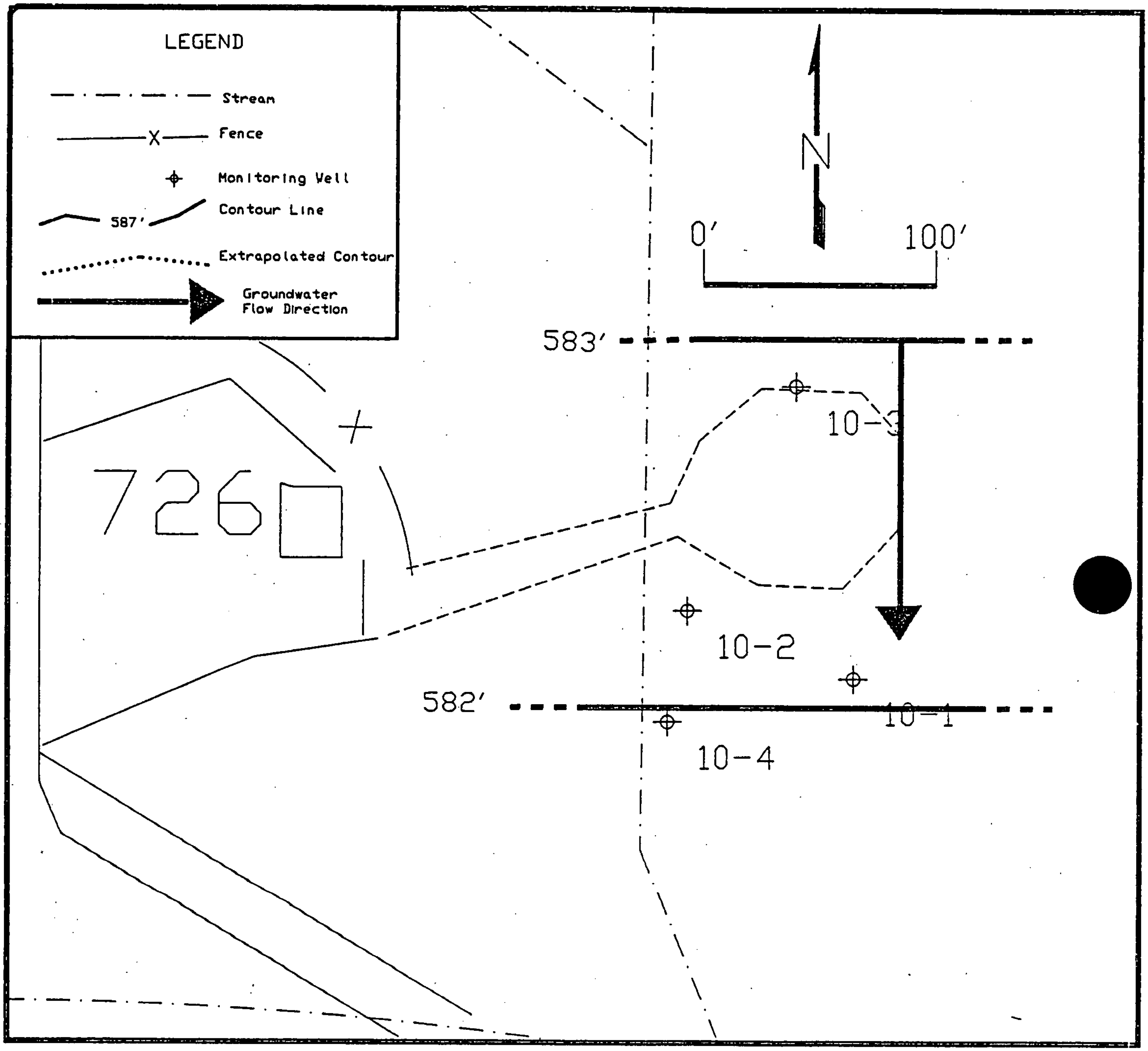


FIGURE 4-40
SITE NO. 10: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

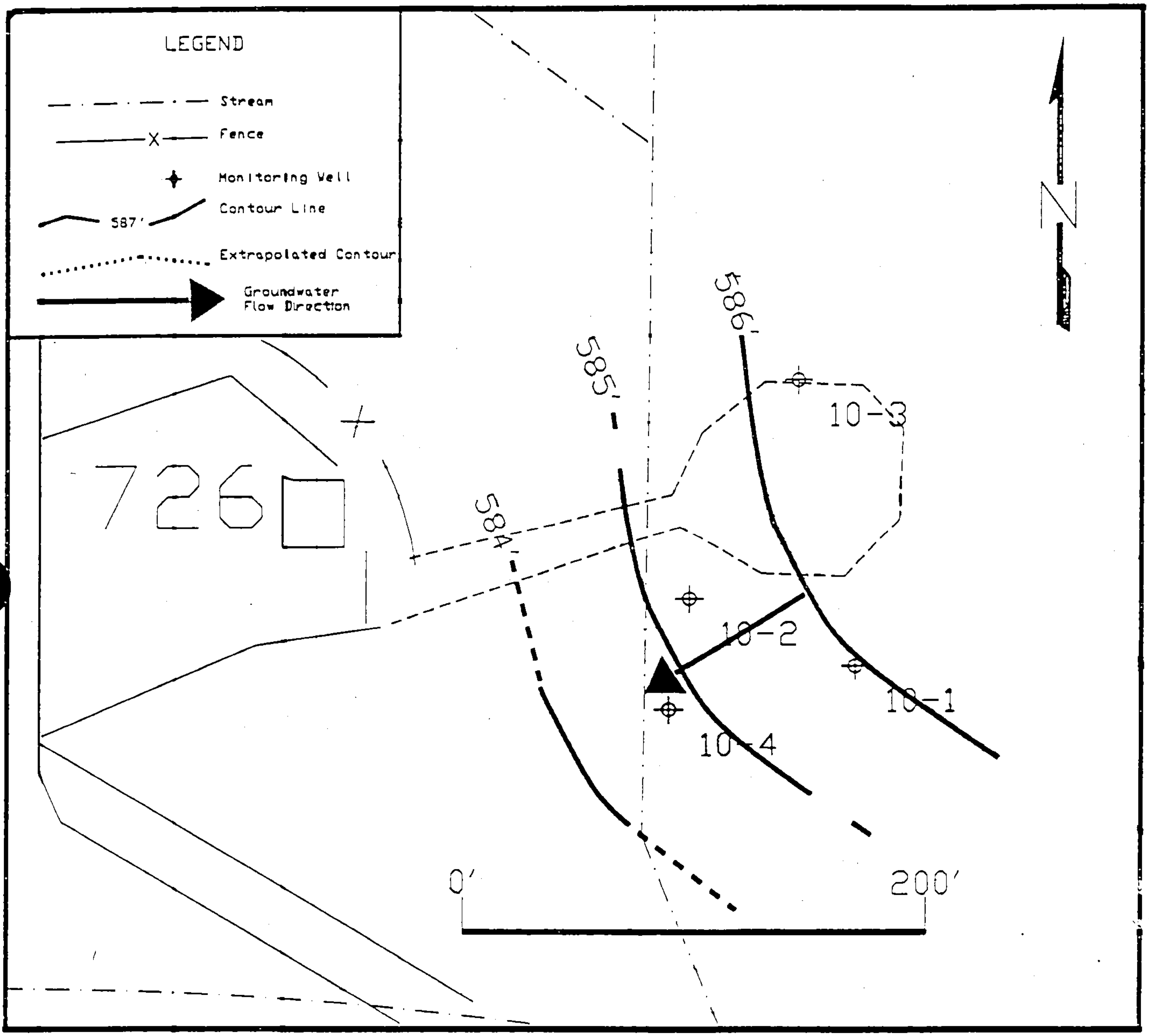


FIGURE 4-41
SITE NO. 10: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

unconsolidated aquifer constructed from the October 1989 and April 1990 water level measurements. Groundwater flow in the shallow system was toward the south in October 1989 and southwest in April 1990. It appears that the drainage ditch just west of the site exerts some influence of the direction of groundwater flow during the wetter Spring months.

Water-bearing zones in the upper portions of the Lockport Dolomite beneath Site No. 10 are likely to be zones of incompetent bedrock. As discussed in Section 4.1.4.1.1, the zones of incompetent bedrock probably consist of regions of fractured bedrock or zones locally concentrated with solution cavities or vugs. During drilling is was not possible to determine if all the incompetent bedrock zones were water-bearing. Since only one bedrock well was installed at the Site No. 10 study area, a range of water levels in the upper bedrock aquifer and a hydraulic gradient could not be established. Between September 1989 and April 1990, water levels in bedrock well MW10-1D occurred at an averaged depth of 3.95 feet. A water level fluctuation of 3.12 feet was observed in the deep well between October 1989 and April 1990. As expected, water levels appear to be highest during the spring months and lowest during the fall months. As described for the other sites, the upper bedrock aquifer is confined by the dense silty clays of the till and lacustrine deposits. Groundwater flow in the upper-bedrock aquifer system, as inferred from hydrogeologic data yielded at nearby sites, is probably to the south.

During the Stage 1 effort, a hydraulic conductivity test (i.e., slug test) was conducted on shallow monitoring well MW10-3. A hydraulic conductivity of 6.2 x 10^{-5} ft/sec(1.9 x 10^{-3} cm/sec) was calculated from the slug test results. As discussed in Section 4.1.1.1.2, the groundwater flow modeling study of the shallow aquifer at the Love Canal (Mercer et. al., 1983), yielded hydraulic conductivities in the range of 10^{-6} to 10^{-7} ft/s, an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. An order of magnitude difference exists between the hydraulic conductivity yielded by the Stage 1 slug test and the highest value reported in the flow modeling study. Utilizing the hydrogeologic data from the flow modeling study, horizontal groundwater flow velocities of 2.1 x 10^{-4} to 2.1 x 10^{-3} ft/day or 7.7 x 10^{-2} to 7.7 x 10^{-1} ft/year are predicted. At a nearby industrial property, the USGS (1985) reported a groundwater velocity range of 2.0×10^{-2} to 6.0×10^{-2} ft/year in the shallow aquifer.

Based upon transmissivities and the average thickness reported for the uppermost water bearing zone of the bedrock at a nearby hazardous waste disposal site and using the gradient measured for the upper bedrock aquifer at Site No. 1,2,4 and 6 (see Section 4.1.1.1.2) and a 26% porosity value (Brassington, 1988), horizontal groundwater velocities on the order of 6.31×10^{-1} ft/day or 230 ft/year are predicted. Horizontal groundwater velocities in the upper bedrock aquifer of Site No. 10 are considerably greater than those predicted for the unconsolidated aquifer.

4.1.4.1.3 Analytical Results for Site No. 10: Headspace Analyses

Headspace analyses were conducted on groundwater samples collected from the three (3) Stage 1 shallow monitoring wells. Isoconcentration contour maps were constructed for trichloroethene (TCE), benzene, and total hydrocarbons (Figure 4-42 through 4-44). Concentrations of 1,1,1-trichloroethane, tetrachloroethane, toluene, ethylbenzene, and xylene occurred at or below instrument detection limits. The headspace analytical data for Site No. 10 is presented in Table 4-52.

Figure 4-42 illustrates the inferred pattern of TCE contamination in groundwater of the shallow unconsolidated aquifer. Highest concentrations were detected in across gradient well MW10-1. Upgradient monitoring well MW10-3 registered the next highest TCE concentration.

Figure 4-43 shows the apparent distribution of benzene contamination in groundwater from the same aquifer. The highest concentrations of benzene was found in downgradient well MW10-2. The across gradient well MW10-1 registered the next highest benzene level followed by upgradient well MW10-3.

Figure 4-44 shows the potential distribution of total hydrocarbons in the shallow aquifer beneath Site No. 10. Once again, shallow downgradient well MW10-2 yielded the highest concentration followed by MW10-1 and MW10-3.

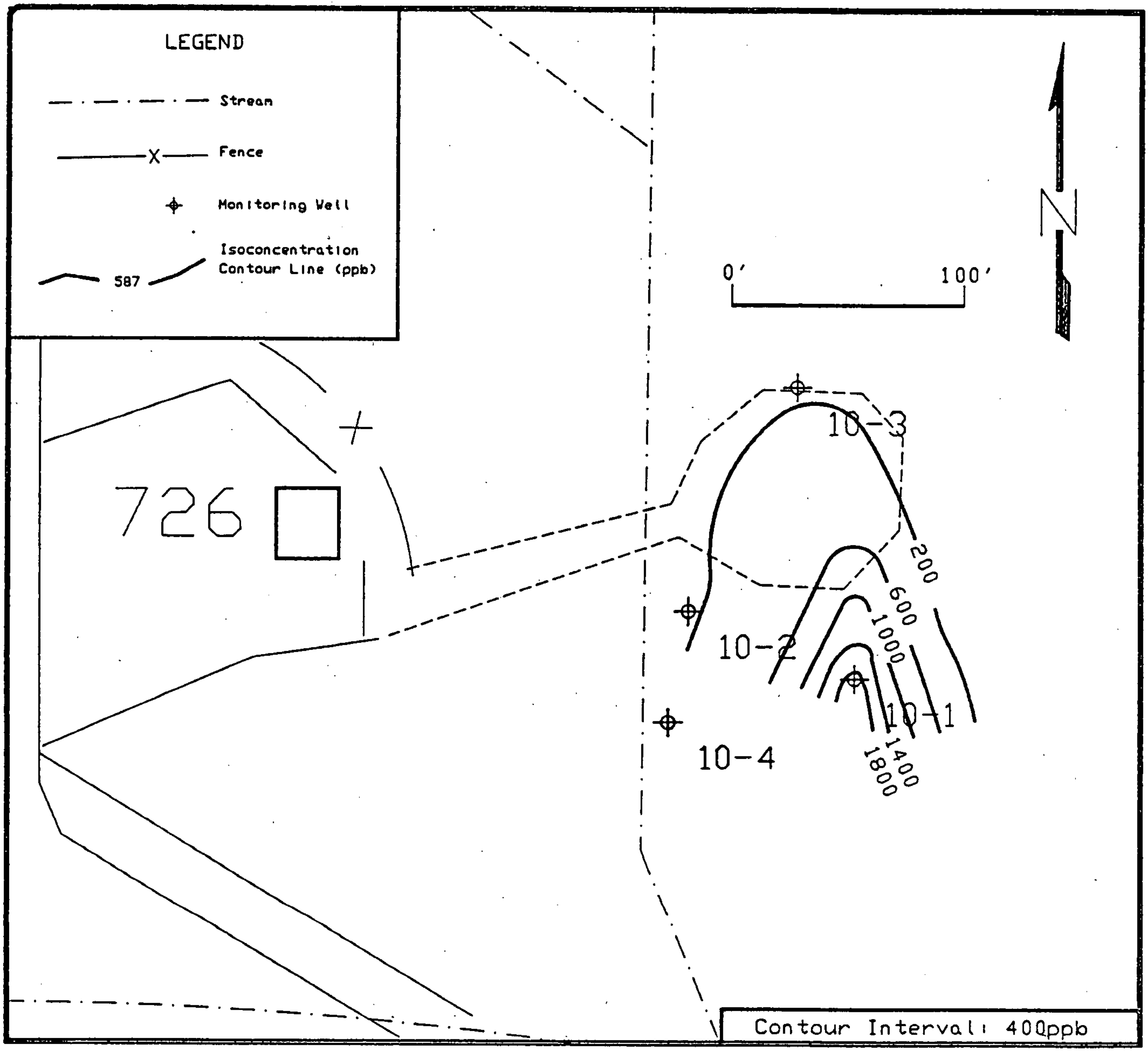


FIGURE 4-42
SITE NO. 10: TRICHLOROETHENE (TCE) ISOCONCENTRATION CONTOUR MAP
GROUNDWATER HEADSPACE ANALYSES

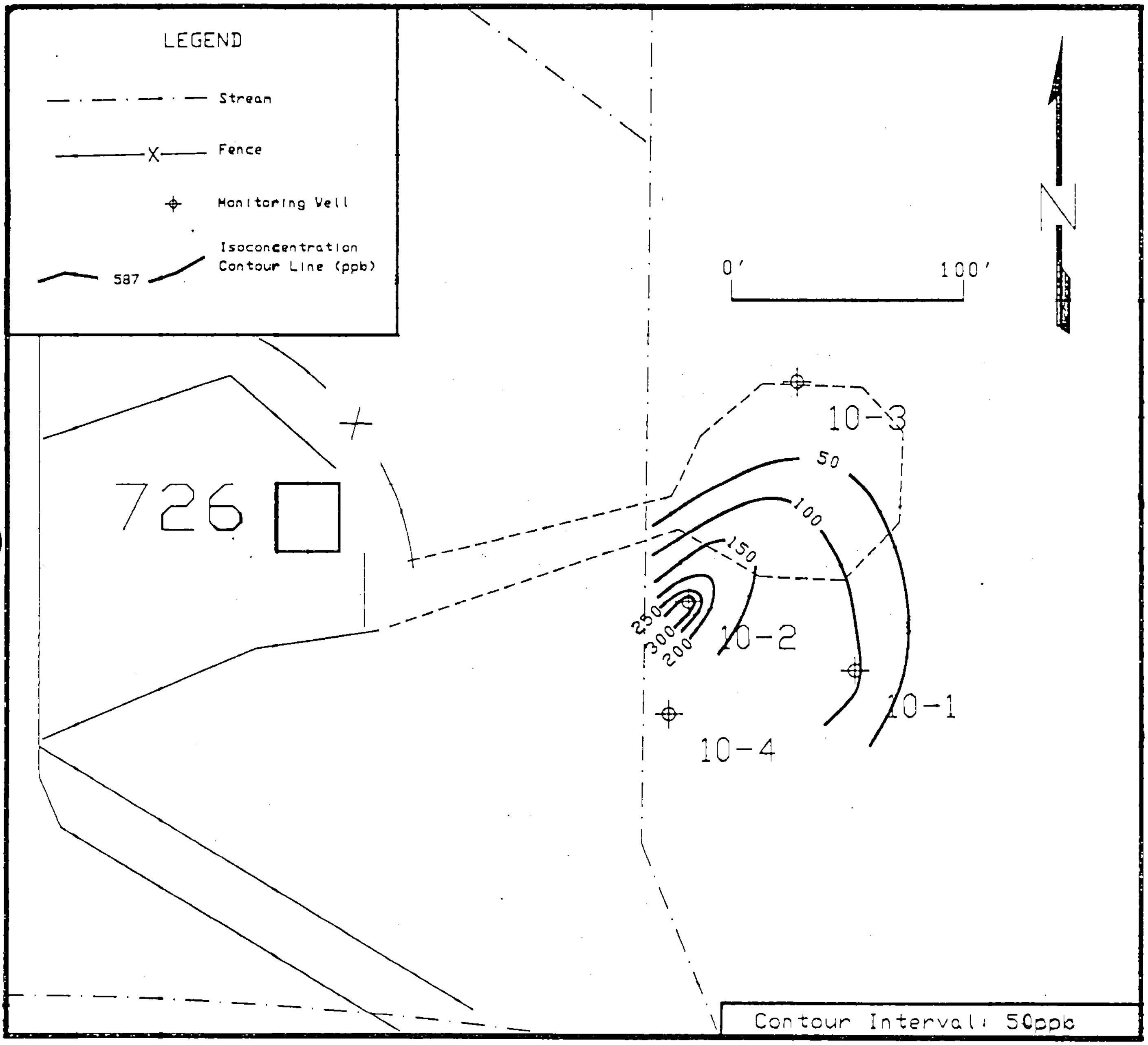


FIGURE 4-43
SITE NO. 10: BENZENE ISOCONCENTRATION CONTOUR MAP
GROUNDWATER HEADSPACE ANALYSES

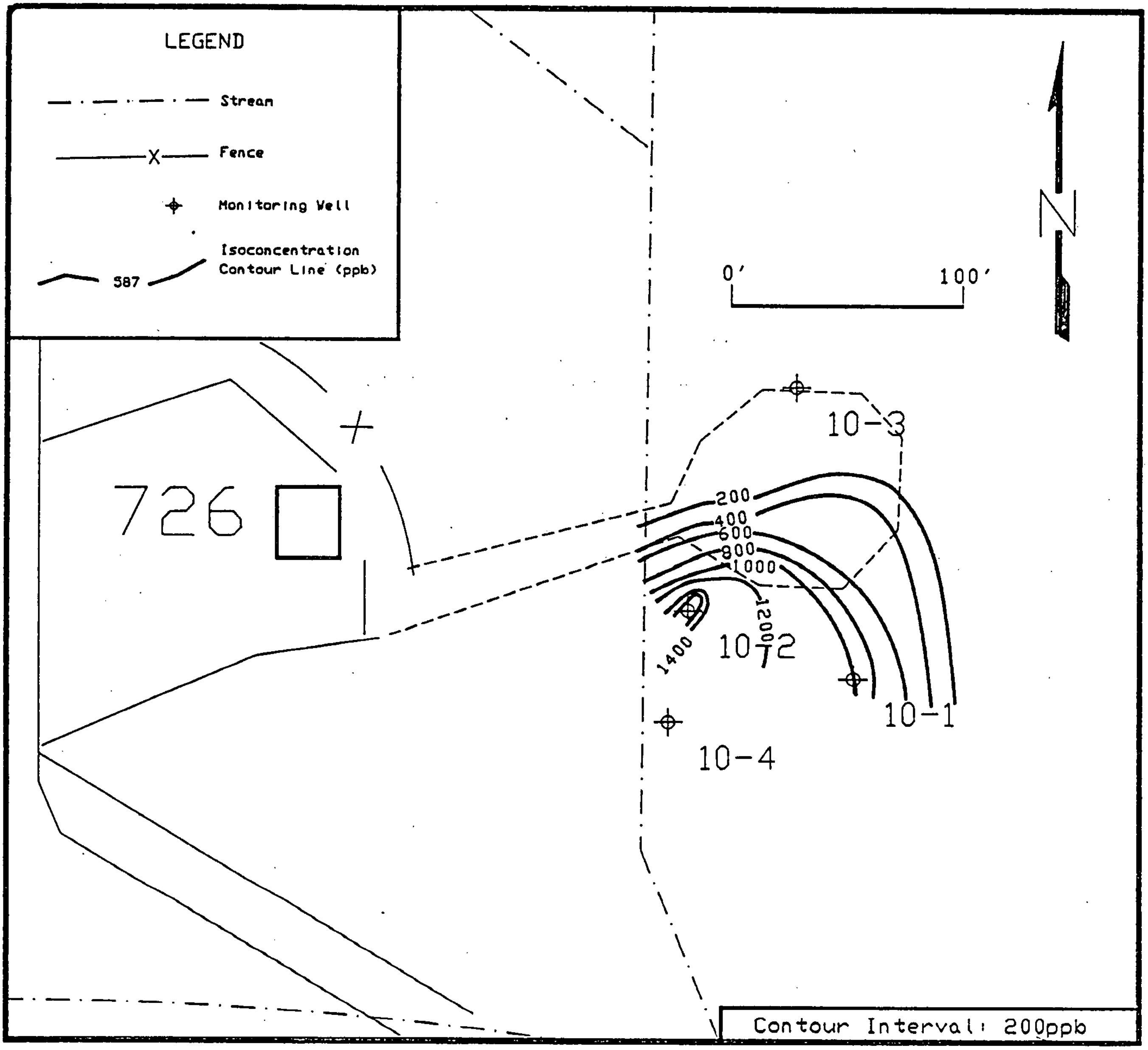


FIGURE 4-44
SITE NO. 10: TOTAL HYDROCARBON ISOCONCENTRATION CONTOUR MAP
GROUNDWATER HEADSPACE ANALYSES

Table 4-52

Site. No. 10: Headspace Analytical Data

Monitoring Well	TCA (µg/l)	TCE (µg/l)	PCE (µg/l)	Benzene (µg/l)	Toluene (µg/l)	Ethyl-Benzene (µg/l)	Xylenes (µg/l)	Total Hydrocarbons (µg/l)
MW10-1	<0.3	2,000	<0.2	130	<0.7	<0.5	<0.8	1,000
MW10-2	<0.0003	5	<0.0002	340	<0.7	<0.5	<0.8	8,100
MW10-3	<0.05	23	<0.04	26	<0.7	<0.5	<0.8	170

4.1.4.1.4 Analytical Results for Site No. 10: Contract Laboratory

Matrix-specific results are presented for each individual sample in Tables 4-53 and 4-54; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-55.

Organic Analyses: Three soil boring samples were analyzed for volatile organics and semivolatile organics. Five groundwater samples and associated field QC blanks were analyzed for purgeable halocarbons and purgeable aromatics. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The volatile organic method blank associated with soil samples WB 10-1D-1 and WB-10-1D-2 had acetone detected, although it was below the detection limit. The method blank analyzed with WB-10-4-5 had acetone present at 0.013 mg/kg. Sample results for acetone ranged from 0.019-0.028 mg/kg and may be biased high.

- The analysis of soil field duplicate pairs (collected at another site during the time period site 10 samples were collected) exceeded 35% RPD for methylene chloride. Both pairs, WB-8-2D-7/7R associated with WB-10-1D-1 and WB-10-1d-2 and WB-13-3-6/6R associated with WB-10-4-5 had an RPD of 200% for methylene chloride. In addition, the field duplicate for the samples from WB-10-1D had an acetone RPD = 74%.

- All soil samples for semivolatile organics had all compounds not-detected; however the laboratory matrix spike/matrix spike duplicate analysis associated with samples WB-10-1D-1/2 had five of eleven precision measurements outside of the RPD control limits. The impact would be limited to an effect on the reported detection limit.

- Surrogate recoveries for the analysis of groundwater samples GW-9, GW-11 and GW-13 for purgeable halocarbons were elevated for bromochloromethane; recoveries = 152%, 155% and 144% respectively (upper control limit = 140%).

- Methylene chloride was detected in all primary and confirmation method blanks associated with the groundwater samples, at concentrations ranging from 2.0-2.9 µg/l. Sample results ranged from 2.2-4160 µg/l; after accounting for sample dilutions the concentrations in the aliquots analyzed ranged from 2.2-4.2 µg/l. Therefore, all sample result for methylene chloride may be biased high.

TABLE 4-53
SITE NO. 10: ANALYTICAL RESULTS: SOILS

PARAMETER (UNITS)	Detection Limits	Sample Field ID (Sample Description) WB-10-1D-1 (5.4'-6-9')	WB-10-1D-2 (6.9'-8.1')	WB-10-4-5 (6.0'-7.5')
EPA METHOD SW8240 (mg/kg)				
Volatile Organics				
Acetone	0.010	0.019 [a,b]	0.028 [a,b]	0.019 [a]
Trichloroethene	0.005	0.010	0.068	0.190
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/8270				
Semivolatile Organics (mg/kg)	See Appendix F	ND	ND	ND
EPA Method SW3050/6010*				
Metals (mg/kg)				
Aluminum[d]	10.0	7830 [a]	3960 [a]	7120
Barium	1.0	1420 [c]	49.5 [c]	94.9
Beryllium	0.2	ND[c]	ND[c]	0.556
Boron	1.0	ND[a]	ND[a]	76.2
Cadmium	0.5	ND	ND	1.55
Calcium[d]	50.0	82,000	116,000	67,600
Chromium	1.0	11.2[c]	650[c]	14.4
Cobalt	1.0	5.32[c]	1.62[c]	11.5
Copper	1.0	9.78[c]	7.17[c]	26.8
Iron[d]	2.5	17,000[a]	7830[a]	31900
Lead	5.0	10.8[e]	10.9[e]	56.6
Magnesium[d]	50.0	17,800	48,300	7,250
Manganese	0.5	680[d]	500[d]	645
Nickel	1.5	15.0[c]	7.24[c]	18.6
Potassium[d]	50.0	1,310	732	715
Silicon[d]	100.0	673[a]	967[a]	1080
Sodium[d]	50.0	144	109	66.3
Vanadium	1.0	15.6[c]	8.22[c]	28.1
Zinc	1.0	174[c]	360[c]	640
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/E418.1				
Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	30	ND

Footnotes:
a = Compound also detected in associated method blank
b = Associated field duplicate analyses exceeded 35% RPD for this parameter.
c = Assolcated matrix spike recoveries were below the lower control limits.
d = Accuracy data not available; compound not spiked (or recovery cannot be caluculated)
e = Associated matrix replicated analyses resulted in RPDs which exceeded the control limit.
* = Or as indicated for those metals analyzed by alternate methods.

TABLE 4-54
SITE NO. 10: ANALYTICAL RESULTS: GROUNDWATER

PARAMETER (units)	Detection Limits	Sample Field Identification (Sample Description)							
		GW11 (MW-10-1)	GW12 (MW-10-4)	GW13 (MW-10-1D)	GW10 (MW-10-2)	GW9 (MW-10-3)	TB15 (Trip Blank)	GW8 (Field Blank)	GW14 (Equip Wash)
EPA Method SW5030/8021 Volatile Organics/Purgeable Halocarbons (µg/L)									
Methylene chloride	0.8	2.2 [a,b]	386 [b]	85 [a,b]	4160 [b]	8.1 [a,b]	3.7 [b]	3.6 [b]	3.5 [b]
Trichloroethene	1	ND [a]	3500	590 [a]	28000	61 [a]	ND	ND	ND
Vinyl Chloride	0.8	21 [a]	ND	115 [a]	ND	ND [a]	ND	ND	ND
Others	See Appendix F	ND [a]	ND	ND [a]	ND	ND [a]	ND	ND	ND
EPA METHOD SW5030/8020 Purgeable Aromatics (µg/L)						ND	ND	ND	ND
Benzene	0.3	6.0	6.1	8.9	360				
Total Xylenes	1.0	2.2	0.95	ND	ND				
Toluene	0.3	0.46	1.3	ND	4.7				
Ethylbenzene	0.3	3.7	ND	ND	ND				
Others	See Appendix F	ND	ND	ND	ND				
EPA Method E200.7* Metals (mg/L)							NA	NA	
Aluminum	0.1	2.53	7.0	0.696	12.7	35.1			ND
Barium	0.01	0.263	0.089	0.122	0.130	0.332			ND
Boron	0.01	0.074 [d]	ND [d]	0.057 [d]	ND [d]	ND [d]			0.033 [d]
Calcium[c]	0.20	203	233	260	288	69.7			2.77
Chromium	0.010	ND	ND	ND	0.033	0.051			ND
Cobalt	0.010	ND	ND	ND	ND	0.023			ND
Copper	0.010	0.019	0.015	ND	0.064	0.098			ND
Iron	0.025	4.74 [d]	11.1 [d]	2.08 [d]	17.6 [d]	58.0 [d]			0.028 [d]
Lead	0.05	ND	ND	ND	0.052	0.206			ND
Lead (E239.2)	0.005	0.011 [d]	0.014 [d]	0.011 [d]	0.070 [d]	0.256 [d]			ND [d]
Magnesium[c]	0.20	97.4	97.3	71.6	148	31.7			ND
Manganese	0.005	0.973	2.69	0.254	0.723	2.64			ND
Molybdenum	0.010	ND	0.016	ND	ND	ND			ND
Nickel	0.015	ND	0.028	ND	0.028	0.079			ND
Potassium[c]	0.4	2.11 [d]	2.84 [d]	1.20 [d]	4.04 [d]	7.79 [d]			ND [d]
Silicon[c]	0.020	9.60	16.1	7.08	27.4	61.6			0.238
Sodium[c]	0.200	27.3	81.1	11.5	19.3	7.73			0.350
Vanadium	0.01	ND	0.015	ND	0.031	0.069			ND
Zinc	0.01	0.147	0.292	0.087	1.11	2.89			ND
Others	See Appendix F	ND	ND	ND	ND	ND			ND

* = Or as indicated for those metals analyzed by alternate methods

TABLE 4-54 (CONT'D)
SITE NO. 10: ANALYTICAL RESULTS: GROUNDWATER

		Sample Field Identification (Sample Description)							
PARAMETER (units)	**Detection Limits**	**GW11 (MW-10-1)**	**GW12 (MW-10-4)**	**GW13 (MW-10-1D)**	**GW10 (MW-10-2)**	**GW9 (MW-10-3)**	**TB15 (Trip Blank)**	**GW8 (Field Blank)**	**GW14 (Equip Wash)**
EPA Method 418.1 (mg/L)									
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND	ND	NA	NA	ND
Miscellaneous Inorganics									
Total Dissolved Solids (E160.1)	1.0	1080	1100	1160	560	740	NA	NA	40
Common Anions (A429)							NA	NA	ND
Fluoride	0.1	0.57	1.4	0.49	0.98	0.78			
Chloride	0.5	76	31	28	72	18			
Sulfate	0.5	230	500	530	460	200			
Total Hardness (E130.1)	1.0	960	1000	1700	1300	3400	NA	NA	ND

Footnotes:

a = Surrogate recovery (for bromochloromethane) exceeded the control limit.
b = Compound also detected in associated method blank.
c = Accuracy data unavailable; compound not spiked.
d = Associated lab matrix replicate analysis had RPD values which were above the control limit.

TABLE 4-55
Field Water Quality Data
Niagara Falls IAP
Site No. 10
9/14/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 10-1	13°	6.85	1440	520	0	0	520	95	very slightly cloudy
MW 10-1D	13.0°	6.97	1410	350	0	0	350	8	clear
MW 10-2	13°	6.97	1030	505	0	0	505	38	slightly cloudy, brown
MW 10-3	13.0°	7.17	890	290	0	0	290	1.8	cloudy, brown, murky
MW 10-4	13°	7.10	1530	530	0	0	530	80	slightly cloudy

Inorganic Analyses: Three soil boring samples were analyzed for metals total petroleum hydrocarbons (TPH). Five groundwater samples and the associated field QC blank were analyzed for metals, TPH, total dissolved solids (TDS), common anions and hardness. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The metals method blank associated with soil boring samples WB-10-1D-1/2 had detected concentrations of aluminum, boron, iron and silicon at 20.3, 1.49, 13.8 and 30.0 mg/l respectively. Sample concentrations of these metals were significantly higher than these background levels.
- Laboratory matrix replicate/matrix spike analyses associated with WB-10-1D-1/2 had the following recovery results which were more than 5% outside of the control limits (=75-125%): barium (= 63% recovery), beryllium (= 64%), cobalt (= 64%), copper (= 69%), nickel (= 66%), vanadium (= 67%), zinc (= 64%). These results do not indicate significant bias, however, the recovery of these metals may be slightly low. In addition the RPD for lead by ICP was 200%.
- All soil samples had antimony non-detected, however significant low bias was indicated for all spike recoveries of antimony. The reported antimony detection limits may be biased low. No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon or sodium as these compounds are not routinely spiked by the laboratory.
- The laboratory matrix replicate/matrix spike analysis associated with the groundwater samples exceeded the RPD control limits (= 20%) for boron (RPD = 26%), iron (= 22%), lead could be made for calcium, magnesium, potassium, silicon or sodium as these compounds were not spiked.

4.1.4.2 Significance of Findings

4.1.4.2.1 Significance of Findings: Site No. 10 - Fire Training Area No. 1

Groundwater and soils were investigated at Site No. 10 to characterize the environmental consequences of fire training exercises conducted during the late 1950s and early 1960s. Tables 4-56 and 4-57 present analyses versus ARARs and/or background levels for all contaminants found in the matrices studied.

During the drilling of the two well borings, soil samples were collected for analyses. A total of nineteen metals were detected at various concentrations in soils from these well borings. Only those metals that can potentially cause

TABLE 4-56
SITE NO. 10: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

		Sample Field ID (Sample Description)				
PARAMETER (UNITS)	Detection Limits	Background[f] (mg/Kg)	Selected Average for Soils[g] (mg/Kg)	WB-10-1D-1 (5.4'-6-9')	WB-10-1D-2 (6.9'-8.1')	WB-10-4-5 (6.0'-7.5')
EPA METHOD SW8240 (mg/kg)						
Volatile Organics						
Acetone	0.010	ND-0.056	--	0.019 [a,b]	0.028 [a,b]	0.019 [a]
Trichloroethene	0.005	ND	--	0.010	0.068	0.190
Others	See Appendix F			ND	ND	ND
EPA Method SW3550/8270						
Semivolatile Organics (mg/kg)	See Appendix F			ND	ND	ND
EPA Method SW3050/6010*						
Metals (mg/kg)						
Aluminum[d]	10.0	2,300-15,600	71,000	7830 [a]	3960 [a]	7120
Barium	1.0	28.4-163	430	1420 [c]	49.5 [c]	94.9
Beryllium	0.2	ND	6	ND[c]	ND[c]	0.556
Boron	1.0	ND	10	ND[a]	ND[a]	76.2
Cadmium	0.5	ND	0.06	ND	ND	1.55
Calcium[d]	50.0	2,120-213,000	13,700	82,000	116,000	67,600
Chromium	1.0	3.29-19.6	100	11.2[c]	650[c]	14.4
Cobalt	1.0	2.10-11.3	8	5.32[c]	1.62[c]	11.5
Copper	1.0	9.92-21.0	30	9.78[c]	7.17[c]	26.8
Iron[d]	2.5	5,060-31,700	38,000	17,000[a]	7830[a]	31900
Lead	5.0	9.96-26.0	10	10.8[e]	10.9[e]	56.6
Magnesium[d]	50.0	4,050-51,900	5,000	17,800	48,300	7,250
Manganese	0.5	386-801	600	680[d]	500[d]	645
Nickel	1.5	4.41-25.1	40	15.0[c]	7.24[c]	18.6
Potassium[d]	50.0	496-2,310	8,300	1,310	732	715
Silicon[d]	100.0	223-345	320,000	673[a]	967[a]	1080
Sodium[d]	50.0	49.6-154	6,300	144	109	66.3
Vanadium	1.0	5.30-32.0	100	15.6[c]	8.22[c]	28.1
Zinc	1.0	53.3-864	50	174[c]	360[c]	640
Others	See Appendix F			ND	ND	ND
EPA Method SW3550/E418.1						
Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	--	ND	30	ND

Footnotes:

a = Compound also detected in associated method blank
b = Associated field duplicate analyses exceeded 35% RPD for this parameter.
c = Assoicated matrix spike recoveries were below the lower control limits.
d = Accuracy data not available; compound not spiked (or recovery cannot be caluculated)
e = Associated matrix replicated analyses resulted in RPDs which exceeded the control limit.
f = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
g = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
* = Or as indicated for those metals analyzed by alternate methods.
NA = Not [illegible]zed
NR = Not [illegible]ted

TABLE 4-57
SITE NO. 10: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

			Sample Field Identification (Sample Description)				
PARAMETER (units)	Detection Limits	ARAR[g]	GW11 (MW-10-1)	GW12 (MW-10-4)	GW13 (MW-10-1D)	GW10 (MW-10-2)	GW9 (MW-10-3)
EPA Method SW5030/8021 Volatile Organics/Purgeable Halocarbons (μg/L)							
Methylene chloride	0.8	0.19[k]	2.2[a,b]	386[b]	85[a,b]	4160[b]	8.1[a,b]
Trichloroethene	1	5.0[i]	ND[a]	3500	590[a]	28000	61[a]
Vinyl Chloride	0.8	2.0[i]	21[a]	ND	115[a]	ND	ND[a]
Others	See Appendix F	-	ND[a]	ND	ND[a]	ND	ND[a]
EPA METHOD SW5030/8020 Purgeable Aromatics (μg/L)							ND
Benzene	0.3	ND[h]	6.0	6.1	8.9	360	
Total Xylenes	1.0	15[i]	2.2	0.95	ND	ND	
Toluene	0.3	5[i]	0.46	1.3	ND	4.7	
Ethylbenzene	0.3	5[i]	3.7	ND	ND	ND	
Others	See Appendix F	-	ND	ND	ND	ND	
EPA Method E200.7* Metals (mg/L)							
Aluminum	0.1	No ARAR	2.53	7.0	0.696	12.7	35.1
Barium	0.01	1.0[i]	0.263	0.089	0.122	0.130	0.332
Boron	0.01	1.0[i]	0.074[d]	ND[d]	0.057[d]	ND[d]	ND[d]
Calcium[c]	0.20	No ARAR	203	233	260	288	69.7
Chromium	0.010	0.050[i]	ND	ND	ND	0.033	0.051
Cobalt	0.010	No ARAR	ND	ND	ND	ND	0.023
Copper	0.010	0.200[i]	0.019	0.015	ND	0.064	0.098
Iron	0.025	0.300[i]	4.74[d]	11.1[d]	2.08[d]	17.6[d]	58.0[d]
Lead	0.05	0.025[i]	ND	ND	ND	0.052	0.206
Lead (E239.2)	0.005	0.025[i]	0.011[d]	0.014[d]	0.011[d]	0.070[d]	0.256[d]
Magnesium[c]	0.20	No ARAR	97.4	97.3	71.6	148	31.7
Manganese	0.005	0.300[i]	0.973	2.69	0.254	0.723	2.64
Molybdenum	0.010	No ARAR	ND	0.016	ND	ND	ND
Nickel	0.015	0.0154[j]	ND	0.028	ND	0.028	0.079
Potassium[c]	0.4	No ARAR	2.11[d]	2.84[d]	1.20[d]	4.04[d]	7.79[d]
Silicon[c]	0.020	No ARAR	9.60	16.1	7.08	27.4	61.6
Sodium[c]	0.200	20[i]	27.3	81.1	11.5	19.3	7.73
Vanadium	0.01	No ARAR	ND	0.015	ND	0.031	0.069
Zinc	0.01	0.300[i]	0.147	0.292	0.087	1.11	2.89
Others	See Appendix F	-	ND	ND	ND	ND	ND

* = Or as indicated for those metals analyzed by alternate methods

TABLE 4-57 (Cont'd)
SITE NO. 10: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

			Sample Field Identification (Sample Description)					
PARAMETER (units)	Detection Limits	ARAR[g]	GW11 (MW-10-1)	GW12 (MW-10-4)	GW13 (MW-10-1D)	GW10 (MW-10-2)	GW9 (MW-10-3)	
EPA Method 418.1 (mg/L)								
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	ND	ND	
Miscellaneous Inorganics								
Total Dissolved Solids (E160.1)	1.0	500[m]	1080	1100	1160	560	740	
Common Anions (A429)						NA	NA	ND
Fluoride	0.1	1.5[i]	0.57	1.4	0.49	0.98	0.78	
Chloride	0.5	250[i]	76	31	28	72	18	
Sulfate	0.5	250[i]	230	500	530	460	200	
Total Hardness (E130.1)	1.0	No ARAR	960	1000	1700	1300	3400	

Footnotes:

a = Surrogate recovery (for bromochloromethane) exceeded the control limit.
b = Compound also detected in associated method blank.
c = Accuracy data unavailable; compound not spiked.
d = Associated lab matrix replicate analysis had RPD values which were above the control limit.
g = Applicable or Revelant or Appropriate Requirements.
h = New York State Groundwater quality standard: "Not ddetectable".
i = New York State Water Quality Standard for class GA groundwater. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F.

adverse health effects at elevated concentrations are discussed. Since no ARARs have been established for soils, the following presents a discussion comparing the Site No. 10 metal data to background and normal trace element averages published for soils:

- Soils at Site No. 10 showed elevated levels of zinc. Zinc levels in soils collected from the 5.4 to 6.9 foot and 6.9 to 8.1-foot intervals of well boring WB-10-1D were 174 mg/kg to 360 mg/kg respectively, while in well boring WB-10-4, a single soil sample from the 6.0 to 7.5-foot interval yielded a zinc level of 640 mg/kg. Although the average zinc concentration for a normal soil is 50 mg/kg, the zinc levels measured at Site No. 10 fall within the range established by the background borings. The higher zinc levels found in the installation soils are explained by localized concentrations of zinc sulfide minerals which were derived from the bedrock.

- Chromium levels were elevated in soils from WB-10-1D. A chromium concentration of 650 mg/kg was measured in the soil sample collected from the 6.9 to 8.1-foot interval of this well boring. This concentration exceeds the range established by the background soil borings and is six times the average chromium concentration reported for most soils.

- Cadmium was detected in the 6.0 to 7.5-foot interval of WB-10-4 at 1.55 mg/kg. Cadmium was not detected in soils of the background soil borings and the average concentration reported for normal soils is 0.06 mg/kg.

- Beryllium and boron were also detected in soil from the 6.0 to 7.5-foot interval of WB-10-4 (0.556 mg/kg and 76.2 respectively). These metals were not detected in the soils of the background borings. The beryllium concentration is below the average reported for normal soils while the boron concentration exceeds the average reported for normal soils by nearly one order of magnitude. Boron is not known to be a product of any current or past Air Force activity at this installation and may be a laboratory contaminant.

- Cobalt was found in all of the Site No. 10 soil samples at levels which fell within the ranges established in background soil borings.

- Barium was also found in the soil at Site No. 10. A concentration of 1420 mg/kg was measured in soil from the 5.4 to 6.9-foot interval of WB-10-1D. This value falls outside the range established in the background soil borings. Barium typically averages 430 mg/kg in soils.

- Copper found in Site No. 10 generally occurred within the background concentration range and below the average reported for most soils.

- A lead concentration of 56.6 mg/kg was recorded in soil from the 6.0 to 7.5-foot interval of WB-10-4. This value was more than double the highest lead level measured in soils from the background soil boring. The average lead content of most soils is reportedly only 10 mg/kg.

The elevated lead level found in the soil sample from WB-10-4 and the generally high background concentrations measured across the installation is explained by the presence of lead sulfide minerals, derived from the bedrock, in the soil.

- Manganese, vanadium and nickel levels measured in Site No. 10 soils occurred within the established background range.

It should be noted, however, that the installations background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area.

The following presents a comparison of the organic analytical soil data yielded by the Site No. 10 soils with background levels:

- Total petroleum hydrocarbons (TPH) were detected in the soil sample collected from the 6.9 to 8.1-foot interval of well boring WB-10-1D at 30 mg/kg. TPH was not detected in any of the soils analyzed from the background soil borings. The presence of TPH in the soils at Site No. 10 can only be related to the fuels that were burned during fire training exercises. This TPH value is low in consideration of the fuel burning activities conducted at this site. The low concentration of TPH in the one soil sample of WB-10-1D suggests that nearly all of the combustible liquids used at this site were consumed by fire.

- Acetone was the only volatile organic compound detected in the soil at Site No. 10. Although typically considered a laboratory contaminant, acetone was not detected above the detection limit in the method blank, therefore it is being listed as a site contaminant. Acetone was also detected in the base background soils. No volatile organic compounds identified as components of fuels were detected in the soils.

- Trichloroethene was detected in soils from both borings. Trichloroethene concentrations in soils from WB-10-1D ranged from 0.010 mg/kg (5.4 to 6.9-foot interval) to 0.068 mg/kg (6.9 to 8.1-foot interval). Trichloroethene was measured at 0.190 mg/kg in soil from the 6.0 to 7.5-foot interval of WB-10-4. The presence of TCE in the soils suggests that solvents were also used during fire training exercises. As TCE would not burn during fire training exercises, TCE which did not volatilize most likely percolated into the soil and migrated away from the fire training oval.

Groundwater samples were collected from the five monitoring wells at Site No. 10. A number of volatile organic compounds were detected in the groundwater. The highest concentrations were found downgradient from the fire pit. Benzene, total xylenes, toluene and trichloroethene were detected in nearly all of the downgradient wells. The presence of volatile organic compounds in the groundwater of Site No. 10 is explained by the fuel and combustible liquid burning practices conducted at this site during the late 1950s and early 1960s. The following presents a comparison of organic compounds measured in the Site No. 10 monitoring wells with ARARs and background levels:

- Benzene concentrations in MW10-1, MW10-4, MW10-2, and MW10-1D were measured at 6 ug/l, 6.1 ug/l, 360 ug/l, and 8.9 ug/l, respectively. All of these levels were considerably higher than the benzene level recorded in the shallow background well. No benzene was detected in the upper bedrock background well. The benzene level found in MW10-2 exceeded the background concentration by a factor of 400. All of the benzene levels measured at Site No. 10 exceeded the "non-detect" New York State Water Quality ARAR.

- Total xylenes and toluene in shallow downgradient aquifer well MW10-1 were measured at 2.2 ug/l, 0.46 ug/l, respectively. In the new shallow downgradient well MW10-4, total xylenes and toluene were detected at 0.95 ug/l and 1.3 ug/l. Toluene was detected at 4.7 ug/l in downgradient shallow aquifer well MW10-2. The toluene levels found in MW10-4 and MW10-2 are slightly above the level found in the background shallow well. Total xylenes and toluene levels found in groundwater at Site No.10 do not exceed the ARARs.

- Ethylbenzene was measured in shallow downgradient aquifer well MW10-1 at 3.7 ug/l. This concentration is well within the established ARAR. Ethylbenzene was not detected in the background wells.

- Trichloroethene was detected in all but one well at Site No. 10; the highest concentrations were found in the downgradient wells. Trichloroethene levels in MW10-4, MW10-1D, MW10-2, and MW10-3 were recorded at 3,500 ug/l, 590 ug/l, 28,000 ug/l and 61 ug/l, respectively. All of these values exceed the 5.0 ug/l New York State Water Quality ARAR promulgated for TCE in groundwater. TCE was not detected in groundwater from the background well. The presence of TCE in soils and groundwater of Site No. 10 implies that various solvent mixtures were also used during fire training exercises. Since TCE does not burn, the practice of using waste solvent mixtures resulted in the TCE contamination groundwater at Site No. 10.

- Groundwater from monitoring wells MW10-1 and MW10-1D yielded 21 ug/l and 115 ug/l vinyl chloride respectively. The ARAR for vinyl chloride is 2 ug/l imposed in the New York State Water Quality Standards. The two vinyl chloride values detected are above the promulgated ARAR.

Vinyl chloride was not detected in groundwater from the background wells. The only explanation for the presence of vinyl chloride in the groundwater at Site No. 10 is that, under certain reducing conditions, vinyl chloride will form as a degradation product of TCE. Vinyl chloride was not known to be used anywhere on the installation.

- o Methylene chloride levels in the groundwater at Site No. 10 are significantly higher than levels measured in the field and laboratory blanks, therefore this compound is not considered to be a laboratory contaminant. Methylene chloride levels in MW10-1, MW10-4, MW10-10, MW10-2, and MW10-3 were recorded at 2.2 ug/l, 386 ug/l, 85 ug/l, 4160 ug/l and 8.1 ug,l, respectively. Much lower levels of methylene chloride were found in the background monitoring wells.

Eighteen inorganic metals were detected above instrument detection limits in groundwater from Site No. 10. As discussed in Section 4.1.1.2.1, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in groundwater at Site No. 10 with ARARs and background values.

- o Iron and manganese in groundwater from most Site No. 10 wells were found to occur at levels above the 0.300 mg/l ARAR imposed in New York State Water Quality Standards. Iron concentrations ranged from 2.08 mg/l in MW10-1D to 58.0 mg/l in MW10-3. Manganese concentration ranged from 0.254 mg/l in MW10-1D to 2.69 mg/l in MW10-4. The manganese level found in MW10-1D was the only concentration which did not exceed the State ARAR. Iron and manganese values obtained from groundwater in the shallow background well also occurred above the State ARARs.
- o Lead measured at 0.070 mg/l and 0.256 mg/l in wells MW10-2 and MW10-3, respectively exceeded the 0.025 mg/l ARAR set by the New York State Water Quality Standards.
- o Chromium found in MW10-3 (0.051 mg/l) slightly exceeded the 0.50 mg/l State ARAR. Chromium was also found in MW10-2 but below the State ARAR. No chromium was found in groundwater from the background wells.
- o The 0.0154 mg/l FWQC Human Health ARAR promulgated for nickel was exceeded in MW10-4 (0.028 mg/l), MW10-2 (0.028 mg/l) and MW10-3 (0.079 mg/l). Nickel was not detected in the background wells.
- o Barium levels found in groundwater at Site No. 10 ranged from 0.089 mg/l in MW10-4 to 0.332 mg/l in MW10-3. All of the concentrations

occurred below the ARAR promulgated in the New York State Water Quality Standards. The barium levels found in MW10-1 (0.263 mg/l), MW10-2 (0.130 mg/l), MW10-1D (0.122 mg/l) and MW10-3 (0.332 mg/l) were substantially higher than the background levels.

- Boron levels found in MW10-1 (0.074 mg/l) and MW10-1D (0.057 mg/l) occurred within the ranges established by the background wells, and do not exceed the New York State Water Quality Standard of 1.0 mg/l.
- Levels of copper found in groundwater from MW10-1 (0.019 mg/l), MW10-4 (0.015 mg/l), MW10-2 (0.064 mg/l) and MW10-3 (0.098 mg/l) occurred below the ARAR promulgated in the State Water Quality Standards. Copper was not detected in groundwater from the background wells.
- Zinc levels in groundwater at Site No. 10 ranged from 0.087 mg/l in MW10-1D to 2.89 mg/l in MW10-3. The zinc level recorded at MW10-3 exceeded the background level by more than a factor of 30. Only the zinc levels encountered in groundwater from MW10-10 and MW10-2 at Site No. 10 exceeded the 0.300 mg/l ARAR set in the New York State Water Quality Standards.
- Cobalt concentration of 0.023 mg/l was measured in MW10-3. Molybdenum was found in MW10-4 (0.016 mg/l) and vanadium was found in MW10-4 (0.015 mg/l), MW10-2 (0.031 mg/l) and MW10-3 (0.069 mg/l). Cobalt, molybdenum and vanadium were not detected in groundwater from the background wells. Presently, no ARARs have been established for these metals.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

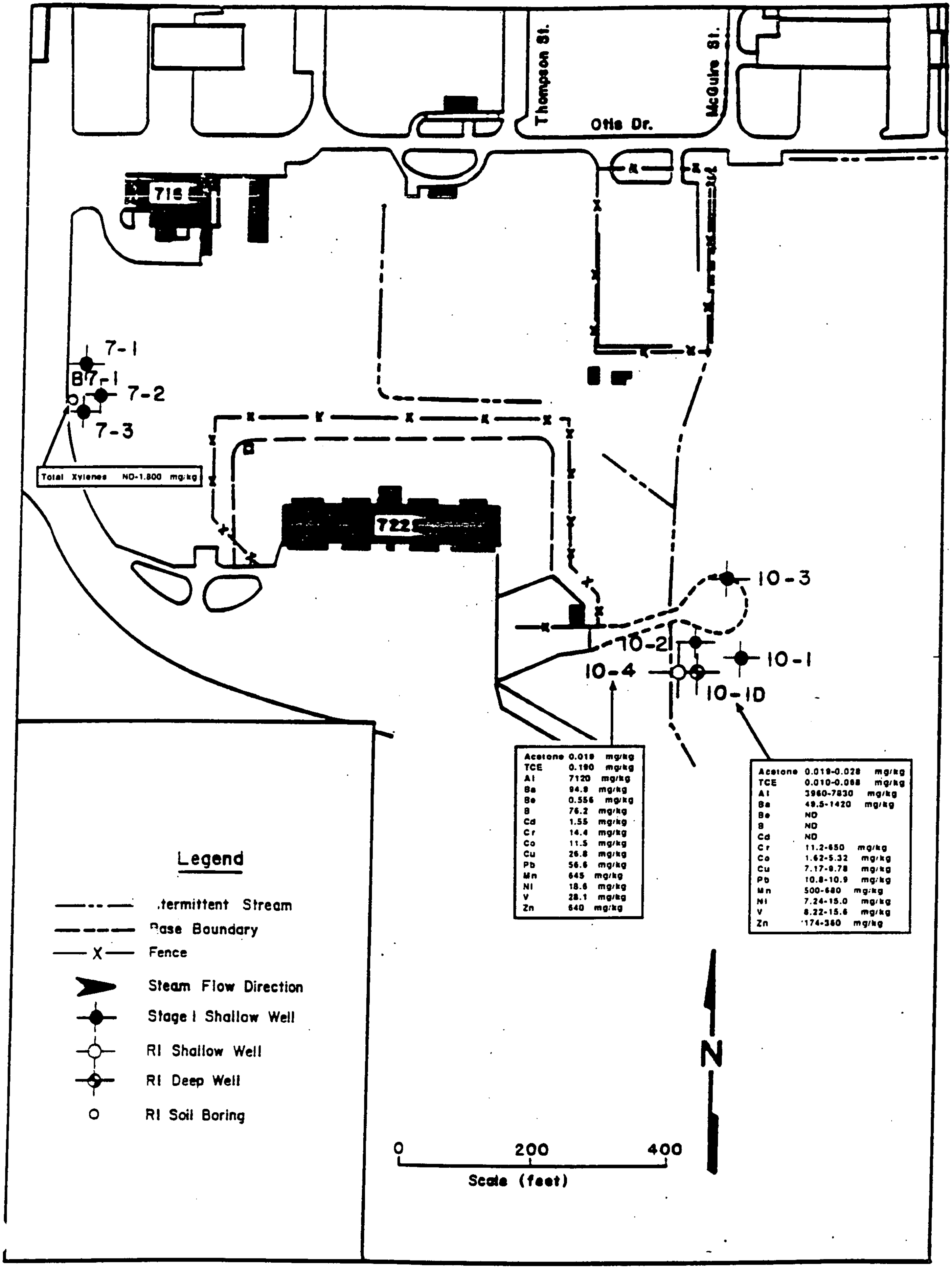
- Total dissolved solids (TDS) in groundwater from Site No. 10 ranged from 560 mg/l to 1160 mg/l in all wells. All levels reported exceeded the 500 mg/l Secondary Drinking Water Standard for TDS.
- Sulfate levels exceeded the 250 mg/l ARAR set in the State Water Quality Standard in MW10-4, MW10-2 and MW10-1D (500 mg/l, 460 mg/l and 530 mg/l respectively).
- Chloride and total hardness levels ranged from 18 mg/l to 76 mg/l and 960 mg/l to 3400 mg/l respectively. Fluoride levels ranged from 0.49 mg/l to 1.4 mg/l.
- Sodium levels exceeded the 20 mg/l standard set in New York Water Quality Regulations in MW10-1 (27.3 mg/l) and MW10-4 (81.1 mg/l).
- The groundwater at Site No. 10 is hard and mineralized.

The generally poor water quality of the groundwater is explained in the literature (Johnston, 1964). Groundwater from the Lockport Dolomite is described as very hard and moderately to highly mineralized. The average hardness and chloride concentrations reported for the Lockport Dolomite are 960 mg/l and 234 mg/l respectively. Typical groundwater from the Lockport is also characterized by high calcium and magnesium, and high sulfate and bicarbonate. According to the literature, water from the unconsolidated deposits is also very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate crystals (gypsum) in the soil and bedrock.

4.1.4.2.2 Zones of Contamination

Figures 4-45 and 4-46 depict the levels of contaminants found at each monitoring station. Groundwater contaminants at Site No. 10 are most concentrated along the south southwest edge of the fire training pit as evidenced in shallow monitoring well MW10-2 (Benzene-360 ug/l, TCE-28,000 ug/l). Contamination extends an undetermined distance south southwest from the site. Concentrations appear to generally decrease with distance downgradient from the site as exhibited in downgradient shallow monitoring well MW10-4 (Benzene-6.1 ug/l, TCE-3,500 ug/l). Contaminant concentrations also decrease in a southeast direction from the site. Information on the pattern of soil contamination is limited, as soils were only analyzed from the two RI well borings. Figures 4-47 and 4-48 present isoconcentration contour maps constructed to illustrate the distribution of TCE, and benzene contamination present in the unconsolidated aquifer. As discussed in Section 4.1.1.2.1, there is convincing evidence suggesting that the elevated metal levels found in the groundwater of Site No. 10 are not related to waste management practices but rather natural background trace element concentrations found in the suspended particulate matter (i.e., clay). Metals are therefore not discussed as contamination.

The pattern of contamination found in the unconsolidated aquifer suggests the development of a plume with its major axis aligned parallel to the groundwater flow direction. The presence of contamination in the downgradient wells does not enable a determination of the full extent of the plume detected in the unconsolidated aquifer. Contamination trends in the upper bedrock aquifer could not be assessed since only one bedrock well currently exists.



Acetone	0.019	mg/kg
TCE	0.190	mg/kg
Al	7120	mg/kg
Ba	94.9	mg/kg
Be	0.556	mg/kg
B	76.2	mg/kg
Cd	1.55	mg/kg
Cr	14.4	mg/kg
Co	11.5	mg/kg
Cu	26.8	mg/kg
Pb	56.6	mg/kg
Mn	645	mg/kg
Ni	18.6	mg/kg
V	28.1	mg/kg
Zn	640	mg/kg

Acetone	0.019-0.028	mg/kg
TCE	0.010-0.068	mg/kg
Al	3960-7830	mg/kg
Ba	49.5-1420	mg/kg
Be	ND	
B	ND	
Cd	ND	
Cr	11.2-650	mg/kg
Co	1.62-5.32	mg/kg
Cu	7.17-8.78	mg/kg
Pb	10.8-10.9	mg/kg
Mn	500-680	mg/kg
Ni	7.24-15.0	mg/kg
V	8.22-15.6	mg/kg
Zn	174-360	mg/kg

FIGURE 4-45
SITE NO. 10: ZONES OF CONTAMINATION - SOIL

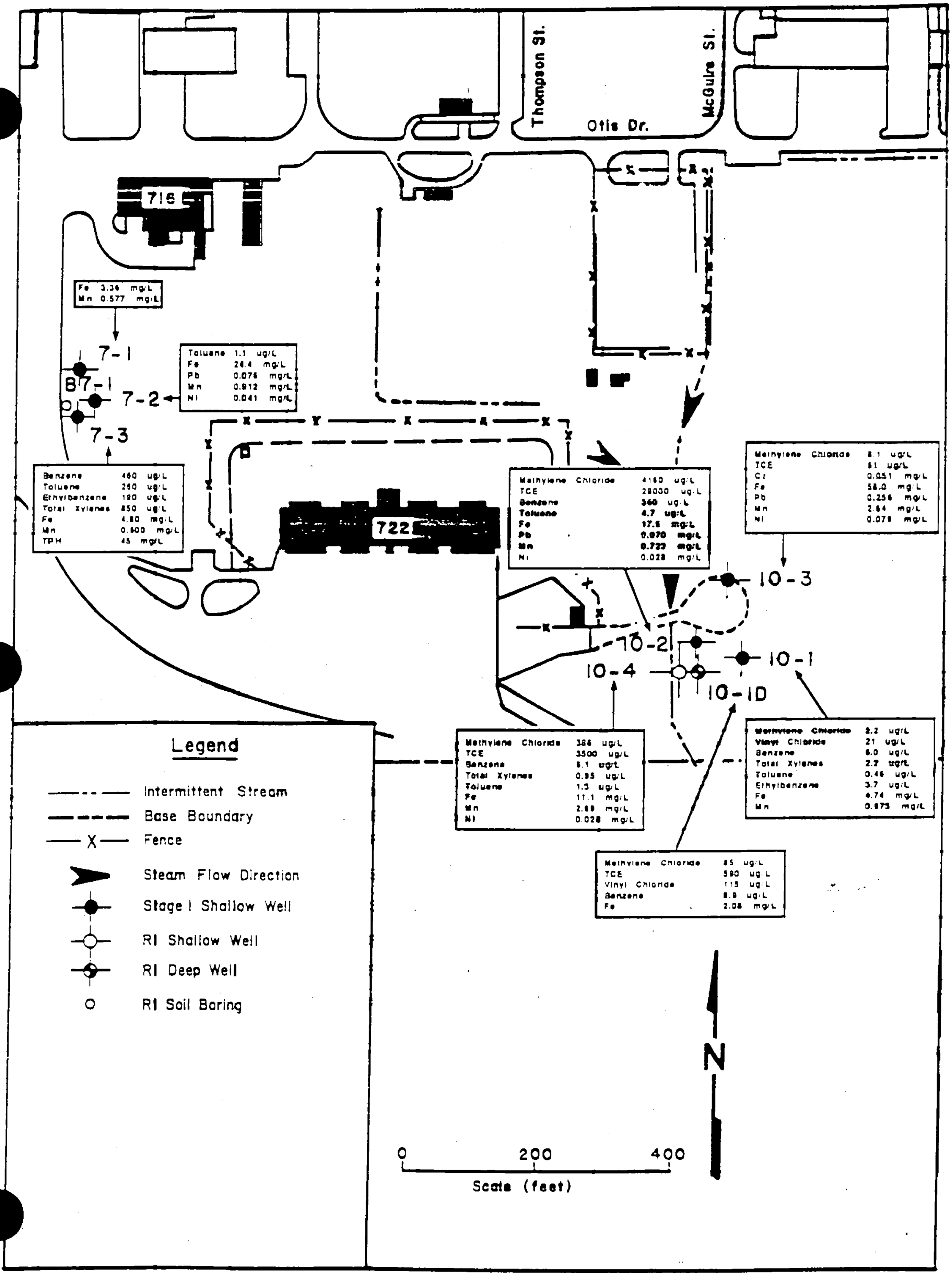


FIGURE 4-46
SITE NO. 10: ZONES OF CONTAMINATION - GROUNDWATER

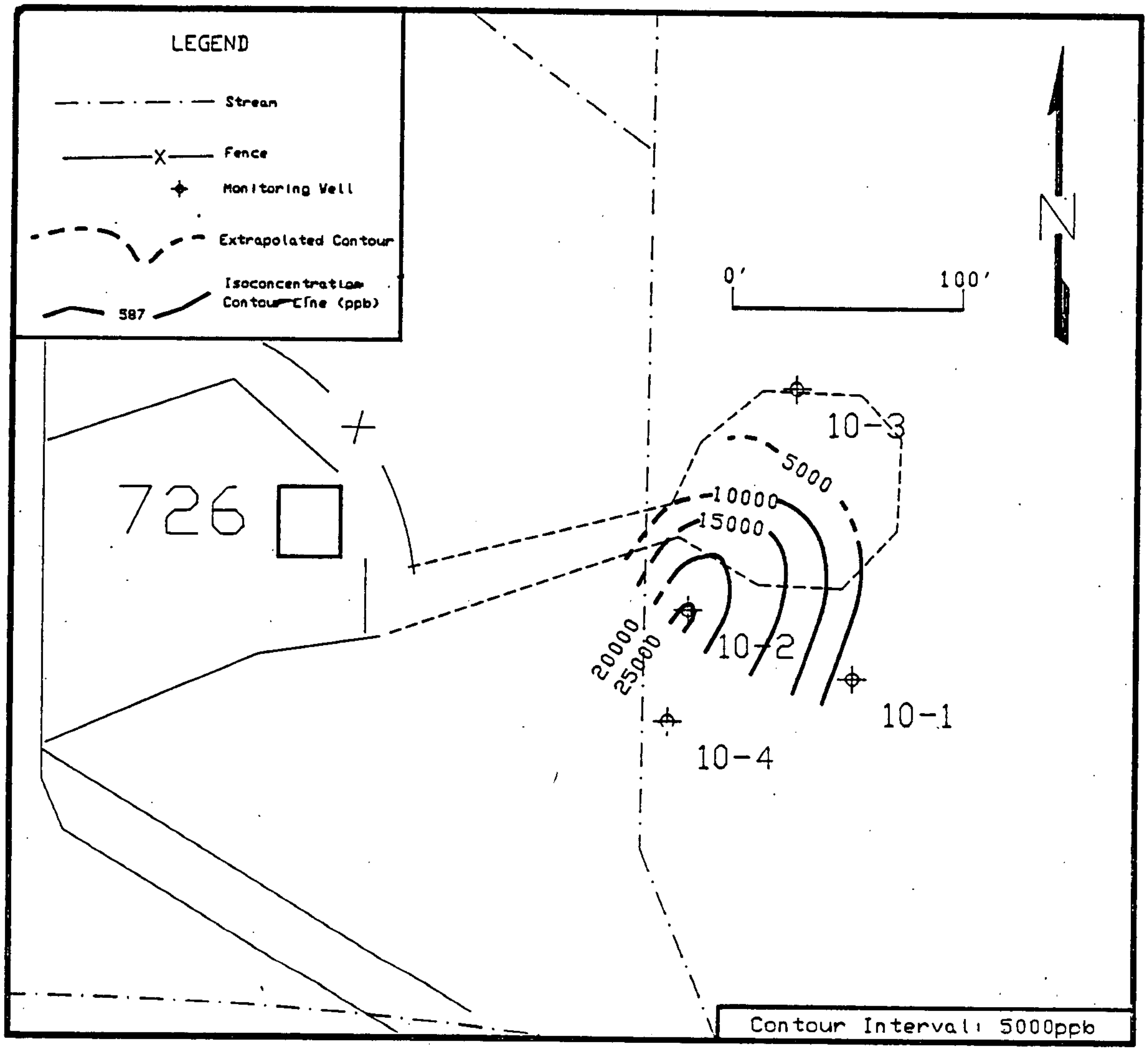


FIGURE 4-47
SITE NO. 10: TRICHLOROETHENE ISOCONCENTRATION CONTOUR MAP
SHALLOW GROUNDWATER ANALYSES

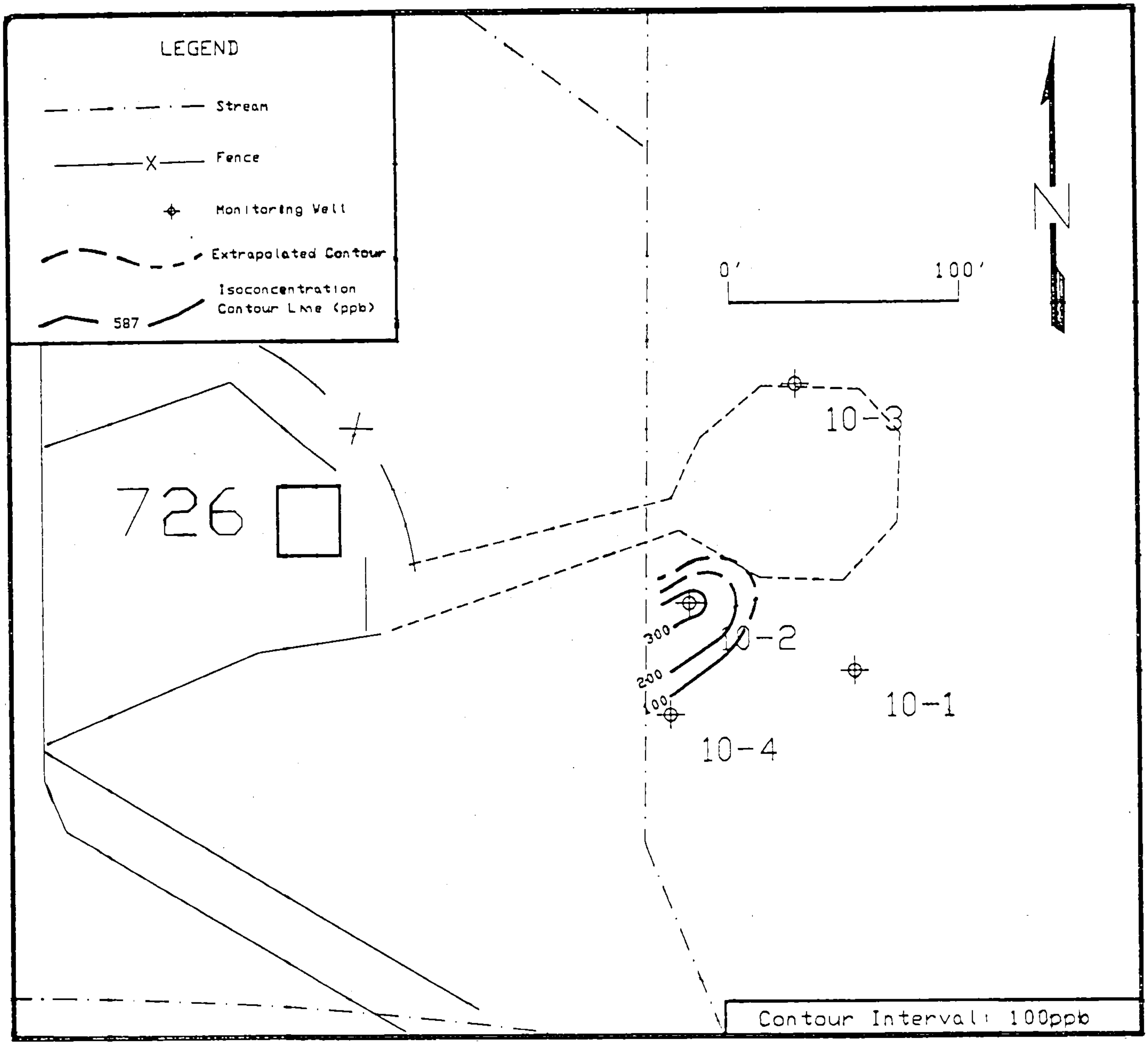


FIGURE 4-48
SITE NO. 10: BENZENE ISOCONCENTRATION CONTOUR MAP
SHALLOW GROUNDWATER ANALYSES

4.1.4.2.3 Contaminant Migration

The distribution and concentrations of contaminants found in the shallow aquifer indicates that contaminants are migrating away from fire training area of Site No. 10. The presence of contamination in the downgradient wells does not enable a determination of the full extent of the plume detected in the unconsolidated aquifer. Migration of contaminants through the upper bedrock aquifer is only assumed since only one bedrock well currently exists in a downgradient position from Site No. 10. Migration of contaminants through the shallow groundwater system, based upon the discussion presented in Section 4.1.4.1.2, is expected to range between 5.48 x 10^{-5} to 2.1 x 10^{-3} ft/day. In consideration of the fire training area's age and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, the following migration distance ranges via the unconsolidated aquifer have been estimated:

Site No. 10 - (Minimum) 7.0 x 10^{-1} feet
- (Maximum) 27 feet

According to the most conservative shallow aquifer migration estimates, contaminants might reach Cayuga Creek, located south of Site 10 in approximately 250 years. If the shallow aquifer discharges to the drainage ditch west of the fire training area part of the year, as suggested by the potentiometric surface maps, site contaminants may have already reached and continue to be periodically discharged to Cayuga Creek via this surface water pathway.

Cultural features, such as sewer line and underground utility lines and pipes may have some affect on patterns and speed of contaminant transport within the subsurface. The are around Site 10 does not contain any underground utilities (as shown in Section 4 Attachment A), therefore abnormal contaminant transport patterns, as a result of cultural features in this area, are not expected.

Since contaminants are found in the shallow downgradient well (MW10-4) located at least 75 feet from the contamination source, migration rates in the unconsolidated aquifer are either occurring at higher rates than predicted by the literature or contaminants are moving away from the site via another migration pathway. Due to the low permeability of the sediments which results in ponding of water after rain events and results in local perched water table conditions, contaminants may migrate more rapidly away from the site via the surface water (i.e., overland flow) pathway before infiltrating into the unconsolidated aquifer.

In any event, Cayuga Creek would likely act as a hydrogeological barrier to dissolved contaminants migrating via the shallow aquifer. Given the physical properties of TCE, the contaminant would tend to follow the permeable-impermeable boundary and not be controlled by hydrogeologic gradients. Direct contact with human receptors via the groundwater pathway is probably unlikely. If contaminants reach the creek they would be substantially diluted prior to reaching the communities south of the installation. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.4.2.4 Baseline Risk Assessment for Site No. 10

This section presents the baseline risk assessment for Site 10. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 10 - Data Analysis and Hazard Identification

Chemicals of concern for Site 10 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

The monitoring well (MW-1-7) which was initially designated as the background well for the base contained detectable concentrations of benzene (0.92 ug/L), toluene (1.0 ug/L), and TPH (1.6 mg/L), thus making it difficult to compare volatile organic values to background. In a USGS study (1985), toluene, methylene chloride, and ethylbenzene ranged from 10 to 230 ug/L, 7.1 to 375 ug/L, and 4.5 to 5.9 ug/L, respectively, in water samples collected from the unconsolidated deposits along the Niagara River. In groundwater samples collected at Site 10, the mean values for toluene, methylene chloride, and ethylbenzene were 1.4 ug/L, 1544 ug/L, and 1.1 ug/L, respectively. One inorganic chemical (chromium at 20 ug/L) in the groundwater samples was above the range (1 to 8 ug/L) found in the USGS study (See Section 2.4.3 of this report for more detail).

TPH was detected in soils at Site 10 in a single sample out of three: 30.00 mg/kg. This indicates the localized presence of aliphatic and olefinic hydrocarbons that have not been incorporated into the listing of chemicals of concern. These unidentified chemicals likely reflect products of incomplete combustion at the site. Given the available data and methods of chemical analysis however, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment. TPH was not detected in groundwater at the site.

Site No. 10 - Exposure Assessment

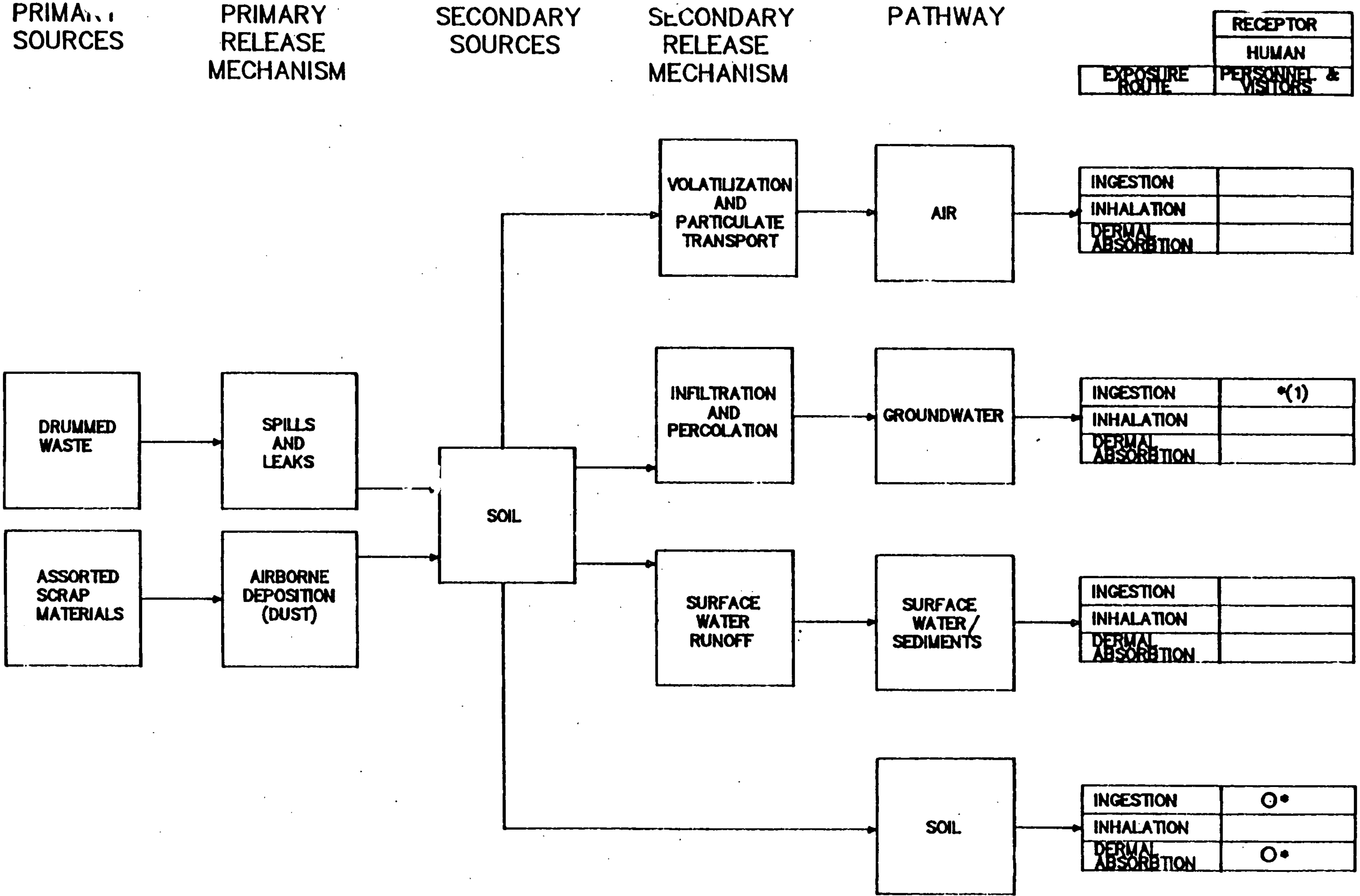
The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation. The conceptual site model for Site 10 is presented in Figure 4-49. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 10 is provided in Appendix G.

Soil

Site 10 served as the base's principle fire fighting training area during the late 1950s and early 1960s. A variety of combustible liquids and contaminated fuels were burned at this site. Currently, the site is not enclosed (fenced). Base personnel have unrestricted access to the site. The exposure assumptions used for Site 4 soil exposure were also adopted for use in assessing exposure at Site 10 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 10 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie, AREA IS SUPPLIED WITH MUNICIP[illegible] WATER)

FIGURE 4-49
CONCEPTUAL SITE MODEL
SITES 9, 10, & 11 FIRE TRAINING AREAS NO. 3, NO. 1, NO. 2

Site No. 10 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 10 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at the Site 10 are presented in Table 4-58. The hazard index for combined exposure across compounds is approximately 9.8. This is attributable to the high value of the hazard quotients for trichloroethylene and benzene (i.e., a value of 6.3 and 2.2, respectively). Elevated levels of lead also contributed to the overall magnitude of the Hazard Index. These results are unacceptably high (i.e., outside the acceptable range established by EPA). Adverse noncarcinogenic effects may be anticipated if groundwater at the site was used as a source of drinking water.

Four potentially carcinogenic compounds were detected in groundwater at Site 10. Benzene and vinyl chloride are classified as Group A carcinogens (known human carcinogens) and trichloroethylene and methylene chloride are classified as Group B2 carcinogens (probable human carcinogen). The excess lifetime cancer risk associated with hypothetical exposure of Base personnel to groundwater is approximately 5×10^{-4}. The magnitude of this estimate is primarily attributable to the presence of trichloroethylene and vinyl chloride. These results exceed the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean concentrations of the following chemicals in groundwater exceeded MCLs and New York standards: lead, benzene, trichloroethylene, and vinyl chloride. The levels of benzene and vinyl chloride were more than 10 times greater than the MCL. The mean concentration of trichloroethylene was more than 1000 times the Federal MCL. New York State groundwater limits were exceeded by mean levels of manganese (1460 ug/L) and zinc (29 mg/l). The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

TABLE 4-58

RISK CHARACTERIZATION FOR SITE NO. 10: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	11600.00			
Barium	187.00	3.67E-02	Hypertension	
Chromium	20.00	3.92E-02	Skin	
Cobalt	9.00		Thyroid, Heart	
Copper	40.00	1.06E-02	GI Tract, Blood	
Lead	72.00	5.05E-01	CNS, Kidney	
Manganese	1460.00	7.16E-02	CNS, Reproductive	
Molybdenum	7.00			
Nickel	30.00	1.47E-02	Skin, Lung	
Vanadium	25.00	3.50E-02	Respiratory Effects	
Zinc	905.00	4.44E-02	GI Tract	
ORGANICS				
Benzene	80.00	2.18E+00	Hematopoietic Sys.	6.50E-06
Ethylbenzene	1.10	1.08E-04	Skin, Liver, Kidney	
Methylene Chloride	1544.00	2.52E-01	Liver, Kidney, CNS	3.25E-05
Toluene	1.40	4.58E-05	CNS	
Trichloroethylene	6430.00	6.31E+00	Liver, Kidney, CNS	1.98E-04
Vinyl Chloride	36.00	2.72E-01	Blood, Liver, CNS	2.32E-04
Xylenes	1.80	8.83E-06	CNS	
Hazard Index: Combined Exposure		9.77E+00		
Excess Lifetime Cancer Risk: Combined Exposure				5E-04

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B

Soil Pathway

The results of risk characterization for exposure to soil at Site 10 are presented in Table 4-59. The hazard index for combined exposure across compounds is approximately 1.3 x 10^{-2}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Two carcinogenic compounds were detected in soils at the site. Beryllium and trichlorethylene are both classified as Group B2 carcinogens (probable human carcinogens). The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils 5 x 10^{-8}. This result falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Site No. 10 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

TABLE 4-59. RISK CHARACTERIZATION FOR SITE 10: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	6303.00			
Barium	521.00	1.64E-03	Hypertension	
Beryllium	0.26	8.23E-06	Lung, Skin, Heart	5.05E-08
Boron	76.20	1.33E-04	CNS, GI Tract, Skin	
Cadmium	0.71	2.23E-04	Kidney	
Chromium	225.20	7.07E-03	Skin	
Cobalt	6.15		Thyroid, Heart	
Copper	14.58	6.19E-05	GI Tract, Blood	
Lead	26.10	2.93E-03	CNS, Kidney	
Manganese	608.00	4.77E-04	CNS, Reproductive	
Nickel	13.60	1.07E-04	Skin, Lung	
Vanadium	17.30	3.88E-04	Respiratory Effects	
Zinc	391.00	3.07E-04	GI Tract	
ORGANICS				
Acetone	0.02	3.45E-08	Liver, Kidney	
Trichloroethylene	0.09	1.40E-06	Liver, Kidney, CNS	4.39E-11
Hazard Index: Combined Exposure		1.33E-02		
Excess Lifetime Cancer Risk: Combined Exposure				5E-08

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the l
of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of Base personnel to contaminated surface soil
Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per
20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

INSTALLATION RESTORATION PROGRAM (IRP)

RI/FS

VOLUME IIB

Section 4 (Cont'd)

Niagara Falls International Airport
Niagara Falls, New York

Science Applications International Corporation (SAIC)
One Sears Drive
Paramus, New Jersey 07652

May 1991

Remedial Investigation/Feasibility Study (RI/FS) Report 1987-1990

PREPARED FOR

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098-6001

UNITED STATES AIR FORCE
HUMAN SYSTEMS DIVISION (AFSC)
IRP PROGRAM OFFICE (HSD/YAQI)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

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4.1.5 Discussion of Results for Sites No. 5 and 8: NYANG Hazardous Waste Drum Storage Area and Drum Storage Yard

4.1.5.1 Presentation of Results

4.1.5.1.1 Site Geology

The geology of Sites No. 5 and 8, as interpreted by the Stage 1 and RI well boring logs, consists of a fine grained veneer of glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The locations of all Site No. 5 and 8 monitoring wells are presented in Figure 4-50. The average thickness of the unconsolidated deposits in the Site No. 5 and 8 study areas is 13.82 feet. Sediment thickness ranged from 12.5 feet at shallow monitoring well MW8-5 to 15.3 feet at upper-bedrock well MW5-1D. In the Site No. 5 study area the sediments exhibited a tendency to thin slightly from south to north. At Site No. 8 well, boring log data suggests a potential thinning of sediments from east to west. As is the case at the other IRP sites, the Lockport Dolomite in this area of Niagara Falls is estimated to be approximately 180 feet thick. A generalized geologic cross-section of the Site No. 5 and 8 study area is presented as Figure 4-51.

Soils encountered at the Site No. 5 and 8 study area are a derivative of the lacustrine sediments, which form the upper unconsolidated unit, and belong to the Odessa Series. Since these soils occur throughout the installation, a description has already been provided in Section 4.1.1.1.1.

As mentioned above, the lacustrine sediments generally form the uppermost unconsolidated unit. A silty clay glacial till forms the lowermost unit and rests directly on the bedrock surface. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. For this reason it is difficult to establish the contact between the two sediment types, as it tends to be obscure, which compounds the difficulties associated with making thickness determinations of both units. A description of the lacustrine sediments and glacial till is provided in Section 4.1.1.1.1 of this report. Due to the inherent problems associated with distinguishing between these units, and sampling related problems discussed in Section 4.1.2.1.1,

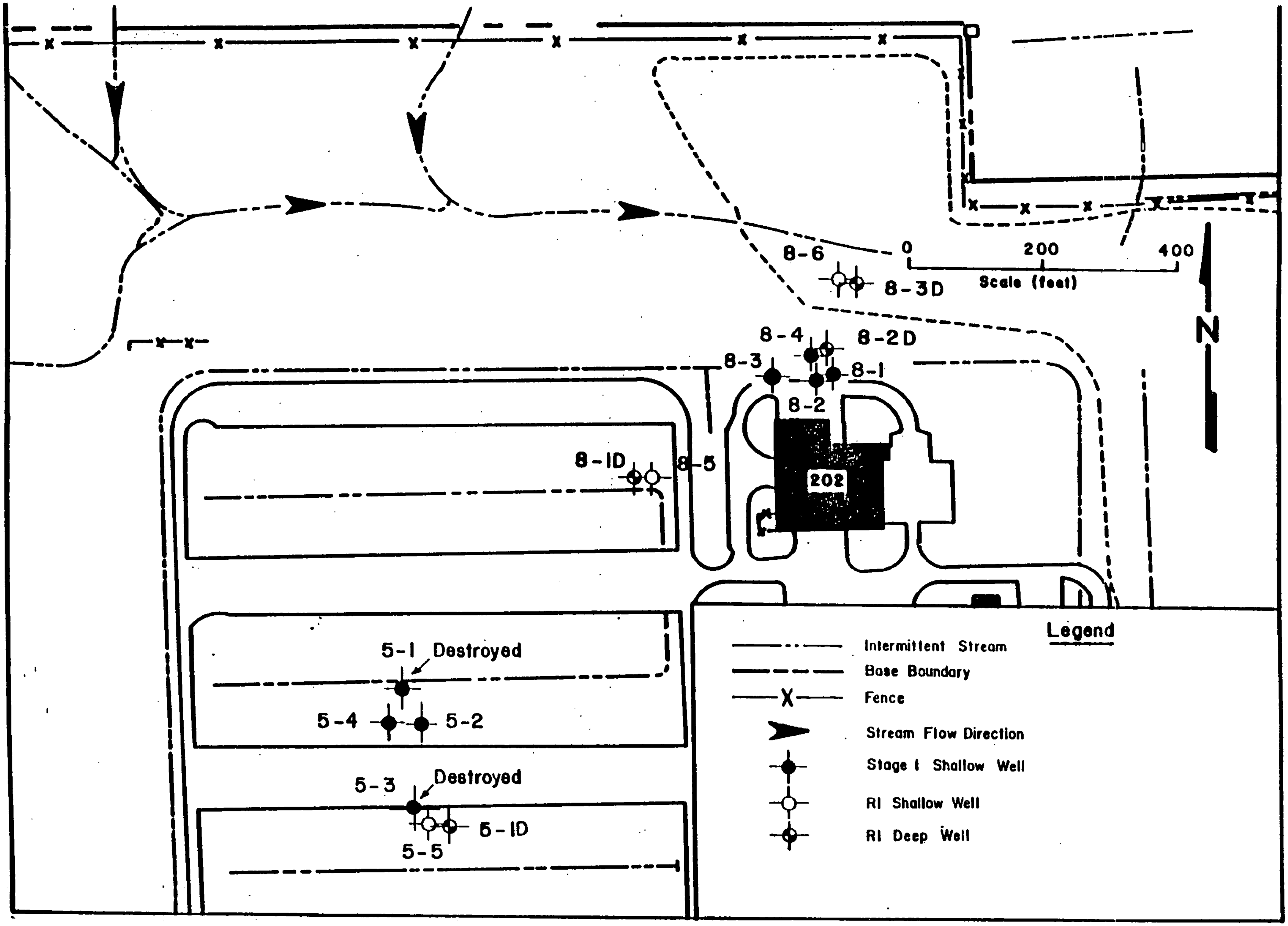


FIGURE 4-50
SITE NOS. 5 AND 8: MONITORING WELL LOCATION MAP

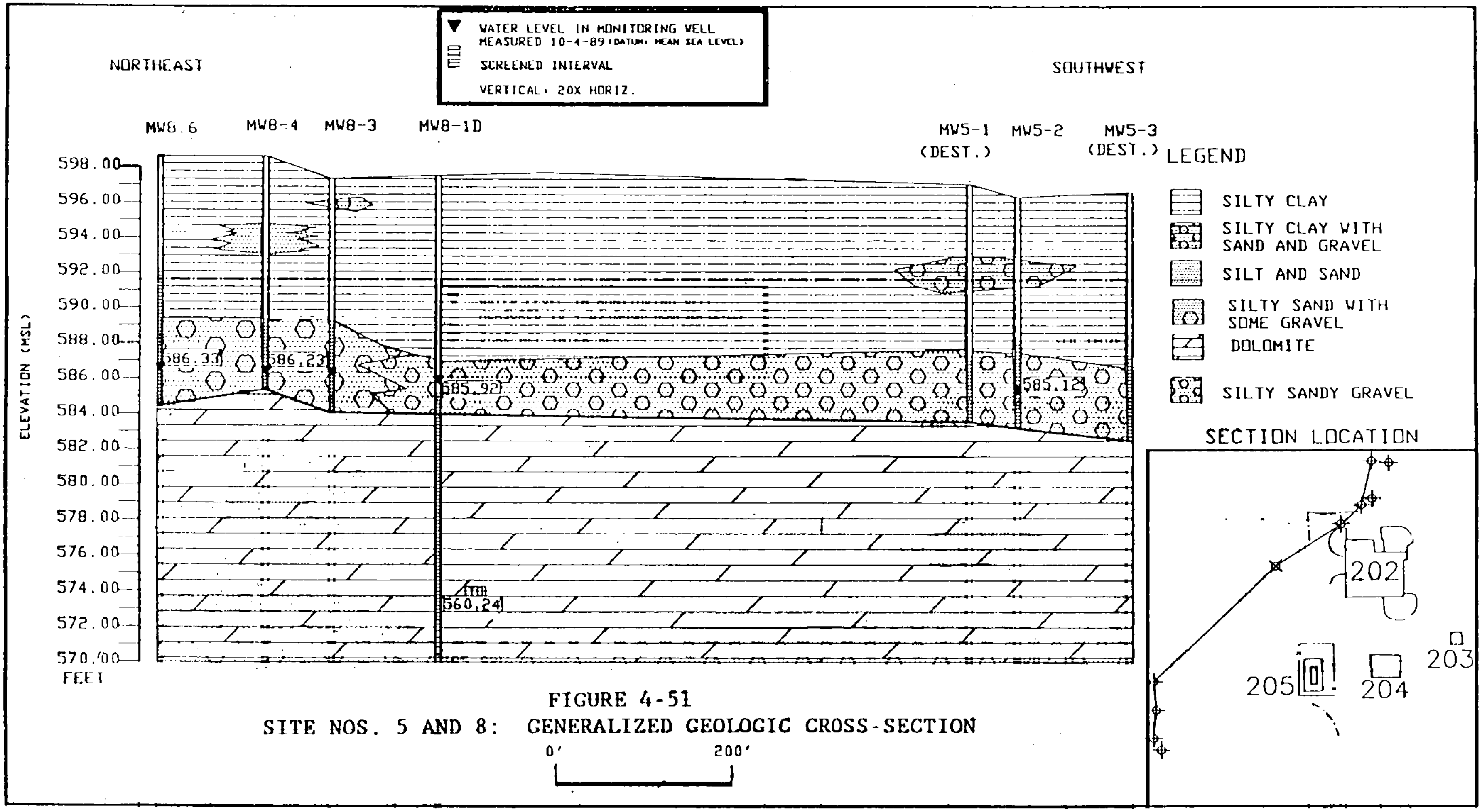


FIGURE 4-51

SITE NOS. 5 AND 8: GENERALIZED GEOLOGIC CROSS-SECTION thickness variations of the till and lacustrine deposits beneath the Site No. 5 and 8 study area could not be ascertained.

Fluvial sediments, although not considered a major unit in most site study areas, were logged at depth in most well borings at Site 5. A significant lens of silty sands, sand and gravel is described in the Stage 1 and RI well borings. The fluvial deposits achieve a maximum thickness in the area of MW5-1 and MW5-4 where sands and gravels with intercalations of silty clay were logged from 4.5 to 14 feet below land surface. Fluvial sediments apparently thin to the southeast where deposits range from 2 to 3 feet and are encountered about 9 feet below land surface. The fluvial materials have a medium dense to loose consistency and are always moist to wet. The sands and gravels are brown, reddish-brown and dark grey in color. Minor intercalations of fluvial sediments probably occur sporadically throughout the Site 8 study area but none were detected during the Stage 1 and RI well boring program.

The bedrock surface in the vicinity of Site No. 5 and 8 as interpreted from the well boring logs seems to be devoid of any significant surface features. An essentially flat profile stands in contrast to the dissected bedrock surface to the east and southeast of the Site No. 5 and 8 study area. Structural contour maps of the Lockport Dolomite surface at Site Nos. 5 and 8 are presented as Figures 4-52 and 4-53.

