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Remedial Investigation Report of Sites 1-9 at Alpens CRTC, Alpena MI. Volume I Sections 1-3.
A remedial investigation was performed on 9 sites at the Alpena CRTC to determine the extent of contamination at the sites. The sites involved in this investigation include: Site 1 POL Storage Area; Site 2 Motor Pool Area; Site 3 Former Garage; Site 4 Third Fire Training Area; Site 5 Second Fire Training Area; Site 6 Former Landfill; Site 7 First Fire Training Area; Site 8 Former Hanger 9; Site 10 Hazardous Waste Storage Area. Soil and groundwater contamination above state action levels was found at the sites. An FS has been initiated.

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INSTALLATION RESTORATION PROGRAM

FINAL
REMEDIAL INVESTIGATION REPORT

VOLUME I: SECTIONS 1 - 3

ALPENA COMBAT READINESS TRAINING CENTER
ALPENA COUNTY REGIONAL AIRPORT, MICHIGAN AIR NATIONAL GUARD
ALPENA, MICHIGAN

JUNE 1995



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HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
Environmental Restoration and Waste Management Programs
Oak Ridge, Tennessee 37831-7606
managed by MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the U.S. DEPARTMENT OF ENERGY under contract DE-AC05-84OR21400

FINAL

INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION REPORT

ALPENA COMBAT READINESS TRAINING CENTER,
ALPENA COUNTY REGIONAL AIRPORT
MICHIGAN AIR NATIONAL GUARD
ALPENA, MICHIGAN

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Submitted by:

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Oak Ridge, Tennessee 37831

For:

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REMEDIAL INVESTIGATION REPORT
ALPENA COMBAT READINESS TRAINING CENTER
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ACRONYMS AND ABBREVIATIONS

AGE	Aerospace Ground Equipment
AMS	Arts Manufacturing and Supply
ANG	Air National Guard
ANGRC	Air National Guard Readiness Center
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
B(a)a	benzo(a)anthracene
B(a)p	benzo(a)pyrene
B(b)f	benzo(b)fluoranthene
BCE	Base Civil Engineer
BEHP	Bis (2-ethylhexyl) Phthalate
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
C	Celsius
CCl_4	Carbon Tetrachloride
CDI	Chronic Daily Intake
CE	Civil Engineering
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Chy	Chrysene
CLP	Contract Lab Program
cm/day	centimeters per day
cm	centimeter(s)
cm/s	centimeters per second
COPC	Chemical of Potential Concern
Cr(III)	Chromium trivalent form
Cr(VI)	Chromium Hexavalent form
$Cr(OH)_3$	Isoluble chromium hydioxide
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CRDL	Contract Required Detection Limits
CRQL	Contract Required Quantitation Limits
CRTC	Combat Readiness Training Center
DBF	dibenzofuran
DCA	Dichloroethane
DCB	Dichlorobenzene
DCE	Dichloroethylene
DD	Decision Document

DL	Detection Limits
DOD	U.S. Department of Defense
DQO	Data Quality Objective
ECD	Electron Capture Detector
EMI	Electromagnetic Induction
EPA	U.S. Environmental Protection Agency
ER	Equipment Rinseates
ES	Executive Summary or Engineering-Science
F	Fahrenheit
FASP	Field Analytical Support Project
FB	Field Blanks
FG	Fighter Group
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
ft/day	feet per day
ft	foot/feet
ft/ft	foot (feet) per foot
ft^2/day	square feet per day
ft^2	square feet
FTA	Fire Training Area
g	gram
g/m^3	gram per cubi meter
g/ml	gram per mililiter
gm/kg	gram per kilogram
gal	gallon(s)
GC/MS	Gas Chromatography/Mass Spectrometry
GC	Gas Chromatograph
gpd	gallons per day
gpm	gallon(s) per minute
GSI	Groundwater-Surface Water Interface
ha	hectare(s)
HAZWRAP	Hazardous Waste Remedial Actions Program
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HMTC	Hazardous Materials Training Center
HQ	Hazard Quotient

I(1,2,3)	Indeno(1,2,3,c-d)pyrene
IARC	Internal Agency for Research on Cancer
ID	Inner Diameter
IRP	Installation Restoration Program
JP-4	Petroleum Jet Fuel #4
K	Hydraulic Conductivity
km	kilometer(s)
ℓ	liter(s)
ℓpm	liter(s) per minute
LCS	Laboratory Control Sample
LOAEL	Lowest Observed Adverse Effect Level
LQL	Lower Quantifiable Limit
µg/g	microgram(s) per gram
µg/ℓ	microgram(s) per liter
µg/kg	microgram(s) per kilogram
µg/m^3	microgram(s) per meter
µm	micrometer
m/m	meter(s) per meter
m	meter(s)
m^2	square meter(s)
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MDNR	Michigan Department of Natural Resources
MERA	Michigan Environmental Response Act
MF	Modifying Factor
mg/kg	milligram(s) per kilogram
mg/ℓ	milligram(s) per liter
mg/m^3	milligram(s) per meter
mi	mile(s)
MIANG	Michigan Air National Guard
ml	milliliter(s)
mm	millimeter(s)
MOC	Method of Characteristics
MOGAS	motorgasoline
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean Sea Level
MTBE	Methyl Tertiary Butyl Ether

NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollution Discharge Elimination System
OD	Outside Diameter
oz	ounce(s)
PA	Preliminary Assessment
PAH	Polynuclear Aromatic Hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCA	Tetrachloroethane
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene or Tetrachloroethylene
PD-680	Petroleum Distillate 680
Phen	Phenanthrene
PID	Photo Ionization Detector
POL	Petroleum, Oil, and Lubricants
ppb	part(s) per billion
ppm	part(s) per million
PPM	Priority Pollutant Metals
PRE	Preliminary Risk Evaluation
PS-661	Petroleum Solvent 661
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA\QC	Quality Assurance\Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RF	Response Factor
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
Sci-Tek	Science and Technology
SF	Slope Factors
SI	Site Investigation
SOP	Standard Operating Procedure
SOV	Soil Organic Vapor
SOW	Statement of Work

SQL	Sample Quantitation Limit
SRAP	Source Removal Action Plan
SVOC	Semivolatile Organic Compound
T	Transmissivity Values
TAL	Target Analyte List
TB	Trip Blanks
TBD	To Be Determined
TCA	Trichloroethane
TCE	Trichloroethene or Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TVOC	Total Volatile Organic Compound
UCL	Upper Confidence Limit
UF	Uncertainty Factor
USCS	Unified Soil Classification System
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WP	Work Plan
yd	yard(s)

EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report documents activities that Earth Tech (The Earth Technology Corporation) performed at the Michigan Air National Guard (MIANG), Alpena Combat Readiness Training Center (CRTC), Alpena County Regional Airport, Alpena, Michigan under the U.S. Department of Defense Installation Restoration Program (IRP). Fifteen disposal/spill sites were identified during the preliminary assessment (PA) (Hazardous Materials Training Center, 1985). The sites are in various stages of the IRP. The status of each site is listed in Table ES-1.

RI data collection activities for Sites 1 through 9 were initiated in November 1992 and completed in September 1993. The RI was conducted to:

- Determine the extent, magnitude, and movement of contamination
- Determine the threat of contamination to human health or the environment.

The RI was limited in scope to determining the extent, magnitude, and movement of contaminants in the shallow aquifer; the evaluation of the limestone aquifer was limited to a qualitative evaluation based on the geology and hydrogeology of the sites. This report presents the findings and conclusions from the RI activities and presents recommendations for the investigated sites.

Field Program

The field program was conducted from 1992-1993. Activities included: geophysical surveys; test pit excavations; well abandonment; soil, soil gas, and groundwater screening; drilling soil borings; installing monitoring wells; soil, sediment, surface water, and groundwater sampling; and aquifer testing. Established protocols for sampling, chain-of-custody, and quality assurance/quality control (QA/QC) were followed during the RI program. The results of the field program for geophysical surveys, test pit excavations, and well abandonment is described in a Technical Memorandum (The Earth Technology Corporation, April 1993.)

Results, Conclusions, and Recommendations

The results, conclusions, and recommendations are summarized by site. The analytical results were compared to the Michigan Act 307 Type A or B cleanup criteria. Type A criteria are local or default background concentrations. The Type B cleanup criteria are risk-based criteria with standardized exposure assumptions. Act 307 also provides for Type C cleanup criteria that are developed on a site-specific basis using site-specific exposure scenarios. A baseline risk assessment was performed for those sites that exceeded the Type A or B criteria as a first step in proposing a Type C cleanup criteria. A qualitative ecological assessment was also performed. Table ES-2 presents a summary of the recommendations for each site.

Table ES-1 Status of IRP Sites
MIANG, Alpena CRTC, Alpena, Michigan

Site Name	Site Status
Site 1 POL Storage Area	RI phase
Site 2 Motor Pool Area	RI Phase
Site 3 Former Site of County Garage	RI Phase
Site 4 Third Fire Training Area	RI Phase
Site 5 Second Fire Training Area	RI Phase
Site 6 Former Solid Waste Landfill	RI Phase
Site 7 First Fire Training Area	RI Phase
Site 8 Former Site of Hangar 9	RI Phase
Site 9 Radar Tower Site	RI Phase
Site 10 Hazardous Waste Storage Area	RI Phase as part of Site 2
Site 11 Underground Fuel Storage Area	SI Phase
Site 12 Salt Storage Area	No further action will be requested
Site 13 Mound Area next to Taxiway C	Approved no further action
Site 14 UST by Fire Station	SI Phase
Site 15 Oiled Roads	No further action will be requested
Site 16 JP-4 Refueler Parking Apron	SI Phase
Site 17 Old Kitchen Landfill	RI Phase as part of Site 4

Site 1 - POL Storage Area

Site 1- POL Storage Area was used for an unspecified time from 1952 until 1987. Fuels stored and dispensed at the site include JP-4 jet fuel and No. 2 fuel oil. Both aboveground and underground storage tanks were used at the facility.

Site 1 soils are sand-rich to a depth of approximately 10 feet (ft) below ground surface (bgs). An intermediate depth clay layer occurs at depths between 10 and 18 ft bgs which separates the shallow aquifer into a perched zone and a lower unconfined zone. No continuous clay unit was observed directly overlying the limestone bedrock, found at 41 ft bgs.

Results from the RI activities at Site 1 suggest that petroleum-based fuels have been released into the subsurface environment. Sources of the fuel released include the aboveground storage tanks, fuels offloading area, and the dispensers formerly at the site. Soils at Site 1 are generally free of chemicals exceeding the Act 307 Type A or B cleanup criteria. Chlorobenzene, ethylbenzene, and styrene were detected in one soil sample at concentrations exceeding the Act

Table ES-2 Recommendations for Phase II of the Remedial Investigation MIANG, Alpena CRTC, Alpena, Michigan

Site	Recommendations
Site 1 - POL Storage Area	■ Additional soil borings ■ Resample wells ■ Focused feasibility study
Site 2 - Motor Pool Area	■ Source removal for soils in drainage ditch ■ No further action for remaining site soils ■ Abandon Production Well PW2
Site 3 - Former Site of County Garage	■ Source removal action for soils ■ Resample wells ■ Sample piezometer CG3PZ1
Site 4 - Third Fire Training Area	■ Source removal for soils ■ Resample springs in the sinkhole ■ No further action on the groundwater
Site 5 - Second Fire Training Area	■ Focused feasibility study for soils and groundwater ■ Additional shallow aquifer wells
Site 6 and 7 - Former Solid Waste Landfill and First Fire Training Area	■ No further action for the soils ■ Resample wells ■ Additional sampling in the backwater area
Site 8 - Former Site of Hangar 9	■ No further action for the soil or groundwater
Site 9 - Radar Tower Site	■ No further action for soils ■ Establish institutional controls for groundwater use ■ Routine monitoring of shallow/deep well pair

307 criteria. No unacceptable carcinogenic risks were calculated for current or future exposure to Site 1 soils. One area of the site poses an unacceptable noncarcinogenic risk. This area corresponds to the location of a pre-existing, aboveground fuel storage tank. It is recommended that a focused feasibility study (FFS) be performed for this area of Site 1. Additional soil borings are recommended to better define the limits of contamination. Results from this sampling should be evaluated and if necessary additional areas should be included in the focused feasibility study.

Volatile organic compounds (VOCs) were detected in both the perched and lower sand layers of the shallow aquifer. Organic compounds (bromodichloromethane and dibromochloro-methane) exceeding the Act 307 Type B cleanup criteria in the lower zone of the shallow aquifer are not indicative of contamination that would have originated from Site 1. There are no current complete exposure pathways to the shallow groundwater. Evaluation of the future complete exposure pathways for groundwater indicates a potential carcinogenic risk, equaling but not exceeding the 1×10^{-6} acceptable risk level, from the domestic use of water from production well PW3. Well PW3 is not used as a water supply well for the facility. It is recommended that PW3 be abandoned to eliminate the potential future use of this well.

Groundwater contained in the shallow aquifer also discharges into the Thunder Bay River. Results obtained from the ecological risk assessment suggest future detrimental effects on the aquatic population in the river from exposure to metals (particularly chromium) contained in the shallow groundwater. It is recommended that the wells be redeveloped and resampled to ensure that representative total metals concentrations for the shallow aquifer were used in the risk evaluation. Sediment samples collected along the Thunder Bay River indicate no adverse impact from activities at Site 1. No further action is recommended for the sediments at Site 1.

The presence of the intermediate-depth clay layer and the analytical results obtained from the S1MW6/S1MW14 well pair suggest that groundwater quality in the limestone aquifer beneath Site 1 has probably not been adversely affected by the VOCs detected in the shallow aquifer beneath Site 1. Future effects could be evaluated by periodic sampling and trend analysis of VOC concentrations from groundwater contained within well S1MW14.