Information was obtained on the Lockport Dolomite during the RI effort though it was not complete. General lithologic and structural logs of the upper dolomite were determined. Air rotary drilling was somewhat successful in detecting horizons of incompetent bedrock, interpreted as fracture zones or localized pockets of vugs or solution cavities. Some of these horizons of incompetent bedrock likely act as water-bearing zones, due to enhanced permeability. As is the case with inferred upper bedrock geology across the installation, incompetent zones tend to be concentrated within the upper 10 to 15 feet of the dolomite. In the case of the upper-bedrock wells at Site 8, a prominent incompetent zone was encountered in the upper 3 feet of dolomite. Below 15 feet of the bedrock surface, incompetent zones are seldom detected.

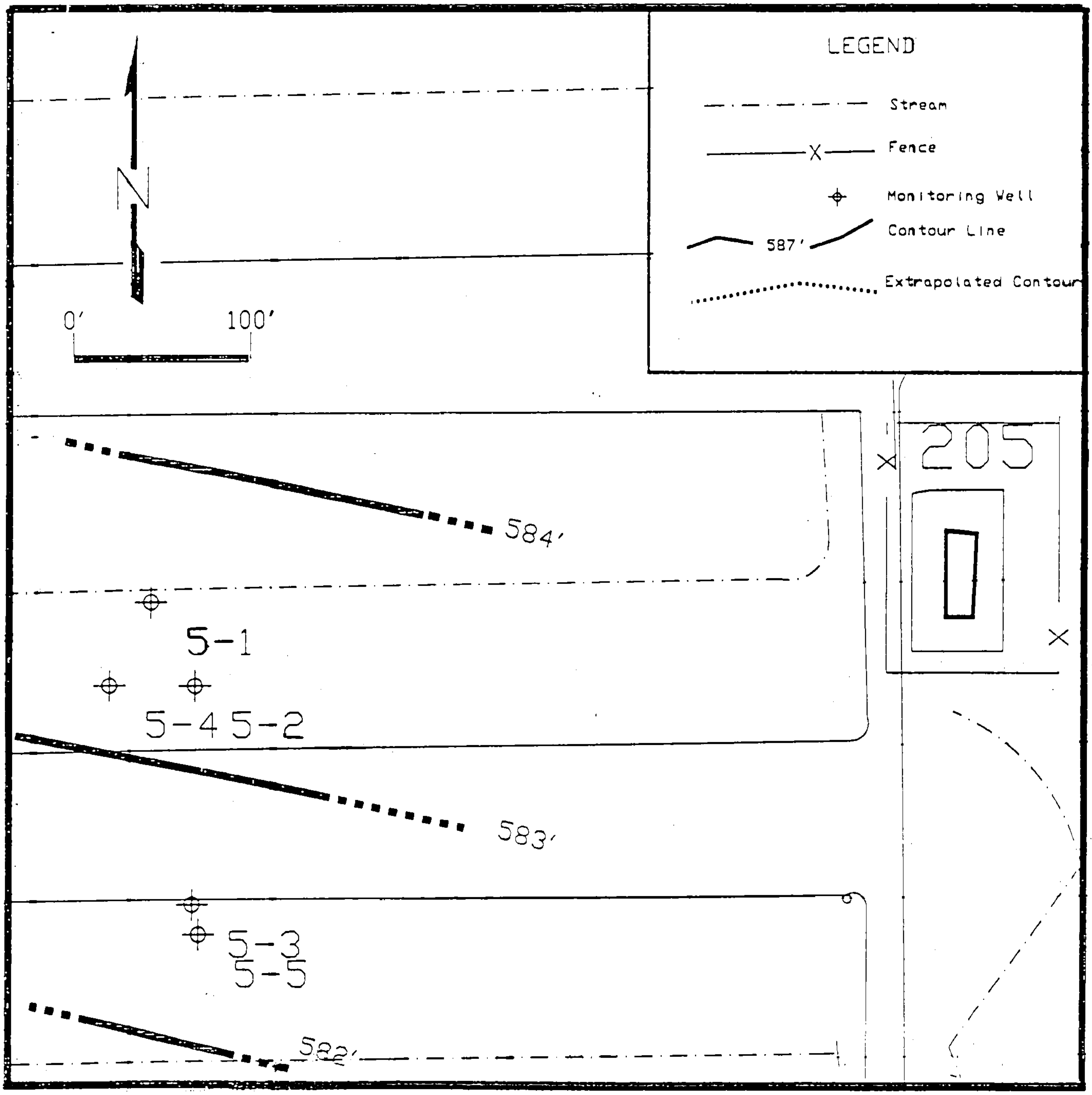


FIGURE 4-52
SITE NO. 5: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

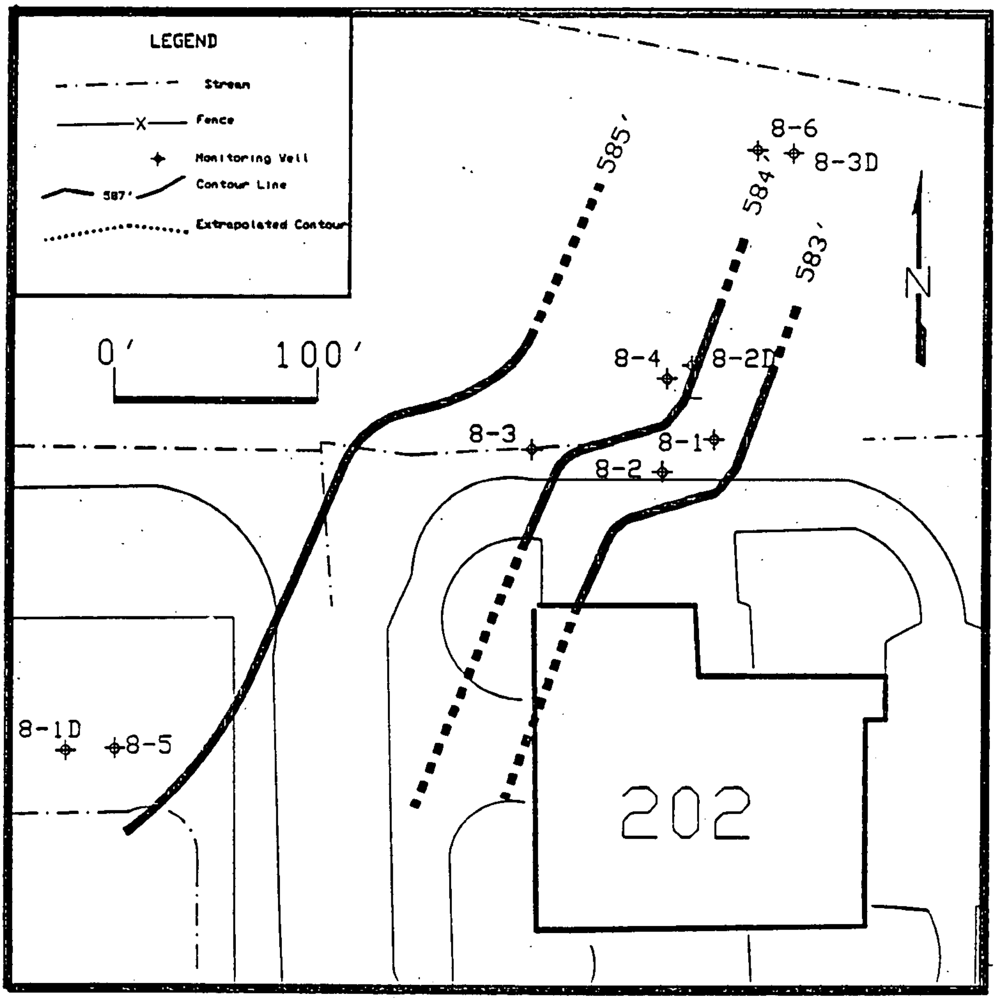


FIGURE 4-53
SITE NO. 8: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

4.1.5.1.2 **Site** Hydrogeology

The shallow unconsolidated aquifer and the upper bedrock aquifer, referenced as the shallow and deep aquifer respectively, were investigated at Site No. 5 and 8. Based upon the Stage 1 and RI well boring logs, the first potential water-bearing zone encountered in the shallow aquifer at Site No. 8 is a 1 to 1.5 foot thick, moist to wet, silty-clay horizon containing trace to some amounts of gravel, which rests directly upon the bedrock surface. This horizon represents a slightly more permeable interval of till. At Site No. 5 the major water producing zone in the shallow aquifer is a large lens of silty sand, sand and gravel which represents the basal unit of the unconsolidated sediments. All other surficial materials encountered at the combined sites lacked sufficient permeability to serve as a viable water-bearing formations and collectively function as an aquitard. This geologic arrangement just described results in a predominantly confined shallow aquifer system. Between May 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 9.54 feet. During April 1990 water levels exhibited a range in elevation from 593.35 feet MSL at MW8-6 to 590.49 feet MSL at MW8-3. The maximum head differential in the shallow aquifer across the Site No. 5 and 8 study areas is 2.86 feet and the hydraulic gradient is 0.0159. This relatively steep hydraulic gradient is probably not representative of the true gradient that prevails at these sites throughout most of the year, but rather is an temporal hydrogeologic feature that establishes itself only during the wetter Spring months. According to the extensive flow modeling study conducted at a nearby hazardous waste site (Mercer et. al., 1983), a more typical hydraulic gradient for the unconsolidated aquifer is 0.0036.

A maximum average water level fluctuation of approximately 6.83 feet was observed in the shallow aquifer wells at the combined sites between October 1989 and April 1990. As a general trend, water levels tended to be lowest in October and highest in April. Table 4-60 presents all the hydrogeological data collected at Site No. 5 and 8. Figures 4-54 and 4-55 present potentiometric surface maps of the shallow unconsolidated aquifer at Site No. 8 constructed from the October 1989 and April 1990 water level measurements. Due to only slight differences in head levels and only three closely spaced wells at Site No. 5, useful potentio-

TABLE 4-60

Site Nos. 5 and 8 - Hydrogeologic Data

Static Water Level Results

Monitor	05-31-89 Water Levels		09-12-89 Water Levels		10-04-89 Water Levels		04-11-90 Water Levels	
Well No	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**	**Elevation feet MSL**	**Depth feet BLS**
5-1	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
5-2	591.01	5.31	585.25	11.07	585.12	11.20	593.29	3.03
5-3	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
5-4	591.01	5.95	585.23	11.73	585.11	11.85	593.32	3.64
5-1D	NI	NI	585.14	12.56	584.90	12.80	592.68	5.02
5-5	NI	NI	585.17	12.64	585.01	12.80	592.12	5.69
8-1	590.59	7.04	588.34	9.29	585.78	11.85	592.48	5.15
8-2	NT	NT	NT	NT	586.18	11.52	NT	NT
8-3	590.57	6.79	586.41	10.95	586.17	11.19	590.49	6.87
8-4	590.59	8.01	586.48	12.12	586.23	12.37	592.49	6.11
8-1D	NI	NI	586.16	11.55	585.92	11.79	592.22	5.49
8-2D	NI	NI	586.41	12.07	586.23	12.25	592.52	5.96
8-3D	NI	NI	586.44	12.39	586.21	12.62	592.52	6.31
8-5	NI	NI	586.68	11.11	586.49	11.30	Destroyed(2)	Destroyed(2)
8-6	NI	NI	586.55	12.04	586.33	12.26	593.35	5.24

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW5-3	5.2×10^{-6} ft/sec	5.0 ft	2.6×10^{-5} ft^2/sec
MW8-1	$\geq 10^{-3}$ ft/sec(1)	5.0 ft	5.00×10^{-3} ft^2/sec

Notes:

NT = Not Taken
NI = Not Installed
(1) Estimated value; injected water could not be added quick enough to maintain a head for measurement of decline.
(2) Well destroyed by construction equipment sometime between 10-4-89 and 4-11-90.
ft.BLS = Feet below land surface
ft.MSL = Feet in reference to mean sea-level
Transmissivity was calculated as follows: K · B = T.
Saturated thickness was determined by measuring the length of screen below the static water-level.

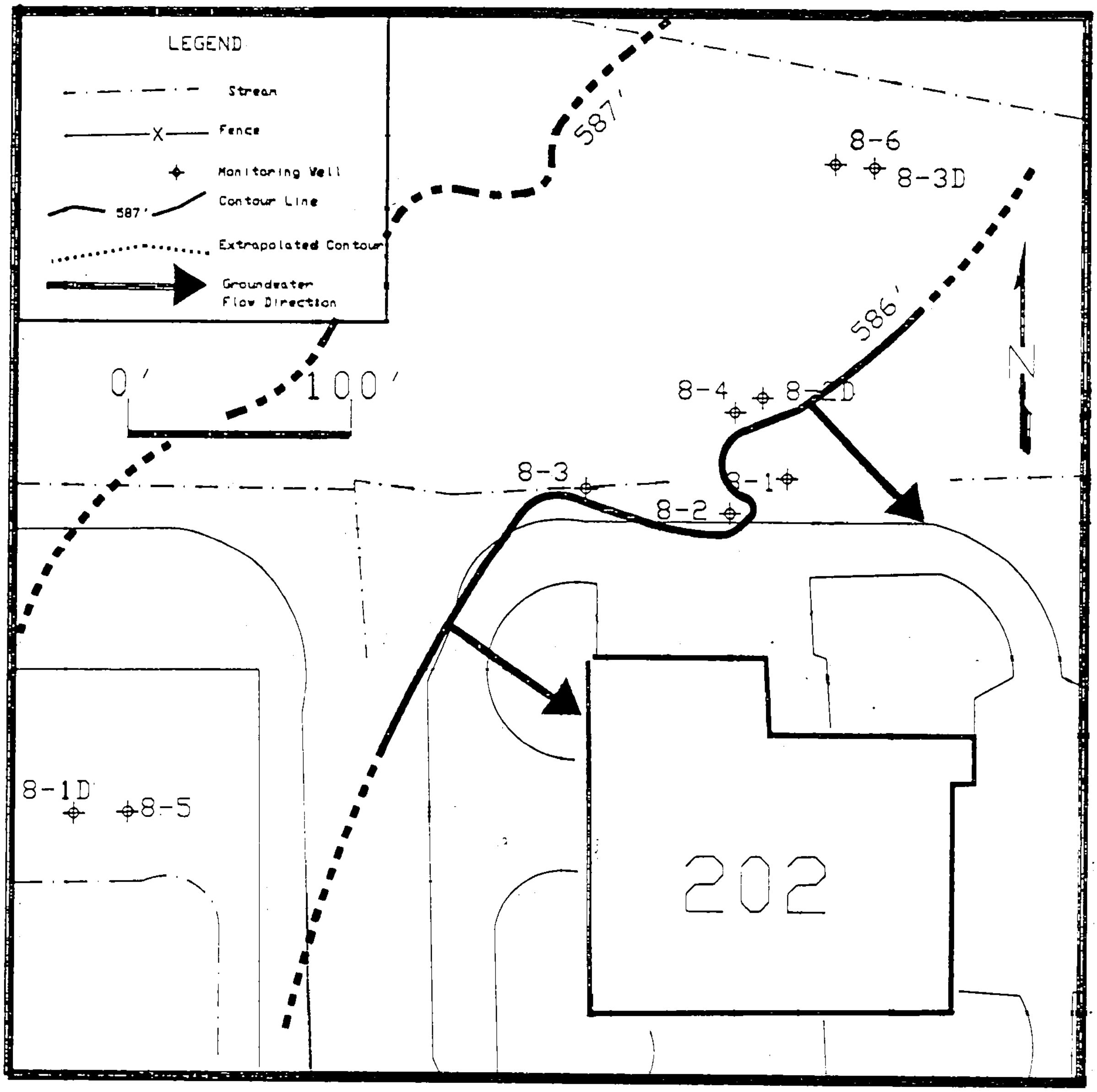


FIGURE 4-54
SITE NO. 8: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

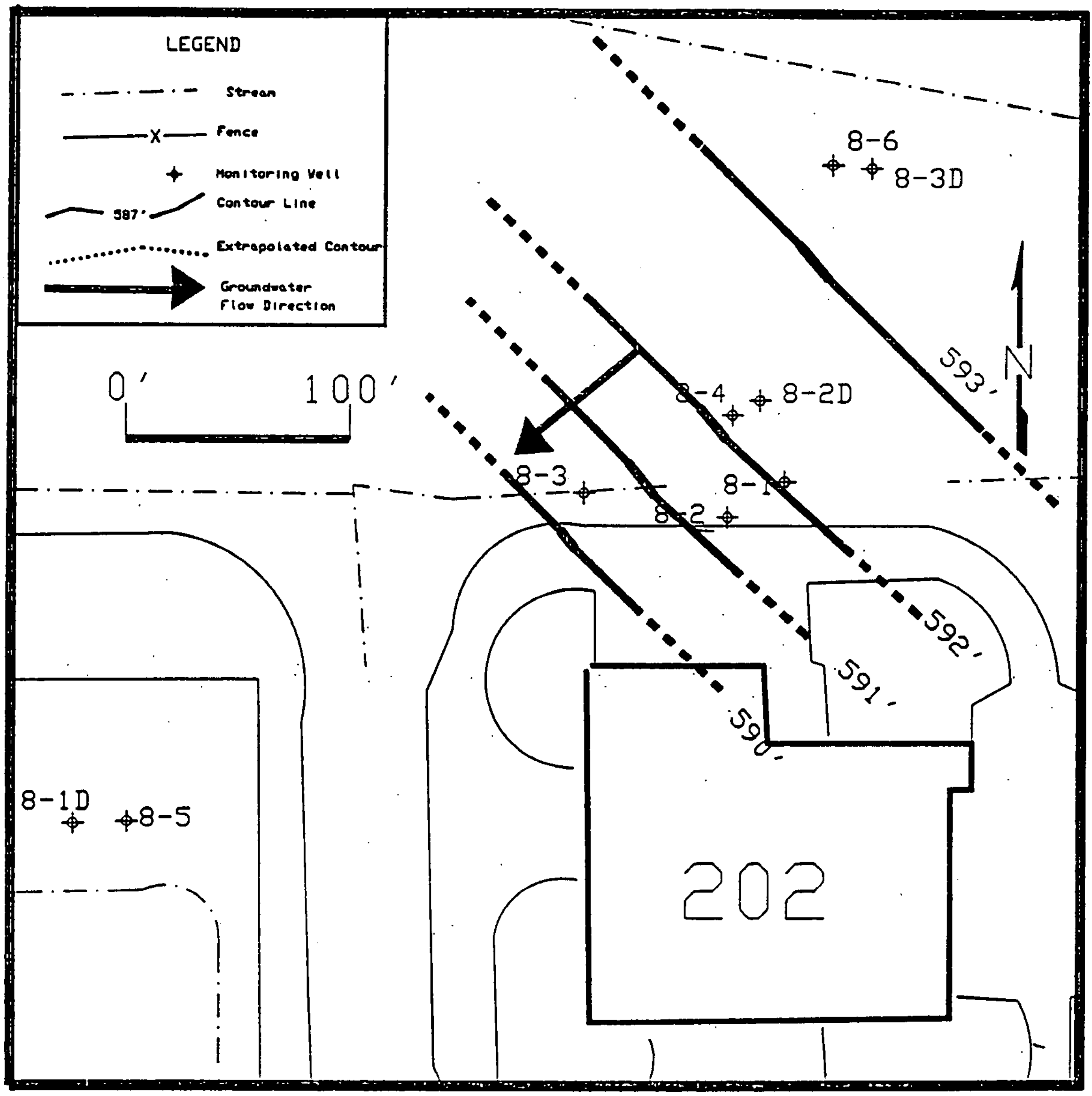


FIGURE 4-55
SITE NO. 8: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

metric surface maps could not be constructed. At Site No. 8, groundwater flow in the shallow aquifer system is currently estimated to be west southwest; however, seasonal water level data suggests that the flow may swing from southwest during the Spring months to southeast in early Autumn. Shifts in groundwater flow direction in the shallow unconsolidated aquifer have been described by other investigators (Johnston, 1964). The inferred shift in groundwater flow at Site Nos. 5 and 8 may not reflect an actual hydrogeologic condition but rather an apparent one caused by the lack of area wide control facilitated by the present well pattern (i.e., wells installed along a northeast-southwest line) and water level variations that are generally on the order of several tenths of a foot.

Water bearing zones in the upper portions of the Lockport Dolomite at Site No. 5 and 8 are likely to be zones of incompetent bedrock. The zones of incompetent bedrock are interpreted as regions of fractured dolomite or concentrations of interconnected solution cavities or vugs. Most of the zones encountered are less than 6-inches thick. Some of these zones may not be water-bearing, although all possess the prerequisite permeability. Between September 1989 and April 1990, water levels in the upper-bedrock aquifer occurred at an average depth of 10.07 feet. During April 1990, water levels exhibited a range in elevation from 592.68 feet MSL at MW5-1D to 592.22 feet MSL at MW8-1D. The maximum head differential across the Site No. 5 and 8 study area is 0.46 feet and the hydraulic gradient is 0.0008. A maximum average water level fluctuation of approximately 6.67 feet was observed in the Site No. 5 and 8 upper-bedrock aquifer between October 1989 and April 1990. Table 4-60 presents all the hydrogeological data collected from the Site No. 5 and 8 bedrock wells. Meaningful potentiometric surface maps could not be constructed for the upper bedrock aquifer at Site Nos. 5 and 8 due to interpretive problems created by minimum differential head levels. According to available literature, groundwater flow direction in the upper bedrock aquifer is generally to the south.

Water level measurements collected between September 1989 and April 1990 showed that shallow-deep well pairs in the combined site study area have only slight differential head potentials (Table 4-60). Unlike the paired wells at Site No. 1,2,4 and 6, the wells at Site No. 5 and 8 seem to respond in a similar fashion to seasonal fluctuations in precipitation. A maximum head potential difference of 1.07 feet was observed in shallow/deep well pair MW8-6/MW8-3D in April 1990. Generally the head potentials differ by an average of 0.40 feet. The similar response to seasonal fluctuations suggests that interaquifer exchange may occur at or close to the locations of these well pairs.

During the Stage 1 effort hydraulic conductivity tests (i.e., slug tests) were conducted on shallow monitoring wells MW5-3 and MW8-1. Head levels were recorded using a weighted graduated line with an attached float. Hydraulic conductivities of 5.2 x 10^{-6} ft/sec (1.6 x 10^{-4} cm/sec) and $\geq 10^{-3}$ ft/sec($\geq 10^{-2}$ cm/sec) were calculated for MW5-3 and MW8-1 respectively. The estimated hydraulic conductivity for MW8-1 is not consistent with the material the well is screened in (i.e., silty clay). Although no portion of this well is screened in the bedrock, hydraulically the two aquifers may be connected if a set of vertical bedrock fractures exists at this location. The hydraulic conductivity calculated for MW5-3 is probably not representative of the shallow aquifer system at Site No. 5 due to the presence of subsurface fluvial sands and gravels at most of the other Site No. 5 well locations. The horizontal velocity of groundwater flow in the shallow aquifer system at Site No. 5 is probably also similar if not greater than that calculated for Site No. 8. No hydrogeological tests were conducted on the upper bedrock wells.

As discussed in Section 4.1.1.1.2, the groundwater flow modeling study at Love Canal (Mercer et. al., 1983) reported bulk hydraulic conductivities for the unconsolidated aquifer in the range of 10^{-6} to 10^{-7} ft/s, an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. The hydraulic conductivity yielded by the Stage 1 slug test on MW5-3 was consistent with the flow modeling values, despite the fact that the well was screened in a higher conductive medium. Utilizing the hydrogeologic data yielded from the flow modeling study, horizontal groundwater flow velocities of 2.1 x 10^{-4} to 2.1 x 10^{-3} ft/day are predicted. These velocity values equate to 7.7 x 10^{-2} to 7.7 x 10^{-1} ft/yr. According to the USGS (1985), groundwater flow in the shallow aquifer at a nearby industrial property ranged from 2.0 x 10^{-2} to 6.0 x 10^{-2} ft/yr. Due to the presence of sand and gravel deposits at the Site No. 5, locally higher groundwater flow velocities can be expected. Due to the non-connective nature of these deposits, these velocities are generally isolated, controlled largely by the dimensions of the higher conductive media. The unconsolidated materials as a whole are characterized by very low permeabilities.

A series of drainage ditches exist in the vicinity of Site No. 8. One drainage ditch runs west to east through a corrugated pipe under the old Drum Storage Yard just north of Building 202. At the time monitoring wells were installed at the Site No. 5 and 8 study area, the ditch did not contain any water and was overgrown with grasses. Located about 200 feet north of this drainage ditch is an intermittent stream, which is essentially just a larger drainage ditch. This stream was flowing at the time of the basewide groundwater sampling program conducted during September 1989. This eastwardly flowing stream is fed by two off-Base tributaries. The eastern most tributary, which was dry at the time of this investigation, intercepts the main stream at a point located 600 feet west northwest of monitoring well MW8-6. The second tributary, which was a major contributor to the flow in the main stream, intercepts the main stream at a point located 1100 feet west-northwest of monitoring well MW8-6. Figure 4-56 shows the Site No. 5 and 8 surface water/sediment sampling stations along the intermittent stream. Table 4-61 displays the average depth, mean velocity, and flow at the three monitoring stations. An average discharge of 2.51 ft^3/sec was calculated from the three monitoring stations. Between the upstream and downstream station there is a net increase in flow of 0.67 ft^3/sec. This increase in flow is being attributed to a few minor upstream tributaries and groundwater seepage. The majority of the flow in the intermittent stream can be attributed to an off-Base discharger located north of the installation.

4.1.5.1.3 Analytical Results For Site No. 5 and 8: Soil Gas Survey/Headspace Analyses

A total of 13 soil gas samples were collected and analyzed in the vicinity of Site No. 8 (Drum Storage Yard). Soil gas techniques were not applied at Site No. 5 (NYANG Hazardous Waste Drum Storage Area). Samples were analyzed for the following volatile compounds:

- 1,1,1-trichloroethane (TCA)
- trichloroethene (TCE)
- tetrachloroethene (PCE)
- benzene

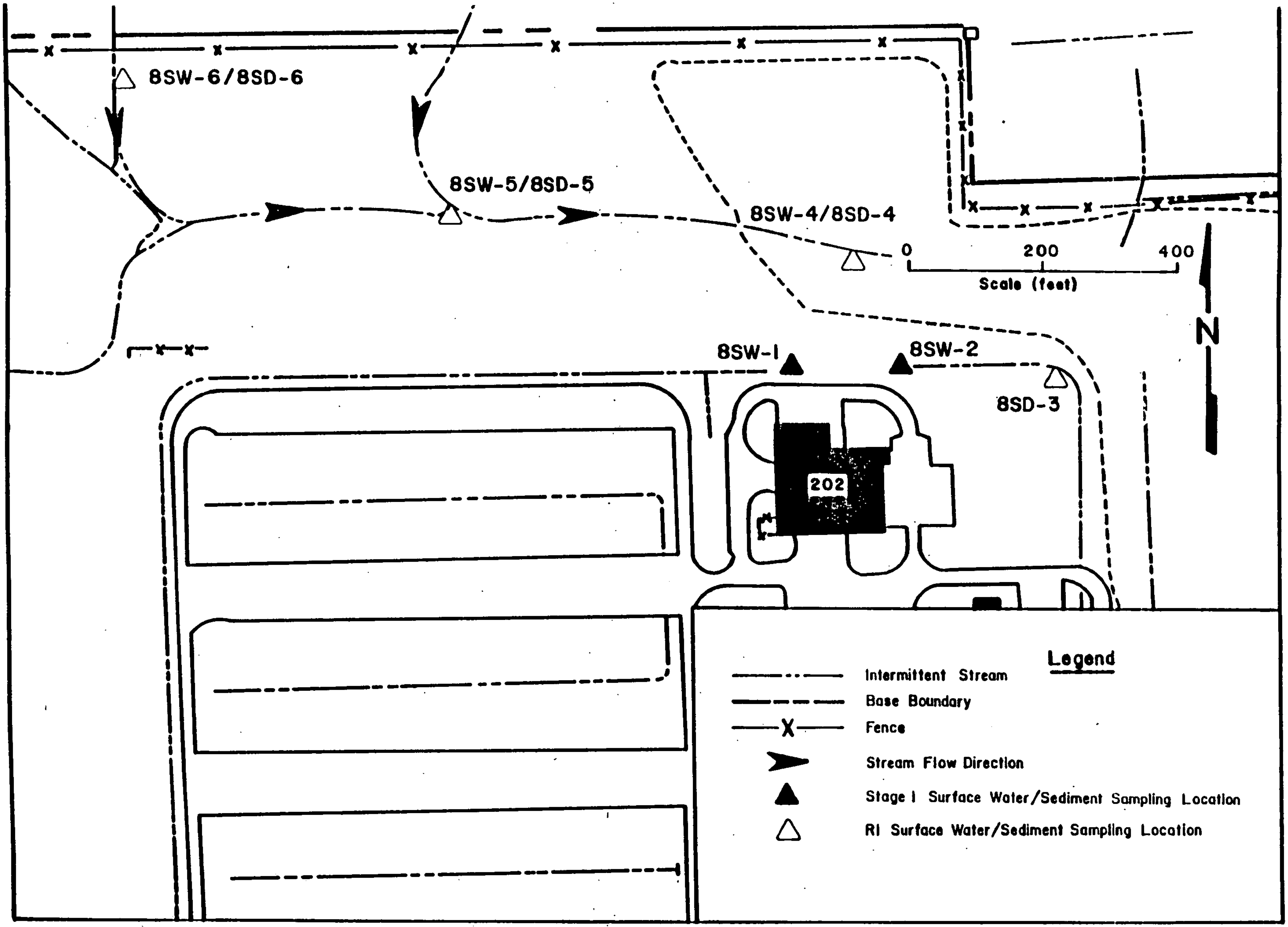


FIGURE 4-56

SITE NOS. 5 AND 8: SURFACE WATER/SEDIMENT SAMPLING STATIONS

TABLE 4-61

Site Nos. 5 & 8: Surface Water Discharge Measurement Data

Station No. (1)	Avg. Depth <ft.>	Mean Velocity <ft/sec>	Discharge <CFS>	Losing (-) Gaining(+) <CFS>
8SW-6/8SD-6	0.62	0.86	2.17	---
8SW-5/8SD-5	0.65	0.95	2.51	+0.34
8SW-4/8SD-4	1.01	1.05	2.84	+0.33

ft - feet
ft/sec - feet per second
CFS - cubic feet per second

* Discharge is the total flow of water through the stream channel cross-sectional area.

(1) Station Numbers are listed starting upstream and continuing downstream along the intermittent stream.

- toluene
- ethylbenzene
- xylenes
- total hydrocarbons.

These volatiles were chosen because of their suspected presence in the subsurface as a result of incidental spills resulting from hazardous waste drum storage and the amenability of these compounds to soil gas detection.

Once again, saturated soil conditions and near surface perched water tables interfered with the implementation of soil gas techniques. Since probes could only be driven one to two feet below land surface, an adequate seal could not be ensured which would prevent surface air from cross-contaminating most samples. Resultingly, data produced from the soil gas survey at this site are more likely to reflect ambient air quality rather than the composition of soil pore gas. Even if the probes could be driven to the required depth, it is doubtful if a representative sample would have been collected due to the extensive swelling of clay minerals in the soils in response to recent rains. The soil gas data for Site No. 8 is presented as Table 4-62. Figure 4-57 presents the soil gas sample location map for Site No. 8. Despite the limiting factors encountered at the Site No. 8 study area, subsurface contamination is suggested at a few locations. In the immediate vicinity of soil gas sampling station SG8-3, TCE, benzene, toluene and total hydrocarbons were detected at 2 ug/l, 4 ug/l, 1 ug/l and 16 ug/l respectively. Other areas of possible subsurface contamination may be in the vicinity of soil gas sampling stations SG8-2, SG8-7, SG8-9, SG8-10, and SG8-12.

Headspace analyses were conducted on groundwater samples collected from the six (6) Stage 1 monitoring wells previously installed at the Site No. 5 and 8 study area. Isoconcentration contour maps were constructed for trichloroethene (TCE), and total hydrocarbons (Figures 4-58 and 4-59). Due to the isolated or low concentrations and/or limited data generated for tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA) and benzene, isoconcentration contour maps were not constructed. PCE was found in only three of the six wells sampled (i.e., 1 ug/l in MW8-1, 0.4 ug/l in MW8-4, 0.01 ug/l in MW5-4). Benzene was only measured in

Table 4–62

Site Nos. 5 and 8: Soil Gas Analytical Data

Sample	Depth	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
Ambient Air		04/20/89	0.002	<0.0009	<0.0007	0.01	<0.01	<0.01	<0.01	0.01
SG-8-1	3'	04/20/89	0.04	0.02	<0.007	0.02	0.02	<0.02	<0.02	0.04
Ambient Air		04/20/89	0.01	<0.0009	<0.0007	0.01	<0.01	<0.01	<0.01	0.01
SG-8-2	2'	04/20/89	0.1	0.08	<0.007	0.4	0.06	<0.01	<0.01	0.8
SG-8-3	2.5'	04/20/89	0.05	2	0.06	4	1	<0.04	<0.4	16
SG-8-4	2.5'	04/20/89	0.02	0.02	<0.007	0.01	<0.01	<0.01	<0.1	0.01
Ambient Air		04/20/89	0.006	<0.0009	<0.0007	0.01	<0.01	<0.01	<0.01	0.01
Ambient Air		04/21/89	0.003	<0.002	0.0006	<0.01	<0.01	<0.03	<0.03	<0.01
SG-8-5	1.5'	04/21/89	0.004	0.04	<0.0006	0.07	<0.01	<0.03	<0.03	0.07
SG-8-6	2.5'	04/21/89	0.002	0.04	<0.0006	0.1	<0.01	<0.06	<0.06	0.1
SG-8-7	2'	04/21/89	0.002	0.04	<0.0006	0.04	0.2	<0.06	<0.06	0.1
SG-8-8	1.5'	04/21/89	0.002	0.02	<0.0006	0.07	0.01	<0.06	<0.06	0.08
SG-8-9	1'	04/21/89	0.001	0.02	<0.0003	0.01	0.2	<0.06	<0.06	0.2
SG-8-10	2'	04/21/89	0.001	0.02	<0.0003	0.06	0.3	<0.06	<0.06	0.2
SG-8-11	1.5'	04/21/89	0.005	0.02	<0.0003	0.04	<0.01	<0.06	<0.06	0.04
SG-8-12	2'	04/21/89	0.006	0.02	<0.0003	0.04	0.4	<0.06	<0.06	0.4
SG-8-13	2'	04/21/89	0.007	0.04	<0.0003	0.01	<0.01	<0.06	<0.06	0.03
Ambient Air		04/21/89	0.003	0.01	<0.0006	0.01	<0.01	<0.06	<0.06	0.01
Ambient Air		04/21/89	0.002	<0.0009	<0.0006	0.006	<0.01	<0.06	<0.06	0.006

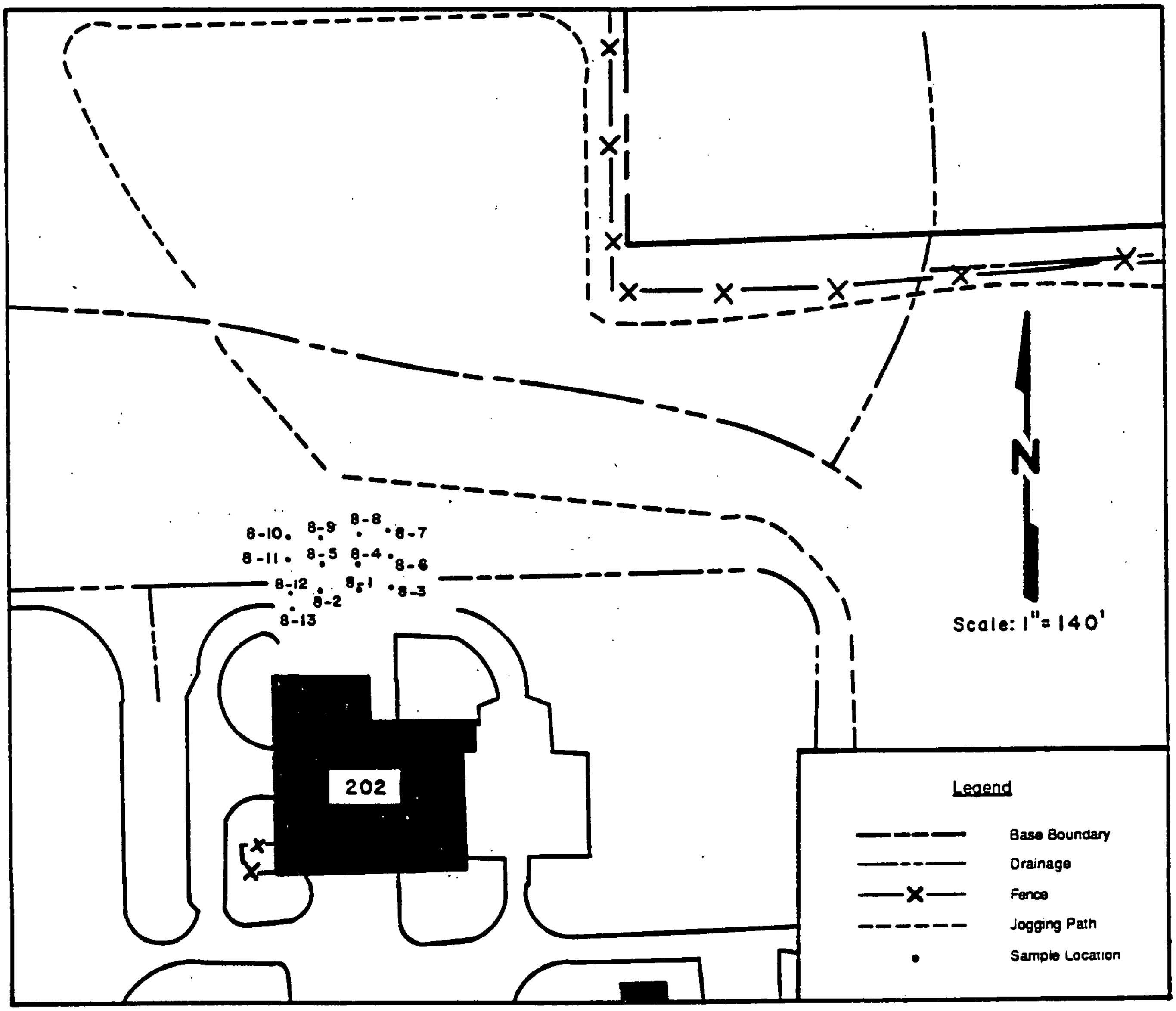


FIGURE 4-57
SITE NOS. 5 AND 8: SOIL GAS SAMPLE STATION LOCATIONS

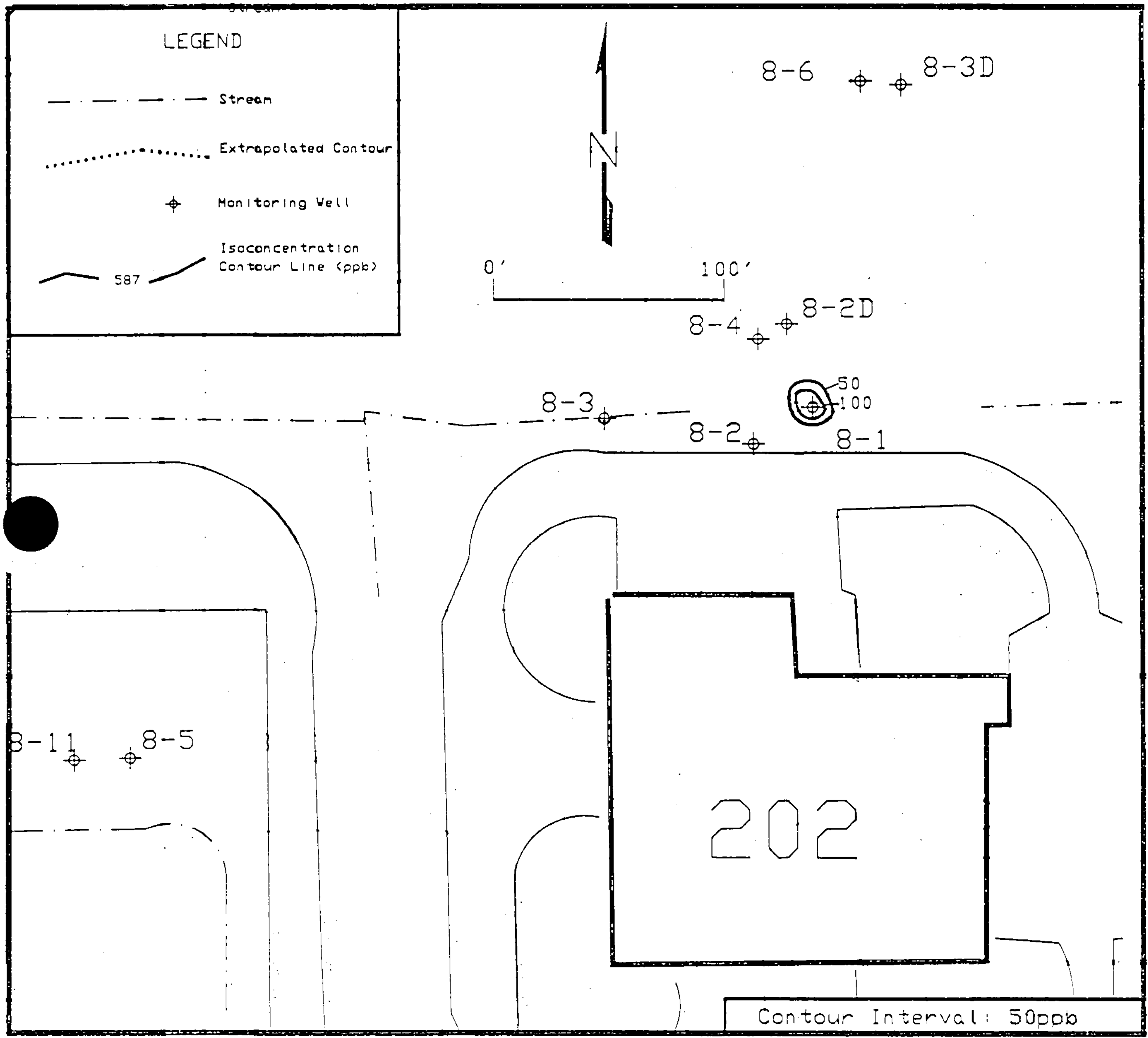


Figure 4-58
Site No. 8: Tricloroethene (TCE) Isoconcentration Contour Map
Groundwater Headspace Analyses

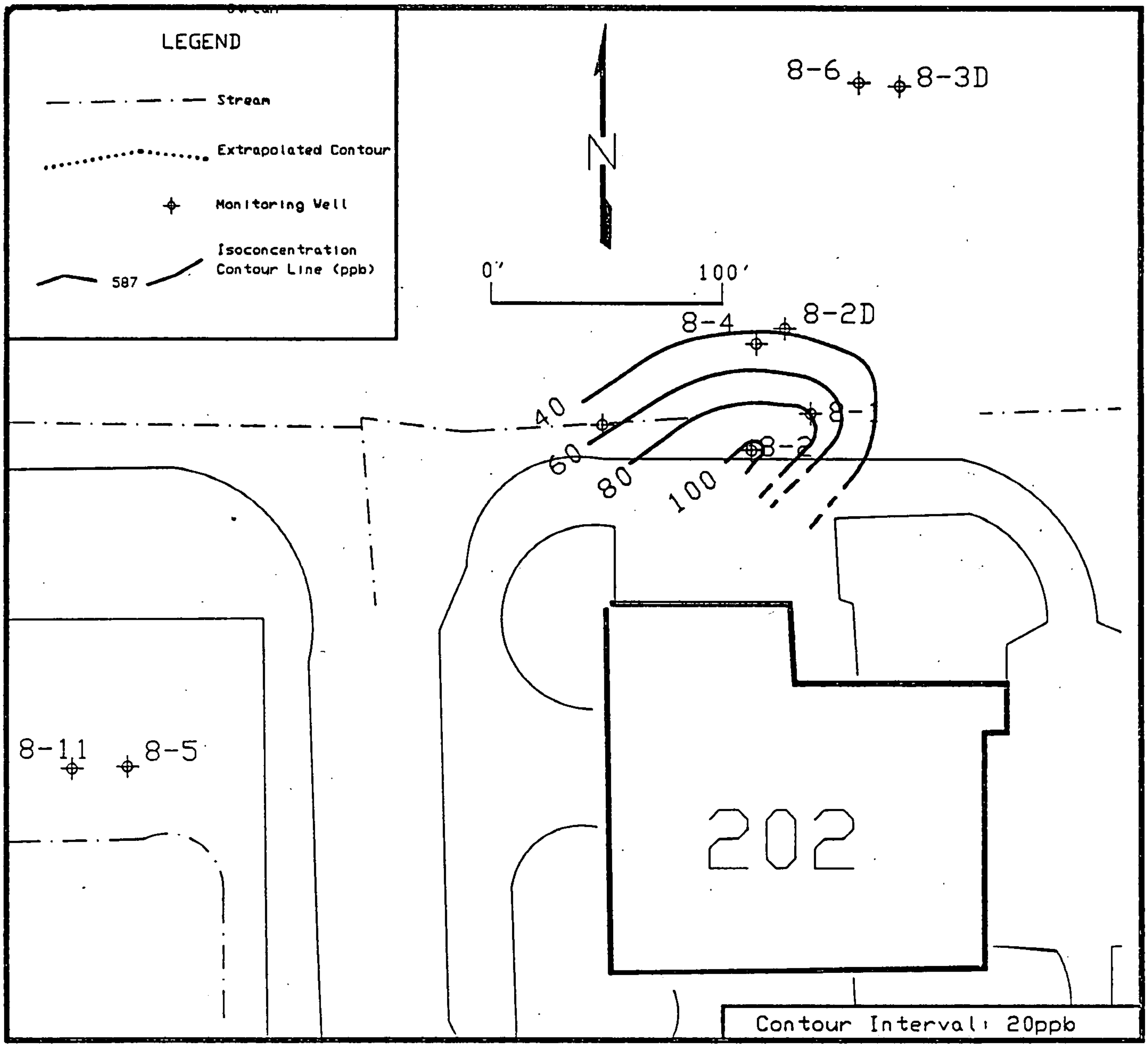


Figure 4-59
Site No. 8: Total Hydrocarbon Isoconcentration Contour Map
Groundwater Headspace Analyses

monitoring well MW8-2 at 18 ug/l. Concentrations of toluene, ethylbenzene and xylenes occurred at or below the instrument's detection limit throughout the study area. The headspace analytical data for Site No. 5 and 8 are presented in Table 4-63.

Figure 4-58 illustrates the inferred pattern of TCE contamination in groundwater of the shallow aquifer beneath Site No. 5 and 8. TCE contamination was detected at both sites. The extent of TCE contamination could not be assessed at Site No. 5 since two of the four Stage 1 wells are no longer in service. Concentrations of 0.01 ug/l, 2 ug/l, 126 ug/l, 1 ug/l, 0.5 ug/l and 4 ug/l were measured in monitoring wells MW5-2, MW5-4, MW8-1, MW8-2, MW8-3 and MW8-4 respectively.

Figure 4-59 depicts the inferred pattern of total hydrocarbon contamination across the Site No. 5 and 8 study area. Total hydrocarbon contamination appears to be fairly evenly distributed between the two study areas. Concentrations of 87 ug/l, 55 ug/l, 80 ug/l, 123 ug/l, 58 ug/l and 47 ug/l were measured in monitoring wells MW5-2, MW5-4, MW8-1, MW8-2, MW8-3 and MW8-4 respectively.

4.1.5.1.4 <u>Analytical Results for Sites No. 5 and 8: Contract Laboratory</u>

Matrix-specific results are presented for each individual sample in Table 4-64 and 4-69; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-70. Engineering property characteristics for soils at Sites No. 5 and 8 are presented in Table 4-71.

<u>Organic Analyses</u>: A total of eleven soil boring samples were collected from both sites and analyzed for volatile organic compounds and semivolatile organic compounds. (Only purgeable aromatic compounds analysis was required at these sites; however due to laboratory configuration, all soil samples were analyzed for full scan volatile organics by GC/MS.) Sixteen groundwater samples from both sites, and associated field QC blanks, were analyzed for purgeable halocarbons, purgeable aromatics, non-halogenated volatiles and semivolatile

Table 4-63

Site Nos. 5 and 8: Summary of Headspace Analytical Results for Groundwater

Sample	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
MW5-2	06/03/89	0.2	0.01	<0.004	<0.4	<0.4	<0.3	<40	87
MW5-4	06/03/89	0.09	2	0.01	<0.4	<0.4	<0.3	<9	55
MW8-1	06/03/89	0.5	126	1	<0.4	<0.4	<0.3	<8	80
MW8-2	06/03/89	<0.003	1	<0.004	18	<0.4	<0.3	<0.9	123
MW8-3	06/03/89	0.2	0.5	<0.004	<0.4	<0.4	<0.3	<18	58
MW8-4	06/03/89	0.5	4	0.4	<0.4	<0.4	<0.3	I	47

Notes:
I = Interference with adjacent peaks

TABLE 4-84
SITE NO. 5: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	WB-5-1D-1 (5.7'-7.7')	WB-5-1D-1R (5.7'-7.7' Duplicate)	WB-5-5-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg) **Volatile Organics**				
Methylene Chloride	0.005	0.0062^{c}	$0.027^{a,c}$	$0.0078^{b,c}$
Acetone	0.010	$0.015^{b,c}$	$0.063^{a,b,c}$	$0.034^{b,e}$
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/8270 **Semivolatile Organics (mg/kg)**	See Appendix F	ND^{d}	ND^{d}	ND^{d}
EPA Method SW3050/6010* **Total Metals (mg/kg)**				
Aluminum[f]	10.0	14100^{b}	14400^{b}	18.6
Antimony	6.0	ND^{e}	ND^{e}	7.79^{e}
Barium	1.0	181^{e}	172^{e}	262
Calcium[f]	50.0	60600	63600	57.1
Chromium	1.0	18.0^{e}	17.6^{e}	23.4
Cobalt	1.0	6.91^{e}	851^{e}	$14.0^{e,g}$
Copper	1.0	13.1^{e}	16.6^{e}	111
Iron[f]	2.5	30200^{b}	34800^{b}	32.6
Lead	5.0	$9.22^{c,g}$	$ND^{c,g}$	$22.6^{c,e}$
Magnesium[f]	50.0	9470	9100	15.7
Manganese	0.5	420^{f}	404^{f}	505
Nickel	1.5	18.5^{e}	20.2^{e}	32.7^{e}
Potassium[f]	50.0	2160	2220	2300
Silicon[f]	100.0	651^{b}	622^{b}	652
Sodium[f]	50.0	160	140	214
Vanadium	1.0	24.9^{e}	25.6^{e}	32.1
Zinc	1.0	43.8^{e}	44.8^{e}	141
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/E418.1 **Total Petroleum Hydrocarbons (mg/kg)**	5.0	ND	ND	ND
EPA Method SW9060 **Total Organic Carbon (mg/kg)**	NR	NA	NA	25000

Footnotes:

a = Surrogate recovery (toluene-d8) below control limit.
b = Compound also detected in associated method blank.
c = Field duplicate analyses exceeded 35% RPD for this parameter.
d = Precision assessment based on lab MS/MSD analysis was either not performed or indicated variability (5 RPDs outside of control limit).
e = Matrix spike had low recovery, below control limit for this parameter.
f = Accuracy data unavailable; this compound was routinely not spiked (or spiked recoveries could not be calculated).
g = Matrix replicates had analytical RPD greater than the control limit.

* = Or as indicated for metal analyzed by alternate methods.
NR = Not reported.

TABLE 4-65
SITE NO. 5: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Detection Limits	Sample Field ID (Sample Description)							
		GW43 (MW-5-2)	GW44 (MW-5-4)	GW45 (MW-5-1D) Duplicate	GW46 (MW-5-5)	GW47 (MW-5-1D)	TB20 Trip Blank	GW42 Field Blank	GW48 Equip. Wash.
EPA Method SW5030/8021 (ug/l)									
Volatile Organics/Purgeable Halocarbons									
Methylene Chloride	0.8	5.3[a,c]	3.7[a]	3.5[a]	4.4[a]	4.6[a]	3.6[a,b]	4.0[a]	1.3[a,b]
Acetone	1	ND[b]	ND	2.4	1.3	2.6	ND[b]	ND	ND[b]
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L)									
Purgeable Aromatic Organics		ND	ND	ND		ND	ND	ND	ND
Toluene	0.3				0.31				
Others	See Appendix F				ND				
EPA Method SW5030/8015 (ug/L)									
Non-Halogenated Volatile Organics	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E625									
Semivolatile Organics (ug/L)	See Appendix F	ND[e]	ND[e]	ND[e]	ND[d,e]	ND[e]	NA	NA	ND[e]
EPA Method E200.7*									
Total Metals (mg/L)							NA	NA	
Aluminum	0.1	11.8	5.79	ND	30.7	ND			ND
Barium	0.01	0.175	0.125	0.143	0.354	0.164			ND
Boron	0.01	0.114[g]	0.079[g]	0.112[g]	0.245[g]	0.063[g]			ND[g]
Calcium[f]	0.20	313	243	218	392	213			0.216
Chromium	0.010	0.020	0.014	ND	0.044	ND			ND
Cobalt	0.010	ND	ND	ND	0.024	ND			ND
Copper	0.010	0.032	ND	ND	0.079	ND			ND
Iron	0.025	18.8	9.48	1.62	52.0	2.18			ND
Lead	0.05	0.100	0.078	ND	0.247	ND			ND
Lead (E239.2)	0.005	0.100[g]	0.068[g]	ND[g]	0.646[g]	0.008[g]			ND[g]
Magnesium[f]	0.20	144	111	78.6	181	79.7			ND
Manganese	0.005	1.38	0.761	0.122	2.75	0.129			ND
Nickel	0.015	0.024	ND	ND	0.057	ND			ND
Potassium[f]	0.4	4.05	3.14	1.93	8.26	1.92			ND
Silicon[f]	0.020	35.0	18.6	6.04	43.8	6.28			0.061
Sodium[f]	0.200	47.2	58.3	36.2	290	41.6			0.261
Vanadium	0.01	0.019	0.008	ND	0.053	ND			ND
Zinc	0.01	1.20[g]	0.634[g]	0.088[g]	1.56[g]	0.128[g]			ND[g]
Others	See Appendix F	ND	ND	ND	ND	ND			ND

TABLE 4-65 (Cont'd)
SITE NO. 5: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Detection Limits	GW43 (MW-5-2)	GW44 (MW-5-4)	GW45 (MW-5-1D) Duplicate	GW46 (MW-5-5)	GW47 (MW-5-1D)	TB20 Trip Blank	GW42 Field Blank	GW48 Equip. Wash.
EPA Method E418.1 (mg/L)									
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	ND	ND	NA	NA	ND
Miscellaneous Inorganics (mg/L)							NA	NA	
Total Dissolved Solids (E160.1)	1.0	980	1000	1100	1700	1200			ND
Common Anions (A429)									
Fluoride	0.1	0.46	0.77	0.30	0.57	0.30			ND
Chloride	0.5	75	160	60	27	64			ND
Sulfate	0.5	300	300	550	920	590			ND
Total Hardness (E130.1)	1.0	1700	1200	960	2100	900			ND

Footnotes:

a = Compound also detected in associated method blank.
b = Associated matrix spikes analysis had recovery above control limit for this compound.
c = Associated matrix spikes analysis had recovery below control limit for this compound.
d = One surrogate recovery (Terphenyl-d14) was below control limit.
e = Precision assessment cannot be made.
f = Accuracy data unavailable; compound not routinely included in spiking solution.
g = Associated field duplicate analysis exceeded 35% RPD for this compound.

SITE NO. 8: ANALYTICAL RESULTS: SOILS

		Sample Field ID (Sample Description)							
Parameter (Units)	Detection Limits	WB-8-1D-1 (7.4'-9.4')	WB-8-2D-7 (9.0'-10.5')	WB-2D-7R (9.0'-10.5') duplicate)	WB-8-3D-1 (7.0'-9.0')	WB-8-5A-1 (0-1.5')	WB-8-5A-4 (4.5'-6.0')	WB-8-5A-7 (9.0'-10.5')	WB-8-6-8 (10.5'-12.0')
EPA Method SW8240 (mg/kg)									
Volatile Organics						ND			
Methylene Chloride	0.005	0.007[b]	<0.0068[*,b]	0.0094[b]	0.0057[b]		0.068[a]	<0.006[*,a]	ND[b]
Acetone	0.010	0.020[a,b]	0.028[a,b]	0.061[a,b]	0.033[a,b]		0.074[a]	0.045[a]	0.030[a]
Others	See Appendix F	ND	ND	ND	ND		ND	ND	ND
EPA Method SW3550/8270									
Semivolatile Organics (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010									
Total Metals (mg/kg)									
Aluminum[d]	10.0	15900[a]	23200	20900	9980[a]	5210	14000	15300	6020
Barium	1.0	132[c]	199	155	1.1[c]	39.8	153	92.4	112
Boron	1.0	ND[a]	ND	ND	ND[a]	ND	ND	ND	21.8
Cadmium	0.5	ND	1.07	0.847	ND	ND	ND	ND	ND
Calcium[d]	50.0	51200	64400	57700	52000	191000	130000	137000	57700
Chromium	1.0	22.9	23.8	24.2	15.0	7.55	17.6	160	10.6
Cobalt	1.0	9.81[c]	12.0	12.9	4.78[c]	3.52[c]	11.2[c]	9.61[c]	7.23
Copper	1.0	17.3[c]	26.6	24.2	17.0[c]	8.08	19.9	17.1	14.6
Iron[d]	2.5	30400[a]	35500	32500	23500[a]	10000	24400	2783	16900
Lead	5.0	28.5[b,e]	20.7	21.5	10.1[b,e]	26.3[c]	14.3[c]	13.8[c]	10.2
Magnesium[d]	50.0	13700	14100	14200	16600	99500	27400	9.98	12700
Manganese	0.5	470[d]	546	568	419[d]	400	467	460	581
Molybdenum	1.0	3.01[c]	ND	ND	ND[c]	ND	ND	ND	ND
Nickel	1.5	28.0[c]	27.3	28.8	15.7[c]	8.32[c]	23.9[c]	20.7[c]	14.6
Potassium[d]	50.0	3220	3890	4090	1930	449	1760	1640	1410
Silicon[d]	100.0	845[a]	464	611	635[a]	476	975	1000	1870
Sodium[d]	50.0	166	219	228	114	108	145	149	153
Vanadium	1.0	30.6[c]	30.9	32.7	20.4[c]	10.6	24.8	22.5	15.7
Zinc	1.0	65.5[c]	69.9	69.7	56.1[c]	117	54.4	50.8	41.9
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg)									
Total Petroleum Hydrocarbons	5.0	ND	ND	ND	240	52	170	12	ND

Footnotes:

a = Compound also detected in associated method blank.
b = Associated field duplicate analyses exceeded 35% RPD for this parameter.
c = Associated lab matrix spike had recoveries below control limit.
d = Accuracy data unavailable; compound not spiked (or recovery could not be calculated).
e = Matrix replicate analyses exceeded 30% RPD control limit for this parameter.
* = Compound present below measurable detection limit.

TABLE 4-67
SITE NO. 8: ANALYTICAL RESULTS: GROUNDWATER

		Sample ID (Sample Description)							
Parameter (Units)	**Detection Limits**	**GW28 (MW-8-6)**	**GW29 (MW-8-3D)**	**GW30 (MW-8-3D) duplicate**	**GW31 (MW-8-5)**	**GW32 (MW-8-1D)**	**GW35 (MW-8-1)**	**GW36 (MW-8-3)**	**GW37 (MW-8-2D) duplicate**
EPA Method SW5030/8021 Volatile Organics/Purgeable Halocarbons (ug/L)									
1,1,1-Trichloroethane	0.4	ND	1.3	1.0	ND	ND	ND^{a}	ND	ND
1,1-Dichloroethane	0.5	ND	1.7	1.2	ND	ND	1.3J^{a}	ND	0.82
Trans-1,2-Dichloroethene	0.3	ND^{d}	1.1^{d}	0.64^{d}	ND^{d}	ND^{d}	ND^{a}	ND	ND
Methylene Chloride	0.8	3.3^{b,c,d}	3.6^{b,c,d}	1.1^{b,c,d}	0.65J^{b,c,d}	1.2^{b,c,d}	19^{a,b,d}	ND^{b,d}	3.0^{b,d}
Dichlorodifluoromethane	2.0	ND^{d}	2.2^{d}	ND^{d}	ND^{d}	ND^{d}	ND^{a}	ND	ND
Trichlorobenzene	1	ND^{d}	1.6^{d}	1.1^{d}	1.7^{d}	4.5^{d}	190^{a}	ND	1.1
1,4-Dichlorobenzene	0.3	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{a}	ND	ND
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L) Purgeable Aromatic Organics		ND	ND	ND	ND	ND	ND	ND	ND
Toluene	0.3								
1,4-Dichlorobenzene	0.7								
Others	See Appendix F								
EPA Method SW5030/8015 (ug/L) Non-halogenated Volatile Organics	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E625 (ug/L) Semivolatile Organics		ND		NA					NA
Di-n-butylphthalate	10		$<10^{*}$		$<10^{*}$	$<10^{*}$	$<10^{*}$	$<10^{*}$	
Bis(2-ethylhexyl)phthalate	10		$<10^{*}$		$<10^{*}$	ND	$<10^{*}$	10	
Others	See Appendix F		ND		ND	ND	ND	ND	
EPA Method E200.7* Total Metals (mg/L)									NA
Aluminum	0.1	2.13	ND^{f}	ND^{f}	18.0^{f}	0.909^{f}	67.0	56.8	
Arsenic (E206.2)	0.005	ND	0.005	0.006	0.005	ND	0.009	0.009	
Barium	0.01	0.040	0.069	0.071	0.283	0.095	0.547	0.547	
Boron	0.01	0.208^{d}	0.106^{b,d}	0.013^{b,d}	0.212^{b,d}	0.125^{b,d}	0.400^{d}	0.369^{d}	
Cadmium	0.005	ND	ND	ND	ND	ND	ND	ND	
Calcium^{f}	0.20	276	259	279	434	189	840	922	
Chromium	0.010	0.012	ND	ND	0.026	ND	0.093	0.086	

TABLE 4-67 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS: GROUNDWATER

		Sample ID (Sample Description)							
Parameter (Units)	**Detection Limits**	**GW28 (MW-8-6)**	**GW29 (MW-8-3D)**	**GW30 (MW-8-3D) duplicate**	**GW31 (MW-8-5)**	**GW32 (MW-8-1D)**	**GW35 (MW-8-1)**	**GW36 (MW-8-3)**	**GW37 (MW-8-2D) duplicate**
EPA Method E200.7*									
Total Metals (mg/L) (Cont'd)									NA
Cobalt	0.010	ND	ND	ND	0.015	ND	0.185	0.041	
Copper	0.010	ND	ND	ND	0.041	ND	0.108	0.161	
Iron	0.025	5.16	4.17[f]	2.93[f]	32.5[f]	0.816[f]	121	90.7	
Lead	0.05	ND	ND	ND	0.080	ND	0.217	0.307	
Lead (E239.2)	0.005	0.007	ND	ND	0.062	ND	0.184	0.534	
Magnesium[f]	0.20	240	137	154	201	72.7	268	409	
Manganese	0.005	2.05	0.164	0.161	2.049	0.052	4.96	4.89	
Mercury (E45.1)	0.0002	ND	ND	ND	ND	ND	ND	ND	
Molybdenum	0.010	0.059	ND	ND	ND	ND	ND	ND	
Nickel	0.015	ND	ND	ND	0.038	ND	0.145	0.104	
Potassium[f]	0.4	7.54	3.67	3.30	6.04	3.50	12.2	12.9	
Silicon[f]	0.020	8.69	6.07[b]	6.48[b]	27.3[b]	8.02[b]	78.6	72.1	
Sodium[f]	0.200	475	56.6	59.0	57.1	47.0	50.2	47.7	
Vanadium	0.01	0.035	ND	ND	0.036	ND	0.112	0.104	
Zinc	0.01	0.076	0.033[g]	0.030[g]	1.04[g]	0.154[g]	4.47	2.68	
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	
EPA Method E418.1 (mg/L)									
Total Petroleum Hydrocarbons	1.0*	ND	ND	ND	ND	ND	ND	ND	NA
Miscellaneous Inorganics (mg/L)									NA
Total Dissolved Solids (E160.1)	1.0	4100	1900	2000	1400	1200	1800	1400	
Common Anions (A429)									
Fluoride	0.1	0.58	0.58	0.61	0.54	0.61	0.54	0.60	
Chloride	0.5	29	82	89	54	68	83	59	
Sulfate	0.5	2500	940	1000	780	510	810	610	
Total Hardness (E130.1)	1.0	1800	1200	1300	1800	830	2800	2600	

TABLE 4-67 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS: GROUNDWATER

	Sample ID (Sample Description)								
Parameter (Units)	**GW38 (MW-8-4)**	**GW39 (MW-8-2D)**	**GW40 (MW-8-2)**	**TB18 Trip Blank**	**TB19 Trip Blank**	**GW27 Field Blank**	**GW34 Field Blank**	**GW33 Equip Wash**	**GW41 Equip. Wash**
EPA Method SW5030/8021 (ug/L)									
Volatile Organics/Purgeable Halocarbons									
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	0.62	0.97	0.37J	ND	ND	ND	ND	ND	ND
Trans-1,2-Dichloroethane	ND	ND	ND	ND	ND	ND^{d}	ND	ND^{d}	ND
Methylene Chloride	ND^{b,d}	ND^{b,d}	ND^{b,d}	3.8^{b}	4.1^{b}	8.5^{b,c,d}	3.7^{b,d}	4.7^{b,d}	3.6^{b,d}
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND^{d}	ND	ND^{d}	ND
Trichloroethene	ND	1.0	11	ND	ND	ND^{d}	ND	ND^{d}	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	2.4^{c}	ND	2.2	ND
Others	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L)									
Purgeable Aromatic Organics	ND	ND		ND	ND		ND		ND
Toluene			0.64			ND		ND	
1,4-Dichlorobenzene			ND			2.9		2.9	
Others			ND			ND		ND	
EPA Method SW5030/8015 (ug/L)									
Non-halogenated Volatile Organics	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E625									
Semivolatile Organics (ug/L)				NA	NA	NA	NA	ND	ND^{h}
Di-n-Butylphthalate	<10^{*,h}	18^{h}	22^{h}						
Bis(2-ethylhexyl)phthalate	<10^{*,h}	20^{h}	38^{h}						
Other	ND	ND	ND						
EPA Method E200.7*									
Total Metals (mg/L)				NA	NA	NA	NA		
Aluminum	45.8	31.7	94.9					ND^{f}	ND
Arsenic (E206.2)	0.011	0.012	0.024					ND	ND
Barium	0.578	0.310	0.954					ND	ND
Boron	0.314^{d}	0.182^{d}	0.512^{d}					0.035^{b,d}	ND^{d}
Cadmium	ND	ND	0.122					ND	ND
Calcium^{f}	949	392	1760					ND	ND
Chromium	0.062	0.025	0.180					ND	ND
Cobalt	0.037	0.010	0.071					ND	ND
Copper	0.143	0.033	0.419					ND	ND
Iron	76.5	30.9	148					ND^{f}	ND
Lead	0.302	0.226	1.03					ND	ND

TABLE 4-67 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	GW38 (MW-8-4)	GW39 (MW-8-2D)	GW40 (MW-8-3D)	TB18 Trip Blank	TB19 Trip Blank	GW27 Field Blank	GW34 Field Blank	GW33 Equip Wash	GW41 Equip. Wash
	Sample ID (Sample Description)								
EPA Method E200.7*									
Total Metals (mg/L) (Cont'd)				NA	NA	NA	NA		
Lead (E239.2)	0.332	0.212	1.24					ND	ND
Magnesium[f]	442	174	509					ND	ND
Manganese	4.76	1.08	9.08					ND	ND
Mercury (E245.1)	ND	ND	0.0004					ND	ND
Molybdenum	ND	ND	ND					ND	ND
Nickel	0.087	0.027	0.194					ND	ND
Potassium[f]	9.31	13.6	14.4					ND	ND
Silicon[f]	58.1	57.2	84.9					0.102[b]	0.078
Sodium[f]	44.2	78.0	13.3					ND	ND
Vanadium	0.080	0.032	0.158					ND	ND
Zinc	2.29	1.40	6.12					ND[g]	ND
Others	ND	ND	ND					ND	ND
EPA Method E418.1 (mg/L)									
Total Petroleum Hydrocarbons	1.0	ND	ND	NA	NA	NA	NA	ND	ND
Miscellaneous Inorganics (mg/L)				NA	NA	NA	NA		
Total Dissolved Solids (E160.1)	1400	1500	460					42	ND
Common Anions (EPA Method A429)									
Fluoride	0.60	0.50	0.14					ND	ND
Chloride	64	81	20					ND	ND
Sulfate	720	750	180					ND	ND
Total Hardness (E130.1)	2600	2000	4900					ND	ND

Footnotes:

a = Surrogate recoveries were above control limits for two compounds.
b = Compound also detected in associated method blank.
c = Associated MS/MSD analyses had recoveries above control limits for one or both spikes.
d = Associated field duplicate analyses exceeded 35% RPD for this compound.
e = Recoveries were below control limits for one or more surrogate compounds.
f = Accuracy data unavilaible; compound not spiked.
J = Estimated value below detection limit.
g = Assoicated lab replicate analysis resulted in RPD values which exceeded the control limit.
h = Analyses required a re-extraction (due to inital low surrogates); re-extraction performed past hold time.
J = Estimated value below detection limit.

TABLE 4-68
SITE NO. 8: ANALYTICAL RESULTS: SURFACE WATERS

		Sample ID (Sample Description)				
Parameter (Units)	**Detection Limits**	**SW-2 (8SW-4)**	**SW-3 (8SW-5)**	**SW-4 (8SW-6)**	**TB26 Trip Blank**	**SW-1 Field Blank**
EPA Method SW5030/8021 (ug/L)						
Volatile Organics/Purgeable Halocarbons						
Methylene Chloride	0.8	1.6[a,b]	1.4[a,b]	1.5[a,b]	1.0[a,b]	3.9[a,b]
Others	See Appendix F	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (µg/L)						
Purgeable Aromatic Organics	See Appendix F	ND	ND	ND	ND	ND
EPA Method SW5030/8015 (ug/L)						
Non-halogenated Volatile Organics	See Appendix F	ND	ND	ND	ND	ND
EPA Method E625 (ug/L)						
Semivolatile Organics	See Appendix F	ND	ND	ND	NA	NA
EPA Method E200.7[e]						
Total Metals (mg/L)					NA	NA
Aluminum	0.1	0.874	1.86	0.894		
Barium	0.01	0.037	0.045	0.032		
Boron	0.01	0.726[a]	0.743[a]	0.638[a]		
Calcium[f]	0.20	599	589	560		
Iron	0.025	1.55[g]	3.50[g]	1.67[g]		
Lead	0.05	ND	ND	ND		
Lead (E239.2)	0.005	ND	0.011	0.005		
Magnesium[f]	0.20	162	171	160		
Manganese	0.005	0.093[c]	0.180[c]	0.099[c]		
Potassium[f]	0.4	22.8	24.0	21.2		
Silicon[f]	0.200	4.39[a]	5.90[a]	4.24[a]		
Sodium[f]	0.200	261	265	259		
Zinc	0.01	0.051	0.143	0.060		
Others	See Appendix F	ND	ND	ND		
EPA Method E418.1 (mg/L)						
Total Petroleum Hydrocarbons	1.0	1.6	ND	ND	NA	NA
Miscellaneous Inorganics (mg/L)					NA	NA
Total Dissolved Solids (E160.1)	1.0	3300	3200	3300		
Common Anions (A429)						
Fluoride	0.1	5.7	0.59	0.59		
Chloride	0.5	400	380	460		
Nitrate-Nitrogen	0.5	0.77	0.75	0.83		
Sulfate	0.5	1700	1700	1700		
Total Hardness (E130.1)	1.0	1900	2100	2000		

TABLE 4-68 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS: SURFACE WATERS

Footnotes:

a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis had recovery below control limit for this compound.
c = Associated field duplicate analysis exceeded 35% RPD.
d = One surrogate compound had a recovery below lower control limit.
e = Precision could not be assessed for this analysis; data unavailable
f = Accuracy data unavailable for these compounds.
g = Associated lab matrix replicate analysis resulted in RPD values above the control limit.
h = Associated matrix spike had recovery above upper control limits.

NR = Not Required
* = Or as indicated if analyzed by a alternate method.

TABLE 4-69
SITE NO. 8: ANALYTICAL RESULTS: SURFACE SEDIMENTS

Parameter (Units)	Detection Limits	Sample ID (Sample Description) SD-2 (8SD-4)	SD-3 (8SD-5)	SD-4 (8SD-6)	SD-5 (8SD-3)
EPA Method SW8240 (mg/kg)					
Volatile Organics					
Methylene Chloride	0.005	0.012	0.0075	0.010	ND
Acetone	0.010	0.079[a,c]	0.018[a,c]	0.025[a,c]	0.050[a,c]
Others	See Appendix F	ND	ND	ND	ND
EPA Method SW3550/8270					
Semivolatile Organics (mg/kg)	See Appendix F	ND[e]	NDe	ND[e]	ND[e]
EPA Method SW3050/6010*					
Total Metals (mg/kg)					
Aluminum[f]	10.0	6180	5960	17800	5140
Barium	1.0	65.8[c,g]	48.2[c,g]	112[c,g]	37.4[c,g]
Beryllium	0.2	ND	ND	0.322	ND
Boron	1.0	38.5	33.4	116	25.7
Cadmium	0.5	1.39	1.46	3.96	3.16
Calcium[f]	50.0	52600[c]	5140[c]	1480[c]	3910[c]
Chromium	1.0	7.52[c]	22.2[c]	22.5[c]	136[c]
Cobalt	1.0	5.11[c]	4.69[c]	12.1[c]	ND[c]
Copper	1.0	8.44	9.52	20.3	48.1
Iron[f]	2.5	11600	9890	36100	7810
Lead	5.0	21.1[c,g]	80.9[c,g]	25.9[c,g]	63.3[c,g]
Magnesium[f]	50.0	13.4[c]	12.3[c]	8670[c]	1830[c]
Manganese	0.5	283[c,h]	273[c,h]	519[c,h]	81.0[c,h]
Nickel	1.5	16.8	16.1	31.4	12.5
Potassium[f]	50.0	1360	1400	3280	836
Silicon[f]	100.0	577[c]	591[c]	370[c]	714[c]
Sodium[f]	50.0	265[c]	304[c]	354[c]	ND[c]
Vanadium	1.0	11.1	8.46	32.5	22.6
Zinc	1.0	291[c]	358[c]	354[c]	722[c]
Others	See Appendix F	ND	ND	ND	ND
EPA Method SW3550/E418.1					
Total Petroleum Hydrocarbons (mg/kg)	5.0	24[c,g]	63[c]	36[c]	190[c]

Footnotes:

a = Compound also detected in associated method blank.
b = Associated MS/MSD analysis had recovery below control limit for this compound.
c = Associated field duplicate analysis exceeded 35% RPD.
d = One surrogate compound had a recovery below lower control limit.
e = Precision could not be assessed for this analysis; data unavailable.
f = Accuracy data unavailable for these compounds.
g = Associated lab matrix replicate analysis resulted in RPD values above the control limit.
h = Associated matrix spike had recovery above upper control limits.

NR = Not Required
* = Or as indicated if analyzed by an alternate method.

TABLE 4-70
Field Water Quality Data
Niagara Falls IAP
Site Nos. 5 and 8
9/21 & 9/19/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 5-1D	14°	6.95	1090	330	0	0	330	Background	clear
MW 5-2	12°	6.33	940	445	0	0	445	Background	cloudy
MW 5-4	12°	7.44	1010	290	0	0	290	Background	clear
MW 5-5	14°	7.14	1570	300	0	0	300	Background	clear
MW 8-1	14°	7.67	1350	380	0	0	380	Background	cloudy
MW 8-1D	10°	7.65	980	220	0	0	220	Background	clear, to slightly cloudy
MW 8-2	14°	8.51	410	130	0	0	130	Background	cloudy, turbid
MW 8-2D	12°	7.92	1290	230	0	0	230	Background	cloudy
MW 8-3	14°	8.13	1120	420	0	0	420	Background	cloudy
MW 8-3D	12°	6.80	1440	260	0	0	260	clear, to slightly cloudy	
MW 8-4	12°	7.19	1150	285	0	0	285	Background	cloudy, brown color
MW 8-5	10.5	7.73	1140	450	0	0	450	Background	turbid
MW 8-6 (1)	10°C	---	---	425	0	0	425	Background	turbid

Notes:

(1) pH and conductivity meter malfunctioning

TABLE 4-71

SITE NOS. 5 AND 8: ENGINEERING PROPERTY CHARACTERISTICS FOR SOILS

Parameter	ASTM Method	Sample Number B-4-1-4C
Soil Moisture	D2216	8.8%
Density	D4287	2.67
Plasticity Index	D4318	29
Grain Size	D422	--- See Appendix D ---

organics. Three surface water samples (from Site 8) were analyzed for purgeable halocarbons, purgeable aromatics, non-halogenated volatile organics and semivolatile organics. Four surface sediments (also from Site 8) were analyzed for volatile and semivolatile organic compounds. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- One soil sample from Site 5, WB-5-1D-1R, had one surrogate recovery above control limits: toluene-d8=122%, upper control limit = 117%.
- Methylene chloride and acetone were detected in almost all the soil samples from both sites; these were not target compounds. However, it should be noted that two of the volatile organic method blanks were contaminated with methylene chloride, and all six of the blanks contained at least trace levels of acetone, which indicates potential bias in the sample results.
- Several field duplicate pairs were associated with the soil samples from these two sites, which were collected on different dates. All three pairs (WB-5-1D-1/1R, WB-8-2D-7/7R and WB-13-3-6/6R) exceeded 35% RPD for methylene chloride and two (from Sites 5 and 8) exceeded 35% RPD for acetone. These were the only two compounds detected in the samples and, again, they are not target compounds. There was no field duplicate associated with the collection of samples WB-8-5A-1/4/7.
- Precision could not be assessed for the semivolatile organic analysis of samples WB-5-5-6, and WB-8-5A-1/4/7 since only a matrix spike and no duplicates were performed. The matrix spike/matrix spiked duplicate (MS/MSD) associated with WB-5-1D-1/1R, WB-8-1D-1 and WB-8-3D-1 had RPD's above the control limits for five out of eleven spiked compounds; however any impact is minimal since all semivolatile compounds were ND in the samples.
- One groundwater sample from Site 8, GW35, had two surrogate recoveries above the control limits for the analysis of purgeable halocarbons: bromochloromethane recovery = 147% (upper control limit = 140%), and 2-chlorobromopropane recovery =130% (control limit = 127%).
- One compound, 2-chloroethylvinyl ether, was not found in the standards associated with the purgeable halocarbon analysis of the groundwater. The compound was reported as NF = Not found in the Appendix F.
- Seven out of eight laboratory method blanks for purgeable halocarbons contained methylene chloride at concentrations ranging from 1.8-6.1 ug/L; all confirmation blanks also had methylene

chloride = 3.4-4.3 ug/L. Field QC blank samples all contained methylene chloride at concentrations of 1.3-8.5 ug/L; groundwater sample concentrations were ND-19 ug/L (12 of 16 samples had methylene chloride above the detection limit). Therefore all sample concentrations of methylene chloride are potentially biased high due to laboratory contamination.

- Several MS/MSD analyses were associated with the purgeable halocarbon analysis of groundwater samples. There was only a matrix spike associated with each of two samples, GW43 and GW48, (therefore no precision measurement) and both had trichloroethene recovery above the control limits: recoveries = 120% and 130%; upper control limit =115%. Other MS/MSD analyses associated with the remaining samples had various compound recoveries above or below control limits, however, none of these were compounds (other than methylene chloride) which were detected in the samples.

- The field duplicate pair, GW29/GW30, associated with the groundwater samples GW27-33 exceeded 35% RPD for trans-1,2-dichloroethene (RPD=53%), methylene chloride (=106%), dichlorodifluoromethane (=200%) and trichloroethene (=37%). The other field duplicate pair from Site 8, GW37/GW39, associated with samples GW34-41 exceeded 35% RPD for methylene chloride which was detected in one sample but not the other.

- Four groundwater samples from Site 8 required semivolatile organic re-extraction/analysis due to out of control surrogate recoveries. These samples, GW38-41, were re-extracted 21 days after sample collection.

- One sample, GW28, had 2 or more base/neutral surrogates slightly below control limits: 2-fluorobiphenyl recovery =42%, lower control limit = 43%; terphenyl-d14 =31%, lower control limit = 33%. (Semivolatile organic analysis allows up to one base/neutral and one acid surrogate be outside of control limits.)

- No assessment of precision for semivolatile organic analysis could be made for samples from Site 5 since only a matrix spike was performed.

- Laboratory method blanks associated with the semivolatile organic analysis of groundwater samples from Site 8 both had di-n-butylphthalate present below the detection limit. The blank for samples GW35, GW36 and GW38-41 also had bis(2-ethylhexyl)phthalate at 10 μg/l. This indicates that presence of these compounds in the samples is probably a result of laboratory contamination.

- The MS/MSD analysis associated with semivolatiles for GW28-33 had two spike recoveries and several RPD values outside of control limits; however this has no real impact on the data. Only a matrix spike was associated with the remaining samples, precluding an assessment of precision.

- The laboratory method blank associated with the purgeable halocarbon analysis of the surface water samples from Site 8 contained methylene chloride at 11 ug/l; the confirmation blank had this compound at 5.8 ug/l. Therefore the sample concentrations of methylene chloride (1.0-3.9 ug/l) are considered biased.

- The purgeable halocarbon MS/MSD analysis for the surface waters had methylene chloride below control limits (recovery =60%, control limit =80%).

- The semivolatile organic analysis of the surface water samples may have been biased for pentachlorophenol. The associated MS/MSD analysis resulted in low recoveries of pentachlorophenol (recovery = 3% and 8%), possibly indicating that detection limits should have been higher than reported.

- The volatile organic method blanks associated with the analysis of surface sediments both contained acetone just at and below the detection limit. This indicates the potential for bias in the sample acetone concentrations, although two of the samples (SD-2 and SD-5) had levels greater than 5 times the detection limit.

- The field duplicate associated with the surface sediments exceeded 35% RPD for methylene chloride (RPD =60%).

- Only a matrix spike was performed for the semivolatile organic analysis of the surface sediments, precluding an assessment of precision.

<u>Inorganic Analyses</u>: Eleven soil boring samples and four surface sediments were analyzed for metals and total petroleum hydrocarbons (TPH). One of the soil samples from Site 5 was analyzed for total organic carbon. Sixteen groundwater samples and three surface waters were analyzed for metals, TPH, total dissolved solid, common anions and total hardness. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The metals method blank associated with soil samples WB-5-1D-1/1R, WB-8-1D-1 and WB-8-3D-1 contained aluminum (=20.3 mg/l), boron (=1.49 mg/l), iron (=13.8 mg/l) and silicon (=30.0 mg/l). Sample concentrations of these metals for the above samples were significantly higher than the bank concentrations for aluminum (sample concentrations ranged from 9,980-15,900 mg/kg), iron (23,500-34,800 mg/kg) and silicon (622-845 mg/kg); boron was not detected in any of these samples. Therefore the apparent contamination of the lab method blank appears to have minimal impact in the sample data.

- Several matrix replicate/matrix spike (MR/MS) analyses were associated with the metals analysis of the soil samples. No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium as these metals are not routinely spiked by the laboratory due to expected high levels native in the samples. For all spike analyses, antimony recovery was significantly below the control limits, indicating potential bias in the analysis. (This would primarily affect the reported detection limit since it was only detected in one sample. The spike for this sample, WB-5-5-6, had antimony recovery =55%). The following recoveries or RPD values were more than 5% outside of the control limits (80-120% recovery and 30% RPD unless noted) for detected metals for the associated samples. The MR/MS associated with WB-5-1D-1/1R, WB-8-1D/1R, WB-8-1D-1 and WB-8-3D-1 had QC outliers for these metals: barium (recovery = 63%), cobalt (=64%), copper (=69%), nickel (= 66%), molybdenum (= 64%), silver (=32%), vanadium (=67%), zinc (= 64%) and the RPD for lead which was detected in one sample but not the other. The MR/MS for WB-5-5-6 and WB-8-5A-1-4/7 had recoveries below limits for nickel (= 68%) and a cobalt RPD =31%.

- Several field duplicates were collected during the same time periods as samples from Sites 5 and 8. Sample pair WB-5-1D-1/1R had lead detected only in one sample, all others (WB-8-2D-7/7R and WB-13-3-6/6R) had all RPD values less than 35%. No field duplicate was associated with WB-8-5A-1/4/7. Note that the field duplicate pairs from Site 5 and 8 were also used for laboratory batch QC purposes.

- The laboratory method blank associated with the metals analysis of groundwater samples GW29-33 contained boron (0.016 mg/l) and silicon (0.057 mg/L). Concentrations of these metals in the equipment wash blank (GW33) were 0.035 mg/l and 0.102 mg/l, respectively. All sample concentrations of silicon were significantly higher than these blank concentrations (6.07-27.3 mg/l). One sample, GW30, had a boron concentration of 0.013 mg/l; the other samples had concentrations ranging from 0.106-0.212 mg/l. Therefore, only the one boron concentration appears potentially biased by background levels.

- The metals MR/MS associated with GW29-33 had zinc detected in one sample but not the other. Aluminum, calcium, iron, magnesium, potassium, silicon and sodium were not spiked. The same compounds, excluding aluminum and iron, were also not spiked in the MS for GW28, GW36, GW38-41. All other MR/MS recoveries and RPD values for metals detected in the groundwater were within QC limits.

- Groundwater field duplicate pair GW45/GW47 exceeded 35% RPD for the metals analysis of boron (RPD = 56%), lead by graphite furnace (detected only in one of the samples) and zinc (35%). The field duplicate pair GW29/GW30 also exceeded 35% RPD for boron (detected only in only sample).

- The metals method blank associated with the Site 8 surface water samples contained boron (0.061 mg/l) and silicon (0.092 mg/l) at levels significantly less than the sample concentrations.

- The MS for the metals analysis of the surface waters was not spiked with calcium, magnesium, potassium, silicon and sodium; therefore, no assessment of accuracy could be made. Molybdenum and vanadium were detected in one sample, but not in the other.

- The field duplicate pair associated with the Site 8 surface waters (SW9/SW10 from another site), also had molybdenum and vanadium detected in only one sample; this seems to indicate that the precision for these metals at concentrations close to the detection limit may not be well defined. Manganese also exceeded 35% RPD (121%).

- The MR/MS analyses associated with the metals determination for the surface sediments exceeded the control limit for RPD (30%) for barium (160%) and lead by ICP (60%). No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium since these metals were not spiked. Recovery was low for antimony (30%) and silver (24%), indicating potential bias which may impact the reported detection limit. Recovery was also above the control limit (120%) for manganese at 148%.

- The field duplicate pair associated with Site 8 sediments (SD9/SD10 for another site), exceeded 35% RPD for barium (RPD = 36%), calcium (= 198%), chromium (= 55%), cobalt, lead by ICP and molybdenum (where only one sample had a detected concentration), magnesium (= 84%), manganese (= 60%), silicon (= 108%), sodium (=49%) and zinc (= 36%).

- A laboratory replicate was performed on sediment sample SD-2 for TPH with 81% RPD between the sample and replicate values (24 and 57 mg/kg, respectively.)

4.1.5.2 Significance of Findings

4.1.5.2.1 Significance of Findings: Sites No. 5 and 8 - NYANG Hazardous Waste Drum Storage Area and Drum Storage Yard

Groundwater, soils and surface water/sediments were investigated at Site No. 5 and 8 to characterize the environmental impact of incidental spills associated with hazardous waste drum storage at these combined sites. Tables 4-72 through 4-76 present analyses versus ARARs and/or background levels for all contaminants found in the matrices studied.

TABLE 4-72
SITE NO. 5: ANALYTICAL RESULTS VS. BACKGROUND CONTAMINATIONS: SOIL

Parameter (Units)	Detection Limits	Sample Field ID (Sample Description) Background[g] (mg/Kg)	Selected Average for Soils[i] (mg/Kg)	WB-5-1D-1 (5.7'-7.7')	WB-5-5-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg)					
Volatile Organics					
Methylene Chloride	0.005	0.0056-0.0091	--	0.0062[c]	0.0078[b,c]
Acetone	0.010	ND-0.056	--	0.015[b,c]	0.034[b,c]
Others	See Appendix F			ND	ND
EPA Method SW3550/8270					
Semivolatile Organics (mg/kg)	See Appendix F			ND[d]	ND[d]
EPA Method SW3050/6010*					
Total Metals (mg/kg)					
Aluminum[f]	10.0	2,300-15,600	71,000	14100[b]	18.6
Antimony	6.0	ND	--	ND[e]	7.79[e]
Barium	1.0	28.4-163	430	181[e]	262
Calcium[f]	50.0	2,120-213,000	13,700	60600	57.1
Chromium	1.0	3.29-19.6	100	18.0[e]	3.4
Cobalt	1.0	2.10-11.3	8	6.91[e]	14.0[e,g]
Copper	1.0	9.92-21.0	30	13.1[e]	111
Iron[f]	2.5	5,060-31,700	38,000	30200[b]	32.6
Lead	5.0	9.96-26.0	10	9.22[c,g]	22.6[c,e]
Magnesium[f]	50.0	4,050-51,900	5,000	9470	15.7
Manganese	0.5	386-801	600	420[f]	505
Nickel	1.5	4.41-25.1	40	18.5[e]	32.7[e]
Potassium[f]	50.0	496-2,310	8,300	2160	2300
Silicon[f]	100.0	223-345	320,000	651[b]	652
Sodium[f]	50.0	49.6-154	6,300	160	214
Vanadium	1.0	5.30-32.0	100	24.9[e]	32.1
Zinc	1.0	53.3-864	50	43.8[e]	141
Others	See Appendix F		--	ND	ND
EPA Method SW3550/E418.1					
Total Petroleum Hydrocarbons (mg/kg)	5.0	ND	--	ND	ND
EPA Method SW9060					
Total Organic Carbon (mg/kg)	NR	NA	25000		

Footnotes:

a = Surrogate recovery (toluene-d8) below control limit.
b = Compound also detected in associated method blank.
c = Field duplicate analyses exceeded 35% RPD for this parameter.
d = Precision assessment based on lab MS/MSD analysis was either not performed or indicated variability (5 RPDs outside of control limit).
e = Matrix spike had low recovery, below control limit for this parameter.
f = Accuracy data unavailable; this compound was routinely not spiked (or spiked recoveries could not be calculated).
g = Matrix replicates had analytical RPD greater than the control limit.
h = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
i = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons, 1979.
* = Or as indicated for metal analyzed by alternate methods.
NR = Not reported.

TABLE 4-73
SITE NO. 5: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	Sample Field Identification (Sample Description) GW43 (MW-5-2)	GW44 (MW-5-4)	GW46 (MW-5-5)	GW47 (MW-5-1D)
EPA Method SW5030/8021 (μg/l)						
Volatile Organics/						
Purgeable Halocarbons						
Methylene Chloride	0.8	0.19[k]	5.3[a,c]	3.7[a]	4.4[a]	4.6[a]
Trichloroethene	1	5[i]	ND[b]	ND	1.3	2.6
Others	See Appendix F	-	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L)						
Purgeable Aromatics Organics			ND	ND		ND
Toluene	0.3	5[i]			0.31	
Others	See Appendix F	-			ND	
EPA Method SW5030/8015 (ug/L)						
Non-Halogenated Volatile Organics	See Appendix F	-	ND	ND	ND	ND
EPA Method E625						
Semivolatile Organics (ug/L)	See Appendix F	-	ND[e]	ND[e]	ND[d,e]	ND[e]
EPA Method E200.7**						
Total Metals (mg/L)						
Aluminum	0.1	No ARAR	11.8	5.79	30.7	ND
Barium	0.01	1.0[i]	0.175	0.125	0.354	0.164
Boron	0.01	1.0[i]	0.114[g]	0.079[g]	0.245[g]	0.063[g]
Calcium[f]	0.20	No ARAR	313	243	392	213
Chromium	0.010	0.050[i]	0.020	0.014	0.044	ND
Cobalt	0.010	No ARAR	ND	ND	0.024	ND
Copper	0.010	0.200[i]	0.032	ND	0.079	ND
Iron	0.025	0.300[i]	18.8	9.48	52.0	2.18
Lead	0.05	0.025[i]	0.100	0.078	0.247	ND
Lead (E239.2)	0.005	0.025[i]	0.100[g]	0.068[g]	0.646[g]	0.008[g]
Magnesium[f]	0.20	No ARAR	144	111	181	79.7
Manganese	0.005	0.300[i]	1.38	0.761	2.75	0.129
Nickel	0.015	0.0154[j]	0.024	ND	0.057	ND
Potassium[f]	0.4	No ARAR	4.05	3.14	8.26	1.92
Silicon[f]	0.20	No ARAR	35.0	18.6	43.8	6.28
Sodium[f]	0.20	20[i]	47.2	58.3	290	41.6
Vanadium	0.01	No ARAR	0.019	0.008	0.053	ND
Zinc	0.01	0.300[i]	1.20[g]	0.634[g]	1.56[g]	0.128[g]
Others	See Appendix F	-	ND	ND	ND	ND

TABLE 4-73 (cont'd)
SITE NO. 5: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	Sample Field Identification (Sample Description)			
			GW43 (MW-5-2)	GW44 (MW-5-4)	GW46 (MW-5-5)	GW47 (MW-5-1D)
EPA Method E418.1 (mg/L)						
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)						
Total Dissolved Solids (E160.1)	1.0	500[m]	980	1000	1700	1200
Common Anions (A429)						
Fluoride	0.1	1.5[i]	0.46	0.77	0.57	0.30
Chloride	0.5	250[i]	75	160	27	64
Sulfate	0.5	250[i]	300	300	920	590
Total Hardness (E130.1)	1.0	No ARAR	1700	1200	2100	900

Footnotes:

a = Compound also detected in associated method blank.
b = Associated matrix spikes analysis had recovery above control limit for this compound.
c = Associated matrix spikes analysis had recovery below control limit for this compound.
d = One surrogate recovery (Terphenyl-d14) was below control limit.
e = Parecision assessment cannot be made.
f = Accuracy data unavailable; compound not routinely included in spiking solution.
g = Associated field duplicate analysis exceed 35% RPD for this compound.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for Class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
L = Applicable or Relevant or Appropriate Requirements.
m = Federal Secondary Drinking Water Standard

SITE NO. 8: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (Units)	Detection Limits	Background[f] (mg/Kg)	Selected Average for Soils[g] (mg/Kg)	Sample Field ID (Sample Description)						
				WB-8-1D-1 (7.4'-9.4')	WB-8-2D-7 (9.0'-10.5')	WB-8-3D-1 (7.0'-9.0')	WB-8-5A-1 (0-1.5')	WB-8-5A-4 (4.5'-6.0')	WB-8-5A-7 (9.0'-10.5')	WB-8-6-8 (0.5-12.0)
EPA Method SW8240 (mg/kg)										
Volatile Organics						ND				
Methylene Chloride	0.005	0.0056-0.0091	--	0.007[b]	<0.0068[*,b]	0.0057[b]		0.068[a]	<0.006[*,a]	ND[b]
Acetone	0.010	ND-0.056	--	0.020[a,b]	0.028[a,b]	0.033[a,b]		0.074[a]	0.045[a]	0.030[a]
Others	See Appendix F			ND	ND	ND		ND	ND	ND
EPA Method SW3550/8270										
Semivolatile Organics (mg/kg)	ND			ND	ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010										
Total Metals (mg/kg)										
Aluminum[d]	10.0	2,300-15,600	71,000	15900[a]	23200	9980[a]	5210	14000	15300	6020
Barium	1.0	28.4-163	430	132[c]	199	1.1[c]	39.8	153	92.4	112
Boron	1.0	ND	10	ND[a]	ND	ND[a]	ND	ND	ND	21.8
Cadmium	0.5	ND	0.06	ND	1.07	ND	ND	ND	ND	ND
Calcium[d]	50.0	2,120-213,000	13,700	51200	64400	52000	191000	130000	137000	57700
Chromium	1.0	3.29-19.6	100	22.9	23.8	15.0	7.55	17.6	160	10.6
Cobalt	1.0	2.10-11.3	8	9.81[c]	12.0	4.78[c]	3.52[c]	11.2[c]	9.61[c]	7.23
Copper	1.0	9.92-21.0	30	17.3[c]	26.6	17.0[c]	8.08	19.9	17.1	14.6
Iron[d]	2.5	5,060-31,700	38,000	30400[a]	35500	23500[a]	10000	24400	2783	16900
Lead	5.0	9.96-26.0	10	28.5[b,e]	20.7	10.1[b,e]	26.3[c]	14.3[c]	13.8[c]	10.2
Magnesium[d]	50.0	4,050-51,900	5,000	13700	14100	16600	99500	27400	9.98	12700
Manganese	0.5	386-801	600	470[d]	546	419[d]	400	467	460	581
Molybdenum	1.0	ND	2	3.01[c]	ND	ND[c]	ND	ND	ND	ND
Nickel	1.5	4.41-25.1	40	28.0[c]	27.3	15.7[c]	8.32[c]	23.9[c]	20.7[c]	14.6
Potassium[d]	50.0	496-2,310	8,300	3220	3890	1930	449	1760	1640	1410
Silicon[d]	100.0	223-345	320,000	845[a]	464	635[a]	476	975	1000	1870
Sodium[d]	50.0	49.6-154	6,300	166	219	114	108	145	149	153
Vanadium	1.0	5.30-32.0	100	30.6[c]	30.9	20.4[c]	10.6	24.8	22.5	15.7
Zinc	1.0	53.3-864	50	65.5[c]	69.9	56.1[c]	117	54.4	50.8	41.9
Others	See Appendix F			ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg)										
Total Petroleum Hydrocarbons	5.0	ND	--	ND	ND	240	52	170	12	ND

Footnotes:

a = Compound also detected in associated method blank.
b = Associated field duplicate analyses exceeded 35% RPD for this parameter.
c = Associated lab matrix spike had recoveries below control limit.
d = Accuracy data unavailable; compound not spiked (or recovery could not be calculated).
e = Matrix replicate analyses exceeded 30% RPD control limit for this parameter.
* = Compound present below measurable detection limit.
f = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
g = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected

TABLE 4-75
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

			Sample ID (Sample Description)					
Parameter (Units)	**Detection Limits**	**ARAR**[L]	**GW28 (MW-8-6)**	**GW29 (MW-8-3D)**	**GW31 (MW-8-5)**	**GW32 (MW-8-1D)**	**GW35 (MW-8-1)**	**GW36 (MW-8-3)**
EPA Method SW5030/8021 **Volatile Organics/Purgeable** **Halocarbons (ug/L)**								
1,1,1-Trichloroethane	0.4	5[i]	ND	1.3	ND	ND	ND[a]	ND
1,1-Dichloroethane	0.5	5[i]	ND	1.7	ND	ND	1.3J[a]	ND
Trans-1,2-Dichloroethene	0.3	5[i]	ND[d]	1.1[d]	ND[d]	ND[d]	ND[a]	ND
Methylene Chloride	0.8	0.19[k]	3.3[b,c,d]	3.6[b,c,d]	0.65J[b,c,d]	1.2[b,c,d]	19[a,b,d]	ND[b,d]
Dichlorodifluoromethane	2.0	No ARAR	ND[d]	2.2[d]	ND[d]	ND[d]	ND[a]	ND
Trichloroethylene	1	5[i]	ND[d]	1.6[d]	1.7[d]	4.5[d]	190[a]	ND
1,4-Dichlorobenzene	0.3	4.7[i]	ND[c]	ND[c]	ND[c]	ND[c]	ND[a]	ND
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L)								
Purgeable Aromatic Organics			ND	ND	ND	ND	ND	ND
Toluene	0.3	5[i]						
1,4-Dichlorobenzene	0.7	4.7[i]						
Others	See Appendix F	-						
EPA Method SW5030/8015 (ug/L)								
Non-halogenated Volatile Organics	See Appendix F	-	ND	ND	ND	ND	ND	ND
EPA Method E625 (ug/L) **Semivolatile Organics**								
Di-n-butylphthalate	10	No ARAR		<10*	<10*	<10*	<10*	<10*
Bis(2-ethylhexyl)phthalate	10	50[i]		<10*	<10*	ND	<10*	10
thers	See Appendix F	-		ND	ND	ND	ND	ND
EPA Method E200.7* **Total Metals (mg/L)**								NA
Aluminum	0.1	No ARAR	2.13	ND[f]	18.0[f]	0.909[f]	67.0	56.8
Arsenic (E206.2)	0.005	0.025[i]	ND	0.005	0.005	ND	0.009	0.009
Barium	0.01	1.0[i]	0.040	0.069	0.283	0.095	0.547	0.547
Boron	0.01	1.0[i]	0.208[d]	0.106[b,d]	0.212[b,d]	0.125[b,d]	0.400[d]	0.369[d]
Cadmium	0.005	0.010[i]	ND	ND	ND	ND	ND	ND
Calcium[f]	0.20	No ARAR	276	259	434	189	840	922
Chromium	0.010	0.050[i]	0.012	ND	0.026	ND	0.093	0.086

TABLE 4-75 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[L]	Sample ID (Sample Description)					
			GW28 (MW-8-6)	GW29 (MW-8-3D)	GW31 (MW-8-5)	GW32 (MW-8-1D)	GW35 (MW-8-1)	GW36 (MW-8-3)
EPA Method E200.7[*]								
Total Metals (mg/L) (Cont'd)								
Cobalt	0.010	No ARAR	ND	ND	0.015	ND	0.185	0.041
Copper	0.010	0.200[i]	ND	ND	0.041	ND	0.108	0.161
Iron	0.025	0.300[i]	5.16	4.17[f]	32.5[f]	0.816[f]	121	90.7
Lead	0.05	0.025[i]	ND	ND	0.080	ND	0.217	0.307
Lead (E239.2)	0.005	0.025[i]	0.007	ND	0.062	ND	0.184	0.534
Magnesium[f]	0.20	No ARAR	240	137	201	72.7	268	409
Manganese	0.005	0.300[i]	2.05	0.164	2.049	0.052	4.96	4.89
Mercury (E45.1)	0.0002	0.002[i]	ND	ND	ND	ND	ND	ND
Molybdenum	0.010	No ARAR	0.059	ND	ND	ND	ND	ND
Nickel	0.015	0.0154[j]	ND	ND	0.038	ND	0.145	0.104
Potassium[f]	0.4	No ARAR	7.54	3.67	6.04	3.50	12.2	12.9
Silicon[f]	0.020	No ARAR	8.69	6.07[b]	27.3[b]	8.02[b]	78.6	72.1
Sodium[f]	0.200	20[i]	475	56.6	57.1	47.0	50.2	47.7
Vanadium	0.01	No ARAR	0.035	ND	0.036	ND	0.112	0.104
Zinc	0.01	0.300[i]	0.076	0.033[g]	1.04[g]	0.154[g]	4.47	2.68
Others	See Appendix F	-	ND	ND	ND	ND	ND	ND
EPA Method E418.1 (mg/L)								
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND	ND	ND	ND
Miscellaneous Inorganics (mg/L)								
Total Dissolved Solids (E160.1)	1.0	500[m]	4100	1900	1400	1200	1800	1400
Common Anions (A429)								
Fluoride	0.1	1.5[i]	0.58	0.58	0.54	0.61	0.54	0.60
Chloride	0.5	250[i]	29	82	54	68	83	59
Sulfate	0.5	250[i]	2500	940	780	510	810	610
Total Hardness (E130.1)	1.0	No ARAR	1800	1200	1800	830	2800	2600

TABLE 4-75 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	ARAR[L]	Sample ID (Sample Description) GW38 (MW-8-4)	 GW39 (MW-8-2D)	 GW40 (MW-8-2)
EPA Method SW5030/8021 (ug/L)				
Volatile Organics/Purgeable Halocarbons				
1,1,1-Trichloroethane	5[i]	ND	ND	ND
1,1-Dichloroethane	5[i]	0.62	0.97	0.37J
Trans-1,2-Dichloroethane	100[i]	ND	ND	ND
Methylene Chloride	0.19[k]	ND[b,d]	ND[b,d]	ND[b,d]
Dichlorodifluoromethane	No ARAR	ND	ND	ND
Trichloroethene	5[i]	ND	1.0	11
1,4-Dichlorobenzene	75[i]	ND	ND	ND
Others	-	ND	ND	ND
EPA Method SW5030/8020 (µg/L)				
Purgeable Aromatic Organics		ND	ND	
Toluene	5[i]			0.64
1,4-Dichlorobenzene	75[i]			ND
Others	-			ND
EPA Method SW5030/8015 (ug/L)				
Non-halogenated Volatile Organics	-	ND	ND	ND
EPA Method E625				
Semivolatile Organics (ug/L)				
Di-n-Butylphthalate	No ARAR	<10[*,h]	18[h]	22[h]
Bis(2-ethylhexyl)phthalate	50[i]	<10[*,h]	20[h]	38[h]
Other	-	ND	ND	ND
EPA Method E200.7[*]				
Total Metals (mg/L)				
Aluminum	No ARAR	45.8	31.7	94.9
Arsenic (E206.2)	0.025[i]	0.011	0.012	0.024
Barium	1.0[i]	0.578	0.310	0.954
Boron	1.0[i]	0.314[d]	0.182[d]	0.512[d]
Cadmium	0.010[i]	ND	ND	0.122
Calcium[f]	No ARAR	949	392	1760
Chromium	0.050[i]	0.062	0.025	0.180
Cobalt	No ARAR	0.037	0.010	0.071
Copper	0.200[i]	0.143	0.033	0.419
Iron	0.300[i]	76.5	30.9	148
Lead	0.025[i]	0.302	0.226	1.03

TABLE 4-75 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	ARAR[L]	Sample ID (Sample Description) GW38 (MW-8-4)	 GW39 (MW-8-2D)	 GW40 (MW-8-2)
EPA Method E200.7				
Total Metals (mg/L) (Cont'd)				
Lead (E239.2)	0.025[i]	0.332	0.212	1.24
Magnesium[f]	No ARAR	442	174	509
Manganese	0.300[i]	4.76	1.08	9.08
Mercury (E245.1)	0.002[i]	ND	ND	0.0004
Molybdenum	No ARAR	ND	ND	ND
Nickel	0.0154[j]	0.087	0.027	0.194
Potassium[f]	No ARAR	9.31	13.6	14.4
Silicon[f]	No ARAR	58.1	57.2	84.9
Sodium[f]	20[i]	44.2	78.0	13.3
Vanadium	No ARAR	0.080	0.032	0.158
Zinc	0.300[i]	2.29	1.40	6.12
Others	-	ND	ND	ND
EPA Method E418.1 (mg/L)				
Total Petroleum Hydrocarbons	No ARAR	ND	ND	ND
Miscellaneous Inorganics (mg/L)				
Total Dissolved Solids (E160.1)	500[m]	1400	1500	460
Common Anions (EPA Method A429)				
Fluoride	1.5[i]	0.60	0.50	0.14
Chloride	250[i]	64	81	20
Sulfate	250[i]	720	750	180
Total Hardness (E130.1)	No ARAR	2600	2000	4900

Footnotes:

a = Surrogate recoveries were above control limits for two compounds.
b = Compound also detected in associated method blank.
c = Associated MS/MSD analyses had recoveries above control limits for one or both spikes.
d = Associated field duplicate analyses exceeded 35% RPD for this compound.
e = Recoveries were below control limits for one or more surrogate compounds.
f = Accuracy data unavilaible; compound not spiked.
J = Estimated value below detection limit.
g = Assoicated lab replicate analysis resulted in RPD values which exceeded the control limit.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
L = Applicable or Relevant or Appropriate Requirements.
m = Federal Secondary Drinking Water Standard

TABLE 4-76
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	ARAR[J]	Sample Field Identification (Sample Description) SW-2 (8SW-4)	SW-3 (8SW-5)	SW-4 (8SW-6)
EPA Method SW5030/8021 (ug/L) **Volatile Organics/Purgeable Halocarbons**					
Methylene Chloride	0.8	0.19[K]	1.6[a,b]	1.4[a,b]	1.5[a,b]
Others	See Appendix F	-	ND	ND	ND
EPA Method SW5030/8020 (µg/L) **Purgeable Aromatic Organics**	See Appendix F	-	ND	ND	ND
EPA Method SW5030/8015 (ug/L) **Non-halogenated Volatile Organics**	See Appendix F	-	ND	ND	ND
EPA Method E625 (µg/L) **Semivolatile Organics**	See Appendix F	-	ND	ND	ND
EPA Method E200.7[*] **Total Metals (mg/L)**					
Aluminum	0.1	No ARAR	0.874	1.86	0.894
Barium	0.01	1.0[L]	0.037	0.045	0.032
Boron	0.01	No ARAR	0.726[a]	0.743[a]	0.638[a]
Calcium[f]	0.20	No ARAR	599	589	560
Iron	0.025	1.0[M]	1.55[g]	3.50[g]	1.67[g]
Lead	0.05	0.32[M]	ND	ND	ND
Lead (E239.2)	0.005	0.32[M]	ND	0.011	0.005
Magnesium[f]	0.20	No ARAR	162	171	160
Manganese	0.005	0.05[N]	0.093[c]	0.180[c]	0.099[c]
Potassium[f]	0.4	No ARAR	22.8	24.0	21.2
Silicon[f]	0.200	No ARAR	4.39[a]	5.90[a]	4.24[a]
Sodium[f]	0.200	No ARAR	261	265	259
Zinc	0.01	0.047[M]	0.051	0.143	0.060
Others	See Appendix F	-	ND	ND	ND
EPA Method E418.1 (mg/L) **Total Petroleum Hydrocarbons**	1.0	No ARAR	ND	ND	ND

TABLE 4-76 (Cont'd)
SITE NO. 8: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	ARAR[J]	SW-2 (8SW-4)	SW-3 (8SW-5)	SW-4 (8SW-6)
			Sample Field Identification (Sample Description)		
Miscellaneous Inorganics (mg/L)					
Total Dissolved Solids (E160.1)	1.0	No ARAR	3300	3200	3300
Common Anions (A429)					
Fluoride	0.1	No ARAR	5.7	0.59	0.59
Chloride	0.5	No ARAR	400	380	460
Nitrate-Nitrogen	0.5	10[L]	0.77	0.75	0.83
Sulfate	0.5	No ARAR	1700	1700	1700
Total Hardness (E130.1)	1.0	No ARAR	1900	2100	2000

Footnote:

a = Compound also detected in associated method blank
b = Associated MS/MSD analysis had recovery below control limit for this compound.
c = Associated field duplicate analysis exceeded 35% RPD.
d = One surrogate compound had a recovery below lower control limit.
e = Precision could not be assessed for this analysis; data unavailable.
f = Accuracy data unavailable for these compounds.
g = Associated lab matrix replicate analysis resulted in RPD value above the control limit.
h = Associated matrix spike had recovery above upper control limits.
J = Applicable or Relevant and Appropriate Requirements.
K = Federal Ambient Water Quality Criteria - for Human Health (FWQC-HH): Adjusted for Drinking Water Only.
L = Maximum Contaminant Level (MCL) established under the Safe Drinking Water Act.
M = Federal Ambient Water Quality Criteria - Fresh Chronic Value for Aquatic Life.
N = Secondary Maximum Contaminant Level (SMCL) established under the Safe Drinking Water Act - Not an ARAR.

NR = Not Required.
* = Or as indicated if analyzed by an alternate method.

During the drilling of the two well borings at the Site No.5, soil samples were collected for analyses. A total of seventeen metals were detected at various concentrations in soils from these well borings. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed. Comparisons are made to background and normal trace element averages published for soils, since no ARARs have been established for soils:

- The single soil sample from the Site No. 5 well boring WB-5-5 (7.5 to 9.0-foot interval) showed elevated antimony, barium and copper levels (i.e., 7.79 mg/kg, 262 mg/kg and 111 mg/kg, respectively). Although antimony was not detected in the background soil borings, a 2 to 10 mg/kg antimony range is not uncommon for most soils (Fairbridge, 1979). The barium level, although higher than background concentrations, is still below the average barium concentration reported for soils. The copper concentration exceeds the highest background concentration by a factor of five and the average concentration reported for soils by nearly a factor of four. The source of copper is probably less related to hazardous waste management activities once conducted at this site than it is to a localized natural enrichment of copper in the soil.

- Chromium levels in Site No. 5 soil generally matched the range established by soils of the background soil borings and were considerably lower than the 100 mg/kg average reported for most soils.

- Cobalt levels found in the Site No 5 soils were fairly similar to background levels. Some of the readings were slightly higher than the average concentration reported in the literature for typical soils.

- Lead levels occurred within the background range. A lead concentration of 22.6 mg/kg found in a soil sample from WB-5-5 was higher than the average lead concentration reported for soils. Lead levels across the installation generally run high due to the naturally elevated lead levels reported for soils in the region.

- Manganese and vanadium concentrations occurred within the established background range and were below the average levels reported in the literature for soils.

- A nickel concentration measured in a soil sample from WB-5-5 was slightly above the highest background reading. All of the nickel levels found in Site No. 5 soils occurred below the average nickel concentration reported for typical soils.

- Zinc levels found in all Site No. 5 soils were within the range established by soils from the background soil borings.

It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often evaluated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area.

No volatile organics, other than methylene chloride and acetone were detected in soils from the Site No. 5 soil borings. Methylene chloride and acetone reported in the soil samples at Site No. 5 are probably laboratory contaminants, as generally comparable concentrations occurred in the volatile organic method blanks. These compounds are also reported in soils from the background soil borings.

During the drilling of the five well borings at Site No. 8, a total of nineteen metals were detected in the soil samples. Only those metal species that pose a potential risk at elevated levels are discussed. Comparisons can only be made to background and normal trace element averages published for soils, since no ARARs have been established for soils:

- o At Site No. 8, a molybdenum level of 3.01 mg/kg was measured from a soil sample collected from the 7.4 to 9.4-foot interval of well boring WB-8-1D. Molybdenum was not detected in any of the background soils; however, the concentration reported slightly exceeds the 2 mg/kg molybdenum average reported for soils.
- o Cadmium showed up in the soil sample from the 9.0 to 10.5-foot interval of well boring WB-8-2D at 1.07 mg/kg. Cadmium was not detected in any of the background soil samples. The 1.07 mg/kg cadmium concentration reported at WB-8-2D also exceeds the average concentration established for soils. The presence of cadmium in the soil at this concentration is being linked to a localized natural enrichment of the soil. The Phase I Record Search document indicated that drums containing waste oils and hazardous waste were stored at this site. Cadmium might be expected in the soils if the drums contained electroplating bath, photography, dyeing, process engraving and lithography, paints and high gloss enamels or battery wastes.

- Barium, cobalt, copper, lead, manganese, nickel, vanadium and zinc detected in Site No. 8 soils occur within or slightly outside the background metal ranges established for the installation's soils. Zinc levels, although within background, are generally much higher than the average zinc levels found in typical soils because of naturally elevated zinc levels in regional soils.

The following presents a comparison of the organic analytical data yielded by the Site No. 8 well borings with the installation's background levels:

- A total petroleum hydrocarbon (TPH) levels of 240 mg/kg (7.0 to 9.0-foot interval) were found in soil from well borings WB-8-3D. A TPH range of 12 mg/kg to 170 mg/kg was found in soils of WB-8-5. TPH was not detected in any of the soil samples analyzed from the background soil borings. The presence of TPH at depth in soils of WB-8-3D may be linked to infiltration of contaminants along the banks of the drainage ditch just north of the well boring. TPH in soils of WB-8-5 is more likely related to infiltration of contaminated runoff from the road and nearby concrete pad, since TPH was only found in the surface soil.

- Methylene chloride and acetone reported in a number of the soil samples at Site No. 8 are probably laboratory contaminants since comparable concentrations of these compounds were found in the volatile organic method blanks. These compounds are also reported in soils from the background soil borings.

Groundwater samples were collected from the four wells at Site No. 5. The following presents a comparison of organic compounds measured in the Site No. 5 monitoring wells with ARARs and installation background levels:

- A low toluene level of 0.31 ug/l was measured in groundwater from shallow aquifer well MW5-5. This level is only slightly above the method detection limit of 0.030 ug/l for this compound and half the value reported in the background shallow well, MW1-7. The presence of toluene may not be related to hazardous waste drum storage but may be present due to localized infiltration of fuel contaminated runoff discharged by heavy construction equipment stored in this area.

- A low trichloroethene level of 1.3 ug/l was also detected in MW5-5. Trichloroethene was also detected in the paired deep well MW5-1D at 2.6 ug/l. Although TCE was not detected in the shallow and deep background wells, the reported levels are below the 5.0 ug/l New York State ARAR. The presence of TCE in monitoring well MW5-1D is probably linked to previous hazardous waste drum storage activities.

- The methylene chloride detected in groundwater samples of Site No. 5 is probably a laboratory contaminant, since comparable concentrations were found in the method blanks and various field blanks.

Seventeen inorganic metals were detected above instrument detection limits in the groundwater at Site No. 5. Only those metals that pose a potential health risk at elevated concentrations are discussed. As discussed in Section 4.1.1.2.1, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals recorded in groundwater are attributed to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in groundwater at Site No. 5 with ARARs and background values:

- Iron and manganese concentrations consistently exceeded the 0.300 mg/l New York State Water Quality ARARs for these metals. Iron concentrations in both background wells also exceeded the State ARAR. Manganese concentrations were exceeded in the shallow background well. Iron concentrations in groundwater from Site No. 5 ranged from 2.18 mg/l to 52.0 mg/l at MW5-1D and MW5-5, respectively. Manganese concentrations in groundwater at Site No. 5 ranged from 0.129 mg/l to 2.75 mg/l in the same wells, respectively. The manganese level at MW5-1D was the only value that did not exceed the State ARAR. Iron levels in groundwater from MW5-5 exceeded the background level by nearly a factor of nine.

- Lead exceeded the 0.025 mg/l New York State Water Quality ARAR in wells MW5-2, MW5-4 and MW5-5 (0.100 mg/l, 0.068 mg/l and 0.646 mg/l, respectively).

- The 0.0154 mg/l FWQC Human Health ARAR promulgated for nickel was exceeded in MW5-2 (0.024 mg/l) and MW5-5 (0.057 mg/l).

- The barium concentrations found in the groundwater at Site No. 5 ranged from 0.125 mg/l to 0.354 mg/l. None of the concentration exceeded the New York State ARAR for barium. The barium levels found in groundwater at Site No. 5 were substantially higher than the background levels.

- Boron levels found in MW5-2 (0.114 mg/l) and MW5-5 (0.245 mg/l) were also substantially higher than background levels. Unlike barium, no ARAR presently exists for boron. Boron is not known to be a product of any current or past Air Force activity at this installation.

- The chromium found in MW5-2 (0.020 mg/l), MW5-4 (0.014 mg/l) and MW5-5 (0.044 mg/l) did not exceed the 0.050 mg/l New York State Water Quality ARAR.

- o Levels of copper found in groundwater from MW5-2 (0.032 mg/l) and MW5-5 (0.079 mg/l) also occurred below the State ARAR. Vanadium levels of 0.019 mg/l, 0.008 mg/l and 0.053 mg/l were found in groundwater from MW5-2, MW5-4 and MW5-5.
- o Sodium exceeded the 20 mg/l New York State Water Quality ARAR in all site wells.
- o Vanadium was not detected in groundwater from the background wells and no ARARs presently exist.
- o Cobalt was detected in groundwater from one well at Site No. 5. Presently no ARARs exist for cobalt and this metal was not detected in the background wells.
- o Zinc levels exceeded tje 0.300 mg/l New York State Water Quality ARAR in wells MW5-2 (1.20 mg/l), MW5-4 (0.634 mg/l) and MW5-5 (1.56 mg/l).

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- o Groundwater from all Site No. 5 wells exceeded the 500 mg/l Secondary Drinking Water Standards for total dissolved solids (TDS). TDS ranged from 980 mg/l in MW5-2 to 1700 mg/l in MW5-5.
- o Sulfate levels measured in all wells exceeded the 250 mg/l New York State Water Quality ARAR for this compound. Sulfate ranged from 300 mg/l in both MW5-2 and MW5-4 to 920 mg/l in MW5-5. Sulfate levels were also exceeded in both the shallow and deep background wells.
- o Chloride and fluoride levels ranged from 27.0 mg/l to 160 mg/l and 0.30 mg/l to 0.77 mg/l respectively.
- o Total hardness ranged from 900 mg/l to 2100 mg/l. Groundwater at Site No. 5 is also very hard.

A number of organic compounds were detected in groundwater collected from the Site No. 8 wells. The following discussion compares the concentrations of organic compounds found in the groundwater of Site No. 8 to ARARs and installation background levels:

- o Trichloroethene was found in groundwater samples collected from MW8-3D, MW8-5, MW8-1D, MW8-1, MW8-2D and MW8-2 (1.6 ug/l, 1.7 ug/l, 4.5 ug/l, 190 ug/l, 1.0 ug/l and 11 ug/l, respectively). Only the level found in MW8-1 (190 ug/l) and MW8-2 (11 ug/l) exceeded the 5.0 ug/l New York State Water Quality ARAR for TCE.

- 1,1,1-Trichloroethane, 1,1-Dichloroethane, possibly trans-1,2-Dichloroethylene and dichlorodifluoromethane (1.3 ug/l, 1.7 ug/l, 1.1 ug/l and 2.2 ug/l, respectively) were found in the new bedrock well MW8-3D. Although none of these compounds were reported in groundwater from the two background wells, none of these concentrations found in MW8-3D exceeded the existing or proposed ARARs for each of these compounds. 1,1-Dichloroethane was also found in MW8-1, MW8-4, MW8-2D and MW8-2 (1.3 ug/l, 0.62 ug/l, 0.97 ug/l and 0.37 ug/l, respectively). None of these levels exceed the 5.0 ug/l ARAR set by the New York Water Quality Standards. The values measured for well MW8-1 and MW8-2 are estimate values below the detection limit.

- A toluene level of 0.64 ug/l was reported in groundwater from shallow aquifer well MW8-2. This level is below the 5 ~~2000~~ ug/l New York State ARAR and is less than the concentration found in groundwater from the shallow background well.

- The methylene chloride detected in groundwater samples of Site No. 8 is probably a laboratory contaminant since comparable concentrations were found in method blanks and various field blanks.

- Di-n-butyl phthalate levels of 18 ug/l and 22 ug/l were found in MW8-2D and MW8-2, respectively. Bis (2-ethylhexyl) phthalate levels of 10 ug/l, 20 ug/l, and 38 ug/l were found in MW8-3, MW8-2D and MW8-2, respectively. Comparable levels of these compounds were found in the various blank, therefore laboratory contamination is suspected. Levels of these compounds can not be compared to background levels since semi volatile analyses were not performed on groundwater from the background wells.

Except for MW8-3D, the presence of volatile organics in the groundwater at Site No. 8 can only be linked to previous hazardous waste management practices. Due to the upgradient position of MW8-3D the source of volatiles in groundwater from this well is possibly linked to contaminants introduced by the drainage ditch or an upgradient, off-base source.

Twenty-one inorganic metals were measured in the groundwater from the Site No. 8 wells. Only those metal species considered to pose a health risk at elevated concentrations are discussed. A number of the metals consistently exceeded the promulgated ARARs. As discussed in Section 4.1.1.2.1, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals recorded in groundwater are attributed to naturally occurring metals found in the suspended sediment.

The following presents a comparison of metal levels measured in groundwater at Site No. 8 with ARARs and installation background values:

- Iron and manganese levels in nearly all the wells exceeded the 0.300 mg/l New York State Water Quality ARAR set for these metals. Iron values ranged from 0.816 mg/l at MW8-1D to 148 mg/l at MW8-2. Manganese concentrations in groundwater from Site No.8 ranged from 0.052 mg/l to 9.08 mg/l. Manganese levels which exceeded the State ARAR were found in groundwater from MW8-6 (2.05 mg/l), MW8-5 (2.049 mg/l), MW8-1 (4.96 mg/l), MW8-3 (4.89 mg/l), MW8-4 (4.76 mg/l), MW8-2D (1.08 mg/l) and MW8-2 (9.08 mg/l). Iron concentrations in both background wells also exceeded the State ARAR, although iron concentrations at Site No. 8 were somewhat higher than background. Manganese concentrations in the shallow background well also exceeded the State ARAR for manganese.

- Lead levels that exceeded the 0.025 mg/l New York State Water Quality ARAR were yielded by MW8-5, MW8-1, MW8-3, MW8-4, MW8-2D, and MW8-2 (0.062 mg/l, 0.184 mg/l, 0.534 mg/l, 0.332 mg/l, 0.212 mg/l and 1.24 mg/l, respectively).

- The 0.05 mg/l chromium ARAR set in the New York State Water Quality Standards was exceeded in groundwater from MW8-1, MW8-3, MW8-4, and MW8-2 (0.093 mg/l, 0.086 mg/l, 0.062 mg/l, and 0.180 mg/l, respectively).

- The State ARARs for cadmium was exceeded in well MW8-2 (0.122 mg/l). Zinc levels in excess of the New York State Water Quality ARAR of 0.300 mg/l were measured in MW8-5 (1.04 mg/l), MW8-1 (4.47 mg/l), MW8-3 (2.68 mg/l), MW8-4 (2.29 mg/l), MW8-2D (1.40 mg/l) and MW8-2 (6.12 mg/l).

- A mercury level of 0.0004 mg/l was also found in MW8-2. This concentration did not exceed the 0.002 mg/l State ARAR.

- The 0.0154 mg/l FWQC Human Health ARAR for nickel was exceeded in groundwater from MW8-5 (0.038 mg/l), MW8-1 (0.145 mg/l), MW8-3 (0.104 mg/l), MW8-4 (0.087 mg/l), MW8-2D (0.027 mg/l) and MW8-2 (0.194 mg/l).

- Arsenic concentrations of 0.005 mg/l, 0.005 mg/l, 0.009 mg/l, 0.009 mg/l, 0.011 mg/l, 0.012 mg/l and 0.024 mg/l were measured in groundwater from MW8-3D, MW8-5, MW8-1, MW8-3, MW8-4, MW8-2D and MW8-2 respectively. All of the arsenic concentrations were below the 0.025 mg/l State Water Quality ARAR.

- A molybdenum concentration of 0.059 mg/l was found in groundwater from MW8-6. No ARAR presently exists for molybdenum.

- The barium concentrations found in the groundwater at Site No. 8 ranged from 0.040 mg/l to 0.954 mg/l. None of the concentration exceeded the New York State ARAR for barium. Barium levels which substantially exceeded those measured in the background monitoring wells were found in MW8-5 (0.283 mg/l), MW8-1 (0.547 mg/l), MW8-3 (0.547 mg/l), MW8-4 (0.578 mg/l), MW8-2D (0.310 mg/l) and MW8-2 (0.954 mg/l).

- Sodium exceeded the New York State Water Quality ARAR of 20 mg/l in all site wells except MW8-2 at concentrations ranging from 475 mg/l to 44.2 mg/l.
- Boron levels in groundwater at Site No 8 tended to be higher than background levels. Boron levels ranged from 0.106 mg/l at MW8-3D to 0.512 mg/l at MW8-2. No ARAR presently exists for boron.
- Copper was found in six of the nine wells at Site No. 8 and exceeded the New York Water Quality ARAR of 0.200 mg/l in MW8-2 (o.419 mg/l).
- ARARs have not been established for vanadium and cobalt but these metals were also found in a number of the Site No. 8 wells.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- The total dissolved solids (TDS) levels exceeded the Secondary Drinking Water Regulations in all wells.
- Sulfate levels in all but one well exceeded New York Water Quality ARAR.
- As was the case at Site No. 5, the groundwater at Site No. 8 is very hard.

The generally poor groundwater quality is explained in the literature (Johnston, 1964). Groundwater from the Lockport Dolomite is described as very hard and moderately to highly mineralized. The average hardness and chloride concentrations reported for the Lockport Dolomite are 960 mg/l and 234 mg/l respectively. Typical groundwater from the Lockport is also characterized by high calcium and magnesium, and high sulfate and bicarbonate. According to the literature, water from the unconsolidated deposits is also very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate crystals (gypsum) in the soil and bedrock.

Surface water and sediment samples were collected along three monitoring locations along a drainage ditch, typically referred to as an intermittent stream, located approximately 200 feet north of the former drum storage yard. A single sediment sample was collected near the bend of another drainage ditch situated 350 feet east of Site No. 8. Since groundwater flow in both aquifers being investigated during this RI have a southerly component, the purpose of sampling this water body was to assess if water flowing in the ditch is contributing contaminants to the Site No. 8 study area. Originally only two surface water/sediment samples were scheduled for the more distant drainage ditch, but on the day of sampling, an unidentified off-base industrial or commercial establishment was discharging to the ditch, so an extra monitoring station was added at the point where the ditch enters the installation. This point was established to assess a potential off-base contaminant source. Table 4-76 presents a comparison of surface water analytical results to the established ARARs.

No volatile organic compounds were detected in the sediment samples, other than methylene chloride and acetone which are considered to be laboratory contaminants due to similar concentrations found in the laboratory method blanks. No semivolatile contaminants were found in the sediments. Total petroleum hydrocarbons (TPH) were found in all the sediment samples. The highest level (190 mg/kg) was found in sediment from 8SD-3 which is in a downstream position to the former drum storage yard. Presently no ARARs have been promulgated for stream sediments nor has background been established.

A total of nineteen metals were detected at various concentrations in sediments from the four monitoring station. Since no ARARs nor background levels have been established for the stream sediments, the metals are discussed with reference to the normal trace element averages published for soils. Only those metals that potentially pose a health risk at elevated concentration are considered here:

- Boron levels appeared to be elevated in the stream sediments of Site No. 8. Boron levels ranged from 25.7 mg/kg at 8SD-3 to 116 mg/kg at 8SD-6. The average boron concentration reported for soils is 10 mg/kg. Boron is not known to be product of any current or past Air Force activity at this installation.
- Cadmium levels in the stream sediments ranged from 1/39 mg/kg at 8SD-2 to 3.96 mg/kg at 8SD-6. The average cadmium concentration reported for normal soils is 0.06 mg/kg.

- Only one chromium value was elevated above the 100 mg/kg average for soils. A value of 136 mg/kg was reported for sediment from 8SD-3.

- Only one cobalt concentration was reported above the 8 mg/kg average reported for soils. This value was yielded by the sediments collected from 8SD-6 (12.1 mg/kg).

- A copper concentration of 48.1 mg/kg registered in sediment from 8SD-3 was the only copper value to exceed the 30 mg/kg average reported for soils.

- All of the lead values exceeded the 10 mg/kg average reported for soils. Lead in the sediments ranged from 21.1 mg/kg at 8SD-4 to 80.9 mg/kg at 8SD-5.

- All of the zinc values exceeded the 50 mg/kg average reported for soils. Zinc concentrations in the sediment ranged from 291 mg/kg at 8SD-4 to 722 mg/kg at 8SD-3.

The elevated levels of lead and zinc, and possibly cadmium, in the stream sediments at Site No. 8 probably correspond to the presence of natural metallic mineral complexes derived from a number of bedrock sources.

Except for methylene chloride, which is believed to be a laboratory contaminant, no volatile organic compounds were detected above instrument detection limits in the surface water samples collected at Site No. 8. The surface water did not yield any semivolatile compounds. A total of thirteen metals were detected in the three surface water samples. Except for iron and zinc, none of the other metals exceeded any of the promulgated ARARs.

- Iron levels yielded by surface water from the three monitoring stations ranged from 1.55 mg/l at 8SW-4 to 3.50 mg/l at 8SW-5. The promulgated ARAR established under the Federal Ambient Water Quality Criteria for chronic affects to aquatic life is 1.0 mg/l.

- Zinc levels ranged from 0.051 mg/l to 0.143 mg/l in surface water from the same monitoring points respectively. The ARAR establish for zinc under the Federal Ambient Water Quality Criteria is 0.047 mg/l.

The elevated levels of iron and zinc are explained by the undissolved metal contribution from suspended sediment in the samples. All of the Site No. 8 surface water samples collected were turbid.

All of the surface water samples were characterized by high total dissolved solids (3200 mg/l to 3300 mg/l), sulfate (1700 mg/l) and chloride (380 mg/l to 460 mg/l). These levels are considerably higher than the levels found in surface waters from Site No. 3 and 9 and more likely reflect the character of the discharge than normal water quality conditions of the drainage ditch.

4.1.5.2.2 Zones of Contamination

Figures 4-60 and 4-61 depict the levels of contaminants found at each monitoring station. No distinct zone of contamination was detected in the Site No. 5 study area. Very low levels of volatile organic contamination (i.e. TCE) were found in groundwater from the new shallow/deep well pair (MW5-5/MW5-1D), but not in any of the shallow Stage 1 wells more proximal to the old drum storage area. Since TCE was not found in the shallow wells closer to the NYANG drum storage area, the TCE found in the new shallow/deep well pair (MW5-5/MW5-1D) may be derived from a slug of contamination that has since migrated away from the site. The TCE could also be related to some other unidentified source or site use. During the RI, the area was used to stockpile various construction and utility equipment and debris, and for staging fill or excavated soil.

There are several, possibly unrelated, pockets of contamination in the area around Site No. 8 (Figures 4-60 and 4-61). Only one of these pockets can be correlated to hazardous waste drum storage activities previously conducted just north of Building 202. Contamination related to drum storage appears to be restricted to an approximate 50 x 75 foot area just north of Building of 202 where the drums used to be stored. The area of suspected contamination is much larger than the area used for drum storage as a result of contaminant migration. Based upon the spatial distribution of TCE and general characteristics of the unconsolidated sediments, it appears that the contamination has not moved significantly from the site source. Groundwater of the shallow unconsolidated aquifer having the highest levels of volatile organic contamination, particularly TCE, occurs in the vicinity of monitoring wells MW8-1 (TCE-190 ug/l) and MW8-2 (TCE-11 ug/l). These wells also contained lower levels of other volatile organic compounds (1,1-dichloroethane and toluene). No TCE or other volatile organic contaminants were found in MW8-3. The absence of contamination in this well implies that the zone of contamination does not extend this far. Due to the very

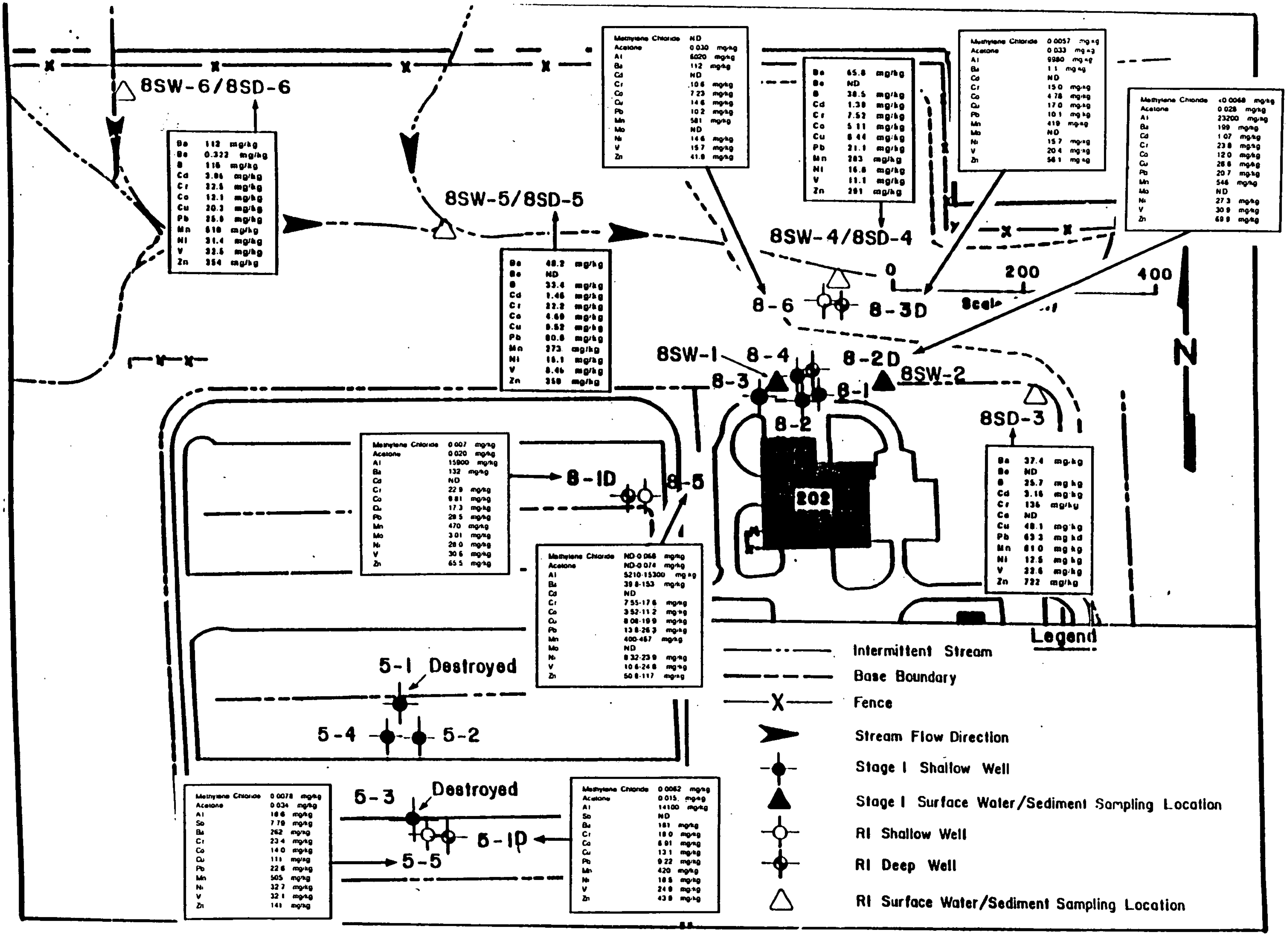


FIGURE 4-60
SITE NOS. 5 AND 8: ZONES OF CONTAMINATION - SOIL AND SEDIMENT

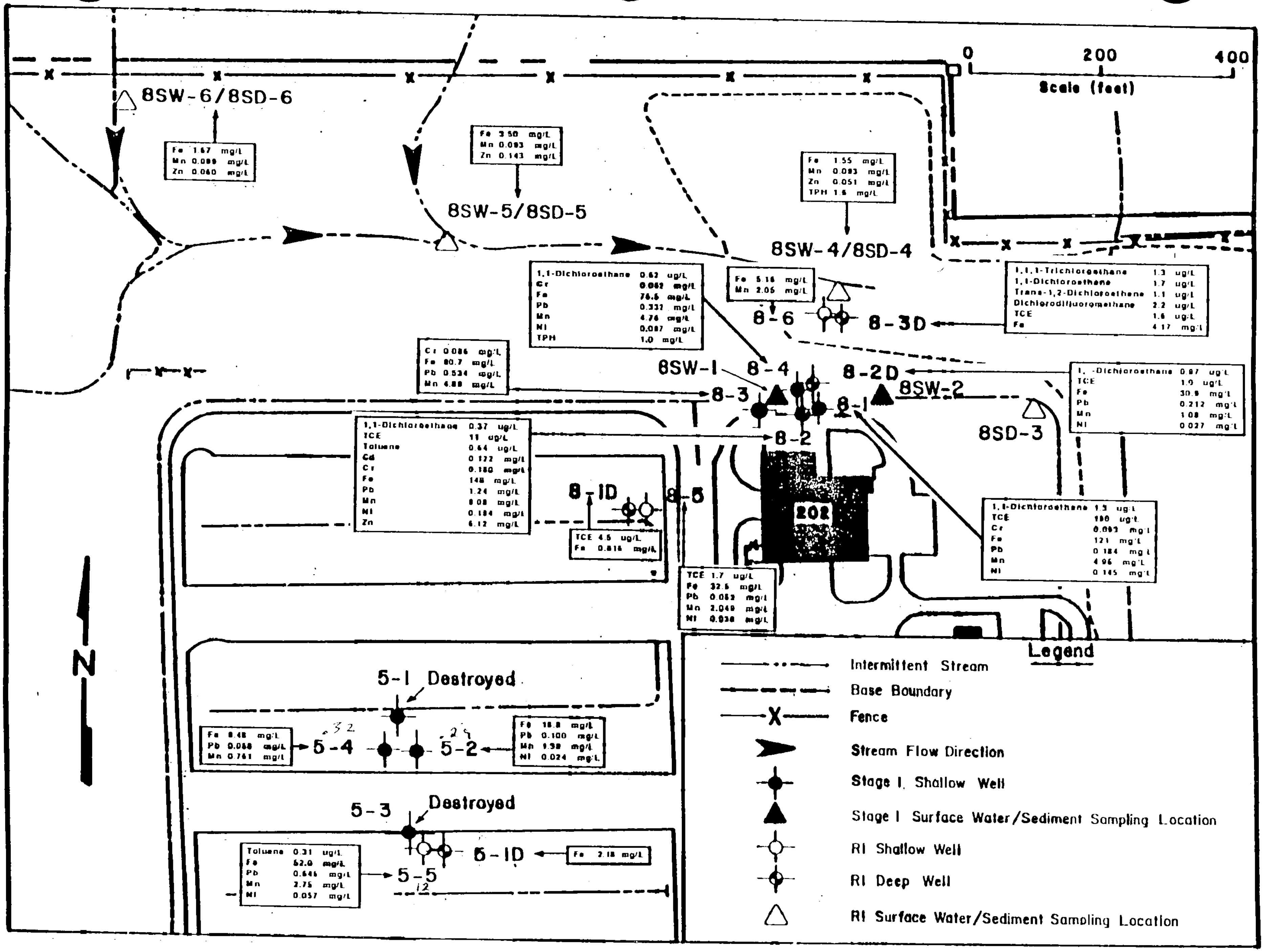


FIGURE 4-61

SITE NOS. 5 AND 8: ZONES OF CONTAMINATION - GROUNDWATER AND SURFACE WATER conductivities of the glacial till which serves as the main water bearing unit of the unconsolidated aquifer, the main zone of contamination is likely restricted to the area just north of Building 202. The distribution patterns of TCE and are depicted in the isoconcentration contour map presented as Figure 4-62.

It is uncertain whether TCE and 1,1-dichloroethane contamination found in the upper bedrock well MW8-2D is linked to the drum storage area contamination since this well is hydrogeologically upgradient from the contamination source and is paired with a shallow Stage 1 well in which no contaminants were detected. Contaminants found in upper bedrock well MW8-3D located approximately 150 feet upgradient from the drum storage yard are most likely introduced to the well from an upgradient, possibly off-base source, or perhaps by the intermittent stream. Surface water/sediment sampling conducted along this intermittent stream (drainage ditch) did not yield any of the contaminants found in MW8-3D. Some of the volatile compounds found in this well are unique to this well alone which further supports a contamination source other than the drum storage yard. TCE contamination was also found in shallow/deep well pair MW8-5/MW8-1D. Given the very low conductivities of the shallow aquifer, it is difficult to link the TCE found in the shallow well to the drum storage yard. The TCE found in the shallow aquifer well must also come from a possible off-base source located to the north or perhaps from a surface runoff pathway. Another possiblity is that the low levels of contamination detected in wells MW8-2Dm MW8-3D, MW8-5, and MW8-1D are the result of undocumented small surface spills that have occurred in the area. Organic contaminants detected in these wells are all present below ARARs and are not expected to pose any threat to human health or the enviroment of the area.

As discussed in Section 4.1.1.2.1, there is convincing evidence suggesting that the elevated metal levels found in the groundwater of Site Nos. 5 and 8 are not related to waste management practices but rather natural background trace element concentrations found in the suspended particulate matter (i.e., clay). Metals are therefore not discussed as contamination.

4.1.5.2.3 Contaminant Migration

There is little evidence to suggest that a contaminant plume has formed and is migrating away from Site No. 8. Although contaminants were found in wells hundreds of feet away from Site No. 8, the zone of contamination attributed to this site appears not to extend much beyond the former hazardous waste drum storage area. At Site No. 5, the contaminants found in the new shallow/deep well

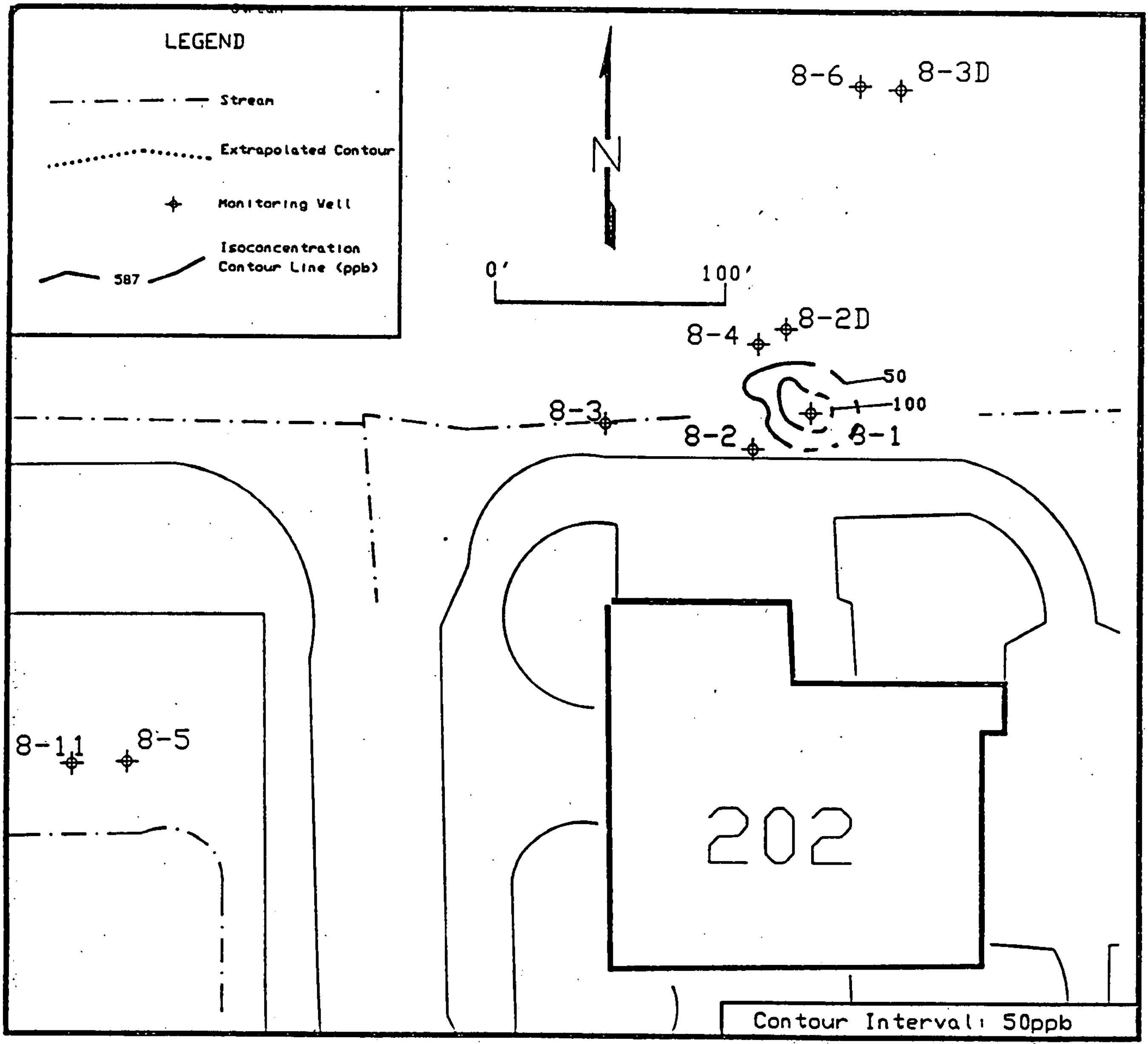


Figure 4-62
Site No. 8: Tricloroethene (TCE) Isoconcentration Contour Map
Shallow Groundwater Analyses

pair, but not in wells located much closer to the source, suggests that the drum storage area might have been a discontinuous source and the groundwater contaminants found in the more distant wells might be part of migrating contaminant slug.

As indicated in the potentiometric surface maps (Figure 4-54 and 4-55) the direction of contaminant migration in the shallow aquifer at both sites probably varies throughout the year. Although the predominant migration path at these sites has not been determined, the evidence suggest that a southeast migration path establishes itself during the drier months of the year and a southwest migration path is operative during the wetter months of the year. The actual contaminant migration path would be more closely aligned to whatever groundwater flow direction is more dominant or a resolution of several groundwater flow directions. At the present time the exact direction of contaminant migration cannot be determined. The present pattern of contamination, particularly that related to operations conducted as Site No. 8, does not suggest any preferred migration direction due to the relative small size of the effected area.

Migration of contaminants by advective means through the unconsolidated aquifer is limited as predicted in the literature. Migration of contaminants through the shallow groundwater system, based upon the discussion presented in Section 4.1.5.1.2, is predicted to range between 5.48×10^{-5} ft/day to 2.1×10^{-3} ft/day. In consideration of the age of the waste management areas and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, and migration via some other preferred pathway not assessed or encountered during this study (i.e., swales and sand lenses/ stringers, sewer and other utility trenches, building foundations, road base) the following migration distance ranges via the unconsolidated aquifer have been estimated:

Site Nos. 5 & 8 - (Minimum) 2.4×10^{-1} feet
- (Maximum) 9.2 feet

Migration rates might be locally higher, particularly at Site No. 5 due to the presence of higher conductive sand lenses/stringers. Cultural features, such as sewer lines and underground utility lines and pipes may have affect on patterns and speed of contaminant transport within the subsurface. The area around Site 8 contains serveral storm drain lines as shown in Section 4 Attachment A. The effect of this utility on contaminant transport patterns, although, is expected to be limited due to the natural geologic and hydraulic conditions of the site and the location of the utility line above the shallow water table of the area. Future investigatory work at this site will include an assessment of this utility as a possible avenue of contaminant migration. Due to the very slow migration rates predicted for the unconsolidated aquifer materials, it is not probable that contaminants would reach off-base receptors prior to a substantial reduction in contaminant levels due to natural attenuation and dilution processes.

The area around Site 5 also contains several storm drain lines as shown in Section 4 Attachment A. The effect of this utility on contaminant transport patterns, although, is expected to be limited due to the natural geologic and hydraulic conditions of the site and the location of the utility line above the shallow water table of the area. The complete lack of detected contamination above ARARs within the groundwater at this site precludes the need for further investigation of this area.

Migration of contaminants through the upper bedrock aquifer at Site No. 8 can not be evaluated since there are presently no upper bedrock wells in a downgradient position from the site. Only one downgradient bedrock well exists at Site No. 5. Contaminants could migrate greater distances in the upper bedrock aquifer as it is significantly more transmissive. As documented in the literature, migration rates measured in the upper bedrock aquifer are orders of magnitude greater than those reported for the shallow unconsolidated aquifer system. Based upon transmissivities reported by the USEPA (1983) and Johnston (1964), and using the hydrogeological gradient calculated for the upper bedrock aquifer in Section 4.1.5.1.2 and an effective porosity of 26% (Brassington, 1988), migration rates might range from 23 ft/year to 97 ft/year. Although Site No. 5 and 8 no longer serves as a source of contaminants as suggested by the absence of organic contamination in soils near the site, contamination retained in the groundwater of the unconsolidated aquifer might periodically introduce contaminants into the upper bedrock aquifer, in situations where the head potential of the unconsolidated aquifer is greater than that of the upper bedrock aquifer. In any event, the presumed southerly migration pattern would direct any the contaminants toward Cayuga Creek. If contaminants reached the creek, the water body would likely function as a hydrological barrier. It is therefore unlikely, assuming contaminants are migrating through the upper bedrock aquifer, that off-base human receptors would be exposed to contaminants via the groundwater pathway. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.5.2.4 Baseline Risk Assessment: Site No. 5 and 8

4.1.5.2.4.1 Baseline Risk Assessment for Site No. 5

This section presents the baseline risk assessment for Site 5. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

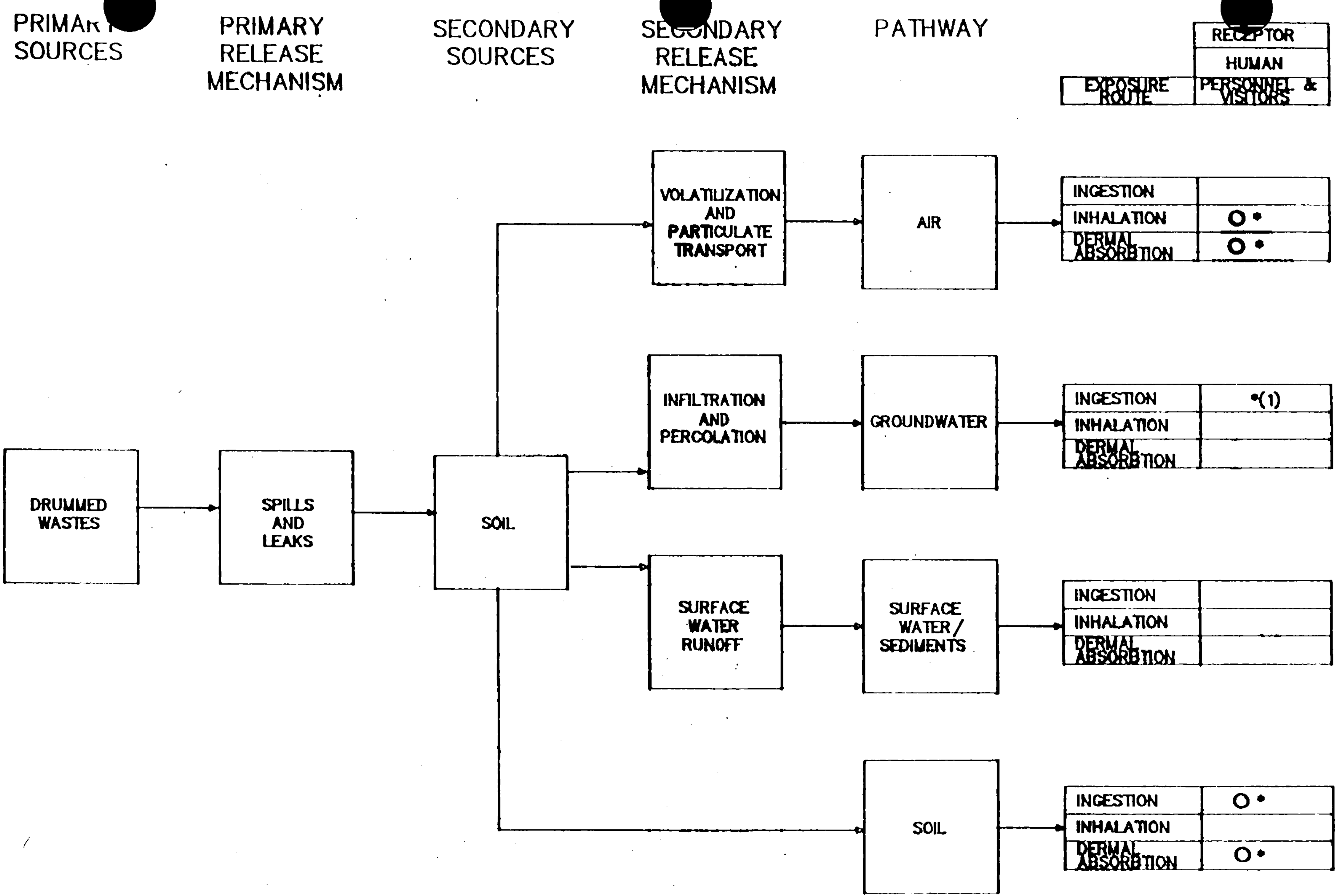
Site No. 5 - Data Analysis and Hazard Identification

Chemicals of concern for Site 5 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

The monitoring well (MW-1-7) which was initially designated as the background well for the base contained detectable concentrations of benzene (0.92 ug/L), toluene (1.0 ug/L), and TPH (1.6 mg/L), thus making it difficult to compare volatile organic values to background. In a USGS study (1985), toluene ranged from 10 to 230 ug/L in water samples taken from the unconsolidated deposits along the Niagara River. In groundwater samples collected at Site 5, the mean value for toluene was 0.19 ug/L. One inorganic (chromium at 21 ug/L) in the groundwater samples was above the range (1 to 8 ug/L) found in the USGS study (See Section 2.4.3 of this report for more detail). TPH was not detected in soils or groundwater at Site 5.

Site No. 5 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation. The conceptual site model for Site 5 is presented in Figure 4-63. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 5 is provided in Appendix G.



PATHWAY	EXPOSURE ROUTE	PERSONNEL & VISITORS
AIR	INGESTION	
	INHALATION	○ *
	DERMAL ABSORBTION	○ *
GROUNDWATER	INGESTION	*(1)
	INHALATION	
	DERMAL ABSORBTION	
SURFACE WATER/ SEDIMENTS	INGESTION	
	INHALATION	
	DERMAL ABSORBTION	
SOIL	INGESTION	○ *
	INHALATION	
	DERMAL ABSORBTION	○ *

* PROJECTED FUTURE USES

○ CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (Ie, AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-63
CONCEPTUAL SITE MODEL
SITE 5 - N.Y.A.N.G. HAZARDOUS
WASTE DRUM STORAGE AREA

Soil

Site 5 is a former waste drum storage area located on a concrete pad in the abandoned BOMARC missile site. During the Phase I investigation, visual evidence of spills were noted. The Site 5 area is presently being used to stockpile construction rubble and utility equipment. This area is situated in a fairly active portion of the installation. Maintenance and construction personnel frequent the area often during normal business hours. The exposure assumptions used for Site 4 soil exposure were also used to assess exposure at Site 5 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Surface Water/Sediments

A risk-based evaluation has not been conducted for exposure to surface water or sediments in the vicinity of Niagara Falls IAP Site 5. The significance of concentrations of contaminants in surface water is evaluated only by comparison with ARARs. An unnamed intermittent stream and its tributaries are located 700 ft north of the site. Flow from this stream discharges into the Cayuga Creek, 2,400 ft south of the study area. Due to the onsite stream's intermittent nature, it cannot support game fish. Thus, no onsite recreational activity (i.e., fishing) takes place in this surface water body. As there is no exposure to sediments or surface waters on base, sediment contamination is not considered in the risk assessment. In addition, no Federal criteria or standards are currently available for sediment contamination.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 5 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

Site No. 5 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 5 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at Site 5 are presented in Table 4-77. The hazard index for combined exposure across compounds is approximately 1.7. This is attributable to the high value of the hazard quotient for lead (i.e., a value of 1.4 corresponding to a groundwater concentration of 205 ug/L). Given this result, adverse noncarcinogenic effects may be anticipated if groundwater at Site 5 was used as a source of drinking water. As discussed in detail in section 4.3, elevated levels of metals in groundwater correspond to naturally occurring trace metals in the suspended sediment.

Trichloroethylene (a Group B2 or probable human carcinogen) was the only carcinogenic compound detected in groundwater at the site. The excess lifetime cancer risk of hypothetical exposure to TCE in groundwater was determined to be approximately 4×10^{-8}. This is within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. The mean value for lead at Site 5 (205 ug/L) greatly exceeded the MCL (25 ug/L). Mean concentrations of manganese were more than four times the New York State groundwater limits (300 ug/L). The mean concentrations of zinc were more than two times New York State groundwater limit (300 ug/l).

Soil Pathway

The results of risk characterization for exposure to soil at Site 5 are presented in Table 4-78. The hazard index for combined exposure across compounds is approximately 6.8×10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Only one carcinogenic compound was detected in soil samples collected at the site. The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing methylene chloride (a Group B2 or probable human carcinogen) is 6×10^{-12}. EPA has established an acceptable range of 10^{-6} to 10^{-4}

TABLE 4-77

RISK CHARACTERIZATION FOR SITE NO. 5: EXPOSURE TO GROUNDWATER

hemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
NORGANICS				
luminum	12100.00			
arium	202.00	3.96E-02	Hypertension	
oron	131.00	1.43E-02	CNS, GI Tract, Skin	
hromium	21.00	4.12E-02	Skin	
obalt	10.00		Thyroid, Heart	
opper	30.00	7.96E-03	GI Tract, Blood	
ead	205.00	1.44E+00	CNS, Kidney	
anganese	1250.00	6.13E-02	CNS, Reproductive	
ickel	24.00	1.18E-02	Skin, Lung	
anadium	21.00	2.94E-02	Respiratory Effects	
inc	876.00	4.30E-02	GI Tract	
RGANICS				
richloroethene	1.20	1.18E-03	Liver, Kidney, CNS	3.70E-08
oluene	0.19	6.21E-06	CNS	
azard Index: Combined Exposure		1.69E+00		
xcess Lifetime Cancer Risk: ombined Exposure				4E-08

. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

. Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-78

RISK CHARACTERIZATION FOR SITE NO. 5: INGESTION EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcingenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	7134.30			
Antimony	5.80	2.28E-03	Heart, Lung	
Barium	219.00	6.88E-04	Hypertension	
Chromium	20.60	6.47E-04	Skin	
Cobalt	10.85		Thyroid, Heart	
Copper	62.90	2.67E-04	GI Tract, Blood	
Lead	14.40	1.61E-03	CNS, Kidney	
Manganese	458.00	3.59E-04	CNS, Reproductive	
Nickel	26.00	2.04E-04	Skin, Lung	
Vanadium	28.70	6.44E-04	Respiratory Effects	
Zinc	92.60	7.27E-05	GI Tract	
RGANICS				
Acetone	0.039	6.12E-08	Liver, Kidney	
Methylene Chloride	0.017	4.45E-08	Liver, Kidney, CNS	5.72E-12
Hazard Index: Combined Exposure		6.77E-03		
Excess Lifetime Cancer Risk: Combined Exposure				6E-12

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment for waste site remediation under the Superfund program. Given this guidance, the result of cancer risk evaluation for soils would be considered acceptable.

Site No. 5 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.1.5.2.4.2 Baseline Risk Assessment for Site No. 8

This section presents the baseline risk assessment for Site 8. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 8 - Data Analysis and Hazard Identification

Chemicals of concern for Site 8 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

The monitoring well (MW-1-7) which was initially designated as the background well for the base contained detectable concentrations of benzene (0.92 ug/L), toluene (1.0 ug/L), and TPH (1.6 mg/L), thus making it difficult to compare volatile organic values to background. In a USGS study (1985), toluene ranged from 10 to 230 ug/L and trans-1,2-dichloroethylene ranged from nondetect to 23 ug/L in water samples taken from the unconsolidated deposits along the Niagara River. In groundwater samples collected at Site 8, the mean values for toluene and 1,2-dichloroethylene were 0.22 ug/L and 0.3 ug/L, respectively. Two inorganics (chromium at 55 ug/L and arsenic at 9 ug/L) in the groundwater samples were above the ranges (1 to 8 ug/L and 1 to 4 ug/L, respectively) found in the USGS study (See Section 2.4.3 of this report for more detail).

Mean levels of TPH in soils and sediments at Site 8 were 69.1 and 78.00 mg/kg respectively indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis however, no correlation can be established between levels of TPH in these media and quantities of organics detected and included in the baseline risk assessment. TPH was not detected in groundwater at the site.

Site No. 8 - Exposure Assessment

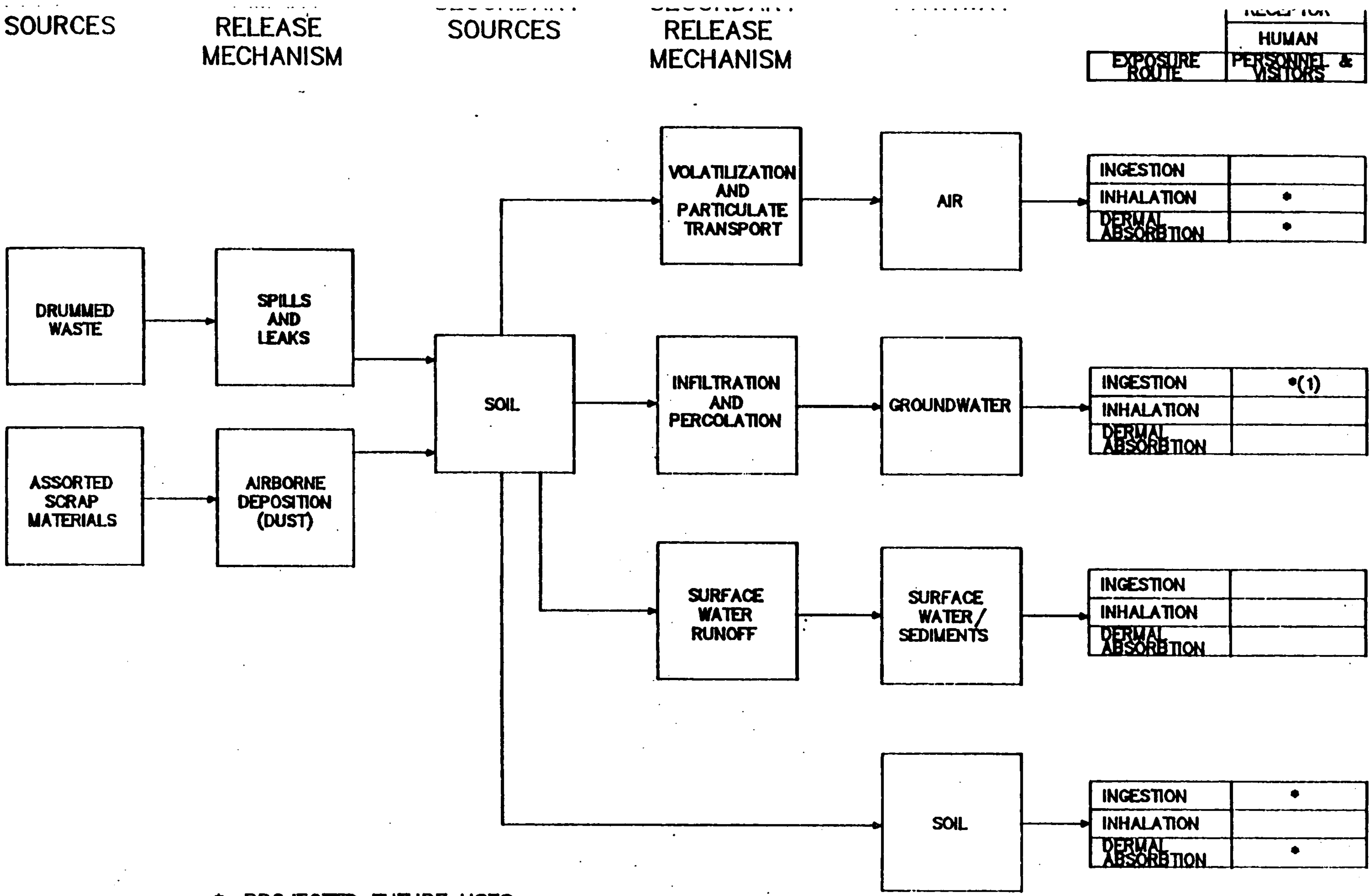
The objectives of the exposure assessment and purpose for evaluating groundwater at the site are presented in Section 4.1.1.2.4.1. Please refer to this section for a detailed presentation. The conceptual site model for Site 8 is presented in Figure 4-64. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 8 is provided in Appendix G.

Note that the exposure and risk characterization for soils and sediments at Site 8 are distinct from those conducted for other sites. As noted in the following sections, recreational facilities are located in the vicinity of the site. The reasonable maximum exposure scenarios for Site 8 are based on exposure of Base personnel and visitors (i.e., children are assumed to be at greatest risk of the receptors in this group) who use the recreation facilities in proximity of the site.

Soil (Direct Ingestion and Inhalation Exposure to Suspended Particulates)

Site 8 was a former paved drum storage area which has recently been repaved. It is currently a repository for construction materials and assorted scrap. Evidence of minor spills were noted during the Phase I site investigation. Although the area is paved, the location of a jogging/exercise station track nearby and two baseball diamonds and a playground within 900 ft of the site warrant an evaluation of hypothetical exposure to soils. Both ingestion and inhalation (suspended particulates) pathways have been considered for Base personnel and visiting children. Note that risk characterization considers combined exposure across pathways. The recreational exposure assumptions used for Site 8 soils are as follows:

- o Base personnel participating in either jogging or baseball come into direct contact with soils at Site 8 and inadvertently ingest 0.1 gramsof soil per day, three days per week, 20 weeks per year, for 20 years out of a 70 year lifetime. Note that monitoring results for the entire soil column were used in calculation of the arithmetic mean. Field screening did not indicate contamination of surface soils. Consequently, an evaluation was conducted of hypothetical chronic exposure to contamination in the soil column. This assessment is designed to provide a measure of the significance of observed levels of chemicals in the subsurface environment.



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie, AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-64
CONCEPTUAL SITE MODEL
SITE 8 - BUILDING 202 DRUM STORAGE YARD

- Base personnel participating in the above mentioned recreational activities (i.e., heavy activity) are assumed to inhale 3.9 m^3/hr for a maximum of 3 hours per day at a particulate loading rate of 130 ug/m^3, 3 days per week, 20 weeks per year, for 20 years. Data on ambient atmospheric levels of suspended particulates were available for a location approximately two miles from the site (AFRES 1989).

- It was assumed that children visiting the Base (ages 3 through 12: average body weight 25 kg) use the recreational facilities in the vicinity of Site 8, and inadvertently ingest 200 mg of soil per day of play, 5 days per week for the summer months (16 weeks), for a nine-year exposure period.

- For the inhalation exposure route, it was assumed that the children have an inhalation rate of 4.2 m^3/hr (heavy activity) and are exposed for a maximum of 5 hours per day to suspended particulates originating from Site 8. The particulates loading rate is taken to be 130 ug/m^3 (as above). The frequency and duration of exposure are the same as for the children's soil ingestion scenario.

- Chemicals in the ingested and inhaled soil and particulates are assumed to be completely bioavailable for uptake and absorption.

- Chemicals in soil at the site are assumed to be conservative (i.e., do not degrade or transform over time).

- The following evaluation of site risk, using the above assumptions, is functionally equivalent to a site specific quantitative assessment of site risk as required by OSWER Directive 9502.00-6D. The specific health-based soil criteria presented OSWER Directive 9502.00-6D do not strictly apply to sites at this base due to variances in exposure assumptions. Sites which demonstrate excess risk from exposure assessments will be targeted for further action, including the calculation of specific quantitative health-based criteria for site remediation.

Surface Water/Sediments

Due to the intermittent nature of the stream in the area of Site 8 (i.e., it is dry during the summer months), surface water exposure was not evaluated. The sediments however, may present an opportunity for exposure of children playing in the area of Site 8. Therefore, the inadvertent ingestion of sediments by children was evaluated using the same assumptions outlined above for soil exposure. Note that the risk assessment assumes simultaneous exposure via soil ingestion, inhalation of soil particulates, and sediment ingestion.

Additional documentation of the assumptions for soil and sediment exposure is also presented in Appendix G.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 8 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G. Note as before, the exposure of Base personnel to groundwater is a hypothetical assessment. Visiting children are not exposed to groundwater and this pathway is not considered for this receptor group. As was the case for waste sites previously considered, the exposure assessment for groundwater is hypothetical, and risks to Base personnel for this pathway are not combined with those for soil ingestion and inhalation of particulates.

Site No. 8 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 8 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at Site 8 are presented in Table 4-79. The hazard index for combined exposure across compounds is 4.97. This is attributable to the high value of the hazard quotients for arsenic and lead (corresponding to concentrations of 9.0 and 286.0 ug/liter respectively). As previously mentioned, arsenic is present at naturally elevated concentrations in the Niagara Falls area. Based on these results, there would be potential for adverse noncarcinogenic effects for hypothetical chronic exposure to groundwater beneath Site 8.

The excess lifetime risk of cancer of hypothetical exposure to groundwater at the site is estimated to be approximately 5×10^{-5}. This magnitude of this result is attributable to the presence of arsenic. The cancer risk estimate falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean concentrations of

TABLE 4-79

RISK CHARACTERIZATION FOR SITE NO. 8: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	35200.00			
Arsenic	9.00	2.00E+00	Skin, Lung	4.42E-05
Barium	383.00	7.52E-02	Hypertension	
Boron	314.00	3.42E-02	CNS, GI Tract, Skin	
Cadmium	16.00	3.14E-01	Kidney	
Chromium	55.00	1.08E-01	Skin	
Cobalt	42.00		Thyroid, Heart	
Copper	102.00	2.70E-02	GI Tract, Blood	
Lead	286.00	2.00E+00	CNS, Kidney	
Manganese	3230.00	1.58E-01	CNS, Reproductive	
Mercury	0.10	3.27E-03	CNS	
Molybdenum	11.00			
Nickel	69.00	3.39E-02	Skin, Lung	
Vanadium	63.00	8.83E-02	Respiratory Effects	
Zinc	2030.00	9.96E-02	GI Tract	
ORGANICS				
1,1,1-Trichloroethane	0.40	4.36E-05	CNS, Lung, Kidney	
1,1-Dichloroethane	0.60	5.89E-05	Liver, Kidney, CNS	1.53E-07
1,2-Dichloroethylene	0.30	1.47E-04	Liver, Kidney, CNS	
Dichlorodifluoromethane	1.40	6.87E-05	Liver, Lung	
Trichloroethene	23.00	2.26E-02	Liver, Kidney, CNS	7.09E-07
Toluene	0.22	7.20E-06	CNS	
Hazard Index: Combined Exposure		4.97E+00		
Excess Lifetime Cancer Risk: Combined Exposure				5E-05

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

Explanation of risk assessment calculations is included in Section 4 Attachment B.

the following compounds at Site 8 exceeded both the Federal MCLs and New York State groundwater limits: cadmium, chromium, lead, zinc, and trichloroethylene. The mean level of manganese was more than 10 times the New York State standard.

Soil Pathway: Base Personnel

The results of risk characterization for recreational exposure of Base personnel to soils in the vicinity of Site 8 are presented in Tables 4-80 through 4-82. The hazard index for combined exposure across compounds and across pathways (i.e., inhalation and ingestion) is approximately 1.5×10^{-2}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Laboratory analysis indicated that a small quantity of methylene chloride may be present in soils at the site. The excess lifetime cancer risk associated with inadvertent ingestion of soils and inhalation of particulates containing this compound is 2×10^{-12}. The acceptable range established by EPA for waste site remediation under the Superfund Program is 10^{-6} to 10^{-4}. Based upon this guidance, this result for Site 8 would be considered to fall within the acceptable range.

Soils and Sediments: Visiting Children

The results of the risk characterization for children exposed to soil at Site 8 are presented in Tables 4-83 through 4-84. The hazard index for combined exposure across compounds and across pathways (i.e., inhalation and ingestion) is approximately 1.5×10^{-1}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Laboratory analysis indicated that a small quantity of methylene chloride may be present in soils at the site. The excess lifetime cancer risk associated with children inadvertently ingesting soils and inhaling particulates containing this compound is 2×10^{-7}, well within the acceptable range established by EPA.

The results of risk characterization for children at play exposed to sediments at Site 8 are presented in Table 4-85. The hazard index for combined exposure across compounds is approximately 1.0×10^{-1}. No adverse

TABLE 4-80

RISK CHARACTERIZATION FOR SITE NO. 8: INGESTION EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES PROJECTED EXPOSURE OF BASE PERSONNEL AT JOGGING TRACK AND BASEBALL FIELD

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	12637.00			
Barium	115.30	5.43E-04	Hypertension	
Cadmium	0.39	1.85E-04	Kidney	
Chromium	16.24	7.65E-04	Skin	
Cobalt	8.36		Thyroid, Heart	
Copper	17.05	1.09E-05	GI Tract, Blood	
Lead	17.80	2.99E-03	CNS, Kidney	
Manganese	479.00	5.64E-04	CNS, Reproductive	
Molybdenum	0.95			
Nickel	19.89	2.34E-04	Skin, Lung	
anadium	22.30	7.50E-04	Respiratory Effects	
nc	65.10	7.66E-05	GI Tract	
ORGANICS				
Acetone	0.036	8.48E-08	Liver, Kidney	
Methylene Chloride	0.006	2.35E-08	Liver, Kidney, CNS	2.02E-12
Hazard Index: Combined Exposure		6.22E-03		
Excess Lifetime Cancer Risk: Combined Exposure				2E-12

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil during recreational activity. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-81

RISK CHARACTERIZATION FOR SITE 8: INHALATION EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES PROJECTED EXPOSURE OF BASE PERSONNEL AT JOGGING TRACK AND BASEBALL FIELD

emical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	12637.00			
rium	115.30	4.13E-03	Hypertension	
dmium	0.39	2.82E-06	Kidney	
romium	16.24	1.16E-05	Skin	
balt	8.36		Thyroid, Heart	
pper	17.05	1.65E-06	GI Tract, Blood	
ad	17.80	4.55E-05	CNS, Kidney	
nganese	479.00	5.72E-03	CNS, Reproductive	
lybdenum	0.95			
ckel	19.89	3.56E-06	Skin, Lung	
nadium	22.30		Respiratory Effects	
nc	65.10	1.17E-06	GI Tract	
GANICS				
etone	0.036		Liver, Kidney	
thylene Chloride	0.006	3.58E-10	Liver, Kidney, CNS	2.89E-18
zard Index: Combined Exposure		9.91E-03		
cess Lifetime Cancer Risk: mbined Exposure				3E-18

Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming inhalation exposure of adults to soils. Exposure assumptions: (1) adult Base personnel are exposed to particulates during recreational activity at the Baseball field and jogging track in the vicinity of Site 8 (baseball and jogging activities assumed mutually exclusive); (2) receptors inhale 3.9 m3 of air per hour (corresponding to heavy activity), 3 hours per day, 3 days per week, 20 weeks per year for a 20-year exposure period; (3) the air inspired is asumed to contain an atmospheric concentration of suspended particulates equal to 130 ug/m3; (4) 100 percent of the TSP levels originate from the site under investigation;

(5) concentration of subject chemicals in the air (Ca) was determined as Cs x Ctsp where Cs is mean concentrations in Site 8 soil, and Ctsp is the maximum 24 hr atmospheric level of total suspended particulates (sampling location 2.5 miles form Base); (6) all inspired air particualtes are assumed to be respirable and absorbed contaminants to be completely bioavailable for absorption across lung membrane into the blood stream.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-82

RISK CHARACTERIZATION FOR SITE 8: COMBINED EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES INGESTION AND INHALATION EXPOSURE OF BASE PERSONNEL AT JOGGING TRACK AND BASEBALL FIELD

emical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	12637.00			
rium	115.30	4.67E-03		
dmium	0.39	1.88E-04		
romium	16.24	7.76E-04		
balt	8.36			
pper	17.05	1.10E-04		
ad	17.80	3.04E-03		
nganese	479.00	6.28E-03		
lybdenum	0.95			
ckel	19.89	2.38E-04		
nadium	22.30			
nc	65.10	7.78E-05		
GANICS				
etone	0.036			
thylene Chloride	0.006	2.39E-08		2.02E-12
zard Index: Combined Exposure		1.54E-02		
cess Lifetime Cancer Risk: mbined Exposure				2E-12

Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming ingestion exposure of adults to soils and site-related suspended particulates. Exposure assumption: personnel are exposed to particulates during recreational activity at the Baseball field and jogging track in the vicinity of Site 8 (baseball and jogging activities assumed mutually exclusive).

Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-83

RISK CHARACTERIZATION FOR SITE 8: INGESTION EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES PROJECTED EXPOSURE OF CHILDREN AT PLAYGROUND AND BASEBALL FIELD

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	12637.00			
Barium	115.30	4.05E-03	Hypertension	
Cadmium	0.39	1.38E-03	Kidney	
Chromium	16.24	5.71E-03	Skin	
Cobalt	8.36		Thyroid, Heart	
Copper	17.05	8.10E-04	GI Tract, Blood	
Lead	17.80	2.24E-02	CNS, Kidney	
Manganese	479.00	4.21E-03	CNS, Reproductive	
olybdenum	0.95			
ickel	19.89	1.75E-03	Skin, Lung	
Vanadium	22.30	5.60E-03	Respiratory Effects	
Zinc	65.10	5.72E-04	GI Tract	
ORGANICS				
Acetone	0.036	6.33E-07	Liver, Kidney	
Methylene Chloride	0.006	1.76E-07	Liver, Kidney, CNS	1.02E-11
Xylenes	0.801	7.04E-07	CNS	
Hazard Index: Combined Exposure		4.64E-02		
Excess Lifetime Cancer Risk: Combined Exposure				1E-11

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming ingestion exposure of children to soils. Exposure assumptions: (1) children ages 3 to 12 years are exposed to soils during recreational activity at the Baseball field and plaground in the vicinity of Site 8; (2) children ingestion 0.2 g soil per day, 5 days per week, 16 weeks per year, for a 9-year exposure period; (3) average body weight of children 3 to 12 years is 25 kg.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-84.

RISK CHARACTERIZATION FOR SITE 8: INHALATION EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES PROJECTED EXPOSURE OF CHILDREN AT PLAYGROUND AND BASEBALL FIELD

emical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Carcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	12637.00			
rium	115.30	5.53E-05	Hypertension	
dmium	0.39	1.89E-05	Kidney	
romium	16.24	7.80E-05	Skin	
balt	8.36		Thyroid, Heart	
pper	17.05	1.11E-05	GI Tract, Blood	
ad	17.80	3.05E-04	CNS, Kidney	
nganese	479.00	5.75E-05	CNS, Reproductive	
lybdenum	0.95			
ckel	19.89	2.39E-05	Skin, Lung	
nadium	22.30	7.65E-05	Respiratory Effects	
nc	65.10	7.81E-06	GI Tract	
GANICS				
etone	0.036	8.64E-09	Liver, Kidney	
thylene Chloride	0.006	2.40E-09	Liver, Kidney, CNS	1.39E-13
lenes	0.801	9.61E-09	CNS	
zard Index: Combined Exposure		6.34E-04		
cess Lifetime Cancer Risk: mbined Exposure				1E-13

Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming inhalation of children to soil. Exposure assumptions: (1) children ages 3 to 12 years are exposed to particulates during recreational activity at the Baseball Field and playground in the vicinity of Site 8 (baseball and playground activities assumed mutulally exclusive); (2) receptors inhale 4.2 m3 of air per hour (corresponding to heavy activity), 3 hours per day, 5 days per week, 16 weeks per year for a 9-year exposure period; (3) the air inspired is assumed to contain an atmospheric concentration of suspended particulates equal to 130ug/m3; (4) 100 percent of the TSP levels originate from the site under investigation; (5) concentration of subject chemicals in the air (Ca) was determined as Cs x Ctsp where Cs is mean concentrations in Site 8 soil, and Ctsp is the maximum 24 hr atmospheric level of total suspended particulates (sampling location 2.5 miles from Base); (6) all inspired air particulates are assumed to be respirable and absorbed contaminants to be completely bioavailable for absorption across lung membrane into the blood stream.

Explanation of risk assessment calculations is included in Section 4 Attachment B.

TABLE 4-85

RISK CHARACTERIZATION FOR SITE 8: INGESTION EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES PROJECTED EXPOSURE OF CHILDREN AT PLAYGROUND AND BASEBALL FIELD

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	8770.00			
Barium	65.80	2.31E-03	Hypertension	
Beryllium	0.20	7.00E-05	Lung, Skin, Heart	1.93E-07
Boron	53.40	1.04E-03	CNS, GI Tract, Skin	
Cadium	2.49	8.76E-03	Kidney	
Chromium	47.00	1.65E-02	Skin	
Cobalt	5.69		Thyroid, Heart	
Copper	21.60	1.03E-03	GI Tract, Blood	
Lead	47.80	6.00E-02	CNS, Kidney	
Manganese	289.00	2.54E-03	CNS, Reproductive	
Nickel	19.20	1.69E-03	Skin, Lung	
Vanadium	18.70	4.70E-03	Respiratory Effects	
Zinc	431.00	3.79E-03	GI Tract	
ORGANICS				
Acetone	0.04	7.21E-07	Liver, Kidney	
Methylene Chloride	0.01	2.48E-07	Liver, Kidney, CNS	1.43E-11
Hazard Index: Combined Exposure		1.02E-01		
Excess Lifetime Cancer Risk: Combined Exposure				2E-07

a. Arithmetic mean of sediment samples column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming ingestion exposure of children to soils. Exposure assumptions: (1) children ages 3 to 12 years are exposed to soils during recreational activity at the Baseball field and plaground in the vicinity of Site 8; (2) children ingestion 0.2 g soil per day, 5 days per week, 16 weeks per year, for a 9-year exposure period; (3) average body weight of children 3 to 12 years is 25 kg.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Two carcinogens, beryllium and methylene chloride were present in the sediment samples. The excess lifetime cancer risk associated with inadvertent ingestion of sediments containing these compounds is 2×10^{-7}, well within the acceptable range established by the EPA.

Table 4-86 is a summary of the projected combined risks of exposure of visiting children to soils and sediments in the vicinity of Site 8. As shown, both the combined hazard index and the combined excess lifetime cancer risk are within the acceptable range established by EPA for waste site remediation.

Surface Water

As noted previously, a risk assessment was not conducted for chemicals in surface water. However, mean concentrations in surface water were compared with Federal ambient water quality criteria (FWQC). None of the chemicals in surface waters where found to exceed the corresponding FWQC (adjusted for drinking water only).

Site No. 8 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

There are a number of other factors that must also be taken into consideration in evaluating the results for Site 8. It is important to note that the site is paved and the soil results were obtained 900 ft from the playground and ballfield. The assessment of recreational exposures is consequently very conservative approach and should be considered an upper-bound estimate of potential risks. This evaluation was conducted to ensure protective of human health.

TABLE 4-86

RISK CHARACTERIZATION FOR SITE 8: COMBINED EXPOSURE TO SOILS DURING RECREATIONAL ACTIVITIES INGESTION AND INHALATION EXPOSURE OF CHILDREN AT PLAYGROUND AND BASEBALL FIELD

Exposure Pathway/Medium	Pathway Summary: Hazard Index Noncarcinogenic Effects (b) (Dose /RfD)	Pathway Summary: Excess Lifetime Carcinogenic Risk (b) (Dose x $q1^*$)
Ingestion Exposure to Soils	4.64E-02	1.02E-11
Inhalation Exposure to Soils (Particulates)	6.34E-02	1.39E-13
Ingestion Exposure to Sediments	1.02E-01	1.93E-07
Hazard Index: Combined Exposure	1.50E-01	
xcess Lifetime Cancer Risk: ombined Exposure		2E-07

a. Explanation of risk assessment calculations is included in Section 4 Attachment B.

4.1.6 Discussion of Results for Site No. 12: Building 850 Drum Storage Yard

4.1.6.1 Presentation of Results

4.1.6.1.1 Site Geology

The geology of Site No. 12, as interpreted by the RI soil boring logs, consists of a veneer of fine grained glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The location of the two Site No. 12 soil borings is presented in Figure 4-65. The average thickness of the unconsolidated deposits at Site No. 12 is unknown, as soil borings did not extend to the bedrock surface. The estimated thickness of the unconsolidated deposits is 15 feet. The Lockport Dolomite beneath Site No. 12 is estimated to be 180 feet thick. A generalized geologic cross-section of the Site No. 12 study area is presented as Figure 4-66. Soils at the Site No. 12 study area belong to the Odessa Series. Since this is a dominant soil type, it was described previously in Section 4.1.1.1.1.

The lacustrine sediments generally form the uppermost unit of the unconsolidated deposits, while glacial till forms the lowermost unit. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. The lacustrine and till deposits are identical to those described at Site No.'s 1, 2, 4, and 6 (Section 4.1.1.1.1). Fluvial sediments, although were not encountered in the two boreholes, probably occur sporadically throughout the study area.

4.1.6.1.2 Analytical Results for Site No. 12: Contract Laboratory

Results are presented for each individual sample in Table 4-87. These data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples.