Site 2- Motor Pool Area

Site 2- Motor Pool Area includes Buildings 7 and 13 and the area between them, and the drainage culvert under 1st Avenue. The drainage culvert is included under a source removal action (The Earth Technology Corporation, June 1994). Wastes generated in the area were engine oil, waste fuel, spent solvents, carbon tetrachloride, chlorobromomethane, and protein foaming agents originating from fire extinguishers. The site includes underground storage tanks currently containing leaded gasoline and diesel fuel.

Site soils are composed predominantly of quartz sand underlain by a clay aquitard at least 3 ft in thickness which separates the shallow aquifer from the limestone bedrock aquifer. Groundwater exists within the shallow aquifer beneath Site 2 at depths between approximately 5 and 8 ft bgs and flows northwest. The saturated thickness of the shallow aquifer beneath Site 2 is approximately 50 ft. A low-permeability clay layer was sampled in two borings located approximately 500 ft apart.

Surface and subsurface soil samples were collected from the most probable sources of environmental contamination existing at Site 2, including the floor drain in front of the vehicle maintenance shop and the facility vehicle refueling underground storage tanks. No chemicals of concern were identified from the analytical results obtained from these soil samples. One detection of lead in a concentration exceeding the Act 307 Type A cleanup criteria was quantified in a surface soil sample located outside the site boundaries. These data were not included in the risk assessment. Based on the soils analytical data evaluated and included in this RI Report, no additional remedial actions are recommended for the soils within Site 2 beyond the remediation planned for the drainage culvert.

The fourth round of groundwater sampling showed that tetrachloroethylene and arsenic (dissolved) were detected at concentrations above the Act 307 Type B cleanup criteria. Groundwater analytical results suggest that the nature and extent of groundwater contamination in the shallow aquifer beneath Site 2 have been delineated. Unacceptable carcinogenic risks for adults and children would result from the use of groundwater from the shallow aquifer. Because only future use of the groundwater beneath Site 2 results in unacceptable risks, it is recommended that the MIANG institute controls to prohibit the use of shallow groundwater from beneath the area. Additionally, future unacceptable carcinogenic risks may occur through migration of Site 2 contaminants to production well PW2, which is screened in the shallow and limestone aquifers. It is recommended that PW2 be abandoned to eliminate this future risk to the limestone bedrock aquifer. If PW2 is abandoned, then there appears to be limited potential for interaction of the two aquifers.

Site 3 - Former Site of County Garage

Site 3 - Former Site of County Garage was used by Alpena County in the late 1940s until 1973 as a maintenance garage. Waste oils were reportedly used for dust control around the garage parking lot and roads.

Site 3 soils are composed mainly of quartz sand underlain by a clay aquitard approximately 10 ft thick, which separates the shallow aquifer from the limestone bedrock aquifer. Groundwater occurs at depths ranging from 11 to 19 ft bgs and flows northwest. The saturated thickness of the shallow aquifer beneath Site 3 is approximately 45 ft.

Surface and subsurface soil samples were collected during the RI from data gaps identified during an evaluation of the Site Investigation (SI) analytical results. The RI soils data were used in a quantitative risk assessment. Unacceptable carcinogenic risks due to exposure to Polynuclear Aromatic Hydrocarbons (PAHs) were calculated for current and future on-site personnel and future child populations under the current and future land use scenarios. Additionally, if construction activities were to be completed for this area of Site 3, excavation workers would be exposed to unacceptable carcinogenic risks from these same soils. The soils containing the PAHs are centered on CG3SB13. It is recommended that a removal action be performed for this area of Site 3.

No chemicals were identified above the Act 307 Type B cleanup criteria in the groundwater. However, VOCs were detected in the newly installed wells placed in the area where the wells

were abandoned in 1992. A hydrocarbon sheen was noted at the time of the well abandonment. It is recommended that the Site 3 wells be resampled to confirm the concentrations detected in the newly installed wells. It is also recommended that piezometer CG3PZ1, also located in the abandoned well area, be sampled. This piezometer was constructed such that it could be developed and sampled if necessary.

Based on the presence of the observed clay layer separating the shallow aquifer from the limestone aquifer, groundwater contained within each aquifer should have a very limited potential for interaction. The groundwater contained within the shallow aquifer is considered to have a low probability of adversely affecting groundwater quality in the limestone aquifer beneath Site 3.

Site 4 - Third Fire Training Area

Site 4 - Third Fire Training Area consists of a concrete pad, earthen dikes, and an underground pipeline through which fuel was pumped from tanker trucks to the concrete pad. This area was used for fire training exercises approximately 10 times per year between 1974 and 1984. JP-4 was the primary fuel used in the exercises.

Groundwater flow beneath the site is strongly influenced by the sinkhole. A clayey sand unit (approximately 2 to 5 ft thick) was observed on the north side of Site 4 during the RI drilling operations separating the shallow aquifer from the limestone. The subsurface unit sampled could probably not be considered a good-quality aquitard. However, a clay layer was described at the base of the shallow aquifer in wells TF4MW1, MW2, and MW3 (Engineering-Science 1990).

The nature and extent of soil contamination were assessed during previous investigations conducted at the site. These soils are included in a source removal action plan (The Earth Technology Corporation, June 1994).

Sediment samples collected from locations by the springs and in the gully leading to the sinkhole from Site 4 contained no compounds above Act 307 Type B cleanup criteria. Surface water samples from the springs and sinkhole contain no organic compounds above Act 307 Type B cleanup criteria. Copper and chromium were detected in the unfiltered water sample at levels exceeding the Act 307 groundwater-surface water interface criteria (GSI). No current complete exposure pathways exist for human exposure to sediment or surface water at the sinkhole. If future recreational activities occur at the sinkhole, no unacceptable health risks are indicated by the risk assessment. The ecological assessment suggests a current and future potential risk to aquatic receptors from metals present in the surface water and sediments at the sinkhole. This assessment was qualitative for the sediments. It is recommended that the springs be resampled to verify the concentrations detected.

No compounds above Act 307 cleanup criteria have been detected in four rounds of groundwater sampling. No chemicals of concern were selected from an evaluation of the Site 4 summer 1993 (Round IV) groundwater analytical results. Based on these analytical results, no remedial actions are recommended for the groundwater contained within the shallow aquifer beneath Site 4.

Because to date, the groundwater analytical results show no measurable adverse impact on

groundwater quality within the shallow aquifer beneath Site 4, it is unlikely that groundwater quality within the limestone aquifer has been adversely affected. Future affects could only be evaluated by periodic sampling and trend analysis of groundwater analyses from the Site 4 monitoring wells.

Site 5 - Second Fire Training Area

Site 5 - Second Fire Training Area consists of an open grassy field. The area was used for fire training exercises from 1965 to 1974. Approximately two to three training exercises were conducted each year using JP-4 fuel.

The shallow aquifer is composed of approximately 20 ft of soil, ranging in composition from clay to sandy gravel. Groundwater is encountered at a depth of 5 to 8 ft bgs and flows southeast toward the sinkhole and west towards the river. The presence of a clay layer between the shallow aquifer and the limestone bedrock was not confirmed at all the locations sampled beneath Site 5.

An area of soil contamination was previously identified at Site 5. Benzene and lead were detected in soils at Site 5 at concentrations exceeding the Act 307 cleanup criteria. A focused FS has been recommended.

Groundwater samples collected from the shallow aquifer contain organic compounds, particularly benzene, in concentrations exceeding the Act 307 Type B cleanup criteria. No current complete exposure pathways are present at Site 5. The only future exposure pathway is ingestion of contaminated fish from Lake Winyah. The shallow aquifer beneath Site 5 is considered too shallow to support a domestic well, and therefore no groundwater pathways were considered. No future unacceptable risk exists for ingestion of fish from Lake Winyah. No ecological risks were identified at Site 5.

Groundwater analytical results (both on-site gas chromatograph analysis and analytical laboratory) suggest that contaminant migration within the shallow aquifer contains a component of downward movement. These data suggest that groundwater flow and contaminant migration are complex beneath Site 5, and that the extent of shallow groundwater contamination beneath the site may not be fully delineated. It is recommended that wells be installed to monitor the lower zone of the shallow aquifer at locations SF5MW5 and SF5MW6. A focused FS is also recommended for the shallow groundwater at Site 5.

The data collected during the RI suggest the possibility that groundwater contained within the shallow aquifer could be migrating down into the limestone aquifer.

Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area

Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area consist of the dirt road and the landfill adjacent to it. The landfill was reportedly used to dispose of waste paints, spent solvents, oils, and waste fuels in addition to garbage and refuse. The FTA was used from 1952 until 1965. Waste fuels, waste oils, and spent solvents were ignited on what is now the dirt road

during these exercises. The area lacked formal containment structures, such as berms and dikes.

Native soils are sandy to a depth of 9 ft bgs. An interbedded sand/sandy clay/clay unit approximately 10 ft thick separates the upper unit from a lower sand unit. The shallow aquifer water table is roughly coincident with the top of the interbedded sand/sandy clay/clay unit. Groundwater within the shallow aquifer beneath Sites 6 and 7 flows west toward the river and southeast toward the sinkhole. The presence of a clay layer beneath the shallow aquifer and the limestone bedrock was not confirmed.

The analytical results obtained during the SI for the surface and subsurface soils at Sites 6 and 7 were not used to perform a risk assessment, but were evaluated with respect to the chemical-specific Act 307 Type A and B cleanup criteria. Only lead, selenium, and zinc were detected in site soils above the Act 307 Type A cleanup criteria. The few occurrences of these compounds exceeding the Act 307 Type A cleanup criteria are considered outliers and are not associated with past fire training or waste disposal activities. Based on these analytical results, no further remedial actions should be taken for the soils beneath Sites 6 and 7.

A groundwater divide exists beneath Sites 6 and 7. Groundwater quality is being monitored on either side of this divide. The analytical results suggest that although organic compounds and inorganic analytes are being detected in the groundwater samples, only one well, LF6MW3, contains or has contained compounds exceeding the Act 307 Type A or B cleanup criteria. The analytical results further suggest that the extent of contamination down gradient of LF6MW3 has been delineated. No current complete groundwater exposure pathways were identified for the site. The shallow aquifer beneath the site was assumed to be too thin to support a domestic well; therefore, no future groundwater exposure pathways were evaluated.

No chemicals of concern were identified for the current surface water pathway. Future chemicals of concern are those chemicals present in the groundwater. No unacceptable human health risk was identified for the future surface water exposure pathways for the adult or child receptors. Potential ecological risks from metals were identified based on groundwater results from the edge of the landfill (LF6MW9). It is recommended that the wells at Sites 6 and 7 be redeveloped and resampled to verify the concentration of metals present in the groundwater.

Chemicals of concern were identified in the sediments of the backwater area of Lake Winyah. This area is not currently used, and no current complete human exposure pathways exist. If receptors are exposed in the future an unacceptable carcinogenic risk may exist. Potential current ecological risks were also identified. The three samples from the backwater area were obtained from the edge of the landfill and were reported to contain asphalt-like particles. It is likely that the PAHs in the sediment will decrease further away from the landfill. Because this is an ecologically sensitive area, it is recommended that additional sediment samples be obtained to further characterize the backwater area.

VOCs exceeding the Act 307 Type B cleanup criteria occur in the lower portion of the shallow aquifer (based on the results from LF6MW3) and no clay layer was observed beneath the site that might prohibit the migration of contaminated groundwater to the limestone aquifer. These data suggest that a potential exists for groundwater quality in the lower aquifer to be adversely affected

by contaminated groundwater contained within the shallow aquifer.

Site 8 - Former Site of Hangar 9

Site 8 - Former Site of Hangar 9 is located northwest of the control tower. The foundation of the old hangar contains six floor drains. This site was not identified during the PA, but was identified during soil vapor monitoring of the area. Sampling activities conducted at Site 8 were focused on soil and groundwater beneath the floor of the former Hangar 9 and the area surrounding Building 320.

The shallow aquifer is approximately 60 ft thick beneath Site 8. The data suggest that there is no well-defined clay layer separating the shallow aquifer from the bedrock. Groundwater flow in the shallow aquifer beneath the site is to the northwest toward the sinkhole.

RI soil and groundwater sampling activities completed for the site were concentrated in the floor of the old Hangar 9 and the area surrounding Building 320. No organic compounds were detected in the site soils above Act 307 Type B cleanup criteria. Antimony and lead were detected in one surface soil sample at concentrations above Act 307 Type A cleanup criteria. Tetrachloroethylene was detected in samples from HN8MW3 during the fourth round of sampling and during previous rounds at concentrations exceeding the Act 307 Type B cleanup criteria. No inorganic analytes have ever been detected in the filtered samples exceeding the Act 307 Type A cleanup criteria. Soil and groundwater analytical results suggest that the nature and extent of contaminated media have been delineated. The Site 8 risk assessment determined that no current or future populations were exposed to unacceptable carcinogenic or noncarcinogenic risks through exposure to site soils or groundwater. Based on the soil and groundwater analytical data evaluated during this RI report, no further remedial actions are recommended for the soils at and the groundwater contained within the shallow aquifer beneath Site 8.

A relatively small vertical gradient exists between the upper and lower zones of the shallow aquifer beneath the site. Groundwater contained in the shallow aquifer appears to have little tendency to flow vertically down through the shallow aquifer toward the limestone aquifer. These data suggest there is a relatively low potential for groundwater contained in the shallow aquifer to be migrating vertically down into the limestone aquifer and affecting groundwater quality in the limestone aquifer.