Organic Analyses: Seven soil boring samples (including one field duplicate) were collected and analyzed for volatile and semivolatile organic compounds. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits:

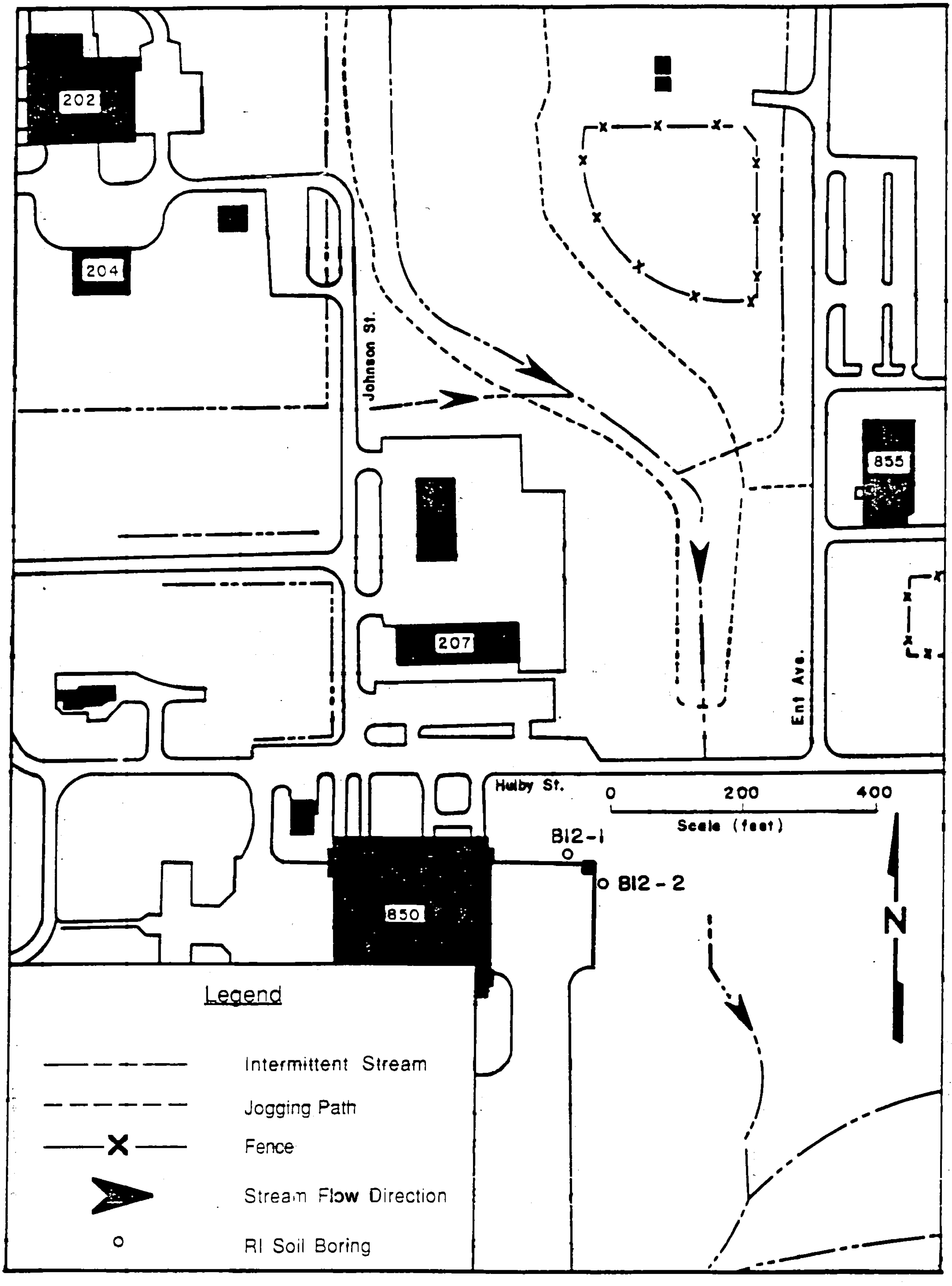


FIGURE 4-65
SITE NO. 12: SOIL BORING LOCATION MAP

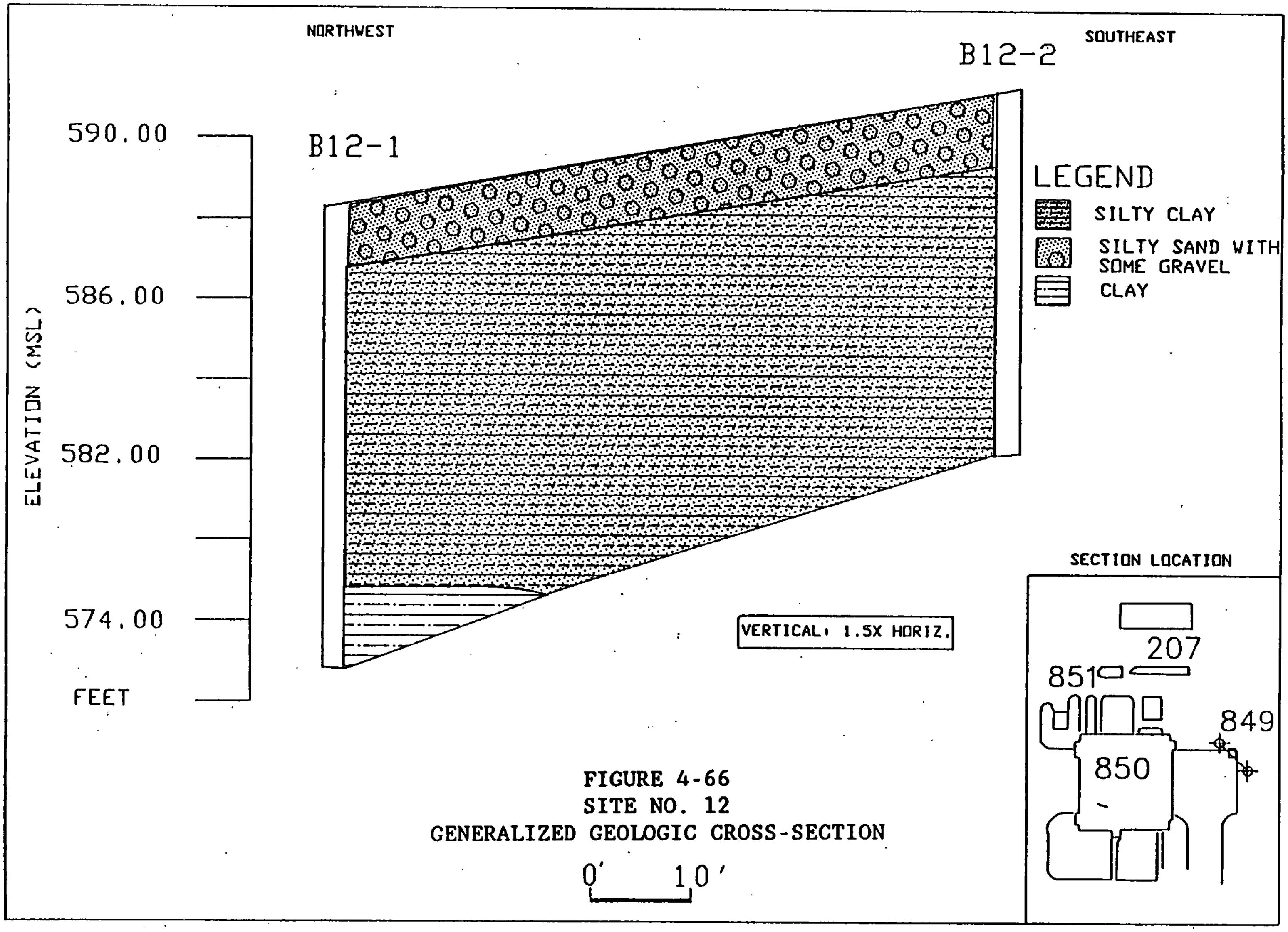


FIGURE 4-66
SITE NO. 12
GENERALIZED GEOLOGIC CROSS-SECTION

TABLE 4-87
SITE NO. 12: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	Sample ID (Sample Description)						
		B-12-1-5 (4.5'-6.0')	B-12-1-5R (4.5'-6.0' duplicate)	B-12-1-7 (9.0'-10.5')	B-12-1-8 (10.5'-12.0')	B-12-2-1 (0-1.5')	B-12-2-4 (4.5'-6.0')	B-12-2-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg) **Volatile Organics**								
Methylene Chloride	0.005	0.014	0.011	0.019	0.0065[a]	0.011[a]	0.0086[a]	0.011
Acetone	0.010	0.084	0.060	0.140	ND[a]	0.030[a]	0.052[a]	0.085
Trans-1,2-Dichlorethene	0.005	ND	ND	ND	ND	ND	0.048	ND
Trichloroethene	0.005	ND	ND	ND	ND	ND	0.550[c]	0.046
Benzene	0.005	ND[b]	ND[b]	ND[b]	ND[b]	ND[b]	0.012[b]	ND[b]
Tetrachloroethene	0.005	ND	ND	ND	ND	<0.0053[*]	ND	0.033
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/8270 **Semivolatile Organics (mg/kg)**								
Phenanthrene	0.33	ND	ND	ND	ND	0.38[c]	ND	ND
Fluoranthene	0.33	ND	ND	ND	ND	0.37[c]	ND	ND
Pyrene	0.33	ND	ND	ND	ND	0.44[c]	ND	ND
Bis(2-ethylhexyl)phthalate	0.33	<0.43[*,a]	<0.40[*,a]	<0.43[*,a]	<0.42[*,a]	0.38[a,c]	<0.41[*,a]	0.43[a]
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010 **Total Metals (mg/kg)**								
Aluminum[d]	10.0	15100	16600	13700	14100	12600	16200	12500
Barium	1.0	55.4[f]	219[f]	117[f]	112[f]	121[f]	332[f]	90.2[f]
Beryllium	0.2	0.26	0.33	ND	ND	ND	ND	ND
Calcium[d]	50.0	3000	31000	38800	50400	41500	40400	43100
Chromium	1.0	19.5[e]	20.4[e]	17.9[e]	22.0[e]	17.2[e]	20.5[e]	15.8[e]
Cobalt	1.0	15.8	10.9	9.01	9.49	10.4	8.69	8.62
Copper	1.0	18.4[a]	17.0[a]	19.0[a]	16.7[a]	17.9[a]	17.9[a]	17.9[a]
Iron[d]	2.5	29700[a]	32600[a]	26600[a]	28200[a]	26200[a]	31400[a]	26600[a]
Lead	5.0	15.1[e]	16.4[e]	17.0[e]	18.5[e]	29.7[e]	18.4[e]	14.4[e]
Magnesium[d]	50.0	9030	11400	13000	9470	14200	9060	4610
Manganese	0.5	618[f]	394[f]	443[f]	492[f]	423[f]	385[f]	385[f]
Nickel	1.5	27.7[e]	25.9[e]	22.2[e]	26.6[e]	23.2[e]	25.2[e]	21.2[e]
Potassium[d]	50.0	2270	2830	2360	2630	2340	2620	2110
Silicon[d]	100.0	332[a,f]	183[a,f]	218[a,f]	392[a,f]	292[a,f]	254[a,f]	340[a,f]
Sodium[d]	50.0	132	135	139	161	109	156	140
Vanadium	1.0	24.9	26.9	23.4	24.6	24.0	26.7	22.1
Zinc	1.0	55.6	55.2	52.5	51.4	84.3	63.4	51.4
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND

TABLE 4-87 (Cont'd)
SITE NO. 12: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	Sample ID (Sample Description)						
		B-12-1-5 (4.5'-6.0')	B-12-1-5R (4.5'-6.0' duplicate)	B-12-1-7 (9.0'-10.5')	B-12-1-8 (10.5'-12.0')	B-12-2-1 (0-1.5')	B-12-2-4 (4.5'-6.0')	B-12-2-6 (7.5'-9.0')
EPA Method SW3550/E418.1								
Total Petroleum Hydrocarbons	5.0	ND	ND	12	7.5	23	7.0	110

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analyses exceeded the RPD control limit for this parameter.
c = Estimate value; compound quantitated outside calibration range but within linear range.
d = Accuracy data unavailable; compound not spiked.
e = Associated matrix spike had recovery below lower control limit.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.

- Two of three volatile organic method blanks contained methylene chloride and acetone. Sample concentrations of these compounds are potentially biased high.
- The matrix spike/matrix spike duplicate (MS/MSD) analyzed had elevated chlorobenzene recovery and RPD values: MSD recovery = 138% (upper control limit = 133%), and RPD = 53% (control limit = 21%).
- The semivolatile organic method blanks associated with these soil samples had bis(2-ethylhexyl)phthalate present below the measurable detection limits. Sample concentrations of this compound are biased by the background laboratory levels.

Inorganic Analyses: Seven soil samples were analyzed for total metals and total petroleum hydrocarbons (TPH). The following is a discussion of potentially biased data:

- The metals method blank contained boron (4.0 mg/L), copper (1.0 mg/L), iron (11.0 mg/L) and silicon (7.1 mg/L). Boron was not detected in any of the samples. The other metals were present in the samples at significantly higher concentrations than in the blank.
- The MR/MS associated with the metals analysis of the soil samples had several outlier recoveries and RPD values. Boron was not detected in the sample, but was detected in the replicate. Chromium, lead and nickel had recoveries below the lower control limit of 75%; recoveries were 53%, 66% and 68% respectively. In addition aluminum, calcium, iron, magnesium, potassium, silicon, and sodium were not spiked, precluding an assessment of accuracy for these metals.
- The field duplicate from this site, B-12-1-5/5R exceeded 35% RPD for barium (RPD = 119%), manganese (44%) and silicon (58%).

4.1.6.2 Significance of Findings

4.1.6.2.1 Significance of Findings: Site No. 12 - Building 850 Drum Storage Yard

Only soils were investigated at Site No. 12 to characterize the environmental impact of hazardous waste drum storage during the 1950s and early 1960s. Table 4-88 presents analyses versus background levels for all contaminants found in the soils.

TABLE 4-88
SITE NO. 12: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (Units)	Detection Limits	Background[a] (mg/Kg)	Selected Average for soils[b] (mg/Kg)	Sample ID (Sample Description)					
				B-12-1-5 (4.5'-6.0')	B-12-1-7 (9.0'-10.5')	B-12-1-8 (10.5'-12.0')	B-12-2-1 (0-1.5')	B-12-2-4 (4.5'-6.0')	B-12-2-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg)									
<u>Volatile Organics</u>									
Methylene Chloride	0.005	0.0056-0.0091	--	0.014	0.019	0.0065[a]	0.011[a]	0.0086[a]	0.011
Acetone	0.010	ND-0.056	--	0.084	0.140	ND[a]	0.030[a]	0.052[a]	0.085
Trans-1,2-Dichlorethene	0.005	ND	--	ND	ND	ND	ND	0.048	ND
Trichloroethene	0.005	ND	--	ND	ND	ND	ND	0.550[c]	0.046
Benzene	0.005	ND	--	ND[b]	ND[b]	ND[b]	ND[b]	0.012[b]	ND[b]
Tetrachloroethene	0.005	ND	--	ND	ND	ND	<0.0053*	ND	0.033
Others	See Appendix F			ND	ND	ND	ND	ND	ND
EPA Method SW3550/8270									
<u>Semivolatile Organics (mg/kg)</u>									
Phenanthrene	0.33	ND	--	ND	ND	ND	0.38[c]	ND	ND
Fluoranthene	0.33	ND	--	ND	ND	ND	0.37[c]	ND	ND
Pyrene	0.33	ND	--	ND	ND	ND	0.44[c]	ND	ND
Bis(2-ethylhexyl)phthalate	0.33	ND-0.39	--	<0.43[*,a]	<0.43[*,a]	<0.42[*,a]	0.38[a,c]	<0.41[*,a]	0.43[a]
Others	See Appendix F			ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010									
<u>Total Metals (mg/kg)</u>									
Aluminum[d]	10.0	2,300-15,600	71,000	15100	13700	14100	12600	16200	12500
Barium	1.0	28.4-163	430	55.4[f]	117[f]	112[f]	121[f]	332[f]	90.2[f]
Beryllium	0.2	ND	6	0.26	ND	ND	ND	ND	ND
Calcium[d]	50.0	2,120-213,000	13,700	3000	38800	50400	41500	40400	43100
Chromium	1.0	3.29-19.6	100	19.5[e]	17.9[e]	22.0[e]	17.2[e]	20.5[e]	15.8[e]
Cobalt	1.0	2.10-11.3	8	15.8	9.01	9.49	10.4	8.69	8.62
Copper	1.0	9.92-21.0	30	18.4[a]	19.0[a]	16.7[a]	17.9[a]	17.9[a]	17.9[a]
Iron[d]	2.5	5,060-31,700	38,000	29700[a]	26600[a]	28200[a]	26200[a]	31400[a]	26600[a]
Lead	5.0	9.96-26.0	10	15.1[e]	17.0[e]	18.5[e]	29.7[e]	18.4[e]	14.4[e]
Magnesium[d]	50.0	4,050-51,900	5,000	9030	13000	9470	14200	9060	4610
Manganese	0.5	386-801	600	618[f]	443[f]	492[f]	423[f]	385[f]	385[f]
Nickel	1.5	4.41-25.1	40	27.7[e]	22.2[e]	26.6[e]	23.2[e]	25.2[e]	21.2[e]
Potassium[d]	50.0	496-2,310	8,300	2270	2360	2630	2340	2620	2110
Silicon[d]	100.0	223-345	320,000	332[a,f]	218[a,f]	392[a,f]	292[a,f]	254[a,f]	340[a,f]
Sodium[d]	50.0	49.6-154	6,300	132	139	161	109	156	140
Vanadium	1.0	5.30-32.0	100	24.9	23.4	24.6	24.0	26.7	22.1
Zinc	1.0	53.3-864	50	55.6	52.5	51.4	84.3	63.4	51.4
Others	See Appendix F			ND	ND	ND	ND	ND	ND

TABLE 4-88 (Cont'd)
SITE NO. 12: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

				Sample ID (Sample Description)					
Parameter (Units)	Detection Limits	Background^g (mg/Kg)	Selected Average for soils^h (mg/Kg)	B-12-1-5 (4.5'-6.0')	B-12-1-7 (9.0'-10.5')	B-12-1-8 (10.5'-12.0')	B-12-2-1 (0-1.5')	B-12-2-4 (4.5'-6.0')	B-12-2-6 (7.5'-9.0')
EPA Method SW3550/E418.1									
Total Petroleum Hydrocarbons	5.0	ND	--	ND	12	7.5	23	7.0	110

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated MS/MSD analyses exceeded the RPD control limit for this parameter.
c = Estimate value; compound quantitated outside calibration range but within linear range.
d = Accuracy data unavailable; compound not spiked.
e = Associated matrix spike had recovery below lower control limit.
f = Associated field duplicate analyses exceeded 35% RPD for this parameter.
g = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
h = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected

During the drilling of the two soil borings at Site No. 12, soil samples were collected for analyses. A total of seventeen metals were detected at various concentrations in soils from these soil borings. Only those metal species that can potentially cause adverse health effects at elevated levels are discussed. The discussion that follows makes comparisons with installation background levels and normal trace element averages published for soils, since no ARARs presently exist for soils:

- Barium concentrations in soils at Site No. 12 ranged from 55.4 mg/kg to 332 mg/kg. The 332 mg/kg concentration measured from soil collected from the 4.5 to 6.0-foot interval of soil boring B-12-2 occurred outside the established range established by the background borings. This level was still below the 430 mg/kg average barium concentration reported for soils.
- Chromium levels in soils of Site No. 12 mostly occurred within the range established by the background borings. Chromium concentrations of 22.0 mg/kg and 20.5 mg/kg in a soil sample from B-12-1 (10.5 to 12.0-foot interval) and B-12-2 (4.5 to 6.0-foot interval) respectively were slightly above background levels. These levels are still well below the 100 mg/kg average chromium concentration reported for soils.
- Beryllium was detected in a soil sample from B-12-1 (4.5 to 6.0-foot interval) at 0.26 mg/kg. Although beryllium was not detected any of the soils from the background borings, the average concentration reported for soils is 6.0 mg/kg.
- Cobalt found in all of the soil samples from Site No. 12 generally occurred within the background range. A cobalt concentration of 15.8 mg/kg recorded from soil of the 4.5 to 6.0-foot interval of B-12-1 was elevated slightly above background.
- A lead level of 29.7 mg/kg found in soil from the 0.0 to 1.5-foot interval of B-12-2 was the only lead value which fell slightly outside the range established by the background soil borings.
- Nickel levels measured in Site No. 12 soils generally were within or slightly outside the upper part of the range established by the background soil borings.
- Copper, zinc, vanadium and manganese levels found in the Site No. 12 soils occurred within the established background ranges.

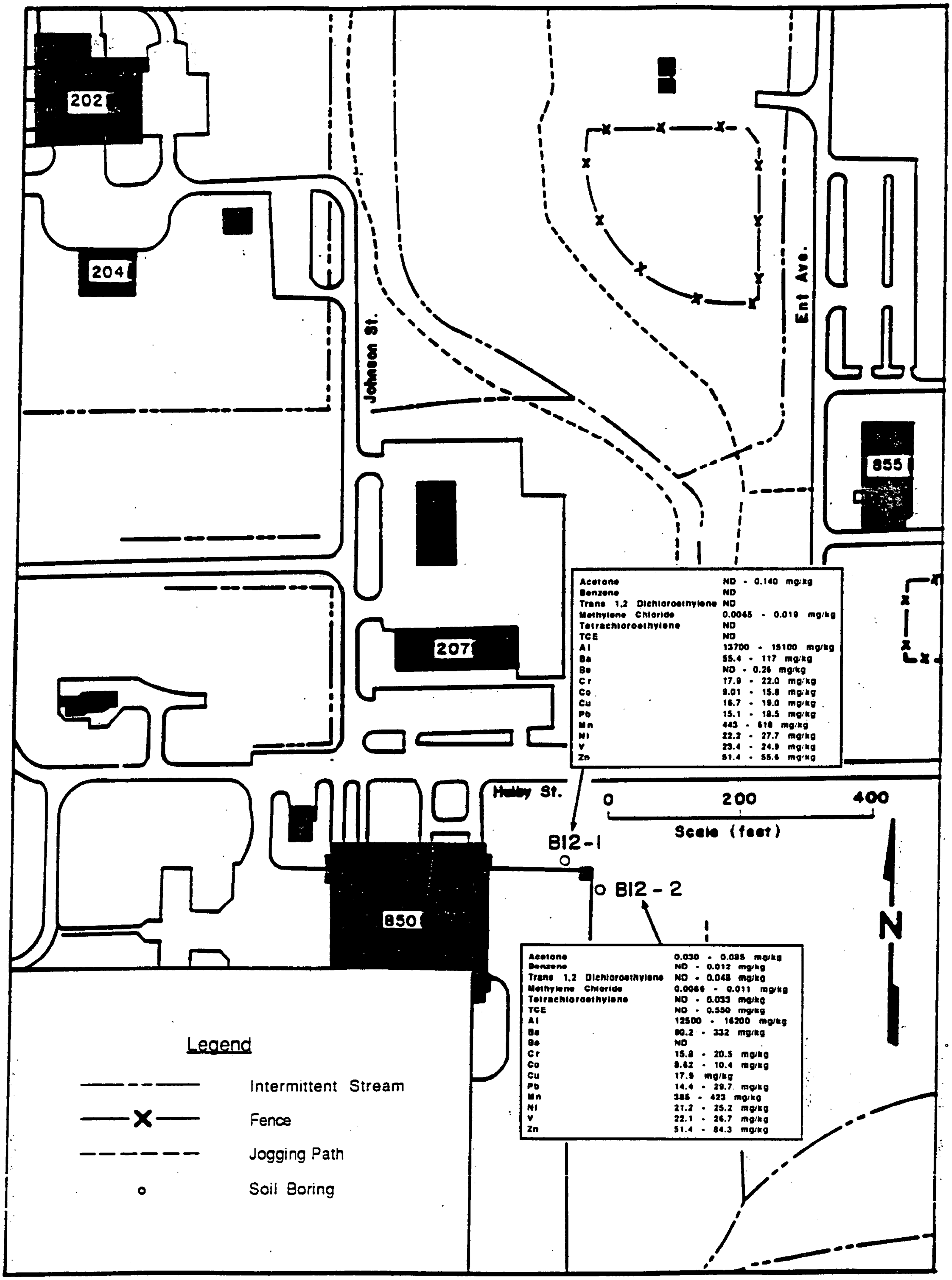
It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area.

The following presents a comparison of the organic analytical data yielded by the Site No. 12 soil borings with installation background levels:

- A total petroleum hydrocarbon (TPH) level of 110 mg/kg was measured in soil collected from the 7.5 to 9.0-foot interval of B-12-2. TPH was detected at lesser amounts in the other soils. TPH was not detected in any of the soil samples analyzed from the background soil borings. The presence of TPH in the Site No. 12 soils may be linked to unreported incidental spills that may have occurred when this area was used as a drum accumulation point.
- A number of volatile organic compounds were detected in soil from the 4.5 to 6.0-foot interval of B-12-2. Trans-1,2-dichloroethene, trichloroethene, benzene and tetrachloroethane levels of 0.048 mg/kg, 0.550 mg/kg, 0.012 mg/kg and 0.033 mg/l were respectively found in one of the soil samples from B-12-2. The presence of volatile organic contamination in subsurface soils of B-12-2 is probably related to unreported incidental spills that may have occurred when this area was used as a drum accumulation point. Even though these concentrations are low, none of these substances were detected in soils from the background borings. A TCE concentration of 0.046 mg/kg also was measured in soil from the 7.5 to 9.0-foot interval of B-12-2.
- Methylene chloride and acetone found in the Site No. 12 soils are probably laboratory contaminants since comparable concentrations were found in the volatile organic method blanks. These compounds are also reported in soils from the background soil borings.
- Phenanthrene, fluoranthene, pyrene and bis(2-ethylhexyl) phthalate were found in the surface soil sample of B-12-2 at 0.38 mg/kg, 0.37 mg/kg, 0.44 mg/kg and 0.38 mg/kg, respectively. In any case, phthalates are typical of laboratory contamination.

4.1.6.2.2 Zones of Contamination

There is no clear zone of contamination at Site No. 12. Soil contamination was only detected in soil from one of the two borings (B-12-2). Since the site was considered a low priority environmental risk, the quality of the groundwater at Site No. 12 was not assessed. Figure 4-67 illustrates levels of contaminants detected at Site No. 12.



B12-1

Acetone	ND - 0.140 mg/kg
Benzene	ND
Trans 1,2 Dichloroethylene	ND
Methylene Chloride	0.0065 - 0.019 mg/kg
Tetrachloroethylene	ND
TCE	ND
Al	13700 - 15100 mg/kg
Ba	55.4 - 117 mg/kg
Be	ND - 0.26 mg/kg
Cr	17.9 - 22.0 mg/kg
Co	9.01 - 15.8 mg/kg
Cu	16.7 - 19.0 mg/kg
Pb	15.1 - 18.5 mg/kg
Mn	443 - 618 mg/kg
Ni	22.2 - 27.7 mg/kg
V	23.4 - 24.9 mg/kg
Zn	51.4 - 55.6 mg/kg

B12-2

Acetone	0.030 - 0.085 mg/kg
Benzene	ND - 0.012 mg/kg
Trans 1,2 Dichloroethylene	ND - 0.048 mg/kg
Methylene Chloride	0.0086 - 0.011 mg/kg
Tetrachloroethylene	ND - 0.033 mg/kg
TCE	ND - 0.550 mg/kg
Al	12500 - 16200 mg/kg
Ba	80.2 - 332 mg/kg
Be	ND
Cr	15.8 - 20.5 mg/kg
Co	8.62 - 10.4 mg/kg
Cu	17.9 mg/kg
Pb	14.4 - 29.7 mg/kg
Mn	385 - 423 mg/kg
Ni	21.2 - 25.2 mg/kg
V	22.1 - 26.7 mg/kg
Zn	51.4 - 84.3 mg/kg

FIGURE 4-67
SITE NO. 12: ZONES OF CONTAMINATION - SOIL

4.1.6.2.3 Contaminant Migration

Because only low levels of contamination were found in one soil sample, contamination migration was not assessed. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.6.2.4 Baseline Risk Assessment for Site No. 12

This section presents the baseline risk assessment for Site 12. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 12 - Data Analysis and Hazard Identification

Chemicals of concern for Site 12 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

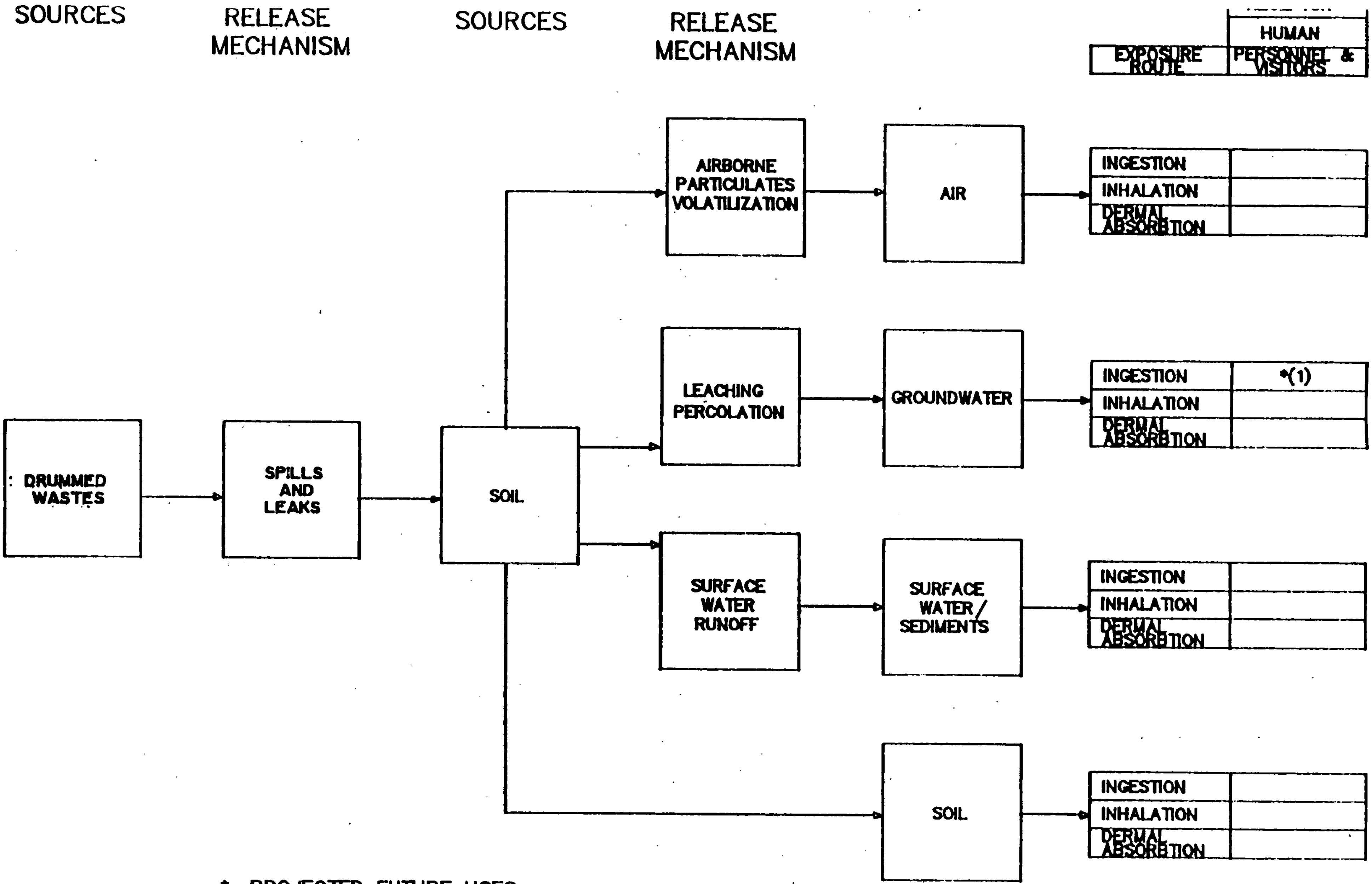
Mean levels of TPH in soils at Site 12 were 27.1 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis however, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment.

Site No. 12 - Exposure Assessment

A conceptual site model for Site 12 is presented as Figure 4-68.

Soil

During the 1950s and early 1960s, this site was used as a hazardous waste drum storage area. There were no reported or observed spills in this area and it is currently covered with grass. Access to the site is not limited, however and soil ingestion scenarios for Base personnel were evaluated. The exposure



* PROJECTED FUTURE USES

O CURRENT USE

(1) HYPOTHETICAL USE OF GROUNDWATER (ie, AREA IS SUPPLIED WITH MUNICIPAL WATER)

FIGURE 4-68
CONCEPTUAL SITE MODEL
SITE 12 - DRUM STORAGE YARD

assumptions used for Site 4 soil exposure were also adopted to assess exposure at Site 12 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Surface Water/Sediments

Although an intermittent stream is located east of the site, a risk-based evaluation has not been conducted for exposure to surface water or sediments in the vicinity of Niagara Falls IAP Site 12. Due to its intermittent nature, the stream cannot support game fish. Thus, no onsite recreational activity (i.e., fishing) takes place in this surface water body. As there is no exposure to sediments or surface waters on base, sediment contamination is not considered in the risk assessment. In addition, no Federal criteria or standards are currently available for sediment contamination.

Site No. 12 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 12 - Risk Characterization

The results of risk characterization for exposure to soil at the Site 12 are presented in Table 4-89. The hazard index for combined exposure across compounds is approximately 4.4 x 10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

As shown in Table 4-89, six potentially carcinogenic compounds were detected in soils at the site. The excess lifetime cancer risk associated with inadvertent ingestion exposure of Base personnel to soils containing these chemicals is approximately 3 x 10^{-8}. EPA has established an acceptable excess lifetime cancer risk range of 10^{-6} to 10^{-4} for waste site remediation under the Superfund Program. Given this guidance, the results for Site 12 would be considered acceptable.

TABLE 4-89

RISK CHARACTERIZATION FOR SITE NO. 12: EXPOSURE TO SOILS

emical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	14158.00			
rium	152.00	4.77E-04	Hypertension	
ryllium	0.15	4.71E-06	Lung, Skin, Heart	2.89E-08
romium	18.90	5.93E-04	Skin	
balt	9.93		Thyroid, Heart	
pper	17.80	7.55E-05	GI Tract, Blood	
ad	18.90	2.12E-03	CNS, Kidney	
nganese	439.00	3.45E-04	CNS, Reproductive	
ckel	24.20	1.90E-04	Skin, Lung	
nadium	24.40	5.47E-04	Respiratory Effects	
nc	59.20	4.65E-05	GI Tract	
GANICS				
etone	0.01	1.88E-08	Liver, Kidney	
nzene	0.005	1.96E-06	Hematopoietic Sys.	5.85E-12
s(2-ethylhexyl) phthalate	0.27	2.12E-06	Liver	1.70E-10
2-Dichloroethylene	0.01	8.24E-08	Liver, Kidney, CNS	
uoranthene	0.24	9.42E-07	Skin	
thylene Chloride	0.09	2.35E-07	Liver, Kidney, CN	3.03E-11
enanthrene	0.24	9.42E-06	Skin	
rene	0.25	9.81E-06	Skin	
trachloroethylene	0.01	1.26E-07	Liver, Kidney, CNS	1.83E-11
ichloroethylene	0.10	1.59E-06	Liver, Kidney, CNS	5.00E-11
zard Index: Combined Exposure		4.42E-03		
cess Lifetime Cancer Risk: mbined Exposure				3E-08

Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

Explanation of risk assessment calculations is included in Section 4 Attachment B.

Site No. 12 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.1.7 Discussion of Results for Site No. 9 - Fire Training Area No. 3

4.1.7.1 Presentation of Results

4.1.7.1.1 Site Geology

The geology of Site No. 9, as interpreted by the Stage 1 and RI soil borings and well boring logs, consists of a veneer of fine grained glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The locations of all Site No. 9 soil borings and monitoring wells is presented in Figure 4-69. The average thickness of the unconsolidated deposits in the Site No. 9 study area is 8.8 feet. The thickness ranged from 7.3 feet at shallow monitoring well MW9-6 to 9.7 feet at monitoring wells MW9-7 and MW9-4. Soil and well boring logs show a tendency for sediments to thin slightly towards the intermittent stream north of the site. The Lockport Dolomite in this area of Niagara Falls is estimated to be approximately 180 feet thick. A generalized geologic cross-section of the Site No. 9 study area is presented in Figure 4-70.

Two soil types occur in the Site No. 9 study area. Soils belonging to the Odessa Series predominate, but a narrow protuberance of Lakemont Series' soils extends north from the western edge of runway 10L/28R into the study area. Soils of the Odessa Series were described previously in Section 4.1.1.1.1. The Lakemont Series' soils are also characterized by gently sloped, poorly to very poorly drained, silty clay loams. The surface soils are eight-inches thick and are comprised of black silty clay loam. The upper part of the subsoil consists of firm gray to light-gray silty clay that has few, prominent, reddish yellow mottles. The lower part of the subsoil consist of firm pinkish-gray silty clay that has few, prominent reddish-yellow mottles. The subsoil is approximately 18 inches thick.

As at all the other sites, lacustrine sediments form the uppermost unconsolidated unit. A silty clay till forms the lowermost unit which rests

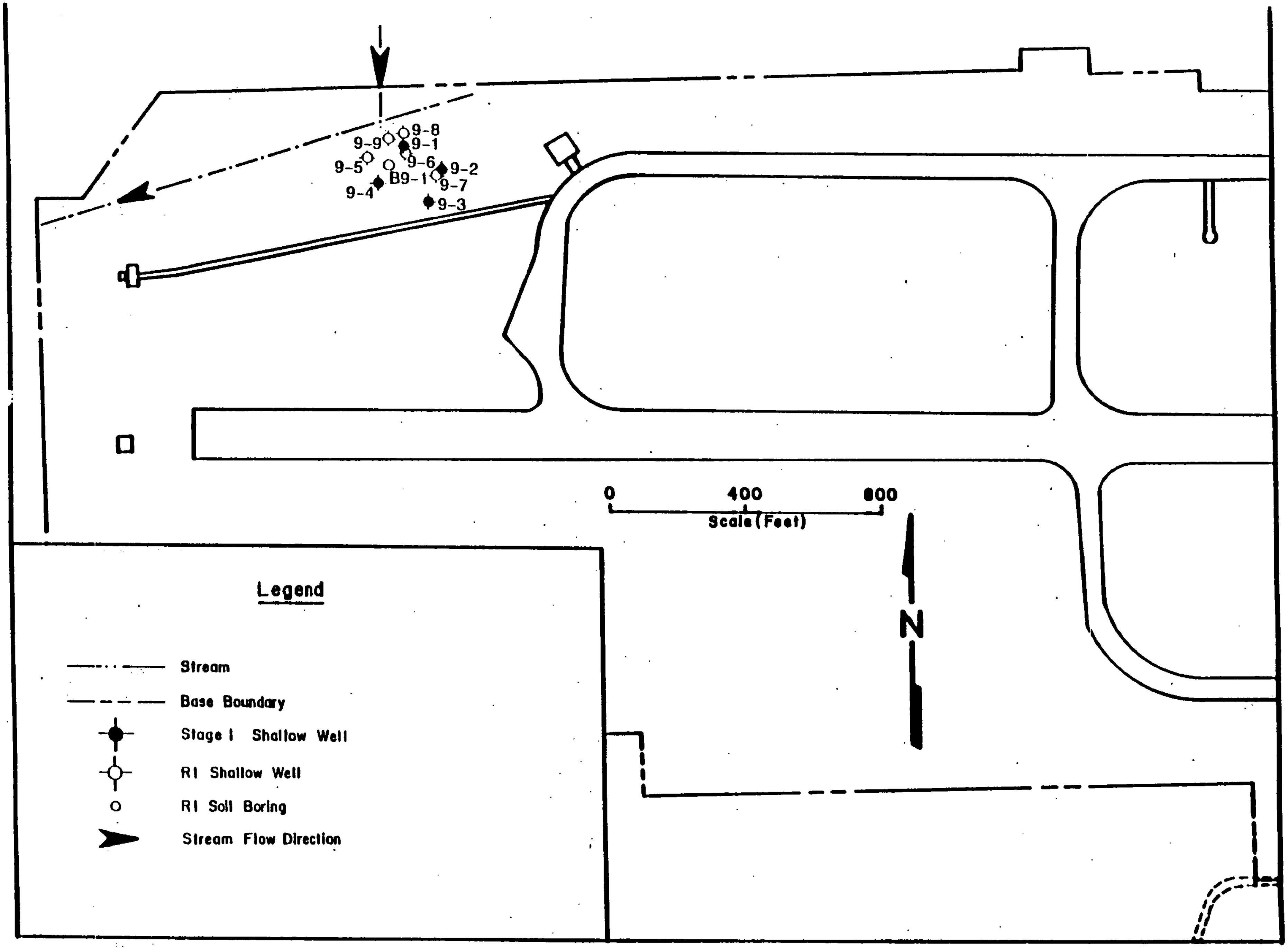


FIGURE 4-69

SITE NO. 9: SOIL BORING AND MONITORING WELL LOCATION MAP

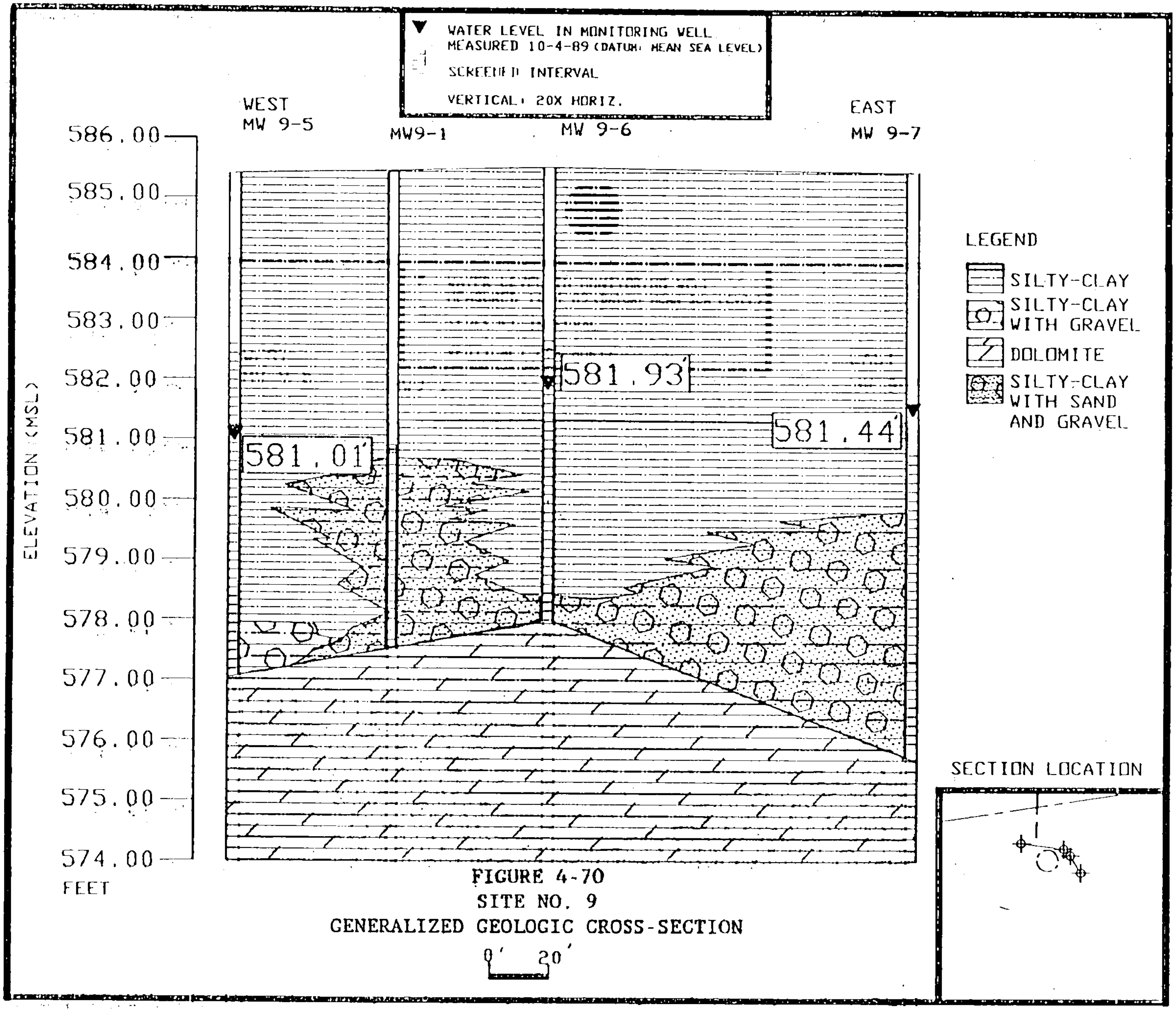


FIGURE 4-70
SITE NO. 9
GENERALIZED GEOLOGIC CROSS-SECTION

directly on the bedrock surface. Both units are similar in texture, consistency and overall appearance which complicates efforts to distinguish one unit from the other. For this reason, it is difficult to establish the thickness of each unit since the contact between the till and lacustrine deposits is indistinct. Both of these units were described previously in Section 4.1.1.1.1. Due to the inherent problems associated with distinguishing between these units, and the sampling problems discussed in Section 4.1.2.1.1., thickness variations in the till and lacustrine deposits could not be ascertained in the study area.

Thin intercalations of fluvial sediments were encountered in several of the Stage 1 and RI well borings. Other thin lenses of fluvial sand and silt may occur sporadically throughout the Site No. 9 study area but were not detected during field sampling.

The bedrock surface, as interpreted from the well and soil boring logs, has little relief. Evidence of preglacial or even glacial erosional features are not apparent. The relatively flat profile stands in contrast to the dissected bedrock surface found at the eastern IRP sites. A structural contour map of the Lockport Dolomite surface at Site No. 9 is presented as Figure 4-71.

Site specific information on bedrock geology at Site No. 9 is unavailable since none of the well borings were completed in the Lockport Dolomite. Structural characteristics, of the Lockport Dolomite are probably similar to that encountered at the other IRP sites.

4.1.7.1.2 Site Hydrogeology

Only the shallow unconsolidated aquifer was investigated at Site No. 9. Based upon the Stage 1 and RI well boring logs, the first potential water-bearing zone encountered is a 1 to 1-1/2 foot silty-clay layer that rests directly on the bedrock surface. This layer generally tends to have a slightly higher concentration of sand or gravel than the typical glacial till, which enhances the permeability of this interval. All of the other unconsolidated materials encountered lack sufficient permeability to function as water-bearing formations and collectively function as an aquitard.

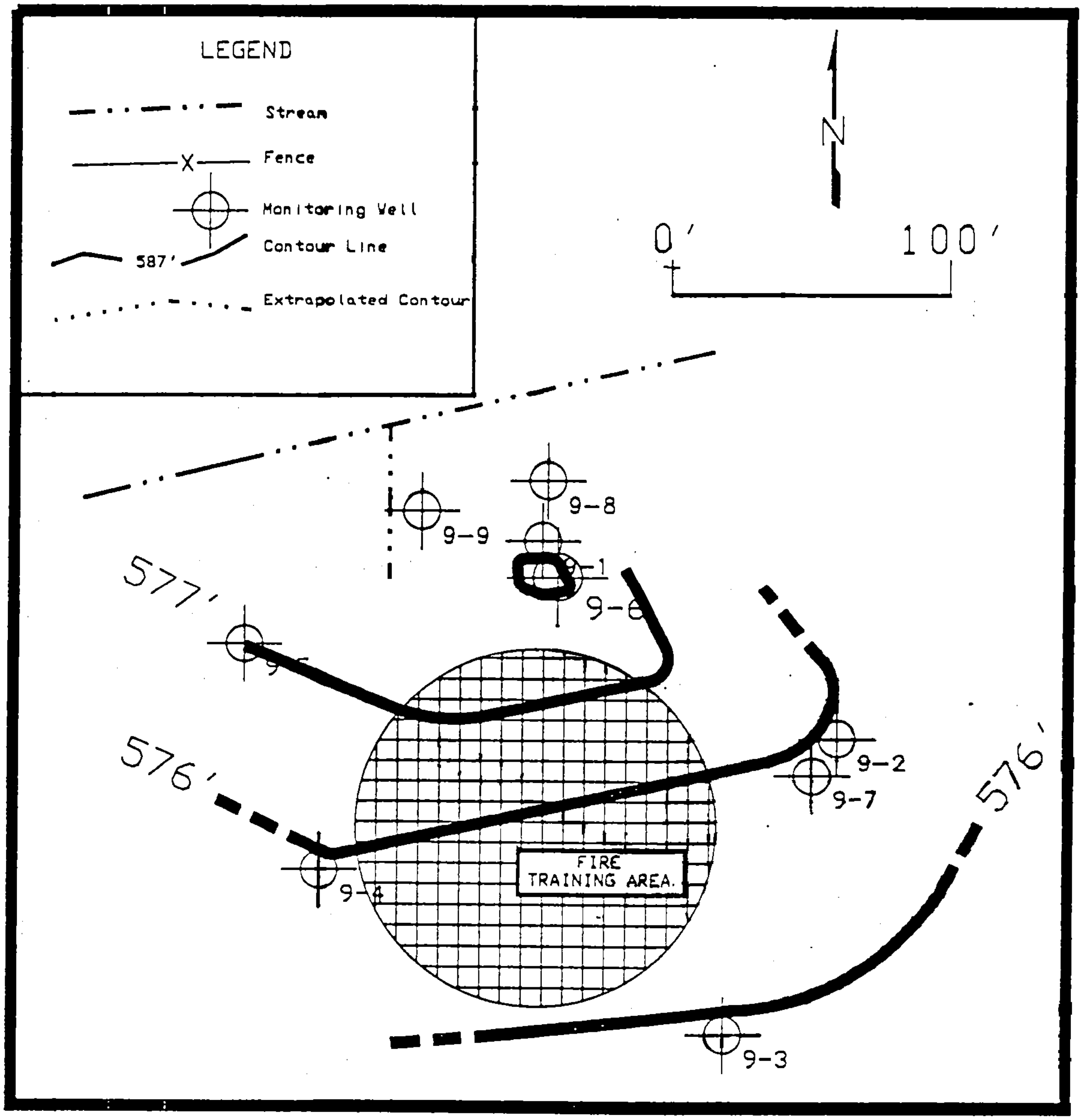


FIGURE 4-71
SITE NO. 9: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

Between September 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 4.14 feet. During April 1990, water levels exhibited a range in elevation from 585.59 feet MSL at MW9-4 to 581.39 feet MSL at MW9-8. The maximum head differential across the Site No. 9 study area is 4.20 feet and the hydraulic gradient is 0.0255. According to the groundwater flow monitoring study discussed previously (Mercer et. al., 1983), a hydraulic gradient of 0.0036 is more typical of the unconsolidated aquifer. The steeper gradient interpreted at Site No. 9 and several other sites across the installation is believed to be a seasonal abnormality that exists only during the wetter Spring months.

A maximum average water fluctuation of approximately 1.67 feet was observed in the shallow aquifer at Site No. 9 between October 1989 and April 1990. Table 4-90 presents all the hydrogeological data collected at Site No. 9. Figures 4-72 and 4-73 present a potentiometric surface maps of the shallow unconsolidated aquifer constructed from the October 1989 and April 1990 water level measurements. The potentiometric surface maps suggest that the groundwater flow direction in the shallow aquifer varies throughout the year. In October 1989, a southwestward flow was inferred from the water level data; in April 1990, a northeast and northwest groundwater flow pattern was interpreted. The fire pit which fills with rainwater probably causes groundwater to mound during the wetter Spring months.

During the Stage 1 effort hydraulic conductivity tests (i.e., slug test) were conducted on shallow monitoring wells MW9-2 and MW9-4. No aquifer testing was conducted during the RI. During Stage 1 the slug tests were performed by recording head levels with a weighted graduated line with an attached float. Hydraulic conductivities of 1.1 x 10^{-6} ft/sec (3.4 x 10^{-5} cm/sec) and 2.5 x 10^{-6} ft/sec (7.6 x 10^{-5} cm/sec) were calculated for MW9-2 and MW9-4 respectively. As discussed in Section 4.1.1.1.2, the groundwater flow modeling study at Love Canal (Mercer et. al., 1983) reported bulk hydraulic conductivities for the unconsolidated aquifer in the range of 10^{-6} to 10^{-7} ft/s, an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. The point source hydraulic conductivities yielded by the Stage 1 slug tests on MW9-2 and MW9-4 are consistent with the values reported in the flow modeling study. Utilizing the

TABLE 4-90

Site No. 9 - Hydrogeologic Data

Static Water Level Results

Monitor	05-31-89 Water Levels		09-12-89 Water Levels		10-04-89 Water Levels		04-11-90 Water Levels	
Well No	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS
9-1	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
9-2	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
9-3	NT	NT	581.52	4.16	581.07	4.61	583.32	2.36
9-4	NT	NT	581.26	4.33	580.79	4.80	585.59	NT
9-5	NI	NI	581.32	4.09	581.01	4.40	581.63	3.78
9-6	NI	NI	582.27	3.17	581.93	3.51	583.99	1.45
9-7	NI	NI	581.88	3.59	581.44	4.03	583.19	2.28
9-8	NI	NI	NI	NI	NI	NI	581.39	6.47
9-9	NI	NI	NI	NI	NI	NI	583.44	4.19

Stage 1 Aquifer Test Results

Well	(K) Hydraulic Conductivity	(B) Saturated Thickness	(T) Transmissivity
MW9-2	1.11×10^{-6} ft/sec	4.0 ft	4.44×10^{-6} ft^2/sec
MW9-4	2.50×10^{-6} ft/sec	4.0 ft	1.00×10^{-5} ft^2/sec

Notes:

NT = Not Taken
NI = Not Installed
ft.BLS = Feet below land surface
ft.MSL = Feet in reference to mean sea-level
Transmissivity was calculated as follows: K · B = T.
Saturated thickness was determined by measuring the length of screen below the static water-level.

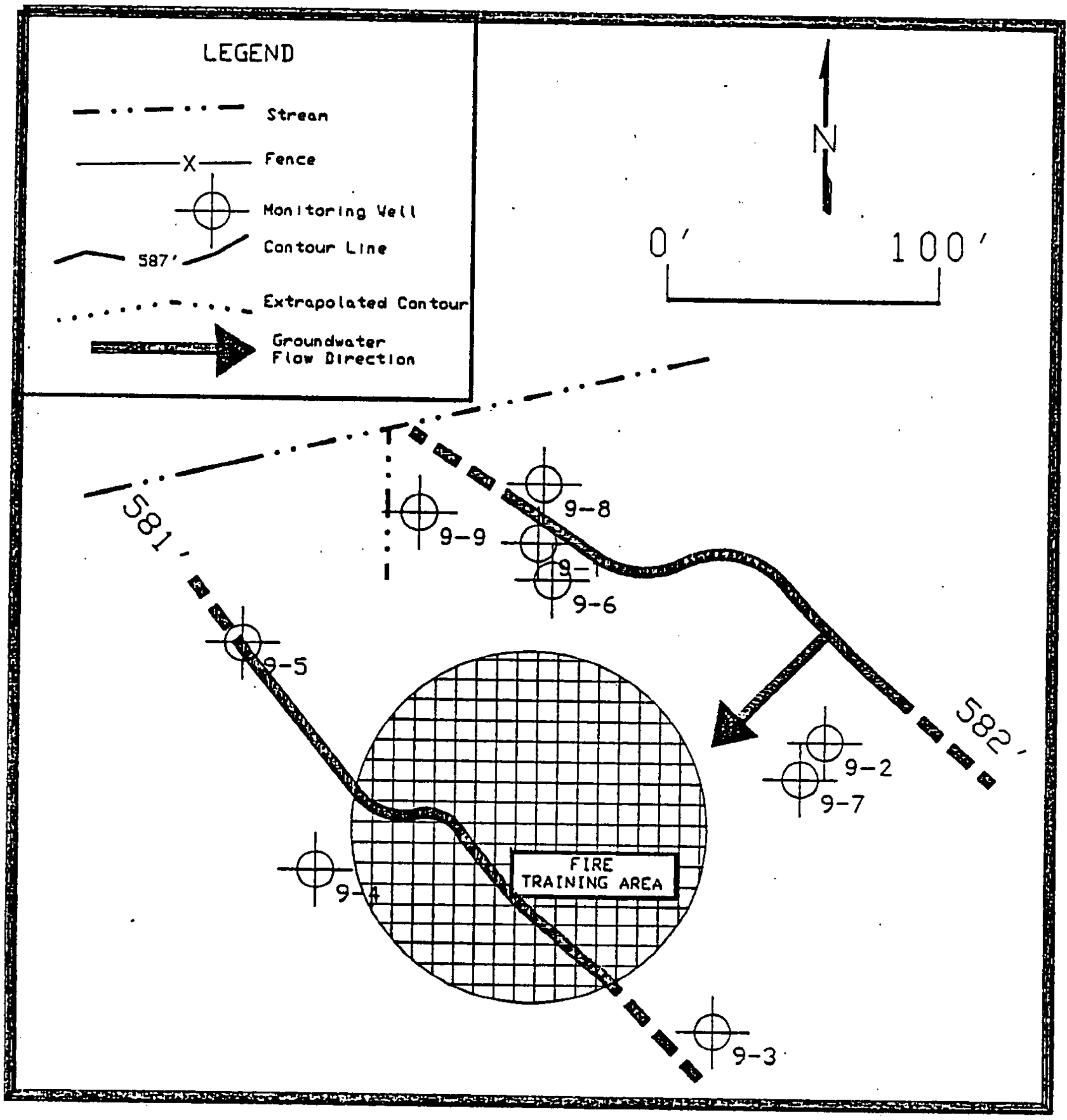


FIGURE 4-72
SITE NO. 9: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

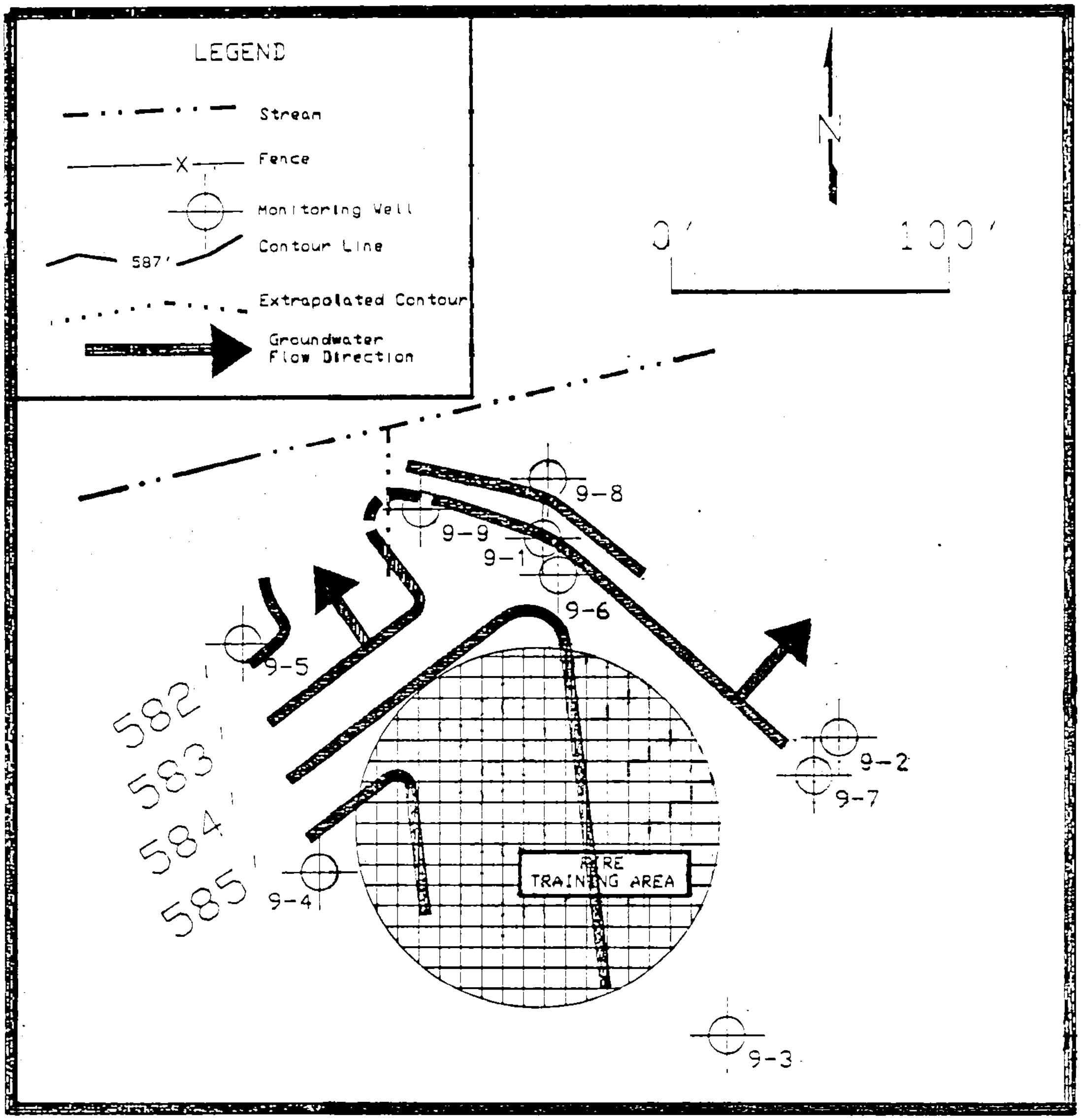


FIGURE 4-73

SITE NO. 9: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

hydraulic data from the flow modeling study, horizontal groundwater flow velocities of 2.1×10^{-4} to 2.1×10^{-3} ft/day or 7.7×10^{-2} to 7.7×10^{-1} ft/year are predicted. According to the USGS (1985), groundwater flow in the shallow aquifer at a nearby industrial property ranged from 2.0×10^{-2} to 6.0×10^{-2} ft/year.

A westward flowing intermittent stream is located just north of the Site No. 9 study area. During the RI surface water/sediment sampling program conducted in September 1989, the stream was overgrown with cattails, bulrush and other varieties of marsh type vegetation. The stream also contained pockets of stagnant water supporting a heavy growth of duck-weed. A southward flowing tributary intercepts the main stream at a point located approximately 70 feet northwest of shallow monitoring well MW9-1. This tributary enters the installation about 100 feet north of its interception point with the main stream. During the surface water/sediment sampling program, this tributary was dry. A 72-acre freshwater wetland is situated west southwest of the Site No. 9 study area. Figure 4-74 shows the Site No. 9 surface water/sediment sampling stations along the intermittent stream. Due to obstructions and stagnant water conditions in the intermittent stream, velocity measurements could not be taken.

4.1.7.1.3 Analytical Results For Site No. 9: Headspace Analyses

Stage 1 monitoring well MW9-3 was the only well in service during the headspace analyses program. All other wells were apparently destroyed by grounds keeping equipment. A total hydrocarbon concentration of 14 ug/l was measured in this well. All other compounds occurred below the instrument's detection limits.

Headspace analyses were conducted on three soil samples collected from shallow hand auger borings at Site No. 9 to augment what little information was yielded from the groundwater. Total hydrocarbon levels of 60 ug/kg, 340 ug/kg and 2 ug/kg were detected in soils from headspace soil borings SB9-1, SB9-2 and SB9-4 respectively. Concentrations of all other compounds occurred at or below the instrument's detection limit. The headspace analyses for groundwater and soils at Site No. 9 are presented in Table 4-91.

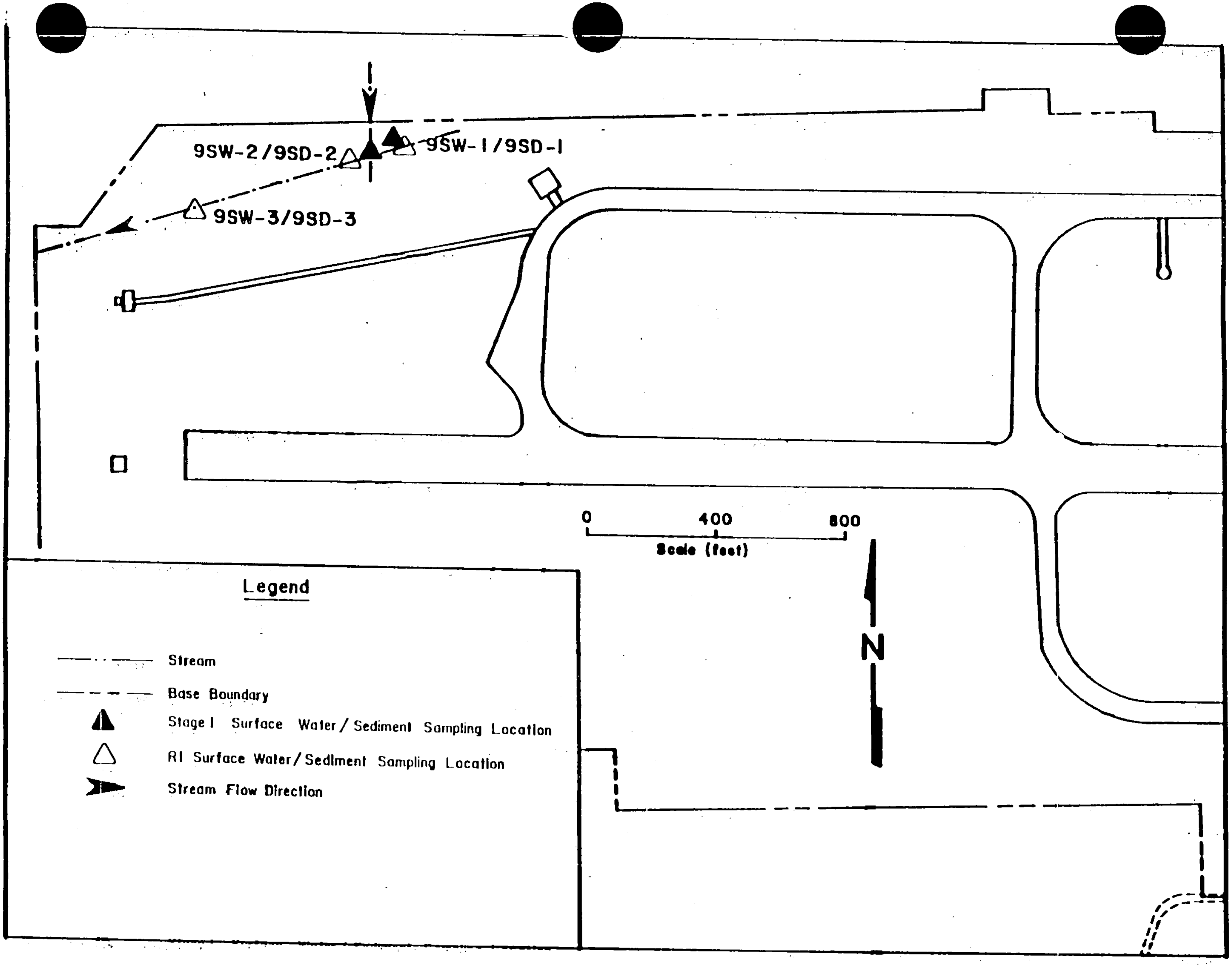


FIGURE 4-74
SITE NO. 9: SURFACE WATER/SEDIMENT SAMPLING STATIONS

TABLE 4-91

Site No. 9: Summary of Headspace Analytical Results for Groundwater and Soils

GROUNDWATER

Sample	Date	TCA (ug/l)	TCE (ug/l)	PCE (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
MW9-3	06/03/89	<0.0002	<0.002	<0.0003	<0.4	<0.4	<0.3	<6	14

SOIL:

Sample	Date	TCA (ug/kg)	TCE (ug/kg)	PCE (ug/kg)	Benzene (ug/kg)	Toluene (ug/kg)	Ethyl Benzene (ug/kg)	Xylenes (ug/kg)	Total Hydroc. (ug/kg)
SB9-1	06/03/89	0.03	<0.002	0.01	<0.5	<0.5	<0.5	<9	60
SB9-2	06/03/89	0.02	<0.002	0.01	<0.5	<0.5	<0.4	<0.7	340
SB9-3	06/03/89	0.02	<0.002	0.009	<0.6	<0.6	<0.5	<12	2

4.1.7.1.4 Analytical Results for Site No. 9: Contract Laboratory

Matrix-specific results are presented for each individual sample in Tables 4-92 through 4-95; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-96.

Organic Analysis: Seven soil boring samples were collected and analyzed for volatile organics and semivolatile organic compounds. Four groundwater samples, and associated field QC blanks, were collected during the original sampling effort and analyzed for purgeable halocarbons and purgeable aromatics. During the additional RI field effort (April, 1990) these four wells along, with two new wells, were collected and analyzed for the same parameters. Three surface water samples were analyzed for purgeable halocarbons and purgeable aromatics, and three surface sediments were analyzed for volatile and semivolatile organics. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The volatile organic analysis of soil sample WB-9-5-6 resulted in one surrogate recovery outside control limits: p-bromofluorobenzene recovery =127%, upper control limit =121%.
- Soil sample WB-9-6-3 was analyzed for volatile organics using methanol extraction; note the elevated detection limits.
- The volatile organic method blanks associated with the analysis of the soil samples all contained methylene chloride and acetone at levels just at or below the detection limits. Therefore the sample concentrations of these compounds are suspected of being biased.
- Field duplicates associated with the soil samples (excluding WB-9-7-6) were collected at different sites during the same time period that samples from Site 9 were collected. Field duplicate pair WB-8-2D-7/7R (applicable to WB-9-5-6, WB-9-6-3/4) exceeded 35% RPD for the volatile organic analysis of methylene chloride (detected in one sample, but not the other) and acetone (74%). This is probably a result of lab bias for these two compounds as opposed to sampling imprecision.
- Method blanks associated with the semivolatile organic analysis of the soil samples all contained bis(2-ethylhexyl)phthalate at levels just below the detection limit (reported as <0.33* mg/kg, where * ="compound present below the measurable detection limit."). Therefore sample concentrations of this compound (ranging from ND-0.39 mg/kg) are suspected of being a result of lab contamination.

TABLE 4-92
SITE NO. 9: ANALYTICAL RESULTS: SOILS

		Sample ID (Sample Description)						
Parameter (Units)	Detection Limits	B-9-1-1 (0'-1.5')	B-9-1-3 (3.0'-4.5')	B-9-1-6 (7.5'-9.0')	WB-9-5-6 (7.5'-8.6')	WB-9-6-3 (3.0'-4.5')	WB-9-6-4 (4.5'-6.0')	WB-9-7-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg)								
Volatile Organics								
Methylene Chloride	0.005	0.021[c]	0.021[c]	0.013[c]	0.0054[a,c,d]	<1.250[*,b,c,d]	0.016[c,d]	ND[c]
Acetone	0.010	0.032[c]	0.023[c]	0.047[c]	0.032[a,c,d]	ND[b,c,d]	0.069[c,d]	0.038[c]
2-Butanone	0.010	ND	ND	ND	ND[a]	ND[b]	0.021	ND
Benzene	0.005	ND	ND	ND	ND[a]	ND[b]	0.013	ND
Toluene	0.005	<0.0060[*]	<0.0060[*]	ND	<0.0055[*,a]	<1.250[*,b]	0.0082	ND
Ethylbenzene	0.005	ND	ND	ND	ND[a]	<1.250[*,b]	0.0082	ND
Total Xylenes	0.005	ND	ND	ND	ND[a]	<1.250[*,b]	0.0100	ND
Others	See Appendix F	ND	ND	ND	ND[a]	ND[b]	ND	ND
EPA Method SW3550/8270								
Semivolatile Organics (mg/kg)								
Naphthalene	0.33	ND	ND	ND	ND[e]	0.650[e]	ND[e]	ND
Bis(2-ethylhexyl)phthalate	0.33	<0.39[*,c,d]	0.39[c,d]	ND[c,d]	ND[c,e]	<0.415[*,c,e]	<0.39[*,c,e]	ND[c]
2-Methylnaphthalene	0.33	ND	ND	ND	ND[e]	0.500[e]	ND[e]	ND
Others	See Appendix F	ND	ND	ND	ND[e]	ND[e]	ND[e]	ND
EPA Method SW3050/6010								
Total Metals (mg/kg)								
Aluminum[f]	10.0	17000	22900	30400	3720[c]	17700[c]	11800[c]	3350
Barium	1.0	122	201	123	43.5[g]	228[g]	106[g]	43.5
Beryllium	0.2	0.498	0.275	ND	ND[g]	ND[g]	ND[g]	ND[g]
Calcium[f]	50.0	3560	54600	105000	114000	62100	88800	314000
Chromium	1.0	26.5	20.7	21.4	6.99[g]	48.6[g]	17.5[g]	4.62
Cobalt	1.0	14.1	11.1	13.2	1.84[g]	25.8[g]	8.00[g]	2.54[g,h]
Copper	1.0	20.8	19.8	22.5	8.42[g]	45.1[g]	12.8[g]	10.9
Iron[f]	2.5	30300	38200	53800	8660[c]	43800[c]	22700[c]	7300
Lead	5.0	26.0	15.2	17.5	7.80[h]	43.5[h]	8.08[h]	21.3[g]
Magnesium[f]	50.0	5900	19800	28100	52600	16100	9070	134000
Manganese	0.5	553	454	586	515[f]	1310[f]	404[f]	595
Nickel	1.5	26.8	25.9	26.7	5.99[g]	63.0[g]	21.0[g]	6.32[g]
Potassium[f]	50.0	1560	2390	2700	841	5990	2260	735
Silicon[f]	100.0	3230	1250	1020	686[c]	1490[c]	654[c]	514
Sodium[f]	50.0	174	238	243	126	404	166	189
Vanadium	1.0	34.9	28.9	29.6	8.79[g]	73.4[g]	21.8[g]	7.43
Zinc	1.0	182	56.3	107	250[g]	132g	46.5[g]	157
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1								
Total Petroleum Hydrocarbons	5.0	18[i]	36[i]	28[i]	20	140	ND	ND

TABLE 4-92 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: SOILS

Footnotes:

* = Compound present below measurable detection limit.
a = Surrogate recovery (4-bromofluorobenzene) above upper control limit.
b = Volatile organic compound analysis performed using methanol extraction; detection limits are approximately 200 times higher than normal.
c = Compound also detected in associated method blank.
d = Associated field duplicate analyses exceeded 35% RPD for this parameter.
e = Associated MS/MSD analyses had recovery and RPD results outside of control limits.
f = Accuracy data unavailable; compound not spiked (or recovery could not be calculated).
g = Associated matrix spike recoveries were below the lower control limit.
h = Associated matrix replicate analyses resulted in RPD's which exceeded the control limit.
i = Associated matrix spike recoveries were above the upper control limit.

TABLE 4-93
SITE NO. 9: ANALYTICAL RESULTS: GROUNDWATER

		Sample ID (Sample Description)						
Parameter (Units)	Detection Limits	GW15 (MW-9-3)	GW16 (MW-9-7)	GW17 (MW-9-6)	GW18 (MW-9-5)	TB16 Trip Blank	GW20 Field Blank	GW19 Equip. Wash
EPA Method SW5030/8021 (ug/L)								
Volatile Organics/Purgeable Halocarbons								
Methylene Chloride	0.8	4.0[a,b,c]	3.8[a,b,c]	3.3[b,c]	3.0[b,c]	1.7[b,c]	5.4[b,c]	4.7[b,c]
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (μg/L)								
Purgeable Aromatic Organics		ND			ND	ND	ND	ND
Benzene	0.3		ND	50				
Total Xylenes	1.0		ND	48				
Toluene	0.3		0.79	2.0				
Ethylbenzene	0.3		ND	9.1				
Others	See Appendix F		ND	ND				
EPA Method E200.7*								
Total Metals (mg/kg)						NA	NA	
Aluminum	0.1	2.54	2.47	ND	0.469			0.100
Barium	0.01	0.029	0.037	0.026	0.021			ND
Boron	0.01	0.587[e]	0.335[e]	0.122[e]	0.077[e]			ND[e]
Calcium[d]	0.20	555	642	560	741			4.47
Cobalt	0.010	ND	ND	ND	0.016			ND
Copper	0.010	0.022	ND	ND	0.017			ND
Iron	0.025	4.51[e]	5.68[e]	2.08[e]	3.45[e]			0.100[e]
Lead	0.05	ND	ND	ND	ND			ND
Lead (E239.2)	0.005	0.010[e]	0.006[e]	ND[e]	ND[e]			ND[e]
Magnesium[d]	0.20	264	325	374	854			5.27
Manganese	0.005	0.453	1.50	3.03	2.48			0.023
Molybdenum	0.010	ND	ND	0.012	0.010			ND
Nickel	0.015	0.020	ND	ND	ND			ND
Potassium[d]	0.4	5.24[e]	52.5[e]	2.16[e]	2.95[e]			ND[e]
Silicon[d]	0.020	9.48	11.6	6.07	8.19			0.217
Sodium[d]	0.200	254	300	173	382			2.36
Zinc	0.01	0.362	0.084	0.019	0.172			ND
Others	See Appendix F	ND	ND	ND	ND			ND

TABLE 4-93 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	Detection Limits	Sample ID (Sample Description)						
		GW15 (MW-9-3)	GW16 (MW-9-7)	GW17 (MW-9-6)	GW18 (MW-9-5)	TB16 Trip Blank	GW20 Field Blank	GW19 Equip. Wash
EPA Method E418.1 (SW3550/E418.1)								
Total Petroleum Hydrocarbons	1.0	ND	1.2	1.5	ND	NA	NA	ND
Miscellaneous Inorganics (mg/L)						ND	ND	
Total Dissolved Solids (E160.1)	1.0	3800	4000	4000	3100			83
Common Anions (A429)								
Fluoride	0.1	1.2	1.0	1.1	1.5			ND
Chloride	0.5	330	130	120	75			ND
Sulfate	0.5	2300	3000	2600	3700			ND
Total Hardness (E130.1)	1.0	2400	2400	2400	3600			ND

Footnotes:

a = Sample had a surrogate recovery above the upper control limit.
b = Compound also detected in associated method blank.
c = Assoicated MS/MSD analyses had high recoveies for this compond.
d = Accuracy data unavailable; compound not spiked.
e = Associate lab matrix replicate analysis had RPD values which were above the control limit.
* = Or as indicated if analyzed by an alternate method.

TABLE 4-93 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: GROUNDWATER

Parameter (Units)	GW115 (MW9-3, add'l RI)	GW116 (MW-9-5, add'l RI)	GW117 (MW-9-6, add'l RI)	GW118 (MW-9-7, add'l RI)	GW119 (MW-9-6 dup, add'l RI)	GW123 (MW-9-8, add'l RI)	GW124 (MW-9-9 add'l RI)	GW112 (Trip Blank)
	Sample ID (Sample Description)							
EPA Method SW5030/8021 (ug/L)								
<u>Volatile Organics/Purg. Halocarbons</u>	ND			ND	ND			ND
Methylene Chloride		1.0	2.1^b			2.7^b	2.5^b	
Others		ND	ND			ND	ND	
EPA Method SW5030/8020 (µg/L)								
<u>Purgeable Aromatic Organics</u>		ND		ND			ND	ND
Benzene	ND		72		69	ND		
Total Xylenes	ND		9.4		9.0	ND		
Toluene	0.44		0.32		0.56	0.56		
Ethylbenzene	ND		11		10	ND		
Others	ND		ND		ND	ND		

<u>Footnotes</u>:

a = Sample had a surrogate recovery above the upper control limit.
b = Compound also detected in associated method blank.
c = Assoicated MS/MSD analyses had high recoveies for this compond.
d = Accuracy data unavailable; compound not spiked.
e = Associate lab matrix replicate analysis had RPD values which were above the control limit.
* = Or as indicated if analyzed by an alternate method.

TABLE 4-93 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: GROUNDWATER

	Sample ID (Sample Description)				
Parameter (Units)	GW120 (Trip Blank)	GW113 (Field Blank)	GW121 (Field Blank)	GW114 (Equip. Wash)	GW122 (Equip. Wash)
EPA Method SW5030/8021					
<u>Volatile Organics/Purgeable Halocarbons</u>					
Methylene Chloride	2.9[b]	5.4	7.7[b]	4.4	7.5[b]
Others	ND	ND	ND	ND	ND
EPA Method (SW5030/8020)(μg/L)					
<u>Purgeable Aromatic Organics</u>	ND		ND		ND
Benzene		ND		ND	
Total Xylenes		ND		ND	
Toluene		0.58		0.51	
Ethylbenzene		ND		ND	
Others		ND		ND	

<u>Footnotes</u>:

a = Sample had a surrogate recovery above the upper control limit.
b = Compound also detected in associated method blank.
c = Assoicated MS/MSD analyses had high recoveies for this compond.
d = Accuracy data unavailable; compound not spiked.
e = Associate lab matrix replicate analysis had RPD values which were above the control limit.
* = Or as indicated if analyzed by an alternate method.

TABLE 4-94
SITE NO. 9: ANALYTICAL RESULTS: SURFACE WATERS

Parameter (Units)	Detection Limits	Sample ID (Sample Description)				
		SW-12 (9SW-1)	SW-13 (9SW-2)	SW-14 (9SW-3)	TB-28 Trip Blank	SW-11 Field Blank
EPA Method SW5030/8021 (ug/L)						
Volatile Organics/Purgeable Halocarbons						
1,1,1-Trichloroethane	0.4	92	74	42	ND	ND
1,1-Dichloroethane	0.5	3.3	3.0	2.5	ND	ND
Chloroform	0.4	ND[a]	0.59[a]	ND[a]	ND[a]	ND[a]
Methylene Chloride	0.8	4.7[a]	4.3[a]	ND[a]	ND[a]	4.7[a]
Trichloroethene	1.0	3.6	2.7	1.5	ND	ND
Others	See Appendix F	ND	ND	ND	ND	ND
EPA Method SW5030/8020 (µg/L)						
Purgeable Aromatic Organics	ND	ND	ND	ND	ND	ND
EPA Method E200.7**						
Total Metals (mg/kg)					NA	NA
Aluminum	0.1	0.188	0.320	0.147		
Barium	0.01	0.091	0.099	0.093		
Boron	0.01	0.206[a,d]	0.241[a,d]	0.250[a,d]		
Calcium[c]	0.05	159	166	162		
Iron	0.025	0.272	0.456	0.279		
Magnesium[c]	0.20	59.	61.0	58.8		
Manganese	0.005	0.069[b]	0.100[b]	0.110[b]		
Mercury (E245.1)	0.0002	1.0[f]	0.40[f]	0.36[f]		
Potassium[c]	0.4	7.74	8.08	7.15		
Silicon[c]	0.020	4.48[a,d]	4.86[a,d]	4.89[a,d]		
Sodium[c]	0.200	80.1	84.1	78.4		
Zinc	0.01	0.728	0.638	0.372		
Others	See Appendix F	ND	ND	ND		
EPA Method E418.1 (mg/L)						
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	NA	NA
Miscellaneous Inorganics (mg/L)					NA	NA
Total Dissolved Solids (E160.1)	1.0	980	110	960		
Common Anions (A429)						
Fluoride	0.1	0.63	0.63	0.62		
Chloride	0.5	150	160	160		
Sulfate	0.5	330	350	330		
Total Hardness (130.1)	1.0	660	680	660		

TABLE 4-94 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: SURFACE WATERS

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated field duplicate analyses exceeded 35% RPD.
c = Accuracy data unavailable.
d = Associated lab matrix replicate analyses resulted in RPD value which was above the control limit.
e = Associated matrix spike analysis had low recovery for the compound.
f = Mercury was determined on samples recollected during the additional RI field effort-sample field ID for these samples was SW-15(=9SW-3) SW-16(=9SW-2) and SW-17 9=9SW-1).
** = Or as indicated if analyzed by an alternate method.

TABLE 4-95
SITE NO. 9: ANALYTICAL RESULTS: SURFACE SEDIMENTS

Parameter (Units)	Detection Limits	Sample ID (Sample Description) SD-12 (9SD-1)	SD-13 (9SD-2)	SD-14 (9SD-3)
EPA Method SW8240				
Volatile Organics (mg/kg)				
Methylene Chloride	0.005	0.036[b]	0.019[b]	ND[b]
Acetone	0.010	0.143[a]	0.042[a]	0.076[a]
1,1-Dichloroethane	0.005	0.089	0.023	<0.020*
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/8270				
Semivolatile Organics (mg/kg)				
Bis(2-ethylhexyl)phthalate	0.033	3.400[a]	1.200[a]	2.500[a]
Others	See Appendix F	ND	ND	ND
EPA Method SW3050/6010**				
Total Metals (mg/kg)				
Aluminum[c]	10.0	16100	6620	21300
Barium	1.0	135[b]	47.7[b]	157[b]
Boron	1.0	121[a,d,e]	60.2[a,d,e]	176[a,d,e]
Cadmium	0.5	3.36[d]	ND[d]	2.82[d]
Calcium[c]	50.0	20000[b]	7650[b]	3440[b]
Chromium	1.0	32.3[b]	12.8[b]	39.8[b]
Cobalt	1.0	7.75[b,d]	2.89[b,d]	11.8[b,d]
Copper	1.0	24.4	9.92	30.0
Iron[c]	2.5	24100	9310	29700
Lead	5.0	32.3[b]	19.6[b]	47.6[b]
Lead (SW7421)	0.5	26	NA	29
Magnesium[c]	50.0	6610[b]	40.4[b]	8900[b]
Manganese	0.5	482[b]	306[b]	724[b]
Mercury (SW7471)	0.1	1.5	0.6	1.4
Nickel	1.5	33.8	11.7	38.7
Potassium[c]	50.0	2310	1060	3330
Silicon[c]	100.0	2830[a,b]	1470[a,b]	3140[a,b]
Sodium[c]	50.0	500[b,d]	306[b,d]	632[b,d]
Vanadium	1.0	29.7	13.1	35.3
Zinc[c]	1.0	5570[b]	1480[b]	4580[b]
Others	See Appendix F	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg)				
Total Petroleum Hydrocarbons	5.0	70[b]	120[b]	240[b]

TABLE
4-95 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS: SURFACE SEDIMENTS

Footnotes:

* = Compound present below measurable detection limit.
a = Compound also detected in associated method blank.
b = Associated field duplicate anayses exceeded 35% RPD.
c = Accuracy data unavailable.
d = Associated lab matrix replicate analyses resulted in RPD value which was above the control limit.
e = Associated matrix spike analysis had low recovery for the compound.
** = Or as indicated if analyzed by an alternate method.
NA = Not analyzed

TABLE 4-96
Field Water Quality Data
Niagara Falls IAP
Site No. 9
9/15/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace[(1)] HNU Reading ppm	Water Clarity
MW 9-3	15.2°	7.25	2650	305	0	0	305	---	slightly cloudy
MW 9-5	15.0°	7.29	3270	395	0	0	395	---	clear
MW 9-6	15.0°	7.24	2600	395	0	0	395	---	clear
MW 9-7	15.0°	7.46	2640	280	0	0	280	---	very slightly cloudy

__Notes__:

(1) OVA malfunctioned, no replacement

- The matrix spike/matrix spike duplicate (MS/MSD) analysis associated with WB-9-5-6 and WB-9-6-3/4 had several precision measurements (RPD values) and two recovery values outside of control limits. This has minimal impact on data quality. No assessment of precision could be made for sample WB-9-7-6 since only a spike was analyzed.

- Field duplicates associated with the semivolatile organic analysis of soil samples from Site 9 were collected from other sites. Duplicate pair B-11-2-4/4R (applicable to B-9-1-1/3/6) had bis(2-ethylhexyl)phthalate detected in one sample, but not the other, due to suspected lab contamination.

- The purgeable halocarbon analysis of two groundwater samples resulted in surrogate recoveries outside of control limits: 1,4-dichlorobutane recovery for GW15 =138%, upper control limit =136%; 1-chloro-2-bromopropane recovery for GW16 =129%, upper control limit =127%.

- Methylene chloride was found during the purgeable halocarbon analysis of several method blanks (ND-2.1 ug/l), field QC blanks (ND-7.7 ug/l) and groundwater samples (ND-4.0 ug/l). Therefore all sample methylene chloride concentrations are considered biased by background contamination.

- The MS/MSD pairs associated with the purgeable halocarbon analysis of the groundwater samples had several recoveries outside of control limits. The only detected compound, methylene chloride, had 125% recovery in one MS/MSD analysis.

- The field duplicate pair collected during the additional RI field effort, GW117/119, had methylene chloride detected in one sample, but not the other. The purgeable aromatic analysis exceeded 35% RPD for toluene (RPD =55%) (See following comment.).

- Toluene was found during the purgeable aromatic analysis of four (out of seven) samples collected during the additional RI effort. Two of the field QC samples also continued toluene at levels similar to the samples. However, toluene was not detected in the method blanks.

- Method blanks associated with the purgeable halocarbon analysis of the surface waters had methylene chloride at concentrations of 1.2-6.2 ug/l and chloroform = 0.57-0.70 ug/l. Sample concentrations of methylene chloride ranged from ND-4.7 ug/l and chloroform = ND-0.59 ug/l.

- 2-Chloroethylvinyl ether was not detected in the standards for purgeable halocarbon analysis. This compound was reported as "NF"=not found for the samples (refer to the ITIR).

- The purgeable halocarbon MS/MSD associated with the surface waters had recovery and RPD values within control limits for all detected compounds, although some additional compounds did not meet control limits.

- o The volatile organic method blank associated with surface sediment samples SD-12 and SD-13 had acetone present below the detection limit.

- o The field duplicate pair associated with the sediments exceeded 35% RPD for methylene chloride (RD = 60%).

- o The semivolatile organic method blank associated with the sediment samples had bis(2-ethylhexyl)phthalate present below the detection limit. Sample concentrations were 4-10 times higher than the detection limit.

- o Note that other semivolatile organic compounds, notably polynuclear aromatic compounds, were reported as being present in the sediment samples at levels below the detection limits, although these compounds were not included in the summary tables in this section. (Refer to Volume III of the ITIR.)

<u>Inorganic Analyses</u>: Seven soil boring samples were collected and analyzed for total metals and total petroleum hydrocarbons (TPH). Four groundwater samples and a field QC blank were analyzed for total metals, TPH, total dissolved solids (TDS), common anions and hardness. Three surface waters were analyzed for total metals, TPH, TDS, common anions and hardness; mercury was not performed on the samples originally collected. During the additional RI field effort, the three surface waters were resampled and analyzed for mercury. Three surface sediments were analyzed for total metals and TPH. The following is a discussion of data which may be biased as a result of blank analysis and/or precision and accuracy data which did not meet QC control limits.

- o The laboratory method blank associated with the metals analysis of soil samples WB-9-5-6 and WB-9-6-3/4 contained aluminum (= 20.3 mg/l), boron (= 1.49 mg/l), iron (= 13.8 mg/l) and silicon (= 30.0 mg/L). Sample concentrations of aluminum, iron and silicon were significantly higher than these background laboratory levels (3720 - 11800 mg/kg, 8660 - 43800 mg/kg and 654-1490 mg/kg, respectively.) Boron was not detected in any samples.

- o Several matrix replicate/matrix spike (MR/MS) analyses were associated with the metals analyses of the soil samples. All antimony spike recoveries were below control limits, indicating potential bias in the analysis. No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium since these metals were not spiked. The following discussions includes recoveries or RPD values more than 5% outside of control limits (generally 75-125% recovery, 30% RPD) for metals detected in the applicable samples. The MR/MS associated with WB-9-5-6 and WB-9-6-3/4 had recoveries below control limits for barium (=63%), beryllium (=64%), cobalt (64%), copper (= 69%), nickel (= 66%); in addition for lead by ICP one sample was **ND** (not detected) while the duplicate had lead present. The MR/MS associated with WB-9-7-6 had beryllium and nickel recoveries =68%.

- The field duplicate analysis associated with B-9-1-1/3/6 exceeded 35% RPD for barium (RPD =57%) and lead (36%). No field duplicate was applicable to WB-9-7-6.

- The matrix spike for TPH analysis of B-9-1-1/3/6 had recovery slightly above the control limit: recovery = 145%, upper control limit = 142%.

- The MR/MS pair associated with the metals analysis of the groundwater samples had RPD values above the control limits (RPD = 20%) for boron (RPD = 26%), iron (=22%), lead by graphite furnace (=63%), and potassium. No assessment of accuracy could be made for the following metals which were not spiked: calcium, magnesium, potassium, silicon, and sodium.

- The laboratory method blank associated with the metals analysis of the surface waters contained boron at 0.497 mg/l and silicon at 0.032 mg/l. Sample concentrations for boron were lower than the blank (0.206-0.250 mg/l) and therefore considered suspect. Sample concentrations of silicon were 4.48-4.89 mg/l, and therefore were not affected by background laboratory levels.

- The metals MR/MS for the surface waters had out of control RPD values for silicon (RPD =57%) and boron (which was detected in the sample but not the duplicate). Some compounds were not spiked (see groundwater metals analysis above), precluding an assessment of accuracy.

- The field duplicate associated with the surface waters exceeded 35% RPD for manganese (RPD = 121%) and molybdenum and vanadium (where the metals were only detected in one of the samples.)

- The metals method blank associated with the sediment samples contained boron (adjusted concentration = 20.2 mg/L) and silicon (adjusted concentration = 4.0 mg/l). Sample concentrations for boron ranged from 60.2-176 mg/kg and silicon = 1470-3140 mg/kg.

- The MR/MS pair associated with the metals analysis of sediment samples indicated significant bias for antimony and silver. In addition the RPD control limit (=30%) was exceeded for boron (RPD =71%; also recovery =60%), cadmium (detected in only one sample), cobalt (= 46%) and sodium (= 36%). No assessment of accuracy could be made for: calcium, magnesium, potassium, silicon and sodium (all of which were not spiked) and aluminum, iron and zinc (for which recoveries could not be calculated due to levels native in the samples).

- The field duplicate pair SD9/SD10 exceeded 35% RPD for barium (RPD = 36%), calcium (=198%), chromium (=55%), magnesium (=84%), manganese (=60%), silicon (=108%), sodium (=49%), zinc (=36%), and cobalt, lead by ICP and molybdenum which were detected in one sample, but not the other.

- The field duplicated analyzed for TPH for the soil borings (WB-3-4D-1/1R) and sediments (SD9/SD10) exceeded 35% RPD; the RPD values were 200% and 115%, respectively.

4.1.7.2 Significance of Findings

4.1.7.2.1 Significance of Findings: Site No. 9 - Fire Training Area No. 3

Groundwater, soils and surface water/sediment were investigated at Site No. 9 to characterize the environmental consequences of the use of combustible liquids wastes during fire training exercises. Tables 4-97 through 4-99 presents analyses versus ARARs and/or background levels for all contaminants found in the matrices studied.

During the drilling of the one soil boring and three well borings, soil samples were collected for analyses. A total of seventeen metals were detected at various concentrations in soils from these borings. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed. Since no ARARs have been established for soils, comparisons are made with regard to the installation's background and normal trace element averages published for soils.

- At Site 9, beryllium was detected at 0.498 mg/kg and 0.275 mg/kg in soils from the 0.0 to 1.5 foot and 3.0 to 4.5-foot intervals of B-9-1. Although beryllium was not detected in soils from the background soil borings, these levels found at B-9-1 were well below the 6.0 mg/kg average reported for normal soils.

- Chromium levels in the soils at Site No. 9 occurred slightly outside the range established by the background soil borings. A 20.7 mg/kg to 26.5 mg/kg chromium range was measured in soils from B-9-1 and a chromium value of 48.6 mg/kg was obtained from the 3.0 to 4.5-foot interval of WB-9-6. All of these values are below the 100 mg/kg average chromium concentration established for normal soils.

- Zinc levels found in all of the soils sampled occurred within the background range. Zinc levels across the installation were generally much higher than the average concentration expected in normal soils due to the presence of zinc sulfide minerals in the soils.

TABLE 4-97

SITE NO. 9: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (Units)	Detection Limits	Background[j] (mg/Kg)	Selected Average for Soils[k] (mg/Kg)	Sample ID (Sample Description) B-9-1-1 (0'-1.5')	B-9-1-3 (3.0'-4.5')	B-9-1-6 (7.5'-9.0')	WB-9-5-6 (7.5'-8.6')	WB-9-6-3 (3.0'-4.5')	WB-9-6-4 (4.5'-6.0')	WB-9-7-6 (7.5'-9.0')
EPA Method SW8240 (mg/kg)										
Volatile Organics										
Methylene Chloride	0.005	0.0056-0.0091	--	0.021[c]	**0.021[c]**	0.013[c]	0.0054[a,c,d]	<1.250[*,b,c,d]	0.016[c,d]	ND[c]
Acetone	0.010	ND-0.056	--	0.032[c]	0.023[c]	0.047[c]	0.032[a,c,d]	ND[b,c,d]	0.069[c,d]	0.038[c]
2-Butanone	0.010	ND	--	ND	ND	ND	ND[a]	ND[b]	0.021	ND
Benzene	0.005	ND	--	ND	ND	ND	ND[a]	ND[b]	0.013	ND
Toluene	0.005	ND	--	<0.0060*	<0.0060*	ND	<0.0055[*,a]	<1.250[*,b]	0.0082	ND
Ethylbenzene	0.005	ND	--	ND	ND	ND	ND[a]	<1.250[*,b]	0.0082	ND
Total Xylenes	0.005	ND	--	ND	ND	ND	ND[a]	<1.250[*,b]	0.0100	ND
Others	See Appendix F	ND	--	ND	ND	ND	ND[a]	ND[b]	ND	ND
EPA Method SW3550/8270										
Semivolatile Organics (mg/kg)										
Naphthalene	0.33	ND	--	ND	ND	ND	ND[e]	0.650[e]	ND[e]	ND
Bis(2-ethylhexyl)phthalate	0.33	ND-0.39	--	<0.39[*,c,d]	0.39[c,d]	ND[c,d]	ND[c,e]	<0.415[*,c,e]	<0.39[*,c,e]	ND[c]
2-Methylnaphthalene	0.33	ND	--	ND	ND	ND	ND[e]	0.500[e]	ND[e]	ND
Others	See Appendix F			ND	ND	ND	ND[e]	ND[e]	ND[e]	ND
EPA Method SW3050/6010										
Total Metals (mg/kg)										
Aluminum[f]	10.0	2,300-15,600	71,000	17000	22900	30400	3720[c]	17700[c]	11800[c]	3350
Barium	1.0	28.4-163	430	122	201	123	43.5[g]	228[g]	106[g]	43.5
Beryllium	0.2	ND	6	0.498	0.275	ND	ND[g]	ND[g]	ND[g]	ND[g]
Calcium[f]	50.0	2,120-213,000	13,700	3560	54600	105000	114000	62100	88800	314000
Chromium	1.0	3.29-19.6	100	26.5	20.7	21.4	6.99[g]	48.6[g]	17.5[g]	4.62
Cobalt	1.0	2.10-11.3	8	14.1	11.1	13.2	1.84[g]	25.8[g]	8.00[g]	2.54[g,h]
Copper	1.0	9.92-21.0	30	20.8	19.8	22.5	8.42[g]	45.1[g]	12.8[g]	10.9
Iron[f]	2.5	5,060-31,700	38,000	30300	38200	53800	8660[c]	43800[c]	22700[c]	7300
Lead	5.0	9.96-26.0	10	26.0	15.2	17.5	7.80[h]	43.5[h]	8.08[h]	21.3[g]
Magnesium[f]	50.0	4,050-51,900	5,000	5900	19800	28100	52600	16100	9070	134000
Manganese	0.5	386-801	600	553	454	586	515[f]	1310[f]	404[f]	595
Nickel	1.5	4.41-25.1	40	26.8	25.9	26.7	5.99[g]	63.0[g]	21.0[g]	6.32[g]
Potassium[f]	50.0	496-2,310	8,300	1560	2390	2700	841	5990	2260	735
Silicon[f]	100.0	223-345	320,000	3230	1250	1020	686[c]	1490[c]	654[c]	514
Sodium[f]	50.0	49.6-154	6,300	174	238	243	126	404	166	189
Vanadium	1.0	5.30-32.0	100	34.9	28.9	29.6	8.79[g]	73.4[g]	21.8[g]	7.43
Zinc	1.0	53.3-864	50	182	56.3	107	250[g]	132g	46.5[g]	157
Others	See Appendix F			ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1										
Total Petroleum Hydrocarbons	5.0	ND	--	18[i]	36[i]	28[i]	20	140	ND	ND

TABLE 4-97 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

__Footnotes__:

* = Compound present below measurable detection limit.
a = Surrogate recovery (4-bromofluorobenzene) above upper control limit.
b = Volatile organic compound analysis performed using methanol extraction; detection limits are approximately 200 times higher than normal.
c = Compound also detected in associated method blank.
d = Associated field duplicate analyses exceeded 35% RPD for this parameter.
e = Associated MS/MSD analyses had recovery and RPD results outside of control limits.
f = Accuracy data unavailable; compound not spiked (or recovery could not be calculated).
g = Associated matrix spike recoveries were below the lower control limit.
h = Associated matrix replicate analyses resulted in RPD's which exceeded the control limit.
i = Associated matrix spike recoveries were above the upper control limit.
j = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
k = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected
NR Not Required

TABLE 4-98

SITE NO. 9: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample ID (Sample Description) GW15 (MW-9-3)	GW16 (MW-9-7)	GW17 (MW-9-6)	GW18 (MW-9-5)
EPA Method SW5030/8021 (ug/L)						
Volatile Organics/Purgeable Halocarbons						
Methylene Chloride	0.8	0.19[k]	4.0[a,b,c]	3.8[a,b,c]	3.3[b,c]	3.0[b,c]
Others	See Appendix F	-	ND	ND	ND	ND
EPA Method SW5030/8020 (µg/L)						
Purgeable Aromatic Organics			ND			ND
Benzene	0.3	ND[h]		ND	50	
Total Xylenes	1.0	15[i]		ND	48	
Toluene	0.3	5[i]		0.79	2.0	
Ethylbenzene	0.3	5[i]		ND	9.1	
Others	See Appendix F	-		ND	ND	
EPA Method E200.7[*]						
Total Metals (mg/kg)						
Aluminum	0.1	No ARAR	2.54	2.47	ND	0.469
Barium	0.01	1.0[i]	0.029	0.037	0.026	0.021
Boron	0.01	1.0[i]	0.587[e]	0.335[e]	0.122[e]	0.077[e]
Calcium[d]	0.20	No ARAR	555	642	560	741
Cobalt	0.010	No ARAR	ND	ND	ND	0.016
Copper	0.010	0.200[i]	0.022	ND	ND	0.017
Iron	0.025	0.300[i]	4.51[e]	5.68[e]	2.08[e]	3.45[e]
Lead	0.05	0.025[i]	ND	ND	ND	ND
Lead (E239.2)	0.005	0.025[i]	0.010[e]	0.006[e]	ND[e]	ND[e]
Magnesium[d]	0.20	No ARAR	264	325	374	854
Manganese	0.005	0.300[i]	0.453	1.50	3.03	2.48
Molybdenum	0.010	No ARAR	ND	ND	0.012	0.010
Nickel	0.015	0.0154[j]	0.020	ND	ND	ND
Potassium[d]	0.4	No ARAR	5.24[e]	52.5[e]	2.16[e]	2.95[e]
Silicon[d]	0.020	No ARAR	9.48	11.6	6.07	8.19
Sodium[d]	0.200	20[i]	254	300	173	382
Zinc	0.01	0.300[i]	0.362	0.084	0.019	0.172
Others	See Appendix F	-	ND	ND	ND	ND

TABLE 4-98 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample ID (Sample Description) GW15 (MW-9-3)	GW16 (MW-9-7)	GW17 (MW-9-6)	GW18 (MW-9-5)
EPA Method E418.1 (SW3550/E418.1)						
Total Petroleum Hydrocarbons	1.0		ND	1.2	1.5	ND
Miscellaneous Inorganics (mg/L)						
Total Dissolved Solids (E160.1)	1.0	500[m]	3800	4000	4000	3100
Common Anions (A429)						
Fluoride	0.1	1.5[i]	1.2	1.0	1.1	1.5
Chloride	0.5	250[i]	330	130	120	75
Sulfate	0.5	250[i]	2300	3000	2600	3700
Total Hardness (E130.1)	1.0	No ARAR	2400	2400	2400	3600

Footnotes:

a = Sample had a surrogate recovery above the upper control limit.
b = Compound also detected in associated method blank.
c = Assoicated MS/MSD analyses had high recoveies for this compond.
d = Accuracy data unavailable; compound not spiked.
e = Associate lab matrix replicate analysis had RPD values which were above the control limit.
g = Applicable or Relevant or Appropriate Requirements.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F.
* = Or as indicated if analyzed by an alternate method.