Site 9- Radar Tower Site

Site 9- Radar Tower Site was not identified during the PA, but was identified during a soil gas survey of the area. The Aerospace Ground Equipment (AGE) Maintenance Shop (Building 417) is located within this area.

RI activities conducted at Site 9 concentrated on areas surrounding the AGE shop. The shallow aquifer is approximately 60 ft thick beneath Site 9. Data suggests that there is no well-defined clay layer separating the shallow aquifer from the bedrock. A relatively large vertical gradient exists between the upper and lower zones of the shallow aquifer beneath the site.

Soil samples were selected from the most probable source areas (based on the soil organic vapor survey) within Site 9. No chemicals of concern (i.e., compounds exceeding the Act 307 Type A or B cleanup criteria) were determined from an evaluation of the RI analytical soil results. Based on this evaluation, it is recommended that no further remedial actions be completed for the Site 9 soils.

Groundwater analytical results suggest that the nature and extent of groundwater contamination in the shallow aquifer beneath Site 9 have been delineated. No current complete groundwater exposure pathways were identified for Site 9. Future shallow aquifer groundwater exposure pathways were evaluated. Future acceptable noncarcinogenic risks were quantified for all receptors potentially using the shallow groundwater. Future unacceptable carcinogenic risks were calculated for children and adults using site groundwater for recreational and domestic-type uses, and for adult employees potentially using the groundwater beneath Site 9. Because only future use of the groundwater beneath the site results in unacceptable risks, it is recommended that the MIANG institute controls to prohibit the use of shallow groundwater from beneath the area.

The analytical data suggest that contaminants are not migrating vertically within the water column beneath the site. Because no clay layer was observed during the drilling operations separating the shallow aquifer from the limestone aquifer beneath Site 9, there is no barrier that could prevent groundwater from migrating into the limestone aquifer. Based on these data there exists a medium to high potential that the limestone aquifer could be adversely affected by contaminated groundwater occurring in the shallow aquifer. It is recommended that the shallow /deep well pair be routinely monitored to detect any migration toward the limestone aquifer.

Production Wells

Six production wells exist on the facility. PW4, PW5, and PW6 are up gradient of the sites and were only sampled during the 1987 initial round of sampling. No compounds were detected above the Act 307 Type A or B cleanup criteria. PW1, PW2, and PW3 have been sampled for four rounds. No organic compounds were detected in the fourth round at concentrations exceeding the Act 307 Type B cleanup criteria in PW1 or PW2. Carbon tetrachloride above Act 307 Type B cleanup criteria was detected in PW3. No inorganic analytes above Act 307 Type A cleanup criteria were detected in PW3. PW1 and PW2 are screened in the limestone aquifer. There is insufficient information available from the facility to quantify local background chemistry for the limestone aquifer.

It is recommended that PW2 and PW3 be abandoned. PW2 is screened in both aquifers and the method of construction may provide a conduit for contaminant migration between the two aquifers. PW3 is screened in the shallow aquifer. VOCs have been detected in this well at concentrations which may pose an unacceptable health risk.

1.0 INTRODUCTION

This report documents the Remedial Investigation (RI) activities Earth Tech (The Earth Technology Corporation) performed at the Alpena Combat Readiness Training Center (CRTC), Alpena County Regional Airport, Michigan Air National Guard (MIANG), Alpena, Michigan, under the U.S. Department of Defense (DOD) Installation Restoration Program (IRP). The field activities were conducted between November 1992 and September 1993. The RI activities were performed in accordance with the Final Remedial Investigation Work Plan (WP), Sampling and Analysis Plan (SAP) (The Earth Technology Corporation, December 1992), and WP Addendum (The Earth Technology Corporation, August 1993).

1.1 INSTALLATION RESTORATION PROGRAM DESCRIPTION

The objectives of the IRP are: to identify and quantify environmental problems caused by hazardous materials used or disposed of at DOD installations; to evaluate the development of feasible remedies for identified problems; and to remediate these problems. The five phases that constitute the IRP process and the purpose and activities associated with each phase are presented below.

- Preliminary Assessment - A Preliminary Assessment (PA) is performed to identify and evaluate the type and location of suspected problems associated with past hazardous waste handling procedures, disposal sites, and spill sites. This is accomplished through interviews with past and present facility employees, historical records searches, and visual site inspections. Detailed geologic, hydrologic, meteorologic, land use, and environmental data for the area of study are also gathered. A detailed analysis of all information obtained identifies sites of concern. The PA for Alpena CRTC was completed by Hazardous Materials Training Center (HMTC) in 1985 (Hazardous Materials Training Center, 1985).

- Site Investigation - The purpose of a Site Investigation (SI) is to acquire the necessary data to either confirm or deny the existence of suspected environmental contamination at each identified site of concern and to preliminarily evaluate the potential risks to human health, welfare, and the environment. The SI includes identification of specific chemical contaminants and their concentrations in environmental media and evaluates the potential for contaminant migration through site-specific hydrogeologic determination. Engineering-Science performed the SI for Sites 2 through 9 in 1987 (Engineering-Science, 1990) and Earth Tech performed an abbreviated SI for Sites 1, 10, 11, 14, and 16 in 1992 (The Earth Technology Corporation, April 1993).

- Remedial Investigation - An RI is conducted to acquire the necessary data to define the extent of confirmed environmental contamination and to further assess the associated potential risks to human health, welfare, and the

environment. The RI quantifies the magnitude and extent of contamination at the sites under investigation and identifies the specific chemical contaminants present and their concentrations in environmental media. A determination is also made as to the potential for contaminant migration by assessing site-specific hydrogeologic and contaminant characteristics. Earth Tech performed the RI between November 1992 and September 1993.

- Feasibility Study - The objective of a Feasibility Study (FS) is to develop the remedial action alternative that mitigates confirmed environmental contamination at each site and meets the applicable or relevant and appropriate requirements (ARARs). The FS considers risk assessments and cost benefit analyses in providing the necessary data, direction, and documented supportive rationale to acquire regulatory concurrence (federal, state, and local) with the recommended remedial alternative. The FS evaluates, develops, and provides recommendations for remedial actions at each site where remediation is required.

- Remedial Design - The Remedial Design (RD) phase provides engineering design drawings and construction specifications required to implement the recommended remedial action selected through the FS process. Implementation of the remediation plan requires appropriate regulatory acceptance.

1.2 REMEDIAL INVESTIGATION OBJECTIVES FOR ALPENA CRTC

The RI activities documented herein were conducted to define the nature and extent of contamination in the shallow aquifer and to evaluate the threat to human health and the environment. These RI activities consisted of: surface geophysical surveys; soil organic vapor surveys; test pit excavations; soil boring and monitoring well installation; and soil, sediment, surface water, and groundwater sampling and analysis. The field events were focused on the shallow soils and aquifer underlying the facility.

Existing below the shallow aquifer is a limestone bedrock aquifer which is used in the area surrounding the facility as a source of domestic water. At the sinkhole, located in the north-central portion of the facility, groundwater is discharging from the shallow aquifer and entering the limestone aquifer. Away from the sinkhole the hydraulic relationship between the two aquifers is unknown. At some localities beneath the facility the bedrock aquifer is separated from the shallow aquifer by a clay layer (Engineering-Science, 1990). This clay layer, where present, may be functioning as an aquitard and prohibiting the mixing of groundwaters contained in each aquifer. An additional site-specific goal of the RI was to acquire data to better define the occurrence of the basal clay layer of the shallow aquifer.

A qualitative assessment has been made of the risk to the limestone aquifer from groundwater contamination occurring within the shallow aquifer. This evaluation is based upon the chemistry and hydrogeology of the shallow aquifer and is provided for each site under investigation. These evaluations are included with the conclusions and recommendations (Section 5.0).

1.3 REPORT ORGANIZATION

This RI report contains the following sections:

- Section 1 - Introduction. The remainder of this section summarizes the history of the facility; the specifics of each individual site; and the previous studies conducted at the facility.
- Section 2 - Field Program. This section describes the activities, methods, and procedures used to determine the presence or absence of environmental contamination. This section addresses background sampling and the disposal of wastes generated during the RI field program.
- Section 3 - Significance of Results. This section provides the geologic, hydrogeologic, and chemical results obtained during the RI program along with the significance of the results. Results from previous studies are included where appropriate.
- Section 4 - Baseline Risk Assessment. In this section, a baseline human health risk assessment is presented for those sites which exceed Michigan Department of Natural Resources (MDNR) Act 307 Type B cleanup criteria. A qualitative ecological risk assessment is also presented in this section.
- Section 5 - Conclusions and Recommendations. This section presents a site-by-site result summary, conclusions of the RI findings, and recommendations for any future IRP activities.
- Section 6 - Bibliography. This section presents the references cited throughout the RI document.

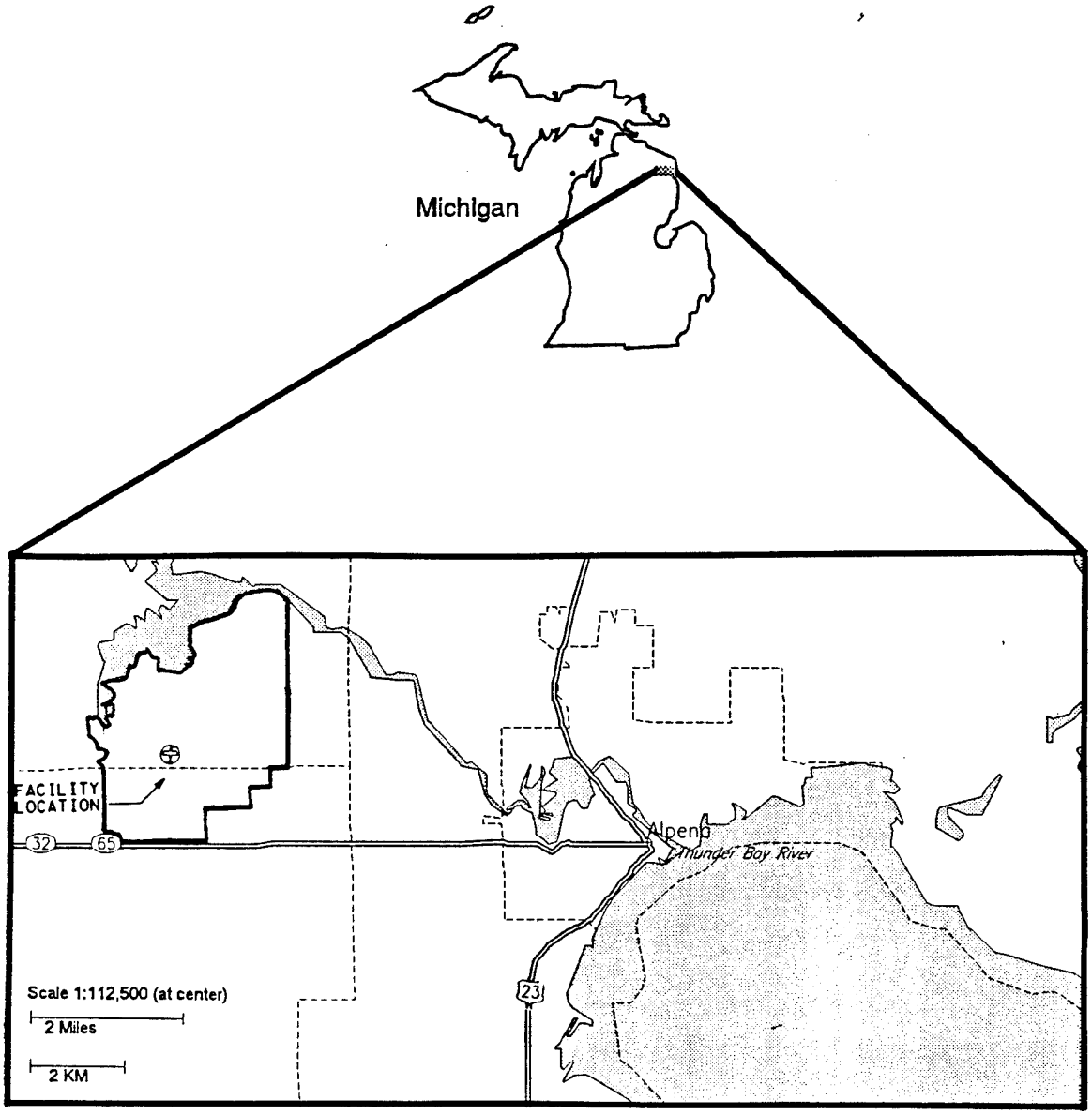
1.4 FACILITY BACKGROUND

The history of Alpena CRTC and a description of each of the sites that were investigated as part of this RI are presented in the following sections.

1.4.1 Facility Description

The Alpena CRTC is located approximately 8 kilometers (km) (5 miles [5 mi]) west of the city of Alpena at the Alpena County Regional Airport. The regional location of the facility is shown in Figure 1-1. The Alpena CRTC occupies approximately 1,100 hectares (ha) (2,700 acres) of land. Of this total, approximately 273 ha (675 acres) are designated for exclusive use by the MIANG, about 110 ha (272 acres ha (1,775 acres and the county. The facility is bordered by the south branch of the Thunder Bay River and Lake Winyah on the west and north, respectively (Figure 1-2).