TABLE 4-98 (Cont'd)
SITE NO. 9: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	ARAR[g]	GW115 (MW-9-3) (add'l RI)	GW116 (MW-9-5) (add'l RI)	GW117 (MW-9-6) (add'l RI)	GW118 (MW-9-7) (add'l RI)	GW123 (MW-9-8) (add'l RI)	GW124 (MW-9-9) (add'l RI)
		Sample ID (Sample Description)					
EPA Method SW5030/8021 (ug/L)							
<u>Volatile Organics/Purg. Halocarbons</u>		ND			ND		
Methylene Chloride	0.19^{k}		1.0	2.1^{b}		2.7^{b}	2.5^{b}
Others	-		ND	ND		ND	ND
EPA Method SW5030/8020 (µg/L)							
<u>Purgeable Aromatic Organics</u>			ND		ND		ND
Benzene	ND^{h}	ND		72		ND	
Total Xylenes	15^{i}	ND		9.4		ND	
Toluene	5^{i}	0.44		0.32		0.56	
Ethylbenzene	5^{i}	ND		11		ND	
Others	-	ND		ND		ND	

Footnotes:

a = Sample had a surrogate recovery above the upper control limit.
b = Compound also detected in associated method blank.
c = Assoicated MS/MSD analyses had high recoveies for this compond.
d = Accuracy data unavailable; compound not spiked.
e = Associate lab matrix replicate analysis had RPD values which were above the control limit.
g = Applicable or Relevant or Appropriate Requirements.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwaters. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
m = Federal Secondary Drinking Water Standard

ITIR = Informal Technical Information Report - Appendix F.
* = Or as indicated if analyzed by an alternate method.

TABLE 4-99
SITE NO. 9: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	ARAR[J]	Sample Field Identification (Sample Description)		
			SW-12 (9SW-1)	SW-13 (9SW-2)	SW-14 (9SW-3)
EPA Method SW5030/8021 (ug/L) **Volatile Organics/Purgeable Halocarbons**					
1,1,1-Trichloroethane	0.4	200[L]	92	74	42
1,1-Dichloroethane	0.5	5[L]	3.3	3.0	2.5
Chloroform	0.4	100[P]	ND[a]	0.59[a]	ND[a]
Methylene Chloride	0.8	0.19[K]	4.7[a]	4.3[a]	ND[a]
Trichloroethene	1.0	5[L]	3.6	2.7	1.5
Others	See Appendix F	-	ND	ND	ND
EPA Method SW5030/8020 (μg/L) **Purgeable Aromatic Organics**	ND	-	ND	ND	ND
EPA Method E200.7** **Total Metals (mg/l)**					
Aluminum	0.1	No ARAR	0.188	0.320	0.147
Barium	0.01	1.0[L]	0.091	0.099	0.093
Boron	0.01	No ARAR	0.206[a,d]	0.241[a,d]	0.250[a,d]
Calcium[c]	0.05	No ARAR	159	166	162
Iron	0.025	1.0[M]	0.272	0.456	0.279
Magnesium[c]	0.20	No ARAR	59	61.0	58.8
Manganese	0.005	0.05[N]	0.069[b]	0.100[b]	0.110[b]
Mercury (E245.1)	0.0002	0.000012[M]	1.0[f]	0.40[f]	0.36[f]
Potassium[c]	0.4	No ARAR	7.74	8.08	7.15
Silicon[c]	0.020	No ARAR	4.48[a,d]	4.86[a,d]	4.89[a,d]
Sodium[c]	0.200	No ARAR	80.1	84.1	78.4
Zinc	0.01	0.047[M]	0.728	0.638	0.372
Others	See Appendix F	-	ND	ND	ND
EPA Method E418.1 (mg/L) **Total Petroleum Hydrocarbons**	1.0	No ARAR	ND	ND	ND

TABLE 4-99
SITE NO. 9: ANALYTICAL RESULTS VS. ARARs: SURFACE WATERS

Parameter (Units)	Detection Limits	ARAR[J]	Sample Field Identification (Sample Description) SW-12 (9SW-1)	SW-13 (9SW-2)	SW-14 (9SW-3)
Miscellaneous Inorganics (mg/L)					
Total Dissolved Solids (E160.1)	1.0	No ARAR	980	110	960
Common Anions (A429)					
Fluoride	0.1	No ARAR	0.63	0.63	0.62
Chloride	0.5	No ARAR	150	160	160
Sulfate	0.5	No ARAR	330	350	330
Total Hardness (E130.1)	1.0	No ARAR	660	680	660

Footnote:

a = Compound also detected in associated method blank.
b = Associated field duplicate analyses exceeded 35% RPD.
c = Accuracy data unavailable.
d = Associated lab matrix replicate analyses resulted in RPD value which was above the control limit.
e = Associated matrix spike analysis had low recovery for the compound.
f = Mercury was determined on samples recollected during the additional RI field effort-sample field ID for these samples was SW-15(=9SW-3) SW-16(=9SW-2) and SW-17(=9SW-1).
J = Applicable or Relevant and Appropriate Requirements.
K = Federal Ambient Water Quality Criteria - for Human Health (FWQC-HH): Adjusted for Drinking Water Only.
L = Maximum Contaminant Level (MCL) established under the Safe Drinking Water Act.
M = Federal Ambient Water Quality Criteria - Fresh Chronic Value for Aquatic Life.
N = Secondary Maximum Contaminant Level (SMCL) established under the Safe Drinking Water Act - Not an ARAR.
P = Maximum Contaminant Level for Total Trihalomethanes: the sum concentration of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

** = Or as indicated if analyzed by an alternate method.

- Barium concentrations of 201 mg/kg and 228 mg/kg reported from the 3.0 to 4.5-foot interval B-9-1 and the 3.0 to 4.5-foot interval of WB-9-6 respectively, occurred outside the background range established for barium. These levels are still below the 430 mg/kg average reported for most soils.

- Cobalt levels in some of the soils exceeded the range established by the background soil borings. Concentrations that exceeded background were found in the 0.0 to 1.5 foot and 7.5 to 9.0-foot interval of B-9-1 (14.1 mg/kg and 13.2 mg/kg respectively) and the 3.0 to 4.5-foot interval of WB-9-6 (25.8 mg/kg).

- Except for a single copper value of 45.1 mg/kg found in soil from the 3.0 to 4.5-foot interval of WB-9-6, copper in all of the other 2 Site No. 9 soils essentially occurred within the background range.

- Lead concentrations in Site No. 9 soils generally occurred within the lead range established from the background soil borings. A concentration of 43.5 mg/kg found in the 3.0 to 4.5-foot interval of WB-9-6 was the only lead value that fell outside this range.

- Soil from this same 3.0- to 4.5-foot interval of WB-9-6 contained 1310 mg/kg of manganese. This was the only manganese value at Site No. 9 that occurred outside the background range.

- Nickel concentrations measured in the Site No. 9 soils generally occurred within the background range. One nickel value of 63 mg/kg found in the 3.0 to 4.5-foot interval of WB-9-6 occurred above the range established in the background soil borings.

- Vanadium was also elevated in the 3.0 to 4.5-foot interval of WB-9-6 (73.4 mg/kg). All other concentrations were measured within or only slightly outside the background range. The higher metal values found in the 3.0 to 4.5-foot interval may be elevated as a result of soil contamination rather than some natural anomaly.

Some of these metals, particularly nickel and vanadium, are known to be concentrated in fuels. As discussed below, this same interval also contains elevated levels of total petroleum hydrocarbons and a number of volatile organic fuel constituents.

It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found on the installation and throughout the Niagara Falls area.

The following presents a comparison of the organic analytical data yielded by the Site No. 9 soil borings with the installation's background levels:

- Total petroleum hydrocarbons (TPH) were detected in soil from the 3.0 to 4.5-foot interval of well boring WB-9-6 at a concentration of 140 mg/kg. Lesser amounts of TPH were found in the soils of B-9-1 and WB-9-5. TPH was not detected in any soils analyzed from the background soil borings.

- 2-butanone, benzene, toluene, ethylbenzene and total xylenes were found in soils from the 4.5 to 6.0-foot interval of WB-9-6 at concentrations of 0.021 mg/kg, 0.013 mg/kg, 0.0082 mg/kg and 0.0100 mg/kg, respectively. The presence of these volatile organics in the soils at Site No. 9 can only be linked to the waste fuels that were utilized during fire training exercises. Methylene chloride and acetone reported in the soils of Site No. 9 were also detected in the volatile organic method blanks at comparable levels. Their presence in the Site No. 9 soils is being attributed to laboratory contamination. These compounds were also found in soils of the background borings.

- Bis(2-ethylhexyl) phthalate was detected at a concentration of 0.39 mg/kg in a single soil sample from B-9-1. Lower levels of this compound were detected in the method blanks associated with the semivolatile organic analysis. Although the sample concentrations of this compound are suspect, not all can be attributed to laboratory contamination. 2-methylnaphthalene was measured at 0.500 mg/kg in one of the two soil samples collected from well boring WB-9-6.

A total of four shallow wells were sampled at Site No. 9 during the main RI effort conducted in September 1989. The same four wells plus two new wells installed during the addition RI effort were sampled for purgeable halocarbons/aromatics in April 1990. Three Stage 1 wells, originally scheduled to be sampled during the main RI effort, were not sampled due to damage sustained by grass cutting equipment. The following presents a comparison of organic compounds measured during the RI in the Site No. 9 monitoring wells with ARARs and installation background levels:

- Benzene was detected in the groundwater of shallow monitoring well MW9-6 at 50 ug/l. The benzene level in MW9-6 was significantly higher than the benzene concentration found in the shallow background well and exceeded the "non-detect" ARAR established in the New York State Water Quality Standards.

- Toluene was detected in the groundwater of shallow monitoring well MW9-6 at 48 ug/l. The toluene level was slightly higher than the background level and occurred below the ARAR set by the State Water Quality Standards. Toluene was also reported in groundwater from shallow well MW9-7 at 0.79 ug/l. The level of toluene found in MW9-7 was less the level found in the shallow background well.

- Total xylenes and ethylbenzene were found in MW9-6 at 48.0 ug/l and 9.1 ug/l, respectively. These compounds were not detected in groundwater from the shallow background well. Both total xylene and ethylbenzene levels exceeded New York State Water Quality ARARs of 5 ug/l and 5 ug/l, respectively.

- TPH was found in MW9-7 and MW9-6 at concentrations of 1.2 mg/l and 1.5 mg/l, respectively. Similar concentrations were found in the shallow background well.

- Levels of methylene chloride detected in groundwater at Site No. 9 were comparable to those measured in the volatile organic method blanks. Therefore, this compound is considered a probable laboratory contaminant.

The following presents a discussion comparing the organic compounds measured during the additional RI effort with ARARs and installation background levels:

- Benzene was once again measured in MW9-6. The benzene concentration was reported at 72 ug/l. The benzene level found in MW9-6 once again exceeds the "non-detect" ARAR set by the State Water Quality Standards.

- Total xylenes and ethylbenzene were found in MW9-6 at 9.4 ug/l and 11 ug/l, respectively. Total xylenes levels did not exceed the ARARs. Ethylbenzene levels exceeded the New York State Water Quality ARAR of 5 ug/l.

- Toluene was also detected in MW9-6, but its presence is unconfirmed due to comparable levels of toluene found in the field and equipment blanks. Toluene detected in MW9-3 and MW9-8 is unconfirmed due to the same problem experienced in MW9-6.

- The presence of these volatile organics is explained by the practice of using combustible liquids (i.e., JP-4) during fire training exercises.

Sixteen inorganic metals were detected above instrument detection limits in groundwater from Site No. 9. As discussed in Section 4.1.1.2.1, elevated metals levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals found in the groundwater are correlated to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in groundwater at Site No. 9 with ARARs and background values:

- Iron and manganese occurred at levels that exceeded the 0.300 mg/l ARAR established in the New York State Water Quality Standards in the five (5) monitoring wells sampled. Iron concentrations ranged from 2.08 mg/l in MW9-6 to 5.68 mg/l in MW9-7. All of these values were lower than the iron level found in the shallow background well. Manganese concentrations ranged from 0.453 mg/l in MW9-3 to 3.03 mg/l in MW9-6. The manganese value found at the shallow background well also exceeded the State standard.

- Barium levels measured in the groundwater at Site No. 9 occurred below the ARAR and the background well concentration.

- Boron levels found at Site No. 9 were generally higher than the background level. Boron levels ranged from 0.077 mg/l at MW9-5 to 0.587 mg/l at MW9-3. Presently, no ARAR has been established for boron.

- Cobalt was only detected in MW9-5 at 0.016 mg/l. Cobalt was not detected in groundwater from the shallow background well. No ARAR presently exist for cobalt in groundwater.

- Copper was measured in two of the four wells at Site No. 9. Although copper was not found in the background well, the concentration found in the two wells at Site No. 9 were well below the ARAR.

- Levels of lead found in two of the well at Site No. 9 occurred well below the 0.025 mg/l ARAR set in the State Water Quality Standards.

- Molybdenum was detected in two of the Site No. 9 wells. This metal was not detected in the shallow background well nor has any ARAR been developed for it.

- The 0.0154 mg/l FWQC Human Health ARAR for nickel was exceeded in MW9-3 (0.020 mg/l). Nickel was not detected in the shallow background well.

- Zinc levels recorded in groundwater at Site No. 9 ranged from 0.019 mg/l at MW9-6 to 0.362 mg/l at MW9-3. The average zinc concentration across the site was higher than the concentration found in the shallow background well. Zinc concentrations in MW9-3 exceeded the New York Water Quality of ARAR of 0.300 mg/l.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Total dissolved solids (TDS) in groundwater from Site No. 9 ranged from 3100 mg/l to 4000 mg/l. These levels exceeded the 500 mg/l Secondary Drinking Water Standard for TDS.

- Sulfate levels exceeded the 250 mg/l ARAR set in the State Water Quality Standards in all wells at Site No. 9. Sulfate levels ranged from 2300 mg/l to 3700 mg/l.
- Chloride and total hardness levels ranged from 75 mg/l to 330 mg/l and 2400 mg/l to 3600 mg/l respectively. Fluoride ranged from 1.0 mg/l to 1.5 mg/l.
- Sodium exceeded the New York State Water Quality ARAR of 20 mg/l in all site wells.
- The groundwater at Site No. 9 is very hard and highly mineralized.

The generally poor water quality of the groundwater is explained in the literature (Johnston, 1964). The water from the unconsolidated deposits is described as very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels reported for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The respective levels at Site No. 9 are slightly above average. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate (gypsum) in the soil and bedrock.

Surface water and sediment samples were collected at three monitoring locations along the intermittent stream just north of fire training area to determine the environmental impact of groundwater infiltration and surface runoff on the water quality of the creek. One monitoring station was located at a point upstream to evaluate the water quality of the upstream as a means portion away from the potential influence of the site. Another point was located just downstream from the point where an intermittent tributary, is intercepted by the larger intermittent stream. The upstream portion of the tributary is located off-base, so this sampling point was located to determine off-base potential surface water/sediment contaminants. The last sampling point was located along the intermittent stream, several hundred feet downstream from the confluence. Table 4-99 presents a comparison of surface water analytical results to the established ARARs.

No ARARs nor background values have been established for stream sediments. The following organic compounds were detected in the stream sediments.

- 1,1-dichloroethane was detected in two sediment samples. Concentrations ranged from 0.023 mg/kg at 9SD-2 to 0.089 mg/kg at 9SD-1.

- Methylene chloride and acetone were also detected but are probably laboratory contaminants as comparable levels were found in the method blanks.

- The only semivolatile compound detected in the sediments was bis (2-ethylhexyl) phthalate. This compound is also believed to be a laboratory contaminant.

- Total petroleum hydrocarbons (TPH) ranged from 70 mg/kg at 9SD-1 to 240 mg/kg at 9SD-3.

A total of twenty metals were detected at various concentrations in sediments from the three monitoring station. Since no ARARs have been established for stream sediments and no background values were established, the metals are discussed with reference to the normal trace element averages published for soils. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed here:

- Boron levels ranged from 60.2 mg/kg at 9SD-2 to 176 mg/kg at 9SD-3. The average boron concentration reported in soils in 10 mg/kg. Boron is not known to be a product of any current or past Air Force activity at this installation.

- Cadmium was detected in sediment from two of the stream monitoring stations. Concentrations of 2.82 mg/kg and 3.36 mg/kg were measured at 9SD-3 and 9SD-1 respectively. The average cadmium concentration reported for normal soils is 0.06 mg/kg.

- One cobalt value was elevated above the 8 mg/kg average reported for soils. A cobalt concentration of 11.8 mg/kg was measured in 9SD-3.

- Lead found in the sediments was elevated above the 10 mg/kg average for soils. Lead levels ranged from 19.6 mg/kg at 9SD-2 to 47.6 mg/kg at 9SD-3.

- Mercury levels in sediments at all of the stream monitoring stations exceeded the 0.03 mg/kg average concentration reported for soils. Mercury levels ranged from 0.6 mg/kg at 9SD-2 to 1.5 mg/kg at 9SD-1.

- Very high levels of zinc were found in all the sediment samples. Concentrations ranged from 1480 mg/kg at 9SD-2 to 5570 mg/kg at 9SD-1. The average concentration of zinc found in typical soils is 50 mg/kg.

The elevated levels of lead and zinc, and possibly cadmium, in the stream sediments at Site No. 9 probably corresponds to the presence of metallic mineral complexes occurring naturally in the bedrock and the unconsolidated overburden.

A number of purgeable halocarbons were detected in the surface water samples collected at the three Site No. 9 monitoring stations. None of the concentrations exceeded the established ARARs:

- o 1,1,1-trichloroethane levels ranged from 42 ug/l at 9SW-3 to 92 ug/l at 9SW-1.
- o 1,1-dichloroethane ranged from 2.5 ug/l at 9SW-3 to 3.3 ug/l at 9SW-1.
- o Trichloroethene concentrations ranged from 1.5 ug/l at 9SW-3 to 3.6 ug/l at 9SW-1.
- o Methylene chloride and chloroform reportedly found in the surface water are probably laboratory contaminants.

None of these organic compounds were found in the groundwater from the shallow aquifer at Site No. 9, so another source is releasing these contaminants. The source is most likely located upstream, since the highest concentration of these contaminants were found in surface water from the most upstream monitoring station. Possible upstream, off-base sources of contamination include a blacktop company and an adjacent construction company on Haseley Drive, directly north of this site.

A total of twelve metals were detected in the surface water samples collected from the three monitoring stations. Zinc and mercury were the only metals found to exceed the limits imposed by the ARARs.

- o Zinc ranged from 0.372 mg/l at 9SW-3 to 0.728 mg/l at 9SW-1. The mercury concentrations can not be attributed to a natural source. Mercury is being released into the stream from an unidentified upstream contaminant source which would be located off-base. Since the clarity of the surface water samples at Site No. 9 were generally clear, zinc found in the samples must represent the dissolved fraction. Zinc found in the surface water is likely derived from the dissolution of zinc minerals locally concentrated in the sediment.
- o Mercury levels ranged from 0.36 mg/l at 9SW-3 to 1.0 mg/l at 9SW-1. The mercury concentrations can not be attributed to a natural source. Mercury is being released into the stream from an unidentified upstream contaminant source which would be located off-base.

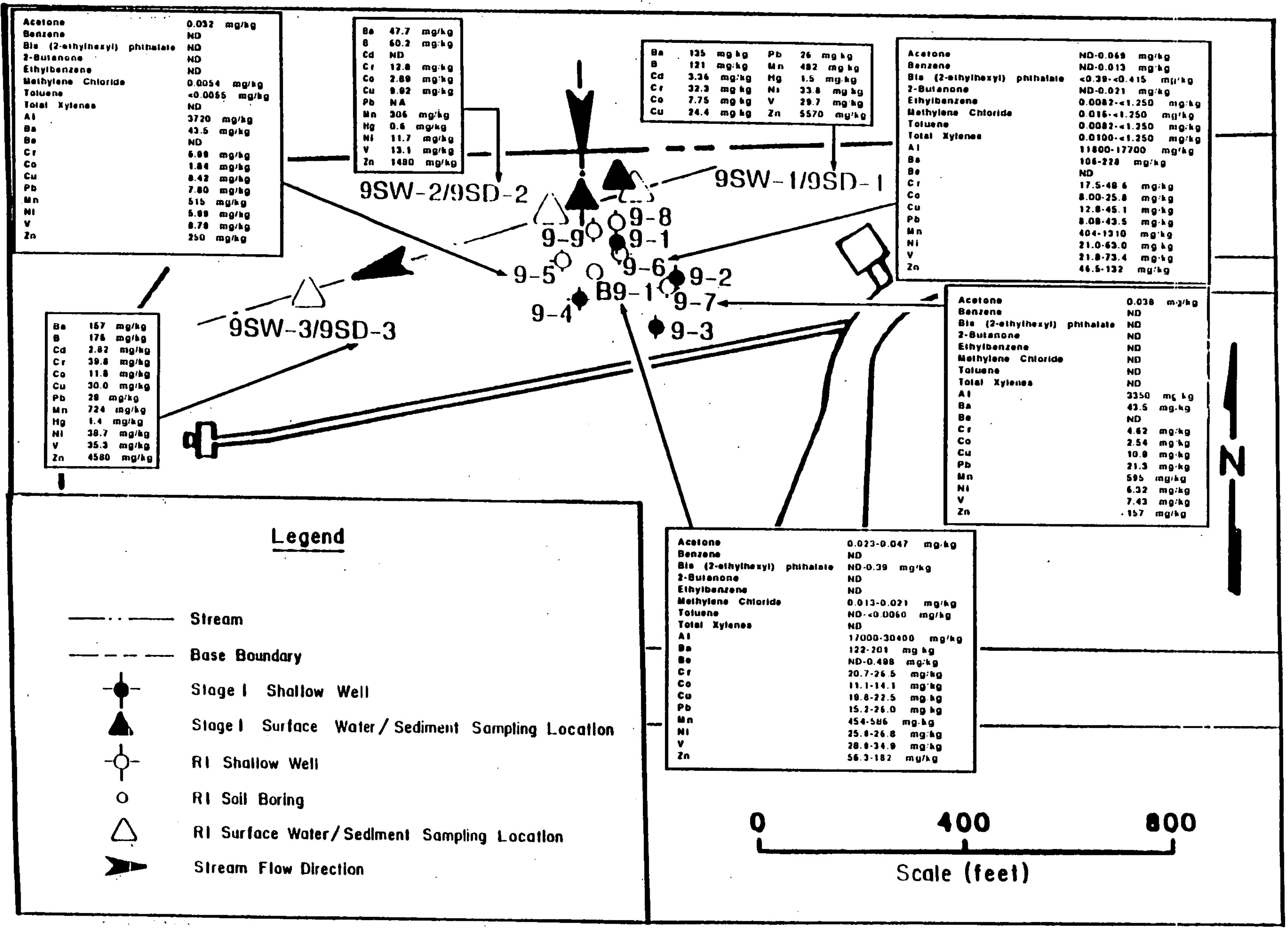
4.1.7.2.2 **Zones** of Contamination

Contamination in the shallow aquifer at Site No. 9 is generally limited. Contamination does not extend beyond monitoring well MW9-6. Figures 4-75 and 4-76 illustrate the levels of contamination found at each monitoring point. Contaminants were not detected in groundwater from the two new downgradient wells installed between MW9-6 and the stream during the additional RI. The absence of contamination in the these wells confirms that the zone of contamination attributed to fire training practices does not extend to the intermittent creek. Only low levels of contaminants were found in the site soils. TCE and mercury contamination found in surface water and mercury contamination found in the sediment of the creek must be coming from an unidentified upstream source and is not related to the fire training area, as the compounds were absent in groundwater and soil around the fire training pit.

As discussed in Section 4.1.1.2.1, there is convincing evidence suggesting that the elevated metal levels found in the groundwater of Site No. 9 are not related to waste management practices but rather natural background trace element concentrations found in the suspended particulate matter (i.e., clay). Metals are therefore not discussed as contamination.

4.1.7.2.3 Contaminant Migration

The contamination pattern inferred from the groundwater analytical results suggests that a small lobe of groundwater contamination extends a short distance north-northeast from the fire training pit. As indicated in the potentiometric surface maps (Figures 4-72 and 4-73) the direction of contaminant migration is not a constant but probably varies throughout the year. Although the predominant migration direction at this site has not been established, the evidence suggests that a southwest migration pattern may be operative during the drier periods of the year. During the wetter times of the year, groundwater mounding effects induced by storm water accumulating in the depressional area occupied by the fire pit may induce a northwest to northeast migration pattern. The actual contaminant migration path would be more closely aligned to whatever groundwater direction is more dominant or a resolution of several groundwater flow directions. At the present time the exact direction of contaminant migration



Acetone	0.032 mg/kg
Benzene	ND
Bis (2-ethylhexyl) phthalate	ND
2-Butanone	ND
Ethylbenzene	ND
Methylene Chloride	0.0054 mg/kg
Toluene	<0.0055 mg/kg
Total Xylenes	ND
Al	3720 mg/kg
Ba	43.5 mg/kg
Be	ND
Cr	6.00 mg/kg
Co	1.84 mg/kg
Cu	8.42 mg/kg
Pb	7.80 mg/kg
Mn	515 mg/kg
Ni	5.88 mg/kg
V	8.78 mg/kg
Zn	250 mg/kg

Ba	47.7 mg/kg
B	60.2 mg/kg
Cd	ND
Cr	12.8 mg/kg
Co	2.89 mg/kg
Cu	9.82 mg/kg
Pb	NA
Mn	306 mg/kg
Hg	0.6 mg/kg
Ni	11.7 mg/kg
V	13.1 mg/kg
Zn	1480 mg/kg

Ba	135 mg/kg	Pb	26 mg/kg
B	121 mg/kg	Mn	482 mg/kg
Cd	3.36 mg/kg	Hg	1.5 mg/kg
Cr	32.3 mg/kg	Ni	33.8 mg/kg
Co	7.75 mg/kg	V	29.7 mg/kg
Cu	24.4 mg/kg	Zn	5570 mg/kg

Acetone	ND-0.069 mg/kg
Benzene	ND-0.013 mg/kg
Bis (2-ethylhexyl) phthalate	<0.39-<0.415 mg/kg
2-Butanone	ND-0.021 mg/kg
Ethylbenzene	0.0082-<1.250 mg/kg
Methylene Chloride	0.016-<1.250 mg/kg
Toluene	0.0082-<1.250 mg/kg
Total Xylenes	0.0100-<1.250 mg/kg
Al	11800-17700 mg/kg
Ba	106-228 mg/kg
Be	ND
Cr	17.5-48.6 mg/kg
Co	8.00-25.8 mg/kg
Cu	12.8-45.1 mg/kg
Pb	8.08-43.5 mg/kg
Mn	404-1310 mg/kg
Ni	21.0-63.0 mg/kg
V	21.8-73.4 mg/kg
Zn	46.5-132 mg/kg

Ba	167 mg/kg
B	176 mg/kg
Cd	2.82 mg/kg
Cr	39.8 mg/kg
Co	11.8 mg/kg
Cu	30.0 mg/kg
Pb	28 mg/kg
Mn	724 mg/kg
Hg	1.4 mg/kg
Ni	38.7 mg/kg
V	35.3 mg/kg
Zn	4580 mg/kg

Acetone	0.038 mg/kg
Benzene	ND
Bis (2-ethylhexyl) phthalate	ND
2-Butanone	ND
Ethylbenzene	ND
Methylene Chloride	ND
Toluene	ND
Total Xylenes	ND
Al	3350 mg/kg
Ba	43.5 mg/kg
Be	ND
Cr	4.62 mg/kg
Co	2.54 mg/kg
Cu	10.8 mg/kg
Pb	21.3 mg/kg
Mn	595 mg/kg
Ni	6.32 mg/kg
V	7.43 mg/kg
Zn	157 mg/kg

Acetone	0.023-0.047 mg/kg
Benzene	ND
Bis (2-ethylhexyl) phthalate	ND-0.39 mg/kg
2-Butanone	ND
Ethylbenzene	ND
Methylene Chloride	0.013-0.021 mg/kg
Toluene	ND-<0.0060 mg/kg
Total Xylenes	ND
Al	17000-30400 mg/kg
Ba	122-201 mg/kg
Be	ND-0.488 mg/kg
Cr	20.7-26.5 mg/kg
Co	11.1-14.1 mg/kg
Cu	18.8-22.5 mg/kg
Pb	15.2-26.0 mg/kg
Mn	454-586 mg/kg
Ni	25.8-26.8 mg/kg
V	28.8-34.9 mg/kg
Zn	56.3-182 mg/kg

FIGURE 4-75

SITE NO. 9: ZONES OF CONTAMINATION - SOILS AND SEDIMENTS

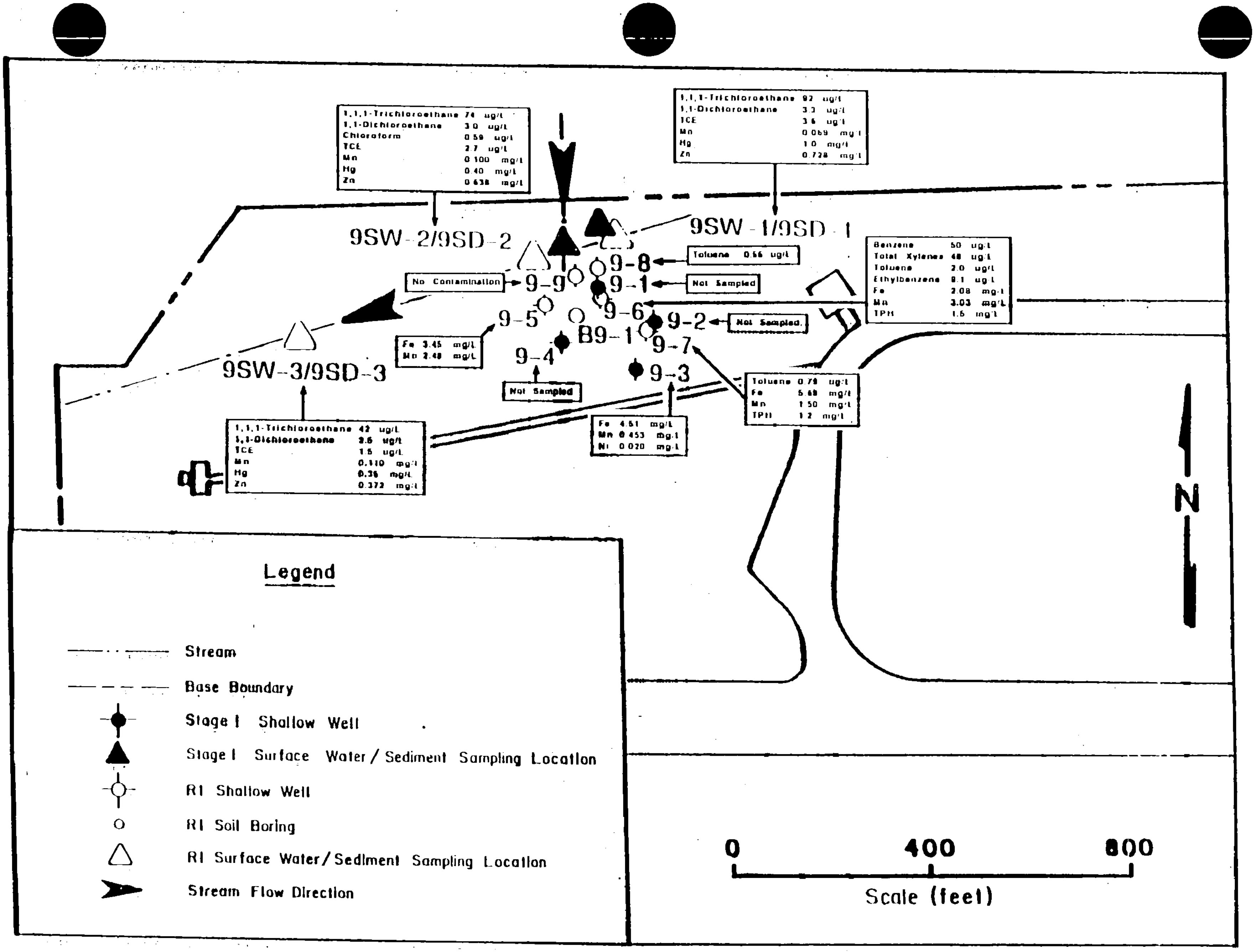


FIGURE 4-76

SITE NO. 9: ZONES OF CONTAMINATION - GROUNDWATER AND SURFACE WATER cannot be determined. The present pattern of contamination suggests that a north to northeast migration direction might be the preferred migration direction. Migration of contaminants through the shallow groundwater system, based upon the discussion presented in Section 4.1.7.1.2, is expected to range between 5.48 x 10^{-5} to 2.1 x 10^{-3} ft/day. In consideration of the fire training area's age and not considering such factors as dispersion, natural attenuation and chemical and biochemical reactions, the following migration distance ranges via the unconsolidated aquifer have been estimated:

Site No. 9 - (Minimum) 5.4 x 10^{-1} feet
- (Maximum) 20.6 feet

Migration rates might be locally higher in certain regions of Site No. 9 due to the presence of higher conductive sand lenses/stringers. Due to the remote location of this site, cultural features, such as sewer lines, pipelines, road base and foundations would have no role in contaminant migration. Due to the very slow migration rates predicted for the unconsolidated aquifer materials, it is not likely that contaminants would reach off-base receptors prior to a substantial reduction in contaminant levels due to natural attenuation and dilution processes. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.7.2.4 Baseline Risk Assessment: Site No. 9

This section presents the baseline risk assessment for Site 9. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 9 - Data Analysis and Hazard Identification

Chemicals of concern for Site 9 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

Mean levels of TPH in soils at Site 9 were 35.4 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons that have not been incorporated into the listing of chemicals of concern. These unidentified chemicals likely reflect products of incomplete combustion at the site. Given the available data and methods of chemical analysis however, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment. Much lower levels of TPH were detected in groundwater at the site (mean equal to 0.93 mg/L)

Site No. 9 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation.. The conceptual site model for Site 9 is presented in Figure 4-49. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 9 is provided in Appendix G.

Soil

Site 9 has served as the Base fire training area since the early 1960s and consist of a broad, oval area surrounded by a low, earthen berm. A variety of combustible liquids has been used at this site. Because Site 9 is not fenced and access to the site by Base personnel is not restricted, soil exposure was evaluated. The exposure assumptions used for Site 4 soil exposure were also used to assess exposure at Site 9 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Surface Water/Sediments

Surface runoff was observed to be toward an intermittent creek just north of the site. A risk-based evaluation has not been conducted for exposure to surface water or sediments in the vicinity of Niagara Falls IAP Site 9. The significance of levels of contaminants in surface water is evaluated only by comparison with ARARs. As with other intermittent streams, no Base personnel exposure to sediments was evaluated.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 9 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

Site No. 9 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 9 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at Site 9 are presented in Table 4-100. The hazard index for combined exposure across compounds is approximately 4.5 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for chronic exposure to groundwater. The excess lifetime cancer risk is estimated to be approximately 8 x 10^{-7} and is attributable to the presence of benzene in groundwater. This risk estimate falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean concentrations of benzene at Site 9 exceed the MCL. New York State groundwater limits were exceeded by the mean concentrations of manganese in groundwater. The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit. Ethylbenzene and total xylenes also exceeded New York State groundwater limits in a single well.

Soil Pathway

The results of risk characterization for exposure to soil at Site 9 are

TABLE 4-100

RISK CHARACTERIZATION FOR SITE NO. 9: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	1380.00			
Barium	28.00	5.49E-03	Hypertension	
Boron	280.00	3.05E-02	CNS, GI Tract, Skin	
Cobalt	7.00		Thyroid, Heart	
Copper	12.00	3.18E-03	GI Tract, Blood	
Lead	5.00	3.50E-02	CNS, Kidney	
Manganese	1860.00	9.12E-02	CNS, Reproductive	
Molybednum	8.00			
Nickel	11.00	5.40E-03	Skin, Lung	
Zinc	159.00	7.80E-03	GI Tract	
RGANICS				
Benzene	9.90	2.70E-01	Hematopoietic Sys.	8.05E-07
Toluene	0.53	1.73E-05	CNS	
Ethylbenzene	2.00	1.96E-04	Skin, Liver, Kidney	
Xylenes	5.10	2.50E-05	CNS	
Hazard Index: Combined Exposure		4.49E-01		
Excess Lifetime Cancer Risk: Combined Exposure				8E-07

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a. Arithmetic mean of groundwater sampling set (9/89 and 4/90). "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

presented in Table 4-101. The hazard index for combined exposure across compounds is approximately 4.9×10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Several potentially carcinogenic compounds were detected in soils at the site. The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these compounds is approximately 4×10^{-8}. This result falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Surface Water

As noted previously, a risk assessment was not conducted for chemicals in surface water. However, mean concentrations in surface water were compared with Federal ambient water quality criteria (FWQC). The mean concentration of mercury exceeded the FWQC adjusted for drinking water at Site 9.

Site No. 9 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.1.8 Discussion of Results for Site No. 11: Fire Training Area No. 2

4.1.8.1 Presentation of Results

4.1.8.1.1 Site Geology

The geology of Site No. 11, as interpreted by the RI soil boring logs, consists of a veneer of fine grained glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The location of the two Site No. 11 soil borings is presented in Figure 4-77. The average thickness of the unconsolidated deposits at Site No. 11 could not be assessed since the soil borings did not extend to the bedrock surface. The estimated thickness of these deposits is 15 feet. The Lockport Dolomite beneath Site No. 11 is estimated to be 180 feet thick. A generalized geologic cross-section of the Site No. 11 study area is presented as Figure 4-78. Soils at the Site No. 11 study area belong to

TABLE 4-101

RISK CHARACTERIZATION FOR SITE NO. 9: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS	Site 9			
Aluminum	15267.00			
Barium	124.00	3.89E-04	Hypertension	
Beryllium	0.20	6.28E-06	Lung, Skin, Heart	3.86E-08
Chromium	20.90	6.56E-04	Skin	
Cobalt	10.94		Thyroid, Heart	
Copper	20.04	8.50E-05	GI Tract, Blood	
Lead	19.91	2.23E-03	CNS, Kidney	
Manganese	631.00	4.95E-04	CNS, Reproductive	
Nickel	25.10	1.97E-04	Skin, Lung	
Vanadium	29.26	6.56E-04	Respiratory Effects	
Zinc	133.00	1.04E-04	GI Tract	
RGANICS				
Acetone	0.04	6.44E-08	Liver, Kidney	
Benzene	0.09	4.06E-05	Hematopoietic Sys.	1.21E-10
Bis(2-ethylhexyl)-phthalate	0.23	1.80E-06	Liver	1.44E-10
2-Butanone	0.19	5.84E-07	CNS, Fetotoxicity	
Ethylbenzene	0.09	1.44E-07	Skin, Liver, Kidney	
Methylene Chloride	0.22	5.63E-07	Liver, Kidney, CNS	7.23E-11
2-Methylnaphalene	0.23	9.03E-06	Skin	
Naphtalene	0.26	1.03E-05	Eye, Blood	
Toluene	0.09	4.81E-08	CNS	
Xylenes	0.09	7.30E-09	CNS	
Hazard Index: Combined Exposure		4.89E-03		
Excess Lifetime Cancer Risk: Combined Exposure				4E-08

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

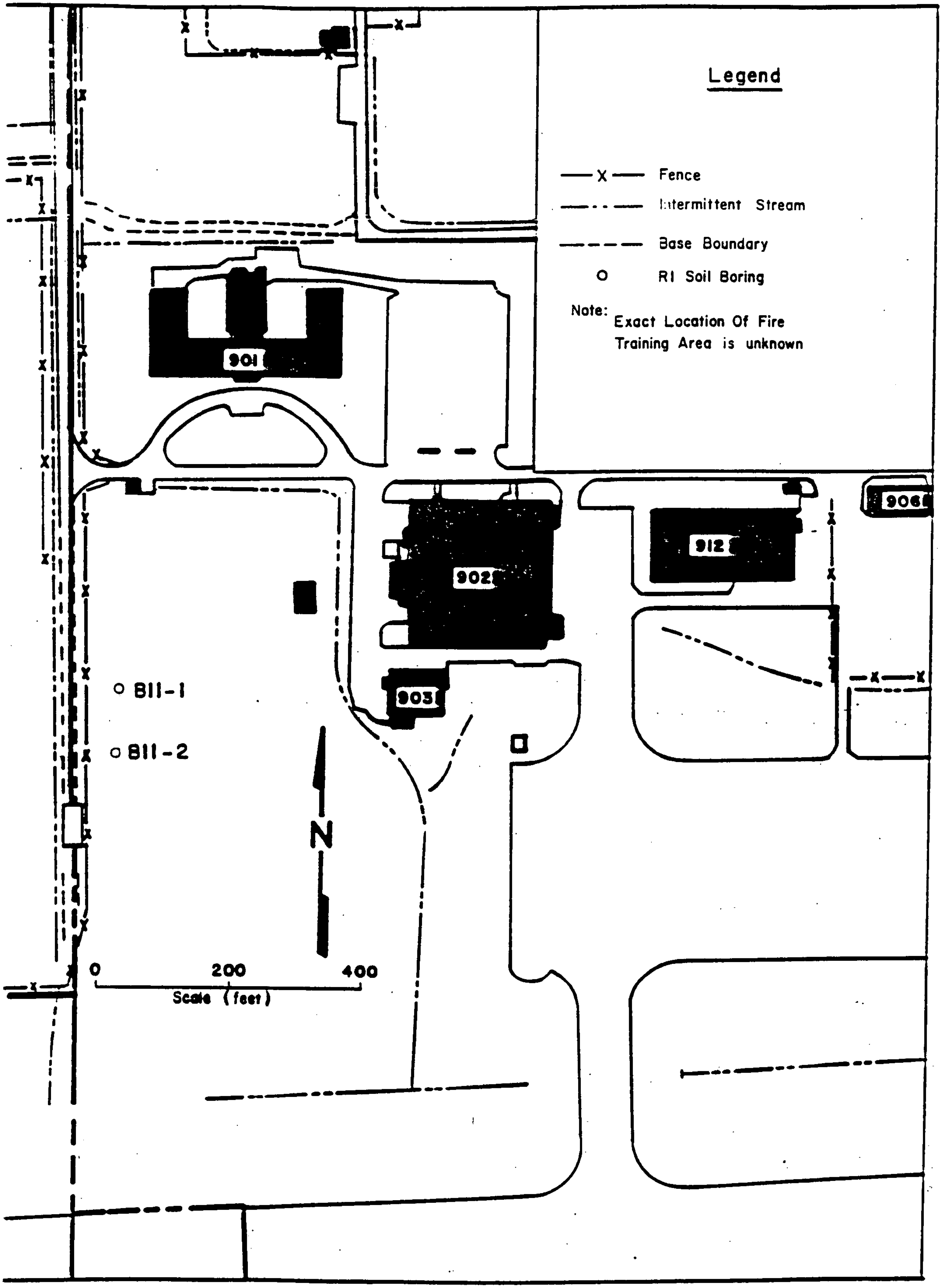


FIGURE 4-77
SITE NO. 11: SOIL BORING LOCATION MAP

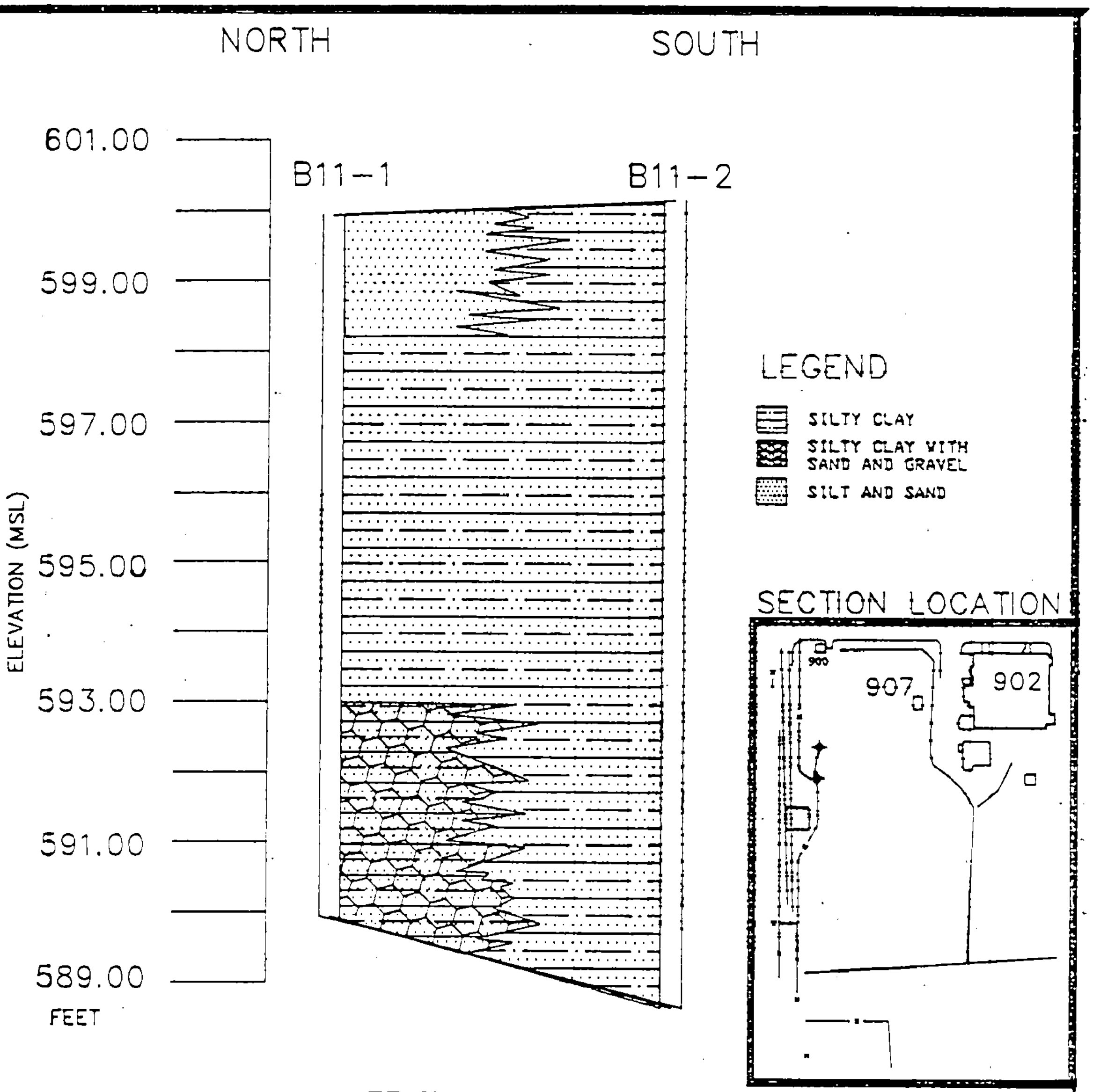


FIGURE 4-78
SITE NO. 11
GENERALIZED GEOLOGIC CROSS-SECTION

0 50

VERTICAL: 20X HORIZ.

the Odessa Series. Since this is a dominant soil type across the installation, it was described previously in Section 4.1.1.1.1.

The lacustrine sediments generally form the uppermost unit of the unconsolidated deposits; glacial till forms the lowermost unit. Both units are similar in texture, consistency and appearance which complicates efforts to distinguish one from the other. These units were described previously in Section 4.1.1.1.1. Fluvial sediments were not encountered in the two boreholes, but probably occur sporadically throughout the Site No. 11 study area. The average thickness of both these units could not be ascertained since the boreholes did not extend all the way to bedrock and for other reasons previously discussed in Section 4.1.2.1.1.

4.1.8.1.2 Analytical Results for Site No. 11: Contract Laboratory

Results are presented for each individual sample in Table 4-102; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples.

Organic Analyses: Six soil boring samples, plus one field duplicate, collected at Site 11 were analyzed for volatile organics (excluding the field duplicate) and semivolatile organics. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The volatile organic method blank contained methylene chloride at 0.005 mg/l; sample concentrations of this compound ranged from ND-0.014 mg/kg. Methylene chloride is a common laboratory contaminant.

- The semivolatile method blank associated with these soil samples contained bis(2-ethylhexyl)phthalate below the detection limit; sample concentrations of this compound ranged from <0.39*-0.59 mg/kg (where <0.39* refers to the compound being present below the measurable detection limit.). Bis(2-ethylhexyl)phthalate is a common laboratory contaminant and sample concentrations are suspect.

- The field duplicate from this site, B-11-2-4/4R, was analyzed for semivolatile organics. Bis (2-ethylhexyl)phthalate was detected in the sample at a concentration of 0.59 mg/kg, and was present below the detection limit (<0.40*) in the duplicate. Again, this compound is considered to be attributable to laboratory contamination.

TABLE 4-102
SITE NO. 11: ANALYTICAL RESULTS: SOILS

Parameter (Units)	Detection Limits	Sample ID (Sample Description)						
		B-11-1-1 (0-1.5')	B-11-1-4 (4.5'-6.0')	B-11-1-7 (9.0'-10.5')	B-11-2-1 (0-1.5')	B-11-2-4 (4.5'-6.0')	B-11-2-4R (4.5'-6.0') duplicate)	B-11-2-8 (10.5'-12.0')
EPA Method SW8240 (mg/kg) Volatile Organics								
Methylene Chloride	0.005	ND[a]	0.011[a]	0.014[a]	0.012[a]	0.0088[a]	NA	0.089[a]
Acetone	0.010	0.140	0.018	0.042	0.015	0.031	NA	0.021
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/8270 Semivolatile Organics (mg/kg)								
Bis(2-ethylhexyl)phthalate	0.33	<0.54[*,b]	0.49[b]	0.47[b]	<0.39[*,b]	0.59[b]	<0.40[*,b]	0.42[b]
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010 Total Metals (mg/kg)								
Aluminum[c]	10.0	22900	8980	3390	23500	14500	14800	2880
Barium	1.0	130[b]	53.0[b]	54.4[b]	151[b]	130[b]	72.4[b]	42.8[b]
Beryllium	0.2	ND	ND	ND	0.391	ND	ND	ND
Calcium[c]	50.0	4680	92400	134000	3180	31900	36600	167000
Chromium	1.0	30.3	11.4	4.26	28.5	20.8	21.3	3.91
Cobalt	1.0	10.2	9.70	2.52	56.3	12.6	10.4	2.49
Copper	1.0	16.3	22.1	15.4	17.9	27.0	21.2	11.1
Iron[c]	2.5	34400	19900	7830	39600	31100	38200	5750
Lead	5.0	41.6[b]	15.4[b]	31.8[b]	32.6[b]	23.2[b]	16.2[b]	15.3[b]
Magnesium[c]	50.0	5800	14100	57200	6070	13100	11800	57600
Manganese	0.5	319	1100	580	2880	545	399	468
Molybdenum	1.0	ND	2.11	ND	ND	ND	ND	ND
Nickel	1.5	23.9	34.9	5.89	28.5	27.5	26.0	5.43
Potassium[c]	50.0	1970	1220	734	1830	2590	2390	568
Silicon[c]	100.0	4040	1600	654	1300	1240	1090	948
Sodium[c]	50.0	107	179	144	81.0	182	168	151
Vanadium	1.0	44.8	21.8	7.56	42.0	30.2	27.3	6.17
Zinc	1.0	76.0	58.4	486	66.0	67.1	68.3	242
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg) Total Petroleum Hydrocarbons	5.0	130[d]	7.1[d]	ND[d]	29[d]	20[d]	19[d]	11[d]

Footnotes:

* Compound present below measurable detection limit.

a Compound also detected in associated method blank.

b Associated field duplicate analyses exceeded 35% RPD for this parameter.

c Accuracy data unavailable; compound not spiked.

d Associated matrix spike recovery exceeded upper control limit.

Inorganic Analyses: Seven soil boring samples (including one field duplicate) were analyzed for total metals and total petroleum hydrocarbons (TPH). The following is a discussion of potentially biased data.

- The matrix replicate/matrix spike (MR/MS) analyzed for TPH with the samples had a spiked recovery (-145%) just slightly above the upper control limit (-142%).
- The MR/MS associated with the metals analysis of the soils was not spike with aluminum, calcium, iron, magnesium, potassium, silicon and sodium; therefore no assessment of accuracy could be made.
- The field duplicate pair from this site exceeded 35% RPD for barium (RPD -56.9%) and lead (-36%).

4.1.8.2 Significance of Findings

4.1.8.2.1 Significance of Findings: Site No. 11 - Fire Training Area No. 2

Only soils were investigated at Site No. 11 to characterize the environmental impact of fire training activities that were briefly conducted at this site during the late 1950s. Table 4-103 presents analyses versus background levels for all contaminants found in the soils.

During the drilling of the soil borings at Site No. 11, soil samples were collected for analyses. A total of eighteen metals were detected at various concentrations in soils from these soil borings. Only those metal species that can potentially cause adverse health effects at elevated levels are considered in the ensuing discussion. The discussion that follows makes comparisons with installation background levels and normal trace element averages published for soils, since no ARARs presently exist for soils.

- Barium found in Site No. 11 soils ranged from 42.8 mg/kg to 151 mg/kg. All of the barium values fell within the range established for barium by the background borings. The barium levels were also well below the 430 mg/l average barium concentration reported for soils.
- Soil from the 0.0 to 1.5-foot interval of B-11-2 yielded a beryllium concentration of 0.391 mg/kg. Although beryllium was not detected in soils from the background soil borings, the average beryllium concentration reported for soils is 6 mg/kg.

TABLE 4-103
SITE NO. 11: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

				Sample ID (Sample Description)					
Parameter (Units)	**Detection Limits**	**Background[c] (mg/Kg)**	**Selected Average for Soils[f] (mg/Kg)**	**B-11-1-1 (0-1.5')**	**B-11-1-4 (4.5'-6.0')**	**B-11-1-7 (9.0'-10.5')**	**B-11-2-1 (0-1.5')**	**B-11-2-4 (4.5'-6.0')**	**B-11-2-8 (10.5'-12.0')**
EPA Method SW8240 (mg/kg) **Volatile Organics**									
Methylene Chloride	0.005	0.0056-0.0091	--	ND[a]	0.011[a]	0.014[a]	0.012[a]	0.0088[a]	0.089[a]
Acetone	0.010	ND-0.056	--	0.140	0.018	0.042	0.015	0.031	0.021
Others	See Appendix F			ND	ND	ND	ND	ND	ND
EPA Method SW3550/8270 **Semivolatile Organics (mg/kg)**									
Bis(2-ethylhexyl)phthalate	0.33	ND-0.39	--	<0.54[*,b]	0.49[b]	0.47[b]	<0.39[*,b]	0.59[b]	0.42[b]
Others	See Appendix F			ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010 **Total Metals (mg/kg)**									
Aluminum[c]	10.0	2,300-15,600	71,000	22900	8980	3390	23500	14500	2880
Barium	1.0	28.4-163	430	130[b]	53.0[b]	54.4[b]	151[b]	130[b]	42.8[b]
Beryllium	0.2	ND	6	ND	ND	ND	0.391	ND	ND
Calcium[c]	50.0	2,120-213,000	13,700	4680	92400	134000	3180	31900	167000
Chromium	1.0	3.29-19.6	100	30.3	11.4	4.26	28.5	20.8	3.91
Cobalt	1.0	2.10-11.3	8	10.2	9.70	2.52	56.3	12.6	2.49
Copper	1.0	9.92-21.0	30	16.3	22.1	15.4	17.9	27.0	11.1
Iron[c]	2.5	5,060-31,700	38,000	34400	19900	7830	39600	31100	5750
Lead	5.0	9.96-26.0	10	41.6[b]	15.4[b]	31.8[b]	32.6[b]	23.2[b]	15.3[b]
Magnesium[c]	50.0	4,050-51,900	5,000	5800	14100	57200	6070	13100	57600
Manganese	0.5	386-801	600	319	1100	580	2880	545	468
Molybdenum	1.0	ND	2	ND	2.11	ND	ND	ND	ND
Nickel	1.5	4.41-25.1	40	23.9	34.9	5.89	28.5	27.5	5.43
Potassium[c]	50.0	496-2,310	8,300	1970	1220	734	1830	2590	568
Silicon[c]	100.0	223-345	320,000	4040	1600	654	1300	1240	948
Sodium[c]	50.0	49.6-154	6,300	107	179	144	81.0	182	151
Vanadium	1.0	5.30-32.0	100	44.8	21.8	7.56	42.0	30.2	6.17
Zinc	1.0	53.3-864	50	76.0	58.4	486	66.0	67.1	242
Others	See Appendix F			ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg) **Total Petroleum Hydrocarbons**	5.0	ND	--	130[d]	7.1[d]	ND[d]	29[d]	20[d]	11[d]

Footnotes:

* Compound present below measurable detection limit.
a Compound also detected in associated method blank.
b Associated field duplicate analyses exceeded 35% RPD for this parameter.
c Accuracy data unavailable; compound not spiked.
d Associated matrix spike recovery exceeded upper control limit.
e The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected

- o Levels of chromium were found in all of the soils from Site No. 11. Levels which exceeded the range established by the background borings were encountered in the 0.0 to 1.5-foot interval of B-11-1 (30.3 mg/kg) and the 0.0 to 1.5 foot and 4.5 to 6.0-foot intervals of B-11-2 (28.5 mg/kg and 20.8 mg/kg respectively). All levels of chromium found in soils at Site No. 11 were well below the 100 mg/kg average reported for most soils.

- o Cobalt found in Site No. 11 generally occurred within the range established by the background borings. An unusually high concentration of cobalt (56.3 mg/kg) was measured in soil from the 0.0 to 1.5-foot interval of B-11-1. The average cobalt concentration reported for soils is 8 mg/kg. The presence of cobalt at such high concentrations in soils from this interval can not be explained.

- o Copper levels in Site No. 11 soils were generally similar to those found in the background soils. Concentrations of 22.1 mg/kg and 27 mg/kg reported in soils from the 4.5 and 6.0-foot interval of B-11-1 and the 4.5 to 6.0-foot interval of B-11-2 respectively. None of the copper levels measured at Site No. 11 exceeded the 30 mg/kg average reported for most soils.

- o Lead levels in a number of soils at Site No. 11 occurred above the background lead levels. The elevated lead levels were encountered in soil from the 0.0 to 1.5 foot and 9.0 to 10.5-foot intervals of B-11-1 (41.6 mg/kg and 31.8 mg/kg respectively) and the 0.0 to 1.5-foot interval of B-11-2 (32.6 mg/kg). Lead levels in all of the Site No. 11 soils were measured above the 10 mg/kg average for soils reported in the literature. The elevated levels of lead are more likely related to the incorporation of lead sulfide minerals from the underlying dolomite into the soil than an indication of site contamination.

- o Manganese levels measured in the 4.5 to 6.0-foot interval of B-11-1 (1110 mg/kg) and the 0.0 to 1.5-foot interval of B-11-2 (2880 mg/kg) occurred outside the background range reported for the soils from the background soil borings.

- o Molybdenum was only detected in the 4.5 to 6.0-foot interval of B-11-1 (2.11 mg/kg). Although molybdenum was not detected in any of the background soil samples, the average value reported in the literature for soils is 2.0 mg/kg.

- o Nickel levels in a few of the soil samples at Site No. 11 were slightly elevated. A concentration of 34.9 mg/kg measured in soil from the 4.5 to 6.0-foot interval of B-11-1 and concentrations of 28.5 mg/kg and 27.5 mg/kg found in soils from the 0.0 to 1.5 foot and 4.5 to 6.0-foot intervals of B-11-2 occurred above range set by the background soil borings. All of the nickel concentration were within the average concentration reported for soils.

- o Vanadium concentrations of 44.8 mg/kg and 42.0 mg/kg measured in soil from the 0.0 to 1.5-foot interval of B-11-1 and the 0.0 to 1.5-foot interval of B-11-2 fall just outside the background range established for this metal. These levels are still well below the 100 mg/kg average reported for most soils.

- Zinc levels range from 58.4 mg/kg to 486 mg/kg in soils at Site No. 11 which is within the range obtained from soils of the background borings. As with the background concentrations, zinc concentrations found in Site No. 11 soils generally are significantly higher than 50 mg/kg average reported for typical soils. The elevated zinc levels can be linked to zinc sulfide mineralization of the bedrock. Zinc mineral complexes were likely incorporated into the overlying unconsolidated deposits during the erosional and depositional cycles that were operative when the sediments were deposited.

It should be noted, however, that the installation background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area.

The following presents a comparison of the organic analytical data yielded by the Site No. 11 soil borings with installation background levels:

- Low levels of total petroleum hydrocarbons (TPH) were found in most of the soils sampled at Site No. 11. TPH was not found in soils from the background borings. Soil from the 0.0 to 1.5-foot interval of B-11-1 contained 130 mg/kg TPH. This elevated TPH value indicates that the old fire training area was located near this boring. The presence of TPH in the soils is likely linked to the combustible liquids that were once used during fire training exercises.

- Besides acetone, no volatile organic components were detected in any of the soils from the two borings. The acetone reported in the soils of Site No. 11 can not be attributed to laboratory contamination since this compound was not detected in the method blank. Acetone was also detected in the background soils.

- Bis(2-ethylhexyl) phthalate was found in two of the soil samples from B-11-1 (0.49 and 0.47 mg/kg) and B-11-2 in one of the soil samples from 0.59 mg/kg. The presence of this compound may be the result of laboratory contamination since it was also detected in the method blank.

4.1.8.2.2 Zones of Contamination

There is no clear zone of contamination at Site No. 11. Figure 4-79 illustrates the levels of contaminants found in soils from the two borings. The only contaminants found in the soil of Site No. 11 were TPH which was found in soils of both borings. Since the site was considered not to pose any serious environmental risk, the quality of the groundwater at Site No. 11 was not assessed.

4.1.8.2.3 Baseline Risk Assessment for Site No. 11

This section presents the baseline risk assessment for Site 11. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

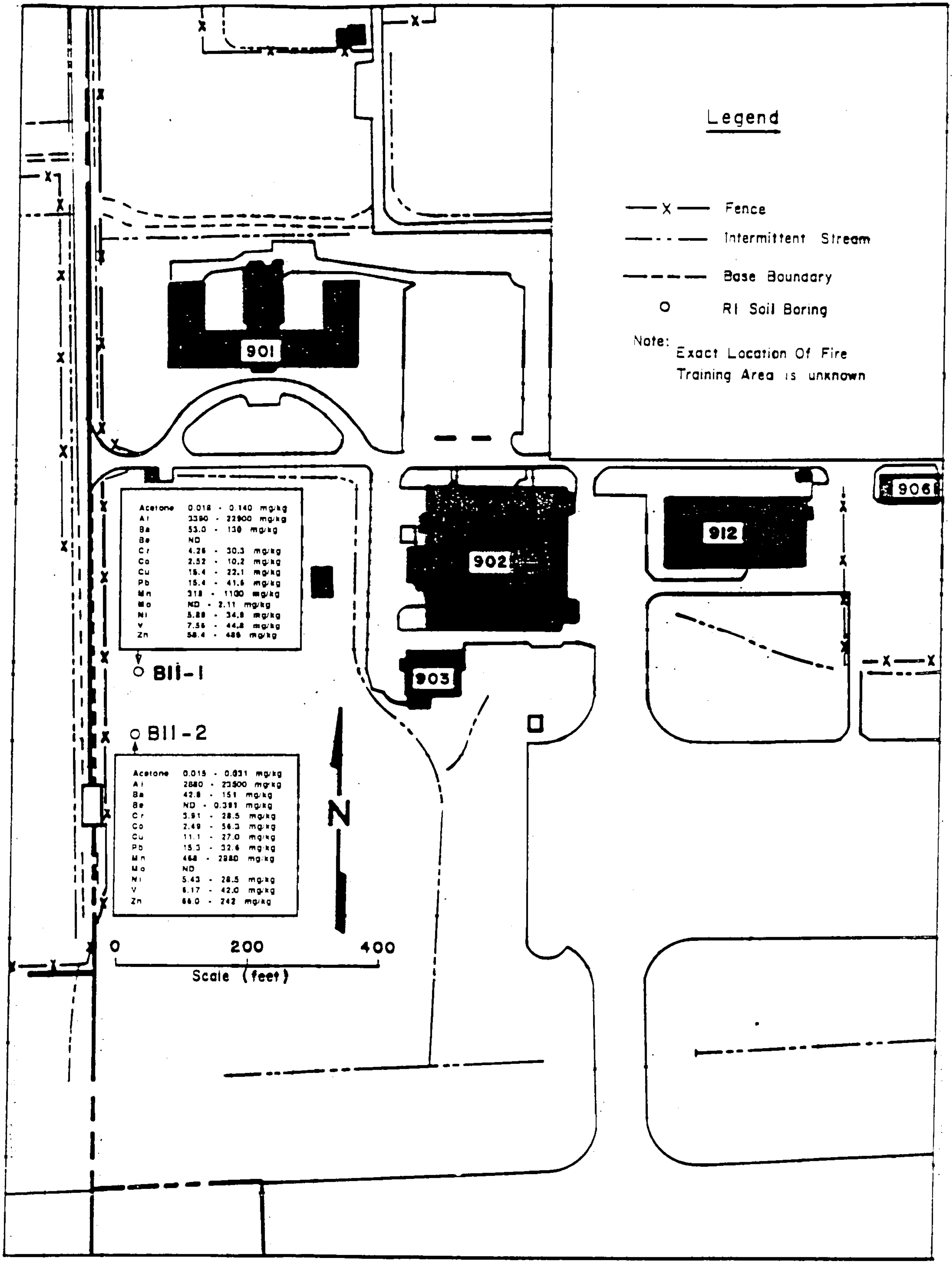
Site No. 11 - Data Analysis and Hazard Identification

Chemicals of concern for Site 11 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

Mean levels of TPH in soils at Site 11 were 33.2 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment.

Site No. 11 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation. The conceptual site model for Site 11 is presented in Figure 4-49. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 11 is provided in Appendix G.



Acetone	0.018 - 0.140	mg/kg
Al	3380 - 22900	mg/kg
Ba	53.0 - 130	mg/kg
Be	ND	
Cr	4.26 - 30.3	mg/kg
Co	2.52 - 10.2	mg/kg
Cu	15.4 - 22.1	mg/kg
Pb	15.4 - 41.6	mg/kg
Mn	318 - 1100	mg/kg
Mo	ND - 2.11	mg/kg
Ni	5.88 - 34.8	mg/kg
V	7.56 - 44.8	mg/kg
Zn	58.4 - 486	mg/kg

Acetone	0.015 - 0.031	mg/kg
Al	2880 - 23500	mg/kg
Ba	42.8 - 151	mg/kg
Be	ND - 0.381	mg/kg
Cr	3.91 - 28.5	mg/kg
Co	2.49 - 56.3	mg/kg
Cu	11.1 - 27.0	mg/kg
Pb	15.3 - 32.6	mg/kg
Mn	468 - 2880	mg/kg
Mo	ND	
Ni	5.43 - 28.5	mg/kg
V	6.17 - 42.0	mg/kg
Zn	66.0 - 242	mg/kg

FIGURE 4-79
SITE NO. 11: ZONES OF CONTAMINATION - SOIL

Soil

Site 11, fire training area No. 2 is adjacent to the western edge of the installation boundary. The site was used briefly prior to the 1950s and fuels were not contained (i.e., bermed) prior to burning. Access to the area is not limited (fenced), therefore, occupational soil exposure was evaluated. The exposure assumptions used for Site 4 soil exposure were also used to assess exposure at Site 11 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Site No. 11 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 11 - Risk Characterization

Soil

The results of the risk characterization for exposure to soil at Site 11 are presented in Table 4-104. The hazard index for combined exposure across compounds is approximately 5.4×10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Two carcinogenic compounds (beryllium and bis(2-ethylhexyl)phthalate, both Group B2 carcinogens) were detected in soils at the site. The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these contaminants is 3×10^{-8}. This result falls within the acceptable range established by EPA for waste site remediation under the Superfund Program.

Site No. 11 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

TABLE 4-104

RISK CHARACTERIZATION FOR SITE NO. 11: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	12717.00			
Barium	88.70	2.78E-04	Hypertension	
Beryllium	0.18	5.59E-06	Lung, Skin, Heart	3.43E-08
Chromium	16.60	5.21E-04	Skin	
Cobalt	15.40		Thyroid, Heart	
Copper	17.80	7.55E-05	GI Tract, Blood	
Lead	26.10	2.93E-03	CNS, Kidney	
Manganese	972.00	7.63E-04	CNS, Reproductive	
Molybdenum	0.89			
Nickel	20.90	1.64E-04	Skin, Lung	
Vanadium	25.20	5.65E-04	Respiratory Effects	
inc	166.00	1.30E-04	GI Tract	
ORGANICS				
Acetone	0.04	6.91E-08	Liver, Kidney	
Bis(2-ethexyl)phthalate	0.37	2.93E-06	Liver	2.34E-10

Hazard Index: Combined Exposure	5.43E-03	
Excess Lifetime Cancer Risk: Combined Exposure		3E-08

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

c. Explanation of risk assessment calculations is included in Section 4 Attachment B.

4.1.9 Discussion of Results for Site No. 13: 4000 Gallon Underground Tank Pit

4.1.9.1 Presentation of Results

4.1.9.1.1 Site Geology

The geology of Site No. 13, as interpreted by the RI well boring logs, consists of a veneer of fine grained glacial till and lacustrine sediments overlying massive to thinly bedded dolomite. The locations of all Site No. 13 monitoring wells is presented in Figure 4-80. The average thickness of the unconsolidated deposits in the Site No. 13 study area is 8.25 feet. The thickness ranges from 7.5 feet at shallow monitoring wells MW13-1 and 13-2 to 9.4 feet at monitoring well MW13-3. Well boring logs show a tendency for sediments to thin slightly to the north, although it is difficult to establish trends due to the small size of the study area. The Lockport Dolomite in this area of Niagara Falls is estimated to be approximately 180 feet thick. A generalized geologic cross-section of the Site No. 13 study area is presented as Figure 4-81. Soils occurring at Site No. 13 are typical of those that develop on lacustrine sediments in this portion of western New York and belong to the Odessa Series. Soils of the Odessa Series were described previously in Section 4.1.1.1.1.

As at the other sites, lacustrine sediments form the uppermost unconsolidated unit and a silty clay till forms the lowermost unit and rests directly on the dolomite surface. Both units are similar in texture, consistency and overall appearance which complicates efforts to distinguish one from the other. For this reason it is difficult to establish the thickness of each unit since the contact between the till and lacustrine deposits is indistinct. A description of both these units was presented in Section 4.1.1.1.1. Thin intercalations of fluvial sand and silt, although not observed in the well borings probably occur sporadically throughout the site.

The bedrock surface as interpreted from the well boring logs has very little relief. Evidence of preglacial or even glacial erosional features are not apparent. The lack of bedrock surface relief may be more a function of the limited number of reference points (i.e. monitoring wells) than a local topographic anomaly. A structural contour map of the Lockport Dolomite surface

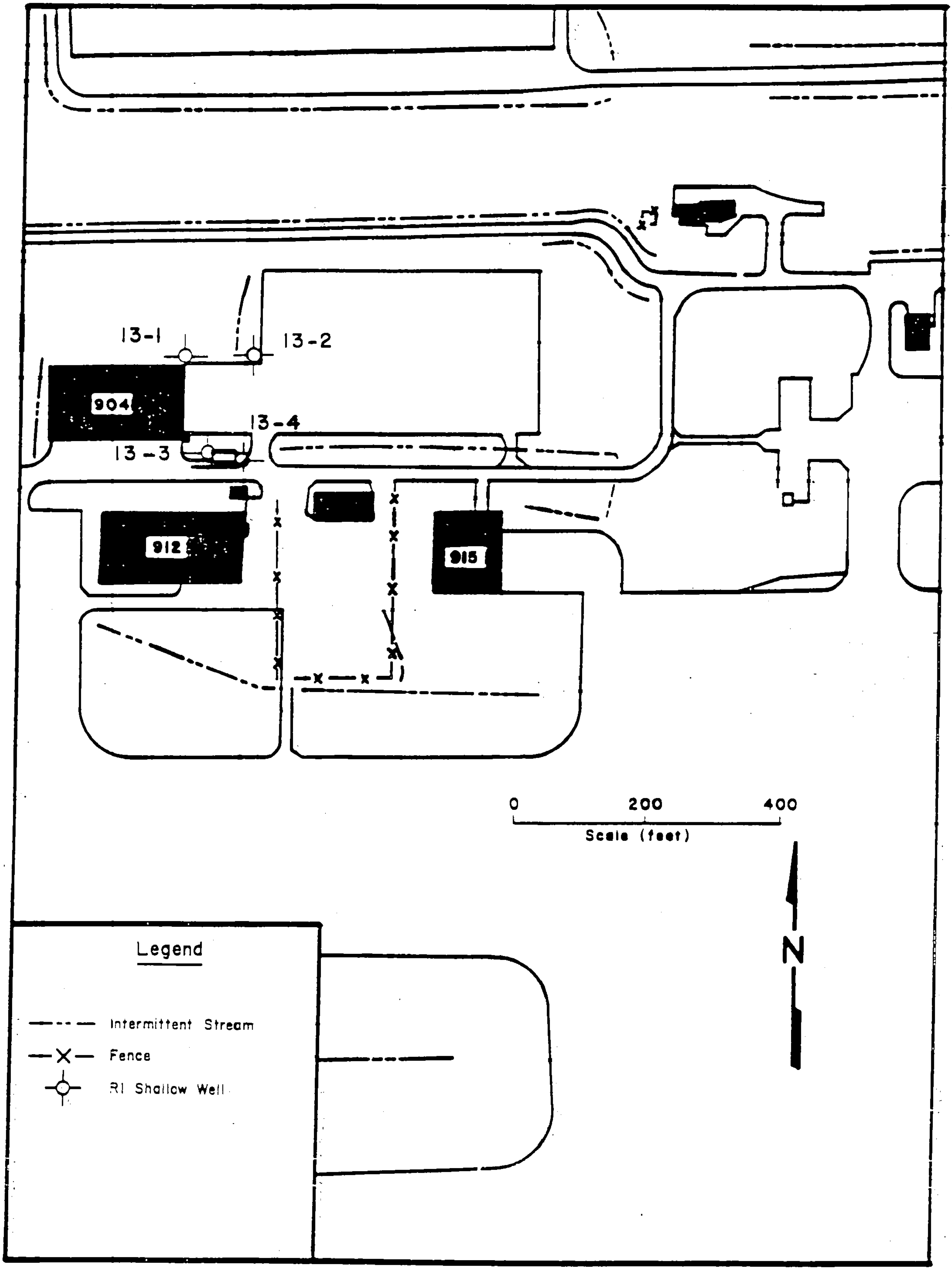


FIGURE 4-80
SITE NO. 13: MONITORING WELL LOCATION MAP

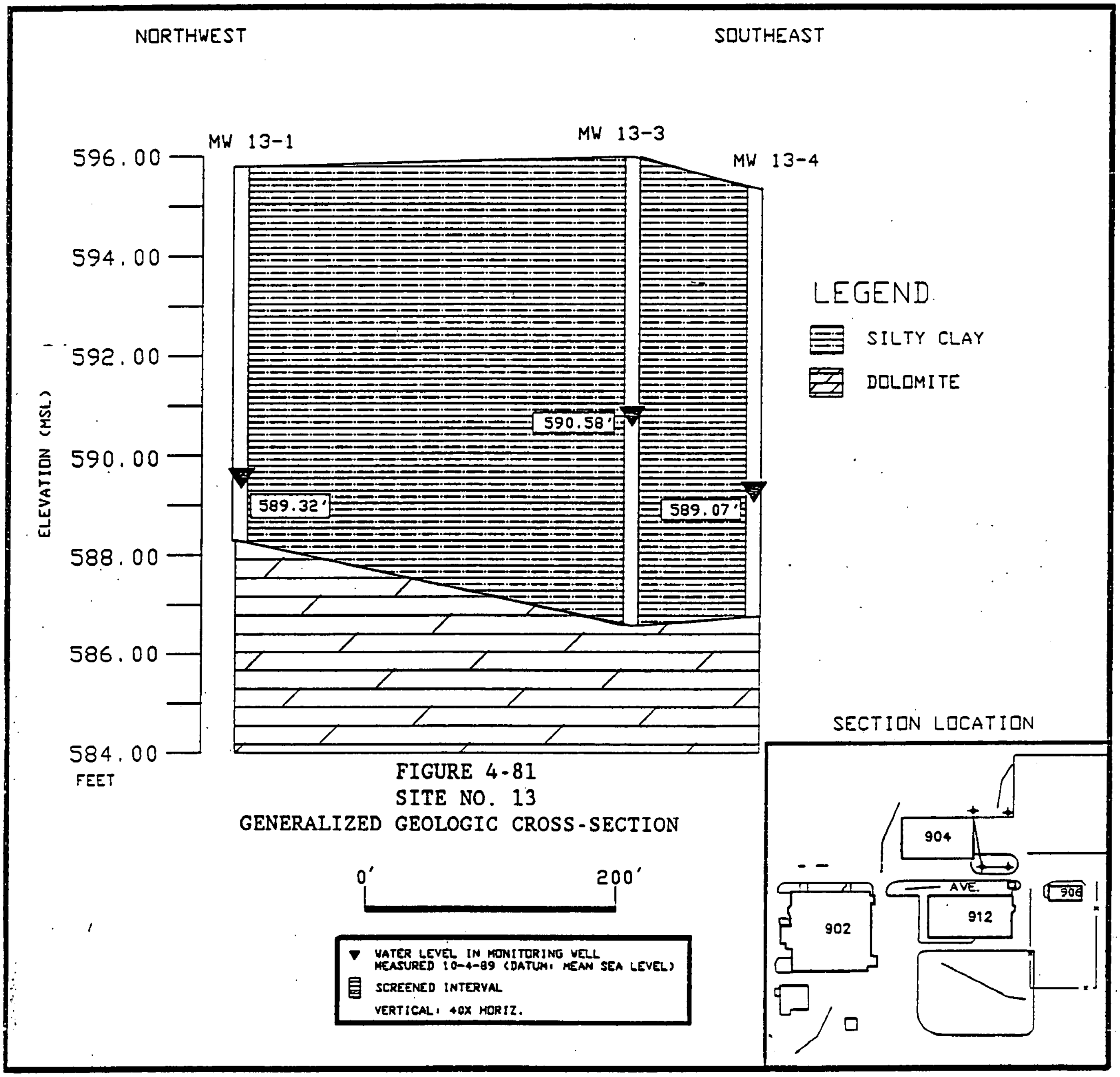


FIGURE 4-81
SITE NO. 13
GENERALIZED GEOLOGIC CROSS-SECTION

at Site No. 9 is presented as Figure 4-82. Site specific information on bedrock geology is unavailable for Site No. 13.

4.1.9.1.2 Site Hydrogeology

Only the shallow unconsolidated aquifer was investigated at Site No. 13. Based upon the RI well boring logs, the first potential water-bearing zone encountered is a 1 to 1-1/2-foot interval of silty clay to clayey silt which lies directly on the bedrock surface. Unlike the other IRP sites, gravel was not always observed in this interval. Although this water-bearing zone is physically similar to the overlying units, it appears to have a slightly higher permeability. The greatest permeability probably occurs along the sediment bedrock contact. The overlying unconsolidated materials appear to lack sufficient permeability to serve as water-bearing formations and collectively function as an aquitard.

Between September 1989 and April 1990, water levels in the shallow unconsolidated aquifer occurred at an average depth of 6.07 feet. During April 1990, water levels exhibited a range in elevation from 591.72 feet MSL at MW13-3 to 589.09 feet MSL at MW13-2. The maximum head differential across the Site No. 13 study area is 2.63 feet and the hydraulic gradient is 0.0159. According to the groundwater flow modeling study conducted at the Love Canal site (Mercer et. al., 1983), a hydraulic gradient of 0.0036 is more typical of the unconsolidated aquifer. The steeper gradient interpreted at Site No. 13 and several other sites across the installation is probably a seasonal abnormality that exists only during the wetter Spring months.

A maximum average water fluctuation of approximately 1.41 feet was observed in the shallow aquifer monitoring wells at Site No. 13 between October 1989 and April 1990. Table 4-105 presents all the hydrogeological data collected at Site No. 13. Figures 4-83 and 4-84 present potentiometric surface maps of the shallow unconsolidated aquifer constructed from the October 1989 and April 1990 water level measurements. Water level measurements from both episodes indicate a groundwater flow direction to the northeast.

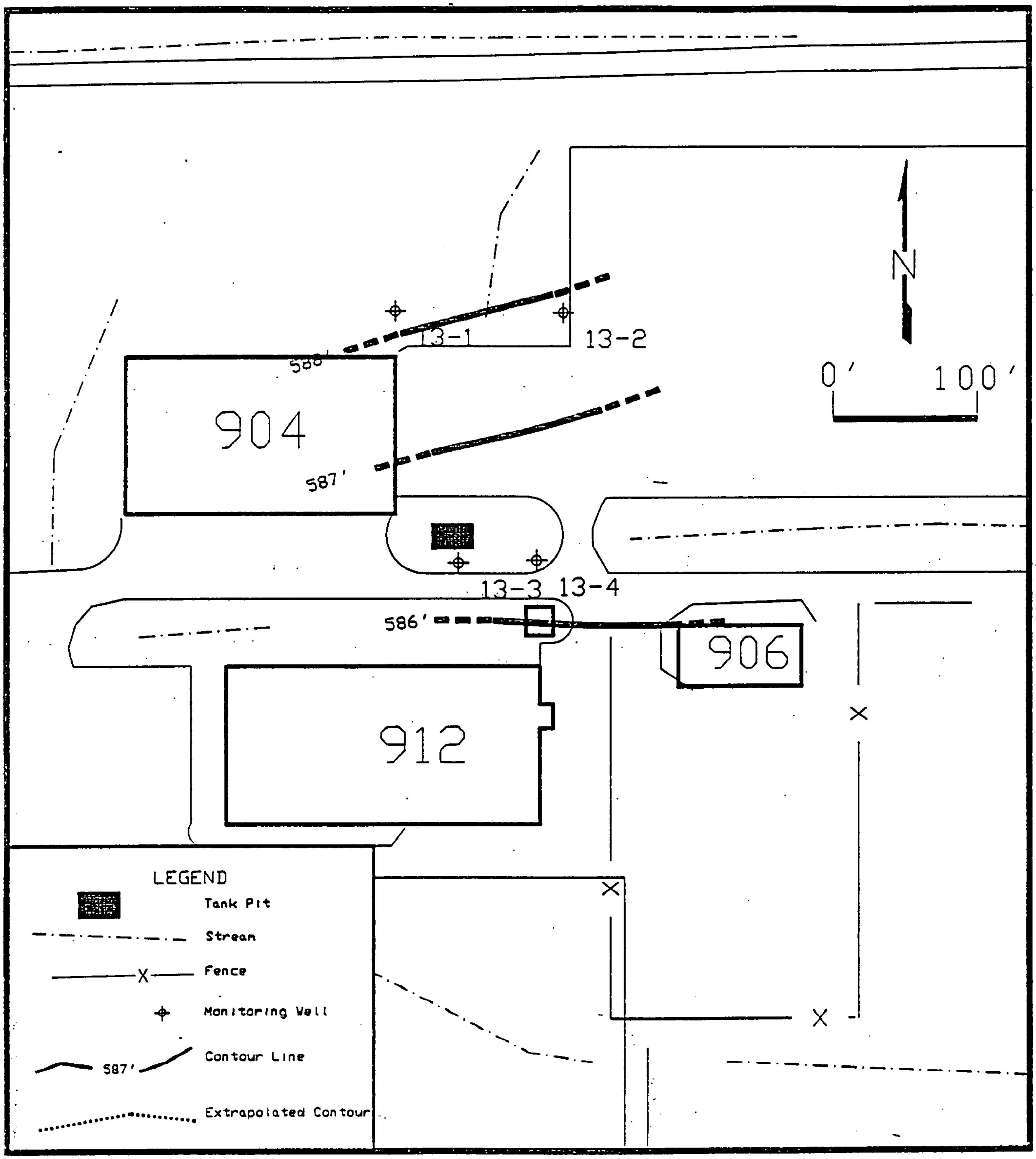


FIGURE 4-82
SITE NO. 13: STRUCTURAL CONTOUR MAP OF THE BEDROCK SURFACE

TABLE 4-105

Site No. 13 - Hydrogeologic Data

Static Water Level Results

	05-31-89		09-12-89		10-04-89		04-11-90	
	Water Levels		Water Levels		Water Levels		Water Levels	
Monitor Well No	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS	Elevation feet MSL	Depth feet BLS
13-1	NI	NI	589.29	6.50	589.32	6.47	NT	NT
13-2	NI	NI	587.78	7.59	587.91	7.46	589.09	6.28
13-3	NI	NI	590.52	5.46	590.58	5.40	591.72	4.26
13-4	NI	NI	589.12	6.24	589.07	6.29	590.98	4.38

Notes:

NT = Not Taken
NI = Not Installed
ft.BLS = Feet below land surface
ft.MSL = Feet in reference to mean sea-level

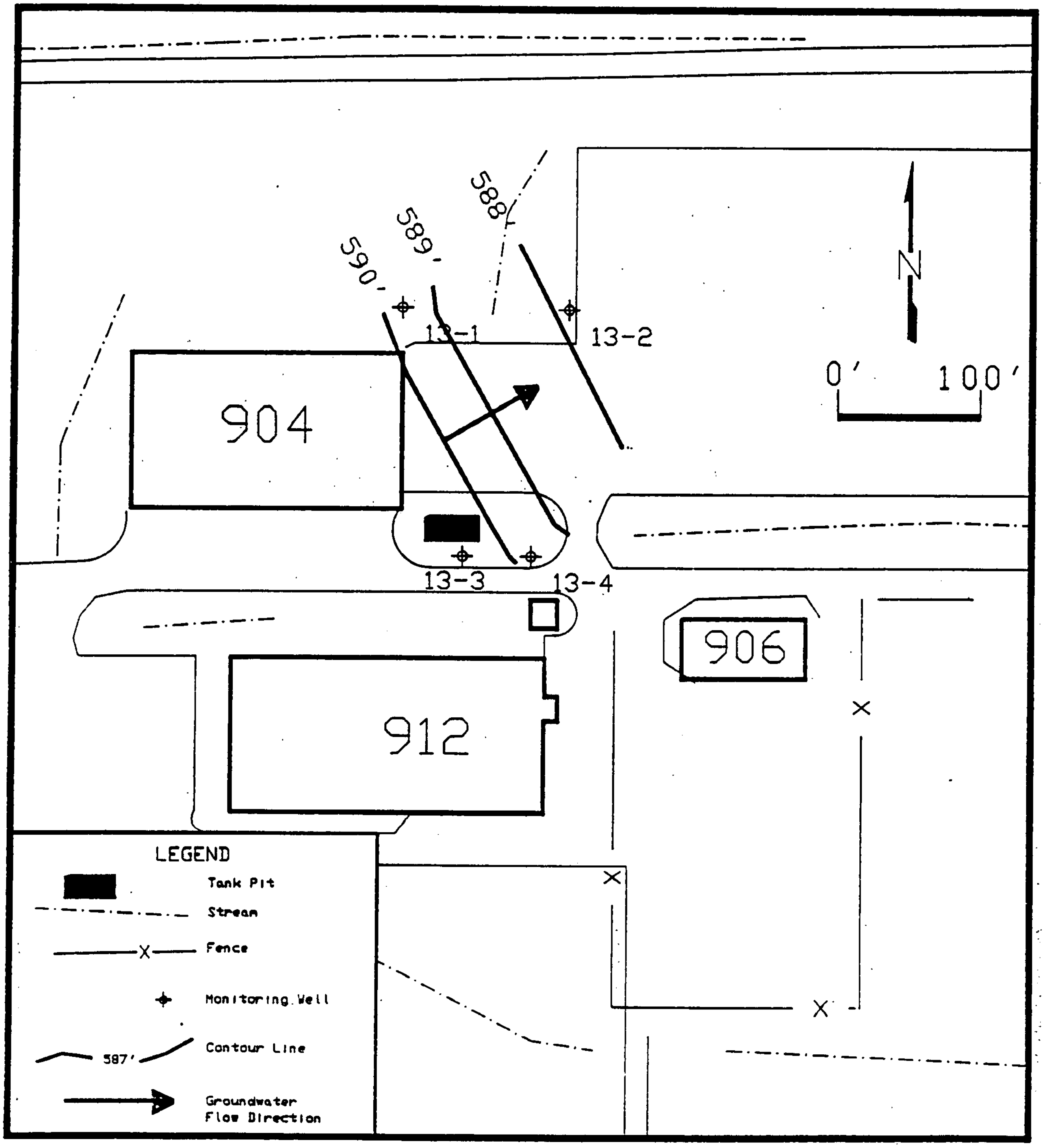


FIGURE 4-83
SITE NO. 13: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (OCTOBER, 1989)

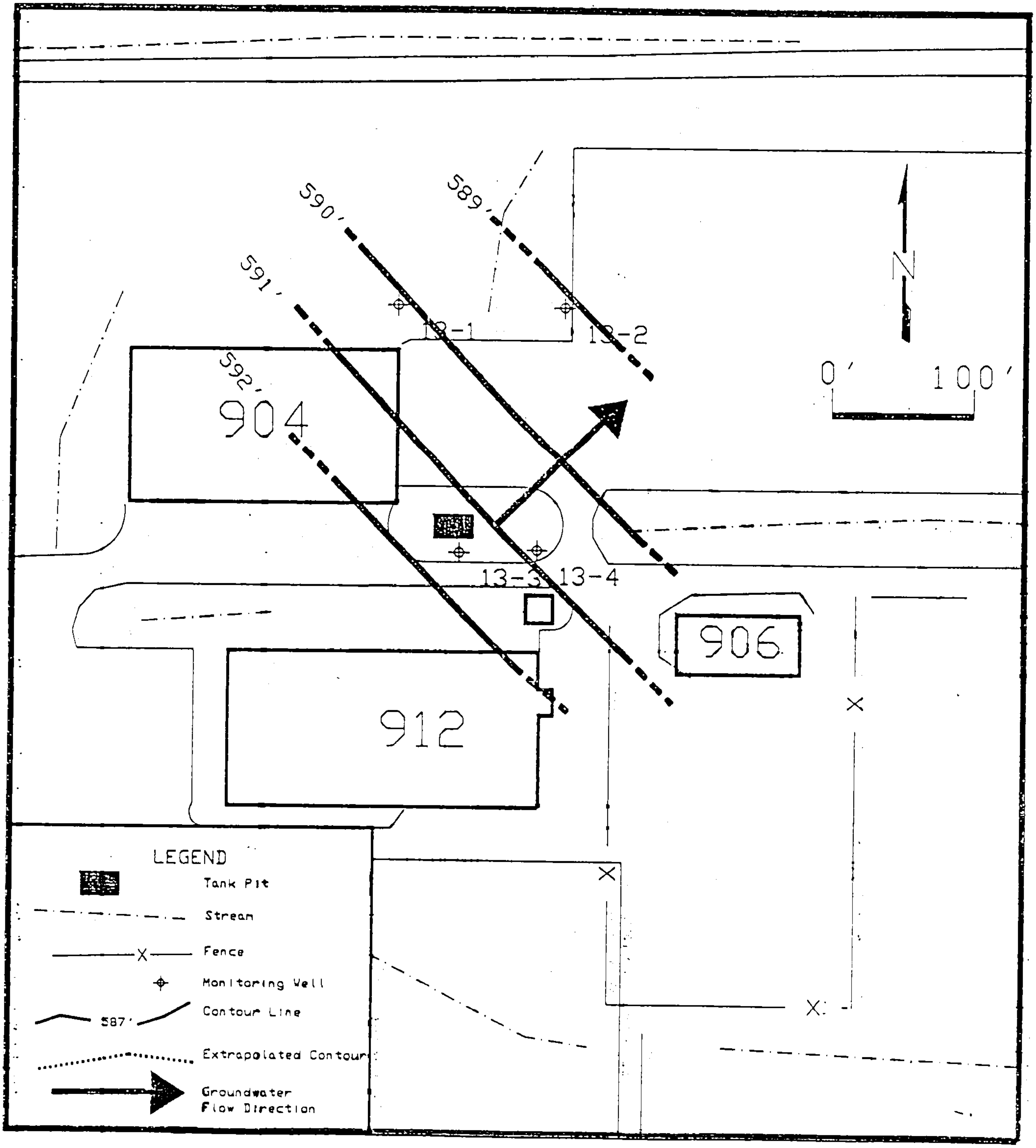


FIGURE 4-84
SITE NO. 13: SHALLOW AQUIFER POTENTIOMETRIC SURFACE MAP (APRIL, 1990)

No hydraulic conductivity tests (i.e., slug tests) were conducted on any of the shallow monitoring wells at Site No. 13. As discussed previously in Section 4.1.1.1.2, the groundwater flow modeling study at Love Canal (Mercer et. al., 1983) reported bulk hydraulic conductivities for the unconsolidated aquifer in the range of 10^{-6} to 10^{-7} ft/s, and an effective porosity of 10-15 percent and an average hydraulic gradient of 0.0036. Utilizing the hydrogeologic data from the flow modeling study, horizontal groundwater flow velocities of 2.1×10^{-4} to 2.1×10^{-3} ft/day or 7.7×10^{-2} to 7.7×10^{-1} ft/year are predicted for Site No. 13. According to the USGS (1985), groundwater flow in the shallow aquifer at an industrial property located nearby ranged from 2.0×10^{-2} to 6.0×10^{-2} ft/year. Locally higher velocities may occur in regions of the unconsolidated aquifer containing higher conductive sand lenses or fill materials associated with underground utilities. The hydraulic conductivities in these regions, as suggested by Mercer et. al. (1983), might be on the order of 3×10^{-4} ft/s.

4.1.9.1.3 Analytical Results for Site No. 13: Contract Laboratory

Matrix-specific results are presented for each individual sample in Tables 4-106 and 4-107; these data have footnotes qualifying the results based on quality control data obtained for field and laboratory QC samples. Field water quality data are presented in Table 4-108.

Organic Analyses: Eight soil samples (including one field duplicate) were collected and analyzed for volatile and semivolatile organic compounds (excluding the duplicate). Three groundwater samples, and associated field QC blanks, were collected during the original field effort and analyzed for purgeable halocarbons, purgeable aromatics, non-halogenated volatile organics, ethylene dibromide and pesticides and PCBs. These three groundwaters (plus one field duplicate) were sampled again during the additional RI field effort (April, 1990) along with a fourth well not previously sampled. All these samples were analyzed for purgeable halocarbons and purgeable aromatics, and are identified in Table 4-107 as GW100-107. The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

TABLE 4-106
SITE NO. 13: ANALYTICAL RESULTS: SOILS

		Sample ID (Sample Description)							
Parameter (Units)	Detection Limits	WB-13-1-5 (6.0'-7.5')	WB-13-2-4 (4.5'-6.0')	WB-13-2-5 (6.0-7.5')	WB-13-3-1 (0-1.5')	WB-13-3-6 (7.5'-9.0')	WB-13-3-6R (7.5'-9.0') duplicate	WB-13-3-7 (7.0'-9.4')	WB-13-4-5 (6.0'-7.5')
EPA Method SW8240 (mg/kg)									
Volatile Organics									
Methylene Chloride	0.005	0.018[a,b]	0.011	0.020	ND[b]	ND[b]	0.0069[b]	<0.0059[*,b]	0.0175[b]
Acetone	0.010	0.042[a,b]	0.060[b]	0.047[b]	0.026[b]	0.039[b]	0.050[b]	0.029[b]	0.038[b]
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E625 (SW3550/8270)									
Semivolatile Organics									
Bis(2-ethylhexyl)phthalate	0.33	<0.43[*,b]	<0.40[*,b]	0.40[b]	<0.375[*,b]	<0.42[*,b]	NA	<0.39[*,b]	<0.42[*,b]
Others	See Appendix F	ND	ND	ND	ND	ND		ND	ND
EPA Method SW3050/6010*									
Total Metals (mg/kg)									
Aluminum[d]	10.0	5030	14700	10400	11900	13400	11000	8590	14100
Barium	1.0	19.1	121	66.2	204	110	114	74.8	112
Calcium[d]	50.0	72500	69800	39300	85700	63000	48700	106000	52300
Chromium	1.0	7.0[c]	18.2[c]	14.9[c]	13.9	17.5	16.8	10.9	17.5
Cobalt	1.0	4.2	10.8	8.0	9.1	14.7	14.5	6.61	12.5
Copper	1.0	8.3[b]	18.0[b]	17.2[b]	16.4	22.2	21.3	14.9	21.9
Iron[d]	2.5	11200[b]	28600[b]	25800[b]	21300	22900	25400	18000	27100
Lead	5.0	26.6[c]	23.2[c]	27.9[c]	19.2	17.0	19.2	12.4	18.0
Magnesium[d]	50.0	43000	23500	12800	14300	20300	16600	49900	10800
Manganese	0.5	343	720	521	727	837	683	446	801
Nickel	1.5	9.4[c]	27.4[c]	19.0[c]	19.1	29.1	26.7	15.9	35.9
Potassium[d]	50.0	658	1950	1340	1270	2010	1890	1360	1870
Silicon[d]	100.0	457[b]	276[b]	222[b]	851[b]	2120[b]	2630[b]	1780[b]	1440[b]
Sodium[d]	50.0	134	152	103	178	187	195	168	165
Vanadium	1.0	9.9	24.6	19.1	19.5	24.0	23.1	15.9	24.5
Zinc	1.0	514	59.4	79.0	102	157	156	106	88.2
Others	See Appendix F	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method SW3550/E418.1 (mg/kg)									
Total Petroleum Hydrocarbons	5.0	ND	ND	ND	21	ND	ND	ND	ND

Footnotes:

a = Surrogate recovey (toluene-d8) was above upper control limit for this analysis.
b = Compound also detected in assoicated method blank.
c = Associated matrix spike recoveries were below lower control limit for this parameter.
d = Accuracy data not available; compound not spiked.

TABLE 4-107
SITE NO. 13: ANALYTICAL RESULTS: GROUNDWATERS

Parameter (Units)	Detection Limits	Sample ID (Sample Description)					
		GW4 (MW-13-3)	GW5 (MW-13-4)	GW2 (MW-13-1)	TB14 Trip Blank	GW1 Field Blank	GW7 Equip. Wash
EPA Method SW5030/8021 (μg/L)							
Volatile Organics/Purgeable Halocarbons							
1,2-Dichloroethane	0.4	ND	2.3	ND	ND[d]	ND	ND
Methylene Chloride	0.8	160[a]	2.3[a]	2.8[a]	3.5[a,d]	4.0[a]	1.8[a]
Vinyl Chloride	0.8	1600	2.9	ND	ND[d]	ND	ND
t-1,2-Dichloroethene	0.3	ND	ND	ND	ND[d]	ND	ND
Trichloroethene	1.0	ND	ND	ND	ND[d]	ND	ND
1,4-Dichlorobenzene	0.3	ND	ND	ND	ND[d]	ND	ND
Others	See Appendix F	ND	ND	ND	ND[d]	ND	ND
EPA Method SW5030/8020(μg/L)							
Purgeable Aromatic Organics			ND		ND	ND	ND
Chlorobenzene	0.3	9.1		ND			
1,2-Dichlorobenzene	1.0	3.6		ND			
1,3-Dichlorobenzene	0.7	1.1		ND			
1,4-Dichlorobenzene	0.7	9.7		ND			
Benzene	0.3	2.98		ND			
Total Xylenes	0.1	7.6		ND			
Toluene	0.3	15		1.3			
Ethylbenzene	0.3	3.6		ND			
EPA Method SW5030/8015 (ug/L)							
Non-Halogenated Volatile Organics	See Appendix F	ND	ND	ND	ND	ND	ND
EPA Method E504.1 (μg/L)							
Ethylene Dibromide	0.3	ND	ND	ND	ND	ND	ND
EPA Method E608 (μg/L)							
Pesticides and PCB's	See Appendix F	ND	ND	NA	NA	NA	ND
EPA Method E200.7*							
Total Metals (mg/l)				NA	NA	NA	
Aluminum	0.1	60.6	35.5				ND
Arsenic	0.05	ND	ND				ND
Arsenic (E206.2)	0.005	0.015	ND				ND
Barium	0.01	0.475	0.245				ND
Boron	0.01	ND[c]	ND[c]				0.022[c]
Calcium[b]	0.20	524	572				ND

TABLE 4-107 (Cont'd)
SITE NO. 13: ANALYTICAL RESULTS: GROUNDWATERS

Parameter (Units)	Detection Limits	GW4 (MW-13-3)	GW5 (MW-13-4)	GW2 (MW-13-1)	TB14 Trip Blank	GW1 Field Blank	GW7 Equip. Wash
		Sample ID (Sample Description)					
EPA Method E200.7*							
Total Metals (mg/l) (Cont'd)							
Chromium	0.010	0.100	0.050				ND
Cobalt	0.010	0.045	0.026				ND
Copper	0.010	0.112	0.083				ND
Iron	0.025	106[c]	57.3[c]				ND[c]
Lead	0.05	0.102	0.102				ND
Lead (E239.2)	0.005	0.063[c]	0.079[c]				ND[c]
Magnesium[b]	0.20	185	412				ND
Manganese	0.005	4.94	3.80				ND
Molybdenum	0.010	0.015	ND				ND
Nickel	0.015	0.125	0.062				ND
Potassium[b]	0.4	14.7[c]	10.6[c]				ND[c]
Silicon[b]	0.020	69.2	63.1				0.176
Sodium[b]	0.200	571	164				ND
Vanadium	0.01	0.122	0.064				ND
Zinc	0.01	0.877	1.31				ND
Others	See Appendix F	ND	ND				ND
EPA Method E418.1 (mg/L)							
Total Petroleum Hydrocarbons	1.0	ND	ND	ND	NA	NA	ND
Miscellaneous Inorganics (mg/L)				NA	NA	NA	
Total Dissolved Solids (E160.1)	1.0	4080	4250				3.0
Common Anions (A429)							
Fluoride	0.1	0.58	1.4				ND
Chloride	0.5	140	200				ND
Sulfate	0.5	2600	2600				ND
Total Hardness (E130.1)	1.0	2600	3300				ND

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not spiked.
c = Associated lab matrix replicate analysis had RPD values which exceeded the control limit.
d = Comfirmation analysis exceeded holding time by one day.
* = Or as indicated for those metals analyzed by an alternate method.

TABLE 4-107 (Cont'd)
SITE NO. 13: ANALYTICAL RESULTS: GROUNDWATERS

Parameter (Units)	Sample ID (Sample Description) GW102 (MW-13-1)	GW103 (MW-13-2)	GW104 (MW-13-4)	GW105 (MW-13-3)	GW106 (MW-13-4, duplicate	GW101 Trip Blank	GW100 Field Blank	GW107 Equip. Wash
EPA Method SW5030/8021 (ug/L)								
Volatile Organics/Purg. Hal.	ND	ND						
1,2-Dichloroethane			1.6	ND	1.4	ND	ND	ND
Methylene Chloride			2.0^a	24^a	3.4^a	1.1^a	3.1^a	5.3^a
Vinyl Chloride			ND	450	6.3	ND	ND	ND
t-1,2-Dichloroethane			ND	4.1	ND	ND	ND	ND
Trichloroethene			ND	14	ND	ND	ND	ND
1,4-Dichlorobenzene			ND	3.1	ND	ND	ND	ND
Others			ND	ND	ND	ND	ND	ND
EPA Method (SW5030/8020)(µg/L)								
Purgeable Aromatic Organics	ND	ND	ND		ND	ND	ND	ND
Chlorobenzene				1.3				
1,2-Dichlorobenzene				1.1				
1,3-Dichlorobenzene				ND				
1,4-Dichlorobenzene				2.6				
Benzene				ND				
Total Xylenes				1.7				
Toluene				3.5				
Ethylbenzene				0.65				

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not spiked.
c = Associated lab matrix replicate analysis had RPD values which exceeded the control limit.
d = Comfirmation analysis exceeded holding time by one day.

TABLE 4-108
Field Water Quality Data
Niagara Falls IAP
Site No. 13
9/13 & 9/14/89

Well No.	Temperature C	pH	Conductivity umhos/cm	Alkalinity mg/l	Total Hydroxide mg/l	Carbonate mg/l	Bicarbonate mg/l	Headspace HNU Reading ppm	Water Clarity
MW 13-1 (1)	---	---	---	---	---	---	---	7-10 ppm	brown, turbid
MW 13-2 (2)	---	---	---	---	---	---	---	---	---
MW 13-3	15°	6.70	4280	255	0	0	255	120 ppm	light brown, turbid
MW 13-4	15°	6.84	4210	266	0	0	266	38 ppm	brown, turbid

Notes:

(1) Well went dry before measurements could be taken.
(2) No water in well.

- The volatile organic analysis of soil sample WB-13-1-5 had one surrogate recovery above the control limit: toluene-d8 recovery =127%, upper control limit =117%.

- Methylene chloride was present in two of the three volatile organic method blanks associated with the soil samples, and acetone was detected in all three. Samples concentration of these two compounds are potentially biased and attributable to suspected laboratory contamination.

- The field duplicate pair from this site, WB-13-3-6/6R, had methylene chloride not present the sample, but detected in the duplicate. Again this is due to suspected laboratory contamination.

- The semivolatile organic method blanks associated with the soil samples contained bis(2-ethylhexyl)phthalate at or just below the detection limit. Sample concentrations are therefore suspect, and attributable to laboratory contamination.

- Only a matrix spike (not a matrix spike/matrix spike duplicate) was analyzed with samples WB-13-1-5 and WB-13-2-4/5 thereby precluding an assessment of batch precision.

- The field duplicate pair associate with the semivolatile organic analysis of the soil samples had bis(2-ethylhexyl)phthalate detected in one sample but not in the other. Bis(2-ethylhexyl)phthalate is a suspected laboratory contaminant.

- One sample, TB14 was analyzed for the confirmation of methylene chloride only on the 15th day after date of collection. The initial analysis, with all other compounds not detected, was performed within holding times.

- The laboratory method blanks associated with the purgeable halocarbon analysis of the groundwaters all contained methylene chloride at concentrations from 2.0-4.4 ug/l. Sample concentrations of this compound are suspected of being laboratory contamination. (The apparently elevated concentrations of methylene chloride in GW4 and GW105 are due to fifty and ten-fold dilution factors, respectively.)

Inorganic Analysis: Eight soil samples were analyzed for metals and total petroleum hydrocarbons. Two groundwater samples (plus one equipment wash blank) were analyzed for total metals, TPH, total dissolved solids (TDS), common anions and hardness. (One well had insufficient volume to collect sample for inorganic parameters). The following is a discussion of data which may be biased as a result of blank analyses and/or precision and accuracy data which did not meet QC control limits.

- The metals method blanks associated with soil samples WB-13-1-5 and WB-13-2-4/5 contained boron (4.0 mg/L), copper (1.0 mg/l), iron (11.0 mg/l) and silicon (7.1 mg/L). Boron was not detected in any of the samples. Copper concentrations in the samples ranged from 8.3 - 18.0 mg/kg. Iron and silicon concentrations in the samples were significantly higher than in the blank.

- The MR/MS associated with the metals analysis of soil samples WB-13-1-5 and WB-13-2-4/5 had several outlier recoveries and RPD values. Boron was not detected in the sample, but was reported in the replicate. Chromium, lead and nickel had recoveries below the lower control limit (75%); recoveries were 53%, 66% and 68%, respectively. No assessment of accuracy could be made for aluminum, calcium, iron, magnesium, potassium, silicon and sodium since these metals were not spiked.

- The MR/MS pair associated with the metals analysis of the groundwater samples had RPD values above the control limits (RPD =20%) for boron (RPD =26%), iron (=22%), lead by graphite furnace (=63%), and potassium. No assessment of accuracy could be made for the following metals which were not spiked: calcium, magnesium, potassium, silicon, and sodium.

4.1.9.2 Significance of Findings

4.1.9.2.1 Significance of Findings: Site No. 13 - 4000 Gallon Underground Tank Pit

Groundwater and soils were investigated at Site No. 13 to characterize the environmental impact of a former underground storage tank used to store various industrial shop wastes. Tables 4-109 and 4-110 present analyses versus ARARs and/or background levels for all contaminants in the matrices studied.

During the drilling of the four well borings at Site No. 13, soil samples were collected for analyses. A total of sixteen metals were detected at various concentrations in soils from these well borings. Only those metals that can potentially cause adverse health effects at elevated concentrations are discussed. Since no ARARs presently exist for soils, comparisons are made with installation background levels and normal trace element averages published for soils:

- Barium was found in all Site No. 13 soils. Barium ranged from 19.1 mg/kg in WB-13-1 (6.0 to 7.5-foot interval) to 204 mg/kg in WB-13-3 (0.0 to 1.5-foot interval). Except for the 204 mg/kg level measured in a soil sample from WB-13-3, all other barium concentrations occurred within the range established by the background soil borings. The highest barium concentration is still less than the 430 mg/kg average barium concentration in normal soils.

TABLE 4-109
SITE NO. 13: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

Parameter (Units)	Detection Limits	Background[e] (mg/Kg)	Selected Average for soil[f] (mg/Kg)	Sample ID (Sample Description) WB-13-1-5 (6.0'-7.5')	WB-13-2-4 (4.5'-6.0')	WB-13-2-5 (6.0-7.5')	WB-13-3-1 (0-1.5')	WB-13-3-6 (7.5'-9.0')	WB-13-3-7 (7.0'-9.4')	WB-13-4-5 (6.0'-7.5')
EPA Method SW8240 (mg/kg) **Volatile Organics**										
Methylene Chloride	0.005	0.0056-0.0091	--	0.018[a,b]	0.011	0.020	ND[b]	ND[b]	<0.0059[*,b]	0.0175[b]
Acetone	0.010	ND-0.056	--	0.042[a,b]	0.060[b]	0.047[b]	0.026[b]	0.039[b]	0.029[b]	0.038[b]
Others	See Appendix F			ND	ND	ND	ND	ND	ND	ND
EPA Method E625 (SW3550/8270) **Semivolatile Organics**										
Bis(2-ethylhexyl)phthalate	0.33	ND-0.39	--	<0.43[*,b]	<0.40[*,b]	0.40[b]	<0.375[*,b]	<0.42[*,b]	<0.39[*,b]	<0.42[*,b]
Others	See Appendix F			ND	ND	ND	ND	ND	ND	ND
EPA Method SW3050/6010* **Total Metals (mg/kg)**										
Aluminum[d]	10.0	2,300-15,600	71,000	5030	14700	10400	11900	13400	8590	14100
Barium	1.0	28.4-163	430	19.1	121	66.2	204	110	74.8	112
Calcium[d]	50.0	2,120-213,000	13,700	72500	69800	39300	85700	63000	106000	52300
Chromium	1.0	3.29-19.6	100	7.0[c]	18.2[c]	14.9[c]	13.9	17.5	10.9	17.5
Cobalt	1.0	2.10-11.3	8	4.2	10.8	8.0	9.1	14.7	6.61	12.5
Copper	1.0	9.92-21.0	30	8.3[b]	18.0[b]	17.2[b]	16.4	22.2	14.9	21.9
Iron[d]	2.5	5,060-31,700	38,000	11200[b]	28600[b]	25800[b]	21300	22900	18000	27100
Lead	5.0	9.96-26.0	10	26.6[c]	23.2[c]	27.9[c]	19.2	17.0	12.4	18.0
Magnesium[d]	50.0	4,050-51,900	5,000	43000	23500	12800	14300	20300	49900	10800
Manganese	0.5	386-801	600	343	720	521	727	837	446	801
Nickel	1.5	4.41-25.1	40	9.4[c]	27.4[c]	19.0[c]	19.1	29.1	15.9	35.9
Potassium[d]	50.0	496-2,310	8,300	658	1950	1340	1270	2010	1360	1870
Silicon[d]	100.0	223-345	320,000	457[b]	276[b]	222[b]	851[b]	2120[b]	1780[b]	1440[b]
Sodium[d]	50.0	49.6-154	6,300	134	152	103	178	187	168	165
Vanadium	1.0	5.30-32.0	100	9.9	24.6	19.1	19.5	24.0	15.9	24.5
Zinc	1.0	53.3-864	50	514	59.4	79.0	102	157	106	88.2
Others	See Appendix F			ND	ND	ND	ND	ND	ND	ND

TABLE 4-109 (Cont'd)
SITE NO. 13: ANALYTICAL RESULTS VS. BACKGROUND CONCENTRATIONS: SOIL

		Sample ID (Sample Description)								
Parameter (Units)	**Detection Limits**	**Background[e] (mg/Kg)**	**Selected Average for soil[f] (mg/Kg)**	**WB-13-1-5 (6.0'-7.5')**	**WB-13-2-4 (4.5'-6.0')**	**WB-13-2-5 (6.0-7.5')**	**WB-13-3-1 (0-1.5')**	**WB-13-3-6 (7.5'-9.0')**	**WB-13-3-7 (7.0'-9.4')**	**WB-13-4-5 (6.0'-7.5')**
EPA Method SW3550/E418.1 (mg/kg)										
Total Petroleum Hydrocarbons	5.0	ND	--	ND	ND	ND	21	ND	ND	ND

Footnotes:

a = Surrogate recovey (toluene-d8) was above upper control limit for this analysis.
b = Compound also detected in assoicated method blank.
c = Associated matrix spike recoveries were below lower control limit for this parameter.
d = Accuracy data not available; compound not spiked.
e = The range of background concentrations are based on the combined analytical results of the two background borings installed during the RI
f = Source: W. Lindsay, Chemical Equilibrium in Soils
New York: John Wiley and Sons., 1979.
NA Not Analyzed
ND Not Detected
NR Not Required

TABLE 4-110
SITE NO. 13: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample ID (Sample Description)		
			GW4 (MW-13-3)	GW5 (MW-13-4)	GW2 (MW-13-1)
EPA Method SW5030/8021 (µg/L)					
Volatile Organics/Purgeable Halocarbons					
1,2-Dichloroethane	0.4	5[i]	ND	2.3	ND
Methylene Chloride	0.8	0.19[k]	160[a]	2.3[a]	2.8[a]
Vinyl Chloride	0.8	2[i]	1600	2.9	ND
t-1,2-Dichloroethane	0.3	5[i]	ND	ND	ND
Trichloroethene	1.0	5[i]	ND	ND	ND
1,4-Dichlorobenzene	0.3	4.7[i]	ND	ND	ND
Others	See Appendix F	-	ND	ND	ND
EPA Method SW5030/8020(µg/L)					
Purgeable Aromatic Organics				ND	
Chlorobenzene	0.3	5[i]	9.1		ND
1,2-Dichlorobenzene	1.0	4.7[i]	3.6		ND
1,3-Dichlorobenzene	0.7	5[i]	1.1		ND
1,4-Dichlorobenzene	0.7	4.7[i]	9.7		ND
Benzene	0.3	ND[h]	2.98		ND
Total Xylenes	0.1	15[i]	7.6		ND
Toluene	0.3	5[i]	15		1.3
Ethylbenzene	0.3	5[i]	3.6		ND
EPA Method SW5030/8015 (ug/L)					
Non-Halogenated Volatile Organics	See Appendix F	-	ND	ND	ND
EPA Method E504.1 (µg/L)					
Ethylene Dibromide	0.3	-	ND	ND	ND
EPA Method E608 (µg/L)					
Pesticides and PCB's	See Appendix F	-	ND	ND	NA
EPA Method E200.7*					
Total Metals (mg/l)			NA		
Aluminum	0.1	No ARAR	60.6	35.5	
Arsenic	0.05	0.025[i]	ND	ND	
Arsenic (E206.2)	0.005	0.025[i]	0.015	ND	
Barium	0.01	1.0[i]	0.475	0.245	
Boron	0.01	1.0[i]	ND[c]	ND[c]	
Calcium[b]	0.20	No ARAR	524	572	
Chromium	0.010	0.050[i]	0.100	0.050	
Cobalt	0.010	No ARAR	0.045	0.026	
Copper	0.010	0.200[i]	0.112	0.083	

TABLE 4-110 (Cont'd)
SITE NO. 13: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	Detection Limits	ARAR[g]	Sample ID (Sample Description) GW4 (MW-13-3)	GW5 (MW-13-4)	GW2 (MW-13-1)
EPA Method E200.7*					
Total Metals (mg/l) (Cont'd)					
Iron	0.025	0.300[i]	106[c]	57.3[c]	
Lead	0.05	0.025[i]	0.102	0.102	
Lead (E239.2)	0.005	0.025[i]	0.063[c]	0.079[c]	
Magnesium[b]	0.20	No ARAR	185	412	
Manganese	0.005	0.300[i]	4.94	3.80	
Molybdenum	0.010	No ARAR	0.015	ND	
Nickel	0.015	0.0154[j]	0.125	0.062	
Potassium[b]	0.4	No ARAR	14.7[c]	10.6[c]	
Silicon[b]	0.020	No ARAR	69.2	63.1	
Sodium[b]	0.200	20[i]	571	164	
Vanadium	0.01	No ARAR	0.122	0.064	
Zinc	0.01	0.300[i]	0.877	1.31	
Others	See Appendix F	-	ND	ND	
EPA Method E418.1 (mg/L)					
Total Petroleum Hydrocarbons	1.0	No ARAR	ND	ND	ND
Miscellaneous Inorganics (mg/L)					NA
Total Dissolved Solids (E160.1)	1.0	500[m]	4080	4250	
Common Anions (A429)					
Fluoride	0.1	1.5[i]	0.58	1.4	
Chloride	0.5	250[i]	140	200	
Sulfate	0.5	250[i]	2600	2600	
Total Hardness (E130.1)	1.0	No ARAR	2600	3300	

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not spiked.
c = Associated lab matrix replicate analysis had RPD values which exceeded the control limit.
d = Confirmation analysis exceeded holding time by one day.
g = Applicable or Relevant or Appropriate Requirements.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwater. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10^{-6} risk level. Methylene Chloride (dichloromethane) is a member of this class.
m = Federal Secondary Drinking Water Standards

* = Or as indicated for those metals analyzed by an alternate method.

TABLE 4-110 (Cont'd)
SITE NO. 13: ANALYTICAL RESULTS VS. ARARs: GROUNDWATER

Parameter (Units)	ARAR[g]	Sample ID (Sample Description)			
		GW102 (MW-13-1)	GW103 (MW-13-2)	GW104 (MW-13-4)	GW105 (MW-13-3)
EPA Method SW5030/8021 (ug/L)					
Volatile Organics/Purg. Hal.		ND	ND		
1,2-Dichloroethane	5^{i}			1.6	ND
Methylene Chloride	0.19^{k}			2.0^{a}	24^{a}
Vinyl Chloride	2^{i}			ND	450
t-1,2-Dichloroethane	5^{i}			ND	4.1
Trichloroethene	5^{i}			ND	14
1,4-Dichlorobenzene	4.7^{i}			ND	3.1
Others	-			ND	ND
EPA Method (SW5030/8020)(μg/L)					
Purgeable Aromatic Organics		ND	ND	ND	
Chlorobenzene	5^{i}				1.3
1,2-Dichlorobenzene	4.7^{i}				1.1
1,3-Dichlorobenzene	5^{i}				ND
1,4-Dichlorobenzene	4.7^{i}				2.6
Benzene	ND^{h}				ND
Total Xylenes	15^{i}				1.7
Toluene	5^{i}				3.5
Ethylbenzene	5^{i}				0.65

Footnotes:

a = Compound also detected in associated method blank.
b = Accuracy data unavailable; compound not spiked.
c = Associated lab matrix replicate analysis had RPD values which exceeded the control limit.
d = Comfirmation analysis exceeded holding time by one day.
g = Applicable or Relevant or Appropriate Requirements.
h = New York State Groundwater quality standard: "Not detectable".
i = New York State Water Quality Standard for class GA groundwater. Federal MCLs are adopted by the state if state requirements have not been developed, or if MCLs are more stringent.
j = Federal Ambient Water Quality Criteria (FWQC) - Human Health: Adjusted for Drinking Water.
k = FWQC-HH for halomethanes as a class of compounds corresponding to the 10-6 risk level. Methylene Chloride (dichloromethane) is a member of this class.
m = Federal Secondary Drinking Water Standards

- Chromium, lead, vanadium, copper and zinc levels found in all Site No. 13 soils generally occurred within the concentration ranges established by the background soil borings. Due to the presence of zinc and lead sulfide minerals in the soil across the installation, lead values in soils were often much higher than the average values reported for normal soils.

- Levels of cobalt found in the Site No. 13 soils generally occurred within or slightly outside the upper range set for cobalt by the background soil borings. Cobalt levels which occurred outside the established range were found in soils from the 7.5 to 9.0-foot interval of WB-13-3 (14.7 mg/kg) and the 6.0 to 7.5-foot interval of WB-13-4 (12.5 mg/kg).

- Manganese levels in the soils of Site No. 13 were similar to those established by the background borings. A manganese concentration of 837 mg/kg found in soil from the 7.5 to 9.0-foot interval of WB-13-3 fell just outside the highest background value.

- Nickel concentrations in site soils ranged from 9.4 mg/kg to 35.9 mg/kg. Nickel concentrations of 27.4 mg/kg, 29.1 mg/kg and 35.9 mg/kg in soils from WB-13-2 (4.5 to 6.0-foot interval), WB-13-3 (7.5 to 9.0-foot interval) and WB-13-4 (6.0 to 7.5-foot interval) respectively occur just outside the background nickel concentration established for the installation's soils. All of these values are below the 40 mg/kg average reported for normal soils.

It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to regional soils has not been determined. This holds especially true for the inorganic compounds (i.e., metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area.

The following presents a comparison of the organic analytical data yielded by the Site No. 13 well borings with background levels:

- Low levels of total petroleum hydrocarbons (TPH) were detected in soils collected at well boring WB-13-3 (0.0 to 1.5-foot interval). TPH was not detected in soils from the background borings.

- Except for methylene chloride and acetone, no volatile organics were detected above measurable detection limits. Methylene chloride and acetone reported in the soil samples at Site No. 13 are considered laboratory contaminants since these compounds were found at comparable levels on the method blanks. These compounds are also reported in soils from the background borings.

- Bis(2-ethylhexyl) phthalate was measured at 0.40 mg/kg in soil from the 6.0 to 7.5-foot interval of WB-13-2. This compound may be the result of laboratory contamination since it was also found in the semi-volatile method blank at or just below the detection limit.

Groundwater samples were collected from three of the four shallow wells at Site No. 13 during the main RI effort conducted during September 1989. MW13-2 could not be sampled as a result of a seasonal low water table situated below the bottom of the well, and only a partial sample could be collected from MW13-1 due to a depressed water column and very slow recharge. All four wells were sampled during the additional RI effort for only purgeable aromatics/halocarbons. The following presents a comparison of organic compounds measured in the Site No. 13 monitoring wells during the main RI effort with ARARs and installation background levels:

- During the main effort, benzene and vinyl chloride were reported in groundwater from MW13-3 at 2.98 ug/l and 1600 ug/l, respectively. This benzene value exceeded the "non-detect" benzene ARAR set in the New York State Water Quality Standards. The 2.8 ug/l benzene concentration exceeded the background concentration by over a factor of three. The vinyl chloride level found in MW13-3 exceeded the 2.0 ug/l ARAR promulgated in the New York State Water Quality Standards by nearly three orders of magnitude. Vinyl chloride was also measured in MW13-4 at 2.9 ug/l. This concentration also exceeded the State ARAR. Vinyl chloride was not measured in groundwater of the background wells. The vinyl chloride found in the two wells might be a degradation product of trichloroethene (TCE).

- Toluene was measured in groundwater from MW13-3 at 15 ug/l. This concentration exceeds the New York State Water Quality ARAR of 5 ug/l. Toluene was also found in the groundwater from well MW13-1 at 1.3 ug/l. This level occurs below the ARAR but is slightly above the level measured in the shallow background well.

- 1,2-dichloroethane was measured in MW13-3 and MW13-4 at 3.6 ug/l and 2.3 ug/l. These concentrations did not exceed the promulgated ARARs. This compound was not detected in groundwater of the background wells.

- Chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, total xylenes and ethylbenzene were reported in groundwater of MW13-3 at 9.1 ug/l, 1.1 ug/l, 9.7 ug/l, 7.6 ug/l and 3.6 ug/l. None of these compounds were detected in the shallow background well. Chlorobenzen and 1,4-dichlcrobenzene exceeded their New York State Water Quality ARARs of 5 ug/l and 4.7 ug/l.

- Methylene chloride reported in the groundwater of Site No. 13 was also detected in the volatile organic method blanks and various field blanks, but at significantly lower levels. Although the sample concentrations of this compound are suspect, not all of the total concentration can be attributed to laboratory contamination. For this reason this compound is suspected to occur as a site contaminant.

Previous sampling of standing water in the tank pit indicated the presence of TCE and tetrachloroethylene. TCE being denser than water may have sunk to the bottom of the aquifer which may explain why it was not detected in MW13-3, or may have found its way to the upperbedrock aquifer, which was not sampled at Site No. 13. The group of volatile organics in the groundwater at Site No. 13 can only be linked to the former underground tank.

Groundwater sampling conducted during the additional RI effort, further confirmed the presence of volatile organic contamination of groundwater at Site No. 13:

- Vinyl chloride , trans-1,2-dichloroethane, TCE, 1,4-dichlorobenzene, chlorobenzene, 1,2-dichlorobenzene, total xylenes, toluene and ethylbenzene were detected in MW13-3 at 450 ug/l, 4.1 ug/l, 14 ug/l, 3.1 ug/l, 1.3 ug/l, 1.1 ug/l, 1.7 ug/l, 3.5 ug/l and 0.65 ug/l respectively. Trans-1,2-dichloroethane and TCE were previously not detected in groundwater from MW13-3. These compounds were probably present in the groundwater but were not detected last time as a result a 12 - 15 hour time delay between well purging and actual groundwater sampling. Sampling conducted during the additional RI occurred immediately after well purging which ensured a thorough mixing of the groundwater from this well. What can not be explained is the conspicuous absence of benzene and 1,3-dichlorobenzene in groundwater from MW13-3. The TCE concentration reported for MW13-3 is above the 5.0 ug/l ARAR established in the New York State Water Quality Standards. The vinyl chloride level, although not as high as before, still exceeds the 2.0 ug/l ARAR promulgated in the State standard. All of the other volatile organic compounds detected in groundwater from MW13-3, although not detected in the shallow background well, do not exceed any of the published ARARs.

- Groundwater from MW13-4 once again contained 1,2-dichloroethane (1.6 ug/l) but vinyl chloride was undetected. The 1,2-dichloroethane level did not exceed any of the published ARARs.

- MW13-1 which contained some toluene the last time it was sampled did not contain any volatile organics during the additional RI sampling effort.

- Methylene chloride once again detected in groundwater samples of Site No. 13 is believed to be present as a site contaminant since ground water concentrations significiantly exeeded method and field blank concntrations.

For reasons explained above, only two wells could be sampled for metals. Groundwater from these wtwo wells yielded a total of eithteen inorganic metals. As discussed in Section 4.1.1.2.1, elevated metal levels found in groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP site. The evidence indicates that the elevated metals can be attributed to naturally occurring metals found in the suspended sediment. The following presents a comparison of metal levels measured in groundwater at Site No. 13 with ARARs and installation background levels:

- Iron and manganese concentrations were found to be above the 0.300 mg/l ARAR promulgated in the New York State Water Quality Standards in groundwater from both wells. Iron concentrations in MW13-3 and MW13-4 were 106 mg/l and 57.3 mg/l respectively. Manganese concentrations in MW13-3 amd MW13-4 were 4.94 mg/l and 3/80 mg/l respectively. Iron and manganese levels in the shallow background well also exceeded the State ARARs.

- Lead levels in both MW13-3 and MW13-4 occurred above the 0.025 mg/l ARAR imposed by the State standard (0.063 mg/l and 0.079 mg/l, respectively).

- Chromium was found in groundwater from both wells. The 0.100 mg/l chromium concentration recorded in shallow well MW13-3 was above the 0.050 mg/l State Water Quality Standard. No chromium was found in the background wells.

- The 0.0154 mg/l FWQC Human Health ARAR promulgated for nickel was exceeded in both wells. Nickel values of 0.125 mg/l and 0.062 mg/l were measured in MW13-3 amd MW13-4 respectively.

- Barium levels in groundwater from the two wells did not occur above the ARAR, but were considerably higher than the level found in the shallow background well. Barium ranged from 0.245 mg/l in MW13-4 to 0.475 mg/l in MW13-3.

- An arsenic value of 0.015 mg/l was found in MW13-3. Although no arsenic was detedted in the shallow background well, the value in MW13-3 was found to be within the State ARAR.

- Copper found in both wells was belo established ARARs. Copper levels ranged from 0.083 mg/l in MW13-4 to 0.112 mg/l in MW13-3. No copper was recorded in groundwater from the shallow background well.

- Zinc levels found in both wells exceeded the 0.300 mg/l ARAR set in the State Water Quality Standards. Zinc levels of 0.887 mg/l and 1.31 mg/l were measured in MW13-3 and MW13-4 respectively. Zinc levels at Site No. 13 exceeded those obtained at the shallow background well by one order of magnitude.

- Cobalt was detected in MW13-3 and MW13-4 at 0.045 mg/l and 0.026 mg/l respectively.

- Vanadium was also found in groundwater from both wells. Concentrations of 0.122 mg/l and 0.064 mg/l were recorded in MW13-3 and MW13-4 respectively. Molybdenum was only found in MW13-3 (0.015 mg/l). Cobalt, vanadium and molybdenum were not detected in groundwater from the background wells. Presently, no ARARs have been established for these metals.

The following discussion presents a comparison of the general chemistry analyses with ARARs, when available:

- Total dissolved solids (TDS) in groundwater from Site No. 13 ranged from 4080 mg/l to 4250 mg/l in two wells. These levels exceeded the 500 mg/l Secondary Drinking Water Standard for TDS.

- Sodium levels exceeded the 20 mg/l ARAR set in the State Water Quality standard in both wells. Sodium levels ranged from 571 mg/l to 164 mg/l.

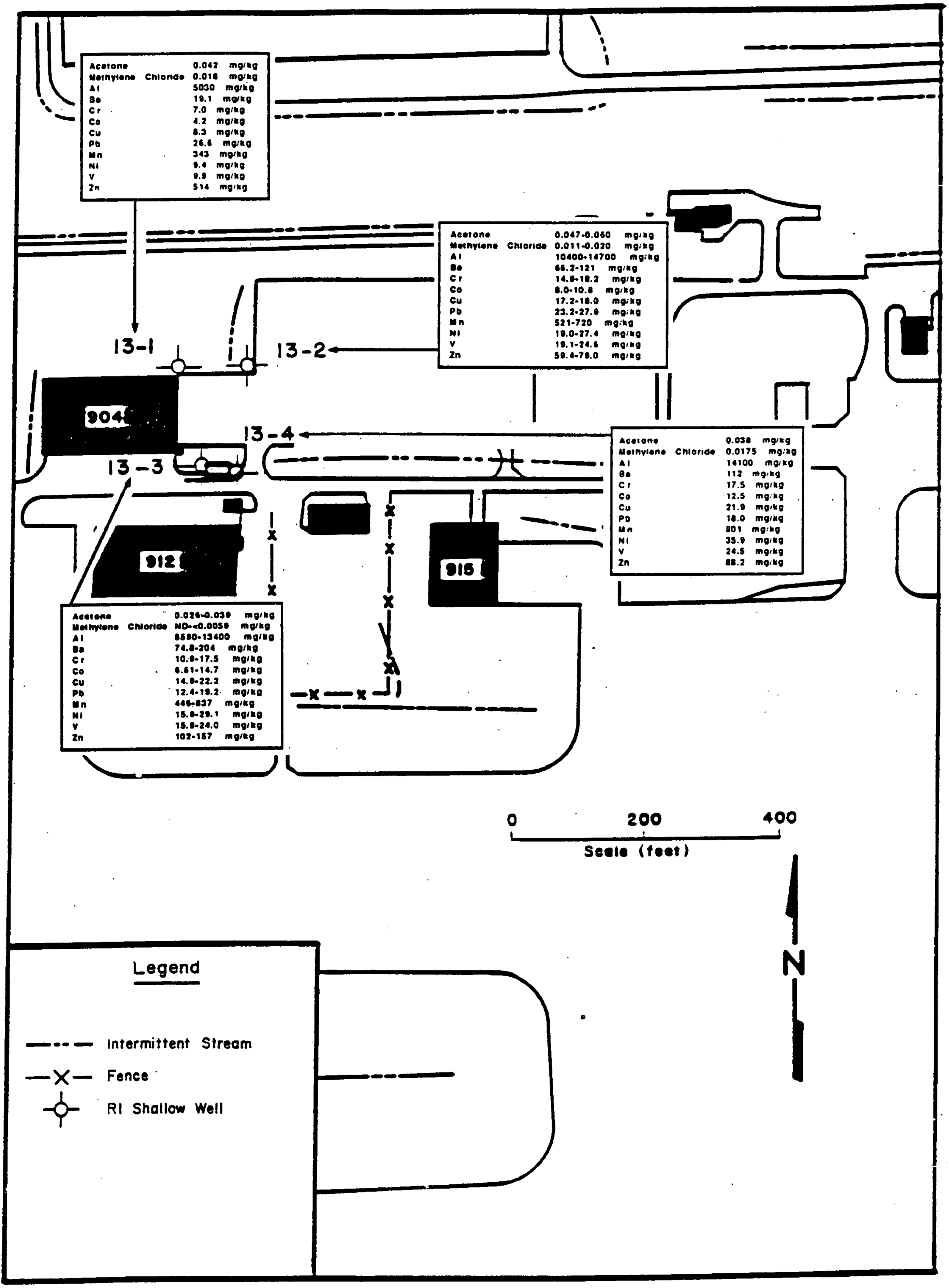
- Sulfate levels exceeded the 250 mg/l ARAR set in the State Water Quality Standard in both wells. A sulfate level of 2600 mg/l was found in both wells.

- Chloride and total hardness levels ranged from 140 mg/l to 200 mg/l and 2600 mg/l to 3300 mg/l respectively. Fluoride ranged from 0.58 mg/l to 1.4 mg/l. The groundwater at Site No. 13 is very hard and highly mineralized.

The generally poor water quality of the groundwater is explained in the literature (Johnston, 1964). The water from the unconsolidated deposits is described as being very hard, but not as highly mineralized as water from the bedrock. Average hardness and chloride levels for the unconsolidated aquifer are 545 mg/l and 118 mg/l respectively. The presence of sulfate in the groundwater is due to the dissolution of calcium sulfate crystals (gypsum) in the soil and bedrock.

4.1.9.2.2 Zones of Contamination

Contamination in the shallow aquifer at Site No. 13 appears to be limited to a small area in the immediate vicinity of the former tank pit. Figures 4-85 and 4-86 illustrate the levels of contaminants found at each monitoring station. Only contamination found in groundwater of the unconsolidated aquifer was assessed. Except for low levels of TPH, very little soil contamination was



Acetone	0.042 mg/kg
Methylene Chloride	0.016 mg/kg
Al	5030 mg/kg
Ba	19.1 mg/kg
Cr	7.0 mg/kg
Co	4.2 mg/kg
Cu	8.3 mg/kg
Pb	26.6 mg/kg
Mn	343 mg/kg
Ni	9.4 mg/kg
V	9.9 mg/kg
Zn	514 mg/kg

Acetone	0.047-0.060 mg/kg
Methylene Chloride	0.011-0.020 mg/kg
Al	10400-14700 mg/kg
Ba	66.2-121 mg/kg
Cr	14.9-18.2 mg/kg
Co	8.0-10.8 mg/kg
Cu	17.2-18.0 mg/kg
Pb	23.2-27.9 mg/kg
Mn	521-720 mg/kg
Ni	19.0-27.4 mg/kg
V	19.1-24.6 mg/kg
Zn	59.4-79.0 mg/kg

Acetone	0.038 mg/kg
Methylene Chloride	0.0175 mg/kg
Al	14100 mg/kg
Ba	112 mg/kg
Cr	17.5 mg/kg
Co	12.5 mg/kg
Cu	21.9 mg/kg
Pb	18.0 mg/kg
Mn	801 mg/kg
Ni	35.9 mg/kg
V	24.5 mg/kg
Zn	88.2 mg/kg

Acetone	0.026-0.039 mg/kg
Methylene Chloride	ND-<0.0059 mg/kg
Al	8580-13400 mg/kg
Ba	74.8-204 mg/kg
Cr	10.9-17.5 mg/kg
Co	6.61-14.7 mg/kg
Cu	14.9-22.2 mg/kg
Pb	12.4-18.2 mg/kg
Mn	446-837 mg/kg
Ni	15.9-29.1 mg/kg
V	15.9-24.0 mg/kg
Zn	102-157 mg/kg

FIGURE 4-85
SITE NO. 13: ZONES OF CONTAMINATION - SOIL

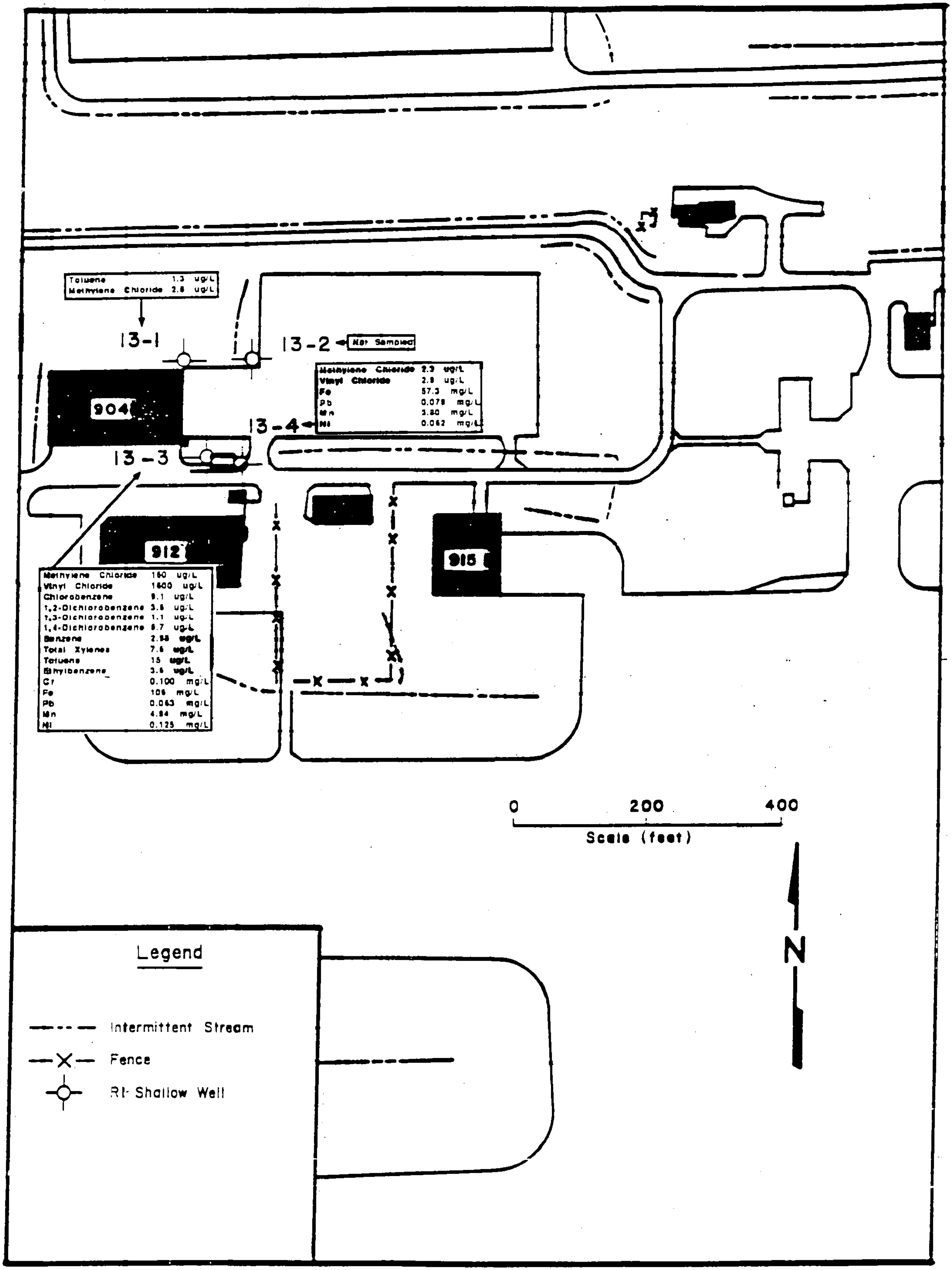


FIGURE 4-86
SITE NO. 13: ZONES OF CONTAMINATION - GROUNDWATER

encountered. A number of volatile organic contaminants, some measured at high levels, were found in the groundwater of one well (MW13-3) installed just outside the former tank pit wall. Only two volatile organic compounds, occurring at substantially lower levels, were found in the across gradient well (MW13-4) located less than 50 feet away. There is little evidence at this time to suggest if a contaminant plume exists in the unconsolidated aquifer at Site No. 13 due to the present groundwater contamination distribution pattern and the minimum number and position of wells at this site. Based upon the hydrogeologic properties of the unconsolidated aquifer alone, conditions are not favorable for good plume development. An attempt to confirm this assumption by installing a well on the north side of the former tank pit was abandoned due to numerous utilities in the area.

As discussed in Section 4.1.1.2.1, there is convincing evidence suggesting that the elevated metal levels found in the groundwater across the installation are not related to waste management practices but rather natural background trace element concentrations found in the suspended particulate matter (i.e., clay). Metals are therefore not discussed as contamination.

4.1.9.2.3 Contaminant Migration

There is little evidence to suggest that a contaminant plume has developed and is migrating away from the Site No. 13. The zone of contamination attributed to this site is interpreted not to extend much beyond the former tank pit. Assuming the backfill in the tank pit has a significantly higher conductivity than the surrounding glacial till and lacustrine deposits, a local groundwater mounding effect might be expected which would locally cause a radial groundwater flow pattern. During extended periods of heavier rainfall, water levels could conceivably rise in the pit bringing contaminants to the surface. The contaminants would then migrate away from the pit via surface runoff. Depending on the surface drainage patterns at this site, contaminants might spread out over the downgradient portion of the land surface, eventually being carried off by the installation's stormwater collection system.

Although there are a number of possible routes for contaminants to migrate through the subsurface, migration of contaminants by advective means through the unconsolidated aquifer is limited as predicted in the literature. The potential for a radial migration pattern exists near the former groundwater pit due to groundwater mounding but an overall northeast migration pattern is interpreted by the water level measurements. Migration of contaminants through the shallow groundwater system, based upon the discussion presented in Section 4.1.9.1.2, is predicted to range to between 5.48 x 10^{-5} ft/day to 2.1 x 10^{-3} ft/day. In consideration of the former tank's age and not considering such factors as dispersion, natural attenuation, chemical and biochemical reactions, the following migration distance ranges via advective means through the unconsolidated aquifer are estimated:

Site No. 13 - (Minimum) 2.2 x 10^{-2} feet
- (Maximum) 8.4 feet

Migration rates might be locally higher in certain regions of Site No. 13 due to the presence of higher conductive sand lenses/stringers. Cultural features, such as sewer lines and underground utility lines and pipes may have some affect on patterns and speed of contaminant transport within the subsurface. The area around Site 13 contains several underground utilities as shown in Section 4 Attachment A. The effect of these utilities on contaminant transport patterns, although, is expected to be limited due to the natural geologic and hydraulic conditions of the site and the location of these utility lines above the shallow water table of the area. Future investigatory work at this site will include an assessment of these utilities as a possible avenue of contaminant migration. Based upon the very low migration rates predicted in the unconsolidated aquifer and the distance to the nearest off base resident, it is unlikely that contaminants would ever reach off-base receptors via this pathway before natural attenuation and dilution substantially reduced the levels of contaminants found at this site. (The physical, chemical, biological and release characteristics of the contaminants detected are generally discussed in the Toxicity Profile Section of Appendix G.)

4.1.9.2.4 Baseline Risk Assessment for Site No. 13

This section presents the baseline risk assessment for Site 13. Additional information on methods and assumptions adopted in this evaluation are provided in Appendix G along with an overall summary of the results of risk assessment for the Niagara Falls IAP Facility. Appendix G also includes a listing of toxicity measures used in risk characterization and toxicity profiles for the identified contaminants of concern.

Site No. 13 - Data Analysis and Hazard Identification

Chemicals of concern for Site 13 were selected and evaluated in the manner described in Section 4.1.1.2.4.1, Data Analysis and Hazard Identification. The reader is referred to this section for a complete discussion.

The monitoring well (MW-1-7) which was initially designated as the background well for the base contained detectable concentrations of benzene (0.92 ug/L), toluene (1.0 ug/L), and TPH (1.6 mg/L), thus making it difficult to compare volatile organic values to background. In a USGS study (1985), the following ranges of values for organic contaminants were identified in water samples taken from the unconsolidated deposits along the Niagara River: toluene (10 to 230 ug/L), trans-1,2-dichloroethylene (nondetect to 23 ug/L), ethylbenzene (4.5 to 5.9 ug/L), and methylene chloride (7.1 to 375 ug/L). In groundwater samples collected at Site 13, the mean values for toluene, 1,2-dichloroethylene, ethylbenzene, and methylene chloride were 2.8 ug/L, 1.3 ug/L, 0.65 ug/L, and 160 ug/L, respectively. Two inorganics (chromium at 75 ug/L and arsenic at 9 ug/L) in the groundwater samples were above the ranges (1 to 8 ug/L and 1 to 4 ug/L, respectively) found in the USGS study (See Section 2.4.3 of this report for more detail).

Mean levels of TPH in soils at Site 13 were 27.1 mg/kg indicating the presence of aliphatic and olefinic hydrocarbons in the subsurface environment that have not been incorporated into the listing of chemicals of concern. Given the available data and methods of chemical analysis, no correlation can be established between levels of TPH in soils and quantities of organics detected and included in the baseline risk assessment. TPH was not detected in groundwater at the site.

Site No. 13 - Exposure Assessment

The objectives of the exposure assessment and purpose for evaluating groundwater and soils at the site are presented in Section 4.1.1.2.4.1, and 4.1.1.2.4.3. Please refer to these sections for a detailed presentation. The conceptual site model for Site 13 is presented in Figure 4-87. The exposure pathways are discussed in detail below. Documentation for the exposure assumptions adopted at Site 13 is provided in Appendix G.

Soil

Site 13, previously an underground tank location, was initially used as a motor fuel tank for a base gas station and later used to store general slop waste when the station was closed. The tank has been pumped out, excavated, and removed. The excavation pit was backfilled in 1987. Reportedly, samples of water collected from the pit contained detectable concentrations of volatile organics. Access to the area is not limited, and therefore exposure of Base personnel to soils were evaluated. The exposure assumptions used for Site 4 soil exposure were also used to assess exposure at Site 13 (Note: Section 4.1.1.2.4.3, Exposure Assessment, Soil). Support for these assumptions is presented in Appendix G.

Groundwater

The rationale for assessing groundwater exposure as a pathway at Site 13 and the assumptions used are presented in Section 4.1.1.2.4.1, Exposure Assessment (Groundwater). A detailed evaluation of the exposure pathways is also presented in Appendix G.

Site No. 13 - Toxicity Assessment

A discussion of the toxicity assessment and an explanation of the toxicity parameters used in the risk characterization is provided in Section 4.1.1.2.4.1, Toxicity Assessment and Appendix G.

Site No. 13 - Risk Characterization

Groundwater Pathway

The results of risk characterization for exposure to groundwater at the Site 13 are presented in Table 4-111. The hazard index for combined exposure across compounds is approximately 3.5. This is attributable to the high value of the hazard quotient for vinyl chloride (i.e., a value of 2.2 corresponding to a mean groundwater concentration of 294 ug/L) and lead, manganese, vanadium, and chromium to a lesser extent. Based on these results, it is concluded that chronic exposure to groundwater at Site 13 would pose an unacceptable risk of adverse noncarcinogenic effects (i.e., if groundwater at the site was used as a source of drinking water).

The excess lifetime risk of cancer of exposure to chemicals in groundwater at the site is estimated to be 2 x 10^{-3}. Again, the magnitude of this estimate is primarily attributable to the presence of vinyl chloride (U.S. EPA Group A, known human carcinogen), and to arsenic (Group A carcinogen) to a lesser extent. As stated previously, the elevated arsenic levels can be attributed to naturally high concentrations found in the Niagara Falls area. This elevated cancer risk

TABLE 4-111

RISK CHARACTERIZATION FOR SITE NO. 13: EXPOSURE TO GROUNDWATER

emical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	48100.00			
senic	9.00	8.83E-02	Skin, Lung	4.42E-05
rium	360.00	7.06E-02	Hypertension	
romium	75.00	1.47E-01	Skin	
balt	36.00		Thyroid, Heart	
pper	98.00	2.60E-02	GI Tract, Blood	
ad	71.00	4.98E-01	CNS, Kidney	
nganese	4370.00	2.14E-01	CNS, Reproductive	
lybdenum	10.00			
ckel	94.00	4.61E-02	Skin, Lung	
nadium	93.00	1.30E-01	Respiratory Effects	
nc	1090.00	5.35E-02	GI Tract	
GANICS				
nzene	0.72	1.96E-02	Hematopoietic Sys.	5.85E-08
lorobenzene	1.40	6.87E-04	Liver, Kidney	
2-Dichlorobenzene	1.10	1.20E-04	Liver, Kidney, CNS	
3-Dichlorobenzene	0.49	5.34E-05	Liver, Kidney, CNS	
4-Dichlorobenzene	2.70	2.94E-04	Liver, Kidney, CNS	1.82E-07
2-Dichloroethane	2.00	1.96E-04	Liver, Kidney, CNS	5.10E-07
2-Dichloroethylene	1.80	8.83E-04	Liver, Kidney, CNS	
hylbenzene	0.65	6.38E-05	Skin, Liver, Kidney	
thylene Chloride	160.00	2.62E-02	Liver, Kidney, CNS	3.36E-06
luene	2.80	9.16E-05	CNS	
ichloroethylene	5.93	5.82E-03	Liver, Kidney, CNS	1.83E-07
nyl Chloride	294.00	2.22E+00	Blood, Liver, CNS	1.90E-03
lenes	1.80	8.83E-06	CNS	
zard Index: Combined Exposure		3.55E+00		
cess Lifetime Cancer Risk: mbined Exposure				2E-03

Arithmetic mean of groundwater sampling set (9/89 and 4/90). "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

Explanation of risk assessment calculations is included in Section 4 Attachment B.

estimate exceeds the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation.

Mean levels of contaminants in groundwater were also evaluated by comparison with Federal and state water quality ARARs. Mean concentrations of the following compounds exceeded MCLs and New York state limits: chromium, lead, and vinyl chloride. The mean value for vinyl chloride was more than 100 times the MCL. New York State standards were also exceeded by mean concentrations of manganese. The New York state groundwater limit for benzene is promulgated as "not detectable". Given this state guideline, benzene exceeds the recommended limit.

Soil Pathway

The results of the risk characterization for exposure to soil at Site 13 are presented in Table 4-112. The hazard index for combined exposure across compounds is approximately 4.4 x 10^{-3}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils.

Only one carcinogenic compound was detected in soils at the site. The excess lifetime cancer risk associated with inadvertent ingestion exposure to these soils is 3 x 10^{-12}. This result falls within the acceptable range established by EPA for waste site remediation.

Site No. 13 - Uncertainty in the Risk Assessment

The evaluation of uncertainty for hypothetical exposure of Base personnel to groundwater and soils is presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3. The reader is referred to these sections for a more complete discussion.

4.2 SITE SUMMARIES AND RECOMMENDATIONS

The following subsections briefly summarize site findings and present recommendations. Analytical data results for each media and the results of the baseline risk assessment were the primary tools for determining recommendations. A table summarizing the general findings by media, associated risks to human health, and recommendations is presented as Table ES-2 in the Executive Summary.

TABLE 4-112

RISK CHARACTERIZATION FOR SITE NO. 13: EXPOSURE TO SOILS

emical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
ORGANICS				
uminum	10989.00			
rium	101.00	3.17E-04	Hypertension	
romium	14.20	4.46E-04	Skin	
balt	9.40		Thyroid, Heart	
pper	16.90	7.17E-05	GI Tract, Blood	
ad	20.80	2.33E-03	CNS, Kidney	
nganese	617.00	4.84E-04	CNS, Reproductive	
ckel	22.10	1.73E-04	Skin, Lung	
nadium	19.60	4.40E-04	Respiratory Effects	
nc	158.00	1.24E-04	GI Tract	
GANICS				
etone	0.05	7.54E-08	Liver, Kidney	
thylene Chloride	0.01	2.62E-08	Liver, Kidney, CNS	3.36E-12
zard Index: Combined Exposure		4.39E-03		
cess Lifetime Cancer Risk: mbined Exposure				3E-12

Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

Dose calculated assuming hypothetical ingestion exposure of base personnel to contaminated surface soil. Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per week, 20 weeks per year, for 20 years of a 70 year lifetime.

Explanation of risk assessment calculations is included in Section 4 Attachment B.

4.2.1 SITE NOS. 1,2,4 AND 6: BUILDING 600 JP-4 PIPELINE LEAK, POL JP-4 TANK C AND A, AND BX MOGAS TANK LEAK

As detailed in Section 4.1.1 of this report, the RI activities conducted at the combined sites during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic risk compounds found in the soils and groundwater at each site, was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of the combined sites (i.e, arsenic, methylene chloride and benzene), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", benzene levels detected in groundwater from at least one well from nearly each site exceeded the imposed limit. The magnitude of the risks calculated for groundwater at each site was attributable to the levels of certain metals (lead, manganese, arsenic, and silver).

Many of these metal species occurred at concentrations which exceeded the ARARs. The elevated metal values in the groundwater from the Site Nos. 1, 2, 4 and 6 monitoring wells can be correlated to metal contributions from particulate clastic and carbonate sources rather than dissolved species. Since the total sample was digested as part of the analysis, the results include any chemical species or trace element comprising the suspended particles in the groundwater. There is, therefore, a strong correlation between samples with high metal content and visual observations of high turbidity recorded during field sampling. As a result, there is a considerable range in the concentrations of metals from well to well. Although metal levels were elevated in the background wells, the concentrations were not as high as groundwater from some of the other wells due to less turbidity. In addition, total metal concentrations (sum of all individual measurements) exceed, by as much as an order of magnitude, the analyses for total dissolved species. Based upon this and the regional groundwater quality reported by other investigators (See Section 2.4.3), it is concluded that the high values of metals were not introduced into the groundwater through activities associated with Base operations, but reflect a natural condition.

The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. Based upon the results of the baseline risk assessment, Site Nos. 1,2,4 and 6 require no further action. Due to the fact that near-site downgradient monitoring wells could not be sampled at Site No. 1, it is recommended that an additional round of groundwater sampling be performed at this site. This resampling effort should include, if necessary, the replacement of previously destroyed downgradient monitoring wells at this site.

4.2.2 SITE NO. 3: LANDFILL

As detailed in Section 4.1.2 of this report, the RI activities conducted at the landfill during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic compounds found in the soils and groundwater was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils from this site. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of Site No. 3 (i.e, beryllium, arsenic, benzene, methylene chloride, trichloroethene and vinyl chloride), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the 0.96 ug/l benzene concentration found in a Site 3 well exceeds this limit. As mentioned in Section 4.1.2, benzene was detected at a comparable in the shallow background well. Trichloroethene and bis(2-ethylhexyl) phthalate also exceeded the ARAR in one well and vinyl chloride exceeded the ARAR in three wells. The magnitude of the risk calculated at Site No. 3 was attributable to the levels of certain metals (lead, manganese, vanadium, cadmium and arsenic). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

Metals found in the soils of Site No 3 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead and cadmium were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to the Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 3 which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment, Site No. 3 is recommended for natural attenuation with long term monitoring.

4.2.3 SITE NO. 7: JP-4 TANK TRUCK SPILL

As detailed in Section 4.1.3 of this report, the RI activities conducted at the tank truck spill area during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenarios outlined in the baseline risk assessment, pose a health risk. Only one contaminant was found in the soil at Site No. 7. According to the hypothetical scenario, no health risk is imposed by the Site No. 7 soils. The calculated hazard index, for non-carcinogenic compounds found in the groundwater exceeds unity (1.0). The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to benzene. Benzene was also the only carcinogenic compound detected in groundwater at Site No. 7. At the levels measured, the lifetime cancer risk of exposure to benzene in groundwater is projected to be approximately 1×10^{-5}. This result is at the upper limit of the acceptable range established by EPA for waste site remediation under the Superfund program. Since the New York State Water Quality Standard for benzene is promulgated as "not detectable", all benzene levels at Site No. 7 exceed this ARAR. Toluene, ethylbenzene, and total xylenes also exceeded their ARARs in a single well. A certain portion of the risk calculated for the groundwater is attributable to the reported concentrations of certain metals (lead, barium, manganese, vanadium, chromium, and nickel). A number of the metals occurred at concentrations which exceeded the ARARs. Since all metal values were reported as total metals, a major part of the concentration can be attributed to undissolved metal species found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

Based upon the results of the baseline risk assessment and the inability of the present monitoring well network to delineate the full extent and magnitude of groundwater contamination at this site, Site No. 7 requires further investigation.

4.2.4 SITE NO. 10: FIRE TRAINING AREA NO. 1

As detailed in Section 4.1.4 of this report, the RI activities conducted at the fire training area during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenario outlined in the baseline risk assessment, pose a significant health risk. According to the hypothetical scenario, no health risk is imposed by the Site No. 10 soils.

The calculated hazard index for combined exposure across compounds found in the groundwater is approximately 9.8. The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to trichloroethene and benzene and to some extent lead. Four potentially carcinogenic compounds were detected in the groundwater at Site No. 10 (benzene, methylene chloride, trichloroethene and vinyl chloride). The excess lifetime cancer risk associated with the hypothetical exposure assumptions is approximately 5 x 10^{-4}. This lifetime cancer risk exceeds the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The magnitude of this estimate is primarily attributable to the presence of trichloroethene and vinyl chloride. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", benzene levels found in four of the monitoring wells exceed this limit. Trichloroethene also exceeded the ARAR in the four wells it was detected, and vinyl chloride exceeded the ARAR in the two wells it was detected. The levels of benzene and vinyl chloride were more than 10 times greater than the MCL. The mean concentration of trichloroethene was more than 1000 times the Federal MCL. Methylene chloride exceeded the ARAR in all wells. Although typically considered a laboratory contaminant, it is being treated a site contaminant in this case since levels reported in groundwater were significantly higher than that reported in the various QA samples. A significant portion of the risk calculated at Site No. 10 was attributable to the levels of certain metals (lead, manganese, vanadium, barium, chromium, copper, nickel, and zinc). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

The calculated hazard index, for non-carcinogenic compounds found in the soils was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to the Site No. 10 soils. Two carcinogenic compounds were detected in the soils at the site (beryllium and trichloroethene). The excess lifetime cancer risk associated with inadvertent ingestion exposure to these soils is 5 x 10^{-8}. This value falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No 10 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead, chromium and cadmium were the only notable exceptions. With the possible exception of chromium, the elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations underground regional soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 10, which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils.

Based upon the results of the baseline risk assessment and the inability of the present monitoring well network to delineate the full extent and magnitude of groundwater contamination at this site, Site No. 10 is recommended for additional investigation.

4.2.5 SITE NOS. 5 AND 8: NYANG HAZARDOUS WASTE DRUM STORAGE AREA AND DRUM STORAGE YARD

As detailed in discussions in Section 4.1.5 of this report, the RI activities conducted at these combined sites during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenarios outlined in the baseline risk assessment, pose a health risk. According to the same hypothetical scenario, no risk is imposed by the Site No. 5 and 8 soils.

At Site No. 5, the hazard index for combined exposure across compounds found in groundwater has been calculated at 1.7. Given this result, adverse noncarcinogenic effects may be anticipated if groundwater at Site No. 5 was used as a source of drinking water. The magnitude of the noncarcinogenic risk is attributed to the high value of the hazard quotient for lead. Since all metal values were reported as total metals, a major part of the concentration can be attributed to undissolved metal species found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. The risk should be recalculated after determining the concentrations of dissolved metal species, particularly lead, in the groundwater at this site. Trichloroethene was the only carcinogenic compound detected in groundwater at this site. The excess lifetime cancer risk of hypothetical exposure to TCE in groundwater was determined to be approximately 4×10^{-8}. This value is considered within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. Levels of TCE found in the groundwater did not exceed Federal and State ARARs. Lead, zinc, manganese and nickel detected in the groundwater at Site No. 5 were found to exceed the ARARs in a number of the wells. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. It is therefore inappropriate to consider these values, not only in a comparison to ARARs but also in any site risk assessment scenario. Based upon the likelihood that the high concentrations of certain metals considered in the risk assessment are elevated due to the undissolved contributions from suspended sediment, Site No. 5 is recommended for no further IRP action.

The calculated hazard index, for non-carcinogenic compounds found in the soils of Site No. 5 was less than 1. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. Only one carcinogenic compound was detected in the soil at the site (methylene chloride). Due to comparable concentrations reported in the method blank, the reported presence of methylene chloride in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 5 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure of these soils is 1×10^{-7}. This value falls within the acceptable range (10^{-6} to 10^{-4}) established by EPA for waste site remediation. Metals found in the soils of Site No. 5 generally occurred within installation background ranges or within the average concentration reported for typical soils. Copper and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. The baseline risk assessment performed for soils and the comparisons of Site No. 5 soils to background levels and the average trace element concentrations further support the classification of Site No. 5 for no further action.

At Site No. 8, the hazard index for combined exposure across compounds is approximately 4.9. Based upon these results, there would be a potential for adverse noncarcinogenic effects for hypothetical chronic exposure to groundwater at Site No. 8. The magnitude of the noncarcinogenic risk is attributed to the high value of the hazard quotients for arsenic and lead. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metals levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

Three carcinogenic compounds were detected in the groundwater at Site No 8 (arsenic, 1,1-dichloroethane and trichloroethene). The excess lifetime cancer risk associated with inadvertent ingestion exposure of these soils is approximately 5×10^{-5}. The cancer risk estimate, although elevated, still falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The magnitude of this risk attributable to the presence of arsenic. Levels of TCE in the groundwater at Site No. 8 exceeded the State Water Quality

ARAR in two wells. Cadmium, chromium, copper, lead, manganese, nickel and zinc detected in the groundwater at Site No. 8 were found to exceed the ARARs in a number of wells. None of the arsenic levels exceeded the ARARs. Since all metal values were reported as total metals, implying that a significant portion of the reported concentration is attributable to the undissolved contributions from suspended sediment, it is inappropriate to consider these values, not only in a comparison to ARARs but also in any site risk assessment scenario. Their inclusion in the risk assessment scenario provides a worst case scenario.

The calculated hazard index for recreational exposure of Base personnel to non-carcinogenic compounds found in the soils of Site No. 8 was less than 1. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. Only one carcinogenic compound was detected in the soil at the site (methylene chloride). Due to comparable concentrations reported in the method blank, the reported presence of methylene chloride in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 8 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion of soils and inhalation of particulates containing this compound is 2 x 10^{-12}. This value falls within the acceptable range (10^{-6} to 10^{-4}) established by EPA for waste site remediation.
The calculated hazard index for combined exposure of children at play to Site No. 8 soils (i.e., across compounds and pathways) is 1.5 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. The excess lifetime cancer risk associated with children inadvertently ingesting soils and inhaling particulates from Site No. 8 would be 2 x 10^{-7}. This value is well within the acceptable range established by the USEPA. The calculated hazard index for combined exposure of children at play to Site No. 8 sediments (i.e., across compounds) is 1.0 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in sediments. Two carcinogens, beryllium and methylene chloride were present in the sediment samples. The excess lifetime cancer risk associated with children inadvertently ingesting sediments from Site No. 8 would be 2 x 10^{-7}, which is well within acceptable range established by the USEPA. As for the

projected combined risk of exposure of visiting children to soils and sediments in the vicinity of Site No. 8, both the combined hazard index and the combined lifetime cancer risk are within the acceptable range.

Metals found in the soils of Site No. 8 generally occurred within installation background ranges or within the average concentration reported for typical soils. Cadmium, lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock.

Based upon the results of the risk assessment, Site No. 8 has undergone the FS process to formulate, evaluate, and select remedial alternatives to address TCE contamination of groundwater of the unconsolidated aquifer. The details of the FS are presented in Section 5.0 of this report.

4.2.6 SITE NO 12: BUILDING 850 DRUM STORAGE YARD

As detailed in Section 4.1.6 of this report, the RI activities conducted at the former drum storage yard during the IRP RI/FS effort confirmed the absence of soil contamination that would pose any health risk. The hazard index, for noncarcinogenic compounds found in the soils was less than 1. This value calculated for combined exposure across compounds would no pose any adverse noncarcinogenic effects for chronic exposure to these soils. Five carcinogenic compounds were detected in the soils at this site (beryllium, benzene, methylene chloride, tetrachloroethene and trichloroethene). Due to comparable methylene chloride concentrations reported in the method blank, the reported presence of this compound in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 12 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these compounds is 1×10^{-6}. This result falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No. 12 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils and sediments found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 12 which posed some carcinogenic risk, occurred well below the average beryllium concentration reported for soils.

Based upon the results of the baseline risk assessment no further action is recommended for Site No. 12.

4.2.7 SITE NO. 9: FIRE TRAINING AREA NO. 3

As detailed in Section 4.1.7 of this report, the RI activities conducted at the fire training area during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic compounds found in the soils and groundwater was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of Site No. 9 (i.e, benzene, beryllium, methylene chloride and bis(2-ethylhexyl) phthalate), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the benzene detected in the one Site No. 9 well exceeds this limit. As mentioned in Section 4.1.7, benzene also was detected in the shallow background well. A portion of the risk calculated for Site No. 9, according to the hypothetical groundwater exposure scenario, is attributable to the concentration of metals measured in the groundwater. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. Metals found in the soils of Site No. 9 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead and manganese were the only notable exceptions. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils and sediments found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 9 which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment and the absence of contamination in the two downgradient shallow wells installed during the additional RI to determine if benzene contamination extended to the intermittent stream, Site No. 9 is recommended for no further IRP action.

4.2.8 SITE NO. 11: FIRE TRAINING AREA NO. 2

As detailed in Section 4.1.8 of this report, the RI activities conducted at the former fire training area during the IRP RI/FS effort confirmed the absence of soil contamination that would pose any health risk. The hazard index, for noncarcinogenic compounds found in the soils was less than 1. This value calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to these soils. Two carcinogenic compounds were detected in the soils at this site (beryllium and bis(2-ethylhexyl)phthalate). The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these compounds is 2×10^{-9}. This result falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No. 11 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock (Litten, 1986). Beryllium, the only metal found at Site No. 11 which posed some carcinogenic risk, occurred well below the average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment and the comparisons with background levels and average trace element concentrations reported for soils, Site No. 11 is recommended for no further IRP action.

4.2.9 SITE NO. 13: 4000 GALLON UNDERGROUND TANK PIT

As detailed in Section 4.1.9 of this report, the RI activities conducted at the former tank pit during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenario outlined in the baseline risk assessment, pose a significant health risk. According to the hypothetical scenario, no health risk is imposed by the Site No. 13 soils.

The calculated hazard index for combined exposure across compounds found in the groundwater is approximately 3.5. The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to the high value of the hazard quotient for vinyl chloride (i.e., a value of 2.2 corresponding to a mean groundwater concentration of 294 ug/l) and lead to a lesser extent. Seven potentially carcinogenic compounds were detected in the groundwater at Site No. 13 (arsenic, benzene, 1,4-dichlorobenzene, 1,2-dichloroethane, methylene chloride, vinyl chloride and trichloroethene). The excess lifetime cancer risk associated with the hypothetical exposure assumptions is approximately 2 x 10^{-3}. This lifetime cancer risk exceeds the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. Again the magnitude of this estimate is primarily attributable to the presence of vinyl chloride and to a lesser extent, arsenic. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the benzene level found in one of the monitoring wells exceeds this limit. Trichloroethene, which was not detected in any of the four wells during the initial round of groundwater sampling, exceeded the ARAR in the one well it was detected during the additional RI round of sampling.

Chlorobenzene, toluene, and 1,4-dichlorobenzene each exceeded the ARAR in one well during the initial round of sampling. Vinyl chloride exceeded the ARAR in two wells during the initial round of sampling and in one well during the additional RI. The mean value of vinyl chloride was more than 100 times the Federal MCL. Methylene chloride exceeded the ARAR in all wells. Although typically considered a laboratory contaminant, it is being treated a site contaminant in this case since levels reported in groundwater were significantly higher than that reported in the various QA samples. A significant portion of the risk calculated at Site No. 13 was attributable to the levels of certain metals (lead, manganese, vanadium, chromium, and zinc). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment.

The calculated hazard index, for non-carcinogenic compounds found in the soils was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to the Site No. 13 soils. Only one carcinogenic compound was detected in the soils at the site (i.e., methylene chloride). Due to comparable methylene chloride concentrations reported in the method blank, the reported presence of this compound in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 13 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure to these soils is 3×10^{-12}. This value falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No 13 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock (Litten, 1986).

Based upon the results of the baseline risk assessment, Site 13 has undergone the FS process to formulate, evaluate, and select remedial alternatives to address contaminated groundwater of the unconsolidated aquifer. The details of the FS are presented in Section 5.0.

4.3 ORIGIN OF HIGH METALS IN GROUNDWATER IN PRESENT STUDY

Several groundwater samples contained high concentrations of toxic and non-toxic metal species in excess of ARARs and/or in concentrations that would impart health related risks on ingestion. An analysis of the data revealed the following conclusions regarding the origin of these species:

1) The metals are not dissolved in the groundwater, and are derived from laboratory digestion and dissolution of particulate clasts introduced into the groundwater during sampling.
2) The presence of these inorganic compounds are not a result of base activities, and are derived from naturally occurring sources such as minerals and associated chemical species. The inorganics found have been documented as constituents within rocks of the area.

Evidence for the origin of high metals is derived from several sources. Collection and analysis of groundwater required unfiltered samples to be acquired. Due to the extremely low hydraulic conductivity and clay content of the shallow aquifer, groundwater sampling occasionally resulted in cloudy and turbid samples. These particle laden samples were digested in the laboratory for the metals analysis, often yielding unusually high inorganic concentrations. This is substantiated by very high concentrations of Silicon and Aluminum in the groundwater. Silicon and Aluminum are the major constituents of clay and silt clasts. In this study, high Silicon and Aluminum in the groundwater samples for the most part correlate with field observations of cloudy and turbid samples. Therefore, it is concluded that the high silicon and aluminum found in the samples is derived from particulates rather than dissolved species.

Analysis of the data shows that high concentrations of most metal species correlates with high concentrations of silicon and aluminum. This is illustrated by plotting the metal against the sum of silicon and aluminum. Figure 4-88 illustrates the correlation between iron and the sum of silicon and aluminum. The iron is derived from the chemical structure of the clastic particles. The high Fe content is not due to the low pH of the groundwater as depicted in the plot of Fe vs pH in Figure 4-89. In addition, highly soluble inorganic species, such as Na, do not exhibit any relationship with the Si and Al content, as depicted in Figure 4-90.

Most metal species show a relationship with Si and Al derived clastic particles. The following metals exhibit a relationship with the Si and Aluminum content, and are depicted in Figures 4-91 through 4-99: As, Ba, Mn, Pb, Cd, Cr, Zn, Ni, and Cu. Notable deviations exist in some metals' content for wells 3-1, 3-2, and 4-3. Another source may be responsible for these high values.

Metal assemblages, similar to the suite encountered from this study, have been documented to occur in bedrock samples from the Niagara area (Litten, 1986). The bedrock is the source of the glacially derived unconsolidated soils of the upper aquifer in the Niagara region. The following metals have been observed to occur and are a source of metal loading to the Niagara River: As, Cr, Cu, Pb, Ni, and Zn. In fact, Litten states that the "Niagara falls itself appears to be the largest point source of Arsenic".

Utilizing background well data to calculate Base induced metal contamination is inappropriate because these wells were sampled and analyzed in the same manner as the Base wells. They are therefore subject to indeterminate and varying levels of particulate contamination.

In conclusion, the dominant source of high metals in groundwater samples is through the presence of clastic particulates. These naturally derived clasts were dissolved in the laboratory, resulting in high concentrations of silicon, aluminum, and their associated metals.

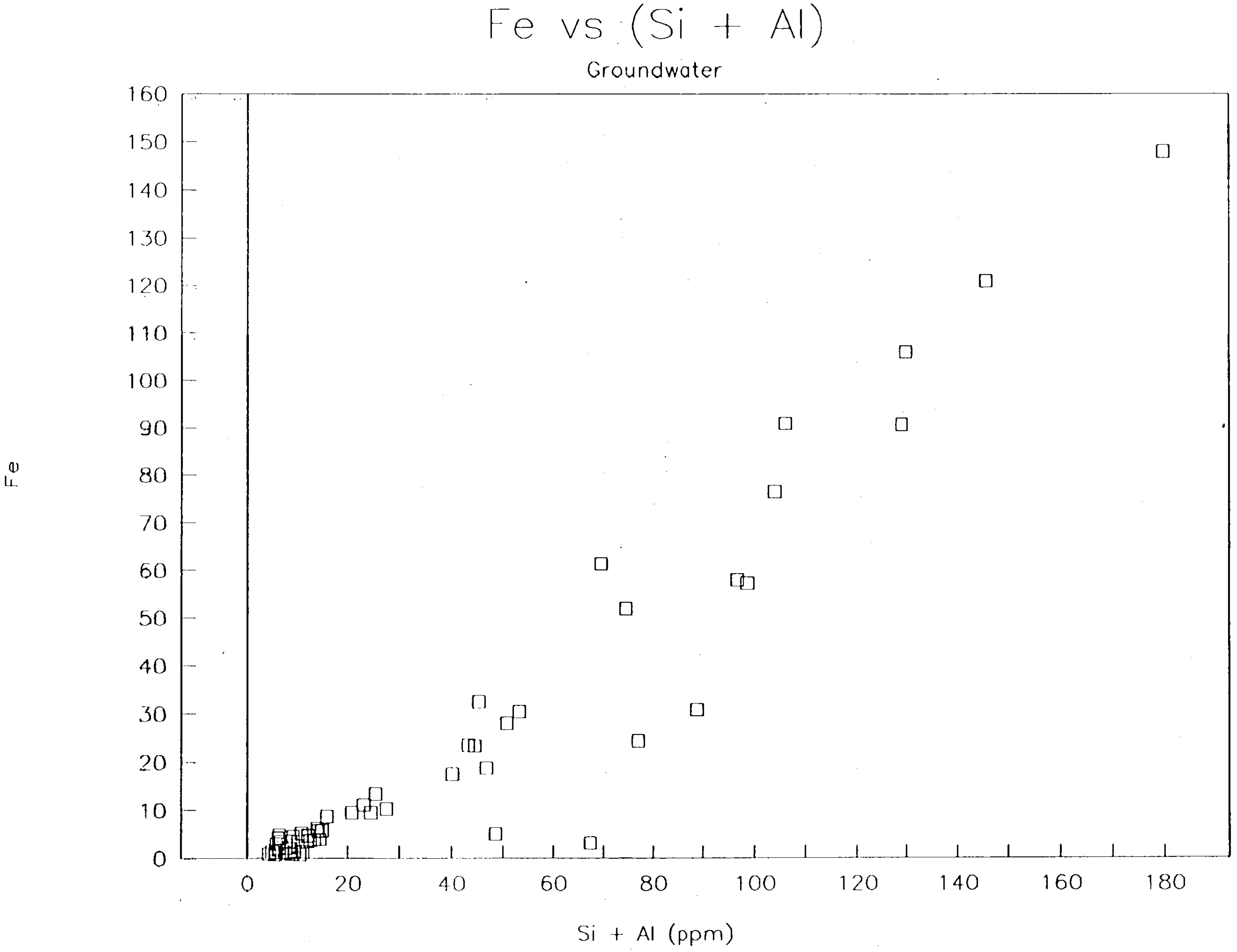
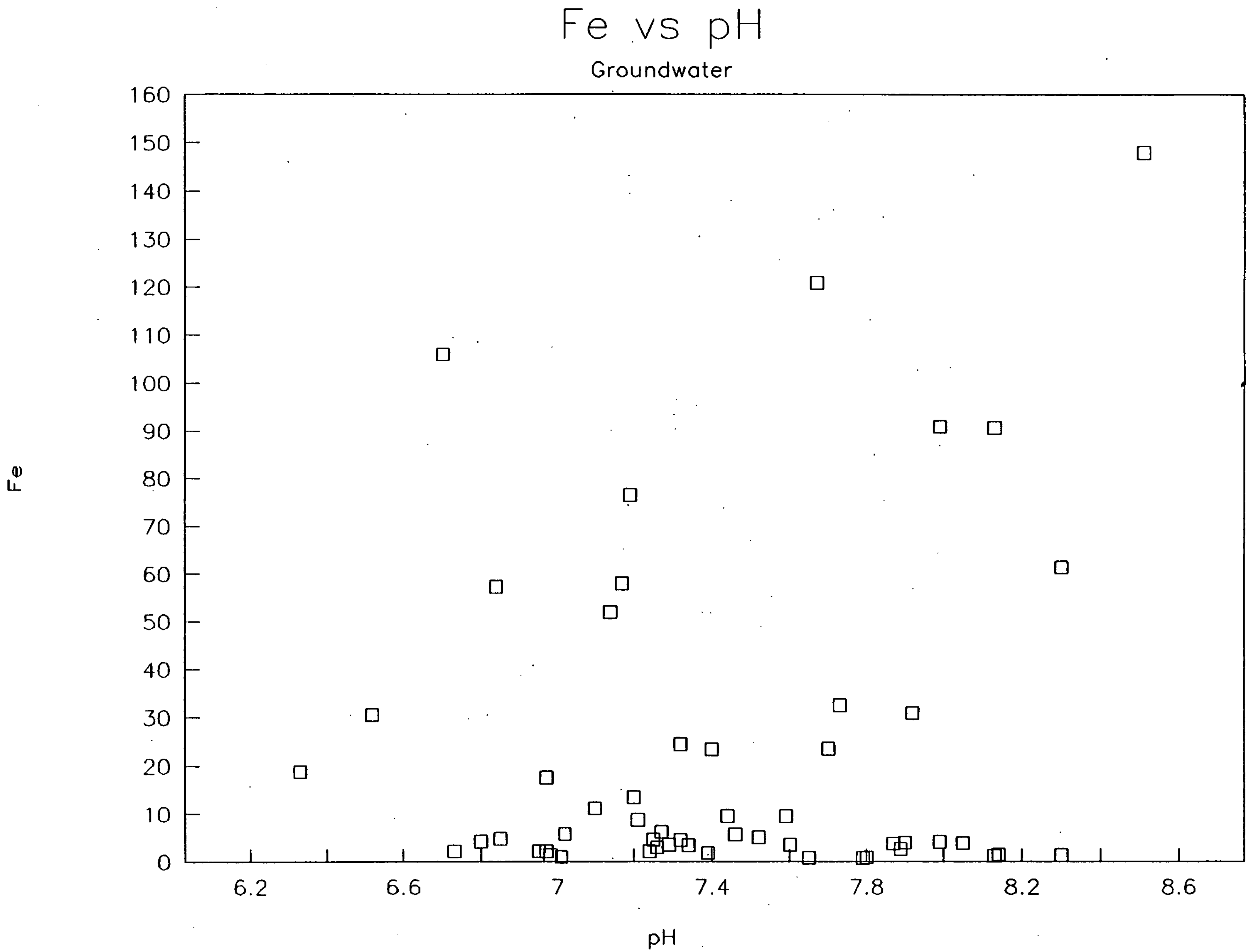

Fe vs (Si + Al)
Groundwater
Fe
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
0
20
40
60
80
100
120
140
160
180
Si + Al (ppm)

FIGURE 4-88



Fe vs pH
Groundwater
Fe
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
6.2
6.6
7
7.4
7.8
8.2
8.6
pH

FIGURE 4-89

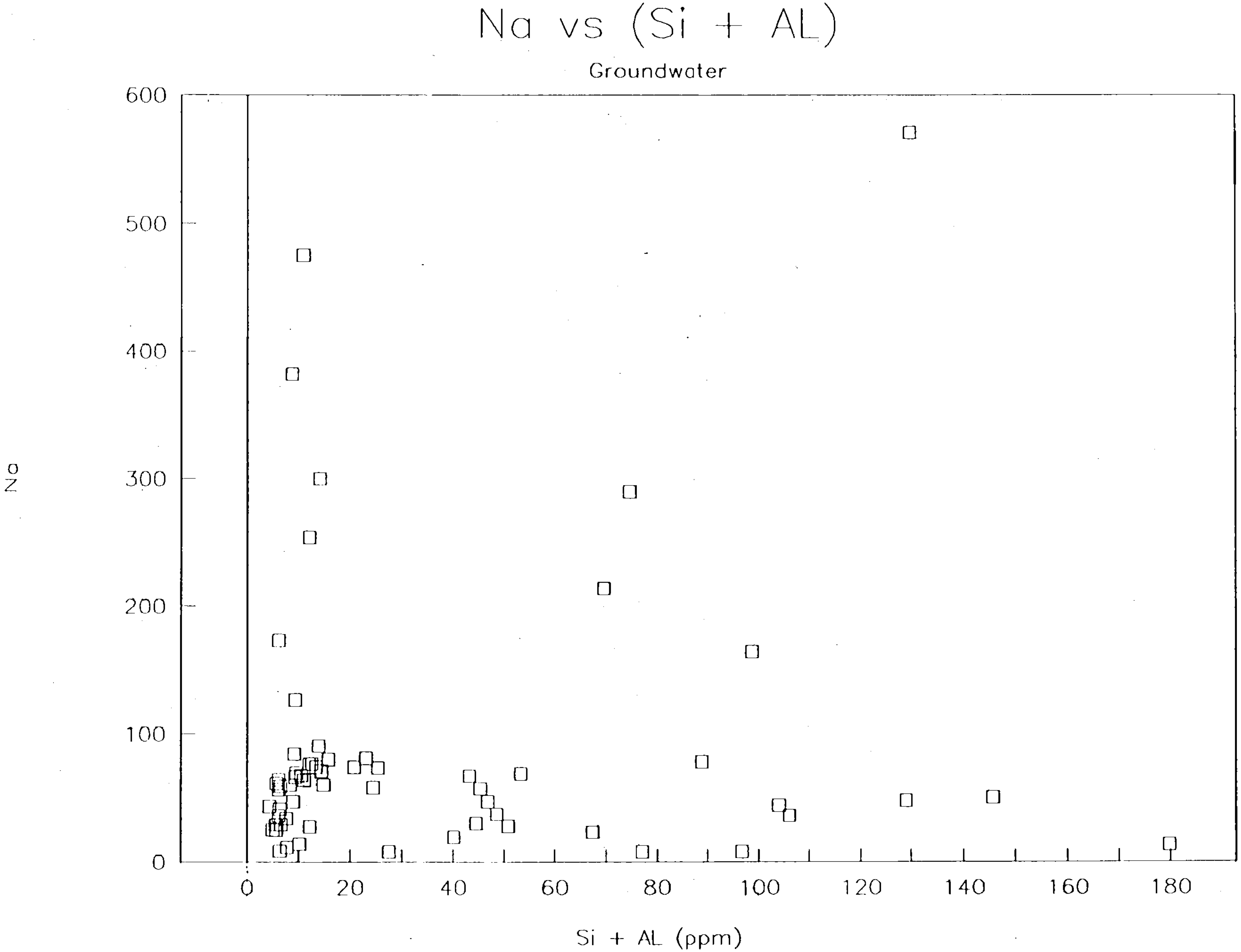

Na vs (Si + AL)
Groundwater
Na
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
Si + AL (ppm)

FIGURE 4-90

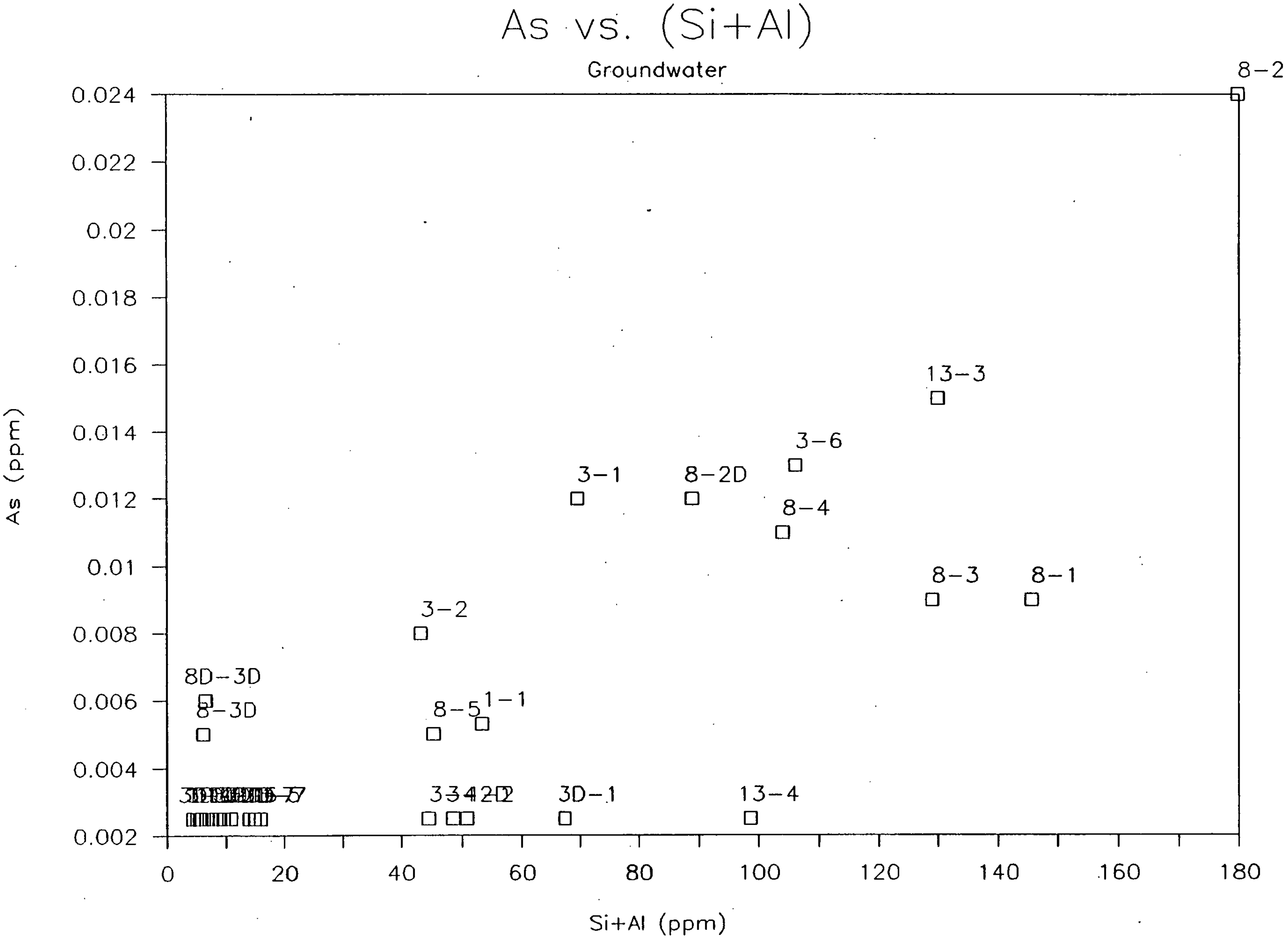

As vs. (Si+Al)
Groundwater
As (ppm)
Si+Al (ppm)
0.024
0.022
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
20
40
60
80
100
120
140
160
180
8-2
13-3
3-6
3-1
8-2D
8-4
8-3
8-1
3-2
8D-3D
8-3D
8-5
1-1
3D-1
13-4

FIGURE 4-91

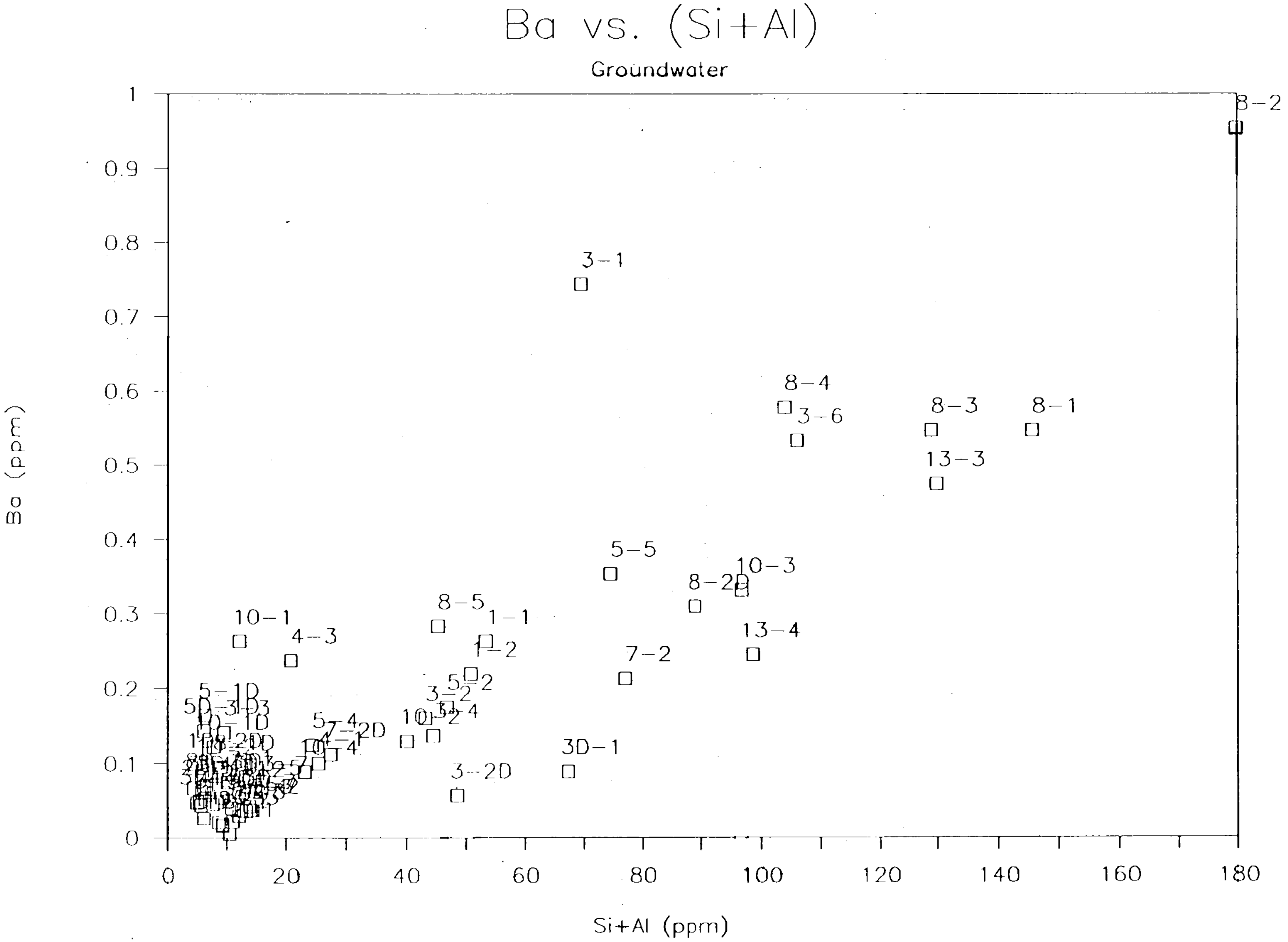

Ba vs. (Si+Al)
Groundwater
Ba (ppm)
Si+Al (ppm)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
20
40
60
80
100
120
140
160
180
8-2
3-1
8-4
3-6
8-3
8-1
13-3
5-5
10-3
8-2D
13-4
7-2
10-1
4-3
8-5
1-1
1-2
5-2
3-2
3-4
10-2
5-4
7-2D
5-1D
5D-3
3D
1D
2D
3D-1
3-2D