ALPENA COMBAT READINESS TRAINING CENTER
MICHIGAN AIR NATIONAL GUARD
ALPENA, MICHIGAN



TETC101

LEGEND

- State route
- Large town
- U.S. route
- Airfield
- Boundary
- State highway
- U.S. highway
- Airport
- Open water

N

Source: DeLorme Mapping

The Earth Technology Corporation

Figure 1-1

Regional Location Map
Alpena Combat Readiness Training Center, MIANG
Alpena County Regional Airport
Alpena, Michigan

RI SITES

SITE 2 MOTOR POOL AREA
SITE 3 FORMER SITE OF COUNTY GARAGE
SITE 4 THIRD FIRE TRAINING AREA
SITE 5 SECOND FIRE TRAINING AREA
SITE 6 FORMER SOLID WASTE LANDFILL
SITE 7 FIRST FIRE TRAINING AREA
SITE 8 FORMER SITE OF HANGAR 9
SITE 9 RADAR TOWER SITE

SI SITES

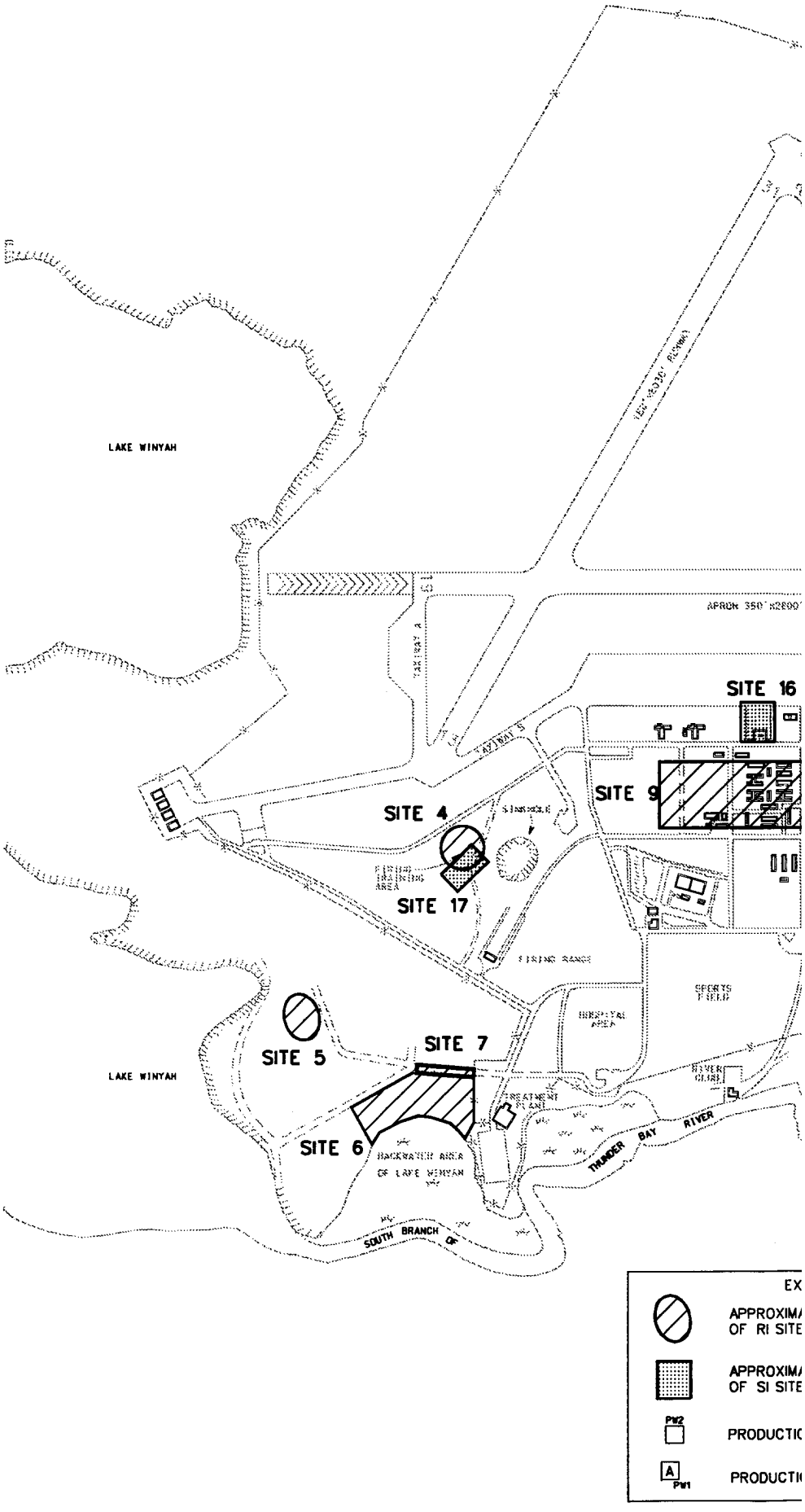
SITE 1 POL STORAGE AREA
SITE 10 HAZARDOUS WASTE STORAGE AREA
SITE 11 UNDERGROUND FUEL STORAGE AREA
SITE 14 UST BY FIRE STATION
SITE 16 JP-4 REFUELER PARKING APRON

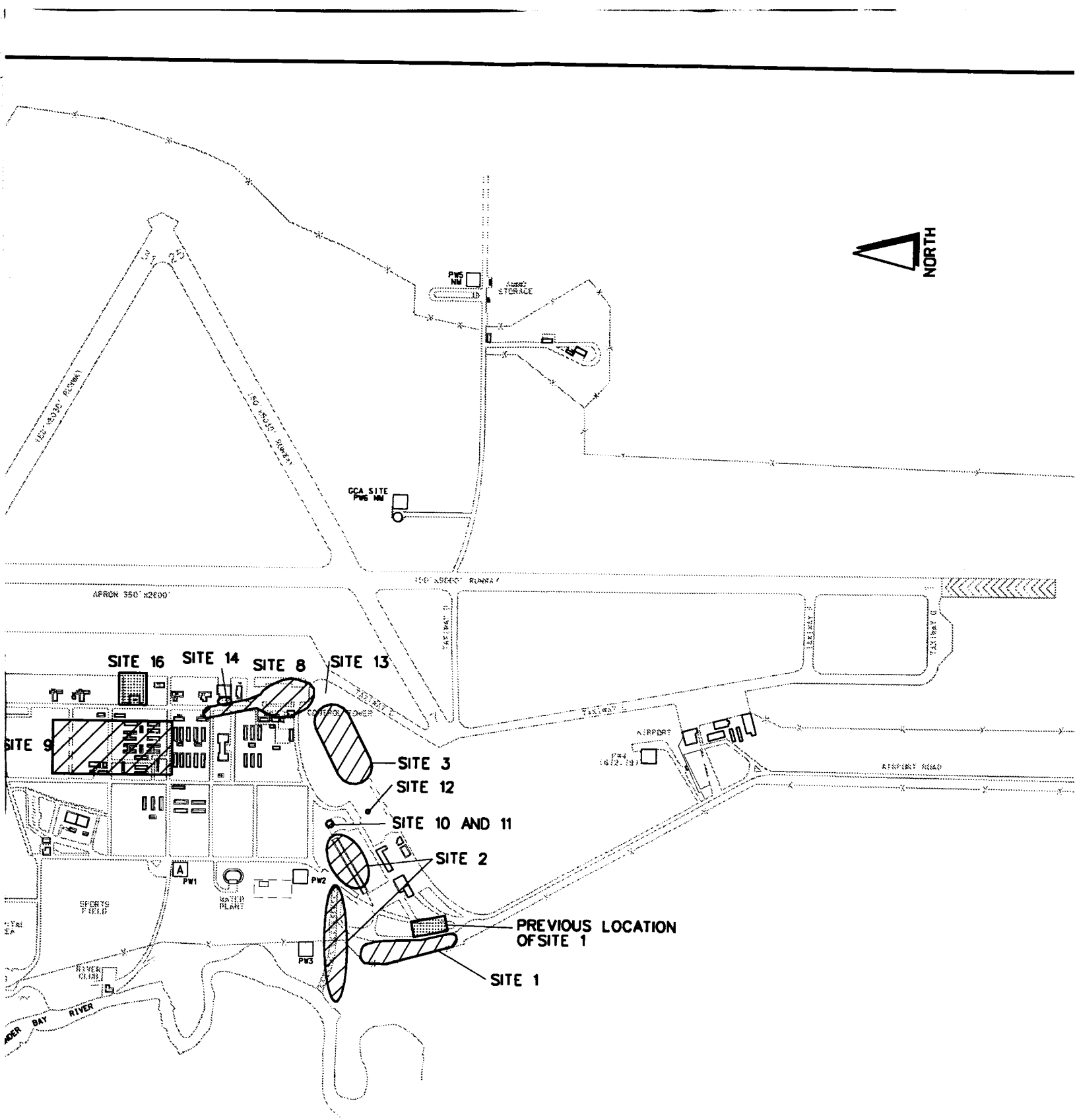
COMPLETED SITES

SITE 13 MOUND AREA NEXT TO T/WC

SITES PROPOSED FOR COMPLETION

SITE 15 OILED ROADS
SITE 17 OLD KITCHEN LANDFILL





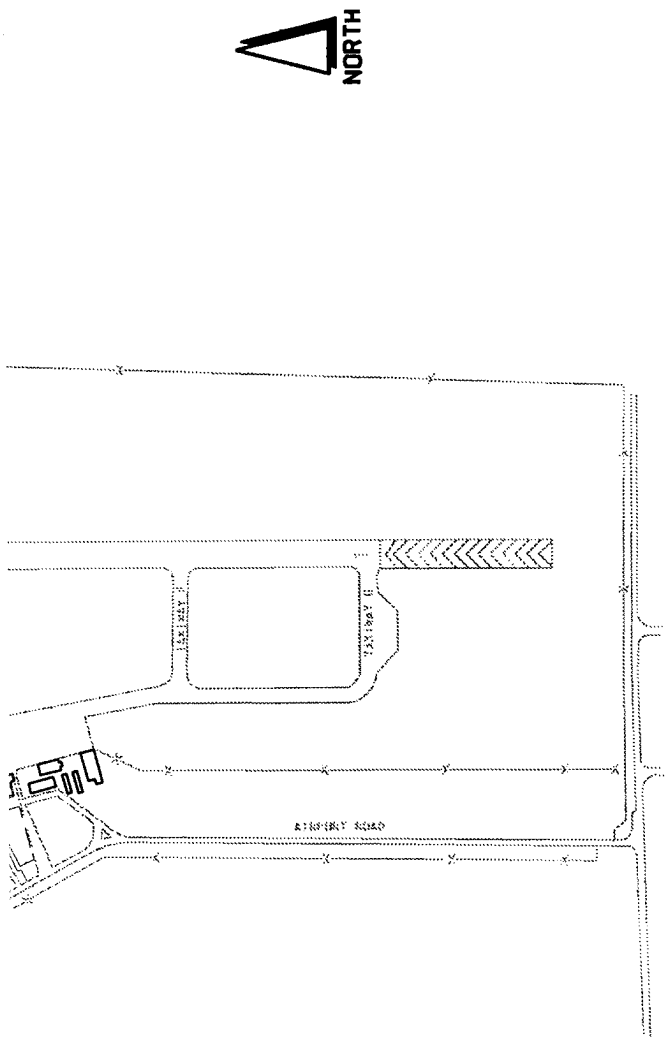
The Earth Technology Corporation

PROJECT NO. MIANG
Alpena C
Alpena, Mi

DRAFT

LOCATIONS O
IRP SITES

6-94



The Earth Technology Corporation

PROJECT NO. 928901
MIANG
Alpena CRTC
Alpena, Michigan

DRAFT

LOCATIONS OF IRP SITES

6-94

Figure 1-2

1.4.2 Facility History

The Alpena CRTC has used the facility as a training field since 1952 under a joint use agreement with Alpena County. Training takes place year-round with the greatest influx of personnel occurring during the months of April through September. Past operations involved the use of hazardous materials in the servicing of aircraft. The hazardous materials or waste associated with these operations were disposed of in a variety of ways. The Alpena CRTC has had no assigned aircraft since the mid-1950s except for the period between 1964 to 1972 when a detachment of aircraft and personnel were on 24-hour intercept alert.

1.5 PREVIOUS PROGRAM ACTIVITIES

A PA was conducted at Alpena CRTC in 1985 (Hazardous Materials Training Center, 1985). Previous field studies included geophysical and soil gas investigations and were conducted in 1985 (Lockheed Engineering , 1987). The SI was completed in 1990 (Engineering-Science, 1990). The status of all sites is summarized in Table 1-1. The history of the sites is detailed in the following subsections.

1.5.1 Preliminary Assessment

The PA was conducted in 1985. Activities included a detailed review of pertinent installation records and two on-site facility visits including interviews with past and present employees. At that time, 15 past disposal and/or spill sites were identified. Of these 15 sites, the following 7 were recommended for further evaluation:

Site 1:	Petroleum, Oil and Lubricants (POL) Storage Area
Site 2:	Motor Pool Area
Site 3:	Former Site of County Garage
Site 4:	Third Fire Training Area
Site 5:	Second Fire Training Area
Site 6:	Former Solid Waste Landfill
Site 7:	First Fire Training Area

Geophysical and soil gas testing performed after the PA and prior to the initiation of the SI (Lockheed Engineering and Management, February 1987) resulted in the deletion of Site 1 from further investigation. Site 8 (former Site of Hangar 9) and Site 9 (Radar Tower Site) were added to the site investigation lists as a result of this testing. A total of eight sites were included in the original site investigation.