FIGURE 4-92

Mn vs. (Si+Al)

Groundwater

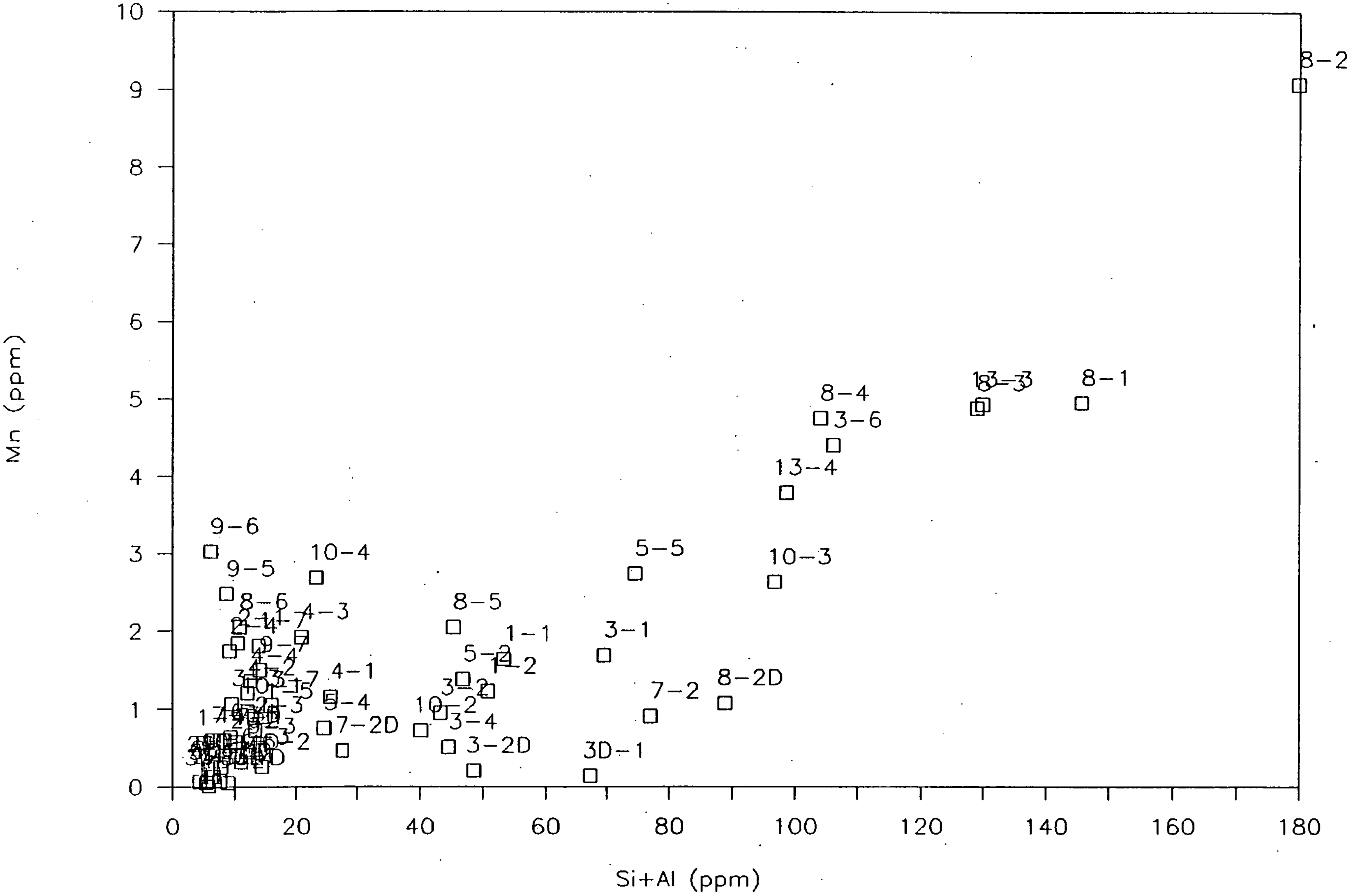


FIGURE 4-93

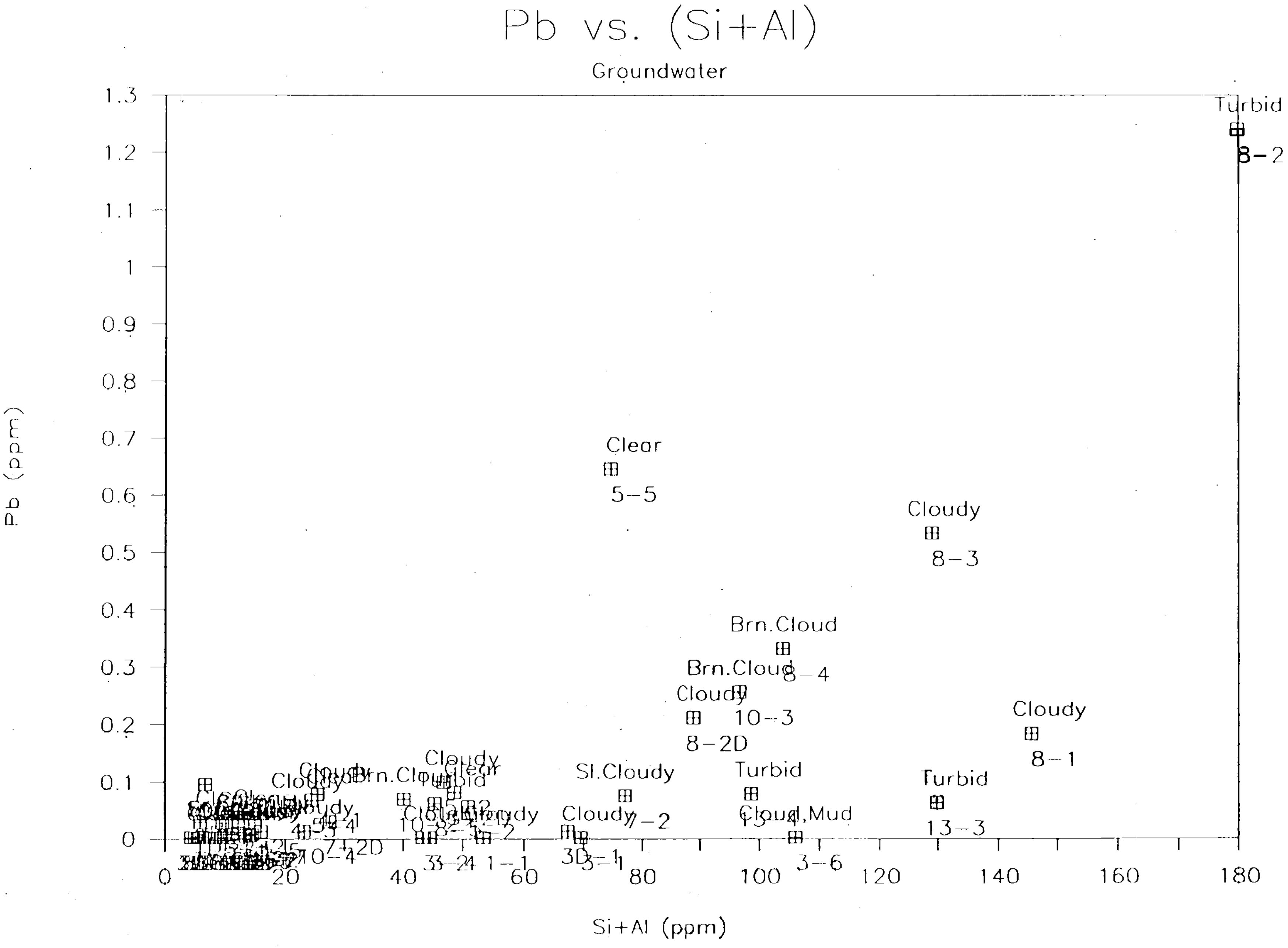

Pb vs. (Si+Al)
Groundwater
Pb (ppm)
Si+Al (ppm)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
0
20
40
60
80
100
120
140
160
180
Turbid
8-2
Clear
5-5
Cloudy
8-3
Brn.Cloud
8-4
Brn.Cloud
10-3
Cloudy
8-2D
Cloudy
8-1
Turbid
13-3
Turbid
Cloud,Mud
3-6
Sl.Cloudy
7-2
Cloudy
3D-1
Cloudy
Clear
Turbid
Brn.Cloud
1-1
3-2
7-2D
10-4

FIGURE 4-94

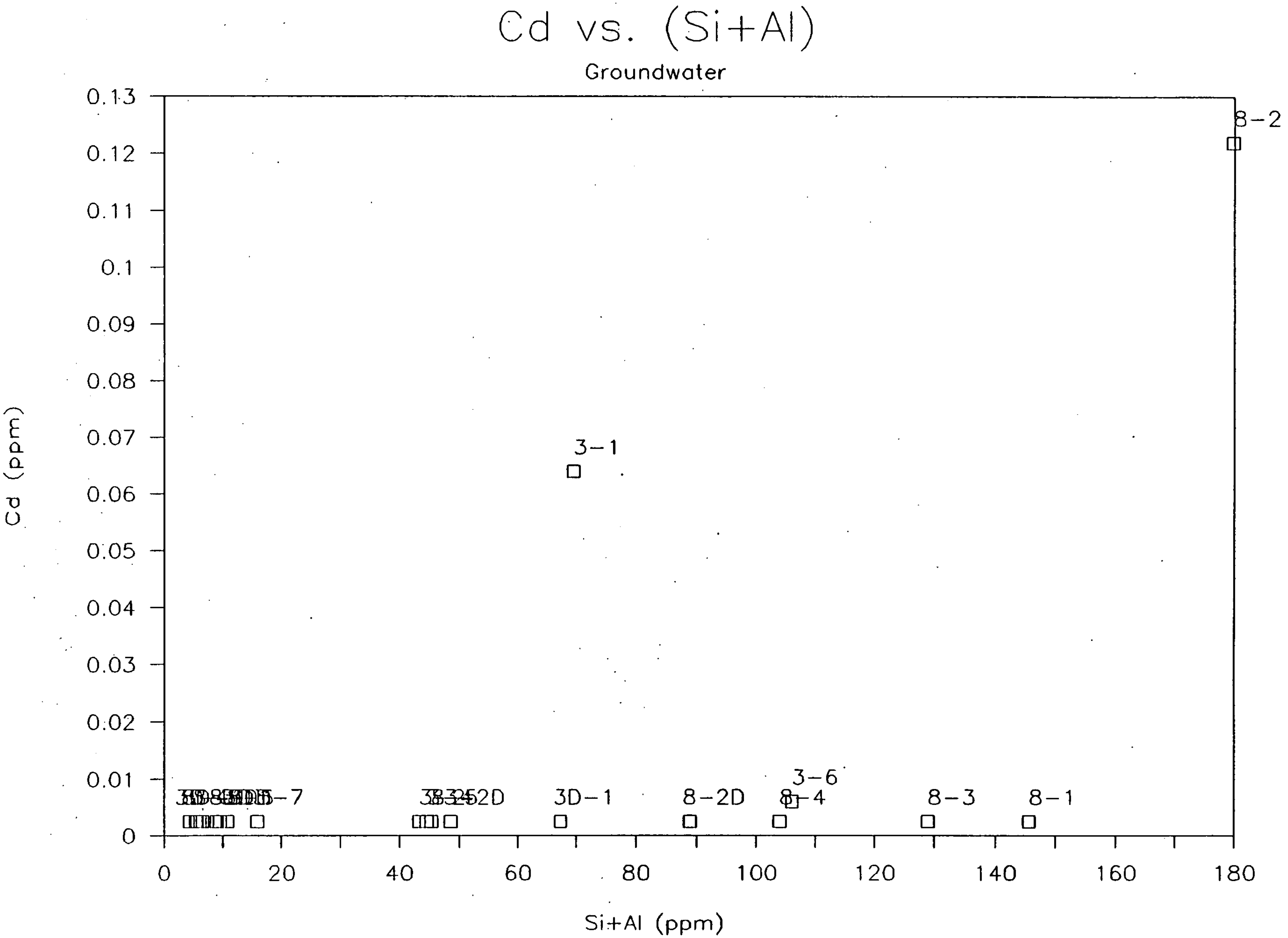

Cd vs. (Si+Al)
Groundwater
Cd (ppm)
Si+Al (ppm)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0
20
40
60
80
100
120
140
160
180
8-2
3-1
3-6
8-4
8-3
8-1
8-2D
3D-1
3-2D
3D-7

FIGURE 4-95

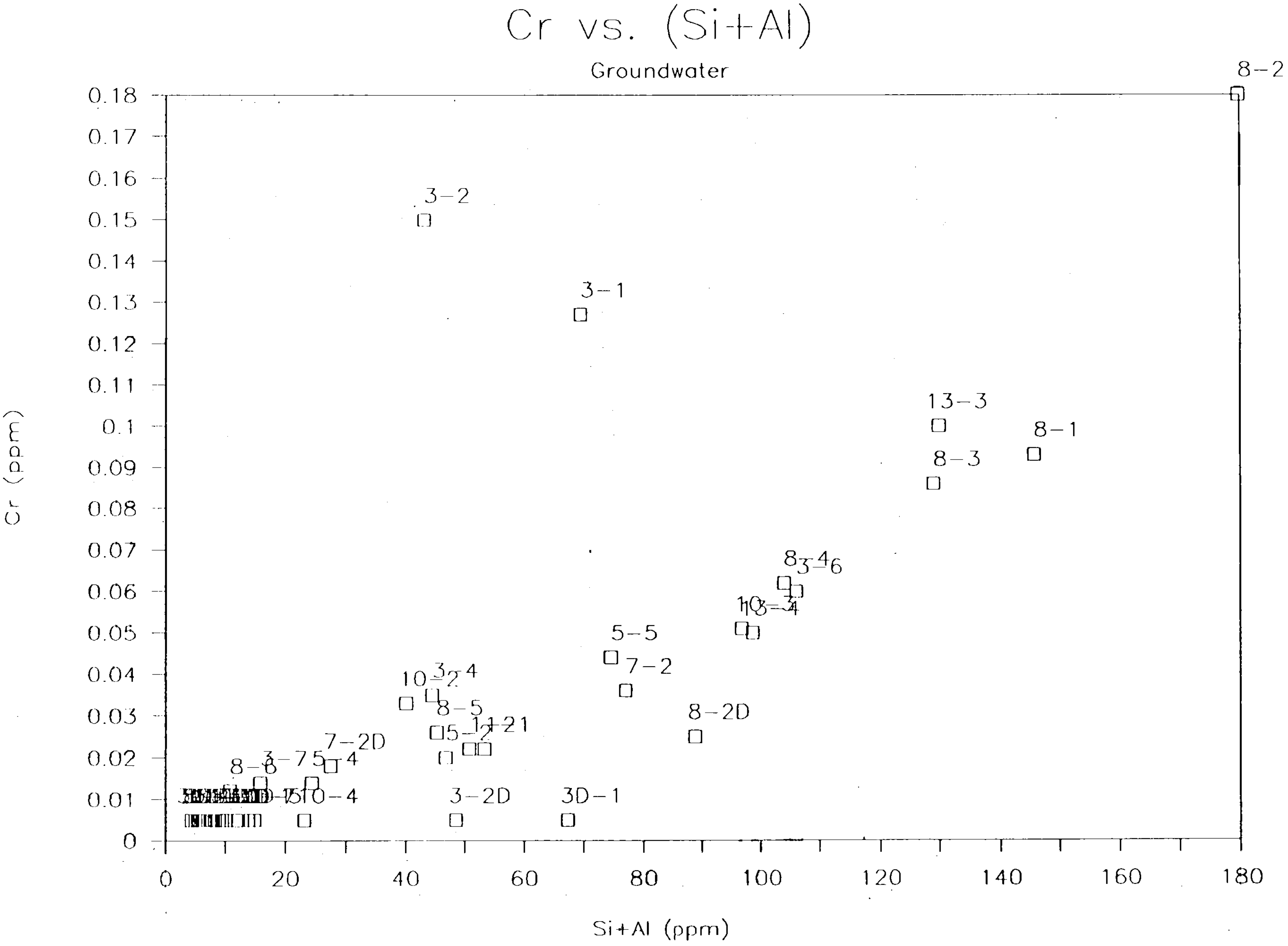
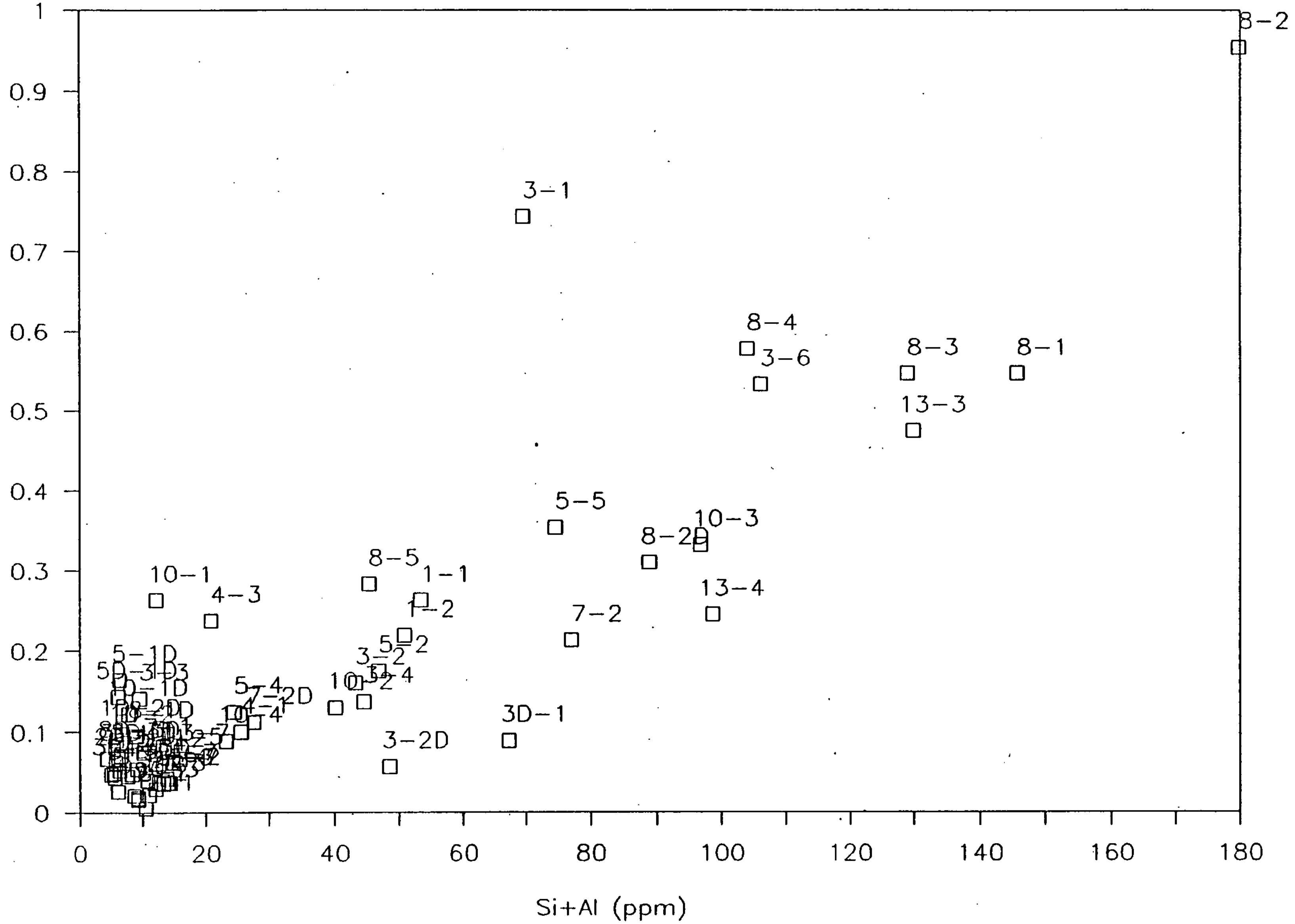

Cr vs. (Si+Al)
Groundwater
Cr (ppm)
Si+Al (ppm)
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
160
180
8-2
3-2
3-1
13-3
8-1
8-3
8-4
3-6
10-3
13-4
5-5
7-2
10-2
3-4
8-5
5-2
11-21
8-2D
7-2D
3-7
5-4
8-6
10-4
3-2D
3D-1

FIGURE 4-96


Zn vs. (Si+Al)

Groundwater

FIGURE 4-97

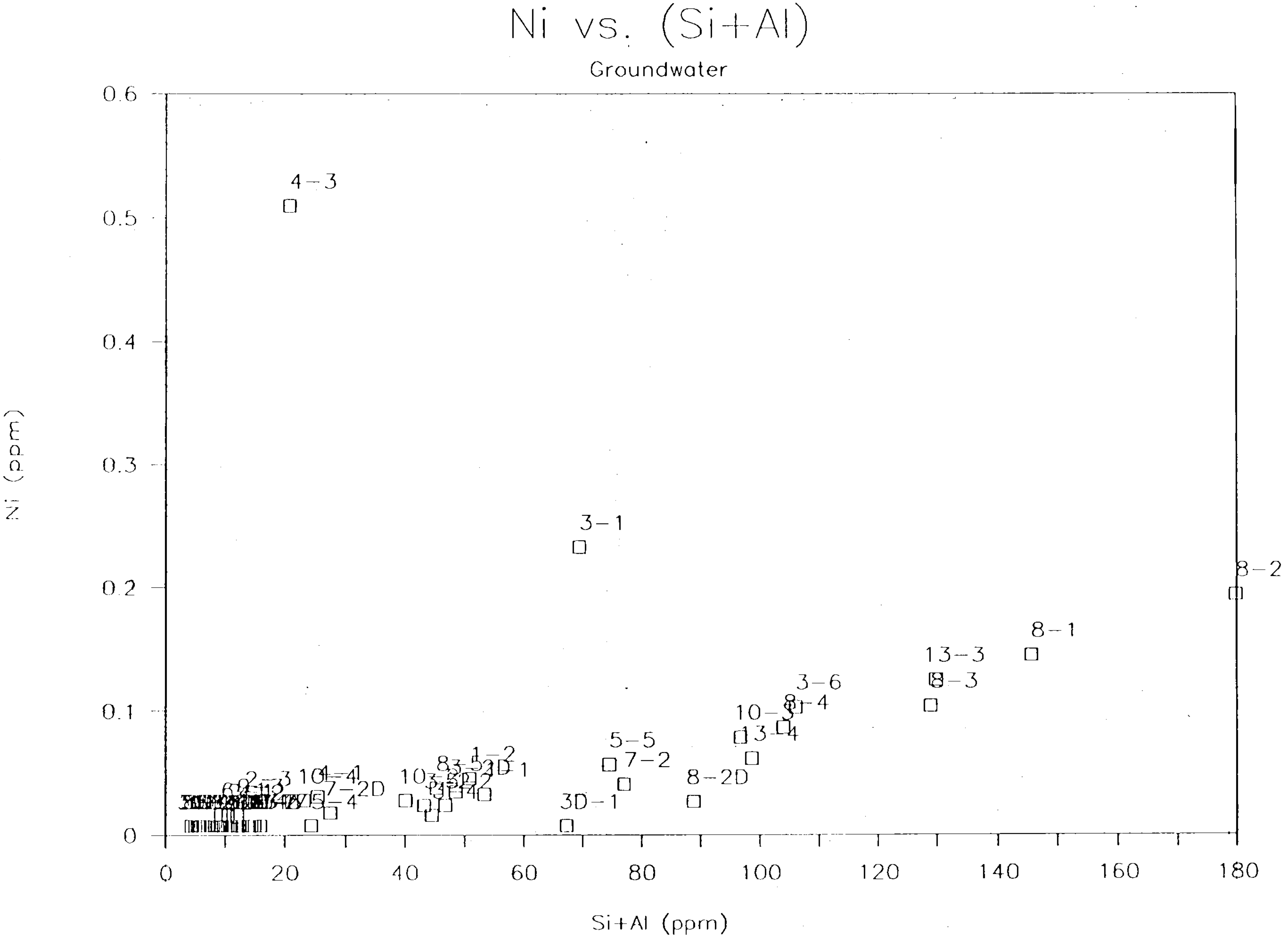

Ni vs. (Si+Al)
Groundwater
Ni (ppm)
Si+Al (ppm)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140
160
180
4-3
3-1
8-2
8-1
13-3
8-3
3-6
8-4
10-3
13-4
5-5
7-2
8-2D
3D-1
1-2
3D-1
10-3
2-3
10-4
4-1
7-2D
5-4

FIGURE 4-98

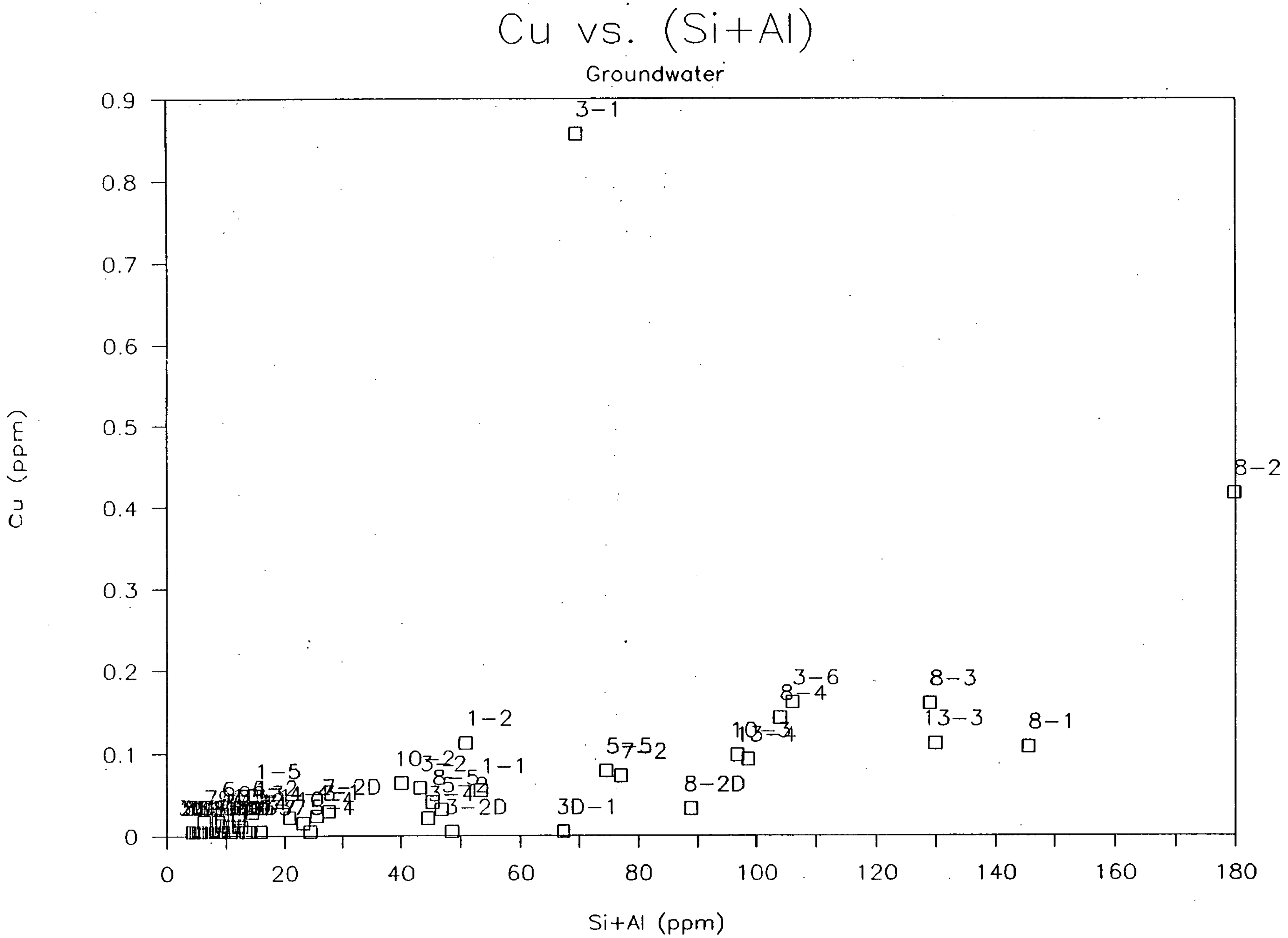
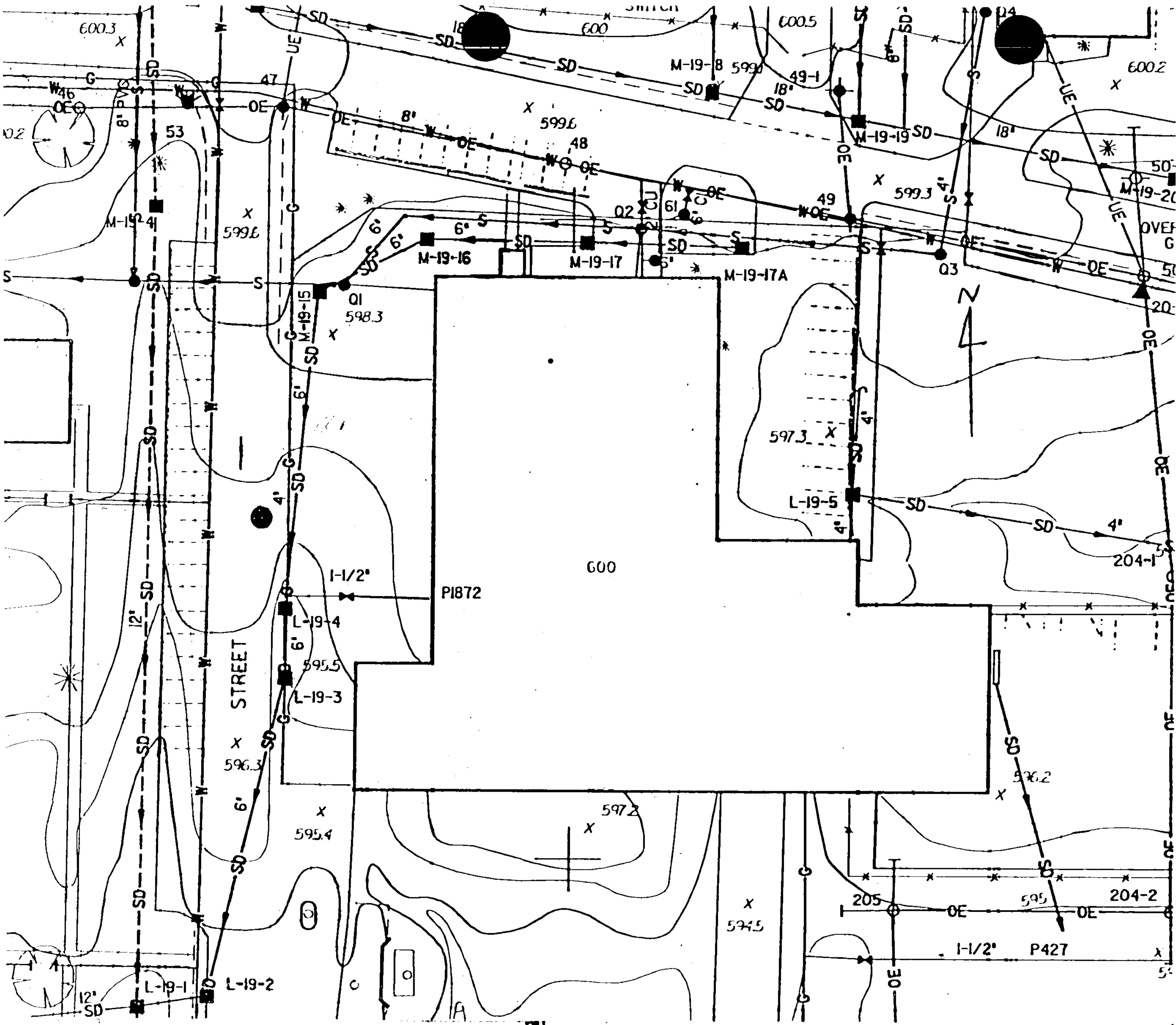
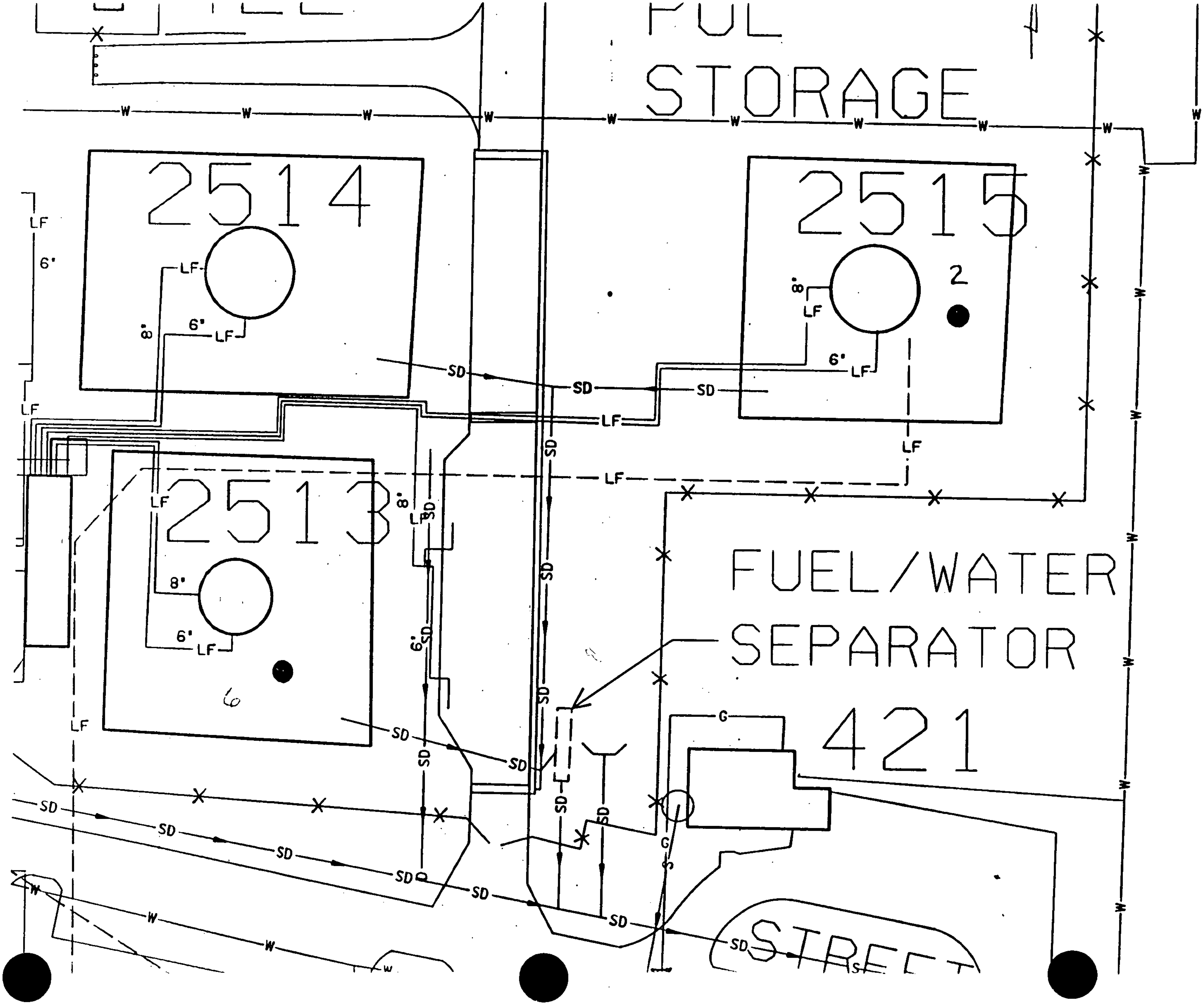

Cu vs. (Si+Al)
Groundwater
Cu (ppm)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Si+Al (ppm)
0
20
40
60
80
100
120
140
160
180
3−1
8−2
3−6
8−4
8−3
13−3
8−1
1−2
10−3
5−5
7−2
8−2D
3D−1
10−2
3−2
1−1
8−5
3−4
3−2D
7−2D
1−5
5−4

FIGURE 4-99

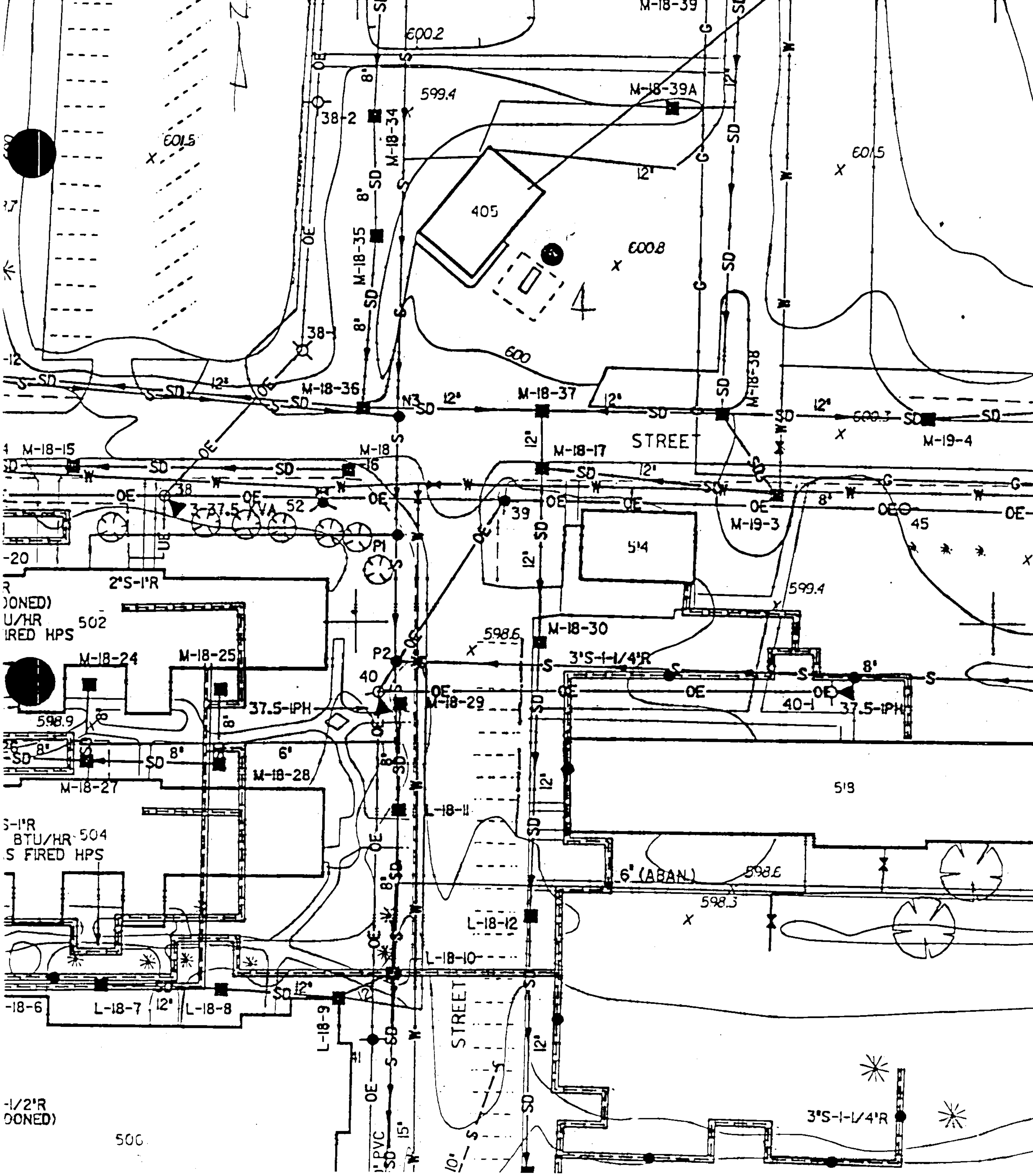
Utility Site Map for Site #1
Niagara Falls IAP, NY





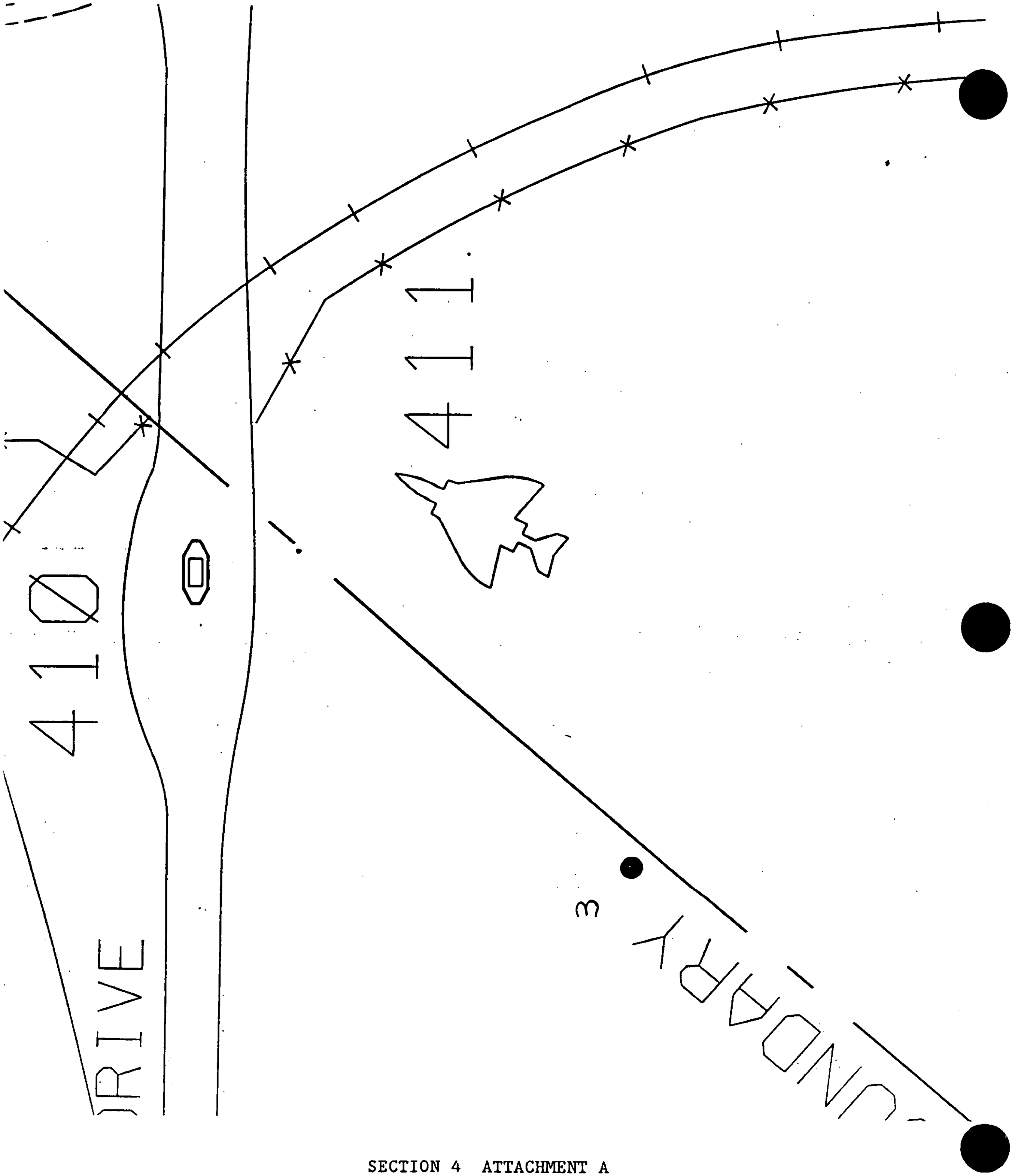
SECTION 4 ATTACHMENT A

Utility Site Map for Sites #2 and #6
Niagara Falls IAP, NY



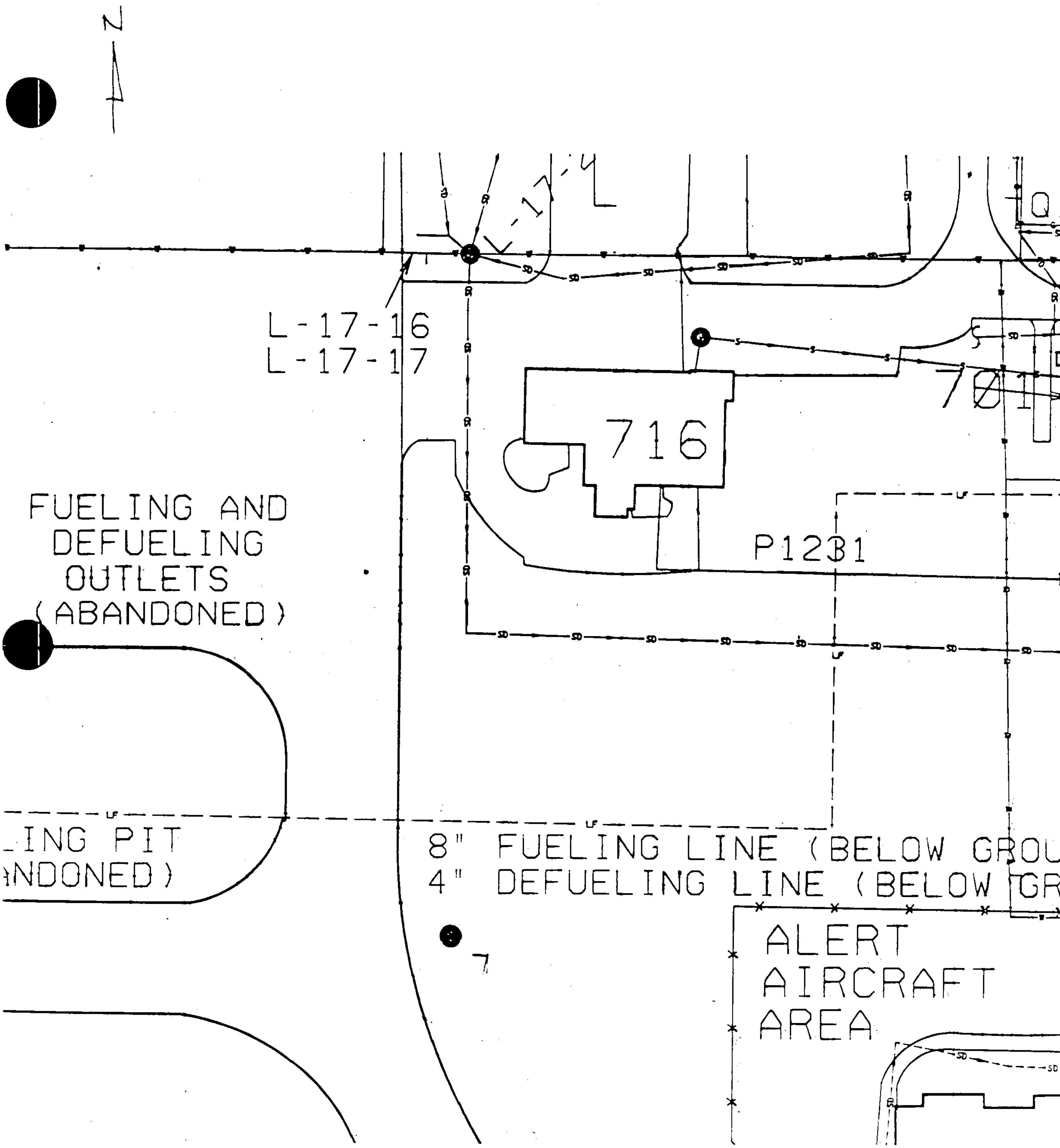
SECTION 4 ATTACHMENT A

Utility Site Map for Site #4
Niagara Falls IAP, NY



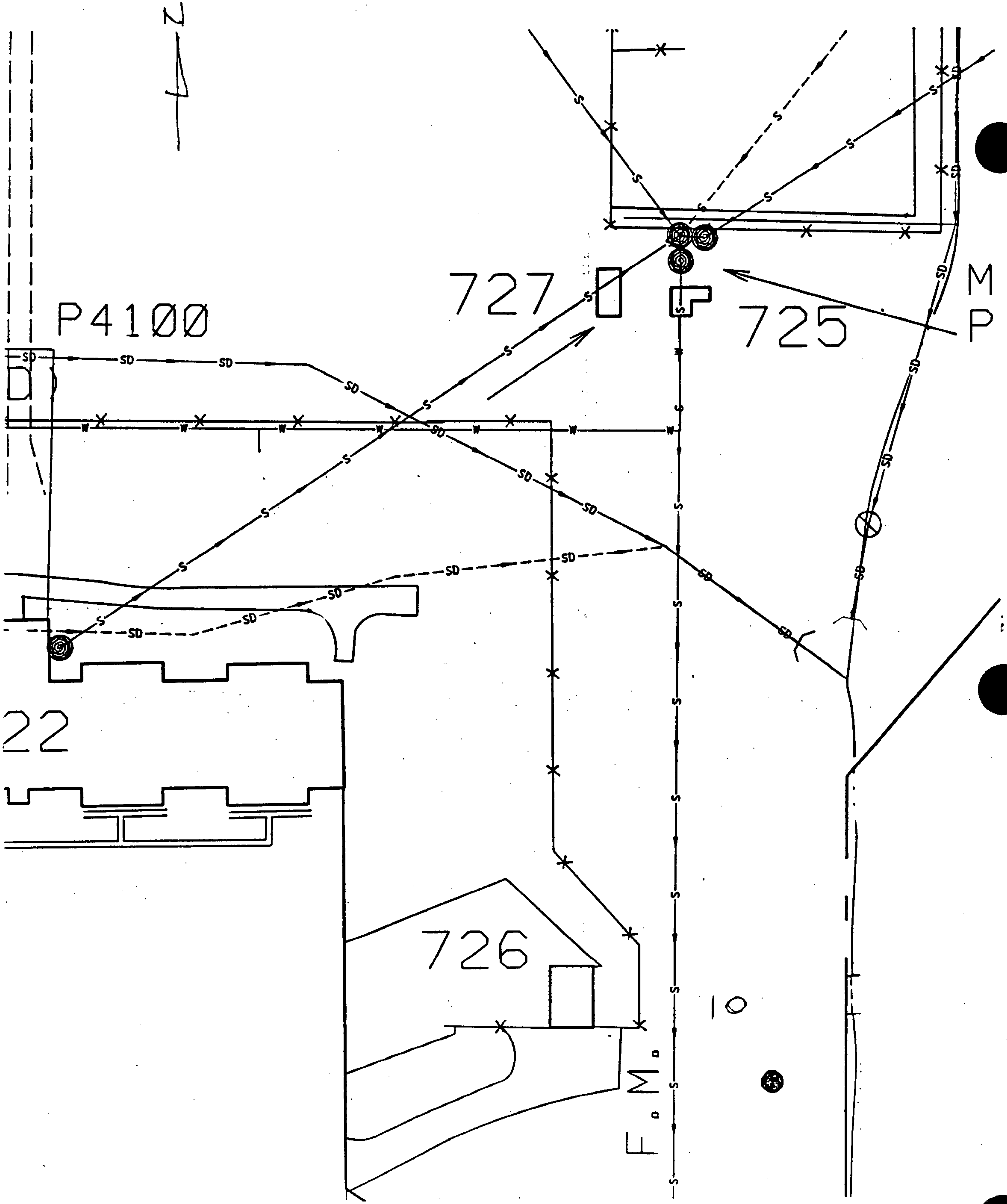
SECTION 4 ATTACHMENT A

Utility Site Map for Site #3
Niagara Falls IAP, NY



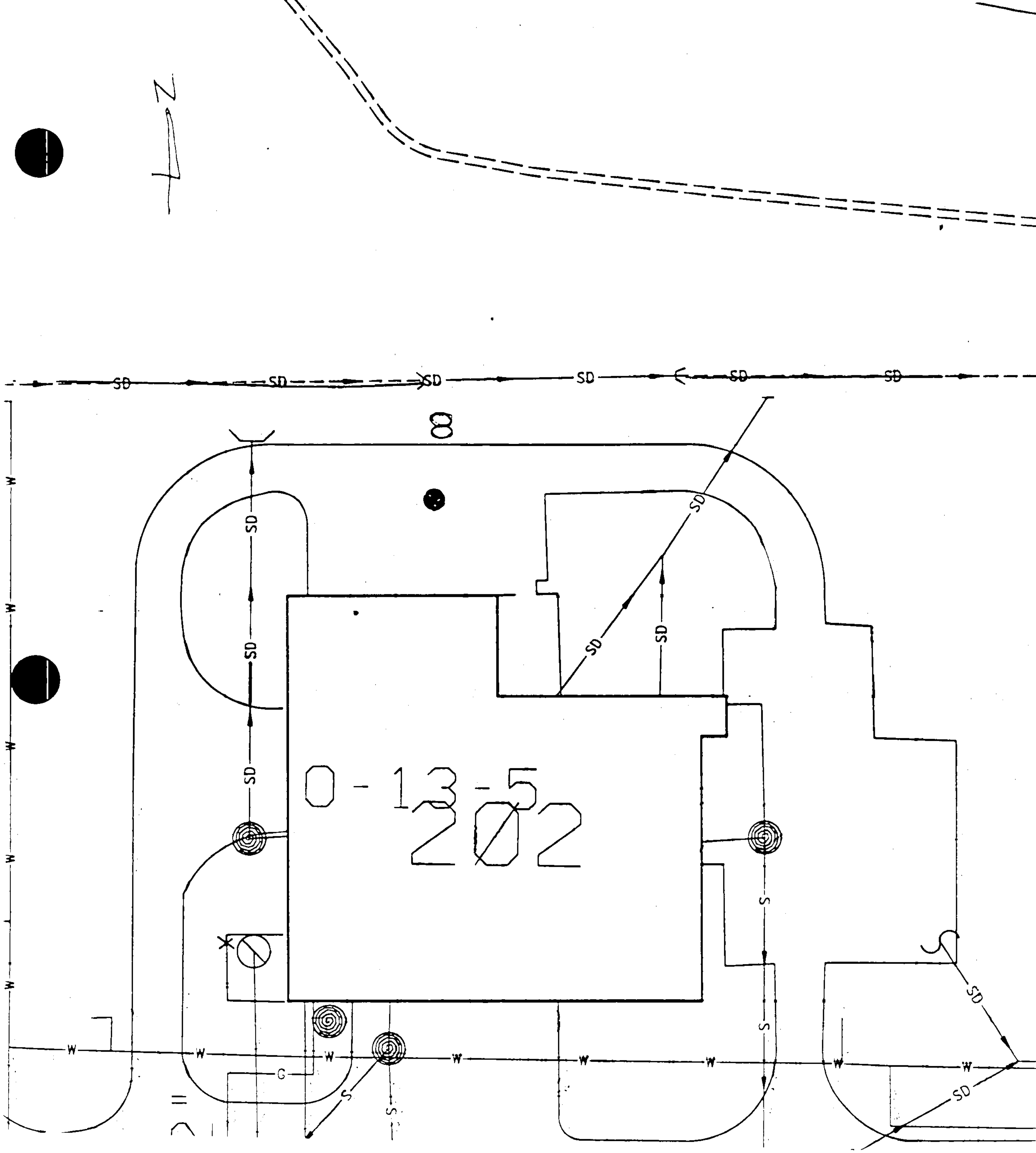
SECTION 4 ATTACHMENT A

Utility Site Map for Site #7
Niagara Falls IAP, NY



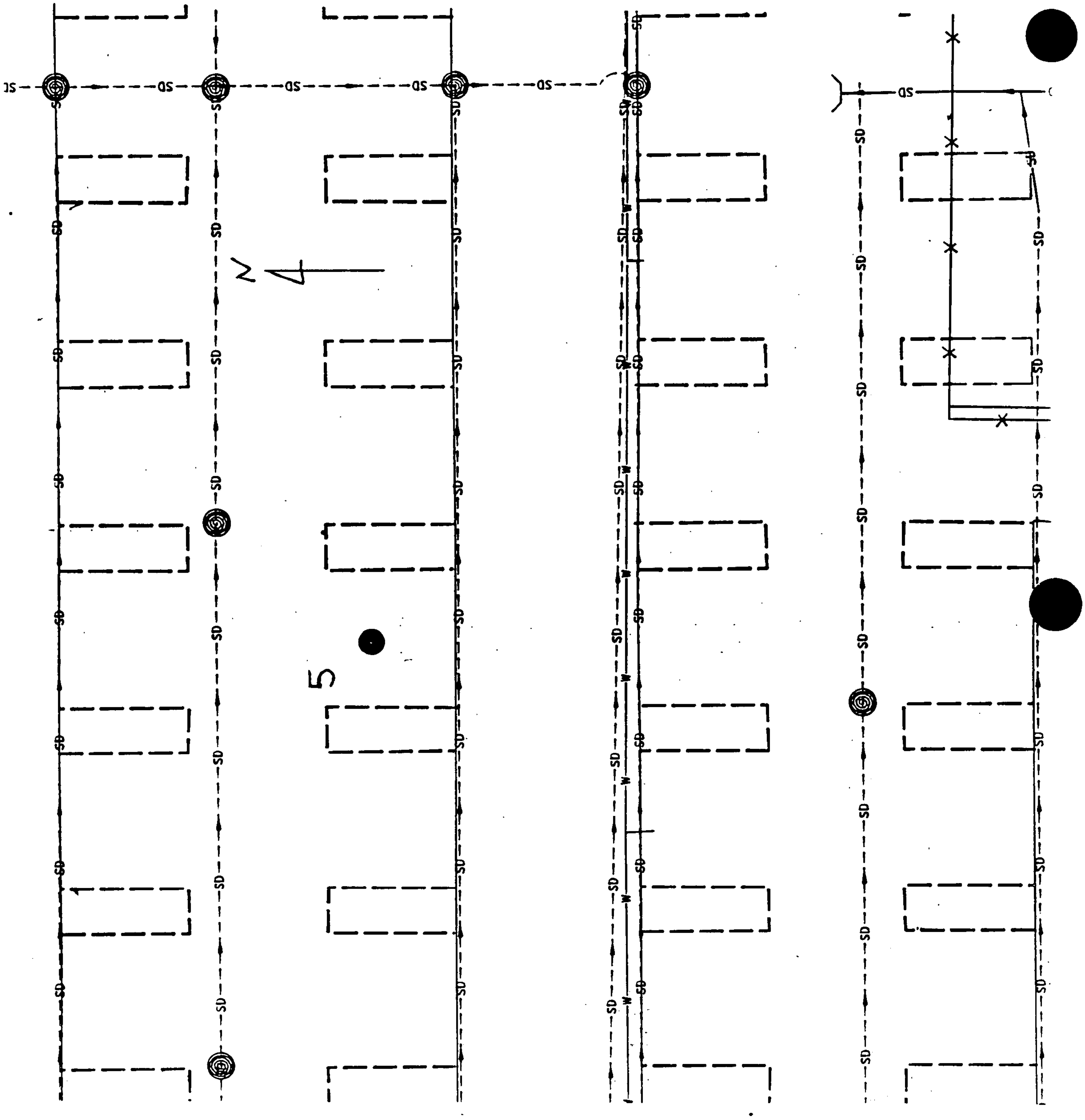
SECTION 4 ATTACHMENT A

Utility Site Map for Site #10
Niagara Falls IAP, NY



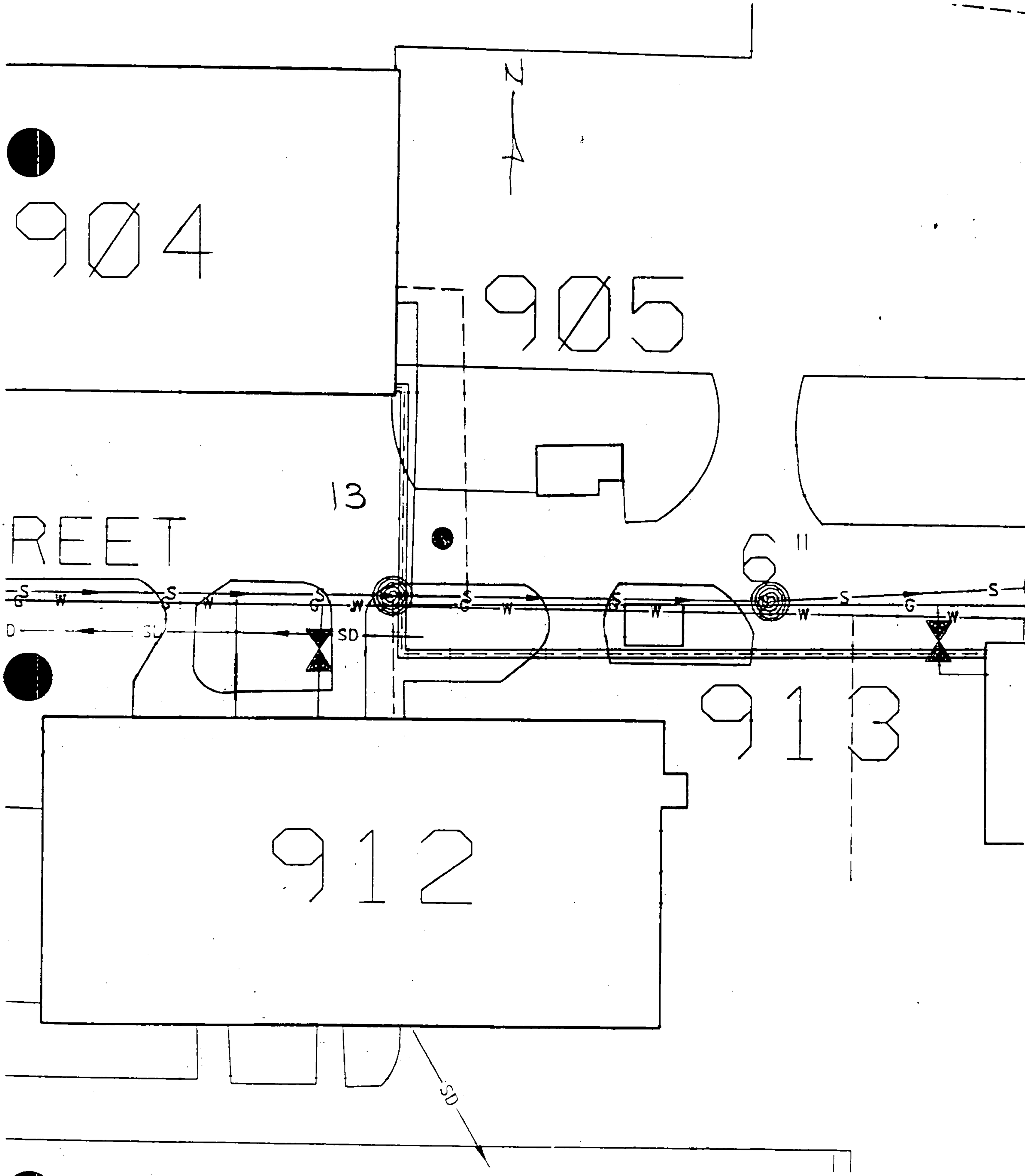
SECTION 4 ATTACHMENT A

Utility Site Map for Site #8
Niagara Falls IAP, NY



SECTION 4 ATTACHMENT A

Utility Site Map for Site #5
Niagara Falls IAP, NY



SECTION 4 ATTACHMENT A

Utility Site Map for Site #13
Niagara Falls IAP, NY

SECTION 4
ATTACHMENT B

1.0 SAMPLE CALCULATIONS FOR RISK ASSESSMENT

1.1 EXPOSURE TO GROUNDWATER: EXAMPLE FOR NONCARCINOGENIC EFFECTS

1.1.1 Intake Estimates for Hypothetical Exposure to Groundwater

Intake estimates for hypothetical exposure of Base personnel to chemicals in groundwater are determined as follows (USEPA 1989):

$$\text{Intake} = C \times \frac{CR \times CF \times EF \times ED}{BW \times AT} \qquad (1)$$

where

C = Mean chemical concentration in the groundwater.
CR = Contact rate: 1 L/day projected as reasonable maximum for Base personnel.
CF = Units conversion factors: 0.001 mg/ug
EF = Exposure frequency: 5 days/week, 50 weeks/year. Reasonable maximum exposure for Base personnel.
ED = Exposure duration: 20 years. Projected length of service (upper bound) at Niagara Falls IAP.
BW = Body weight for adults: 70 kg

and,

AT = Averaging time for noncarcinogenic effects, chronic exposure: 20 years x 365 days/year

Example calculation of intake for cadmium in Site 3 groundwater:

Substituting a mean concentration of cadmium of 9. ug/L into equation (1) above and using the specified exposure factors, a chronic intake value of 8.8×10^{-5} mg/kg body weight-day is calculated.

1.1.2 Risk Estimates for Noncarcinogenic Effects

Noncancer risk estimates for a given chemical are derived by calculating the Hazard Quotient as follows (USEPA 1989):

$$HQ = \frac{\text{Intake}}{\text{RfD}} \qquad (2)$$

where

HQ = Hazard Quotient: potential for adverse noncarcinogenic effects

Intake = average daily intake for chronic exposure (mg/kg body weight-day)

and,

RfD = EPA verified acceptable intake for chronic oral exposure (mg/kg body weight-day)

Intake and the RfD are expressed in the same units and are based upon common exposure periods. In the risk assessment of Niagara IAP, risk estimates for combined exposure across compounds is evaluated by summing the HQ values to derived a Hazard Index (USEPA 1989). If HI is > 1, then is may be concluded that there is potential for adverse noncarcinogenic effects at the given exposure/intake level.

Example risk calculation for hypothetical ingestion exposure of Base personnel to cadmium in groundwater at Site 3.

> Substituting into equation (2) above, the intake value determined from equation (1) and the EPA verified RfD for oral exposure, a Hazard Quotient of 0.18 is derived i.e., (8.8×10^{-5} mg/kg-day)/(5×10^{-4} mg/kg-day).

1.2 EXPOSURE TO GROUNDWATER: EXAMPLE FOR CARCINOGENIC EFFECTS

1.2.1 Intake Estimates for Lifetime Exposure to Carcinogens

Intake estimates for lifetime exposure to carcinogens are determined as follows (USEPA 1989):

$$\text{Intake} = C \times \frac{CR \times CF \times EF \times ED}{BW \times AT} \qquad (3)$$

where

C = Arithmetic mean chemical concentration in the groundwater. Not detected values treated as half the limit of detection.

CR = Contact rate: 1 L/day projected as reasonable maximum for Base personnel.

CF = Units conversion factors: 0.001 mg/ug

EF = Exposure frequency: 5 days/week, 50 weeks/year. Projected reasonable maximum exposure for Base personnel.

ED = Exposure duration: 20 years. Projected length of service (upper bound) at Niagara Falls IAP.

BW = Body weight for adults: 70 kg

and,

AT = Averaging time for carcinogenic effects; lifetime exposure: 70 years x 365 days/year

Example calculation of intake for trichloroethylene (TCE) in Site 3 groundwater:

> Substituting a mean concentration of TCE of 6 ug/L into equation (3) above and using the specified exposure factors, a lifetime intake value of 1.68×10^{-5} mg/kg body weight-day is calculated.

1.2.2 Risk Estimates for Carcinogenic Effects

The excess lifetime cancer risk to the exposure individual is calculated as follows (USEPA 1989):

$$\text{Risk} = \text{CDI} \times \text{CSF} \qquad (4)$$

where

Risk = Upper bound estimate of the excess lifetime cancer risk to an individual (unitless probability).

CDI = Chronic daily dose averaged over a 70 year period (mg/kg body weight-day)

and,

CSF = 95% upper-bound estimate of the slope of the dose-response curve $(\text{mg/kg body weight-day})^{-1}$

The slope factor CSF is used to convert estimates of daily intake or dose averaged over a lifetime, to incremental excess risk of an individual developing cancer. Use of this equation assumes that the dose-response relationship is linear in the low-dose portion of the multistage model dose-response curve (USEPA 1989a: A linearized multistage dose response model is most commonly used by EPA in deriving the slope estimates.) Given this assumption, the slope factor is a constant and risk is directly proportional to intake.

Example risk calculation for hypothetical ingestion exposure of Base personnel to TCE in groundwater at Site 3.

> Substituting into equation (2) above, the intake value determined from equation (4) and the EPA verified CSF for oral exposure, an excess lifetime cancer risk of approximately 2×10^{-7} is derived for exposure to TCE.

1.3 EXPOSURE OF CHILDREN TO SOILS: EXAMPLE FOR NONCARCINOGENIC EFFECTS

1.3.1 Intake Estimates for Exposure to Soils

Site 8 is in the vicinity of a playground and baseball field. As noted in the RI, these recreational facilities are reported to be used by the general public. Intake estimates for ingestion exposure of children to soils in the vicinity of Site 8 (i.e., during recreational activities) are determined as follows (USEPA 1989):

$$\text{Intake} = C \times \frac{CR \times CF \times EF \times ED}{BW \times AT} \qquad (5)$$

where

C = Arithmetic mean chemical concentration in surface soils. Not detected values treated as half the limit of detection.
CR = Contact rate: 0.2 grams/day projected as conservative exposure in the absence of site-specific information (EPA default value).
CF = Conversion factor to intake in units of kg/day: 0.001 kg/gram.
EF = Exposure frequency: 5 days/week, 16 weeks/year. Projected conservative exposure for children ages 3 to 12 years during summer months.
ED = Exposure duration: 9 years. Children ages 3 to 12 years.
BW = Average body weight for children in age group 3 to 12 years: 25 Kg.

and,

AT = Averaging time for noncarcinogenic effects, chronic exposure: 9 years x 365 days/year.

Example calculation of intake of chromium (valence III assumed) in soils at Site 8:

> Substituting a mean soils concentration of chromium of 16.24 mg/Kg into equation (5) above and using the specified exposure factors, a chronic intake value of 2.86×10^{-5} mg/kg body weight-day is calculated.

1.3.2 Risk Estimates for Noncarcinogenic Effects

Noncancer risk estimates for a given chemical are derived by calculating the Hazard Quotient as shown in equation (2) above (USEPA 1989).

Example risk calculation for hypothetical ingestion exposure of children to chromium in soils in the vicinity of Site 8.

> Substituting into equation (2) above, the intake value determined from equation (5) and the EPA verified RfD for oral exposure, a Hazard Quotient of 5.7×10^{-3} is derived i.e., (2.86×10^{-5} mg/kg-day)/(5×10^{-3} mg/kg-day).

INSTALLATION RESTORATION PROGRAM (IRP)

RI/FS

VOLUME III

Section 5 and 6

Niagara Falls International Airport
Niagara Falls, New York

Science Applications International Corporation (SAIC)
One Sears Drive
Paramus, New Jersey 07652

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Remedial Investigation/Feasibility Study (RI/FS) Report 1987-1990

PREPARED FOR

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098-6001

UNITED STATES AIR FORCE
HUMAN SYSTEMS DIVISION (AFSC)
IRP PROGRAM OFFICE (HSD/YAQI)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

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5.0 ALTERNATIVE REMEDIAL MEASURES

The FS (Feasibility Study) process is accomplished in three phases. The first phase (FS-I) identifies remediation alternatives. Screening of these alternatives, and elimination of inapplicable technologies, occurs during the second phase (FS-II). Finally, a detailed analysis of the screened alternatives is accomplished during the final phase (FS-III).

5.1 PRELIMINARY ALTERNATIVE REMEDIAL ACTIONS

Based on results from the remedial investigations and site characterizations, alternative remedial strategies were developed for each hazardous waste and spill site investigated that warranted further action. The criteria for further action was developed in the risk assessment exercises and is based on predicted media exposures and their potential threat to human health and the environment.

The screening of alternatives is accomplished by applying the following steps:

1. Define remedial action objectives. The remedial action objectives, for specific contaminants and media pathways, are developed based on risk related factors and chemical specific ARARs.

2. Develop general response actions for each media that would satisfy the remedial action objectives stated. General response actions also include a "no action" that serves as a baseline scenario.

3. Identify and screen technologies that satisfy requirements stated in the remediation action objectives as a means for eliminating inapplicable and logistically non-implementable technologies.

4. Group technologies into Operable Units (OUs) based on a discrete part of the entire response action.

5. Assemble the selected remedial technologies into alternatives representing a range of treatment options.

Thirteen sites were analyzed as part of the remedial investigation portion of the study. Of the thirteen, two sites were recommended for a feasibility analysis due to contamination levels of a magnitude great enough to threaten human health and the environment. These are Site 8, Building 202 drum storage yard, and Site 13, 4,000 gallon underground tank pit.

Site 8

Site 8, previously described as a gravel area north of Building 202, is a paved parking area. In the past, the site has been used for hazardous waste drum accumulation. Presently, it is a repository for construction materials and scrap. Minor spills have been reported and evidence of spills were observed during the Phase I site investigation.

The risk assessment revealed no significant health and environmental risks associated with soil ingestion and inhalation and/or groundwater ingestion. However, Trichloroethene (TCE) exceeded New York State Water Quality ARARs for groundwater. Trichloroethene concentration in the groundwater at Site 8 averaged 23 ppb, with a range from ND to 190 ppb. The New York State water quality standard for TCE from class GA groundwaters is 5 ppb.

Site 13

Site 13 is located south of Building 904 and west of Building 905. The 4,000 gallon underground storage tank was originally used as a motor fuel tank for a Base gas station. However, when the station closed, the tank was used for general slop waste storage. The tank has been pumped out, excavated, and removed.

Based on a risk analysis, concentrations of chemicals in the groundwater from shallow wells within the site were in excess of New York State Water Quality Regulations and/or posed a site specific health risk warranting remedial action as specifies by the EPA. Chemicals in the soil do not pose any health hazard as determined by the risk assessment.

The following chemical species were in excess of the New York State ARARs for water quality: Vinyl Chloride (mean: 294 ppb, range ND - 1600 ppb) and Benzene (mean: 0.72 ppb, range ND - 2.98 ppb). In addition, the risk assessment revealed that vinyl chloride concentrations in the groundwater posed health risks of a magnitude to warrant waste site remediation as specified by the EPA.

5.1.1 Identification of General Response Actions

In order to properly identify general response actions, it is first necessary to state site specific remedial action objectives. The remedial action objectives are developed for each site and represent quantitative cleanup goals for each species within each contaminated media. These objectives are then used to gauge the effectiveness of a remedial alternative in meeting the overall goal of protecting human health and the environment. While developing the specific remedial action goals, a discussion of the area of attainment will be presented.

5.1.1.1 Remedial Action Objectives - Site 8

The media contaminated at Site 8 is the groundwater from the shallow unconsolidated aquifer. Trichloroethene (TCE) is the only chemical species that will be investigated for remedial action in the upper aquifer groundwater at the site.

The specific remedial objectives for Site 8 are:

- Restore groundwater at the site for potential future use. This is accomplished by reducing TCE contamination in the groundwater from the upper aquifer to levels below 5 ppb. (The 5 ppb level is derived from the New York State Water Quality ARAR for TCE).
- Protect uncontaminated ground and surface water for future use. This is accomplished by eliminating the source of groundwater contamination. Since no apparent contamination of the soil remains at the site, this objective is satisfied by restoration of the groundwater for TCE.

Determining the area of attainment and groundwater characteristics at Site 8 is critical to evaluating remediation alternatives for the upper unconsolidated aquifer. Based on the spatial distribution of TCE and general characteristics of the unconsolidated sediments, it appears that the contamination has not moved significantly from the source site. Hydraulic conductivity values for the unconsolidated upper aquifer derived from previous regional studies range from 7.6 x 10^{-9} cm/sec (USGS, 1985) to 1.0 x 10^{-3} cm/sec (Johnston, 1964). The higher conductivity value was attributed to local sand layers within the sediments. Horizontal groundwater velocities (USGS, 1985) were calculated to range from 0.003 to 1.8 ft/yr. The rate of groundwater movement in the unconsolidated sediments at the nearby Buffalo Color Corp. was 0.02 to 0.06 ft/yr. Productivity of domestic and industrial wells from the shallow aquifer in the region are very low and are typically less than 100 gal/day.

The most comphrehensive groundwater study in the region was accomplished at Love Canal (Mercer et al., 1983). This study developed extensive groundwater flow modeling systems for the unconsolidated aquifer. In addition, the results from the modeling was compared against actual groundwater extraction systems. Hydraulic conductivities from the glacial till material from the unconsolidated aquifer was measured at 8 x 10-9 cm/s. This value is in accordance with previous studies which determined hydraulic conductivities to be in the range of 10-8 to 10-9 cm/s (Glaubinger et al., 1979). Additionally, the unconsolidated system can contain more permeable swales and sand bodies. These deposits can be derived from local events during the depositional process, or through man induced activities such as excavation and backfill. These swales/sand lenses effectively increase the hydraulic conductivity of the aquifer. Due to the influence of these areas of localized higher hydraulic conductivity, the average conductivity of the unconsolidated groundwater system is somewhat higher than values determined from point source well testing methods. Based on extensive modeling and comparisons with French drain flows, the shallow unconsolidated aquifer was characterized as having hydraulic conductivities in the range of 10-4 to 10-5 cm/s, with an effective porosity of 10 to 15% . The study concluded that groundwater velocities in the glacial till was approximately one foot/year with locally higher velocities possible in the more permeable sand and swale bodies.

Groundwater direction at the site is variable and based on seasonal factors. Groundwater movement during the Fall appears to move towards the east southeast. During the Spring, movement appears to be towards the southwest.

The extremely low groundwater velocities and variable groundwater flow directions within the upper aquifer indicate that the contamination has not moved significantly from the immediate vicinity of the drum storage yard. This is confirmed by the groundwater chemical analyses for TCE across the site. Wells 8-1 and 8-2 are the only wells having TCE values in excess of ARARs (190 ppb and 11 ppb respectively). These wells are immediately adjacent to the drum storage yard. The presence of TCE at a low level (1.7 ppb) in well 8-5 may not be associated with groundwater migration from the drum storage area. TCE may have been derived from surface runoff pathways. In addition, the absence of TCE in well 8-3 (directly between well 8-5 and the drum storage yard) further confirms the absence of a groundwater migration pathway.

Based on data from regional groundwater studies, and results obtained from the present study, contaminant migration rates are defined as approximately one foot/year for the unconsolidated aquifer at Site 8. Contaminant migration from the site, assuming introduction of contamination 15 years ago, would be 15 feet. The exact direction of the migration plume cannot be determined due to the variable flow direction. However, migration direction can be characterized as generally to the southeast and southwest.

Therefore, the area of attainment will be defined as the area surrounding the drum storage yard. This delineation would conservatively capture all contamination derived from past activities at the site. Specifically, the area is 75 feet wide (east-west direction) by 100 feet long (north-south direction), starts approximately 25 feet north of building 202, and surrounds wells 8-1, 8-2, 8-4, and 8-2D.

5.1.1.2 Remediation Action Objectives - Site 13

Contaminated media applicable to remedial investigations at Site 13 consists of groundwater of the shallow unconsolidated aquifer. The presence of vinyl chloride and benzene, in excess of New York State Drinking Water Quality ARARs, were encountered in wells at the site. The vinyl chloride is probably derived through sub-surface anaerobic transformations of chlorinated hydrocarbons such as TCE and 1,1 dichloroethane (DCE). Benzene contamination is associated with previous storage of petroleum products in the underground storage tanks.

Specific remedial objectives for Site 13 are:

- o Restore groundwater at the site for potential future use. This can be accomplished by reducing the concentrations of organic contaminants detedted at the site (vinyl chloride, methylene chloride, toluene, benzene, trichloroethylene, chlorobenzene, and 1,4-dichlorobenzene) to levels consistent with or below applicable New York State Groundwater Quality Standards.

vinyl chloride and non-detectable benzene goals are derived from the New York State Water Quality ARARs).

- Protect uncontaminated ground and surface water for future use. This is accomplished by removing the source of contamination at the site. Since no significant soil contamination remains at the site, this objective can be satisfied by restoring the groundwater for vinyl chloride and benzene.

The area of attainment for groundwater remediation for vinyl chloride and benzene at Site 13 is limited to the area immediately surrounding the site of the excavated underground storage tank. Wells placed downgradient, and approximately 150 feet from the former tank site, do not exhibit vinyl chloride or benzene contamination. As discussed for Site 8, hydraulic conductivity within the silty clays of the upper aquifer are extremely low, resulting in negligible groundwater and contaminant movement. Based on an average groundwater flow rate of one foot/year, contaminant migration over the last 15 years has resulted in a maximal migration of 15 feet from the source of contamination. It is therefore concluded that the Vinyl Chloride and Benzene have not moved appreciably from the vicinity of the former underground storage tank. Specifically, to capture all potential contamination, the area of attainment is 100'x 100', and completely surrounds the former underground storage tank site north of building 912.

5.1.1.3 General Response Actions for Sites 8 & 13

General response actions for Sites 8 & 13 consist of the following categories:

No Action -	The no action alternative serves as a baseline to compare the effectiveness of other remedial alternatives.
Natural Attenuation -	The natural attenuation alternative utilizes natural groundwater flushing mechanisms in conjunction with institutional controls to lower contamination levels and restrict potential access to the groundwater before cleanup.
Containment -	Containment options minimize the spread of the contaminant plume by intercepting and diverting groundwater flow around the contaminated strata .

Active Restoration -	Active restoration reduces contamination levels by removing, immobilizing, or transforming the offending chemicals in the groundwater. Response actions for active restoration will consist of collection and discharge, collection, treatment, and discharge, excavation and disposal, and in-situ treatment.

5.1.2 Identification of Potential Remedial Technologies

Potential remedial technologies for each general response action are compiled for each contaminated media. Since groundwater is the only contaminated media, potential remedial technologies are applicable to both Site 8 and Site 13. In addition, remedial technologies applicable to organic contamination are only discussed.

The remedial technologies for the response actions are presented in Table 5-1.

5.1.3. Initial Screening of Possible Remedial Technologies

The remedial technologies identified in the preceding section are screened to remove inapplicable and infeasible technologies. Criteria used for the elimination of a specific technology is based on site and waste characteristics as well as technical requirements.

The screening of remedial technologies has been performed separately for Site 8 and Site 13. This approach allows for focused and site specific remediation plans that are tailored to waste and site characteristics.

5.1.3.1 Initial screening of technologies - Site 8

Table 5-2 is a summary of the initial technology screening exercise for Site 8.

The No Action general response action is included in all assessments as a baseline in which to compare all other remedial alternatives.

Natural attenuation utilize institutional controls, such as deed restrictions, in conjunction with monitoring technologies. This allows natural

TABLE 5-1

IDENTIFICATION OF REMEDIAL TECHNOLOGIES

Groundwater General Response Action	*General Technology*	*Specific Technology*	*Technology Description*
NO ACTION	NONE	NONE	No action required Serves as baseline
NON-CLEANUP	DEED RESTRICTS.	DEED RESTRICTS.	Restriction of groundwater use and denial of well permits
	MONITORING	MONITORING	Monitor progress of naturally attenuated remediation
CONTAINMENT	CAPS	MULTI LAYERED	Combination of vegetative layer, sand, and synthetic membrane
		SINGLE LAYERED	Single component such as cement or asphalt
	SUBSURFACE BARRIERS	SLURRY WALLS	Vertical trench excavated under a slurry
		GROUTED BARRIERS	Injection of grout to strengthen the formation
		SHEET PILING	Pilings of wood, steel, or concrete
		BOTTOM SEALING	Grouting or block displacement to form a horizontal bottom seal
COLLECTION DISCHARGE	EXTRACTION WELLS	EXTRACTION WELLS	Pumping wells to extract groundwater
		EXTRACTION/ INJECTION	Pumping wells to extract with injection wells for flushing
	SUBSURFACE DRAINS	INTERCEPTOR DRAINS	Subsurface drainage installed perpendicular to groundwater flow
		RELIEF DRAINS	Subsurface drains installed parallel to flow or around the perimeter
	ONSITE DISCHARGE	SURFACE WATER	Discharge untreated groundwater to surface water bodies onsite
	OFFSITE DISCHARGE	OFFSITE TREATMENT	Transport and treat contaminated groundwater at offsite facility
		POTW	Discharge untreated groundwater to POTW
		SURFACE WATER	Discharge untreated groundwater to offsite surface water
EXCAVATION/ DISPOSAL		EXCAVATION	Excavate unconsolidated overburden including the saturated zone
		DISPOSAL	Dispose soils (including contaminated porewaters) in treatment and disposal facility

TABLE 5-1 (continued)

IDENTIFICATION OF REMEDIAL TECHNOLOGIES

Groundwater General Response Action	*General Technology*	*Specific Technology*	*Technology Description*
COLLECTION TREATMENT DISCHARGE	EXTRACTION WELLS	EXTRACTION WELLS	Pumping wells to extract groundwater
		EXTRACTION/ INJECTION	Pumping wells to extract with injection wells for flushing
	SUBSURFACE DRAINS	INTERCEPTOR DRAINS	Subsurface drainage installed perpendicular to groundwater flow
		RELIEF DRAINS	Subsurface drains installed parallel to flow or around the perimeter
	BIOLOGICAL	AEROBIC	Transformation of organics via aerobic microorganisms
		ANAEROBIC	Transformation of organics via anaerobic microorganisms
	PHYSICAL	AIR STRIPPING	Removal of VOCs in groundwater by transfer to gaseous phase
		STEAM STRIPPING	Removal of low VOCs by steam
		CARBON ADSORPTION	Adsorption of of certain organic onto activated carbon
		MEMBRANES	Concentration of organic and inorganic species by reverse osmosis or ultrafiltration
	CHEMICAL	OXIDATION	Destruction of organics by oxidation using ozone/UV or ozone/peroxide
	ONSITE DISCHARGE	SURFACE WATER	Discharge treated groundwater to surface water bodies onsite
	OFFSITE DISCHARGE	POTW	Discharge treated groundwater to POTW
		SURFACE WATER	Discharge treated groundwater to offsite surface water
IN-SITU TREATMENT	BIO-RECLAMATION	AEROBIC	In-situ stimulation and enhancement of aerobic degradative processes
		ANAEROBIC	In-situ stimulation and enhancement of anaerobic degradative processes
	CHEMICAL	IMMOBIL.	Subsurface immobilization of contamination
		SOIL WASHING	Mobilization and extraction of subsurface contaminants

TABLE 5-2

INITIAL SCREENING OF TECHNOLOGIES - SITE 8

Groundwater General Response Action	*General Technology*	*Specific Technology*	*Selection Criteria*
NO ACTION	NONE	NONE	Required as baseline
NON-CLEANUP	DEED RESTRICTS.	DEED RESTRICTS.	Potentially applicable
	MONITORING	MONITORING	Potentially applicable
▨ CONTAINMENT	▨ CAPS	▨ MULTI LAYERED	Inapplicable. Capping is unnecessary due to lack of soil contamination.
		▨ SINGLE LAYERED	
	▨ SUBSURFACE BARRIERS	▨ SLURRY WALLS	Barriers to inhibit contaminant movement are unnecessary at this site. Groundwater movement is extremely slow and does not threaten any drinking water or surface water.
		▨ GROUTED BARRIERS	
		▨ SHEET PILING	
		▨ BOTTOM SEALING	
COLLECTION DISCHARGE	▨ EXTRACTION WELLS	▨ EXTRACTION WELLS	Permeabilities of the upper aquifer are too low to technologically utilize pumping methods.
		▨ EXTRACTION/ INJECTION	
	SUBSURFACE DRAINS	INTERCEPTOR DRAINS	Potentially applicable
		RELIEF DRAINS	Potentially applicable
	ONSITE DISCHARGE	SURFACE WATER	Potentially applicable
	OFFSITE DISCHARGE	OFFSITE TREATMENT	Potentially applicable
		POTW	Potentially applicable
		SURFACE WATER	Potentially applicable
EXCAVATION/ DISPOSAL		EXCAVATION	Potentially applicable
		DISPOSAL	Potentially applicable

▨ = *Eliminated Technology*

TABLE 5-2 (continued)

INITIAL SCREENING OF TECHNOLOGIES - SITE 8

Groundwater General Response Action	*General Technology*	*Specific Technology*	*Selection Criteria*
COLLECTION	▨ EXTRACTION WELLS	▨ EXTRACTION WELLS ▨ EXTRACTION/ INJECTION	Permeabilities in the upper aquifer are too low to technologically utilize pumping methods
	SUBSURFACE DRAINS	INTERCEPTOR DRAINS	Potentially applicable
		RELIEF DRAINS	Potentially applicable
TREATMENT	▨ BIOLOGICAL	▨ AEROBIC ▨ ANAEROBIC	Biological methods have not been demonstrated effective for chlorinated hydrocarbons
	PHYSICAL	AIR STRIPPING	Potentially applicable
		▨ STEAM STRIPPING	Not necessary due to volatility of TCE
		CARBON ADSORPTION	Potentially applicable
		MEMBRANES	Potentially applicable
	CHEMICAL	OXIDATION	Potentially applicable
DISCHARGE	ONSITE DISCHARGE	SURFACE WATER	Potentially applicable
	OFFSITE DISCHARGE	POTW	Potentially applicable
		SURFACE WATER	Potentially applicable
▨ IN-SITU TREATMENT	▨ BIO-RECLAMATION	▨ AEROBIC ▨ ANAEROBIC	Not feasible due to low permeability of aquifer which would inhibit introduction of remediating agents
	▨ CHEMICAL	▨ IMMOBIL. ▨ SOIL WASHING	

▨ = *Eliminated Technology*

attenuative processes to reduce contamination. These technologies were retained as viable because of the moderate TCE concentration and its well confined nature in the groundwater. In addition, there is no immediate or long term potential threat to existing useable groundwater systems. This is due to the extremely low migration rates of the contaminants and the great distance to any viable groundwater system.

Containment technologies were ruled out based on the nature of the waste and site characteristics. Capping technologies were deemed inapplicable because of the lack of the need to inhibit vertical groundwater flushing of the surficial soils. Soil boring analyses revealed no evidence of excessive residual contamination in the soil. The use of subsurface barriers to halt contaminant migration is unnecessary due to the low hydraulic conductivity in the groundwater zone. Reported hydraulic conductivities in the upper aquifer are extremely low and approach values for commercially acceptable barrier materials.

For the collection/discharge general response action, extraction wells were eliminated due to site characteristics. The low permeabilities of the aquifer negate the technical practicality of pumping wells as an extraction technology.

The excavation/disposal general response action, usually reserved for soil remediation, is being considered as a groundwater remedial technology because of the limited areal contamination and relatively shallow aquifer depth at the site.

For the collection/treatment/discharge general response action, extraction wells are eliminated based on aquifer characteristics. Biological treatment technologies are eliminated due to waste characteristics, and steam stripping is unnecessary due to the relatively high volatility of TCE.

All in-situ remediation technologies are not being considered based on site characteristics. The low permeabilities of the upper aquifer would physically impede remediating agents, significantly reducing the effectiveness of these technologies.

5.1.3.2 Initial screening of technologies - Site 13

Table 5-3 is a summary of the initial screening of technologies for Site 13.

As discussed in the previous section, containment technologies are either inapplicable or unnecessary due to waste and site characteristics, and extraction wells and in-situ treatment are not feasible due to the low permeability of the upper aquifer.

For the collection/discharge response action, onsite discharge and discharge to offsite POTW facilities or surface waters for the untreated groundwater are not being considered because of the high Vinyl Chloride concentration and its extreme toxicity.

The excavation/disposal general response action at Site 13 is eliminated because of the complexity of utility services resulting in excessive cost and logistic problems.

For treatment technologies, biological treatment has not been demonstrated as being effective on chlorinated compounds, and steam stripping is not necessary due to the extremely high volatility of Vinyl Chloride.

In-situ treatments are not feasible due to the low permeability of the aquifer.

5.1.4 Identification of Remedial Technologies

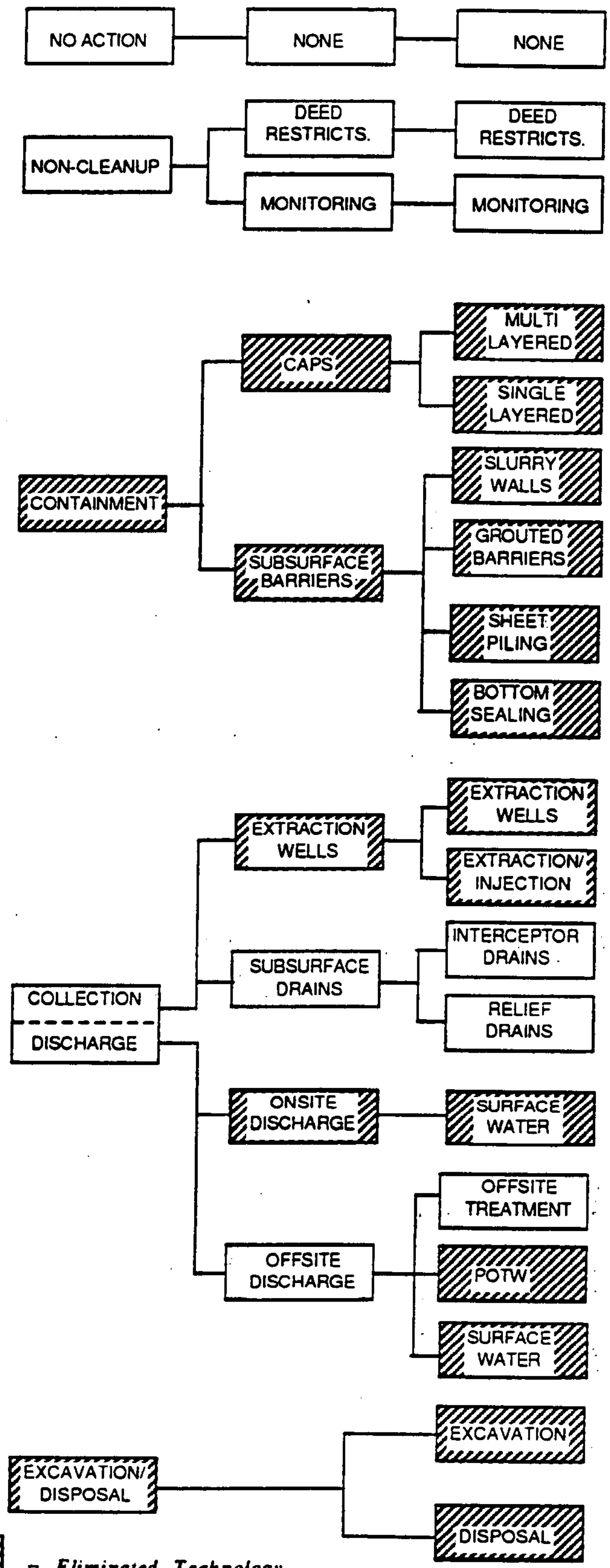
In order to efficiently develop remedial alternatives, it is necessary, when appropriate, to select specific technologies from each general technology category. Selection is based on effectiveness of the technology and implementability. The identification of remedial technologies for each site are examined separately.