The remaining eight sites were not evaluated because it was thought that they exhibited no potential for contaminant migration, thereby posing no significant hazard to health or welfare. These eight sites are as follows:

Site 10:	Hazardous Waste Storage Area
Site 11:	Underground Fuel Storage Tank
Site 12:	Salt Storage Area
Site 13:	Mound Area next to T/WC

Table 1-1 Status of IRP Sites
MIANG, Alpena CRTC, Alpena, Michigan

Site Name		Site Status
Site 1	POL Storage Area	RI Phase
Site 2	Motor Pool Area	RI Phase
Site 3	Former Site of County Garage	RI Phase
Site 4	Third Fire Training Area	RI Phase
Site 5	Second Fire Training Area	RI Phase
Site 6	Former Solid Waste Landfill	RI Phase
Site 7	First Fire Training Area	RI Phase
Site 8	Former Site of Hanger 9	RI Phase
Site 9	Radar Tower Site	RI Phase
Site 10	Hazardous Waste Storage Area	RI Phase as part of Site 2
Site 11	Underground Fuel Storage Area	SI Phase
Site 12	Salt Storage Area	No further action will be requested
Site 13	Mound Area next to Taxiway C	Approved no further action
Site 14	UST by Fire Station	SI Phase
Site 15	Oiled Roads	No further action will be requested
Site 16	JP-4 Refueler Parking Apron	SI Phase
Site 17	Old Kitchen Landfill	RI Phase as part of Site 4

Site 14: Underground Storage Tank by Fire Station
Site 15: Oiled Roads
Site 16: Jet Petroleum (JP)-4 Refueler Parking Apron
Site 17: Old Kitchen Landfill

Decision documents (DDs) were submitted to the MDNR for Site 1 and seven of the eight sites which exhibited no potential for contaminant migration. No further action since no facility operations which could have caused contamination occurred at Site 12, the Salt Storage Area, the site was referred to Alpena County, which had originally stored the salt at the site. DDs for Sites 10 and 17, will be resubmitted based on RI findings at Sites 2 and 4, which are coincident with Sites 10 and 17 respectively. The remaining sites were evaluated under an abbreviated SI (The Earth Technology Corporation, November, 1993).

1.5.2 Site Investigation

The original SI activities for Sites 2 through 9 were conducted at Alpena CRTC between 1987 and 1988, and the final SI report was completed in 1990 (Engineering-Science, 1990). It

recommended that further IRP action be implemented at four of the eight sites at the facility. MDNR requested additional activities at all sites. Site 3 was deferred to Alpena County since no facility activities occurred at that site which would cause contamination. In October 1991, an additional round of groundwater sampling was performed to collect data necessary for the preparation of the RI WP. An abbreviated SI for Sites 1, 11, 14, and 16 was performed in 1992 (The Earth Technology Corporation, November 1993). The abbreviated SI consisted of site-specific actions requested by MDNR. Based on the abbreviated SI results, a recommendation was made for further IRP action at Site 1 and DDs were recommended for Sites 11, 14, and 16. Site 1 was subsequently added to the RI program through an addendum to the WP (The Earth Technology Corporation, August 1993). Site 3 was added back into the RI program when efforts to transfer the site to the county failed.

Results of the analyses completed on the groundwater samples collected during the SI and third round of groundwater sampling are presented in Section 3 under results and discussion for each site. A summary of the field activities which occurred prior to the RI is presented in Table 1-2.

1.6 SITE DESCRIPTIONS

Site 1 and all eight sites investigated during the original SI were investigated during the RI field investigations. Descriptions for each site are presented in the following subsections.

1.6.1 Site 1 - POL Storage Area

Site 1 consisted of various abandoned aboveground storage tanks, associated distribution lines, and dispensers. The Site 1 POL area was used for an unspecified amount of time during the period beginning in 1952 and ending in July 1987 when it was dismantled and the new POL area west of Site 9 was put into use. Fuels stored and dispensed at the Site 1 POL facility were JP-4 jet fuel, motor gasoline (MOGAS), and No.2 fuel oil. JP-4 was stored in aboveground tanks with a total capacity of approximately 1,700,000 liters (ℓ) (447,000 gallons [gal]) (Hazardous Materials Training Center, 1985). No.2 fuel oil was used throughout the facility and stored in both aboveground and underground storage tanks. The POL area also maintained three aboveground storage tanks with an approximate capacity of 38,000 ℓ (10,000 gal) which may have been used to store No.2 fuel oil. According to the PA, all MOGAS used at the facility was stored in underground tanks.

The Site 1 boundary was originally thought to be located within the grassy area directly adjacent to First Avenue. However, after additional discussions with facility personnel and a review of existing aerial photographs of the old POL area, it was determined that the location of Site 1 is actually immediately west of the previously identified location of Site 1 (Figure 1-2) and is situated within the existing gravel-covered parking area of the former POL area (Figure 1-3). Figure 1-4 illustrates the layout of the POL area when it was operational.

Most of the site is now a gravel-covered parking lot. Adjacent to the gravel-covered parking area just east of R/G road is a grassy field, while the area just east of Building 38 is a grassy area with many trees present. West of the deer fence around the perimeter of Site 1 is a heavily forested area that is continuous to the west to the Thunder Bay River. All structures

Table 1-2 Summary of IRP Activities Prior to RI
MIANG, Alpena CRTC, Alpena, Michigan

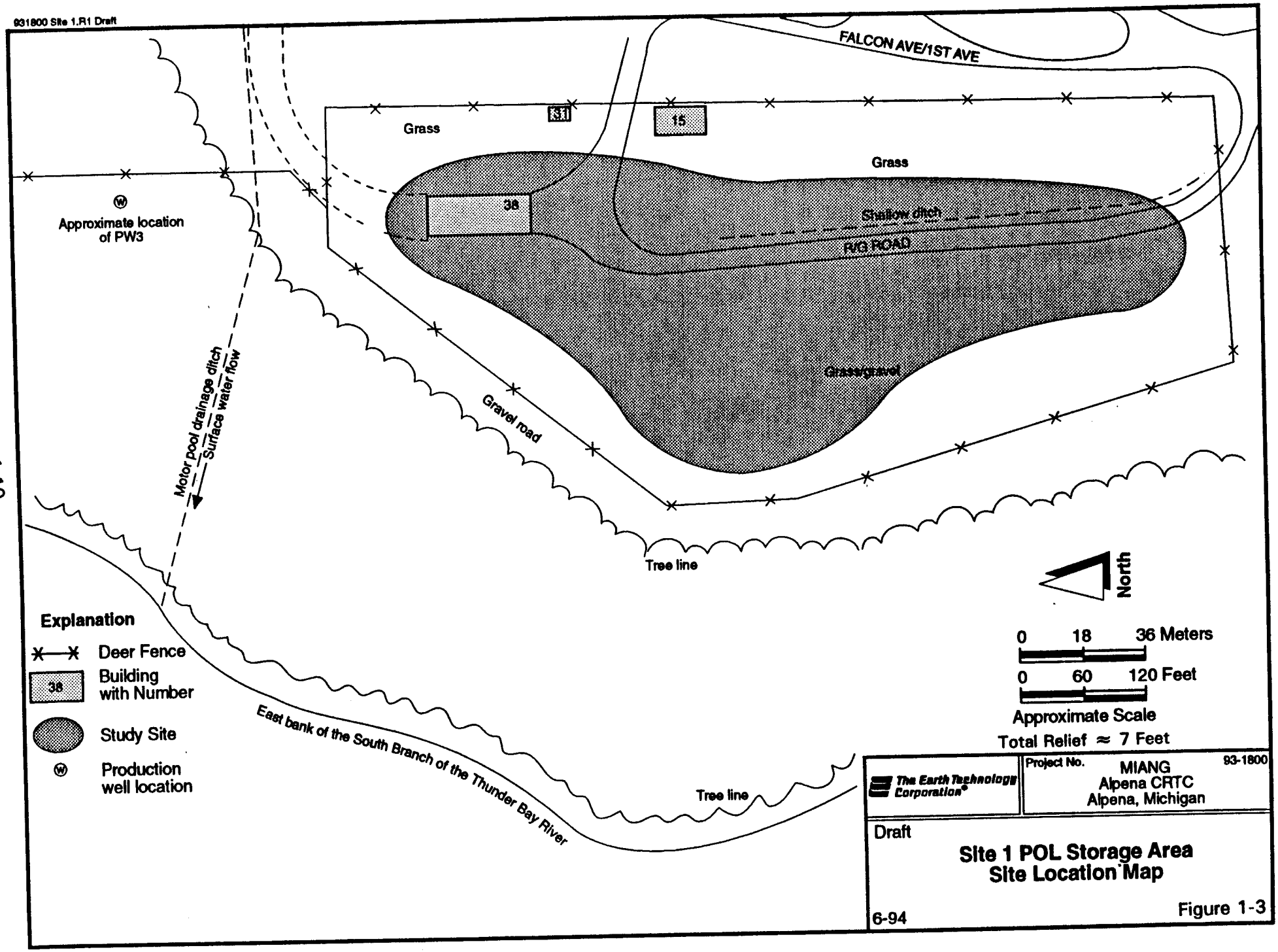
Site	Soil Gas Survey Points	Geophysical Survey Grids	Soil Boring Installed	Soil Borings Samples	Monitoring Wells Installed	Groundwater Samples	Surface Water Samples	Sediment Samples
1	22		3					
2	4		2	4	5	15	3	5
3	15		10	21	5	15		
4	11	1	5	12	4	12	8	9
5	24		4	10	4	12		
6	7	1	6	9	3	9	3	3
7	20		4	8				
8	8	1	1	5	4	12		
9	26	1	6	14	5	15		
Production Wells						15		

at the POL area were dismantled in 1987. The only existing structure at Site 1 is Building 38, which was constructed in 1991, and is used to store equipment for the roads and grounds personnel.

In May 1983, one of the former aboveground storage tanks located southwest of Building 15 released approximately 1,900 to 3,000ℓ (500 to 800gal) of JP-4. It was reported by facility personnel that within minutes nearly 90 percent of the spilled fuel was recovered and the remainder evaporated or was absorbed into the ground. The PA visual site inspection in August 1984 (Hazardous Materials Training Center, 1985) found no environmental stress due to contamination.

1.6.2 Site 2 - Motor Pool Area

Site 2 is referred to as the Motor Pool Area, which includes Buildings 7 and 13 and the area between them, and the drainage culvert under 1st Avenue. The drainage culvert conducts surface runoff from the Motor Pool area to the South Branch of the Thunder Bay River (Figure 1-5). The ground surface of the Motor Pool area between Buildings 7 and 13 is covered by asphalt. Adjacent to Site 2 are several grassy fields. The wastes generated in the area were engine oil, waste fuel, spent solvents, carbon tetrachloride, chlorobromomethane, and protein foaming agents originating from fire extinguishers. The site includes underground tanks currently containing leaded gasoline and diesel fuel. During the SI, petroleum hydrocarbons were found in site soil, surface water, sediment, and groundwater. A source removal action is planned for the drainage ditch portion of the site (The Earth Technology Corporation, June 1994).



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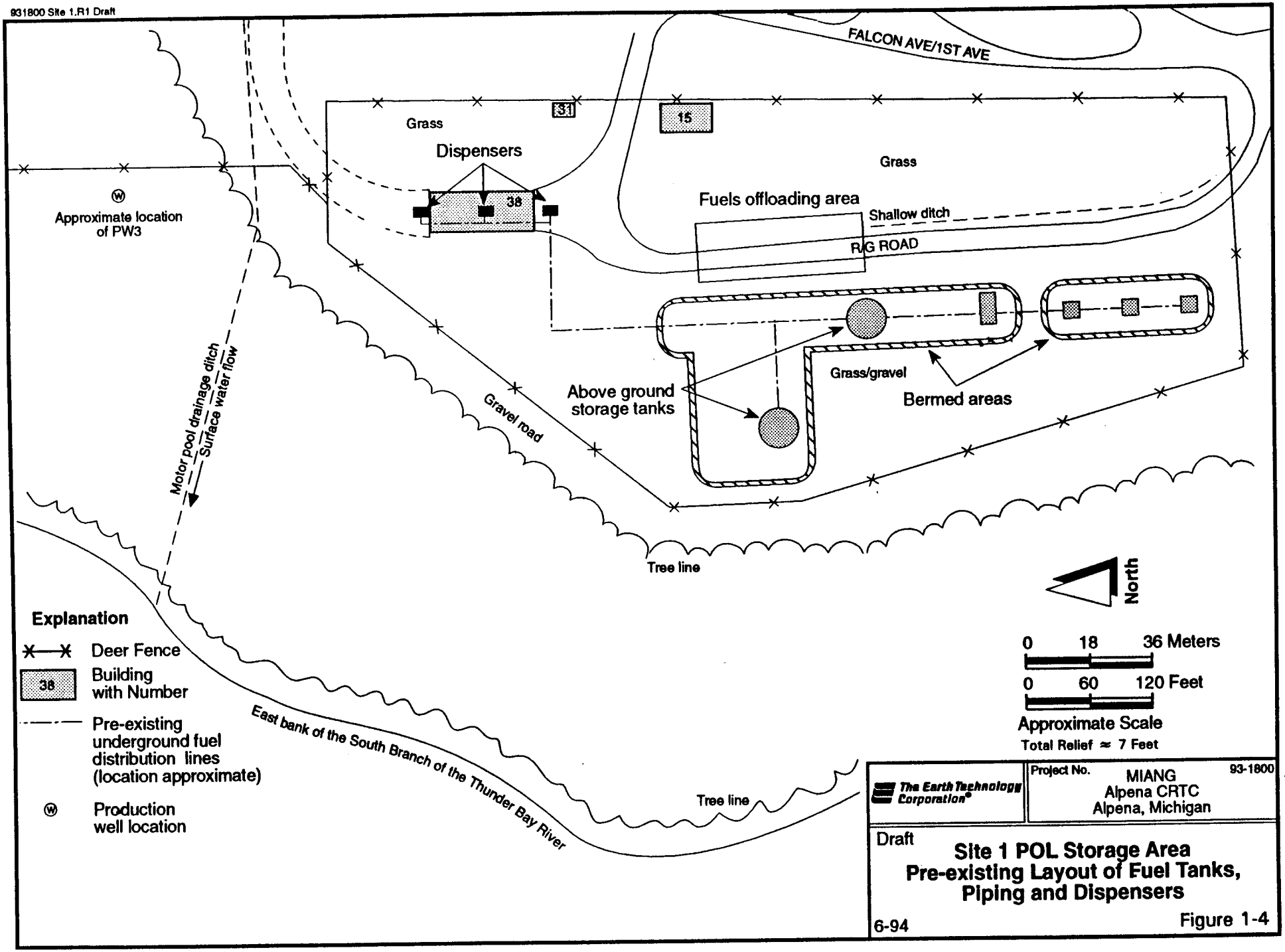
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Alpena, Michigan

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Site 1 POL Storage Area
Site Location Map

6-94

Figure 1-3



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Project No. 93-1800

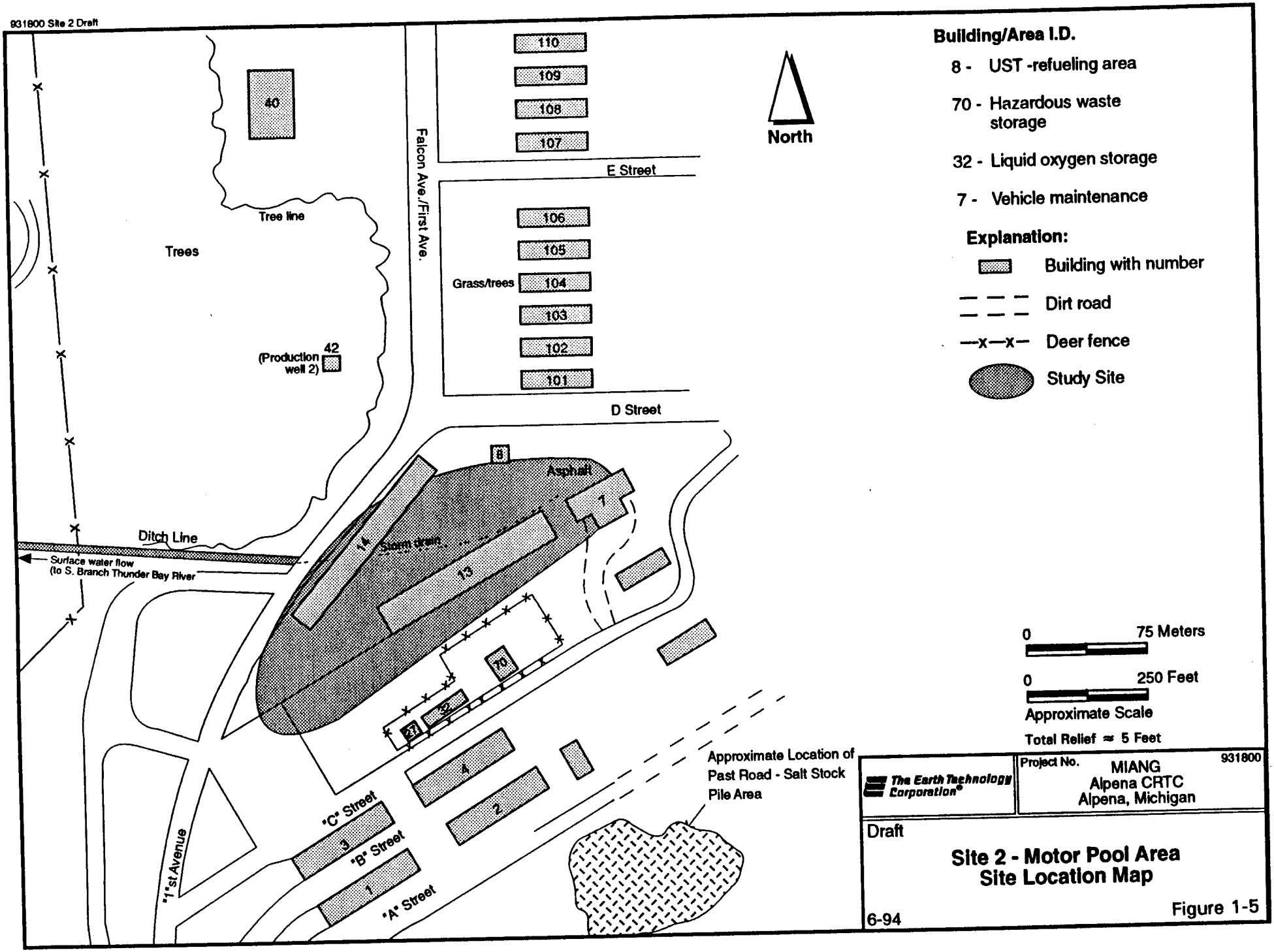
MIANG
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Alpena, Michigan

Draft

Site 1 POL Storage Area
Pre-existing Layout of Fuel Tanks, Piping and Dispensers

6-94

Figure 1-4


Building/Area I.D.
8 - UST -refueling area
70 - Hazardous waste storage
32 - Liquid oxygen storage
7 - Vehicle maintenance
Explanation:
Building with number
Dirt road
Deer fence
Study Site
North
40
110
109
108
107
E Street
106
105
104
103
102
101
D Street
Falcon Ave./First Ave.
Tree line
Trees
Grass/trees
(Production well 2) 42
Ditch Line
Surface water flow (to S. Branch Thunder Bay River
Storm drain
Asphalt
8
1
13
70
32
31
4
2
3
1
"C" Street
"B" Street
"A" Street
"1"st Avenue
Approximate Location of Past Road - Salt Stock Pile Area
0 75 Meters
0 250 Feet
Approximate Scale
Total Relief ≈ 5 Feet
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Site 2 - Motor Pool Area
Site Location Map
6-94
Figure 1-5

1.6.3 Site 3 - Former Site of County Garage

Site 3 is located approximately 91 m (100 yd) east of Site 2, Motor Pool area, (Figure 1-65). Site 3 is mostly a grassy area, although the southern portion of the site is a wooded area. Alpena County operated a maintenance garage at this site from the late 1940s until approximately 1973. Reportedly, an unspecified amount of waste oils were used as a means of dust control around the garage parking lots and roads (Hazardous Materials Training Center, 1985). In 1985, Gourdie/Fraser and Associates, Inc. installed an unknown number of soil borings and 7 monitoring wells in the western portion of the site at the proposed location of a fuel storage facility.

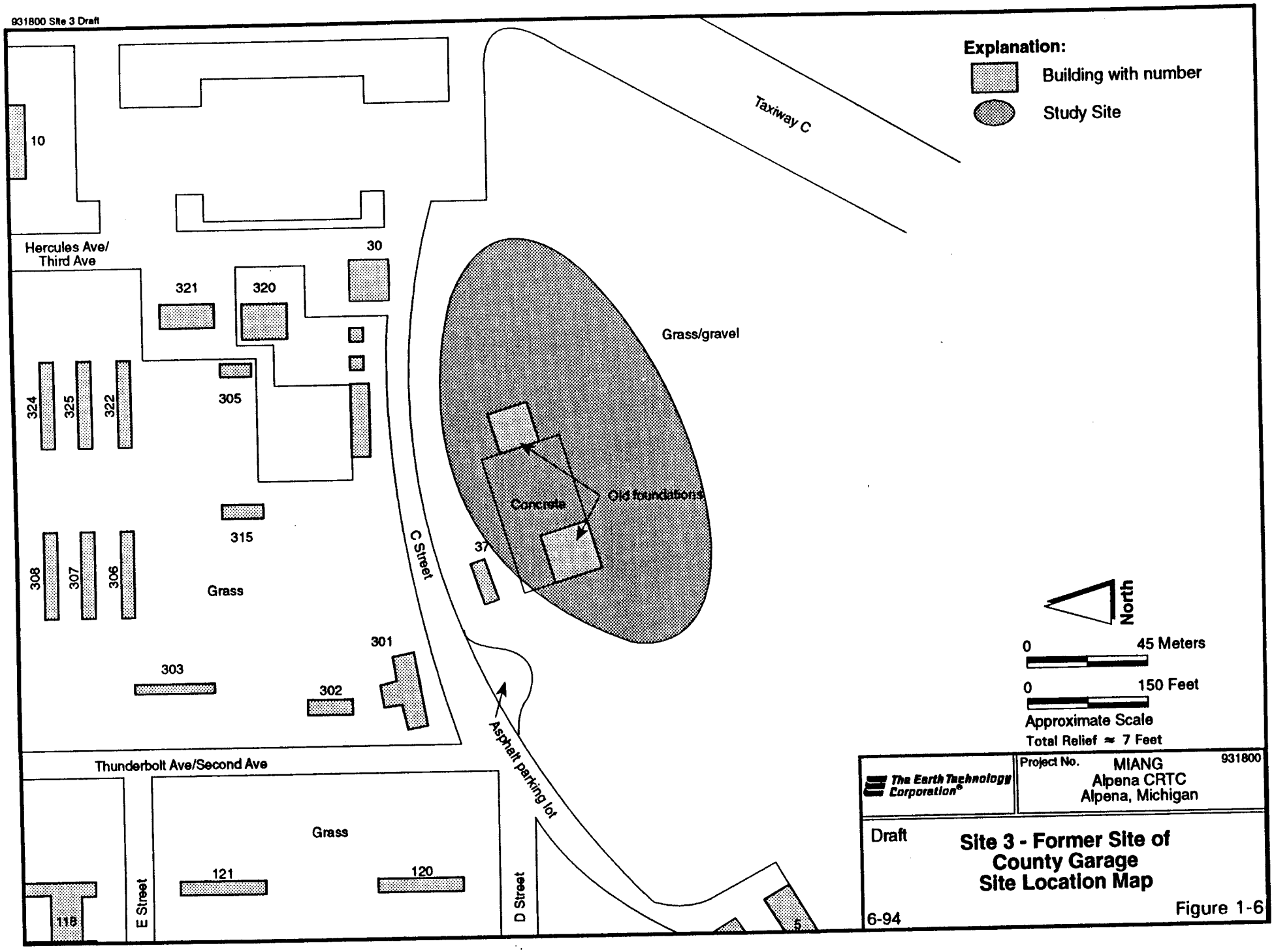
In February 1989 an SI was completed at Site 3 by Engineering-Science. The program consisted of the installation and sampling of ten soil borings and five groundwater monitoring wells. Analytical results indicated the presence of elevated levels of vinyl chloride and petroleum hydrocarbons within the soil and groundwater at Site 3. The SI did not identify groundwater contamination in samples from the seven monitoring wells (Engineering-Science, 1989). It was also determined during the SI that the seven monitoring wells previously installed by Gourdie/Fraser and Associates did not contain a proper surface seal and were deemed unsuitable for future monitoring efforts (Engineering-Science, 1989). These wells were subsequently abandoned in October 1992. During the abandonment a strong hydrocarbon odor and sheen was noted on the returned soil cuttings (The Earth Technology Corporation, 1993).

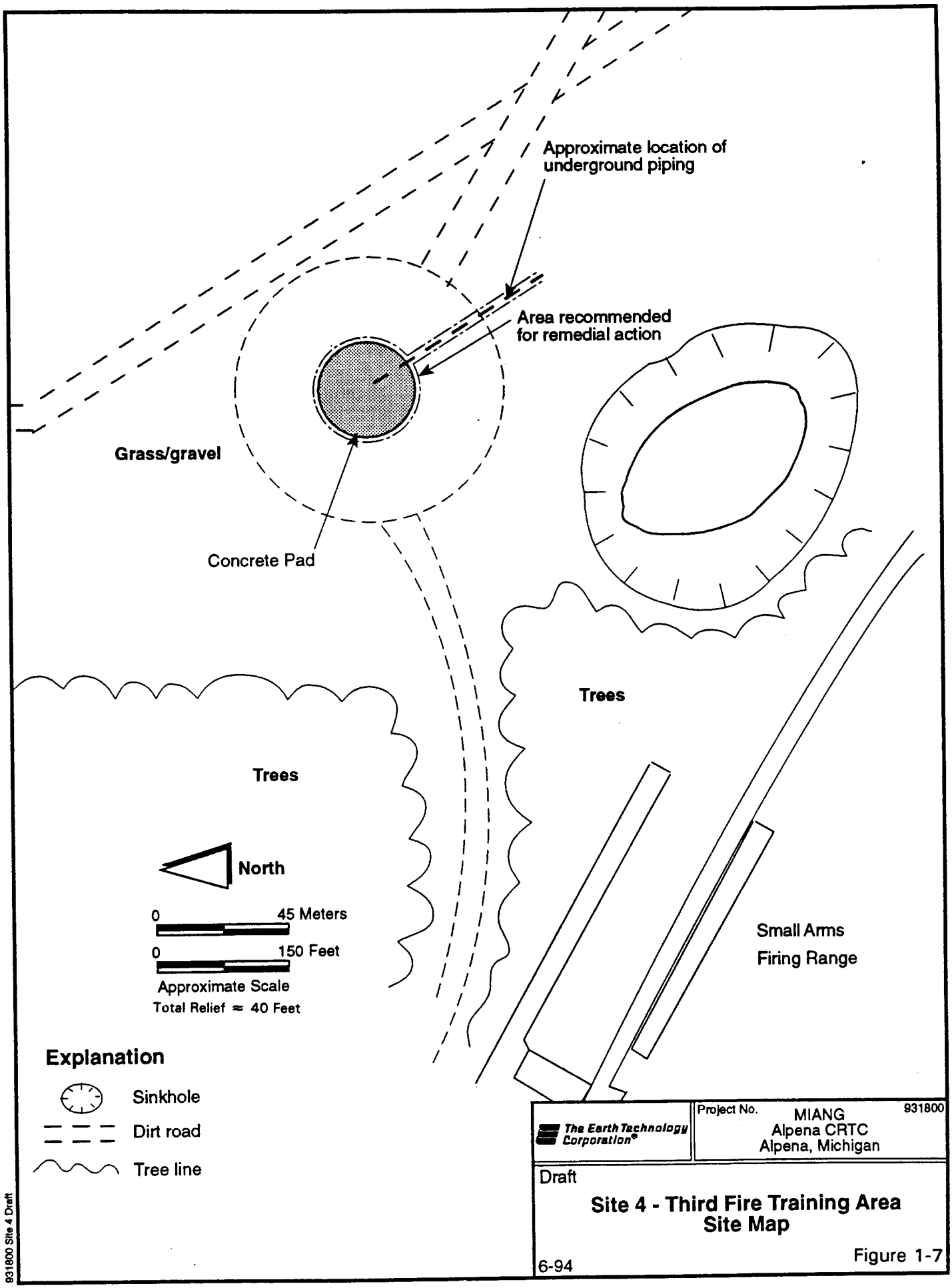
Analytical results on soil samples collected during this investigation revealed the presence of some volatile organic compound (VOCs) within the soil at Site 3. Detected compounds included methylene chloride, 1,1-dichloroethane (DCA), 1,1,2-trichloroethane (TCA), trichloroethene (TCE), and benzene, toluene, ethylbenzene, xylene (BTEX).