5.1.4.1 Identification of remedial technologies - Site 8

The final screening and selection of technologies is presented in Table 5-4 for Site 8.

TABLE 5-3

INITIAL SCREENING OF TECHNOLOGIES - SITE 13



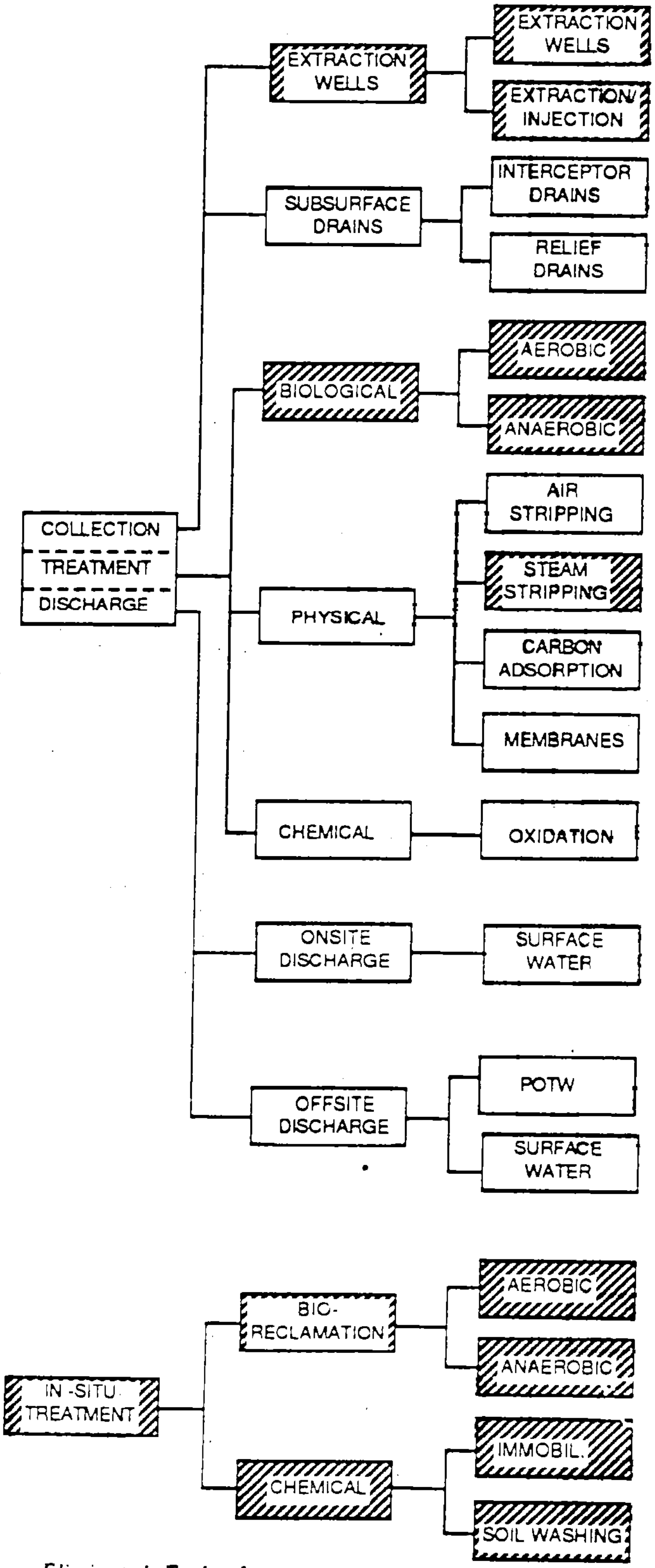
Groundwater General Response Action	*General Technology*	*Specific Technology*	*Selection Criteria*
NO ACTION	NONE	NONE	Required as baseline
NON-CLEANUP	DEED RESTRICTS.	DEED RESTRICTS.	Potentially applicable
	MONITORING	MONITORING	Potentially applicable
▨ CONTAINMENT	▨ CAPS	▨ MULTI LAYERED	Inapplicable. Capping is unnecessary due to lack of soil contamination.
		▨ SINGLE LAYERED	
	▨ SUBSURFACE BARRIERS	▨ SLURRY WALLS	Barriers to inhibit contaminant movement are unnecessary at this site. Groundwater movement is extremely slow and does not threaten any drinking water or surface water.
		▨ GROUTED BARRIERS	
		▨ SHEET PILING	
		▨ BOTTOM SEALING	
COLLECTION DISCHARGE	▨ EXTRACTION WELLS	▨ EXTRACTION WELLS	Permeabilities of the upper aquifer are too low to technologically utilize pumping methods.
		▨ EXTRACTION/ INJECTION	
	SUBSURFACE DRAINS	INTERCEPTOR DRAINS	Potentially applicable
		RELIEF DRAINS	Potentially applicable
	▨ ONSITE DISCHARGE	▨ SURFACE WATER	Not feasible due to potentially high concentrations of Vinyl Chloride
	OFFSITE DISCHARGE	OFFSITE TREATMENT	Potentially applicable
		▨ POTW	Not feasible due to potentially high concentrations of Vinyl Chloride
		▨ SURFACE WATER	Not feasible due to potentially high concentrations of Vinyl Chloride
▨ EXCAVATION/ DISPOSAL		▨ EXCAVATION	Not feasible due to utility services and logistic problems
		▨ DISPOSAL	

▨ = *Eliminated Technology*

TABLE 5-3 (continued)

INITIAL SCREENING OF TECHNOLOGIES - SITE 13

Groundwater General Response Action | *General Technology* | *Specific Technology* | *Selection Criteria*



Permeabilities in the upper aquifer are too low to technologically utilize pumping methods

Potentially applicable

Potentially applicable

Biological methods have not been demonstrated for chlorinated organics. Technologically unsuitable for the low levels of Benzene encountered

Potentially applicable

Not necessary due to volatility of Vinyl Chloride

Potentially applicable for Benzene removal. Not applicable for Vinyl Chloride

Potentially applicable

Potentially applicable

Potentially applicable

Potentially applicable

Potentially applicable

Not feasible due to low permeability of aquifer which would inhibit introduction of remediating agents

▨ = *Eliminated Technology*

TABLE 5-4

FINAL SCREENING AND SELECTION OF TECHNOLOGIES - SITE 8

Groundwater General Response Action	*General Technology*	*Specific Technology*	*Selection Comments*
NO ACTION	NONE	NONE	The No Action general response action serves as a baseline.
NON-CLEANUP	DEED RESTRICTS.	DEED RESTRICTS.	Both deed restrictions and monitoring are necessary actions for the Non-Cleanup general response action.
	MONITORING	MONITORING	
COLLECTION / DISCHARGE	SUBSURFACE DRAINS	▨ INTERCEPTOR DRAINS	Relief drains were chosen as the collection technology because of the need to surround the contamination at the site.
		RELIEF DRAINS	
	▨ ONSITE DISCHARGE	▨ SURFACE WATER	
	OFFSITE DISCHARGE	OFFSITE TREATMENT	Treatment of the extracted groundwater at an offsite treatment facility.
		▨ POTW	
		▨ SURFACE WATER	
EXCAVATION/ DISPOSAL	EXCAVATION		Both soil excavation and disposal are needed to fulfill the general response action.
	DISPOSAL		
COLLECTION / TREATMENT / DISCHARGE	SUBSURFACE DRAINS	▨ INTERCEPTOR DRAINS	Relief drains were chosen as the collection technology because of the need to surround the contamination at the site.
		RELIEF DRAINS	
	PHYSICAL	▨ AIR STRIPPING	Carbon adsorption was chosen as a representative of physical treatment technologies. It was selected over air stripping because of the small predicted volumes of water that will be generated and its ease of scaling down to small volumes. Membrane technologies were not selected because of extensive pre-treatment requirements, and poor effectiveness at low contaminant concentrations.
		CARBON ADSORPTION	
		▨ MEMBRANES	
	CHEMICAL	OXIDATION	
	ONSITE DISCHARGE	SURFACE WATER	Onsite discharge of the treated water was chosen as the disposal technology. The treatment technologies chosen would lower contamination levels to appropriate levels for surface discharge.
	▨ OFFSITE DISCHARGE	▨ POTW	
		▨ SURFACE WATER	

▨ = *Eliminated Technology*

For the collection/discharge general response action, relief drains and offsite discharge to a POTW was retained. Relief drains were chosen because of the need to surround the site due to the variability in the direction of groundwater movement. Discharge to a POTW was deemed feasible because of the moderate TCE concentrations and moderate volumes of water.

For the collection/treatment/discharge general response action, relief drains were retained as the collection technology, carbon adsorption and chemical oxidation as treatment technologies, and discharge to surface waters as the discharge option.

Carbon adsorption was chosen over air stripping based on the predicted small rates and volumes of groundwater that would be generated. Carbon adsorption can be easily and economically scaled to any volume. Membrane processes were eliminated because of extensive pre-treatment requirements and poor recoveries at low solute concentrations.

5.1.4.2 Final screening and selection of technologies - Site 13

The final screening and selection of technologies for Site 13 are presented in Table 5-5.

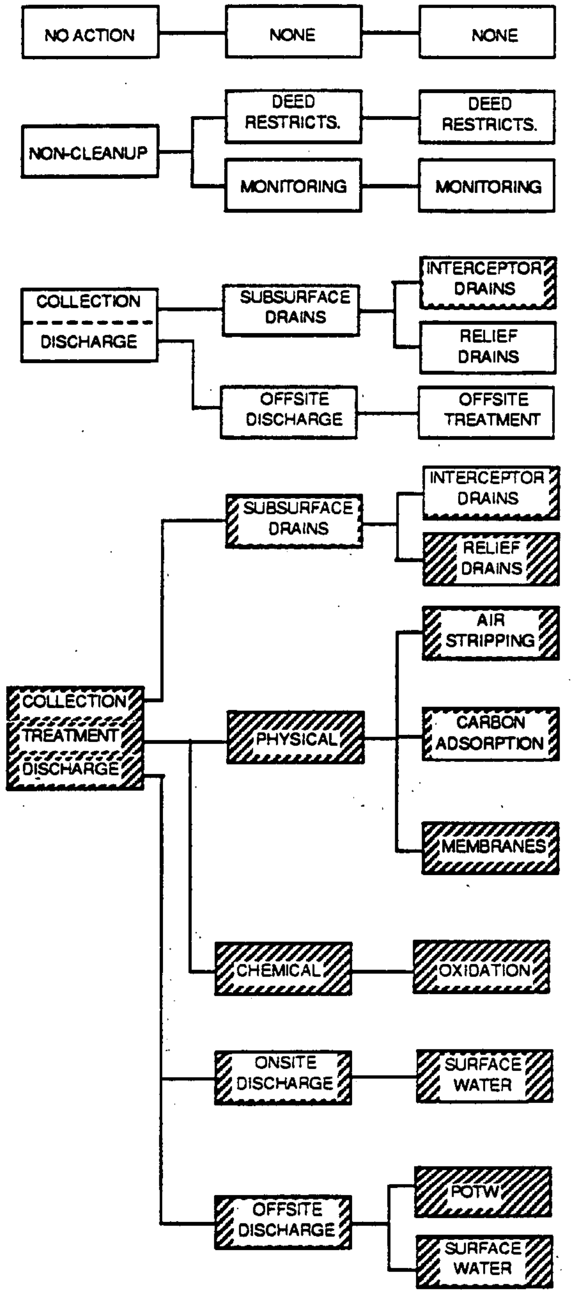
For the collection/discharge general response action, relief drains were chosen as the collection technology. By surrounding the old underground storage tank site, complete drainage of all contaminated groundwater can be assured. The collected groundwater could then be transported offsite and treated for Vinyl Chloride and Benzene contamination.

All technologies based on onsite treatment of the extracted groundwater are being eliminated based on site and waste characteristics. The low extraction rates for the site render air stripping technically infeasible. Long term accumulation and storage of the Vinyl Chloride contaminated groundwater, as would be necessary for on site treatment, is impractical due to its volatility and toxicity as a potential impact on human and environmental safety. Membrane processes and chemical oxidation have not been demonstrated as effective in treating groundwater contaminated with Vinyl Chloride.

TABLE 5-5

FINAL SCREENING AND SELECTION OF TECHNOLOGIES - SITE 13

Groundwater General Response Action | ***General Technology*** | ***Specific Technology*** | ***Selection Comments***



The No Action General response action serves as a baseline.

Both deed restrictions and monitoring are necessary actions for the Non-Cleanup general response action.

Relief drains were chosen as the collection technology, based on perimiterizing the old underground storage tank site.

Offsite treatment of the groundwater is the only remedial technology applicable to this alternative.

All onsite treatment technologies are being eliminated based on site and waste characteristics.

The site characteristics include low groundwater delivery rates. These low rates render onsite treatment technologies impractical due to scaling problems and waste storage requirements.

Waste characteristics include the high volatility and toxicity of Vinyl Chloride. These factors increase personal safety and environmental risks if onsite treatment is utilized.

▨ = *Eliminated Technology*

5.1.5 Description of Remedial Alternatives

The technologies identified and screened for the general response actions in the previous sections are assembled into a range of remedial alternatives. The purpose of developing alternatives is to evaluate several remediation options in terms of effectiveness, technical feasibility, health and safety, and cost.

The first step in describing remedial alternatives is to assemble the alternatives based on the screened technologies. The remedial alternatives can then be described in terms of the technological elements. Assemblage and description of alternatives will be presented separately for sites 8 and 13.

5.1.5.1 Assemblage and Description of Alternatives - Site 8

The medium targeted for remediation at Site 8 is the groundwater from the upper unconsolidated aquifer. As discussed in previous sections, it has been demonstrated through regional groundwater studies and contaminant distribution over the site, that contaminant movement is minimal and confined to the immediate area around the drum storage yard. Based on these observations, the groundwater contaminated zone is being defined as a 75' x 100' area. This converts to an area of 7500 square feet. Assuming an average aquifer thickness of 1.5 feet and a porosity of approximately 15%, the total volume of contaminated groundwater at the site is 14,000 gallons.

Table 5-6 illustrates the assemblage of remedial alternatives for Site 8.

The following sections are descriptions of each remedial alternative.

Alternative 1 - No Action

The no action remedial alternative serves as a baseline to compare other alternatives. Under this alternative, no remedial actions or controls are undertaken.

Alternative 2 - Natural Attenuation

This alternative allows natural processes to reduce groundwater contamination over time. These mechanisms include dispersion of the contaminants during migration, complexation and immobilization on inorganic media, and

TABLE 5-6

ASSEMBLAGE OF REMEDIAL ALTERNATIVES - SITE 8

REMEDIAL TECHNOLOGY	*ALTER. 1 NO ACTION*	*ALTER. 2 NON-CLEANUP*	*ALTER. 3 DRAIN COLLECTION/ DISCHARGE TO POTW*	*ALTER 4 EXCAVATION/ DISPOSAL*	*ALTER 5 COLLECTION/ CARBON TREATMENT/ DISCHARGE*	*ALTER 6 COLLECTIO/ OXIDATION TREATMENT/ DISCHARGE*
No Action	*					
Deed Restrictions		*	*		*	*
Monitoring		*	*		*	*
Subsurface Drains			*		*	*
Offsite Treatment			*			
Discharge Surface					*	*
Excavation Disposal				*		
Carbon Adsorption					*	
Chemical Oxidation						*

biological transformations. Implementation of this alternative requires institutional controls such as groundwater deed restrictions and groundwater monitoring to track contaminant attenuation.

Alternative 3 - Subsurface Drain Collection/Discharge to Offsite Treatment Facility

Alternative 3 involves collection of contaminated groundwater by surrounding the waste site with a 130 foot square drain collection system. The collected groundwater would then be transportrd to a regional offsite treatment facility.

Alternative 4 - Excavation/Disposal

This alternative involves the excavation of overburden soils and the unconsolidated aquifer silty clays, transportation and disposal of the soils, and fill with clean materials. These remedial measures are usually applied to contaminated soils. However, several factors make this alternative attractive to groundwater remediation. First, the area of contamination is small (7500 sq. feet) and depth to the bottom of the aquifer is relatively shallow (average 14 feet), yielding a total excavation volume of 100,000 cubic feet or approximately 7,000 tons of soil. Second, based on contamination levels for soil, 90% of the excavated soil can be treated as non-hazardous. Third, this alternative results in immediate remediation.

Alternative 5 - Subsurface Drain Collection/Carbon Adsorption Treatment/Discharge to Surface Waters

This alternative utilizes subsurface drainage to collect contaminated groundwater, onsite treatment with activated carbon to remove TCE concentrations to below 5 ppb, and discharge of the treated water to surface waters.

Alternative 6 - Subsurface Drain Collection/Oxidative Destruction/Discharge to Surface Waters

Alternative 6 involves collection of groundwater with subsurface drains, onsite chemical treatment with oxidative technologies such as combinations of UV light, hydrogen peroxide, and ozone, and discharge of the treated water to surface waters.

5.1.5.2 Assemblage and Description of Alternatives - Site 13

Contaminated groundwater from the shallow unconsolidated aquifer is the subject of remedial alternatives at Site 13. Based on the low permeabilities of the aquifer, in conjunction with the contamination profile across the site, groundwater contamination is limited to the area immediately adjacent to the excavated underground storage tank. An area of approximately 10,000 sq. ft. (100' x 100') surrounding the tank storage area will be treated. This converts to approximately 18,000 gallons of groundwater, asuming an average aquifer (saturated zone) thickness of 1.5 feet, and a porosity of 15%.

Table 5-7 illustrates the assemblage of remedial alternatives for Site 13.

The following sections are descriptions of each remedial alternative.

Alternative 1 - No Action

The no action remedial alternative serves as a baseline to compare other alternatives. Under this alternative, no remedial actions or controls are undertaken.

Alternative 2 - Natural Attenuation

This alternative allows natural processes to reduce groundwater contamination over time. These mechanisms include dispersion of the contaminants during migration, complexation and immobilization on inorganic media, and biological transformations. Implementation of this alternative requires institutional controls such as groundwater deed restrictions and groundwater monitoring to track contaminant attenuation.

Alternative 3 - Subsurface Drain Collection/Offsite Treatment

Alternative 3 involves collection of contaminated groundwater via a subsurface drain system of 150 linear feet, temporary storage of contaminated groundwater in an appropriately designed containment system, and periodic transportation to an offsite treatment facility.

TABLE 5-7

ASSEMBLAGE OF REMEDIAL ALTERNATIVES - SITE 13

REMEDIAL TECHNOLOGY	*ALTER. 1 NO ACTION*	*ALTER. 2 NON-CLEANUP*	*ALTER. 3 DRAIN COLLECTION/ OFFSITE TREATMENT*
No Action	*		
Deed Restrictions		*	*
Monitoring		*	*
Subsurface Drains			*
Offsite Treatment			*

5.2 INITIAL SCREENING OF ALTERNATIVES

The remedial alternatives developed during the Phase I feasibility study are screened to eliminate those that are infeasible based on effectiveness, implementability, and cost.

The initial screening of alternatives will be undertaken separately for Sites 8 and 13.

5.2.1 Alternative 1 - Site 8: No Action

The no action alternative does not actively reduce TCE contamination in the groundwater to below values of 5 ppb, nor take steps to reduce contact with the contaminated groundwater, nor monitor the movement and direction of the contamination. This alternative does not provide protection to human health and the environment. Implementation of the no action alternative does not impose any additional human or environmental risks. There is no additional costs associated with the implementation of the no action alternative.

The purpose of the no action alternative in the feasibility study is as a baseline on which to measure other remedial alternatives.

5.2.2 Alternative 2 - Site 8: Natural Attenuation

This remedial alternative relies on natural processes within the subsurface environment, in conjunction with institutional controls and monitoring, to attenuate TCE contamination over time.

In particular, natural attenuation relies on advection and dispersion of contamination, in conjunction with adsorption and degradative microbiological processes, to reduce the concentration and toxicity of organic species in groundwater. In this alternative, these natural processes would reduce the concentration and toxicity of the groundwater over time. Deed restrictions would control the present and future use of the aquifer so as to eliminate the potential ingestion of groundwater. Periodic monitoring of the groundwater through the existing well system will assess contaminant attenuation and track contamination migration.

5.2.2.1 Effectiveness

Deed restrictions on groundwater usage would reduce risks of short-term ingestion. Long-term human health reduction would be dependent on the rate and magnitude of natural attenuative processes. There are no nearby aquifers that are being utilized as drinking water sources, therefore, there is little risk of future contamination by migration. There are no additional risks associated with implementation of this alternative. Under this alternative, TCE could be destroyed by subsurface natural microbiological populations, however, the time required for destruction would be greater than for active remedial activities. In addition, there is the possibility that the TCE could be biologically transformed into more toxic species such as vinyl chloride.

5.2.2.2 Implementability

There are no limiting technical requirements for implementation of this alternative. Groundwater samples would be acquired through the existing monitoring well system. Analysis activities do not pose any technical barriers.

5.2.2.3 Cost

Cost associated with implementation of this alternative is derived from labor for sampling of groundwater, and analysis of the groundwater for volatile compounds. Based on a semi-annual monitoring program consisting of groundwater collection at one deep well and three shallow down gradient wells, and analysis for volatile compounds, annual costs would be $2,600.

5.2.3 Alternative 3 - Site 8: Subsurface Drain Collection/ Offsite Treatment

One of the active restoration remedial alternatives is to extract the groundwater through a subsurface drain system, and transport the waters to an offsite treatment facility. As discussed earlier, a subsurface drain system is needed due to the low hydraulic conductivity of the unconsolidated aquifer. Based on the available areal distribution of TCE contamination, a subsurface drain system of 130 linear feet is proposed. During the implementation and remediation stages, deed restrictions on groudwater utilization will temporarily prevent the ingestion of groundwater.

Accumulation of the extracted water onsite would be necessary in an appropriately designed storage tank. Treatment and destruction of the TCE would be accomplished at an offsite facility.

5.2.3.1 Effectiveness

Short term protection against groundwater ingestion is provided through the mechanism of deed restrictions. This action would prevent the utilization and ingestion of groundwater from the contaminated aquifer. It is important to note thet the contaminated aquifer at Site 8 is not presently utilized as a drinking water source and is not endangering any known water source in the area.

Minor environmental and public health risks are associated with this alternative and originate during the storage and transportation of contaminated groundwater. Accumulation of groundwater onsite poses a slight environmental and public health risk. Design of a proper storage vessel, with appropriate emission controls, will minimize potential environmental release. Transportation risks can be minimized by reducing travel distance to the treatment facility. There is a suitable treatment facility adjacent to the Base and within 2 miles.

Long-term effectiveness of this remedial alternative will result in the comtainment of further migration of TCE in the groundwater from the unconsolidated aquifer at the site. This is accomplished by extraction of water by the susbsurface drainage system. This alternative significantly reduces the toxicity and mobility of TCE at the site by contaminant removal. Based on a random walk model for contaminant removal, it should require approximately 12 years for restoration of the groundwater for TCE to levels below the ARAR of 5 ppb.

5.2.3.2 Implementability

There are no significant technical or administrative barriers that would impact the implementation of this alternative. All activities, including trench excavation, drain placement, groundwater pumping, storage, transportation, and treatment are technically and administratively feasible.

5.2.3.3 Cost

The cost of the subsurface drainage groundwater extraction system is estimated to be $15,000. This includes trench excavation, filter fabrics, gravel, piping, sumps, and a pumping system. Treatment, transportation, and monitoring costs over the life of the project are estimated to be $60,000, assuming a remedial time frame of 12 years. This would bring the total cost of this remedial alternative to $75,000.

5.2.4 Excavation/Disposal

The excavation and disposal alternative remedial action is an unorthodox approach for groundwater remediation. However, due to site and waste characteristics, it merits further consideration.

Basically, this remedial alternative involves excavation of all soils contained within the contaminated 100' x 75' area. This action would remove the aquifer, including the TCE contaminated groundwater within the pores of the aquifer. Disposal of the soils overlying the contaminated aquifer could be handled as non-hazardous. Disposal of the contaminated saturated soils of the aquifer would be disposed offsite as hazardous. Clean backfill would be utilized to cover the excavated pit. The alternative is attractive because of the elimination of a complex groundwater extraction system, necessitated due to low aquifer permeabilities. In addition, remediation would be rapid.

The plan calls for a two phase excavation and disposal process. Soils above and up to the aquifer will be excavated and disposed of as non-hazardous waste. The estimated depth to the top of the aquifer is 12.5 feet, resulting in a total weight of 5400 tons. The groundwater aquifer (1.5 feet above bedrock) will then be excavated and disposed of as a hazardous waste. Total weight for this interval will be approximately 750 tons.

5.2.4.1 Effectiveness

The remedial option is effective in the short and long-term by immediately removing the contaminated groundwater.

Excavation of the soils above the shallow unconsolidated aquifer do not pose any significant environmental hazards assuming that there are no residual soil contamination hot spots. Excavation and handling of soils from the groundwater aquifer would require special safety measures.

The expedient remediation of the site under this alternative has positive public health and environmental benefits. In comparison to groundwater extractive methods, the excavation/disposal plan would virtually immediately restore the site.

However, due to the unorthodox approach, success cannot be assured. In addition, an accurate delineation of the contaminant plume is necessary for assured remediation.

5.2.4.2 Implementability

The only technical or logistic impediments to this alternative would be the presence of significant underground utilities in the area. In addition, other structures at the site might render excavation logistically infeasible.

5.2.4.3 Cost

Cost for excavation/disposal and backfilling of the non-hazardous soils above the aquifer is estimated at $470,000.
Cost for excavation/disposal and backfill of the hazardous aquifer soils is estimated at $200,000. Total remediation costs for this alternative are estimated at $670,000.

5.2.5 Alternative 5 - Site 8: Subsurface Drain Collection/ Carbon Adsorption/ Discharge to Surface Waters

This active restoration remedial alternative utilizes a subsurface drainage collection system which supplies contaminated groundwater to an onsite, Granulated Activated Carbon (GAC) adsorption unit. The treated waters can then be discharged, with the necessary permits, to surface waters on the base. During implementation and remediation, deed restrictions will eliminate the possibility of utilization and ingestion of groundwater.

The subsurface collection system was described in Section 5.2.3 under Remedial Alternative 3.

A groundwater monitoring program must also be established to gauge the effectiveness and rate of the remedial action.

5.2.5.1 Effectiveness

Short-term effectiveness of the remedial alternative is provided through the imposition of deed restrictions. This action serves to eliminate the risks of utiization and ingestion of groundwater at or around the site during the implementation and remedial phases of the project.

There is only a slight potential environmental and health risk associated with implementation of this remedial alternative. These risks originate from storage of the groundwater and onsite treatment by GAC.

Risks associated with the treatment are minimal and originate from the fact that the TCE **is** not destroyed by this process, but adsorbed and concentrated on the GAC. Precautions must be taken in the unlikely event of carbon loss from the system.

Long-term effectiveness of this remedial alternative will result in the comtainment of further migration of TCE in the groundwater from the unconsolidated aquifer at the site. This is accomplished by extraction of water by the susbsurface drainage system. This alternative significantly reduces the toxicity and mobility of TCE at the site by contaminant removal. Complete restoration of the aquifer to ARAR levels (< 5 ppb TCE) should occur in approximately 12 years.

5.2.5.2 Implementability

Activated carbon technology for aqueous waste streams is a reliable and effective method for removing organics. It has been repeatedly demonstrated effective for remediating TCE contaminated waters over a large concentration range (5ug/L to 16 mg/L) to effluent concentrations of less than 1 ug/L.

The process operates by adsorption (molecular attraction) of an organic species to the surface of the carbon. The degree of attraction is dependent on the characteristics of the organic species (hydrophilicity, molecular weight) and other organic and inorganic species which may compete with available binding sites. When the surface structure of the activated carbon is saturated, the carbon must be regenerated or replaced. Regeneration is usually accomplished through thermal desorption and destruction at an offsite facility. Under this proposal, spent carbon cartridges would be replaced with fresh material.

A design based on groundwater accumulation rates between around 10 gallons per day (based on regional studies and modeling) is proposed. The system would consist of two 12" diameter by 48" long carbon modules, preceded by a media filtration module to remove organic and inorganic particulate materials. Appropriate sampling valves and plumbing will also be provided. Effluent monitoring would be required to comply with discharge requirements, and to determine a carbon changeout schedule.

Implementation of this alternative also requires permitting to treat the groundwater onsite as well as discharge the treated groundwater to surface waters.

5.2.5.3 Cost

Costs associated with this remedial alternative include a subsurface-drainage collection system, GAC treatment unit, and monitoring program.

Costs associated with the subsurface drain and GAC system are $25,000. GAC replacement costs and monitoring costs over the life of the 12 year project are approximately $60,000. Total costs for the project are estimated to be $85,000.

5.2.6 Alternative 6 - Site 8: Subsurface Drain Collection/ Oxidative Destruction/ Discharge to Surface Waters

This alternative utilizes subsurface drains as the collection technology, followed by treatment and destruction of the TCE in the groundwater by oxidation, and discharge of the treated water to the surface waters.

Oxidative processes are defined in this context as a technique which can destroy organic contaminants (in particular TCE) through the use of singular or combinations of the following technologies: UV irradiation, ozone treatment, hydrogen peroxide treatment.

The major advantage of oxidative processes is that the organic contaminant is destroyed as compared to phase exchange processes such as air stripping and carbon adsorption.

Oxidative processes have not been fully proven as an applicable groundwater treatment technology. Problems associated with these techniques include the fouling of UV lamps, high energy costs of ozone generators, and the safety, handling, and decontamination of hydrogen peroxide. Because of these limitations, oxidative processes will not be further evaluated as part of this Feasibility Study.

5.2.7 Alternative 1 - Site 13: No Action

The no action remedial alternative at Site 13 does not actively reduce vinyl chloride and benzene contamination in the groundwater to values below 2 ppb, and 0.7 ppb respectively. The no action alternative does not provide measures to effectively eliminate or reduce present and future ingestion of contaminated groundwaters. Implementation of the no action alternative does not impose any costs. The no action alternative will not create any additional health and environmental hazards.

The purpose of the no action alternative is to serve as a baseline upon which to measure other remedial options.

5.2.8 Alternative 2 - Site 13: Natural Attenuation

This alternative relies on natural subsurface processes to attenuate contamination by advective and biological means. The natural attenuation alternative utilizes deed restrictions to insure the present and future prohibition of groundwater utilization at the site. Monitoring is used to ascertain the movement of the plume and warn of potential contamination of adjacent groundwater and surface water sources that may negatively impact on human and environmental safety.

The natural attenuation alternative does not actively achieve reduction of vinyl chloride concentrations to less than 2 ppb, and benzene concentrations to less than 0.7 ppb. Natural attenuative processes would, over time, reduce contaminant concentration. However, the time frame required for these processes are much greater as compared to active restoration programs. Prediction of this time frame through application of transport and fate models is outside the scope of the available data collected in this program.

5.2.8.1 Effectiveness

Short-term effectiveness is provided through the issuance of deed restrictions on the present and future utilization of the aquifer as a drinking water source.

Long-term effectiveness is dependent on natural subsurface biological and chemical processes that may, over time, reduce vinyl chloride and benzene concentrations. Due to the high concentration of vinyl chloride at the site, and its high toxicity, the natural attenuation action will not adequately protect human and environmental health.

Implementation of this alternative would not impose additional public health and environmental risks.

5.2.8.2 Implementability

There are no technical barriers to implementation of this alternative. Groundwater samples would be acquired through the existing monitoring well system. Additional well installation may be necessary to satisfy the remedial action objective of protecting the bedrock aquifer.

5.2.8.3 Cost

Based on a semi-annual monitoring program consisting of collection and volatile analyses from existing and possible other wells, annual costs for this remedial alternative will be $7,000.

5.2.9 Alternative 3 - Site 13: Subsurface Drain Collection/ Offsite Treatment

The only active restoration remedial alternative for Site 13 is the extraction of groundwater through a subsurface drainage collection system and treatment of the collected waters at an offsite facility.

The subsurface drainage system is needed because of the low hydraulic conductivities associated with the silty-clays of the unconsolidated aquifer. Based on an estimate of the areal extent of groundwater contamination, a 150 foot linear subsurface drainage system is proposed.

Deed restrictions will be used to eliminate the risk of groundwater ingestion during the remedial action.

Storage and accumulation of groundwater for offsite disposal would be in an appropriately designed vessel, complete with safety and emission control measures. Treatment of the vinyl chloride and benzene contaminated waters would be accomplished offsite, in an approved hazardous waste treatment facility.

5.2.9.1 Effectiveness

Short-term protection of groundwater ingestion is provided through the issuance of deed restrrictions on groundwater utilization.

Vinyl chloride is a highly toxic known carcinogen. It is slightly soluble in water (1.1 mg/liter @ 25 C), and exhibits a very high Henry's law constant (390,000) indicating a great propensity for volatilization when exposed to air. The very high vinyl chloride concentration in well 13-3 is at the saturation limits for this material in water.

Due to these factors, considerable care must be exercised during the extractive process and subsequent storage to prevent contact and fugative emissions. This will require the use of special liquid handling equipment such as non-cavitating pumps and emission controlled storage vessels.

Transportation of the groundwater poses little risk to the general public since a hazardous waste treatment facility is located adjacent to the Base.

Long-term effectiveness is provided by the containment of further migration of vinyl chloride in the shallow aquifer system. The remedial action will also significantly reduce toxicty by mass reduction. Complete restoration of the aquifer in regards to vinyl chloride and benezene should occur in approximately 20 years.

5.2.9.2 Implementability

There are no major technological or administrative barriers to implementation. Logistically, there may be excavation concerns based on the density of utilities in the area. Adequate health and safety precautions must be exercised due to the high toxicity and volatility of vinyl chloride.

5.2.9.3 Cost

Based on the assumption of installing a 150 foot subsurface drainage system to an average depth of 14 feet, the cost is estimated to be $16,000. This includes trench excavation, filter fabrics, gravel, piping, sumps, and a manhole. Treatment, transportation, and monitoring costs over the 20 year life of the project are estimated at $100,000. Total costs for this alternative are estimated at $116,000.

5.2.10 Conclusions

Based on the information gathered during the screening process for Site 8, the Subsurface Drain Collection/ Oxidative Destruction/ Surface Water Discharge option has been eliminated based on the lack of demonstratable data for oxidative technologies. The excavation/disposal alternative has been eliminated due to excessive cost in relation to the level and magnitude of contamination, and uncertainties associated with implementation.

The remaining alternatives are feasible and include the following: No Action, Natural Attenuation, Subsurface Drain Collection/ Discharge to Offsite Treatment Facility, and Subsurface Drain Collection/ Carbon Adsorption Treatment/ Discharge to Surface Waters.

Based on information gathered during the screening process for Site 13, the natural attenuation alternative is not being considered for a detailed analysis. This decision is based on the highly toxic nature of vinyl chloride and its high concentration in one well at Site 13. An active restoration process is needed to address these public health and environmental concerns. Therefore, the following alternatives are retained for detailed analysis: No Action, and Subsurface Drain Collection/ Offsite Treatment.

5.3 DETAILED ANALYSIS OF ALTERNATIVES

A detailed analysis will be performed for all remaining remedial alternatives for Sites 8 and 13. The detailed analysis will evaluate each alternative based on the following criteria as described under CERCLA. These are:

Overall protection of human health and the environment
Compliance with ARARs
Long-term effectiveness and permanence
Reduction of toxicity, mobility, and volume
Short-term effectiveness
Implementability
Cost

State acceptance and Community acceptance will be addressed after comments from the State.

A comparison of the alternatives for present worth costs, health information, environmental effects, technical aspects, community effects, and any other information that would affect implementability, will be used to select the final remedial alternative.

The detailed analysis of alternatives will be evaluated separately for Sites 8 and 13.

The detailed analysis of alternatives for Site 8 are:

- No Action
- Natural Attenuation
- Subsurface Drain Collection/ Offsite Treatment
- Subsurface Drain Collection/ Carbon Adsorption Treatment/ Discharge to Surface Waters

The detailed analysis of alternatives for Site 13 are:

- o No Action
- o Subsurface Drain Collection/ Offsite Treatment

5.3.1 Detailed Analysis: No Action Alternative

Site 8 was utilized as a hazardous waste drum storage area, but has been cleaned-up and is presently utilized for storage of scrap construction materials. The remedial investigation revealed the presence of organic and inorganic constituents in the groundwater from the upper unconsolidated aquifer that exceeded New York State ARARs or posed a significant health risk. Inorganic contamination in the groundwater samples appears to be an artifact of the analytical procedure, and is not indicative of contamination levels in water that would be ingested. This natural contamination is derived from particulate minerals that were collected, digested, and analyzed as total inorganic content. Using normal drinking water treatment, the particulate material would be filtered. Therefore, based on the remaining contaminant profile, TCE was the only species in excess of New York State ARARs.

Trichloroethene (TCE) was detected in wells from Site 8. Only two wells contained levels in excess of the 5 ppb ARAR for TCE. These were well 8-1 (190 ppb), and well 8-2 (11 ppb). These wells are immediately adjacent to the site of the old hazardous waste storage area.

The sitewide average for TCE is 23.0 ppb. Based on the hypothetical assumption of ingestion of groundwater by base personnel of 1 liter of water per day (70 kg adult), 5 days per week, 50 weeks per year, for 20 years, the excess lifetime carcinogenic risk is 7.09 x 10-7, and the noncarcinogenic hazard quotient is 2.26 x 10-2. These are both below the values associated with health risks. However, the sitewide average for TCE is greater than the New York State groundwater ARAR (5 ppb). Based on TCE values in excess of the 5 ppb New York State ARAR, a remedial study was undertaken.

Under the no action alternative, no active steps are taken to reduce TCE contamination in the groundwater, or limit human exposure through institutional means. TCE levels in the groundwater would naturally abate through advective and biological processes. However, the migration of the plume and the rate of dispersement would not be monitored under this alternative.

The no action alternative does not provide any protection of human health and environment. Risks associated with exposure remain the same.

The no action alternative does not actively comply with groundwater specific ARARs for TCE (5 ppb). Under the no action alternative, TCE may attenuate under natural conditions. However, the rate and magnitude of this attenuation is neither controlled nor monitored.

The long-term effectiveness and pemanence of this alternative provides no assurance of abatement of risk. The alternative does not monitor contaminant movement or take corrective measures to permanently restrict exposure to TCE contamination in the groundwater.

The no action alternative does not actively reduce TCE toxicity, mobility, and volume. Natural mechanisms may gradually reduce toxicity, however, the magnitude of this process cannot be determined under this alternative.

There is no short-term effectiveness under the no action alternative since no active steps are undertaken to reduce exposure risk.

There are no implementability or cost analyses for the no action alternative.

5.3.2 Detailed Analysis: Natural Attenuation Alternative

The natural attenuation remedial alternative utilizes natural attenuative processes in the groundwater, in conjunction with deed restrictions and monitoring, to slowly decrease contamination through natural processes, and at the same time assure public safety by restricting groundwater usage and tracking movement.

Under the natural attenuation remedial alternative, there is no active and predictable reduction of TCE at the site. However, natural processes of indeterminate magnitude will be operable. There is no active control over the direction and degree of TCE contamination. Monitoring of these groundwater attenuative processes allows for tracking contaminant migration, and to possibly intercept contamination in the event of potential contamination of useable water sources.

As compared to the baseline no-action alternative, this alternative will provide the same level of restoration.

5.3.2.1 Overall Protection of Human Health and the Environment

The natural attenuation alternative is effective in limiting access to the contaminated groundwater through deed restrictions. It will also track the migration and rate of attenuation through the use of groundwater contaminant monitoring. It will not actively and controllably contain the further spread of TCE contamination at the site. In addition, the natural attenuation alternative may not provide sufficient degradative processes to actively restore the groundwater for future use. However, it is important to note that the unconsolidated aquifer at Site 8 is not presently being utilized as a drinking water source. In addition, there are no known surface or subsurface waters in the vicinity being utilized that are in jeopardy of contamination from groundwater at Site 8. Based on the extremely slow velocity (1 foot/year) of the groundwater plume, there is little risk of contaminant migration outside the immediate contamination zone.

5.3.2.2. Compliance with ARARs

The natural attenuation alternative will not, in the short term, comply with the New York State ARAR for TCE in groundwater (5 ppb). However, long term attenuation of TCE is possible. The exact restorative time frame is indeterminate and of a longer time frame as compared to active restoration actions.

5.3.2.3 Long-term Effectiveness and Permanence

The natural attenuation alternative does not insure permanent or long term remediation of the groundwater in regards to contaminant abatement and institutional controls on groundwater utilization. Long term effectiveness is dependant on unpredictable and complex biological and geochemical processes operative over long time periods.

5.3.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Evaluation of the natural attenuation alternative in this section is inapplicable since no treatment is recommended.

5.3.2.5 Short-term Effectiveness

The natural attenuation alternative stipulates that deed restrictions be placed on the groundwater from the upper aquifer at Site 8. Since the groundwater is not presently being utilized as a drinking water source, this measure should provide short-term public health protection.

5.3.2.6 Implementability

There are no major impedements to the implementation of this alternative.

This alternative requires that groundwater be collected and tested on a regular basis to document the movement and attenuation of TCE. Monitoring of groundwater contamination levels will be performed on a semi-annual basis. Groundwater samples would be collected from shallow wells 8-1, 8-2, and 8-3, and the deep well 8-2D. The groundwater will be tested for TCE as part of the volatile organics package.

Special site requirements for this remedial alternative are the proper maintenance and protection of the monitoring well systems.

Central to the implementation of this alternative is the successful issuance and enforcement of restrictive measures for groundwater usage within the boundaries of the site. This is accomplished through deed restrictions that must be enforced through any title changes and land use modifications.

5.3.2.7 Cost

Estimated costs for the implementation of the natural attenuation alternative are derived from expenses related to sampling of existing wells, and chemical analyses for volatile organics (TCE). Based on a semi-annual sampling scheme, sample capture costs would be $1,000/year. Based on an analytical cost of $200/sample, yearly analytical costs would be $1,600. Total costs for this remedial action are $2,600/year. There are no capital costs associated with this remedial alternative. A present worth analysis cannot be determined due to the uncertain time to restoration under the natural attenuation scheme.

5.3.3 Detailed Analysis: Subsurface Drain Collection/ Offsite Treatment

The subsurface drain collection/offsite treatment alternative will remove TCE contamination from the groundwater at Site 8, and hence restore the groundwater for future use.

The remedial plan calls for the placement of 130 feet of subsurface drain centered on well 8-1 and configured as in Figure 5-1. Based on modeling with the existing contaminant distribution profile and regional hydrological data, the drainage system will take approximately 12 years to restore the aquifer for TCE to values below the ARAR of 5 ppb. The system will start with a flow rate of approximately 100 gallons/day and gradually reduce to a steady state flow of approximately 11 gallons/day after approximately 2 months. Based on the life of the project, approximately 50,000 gallons of groundwater will be extracted and treated offsite.

The drain system will be placed at the bottom of the unconsolidated aquifer, therefore resting on top of bedrock. This requires excavation to an average depth of 14 feet at Site 8. Four inch perforated PVC pipe will be placed in the trench, wrapped with filter fabric, and surrounded with 3/4" crushed stone to intercept the 1.5 foot thick aquifer. The groundwater will be collected in an eight foot diameter, air-tight manhole, placed six feet into the bedrock. The manhole will store approximately 2250 gallons of groundwater. A level detection and alarm system will signal and alert personell to arrange for offsite transportation and treatment of the groundwater. Pick-up would occur on at least a 90 day basis, or sooner, dependant on the level of groundwater in the manhole. The groundwater would be pumped out, and transported offsite for appropriate treatment and disposal.

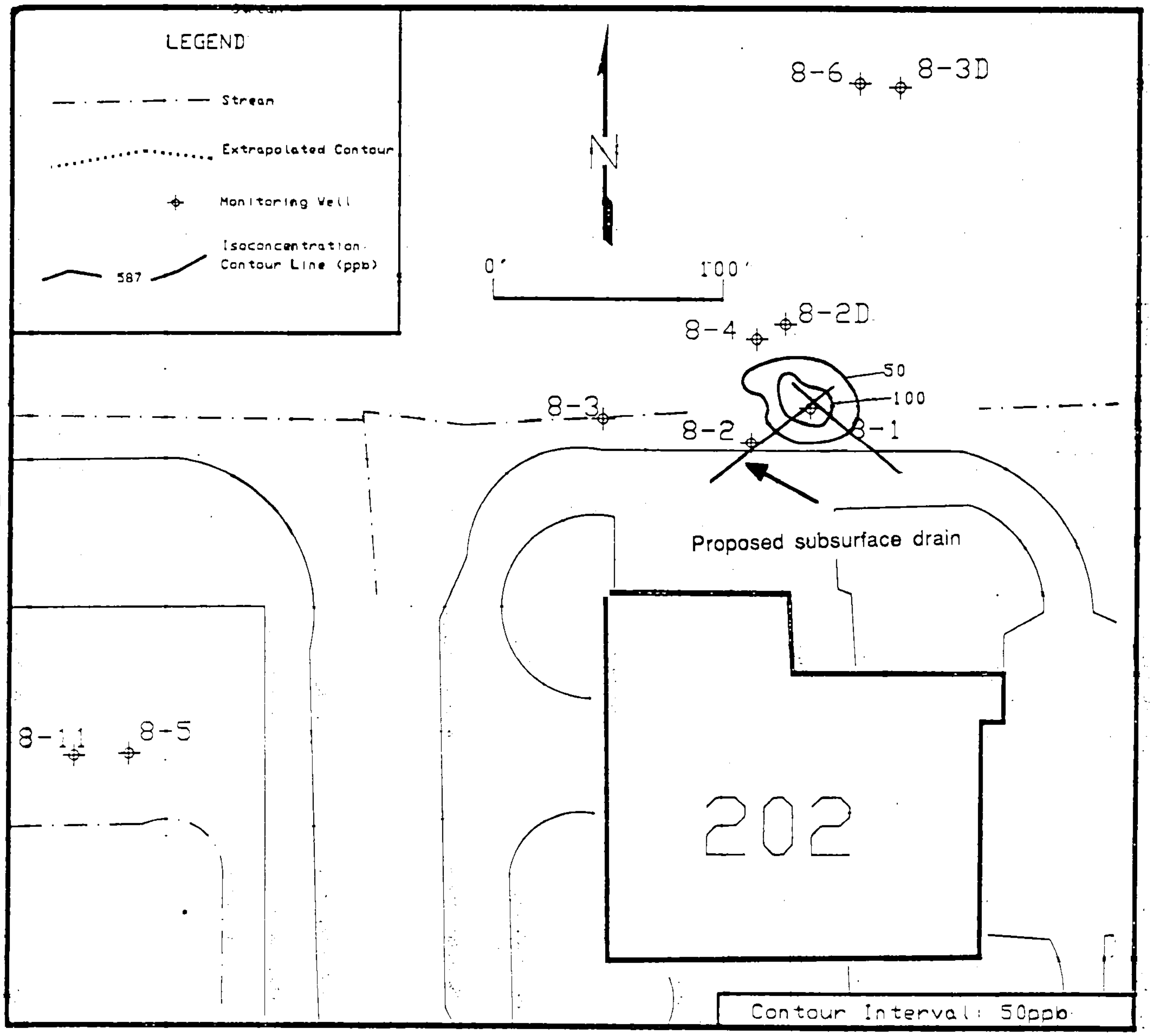


Figure 5-1. Proposed Subsurface Drain for Site 8

5.3.3.1 Overall Protection of Human Health and the Environment

This remedial action will be effective in protecting human health and the environment by removing the TCE contamination from the groundwater.

5.3.3.2 Compliance with ARARs

This remedial alternative will meet the remedial objective of reducing TCE contamination in the unconsolidated aquifer to levels less than 5 ppb. This will be accomplished by extraction of the groundwater from the aquifer and removal offsite for treatment.

5.3.3.3 Long-term Effectiveness and Permanence

This alternative will remove the contaminated groundwater and effectively destroy the contamination at an offsite facility. It will result in a permanent solution to the groundwater contamination problem. The restorative time frame for complete restoration is estimated to be 12 years.

5.3.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The subsurface drain system, in conjunction with offsite treatment, will significantly reduce the toxicity and mobility of TCE in the groundwater. The extraction system will reverse the direction of groundwater movement so as to inhibit further contaminant migration. The drainage system is centered on the area of highest contamination, and will therefore begin extracting groundwater in the area of greatest contamination. This will result in mass reduction of TCE and hence toxicity of the groundwater.

5.3.3.5 Short-term Effectiveness

Protection of the community during the remedial activity will be provided through implementing deed restrictions on groundwater utilization. These restrictions will be in effect until the groundwater has been restored.

Precautions must be made to control emissions that may occur through volatilization of the stored TCE laden groundwater. These requirements can be met by incorporating air tight covers on the manhole, and providing proper worker protection during transfer operations.

5.3.3.6 Implementability

There are no extraordinary barriers to implementation of this remedial alternative. Construction, operation, and maintenance of the subsurface drainage system is routine.

Requirements to determine the effectiveness of this remedial alternative consist of semi-annual monitoring of groundwater from existing wells. Groundwater samples would be collected from shallow wells 8-1, 8-2, and 8-3, and deep well 8-2D. Analytical requirements call for measurement of TCE as part of the volatile package.

Operation of the groundwater extraction system will require minimal periodic monitoring to insure proper functioning of equipment. This should not impose any constraints since the proposed installation is within close distance to active Base operations.

The remedial alternative calls for the utilization of an offsite facility to treat and discharge the collected groundwater. CECOS, International (Niagara Falls, NY) has been identified as a prime candidate due to their proximity and familiarity and experience with regional hazardous waste treatment projects. CECOS's treatment facilities are located on a property adjacent to the Base and within a two mile radius of the site.

This remedial alternative will require a manhole to accumulate extracted groundwater prior to transportation for offsite treatment. Storage of accumulated groundwater must adhere to requirements set forth in the 1986 New York State Hazardous Substance Bulk Storage Act. This statute governs the bulk storage of hazardous substance bulk storage facilities. Accumulation of contaminated groundwater should not require further permits if accumulation is less than 90 days. This can be satisfied by arranging pickups at least on a 90 day schedule.

Transportation of the extracted groundwater to the treatment facility will be necessary. Means of transportation will be via a truck tanker. Transportation should not impose any serious logistic problems, due to the

Groundwater would be extracted from the aquifer utilizing a subsurface drainage system as described in Section 5.3.3. The groundwater would be temporarily stored in the manhole and periodically processed through Granulated Activated Carbon (GAC) to remove TCE contamination. The treated groundwater would be discharged to local surface waters.

The GAC system would consist of two 12" diameter by 48" long carbon modules (each module contains 1.7 cu ft of carbon), preceded by a media filter to remove particulates. Based on an accumulation of approximately 1,000 gallons every three months, the groundwater can be batch processed through the carbon system. Delivery of the groundwater to the GAC system would be by a submersible pump. At a delivery rate of 5 gpm, the entire batch could be procesed in less than 5 hours. The treated water would be discharged to local surface waters at the site.

5.3.4.1 Overall Protection of Human Health and the Environment

This remedial action will be effective in protecting human health and the environment by removing the TCE contamination from the groundwater.

5.3.4.2 Compliance with ARARs

This remedial alternative will meet the remedial objective of reducing TCE contamination in the unconsolidated aquifer to levels less than 5 ppb. This will be accomplished by extraction of the groundwater from the aquifer and treatment by Granulated Activated Carbon (GAC). GAC technology has been proven very effective for removing TCE from groundwater.

5.3.4.3 Long-term Effectiveness and Permanence

This alternative will remove the contaminated groundwater and effectively treat and remove the contamination by carbon adsorption. The adsorbed contamination will be destroyed offsite. It will result in a permanent solution to the groundwater contamination problem. The restorative time frame for complete restoration is estimated to be 12 years.

5.3.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The subsurface drain system, in conjunction carbon adsorption, will significantly reduce the toxicity and mobility of TCE in the groundwater. The extraction system will reverse the direction of groundwater movement so as to inhibit further contaminant migration. The drainage system is centered on the area of highest contamination, and will therefore begin extracting groundwater in the area of greatest contamination. This will result in mass reduction of TCE and hence toxicity of the groundwater.

Activated carbon technology for aqueous waste streams is a reliable and effective method for removing organics. It has been repeatedly demonstrated effective for remediating TCE contaminated waters over a large concentration range (5ug/L to 16 mg/L) to effluent concentrations of less than 1 ug/L.

5.3.4.5 Short-term Effectiveness

Protection of the community during the remedial activity will be provided through implementing deed restrictions on groundwater utilization. These restrictions will be in effect until the groundwater has been restored.

Precautions must be made to control emissions that may occur through volatilization of the stored TCE laden groundwater. These requirements can be met by incorporating air tight covers on the manhole, and providing proper worker protection during transfer operations.

There are no major safety requirements needed for implementation of this alternative. Precautions should be taken to minimize human exposure of contaminated groundwater during the extraction, storage, and treatment phases. Since dermal contact is not a health hazard for the concentrations of TCE encountered in the groundwater at the site, precautions need only be taken to prevent the highly unlikely ingestion of contaminated water.

The restorative time frame for groundwater remediation is approximately 12 years, based on the contaminant areal concentration, hydrological parameters derived from regional studies, and random walk contaminant modeling:

5.3.4.6 Implementability

There are no extraordinary barriers to implementation of this remedial alternative. Construction, operation, and maintenance of the subsurface drainage system is routine. Carbon adsorption is an effective and accepted technology for treating TCE contaminated groundwater.

Requirements to determine the effectiveness of this remedial alternative consist of semi-annual monitoring of groundwater from existing wells. Groundwater samples would be collected from shallow wells 8-1, 8-2, and 8-3, and deep well 8-2D. Analytical requirements call for measurement of TCE as part of the volatile package.

Operation of the groundwater extraction system will require minimal periodic monitoring to insure proper functioning of equipment. This should not impose any constraints since the proposed installation is within close distance to active Base operations.

This remedial alternative will require a manhole to accumulate extracted groundwater prior to transportation for offsite treatment. Storage of accumulated groundwater must adhere to requirements set forth in the 1986 New York State Hazardous Substance Bulk Storage Act. This statute governs the bulk storage of hazardous substance bulk storage facilities. Accumulation of contaminated groundwater should not require further permits if accumulation is less than 90 days. This can be satisfied by treating the groundwater on a 90 day schedule.

The carbon treatment system must be monitored to insure that the water is treated to remove TCE contamination below 5 ppb. This can be accomplished by sampling during batch treatment (90 days) for TCE. With the two cartridge system, a sample port could be placed before the last carbon canister. Changeout of the first canister would occur when monitoring indicates TCE breakthrough. The last cartridge acts as insurance against unusual conditions that may arise, preventing discharge of contaminated groundwater to the surface waters.

An offsite facility will supply the carbon adsorption equipment, and provide replacement modules when necessary. Carbon adsorption operates by transfer of organic materials from a liquid phase to a solid surface. In this respect, the technology concentrates the contaminant for ease of disposal. The adsorbed contamination on the solid phase carbon must be desorbed from the carbon and destroyed by thermal treatment. This regenerative process will be handled by the vendor.

In order to treat the TCE contaminated water onsite, it is necessary to obtain a permit. These permits, referred to as New York State Part 373 permits, are needed for hazardous waste management facilities used for treating, storing, or disposing of hazardous waste.

Under this remedial alternative, the treated groundwater is discharged to the surface water system. In New York State, it will necessary to obtain a SPDES (State Pollution Discharge Elimination System) permit in order to discharge the treated water. This permit must be filed 180 days before the proposed discharge is to begin.

5.3.4.7 Cost

Costs associated with the construction, operation, and maintenance of the subsurface drain system are outlined in Section 5.3.3.7. The total capital costs for the drainage system are $15,200. The remedial action calls for the acquisition of two carbon adsorption modules and a media filter. The capital costs, including necessary plumbing, are approximately $5,000. The cost for a submersible pump is approximately $5,000. Total capital costs are estimated to be $25,200.

Operation and maintenance costs include replacement of GAC cartridges, replacement of filter modules, analytical costs for GAC carbon life, and monitoring costs for remedial effectiveness. Cartridge and filter changeout frequency can only be determined under actual operating conditions. However, it is estimated that changeout will occur on an annual basis. Total replacement costs will be $1,000. Analytical costs to determine the life of the GAC unit will be $800/year. Monitoring costs to determine remedial effectiveness will be $2,600 year. Total annual costs are estimated to be $4,400.

Present worth is estimated to be $83,391, based on a government escalation rate of 1.0175 and a project lifetime of 12 years.

5.3.5 Detailed Analysis: No Action Alternative

Site 13 is located south of Building 904 and west of Building 905. The 4,000 gallon underground storage tank was originally used as a motor fuel tank for a Base gas station. However, when the station closed, the tank was used for general slop waste storage. The tank has been pumped out, excavated, and removed. The remedial investigation revealed the presence of organic (vinyl chloride and benzene) and inorganic contamination in the groundwater from the upper unconsolidated aquifer in excess of New York State ARARs. The inorganic contamination in the groundwater samples was deemed an artifact of the analytical sampling protocol. This inorganic contamination is probably naturally derived from particulate minerals that were collected, digested, and analyzed as total inorganic metals. Using normal drinking water treatment methods, this particulate material would be filtered, and therefore not bio-available. Therefore, based on the remaining contaminant profile, vinyl chloride and benzene were the only species in excess of New York State ARARs and addressable in the present FS.

Vinyl chloride was detected in the groundwater from two wells from Site 13. The concentration of vinyl chloride in wells 13-3 , and 13-4 were 1,600 ppb and 2.9 ppb, respectively. The ARAR for vinyl chloride is 2 ppb. Benzene was detected in well 13-3 at a concentration of 2.98 ppb. The New York State ARAR for benzene is non detect (0.70 ppb).

The sitewide average for vinyl chloride at Site 13 is 294 ppb. The sitewide average for benzene at Site 13 is 0.72 ppb. Based on the hypothetical assumption of ingestion of groundwater by base personnel of 1 liter of water per day (70 kg adult), 5 days per week, 50 weeks per year, for 20 years, the excess lifetime carcinogenic risk is 4×10^{-3} and 5.85×10^{-8} for vinyl chloride and benzene, respectively. The noncarcinogenic hazard quotient for vinyl chloride is 2.22, and for benzene is 1.96×10^{-2}.

Under the no action alternative, the fate of groundwater contamination at site 13 is based on natural attenuation processes. Vinyl chloride and benzene will eventually be reduced in concentration through dispersion and degradative processes operative in the groundwater system. However, the restorative time frame and the future direction of groundwater contaminant migration cannot be predicted nor monitored under the no action alternative.

Under the no action remedial alternative, no active technical or institutional measures are undertaken to control contaminant plume migration or prevent exposure to the general public and the environment. Under this alternative, vinyl chloride and benzene contamination would naturally attenuate over time. However, the rate of contaminant abatement and the direction of contaminant migration would not be monitored.

The no action alternative does not provide any protection of human health and environment. Risks associated with exposure remain the same.

The no action alternative does not actively comply with groundwater specific ARARs for vinyl chloride (2 ppb) or benzene (non-detect). Under the no action alternative, vinyl chloride and benzene may attenuate under natural conditions. However, the rate and magnitude of this attenuation is neither controlled nor monitored.

The long-term effectiveness and pemanence of this alternative provides no assurance of abatement of risk. The alternative does not monitor contaminant movement or take corrective measures to permanently restrict exposure to vinyl chloride and/or benzene contamination in the groundwater.

The no action alternative does not actively reduce vinyl chloride or benzene toxicity, mobility, and volume. Natural mechanisms may gradually reduce toxicity, however, the magnitude of this process cannot be determined under this alternative.

There is no short-term effectiveness under the no action alternative since no active steps are undertaken to reduce exposure risk.

There are no implementability or cost analyses for the no action alternative.

5.3.6 Detailed Analysis: Subsurface Drain Collection/ Offsite Treatment

The subsurface drain collection/ offsite treatment remedial alternative is the only active remedial option under consideration in the Phase III detailed analysis.

The remedial approach is to collect the contaminated groundwater through extraction with a 150 foot subsurface drainage system, illustrated as in Figure 5-2. The subsurface drainage system will require approximately 20 years to restore the aquifer in respect to vinyl chloride and benzene contamination. The system will initially extract groundwater at the rate of 115 gallons/day, and gradually reach a steady state extraction rate of approximately 13 gallons/day. BAsed on the life of the project, approxiamtely 95,000 gallons of groundwater will be extracted and transported offsite for treatment.

The subsurface drain system will be placed at the bottom of the unconsolidated aquifer and rest on top of bedrock. This will require excavation to a depth of approximetely 14 feet. Four inch perforated PVC pipe will be placed in the trench, wrapped with filter fabric, and surrounded with 3/4" crushed stone to intercept the 1.5 foot thick aquifer. The groundwater will be collected in an eight foot diameter, air-tight manhole, placed six feet into the bedrock. The manhole will store approximately 2250 gallons of groundwater. A level detection and alarm system will signal and alert personell to arrange for offsite transportation and treatment of the groundwater. Pick-up would occur on at least a 90 day basis, or sooner, dependant on the level of groundwater in the

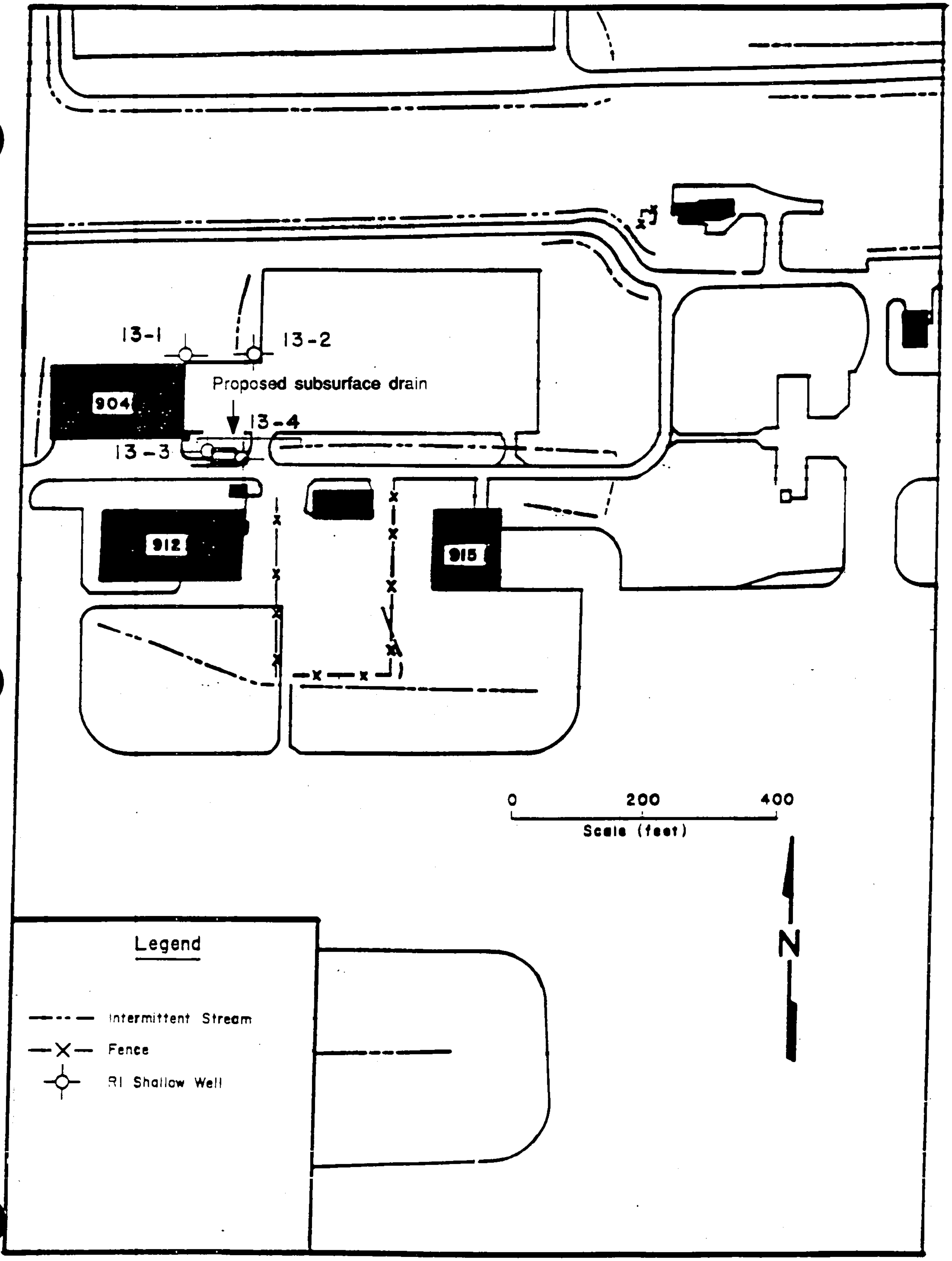


Figure 5-2. Proposed Subsurface Drain for Site 13

manhole. The groundwater would be pumped out, and transported offsite for appropriate treatment and disposal.

5.3.6.1 Overall Protection of Human Health and the Environment

This remedial action will be effective in protecting human health and the environment by removing the vinyl chloride and benezene contamination from the groundwater.

5.3.6.2 Compliance with ARARs

This remedial alternative will meet the remedial objective of reducing vinyl chloride contamination in the unconsolidated aquifer to levels less than 2 ppb, and benzene contamination to non-detectable limits. This will be accomplished by extraction of the groundwater from the aquifer and removal offsite for treatment.

5.3.6.3 Long-term Effectiveness and Permanence

This alternative will remove the contaminated groundwater and effectively destroy the contamination at an offsite facility. It will result in a permanent solution to the groundwater contamination problem. The restorative time frame for complete restoration is estimated to be 20 years.

5.3.6.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The subsurface drain system, in conjunction with offsite treatment, will significantly reduce the toxicity and mobility of vinyl chloride and benzene in the groundwater. The extraction system will reverse the direction of groundwater movement so as to inhibit further contaminant migration. The drainage system is placed proximal to the area of highest contamination, and will therefore begin extracting groundwater in the area of greatest contamination. This will result in mass reduction of vinyl chloride and benezene and hence reduction groundwater toxicity.

5.3.6.5 Short-term Effectiveness

Protection of the community during the remedial activity will be provided through implementing deed restrictions on groundwater utilization. These restrictions will be in effect until the groundwater has been restored.

Precautions must be made to control emissions that may occur through volatilization of the stored viny; chloride laden groundwater. These requirements can be met by incorporating air tight covers on the manhole, and providing proper worker protection during transfer operations.

5.3.6.6 Implementability

There are no extraordinary barriers to implementation of this remedial alternative. Construction, operation, and maintenance of the subsurface drainage system is routine.

Requirements to determine the effectiveness of this remedial alternative consist of semi-annual monitoring of groundwater from existing wells. Groundwater samples would be collected from shallow wells 13-1, 13-2, and 13-3, and deep well 13-4. Analytical requirements call for measurement of vinyl chloride and benzene as part of the volatile package.

Operation of the groundwater extraction system will require minimal periodic monitoring to insure proper functioning of equipment. This should not impose any constraints since the proposed installation is within close distance to active Base operations.

The remedial alternative calls for the utilization of an offsite facility to treat and discharge the collected groundwater. CECOS, International (Niagara Falls, NY) has been identified as a prime candidate due to their proximity and familiarity and experience with regional hazardous waste treatment projects. CECOS's treatment facilities are located on a property adjacent to the Base and within a two mile radius of the site.

This remedial alternative will require a manhole to accumulate extracted groundwater prior to transportation for offsite treatment. Storage of accumulated groundwater must adhere to requirements set forth in the 1986 New York State Hazardous Substance Bulk Storage Act. This statute governs the bulk storage of hazardous substance bulk storage facilities. Accumulation of contaminated groundwater should not require further permits if accumulation is less than 90 days. This can be satisfied by arranging pickups at least on a 90 day schedule.

Transportation of the extracted groundwater to the treatment facility will be necessary. Means of transportation will be via a truck tanker. Transportation should not impose any serious logistic problems, due to the proximity to the treatment facility. Transportation of the accumulated groundwater will also require preparation of a manifest. The transporter must also have a permit and an EPA identification number. Prior to shipment, the treatment facility must provide written confirmation that the facility has adequate capacity and will assure that the disposal method is followed. The treatment facility is required to have a permit designating adequate capabilities to treat, store, or dispose of the waste.

5.3.6.7 Cost

The cost for materials and construction of the subsurface drain is estimated to be $6,000, based on a length of 150 feet at a cost of $40 linear foot. Cost for the manhole is estimated to be $7,000. The liquid level control and alarm system will cost approximately $3,000. Total capital costs for the extraction system is estimated at $16,000.

Yearly treatment costs are based on an extraction volume of approximately 4,700 gallons at $0.20/gallon, yielding $940/year.
Transportation costs, based on a pickup schedule of four times year at a cost of $300/pickup, equals $1,200/year. Monitoring and analytical costs are estimated at $2,600/year. Total annual costs are estimated to be $4,740.

Present worth analysis, based on a government escalation rate of 1.0175 and a 20 year project lifetime, is $128,346.

5.3.7 Comparative Analysis and Recommendations

The alternatives are compared against each other utilizing the results from the detailed analysis. The comparisons are presented in Table 5-8 for Site 8, and Table 5-9 for Site 13.

Table
COMPARISON OF ALTERNATIVES - SITE 8

CRITERIA	NO ACTION ALTERNATIVE	NATURAL ATTENUATION	SUBSURFACE DRAINAGE/ OFFSITE TREATMENT	SUBSURFACE DRAINAGE/ CARBON ADSORPTION/ SURFACE DISCHARGE
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	Does not provide any protection of human health and the environment	Limits access to groundwater. Tracks migration of TCE. No active containment	Effective in protecting human health and the environment.	Effective in protecting human health and the environment.
COMPLIANCE WITH ARARs	Does not comply with ARARs for TCE in groundwater.	Potential compliance with ARARs through natural processes. Timeframe uncertain.	Will comply with ARARs for TCE.	Will comply with ARARs for TCE.
LONG TERM EFFECTIVENESS	Does not provide assurance of long-term effectiveness	Dependant on unpredictable natural biological and chemical processes.	Effective in restoring aquifer. Restoration timeframe is 12 years.	Effective in restoring aquifer. Restoration timeframe is 12 years.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	No active reduction in toxicity, mobility, and volume. Natural processes may reduce toxicity and mobility, however timeframe indeterminate.	No active reduction in toxicity, mobility, and volume. Natural processes may reduce toxicity and mobility, however timeframe indeterminate.	Remedial action will immediately begin to reduce mobility, toxicity, and volume.	Remedial action will immediately begin to reduce mobility, toxicity, and volume.
SHORT-TERM EFFECTIVENESS	No short-term effectiveness provided.	Deed restrictions will provide short-term protection against groundwater utilization.	Deed restrictions will provide short-term protection against groundwater utilization.	Deed restrictions will provide short-term protection against groundwater utilization.
IMPLEMENTABILITY	Not applicable	Requires collection of samples for testing and monitoring . Requires issuance of deed restrictions.	Requires monitoring of groundwater. Requires installation of drains. Requires utilization of offsite treatment facility. Requires storage and transportation permits.	Requires monitoring of groundwater. Requires installation of drains. Requires installation and operation of carbon adsorption system. Requires storage and treatment permits. Requires discharge permits.
COST	None	$2,600 per annum	Capital - $15,200 Annual O&M - $4,600 Present worth - $76,036	Capital - $25,200 Annual O&M - $4,400 Present worth - $83,391
STATE ACCEPTANCE *				
COMMUNITY ACCEPTANCE *				

* These criteria are assessed following comment on the RI/FS report and the proposed plan.

Table 5-9
COMPARISON OF ALTERNATIVES - SITE 13

CRITERIA	NO ACTION ALTERNATIVE	SUBSURFACE DRAINAGE/ OFFSITE TREATMENT
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	Does not provide any protection of human health and the environment	Effective in protecting human health and the environment.
COMPLIANCE WITH ARARs	Does not comply with ARARs for vinyl chloride and benzene in groundwater.	Will comply with ARARs for vinyl chloride and benzene
LONG TERM EFFECTIVENESS	Does not provide assurance of long-term effectiveness	Effective in restoring aquifer. Restoration timeframe is 20 years.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	No active reduction in toxicity, mobility, and volume. Natural processes may reduce toxicity and mobility, however timeframe indeterminate.	Remedial action will immediately begin to reduce mobility, toxicity, and volume.
SHORT-TERM EFFECTIVENESS	No short-term effectiveness provided.	Deed restrictions will provide short-term protection against groundwater utilization.
IMPLEMENTABILITY	Not applicable	Requires monitoring of groundwater. Requires installation of drains. Requires utilization of offsite treatment facility. Requires storage and transportation permits.
COST	None	Capital - $16,000 Annual O&M - $4,740 Present worth - $128,346
STATE ACCEPTANCE*		
COMMUNITY ACCEPTANCE*		

* These criteria are assessed following comment on the RI/FS report and the proposed plan.

Based on the comparative analysis for Site 8, the subsurface drainage/off-site treatment alternative is recommended. The No Action alternative does not provide any protection. The Natural Attenuation alternative will provide short term protection, however this alterative does not assure aquifer restoration through active measures. The subsurface drainage/offsite treatment and subsurface drainage/carbon adsorption/surface discharge both will actively restore the aquifer in approximately 12 years. The subsurface drainage/offsite treatment is preferable based on cost and ease of technical and administrative implementation.

Based on the comparative analyses for Site 13, the subsurface drainage/offsite treatment alternative is recommended. This alternative is the only remedial action that will assure restoration of the aquifer for vinyl chloride and benzene.

6.0 RECOMMENDATIONS

Recommendations regarding depiction and approach for future Installation Restoration Program (IRP) actions are presented for each of the thirteen Niagara Falls International Airport (IAP) hazardous material/waste management sites. The following subsections briefly summarize site findings and present recommendations for further IRP action. Analytical data results for each media and the results of the baseline risk assessment were the primary tools for determining recommendations. A table summarizing the general findings by media, associated risks to human health, and recommendations is presented as Table ES-2 in the Executive Summary.

6.1 SITE NOS. 1,2,4 AND 6: BUILDING 600 JP-4 PIPELINE LEAK, POL JP-4 TANK C AND A, AND BX MOGAS TANK LEAK

As detailed in Section 4.1.1 of this report, the RI activities conducted at the combined sites during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic risk compounds found in the soils and groundwater at each site, was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of the combined sites (i.e, arsenic, methylene chloride and benzene), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", benzene levels detected in groundwater from at least one well from nearly each site exceeded the imposed limit. The magnitude of the risks calculated for groundwater at each site was attributable to the levels of certain metals (lead, manganese, arsenic, and silver).

Many of these metal species occurred at concentrations which exceeded the ARARs. The elevated metal values in the groundwater from the Site Nos. 1, 2, 4 and 6 monitoring wells can be correlated to metal contributions from particulate clastic and carbonate sources rather than dissolved species. Since the total sample was digested as part of the analysis, the results include any chemical species or trace element comprising the suspended particles in the groundwater. There is, therefore, a strong correlation between samples with high metal content and visual observations of high turbidity recorded during field sampling. As a result, there is a considerable range in the concentrations of metals from well to well. Although metal levels were elevated in the background wells, the concentrations were not as high as groundwater from some of the other wells due to less turbidity. In addition, total metal concentrations (sum of all individual measurements) exceed, by as much as an order of magnitude, the analyses for total dissolved species. Based upon this and the regional groundwater quality reported by other investigators (See Section 2.4.3), it is concluded that the high values of metals were not introduced into the groundwater through activities associated with Base operations, but reflect a natural condition.

The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. Based upon the results of the baseline risk assessment, Site Nos. 2,4 and 6 require no further action. Due to the fact that near-site downgradient monitoring wells could not be sampled at Site 1, it is recommended that an additional round of groundwater sampling be conducted at this site. This resampling effort should include, if necessary, the replacement of previously destroyed downgradient monitoring wells at this site.

If the Air Force does not utilize these monitoring wells, SAIC is recommending that abandonment measures be initiated to preclude the possibility of these wells serving as future avenues of contaminant migration to the groundwater. Well abandonment procedures should be coordinated with NYDEC. In the meantime, all wells should be periodically inspected to ensure their integrity and security.

6.2 SITE NO. 3: LANDFILL

As detailed in Section 4.1.2 of this report, the RI activities conducted at the landfill during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic compounds found in the soils and groundwater was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils from this site. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of Site No. 3 (i.e, beryllium, arsenic, benzene, methylene chloride, trichloroethene and vinyl chloride), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the 0.96 ug/l benzene concentration found in a Site 3 well exceeds this limit. As mentioned in Section 4.1.2, benzene was detected at a comparable in the shallow background well. Trichloroethene and bis(2-ethylhexyl)phthalute also exceeded the ARAR in one well and vinyl chloride exceeded the ARAR in three wells. The magnitude of the risk calculated at Site No. 3 was attributable to the levels of certain metals (lead, manganese, vanadium, cadmium and arsenic). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. Metals found in the soils of Site No 3 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead and cadmium were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to the Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 3 which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment, Site No. 3 is recommended for natural attenuation no further action with long term monitoring.

If the Air Force does not utilize these monitoring wells, SAIC is recommending that abandonment measures be initiated to preclude the possibility of these wells serving as future avenues of contaminant migration to the groundwater. Well abandonment procedures should be coordinated with NYDEC. In the meantime, all wells should be periodically inspected to ensure their integrity and security.

6.3 SITE NO. 7: JP-4 TANK TRUCK SPILL

As detailed in Section 4.1.3 of this report, the RI activities conducted at the tank truck spill area during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenarios outlined in the baseline risk assessment, pose a health risk. Only one contaminant was found in the soil at Site No. 7. According to the hypothetical scenario, no health risk is imposed by the Site No. 7 soils. The calculated hazard index, for non-carcinogenic compounds found in the groundwater exceeds unity (1.0). The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to benzene. Benzene was also the only carcinogenic compound detected in groundwater at Site No. 7. At the levels measured, the lifetime cancer risk of exposure to benzene in groundwater is projected to be approximately 1×10^{-5}. This result is at the upper limit of the acceptable range established by EPA for waste site remediation under the Superfund program. Since the New York State Water Quality Standard for benzene is promulgated as "not detectable", all benzene levels at Site No. 7 exceed this ARAR. Toluene, ethylbenzene, and total xylenes also exceeded their ARARs in a single well. A certain portion of the risk calculated for the groundwater is attributable to the reported concentrations of certain metals (lead, barium, manganese, vanadium, chromium, and nickel). A number of the metals occurred at concentrations which exceeded the ARARs. Since all metal values were reported as total metals, a major part of the concentration can be attributed to undissolved metal species found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

Based upon the results of the baseline risk assessment and the inability of the present monitoring well network to delineate the full extent and magnitude of groundwater contamination at this site, Site No. 7 requires further investigation. Presently the site only has one shallow downgradient well and the highest levels of groundwater contamination were measured in groundwater from this well. Although migration rates through the unconsolidated aquifer are predicted to be limited, if contaminants have entered the upper bedrock aquifer much greater migration rates can be expected. Since no bedrock well presently exists at Site No. 7, the presence or absence of contamination in the upper bedrock aquifer needs to be confirmed. If contamination is confirmed, the magnitude and extent of this contamination needs to be determined. Although migration rates can be estimated based upon hydrogeological values reported in the literature, site specific values should be determined. The specific details of further investigation work to be completed will be addressed in a separate Air Force contract.

6.4 SITE NO. 10: FIRE TRAINING AREA NO. 1

As detailed in Section 4.1.4 of this report, the RI activities conducted at the fire training area during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenario outlined in the baseline risk assessment, pose a significant health risk. According to the hypothetical scenario, no health risk is imposed by the Site No. 10 soils.

The calculated hazard index for combined exposure across compounds found in the groundwater is approximately 9.8. The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to trichloroethene and benzene and to some extent lead. Four potentially carcinogenic compounds were detected in the groundwater at Site No. 10 (benzene, methylene chloride, trichloroethene and vinyl chloride). The excess lifetime cancer risk associated with the hypothetical exposure assumptions is approximately 5×10^{-4}. This lifetime cancer risk exceeds the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The magnitude of this estimate is primarily attributable to the presence of trichloroethene and vinyl chloride. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", benzene levels found in four of the monitoring wells exceed this limit. Trichloroethene also exceeded the ARAR in the four wells it was detected, and vinyl chloride exceeded the ARAR in the two wells it was detected. The levels of benzene and vinyl chloride were more than 10 times greater than the MCL. The mean concentration of trichloroethene was more than 1000 times the Federal MCL. Methylene chloride exceeded the ARAR in all wells. Although typically considered a laboratory contaminant, it is being treated a site contaminant in this case since levels reported in groundwater were significantly higher than that reported in the various QA samples. A significant portion of the risk calculated at Site No. 10 was attributable to the levels of certain metals (lead, manganese, vanadium, barium, chromium, copper, nickel, and zinc). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

The calculated hazard index, for non-carcinogenic compounds found in the soils was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to the Site No. 10 soils. Two carcinogenic compounds were detected in the soils at the site (beryllium and trichloroethene). The excess lifetime cancer risk associated with inadvertent ingestion exposure to these soils is 5×10^{-8}. This value falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No 10 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead, chromium and cadmium were the only notable exceptions. With the possible exception of chromium, the elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations underground regional soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 10, which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils.

Based upon the results of the baseline risk assessment and the inability of the present monitoring well network to delineate the full extent and magnitude of groundwater contamination at this site, Site No. 10 is recommended for additional investigation. Additional RI/FS work is being accomplished by the Air Force under a separate contract. Migration of contaminants in the upper bedrock aquifer monitoring well has been confirmed. This RI will include the following work:

- Installation of three monitoring wells (one deep) and sampling of these wells and the existing wells.
- Surface water/sediment samples will be taken in the drainage ditch which discharges into Cayuga Creek to determine if this ditch serves as a viable contamination migration pathway.
- Prior to groundwater sampling, all wells will be inspected for floating and sinking immiscible contaminants. If an immiscible layer is detected, an attempt will be made to sample this layer.
- Aquifer (slug) tests will be performed on downgradient wells to establish site specific hydrogeologic properties of the aquifer.

6.5 SITE NOS. 5 AND 8: NYANG HAZARDOUS WASTE DRUM STORAGE AREA AND DRUM STORAGE YARD

As detailed in discussions in Section 4.1.5 of this report, the RI activities conducted at these combined sites during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenarios outlined in the baseline risk assessment, pose a health risk. According to the same hypothetical scenario, no risk is imposed by the Site No. 5 and 8 soils.

At Site No. 5, the hazard index for combined exposure across compounds found in groundwater has been calculated at 1.7. Given this result, adverse noncarcinogenic effects may be anticipated if groundwater at Site No. 5 was used as a source of drinking water. The magnitude of the noncarcinogenic risk is attributed to the high value of the hazard quotient for lead. Since all metal values were reported as total metals, a major part of the concentration can be attributed to undissolved metal species found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. The risk should be recalculated after determining the concentrations of dissolved metal species, particularly lead, in the groundwater at this site. Trichloroethene was the only carcinogenic compound detected in groundwater at this site. The excess lifetime cancer risk of hypothetical exposure to TCE in groundwater was determined to be approximately 4×10^{-8}. This value is considered within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. Levels of TCE found in the groundwater did not exceed Federal and State ARARs. Lead, zinc, manganese and nickel detected in the groundwater at Site No. 5 were found to exceed the ARARs in a number of the wells. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. It is therefore inappropriate to consider these values, not only in a comparison to ARARs but also in any site risk assessment scenario. Based upon the likelihood that the high concentrations of certain metals considered in the risk assessment are elevated due to the undissolved contributions from suspended sediment, Site No. 5 is recommended for no further IRP action.

The calculated hazard index, for non-carcinogenic compounds found in the soils of Site No. 5 was less than 1. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. Only one carcinogenic compound was detected in the soil at the site (methylene chloride). Due to comparable concentrations reported in the method blank, the reported presence of methylene chloride in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 5 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure of these soils is 1×10^{-7}. This value falls within the acceptable range (10^{-6} to 10^{-4}) established by EPA for waste site remediation. Metals found in the soils of Site No. 5 generally occurred within installation background ranges or within the average concentration reported for typical soils. Copper and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils found at the installation and throughout the Niagara Falls area. The baseline risk assessment performed for soils and the comparisons of Site No. 5 soils to background levels and the average trace element concentrations further support the classification of Site No. 5 for no further action.

At Site No. 8, the hazard index for combined exposure across compounds is approximately 4.9. Based upon these results, there would be a potential for adverse noncarcinogenic effects for hypothetical chronic exposure to groundwater at Site No. 8. The magnitude of the noncarcinogenic risk is attributed to the high value of the hazard quotients for arsenic and lead. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metals levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption.

Three carcinogenic compounds were detected in the groundwater at Site No 8 (arsenic, 1,1-dichloroethane and trichloroethene). The excess lifetime cancer risk associated with inadvertent ingestion exposure of these soils is approximately 5×10^{-5}. The cancer risk estimate, although elevated, still falls within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. The magnitude of this risk attributable to the presence of arsenic. Levels of TCE in the groundwater at Site No. 8 exceeded the State Water Quality ARAR in two wells. Cadmium, chromium, copper, lead, manganese, nickel and zinc detected in the groundwater at Site No. 8 were found to exceed the ARARs in a number of wells. None of the arsenic levels exceeded the ARARs. Since all metal values were reported as total metals, implying that a significant portion of the reported concentration is attributable to the undissolved contributions from suspended sediment, it is inappropriate to consider these values, not only in a comparison to ARARs but also in any site risk assessment scenario. Their inclusion in the risk assessment scenario provides a worst case scenario.

The calculated hazard index for recreational exposure of Base personnel to non-carcinogenic compounds found in the soils of Site No. 8 was less than 1. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. Only one carcinogenic compound was detected in the soil at the site (methylene chloride). Due to comparable concentrations reported in the method blank, the reported presence of methylene chloride in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 8 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion of soils and inhalation of particulates containing this compound is 2 x 10^{-12}. This value falls within the acceptable range (10^{-6} to 10^{-4}) established by EPA for waste site remediation. The calculated hazard index for combined exposure of children at play to Site No. 8 soils (i.e., across compounds and pathways) is 1.5 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in soils. The excess lifetime cancer risk associated with children inadvertently ingesting soils and inhaling particulates from Site No. 8 would be 2 x 10^{-7}. This value is well within the acceptable range established by the USEPA. The calculated hazard index for combined exposure of children at play to Site No. 8 sediments (i.e., across compounds) is 1.0 x 10^{-1}. No adverse noncarcinogenic effects would be anticipated for the observed levels of contaminants in sediments. Two carcinogens, beryllium and methylene chloride were present in the sediment samples. The excess lifetime cancer risk associated with children inadvertently ingesting sediments from Site No. 8 would be 2 x 10^{-7}, which is well within acceptable range established by the USEPA. As for the projected combined risk of exposure of visiting children to soils and sediments in the vicinity of Site No. 8, both the combined hazard index and the combined lifetime cancer risk are within the acceptable range.

Metals found in the soils of Site No. 8 generally occurred within installation background ranges or within the average concentration reported for typical soils. Cadmium, lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock.

Based upon the results of the risk assessment, Site No. 8 has undergone the FS process to formulate, evaluate, and select remedial alternatives to address TCE contamination of groundwater of the unconsolidated aquifer. The details of the FS are presented in Section 5.0 of this report. Based on the comparative analysis for Site 8 in Section 5.0 of this report, the subsurface drainage/off-site treatment alternative is recommended. The No Action alternative does not provide any protection. The Natural Attenuation alternative will provide short term protection, however this alterative does not assure aquifer restoration through active measures. The subsurface drainage/offsite treatment and subsurface drainage/carbon adsorption/surface discharge both will actively restore the aquifer in approximately 12 years. The subsurface drainage/offsite treatment is preferable based on cost and ease of technical and administrative implementation.

6.6 SITE NO 12: BUILDING 850 DRUM STORAGE YARD

As detailed in Section 4.1.6 of this report, the RI activities conducted at the former drum storage yard during the IRP RI/FS effort confirmed the absence of soil contamination that would pose any health risk. The hazard index, for noncarcinogenic compounds found in the soils was less than 1. This value calculated for combined exposure across compounds would no pose any adverse noncarcinogenic effects for chronic exposure to these soils. Five carcinogenic compounds were detected in the soils at this site (beryllium, benzene, methylene chloride, tetrachloroethene and trichloroethene). Due to comparable methylene chloride concentrations reported in the method blank, the reported presence of this compound in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 12 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these compounds is 1×10^{-6}. This result falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No. 12 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils and sediments found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 12 which posed some carcinogenic risk, occurred well below the average beryllium concentration reported for soils.

Based upon the results of the baseline risk assessment no further action is recommended for Site No. 12.

6.7 SITE NO. 9: FIRE TRAINING AREA NO. 3

As detailed in Section 4.1.7 of this report, the RI activities conducted at the fire training area during the IRP RI/FS effort confirmed the absence of groundwater and soil contamination that would pose any health risk. The calculated hazard index, for non-carcinogenic compounds found in the soils and groundwater was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to groundwater and soils. A number of compounds that pose a carcinogenic risk were detected in the groundwater and soil of Site No. 9 (i.e, benzene, beryllium, methylene chloride and bis(2-ethylhexyl) phthalate), but the lifetime cancer risk of the hypothetical exposures were calculated to occur within the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste remediation. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the benzene detected in the one Site No. 9 well exceeds this limit. As mentioned in Section 4.1.7, benzene also was detected in the shallow background well. A portion of the risk calculated for Site No. 9, according to the hypothetical groundwater exposure scenario, is attributable to the concentration of metals measured in the groundwater. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment. The use of present reported metal levels in the ARAR comparisons and in the site risk analysis provided a worst case scenario, but may not be realistic since groundwater would be treated by filtration prior to human consumption. Metals found in the soils of Site No. 9 generally occurred within installation background ranges or within the average concentration reported for typical soils. Zinc, lead and manganese were the only notable exceptions. It should be noted, however, that the installation's background ranges were established on soils analyzed from only two background soil borings. The full range of possible background concentrations indigenous to Niagara Falls soils has not been determined. This holds especially true for the inorganic compounds (i.e. metals). The literature links the often elevated metal content of Niagara Falls soils to a variety of bedrock sources (Litten, 1986). These bedrock sources were also the source of the glacially derived unconsolidated soils and sediments found at the installation and throughout the Niagara Falls area. Beryllium, the only metal found at Site No. 9 which posed some carcinogenic risk, occurred well below average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment and the absence of contamination in the two downgradient shallow wells installed during the additional RI to determine if benzene contamination extended to the intermittent stream, Site No. 9 is recommended for no further IRP action.

Although no risk is posed by levels of contaminants measured in the soil and groundwater at Site No. 9, significant levels of TCE and mercury contamination were detected in the surface water and sediment of the intermittent stream just north of the fire training area. The contamination appears to be from an off-base source. Consideration should be given by the Air Force to investigate this problem. Surface water and sediment samples should be collected at 50 to 100 foot intervals upstream to identify the source of purgeable organic and mercury contamination.

If the Air Force does not utilize the monitoring wells at Site No. 9, SAIC recommends that abandonment measures be initiated to preclude the possibility of these wells serving as future avenues of contaminant migration to the groundwater. Well abandonment procedures should be coordinated with NYDEC. In the meantime, all wells should be periodically inspected to ensure their integrity and security. Well abandonment measures should be initiated immediately for the three damaged Stage 1 wells (i.e., MW9-1, MW9-2 and MW9-4).

6.8 SITE NO. 11: FIRE TRAINING AREA NO. 2

As detailed in Section 4.1.8 of this report, the RI activities conducted at the former fire training area during the IRP RI/FS effort confirmed the absence of soil contamination that would pose any health risk. The hazard index, for noncarcinogenic compounds found in the soils was less than 1. This value calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to these soils. Two carcinogenic compounds were detected in the soils at this site (beryllium and bis(2-ethylhexyl)phthalate). The excess lifetime cancer risk associated with inadvertent ingestion exposure to soils containing these compounds is 2 x 10^{-9}. This result falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No. 11 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock (Litten, 1986). Beryllium, the only metal found at Site No. 11 which posed some carcinogenic risk, occurred well below the average beryllium concentration reported for soils. Based upon the results of the baseline risk assessment and the comparisons with background levels and average trace element concentrations reported for soils, Site No. 11 is recommended for no further IRP action.

6.9 SITE NO. 13: 4000 GALLON UNDERGROUND TANK PIT

As detailed in Section 4.1.9 of this report, the RI activities conducted at the former tank pit during the IRP RI/FS effort confirmed the presence of groundwater contamination, which according to the hypothetical scenario outlined in the baseline risk assessment, pose a significant health risk. According to the hypothetical scenario, no health risk is imposed by the Site No. 13 soils.

The calculated hazard index for combined exposure across compounds found in the groundwater is approximately 3.5. The hazard index calculated for combined exposure across compounds indicates that adverse noncarcinogenic effects may be anticipated if groundwater at the site were used as a drinking water source. The magnitude of the risk is attributed to the high value of the hazard quotient for vinyl chloride (i.e., a value of 2.2 corresponding to a mean groundwater concentration of 294 ug/l) and lead to a lesser extent. Seven potentially carcinogenic compounds were detected in the groundwater at Site No. 13 (arsenic, benzene, 1,4-dichlorobenzene, 1,2-dichloroethane, methylene chloride, vinyl chloride and trichloroethene). The excess lifetime cancer risk associated with the hypothetical exposure assumptions is approximately 2 x 10^{-3}. This lifetime cancer risk exceeds the acceptable range of 10^{-6} to 10^{-4} established by EPA for waste site remediation. Again the magnitude of this estimate is primarily attributable to the presence of vinyl chloride and to a lesser extent, arsenic. Since the New York State Water Quality Standard for benzene is promulgated at "not detectable", the benzene level found in one of the monitoring wells exceeds this limit. Trichloroethene, which was not detected in any of the four wells during the initial round of groundwater sampling, exceeded the ARAR in the one well it was detected during the additional RI round of sampling. Chlorobenzene, toluene, and 1,4-dichlorobenzene each exceeded their ARAR in one well during the initial round of sampling. Vinyl chloride exceeded the ARAR in two wells during the initial round of sampling and in one well during the additional RI. The mean value of vinyl chloride was more than 100 times the Federal MCL. Methylene chloride exceeded the ARAR in all wells. Although typically considered a laboratory contaminant, it is being treated a site contaminant in this case since levels reported in groundwater were significantly higher than that reported in the various QA samples. A significant portion of the risk calculated at Site No. 13 was attributable to the levels of certain metals (lead, manganese, vanadium, chromium, and zinc). A number of the metals occurred at concentrations which exceeded the ARARs. As discussed throughout the report, but particularly in Section 4.3, elevated metal levels found in the groundwater throughout the installation are not considered to be the result of hazardous waste management activities at the IRP sites. The evidence indicates that the elevated metals in groundwater are correlated to naturally occurring metals found in the suspended sediment.

The calculated hazard index, for non-carcinogenic compounds found in the soils was less than 1. The hazard indices calculated for combined exposure across compounds would not pose any adverse noncarcinogenic effects for chronic exposure to the Site No. 13 soils. Only one carcinogenic compound was detected in the soils at the site (i.e., methylene chloride). Due to comparable methylene chloride concentrations reported in the method blank, the reported presence of this compound in the soils is suspect. Since no other field related blanks were available to further substantiate the likelihood of laboratory contamination, the reported concentrations of methylene chloride in Site No. 13 soils were retained for use in the risk analysis to provide a worst case scenario. The excess lifetime cancer risk associated with inadvertent ingestion exposure to these soils is 3 x 10^{-12}. This value falls within the acceptable range established by EPA for waste site remediation. Metals found in the soils of Site No 13 generally occurred within installation background ranges or within the average concentration reported for typical soils. Lead and zinc were the only notable exceptions. The elevated levels of these metals may be attributed to metallic mineral complexes derived from the underlying bedrock (Litten, 1986).

Based upon the results of the baseline risk assessment, Site 13 has undergone the FS process to formulate, evaluate, and select remedial alternatives to address contaminated groundwater of the unconsolidated aquifer. The details of the FS are presented in Section 5.0. A subsurface drainage/off-site treatment remediation plan is recommended to address this contamination. Some data gaps do exist concerning the total extent of contamination. These data gaps will be addressed during the remedial design or immediately prior to the design.

The only remaining alternative for Site 13 is the subsurface drainage/offsite treatment remediation plan. The high concentration and toxicity of vinyl chloride at the site necessitates the implementation of an active restoration program for the groundwater within the unconsolidated aquifer. Based on site and waste conditions, and safety considerations, the subsurface drainage/ offsite treatment alternative is the only remaining feasible option.