1.6.4 Site 4 - Third Fire Training Area

The Third Fire Training Area is located just north of a large sinkhole, approximately 300 feet (ft) in diameter, and just west of Taxiway B (Figure 1-7). The area just west of the site is a heavily wooded area. The fire training area (FTA) consists of a concrete pad, earthen dikes for containment of fires, and an underground pipeline through which fuel was pumped from tanker trucks to the concrete pad. However, the concrete is jointed and not impervious to the penetration of fuels or other compounds that may have been used to extinguish fires. Site 4 is located hydraulically up gradient from the sinkhole. On the ground surface to the north of the sinkhole, a large gully exists which may have channeled runoff from Site 4 into the sinkhole.

The third FTA was used for fire training exercises approximately ten times per year between 1974 and 1984. Each training exercise used approximately 1,100 ℓ (300 gal) of JP-4, except for one exercise when approximately 1,100 ℓ (300 gal) of acetone were reportedly burned (Hazardous Materials Training Center, 1988). Fuel was placed directly on the ground and ignited. During the SI, petroleum hydrocarbons, VOCs, and metals were found in soil, sediment, surface water, and groundwater at the site or the adjacent sinkhole. The soils at the FTA, the pipeline, and the gully are included in a Source Removal Action Plan (SRAP) (The Earth Technology Corporation, June 1994).


931800 Site 3 Draft
Explanation:
Building with number
Study Site
Taxiway C
10
Hercules Ave/
Third Ave
30
321
320
Grass/gravel
324
325
322
305
Concrete
Old foundations
315
37
C Street
308
307
306
Grass
301
303
302
Asphalt parking lot
Thunderbolt Ave/Second Ave
Grass
121
120
118
E Street
D Street
5
North
0
45 Meters
0
150 Feet
Approximate Scale
Total Relief ≈ 7 Feet
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Site 3 - Former Site of
County Garage
Site Location Map
6-94
Figure 1-6


Approximate location of underground piping
Area recommended for remedial action
Grass/gravel
Concrete Pad
Trees
Trees
North
0 45 Meters
0 150 Feet
Approximate Scale
Total Relief ≈ 40 Feet
Small Arms Firing Range
Explanation
Sinkhole
Dirt road
Tree line
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Site 4 - Third Fire Training Area
Site Map
Figure 1-7
6-94
931800 Site 4 Draft

1.6.5 Site 5 - Second Fire Training Area

Site 5 is located in the northwestern section of the facility near the backwaters of Lake Winyah (Figure 1-8). The area consists of an open grassy field with several dirt roads running across it. The area is used by Air National Guard (ANG) units training at the CRTC for combat exercises. In addition, at the southern end of Site 5 the lacustrine sand outcrops and is quarried in this location to make sand bags for training exercises at the facility. From 1965 to 1974, approximately two to three training exercises were conducted each year. Approximately 1,100 ℓ(300 gal) of JP-4 were used in each training exercise. The site lacked formal containment structures such as a concrete pad or berm. The fuel was applied directly to the ground and ignited. Petroleum hydrocarbons, VOCs, and selected metal contamination was detected in site soils and groundwater during the SI. A focused FS is planned for the soils at Site 5.

1.6.6 Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area

These sites are located adjacent to the facility wastewater treatment plant on the edge of the backwater area of Lake Winyah and the south branch of the Thunder Bay River. Site 6 directly borders the backwater area of Lake Winyah. Site 7 is directly adjacent to, and east of, Site 6 (Figure 1-98). Site 7 is the dirt road adjacent to Site 6. To the north of the sites is a heavily forested area. Sites 6 & 7 were combined into one IRP site due to their close proximity to each other.

Site 6 was reportedly used for disposal of waste paints, spent solvents, oils, and waste fuel in addition to garbage and refuse. Historical photographs show actual burial of crushed drums. Site 7 was used for fire training exercises from 1952 until 1965. An average of ten fire training exercises were conducted each year during the first two years of use of the site. After 1954 the frequency of exercises decreased to approximately two per year. During each training exercise, 600 to 1,200 ℓ(150 to 500 gal) of waste fuels, waste oils, and spent solvents were burned. The fire training area lacked any formal containment structures, such as dikes or a paved base.

Purgeable halocarbons, aromatic volatiles, and petroleum hydrocarbons were detected in groundwater samples collected at Sites 6 and 7 (Engineering-Science, 1990).

1.6.7 Site 8 - Former Site of Hangar 9

This site is located northeast of the control tower (Figure 1-10). The entire concrete floor of the old hangar has been incorporated into the apron/parking area east of the tower. The hangar was built in 1942 and dismantled in 1978. The foundation of the old hangar contains six floor drains. The area to the east is a grassy field and extends to the runway. To the north and west are grassy areas with multiple buildings present. The site was identified by soil vapor monitoring conducted in the vicinity of the site. During the SI, sampling revealed organic compounds in groundwater and soil (Engineering-Science, 1990).

1.6.5 Site 5 - Second Fire Training Area

Site 5 is located in the northwestern section of the facility near the backwaters of Lake Winyah (Figure 1-8). The area consists of an open grassy field with several dirt roads running across it. The area is used by Air National Guard (ANG) units training at the CRTC for combat exercises. In addition, at the southern end of Site 5 the lacustrine sand outcrops and is quarried in this location to make sand bags for training exercises at the facility. From 1965 to 1974, approximately two to three training exercises were conducted each year. Approximately 1,100 ℓ(300 gal) of JP-4 were used in each training exercise. The site lacked formal containment structures such as a concrete pad or berm. The fuel was applied directly to the ground and ignited. Petroleum hydrocarbons, VOCs, and selected metal contamination was detected in site soils and groundwater during the SI. A focused FS is planned for the soils at Site 5.

1.6.6 Sites 6 and 7 - Former Solid Waste Landfill and First Fire Training Area

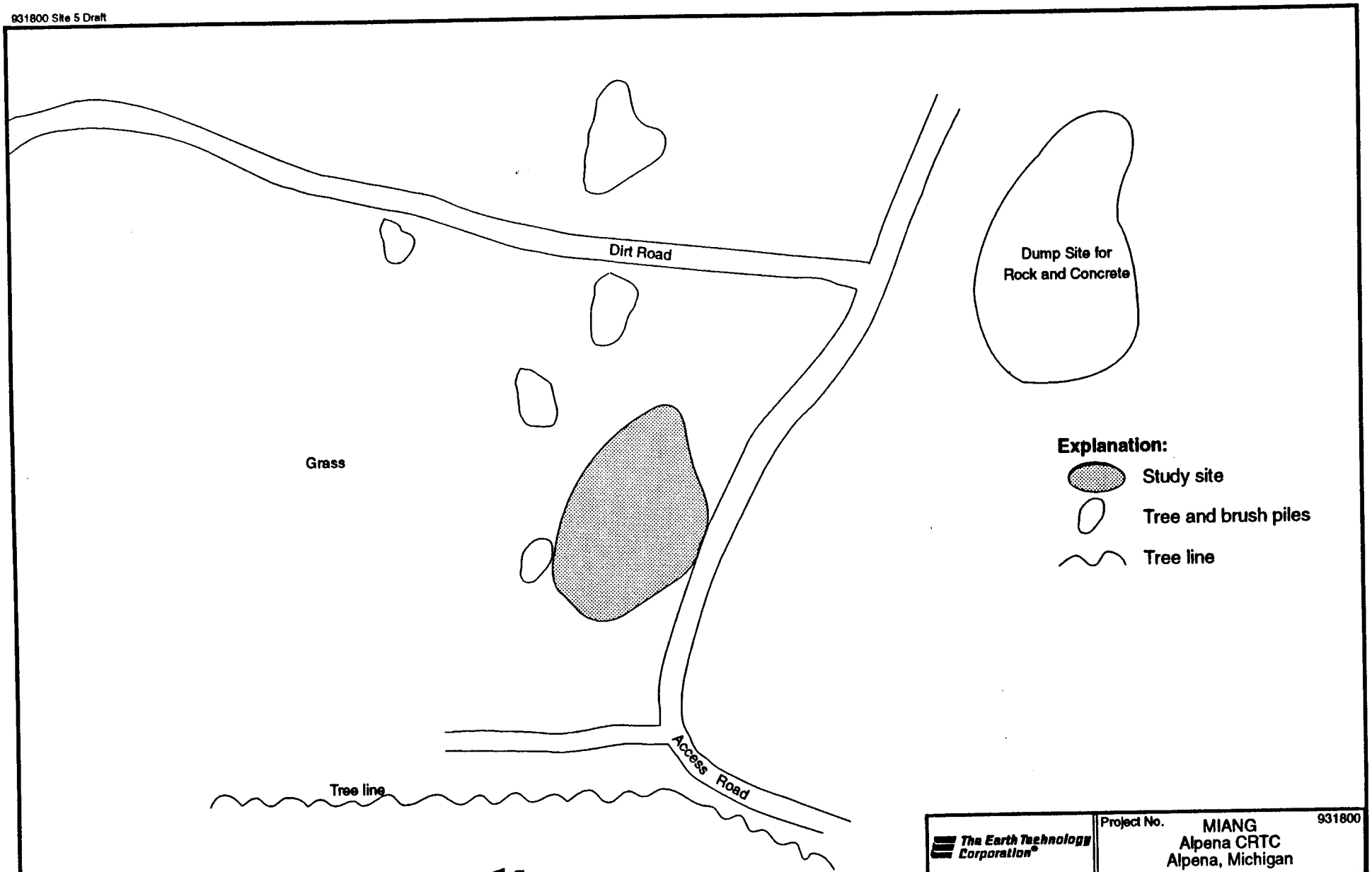
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Site 6 was reportedly used for disposal of waste paints, spent solvents, oils, and waste fuel in addition to garbage and refuse. Historical photographs show actual burial of crushed drums. Site 7 was used for fire training exercises from 1952 until 1965. An average of ten fire training exercises were conducted each year during the first two years of use of the site. After 1954 the frequency of exercises decreased to approximately two per year. During each training exercise, 600 to 1,200 ℓ(150 to 500 gal) of waste fuels, waste oils, and spent solvents were burned. The fire training area lacked any formal containment structures, such as dikes or a paved base.

Purgeable halocarbons, aromatic volatiles, and petroleum hydrocarbons were detected in groundwater samples collected at Sites 6 and 7 (Engineering-Science, 1990).

1.6.7 Site 8 - Former Site of Hangar 9

This site is located northeast of the control tower (Figure 1-10). The entire concrete floor of the old hangar has been incorporated into the apron/parking area east of the tower. The hangar was built in 1942 and dismantled in 1978. The foundation of the old hangar contains six floor drains. The area to the east is a grassy field and extends to the runway. To the north and west are grassy areas with multiple buildings present. The site was identified by soil vapor monitoring conducted in the vicinity of the site. During the SI, sampling revealed organic compounds in groundwater and soil (Engineering-Science, 1990).



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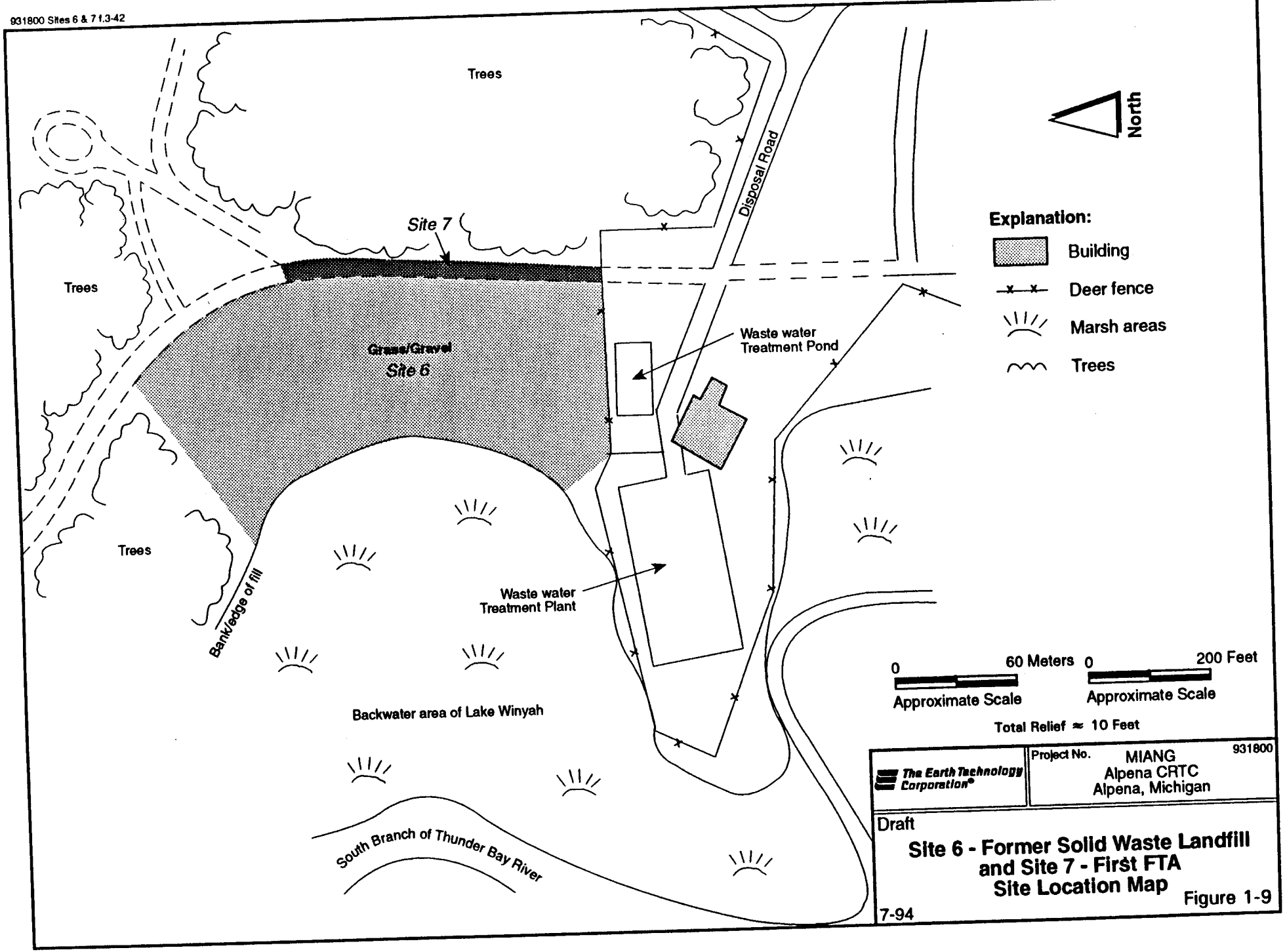
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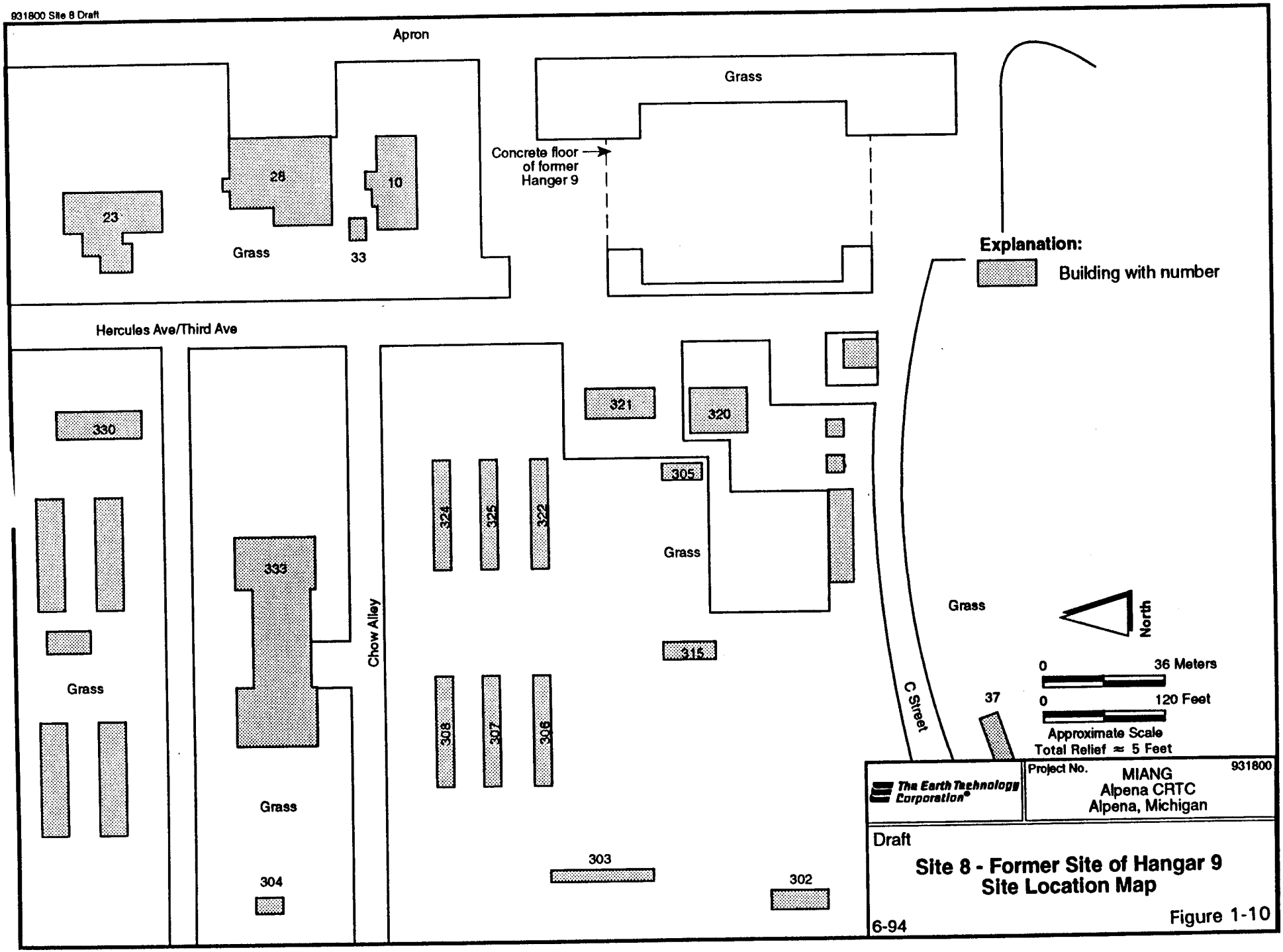
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Site 5 - Second Fire Training Area
Site Location Map

6-94

Figure 1-8


Trees
Site 7
Disposal Road
North
Explanation:
Building
Deer fence
Marsh areas
Trees
Trees
Grass/Gravel
Site 6
Waste water
Treatment Pond
Trees
Bank/edge of fill
Waste water
Treatment Plant
Backwater area of Lake Winyah
South Branch of Thunder Bay River
0
60 Meters
Approximate Scale
0
200 Feet
Approximate Scale
Total Relief ≈ 10 Feet
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MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 6 - Former Solid Waste Landfill
and Site 7 - First FTA
Site Location Map
Figure 1-9
7-94


931800 Site 8 Draft
Apron
Grass
Concrete floor of former Hanger 9
28
10
23
Grass
33
Explanation:
Building with number
Hercules Ave/Third Ave
330
321
320
305
324
325
322
Grass
333
Chow Alley
315
Grass
North
0
36 Meters
0
120 Feet
Approximate Scale
Total Relief ≈ 5 Feet
C Street
37
308
307
306
Grass
304
303
302
The Earth Technology Corporation
Project No.
931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 8 - Former Site of Hangar 9
Site Location Map
6-94
Figure 1-10

1.6.8 Site 9 - Radar Tower Site

Site 9 is located north of G Street, between 2nd and 3rd Avenues (Figure 1-11). The area surrounding Site 9 consist of grassy fields and some wooded areas dissected by the facility roadways. The Aerospace Ground Equipment (AGE) Maintenance shop, Building 417, is located within this site. This shop maintains ground equipment in support of aircraft operations. Painting is also done in this shop. Results of a soil organic vapor (SOV) survey indicated the presence of VOCs in several locations around the building. During the SI, tetrachloroethylene was detected in the soil and groundwater (Engineering-Science, 1990).

1.7 ENVIRONMENTAL SETTING

The environmental setting of Alpena CRTC is described in this section. The regional and facility-specific environmental setting is presented in the following subsections.

1.7.1 Meteorology

The climate of Alpena CRTC is characterized as semi-maritime and is affected by the proximity of Lake Huron to the east which modifies most extremes in the weather. Summers are warm and sunny while winters are cloudy and snow is common. The precipitation in the area is evenly distributed throughout the year. Table 1-3 summarizes the temperature, rainfall, and snowfall of the area obtained from National Oceanic and Atmospheric Administration (NOAA) records dating from 1957 to 1986 (NOAA, 1987). The meteorological recording station is located at the Alpena County Regional Airport which utilizes the runways of the MIANG facility.

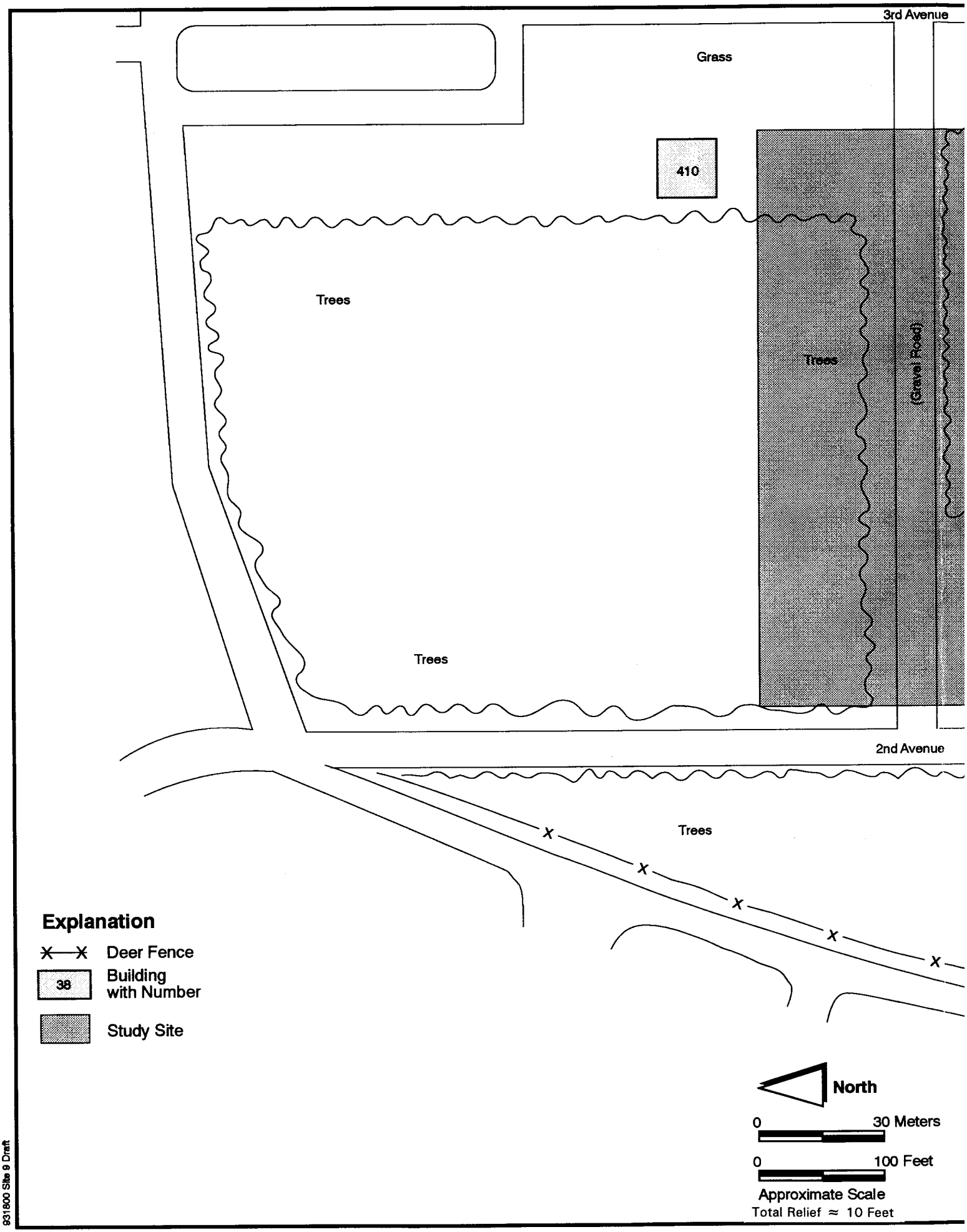
The data indicate that the mean annual precipitation for the 29-year period beginning in 1957 is 74 centimeters (cm) (29.15 inch (in) (NOAA, 1987). The estimated mean annual lake evaporation for the area is 66 cm (26 in) (NOAA, 1983).

Two climatic features of interest in the movement of surface and groundwater are the net precipitation (precipitation minus evaporation) and the 1-year 24-hour rainfall event. The net precipitation is an indicator of the potential for leachate generation. The estimated net precipitation for the area is plus 8 cm (3 in). The 1-year 24-hour rainfall event is an indicator of the potential for storms to cause excessive runoff and erosion. The 1-year 24-hour rainfall event for the area is estimated to be 4.45 cm (1.75 in) (NOAA, 1963).

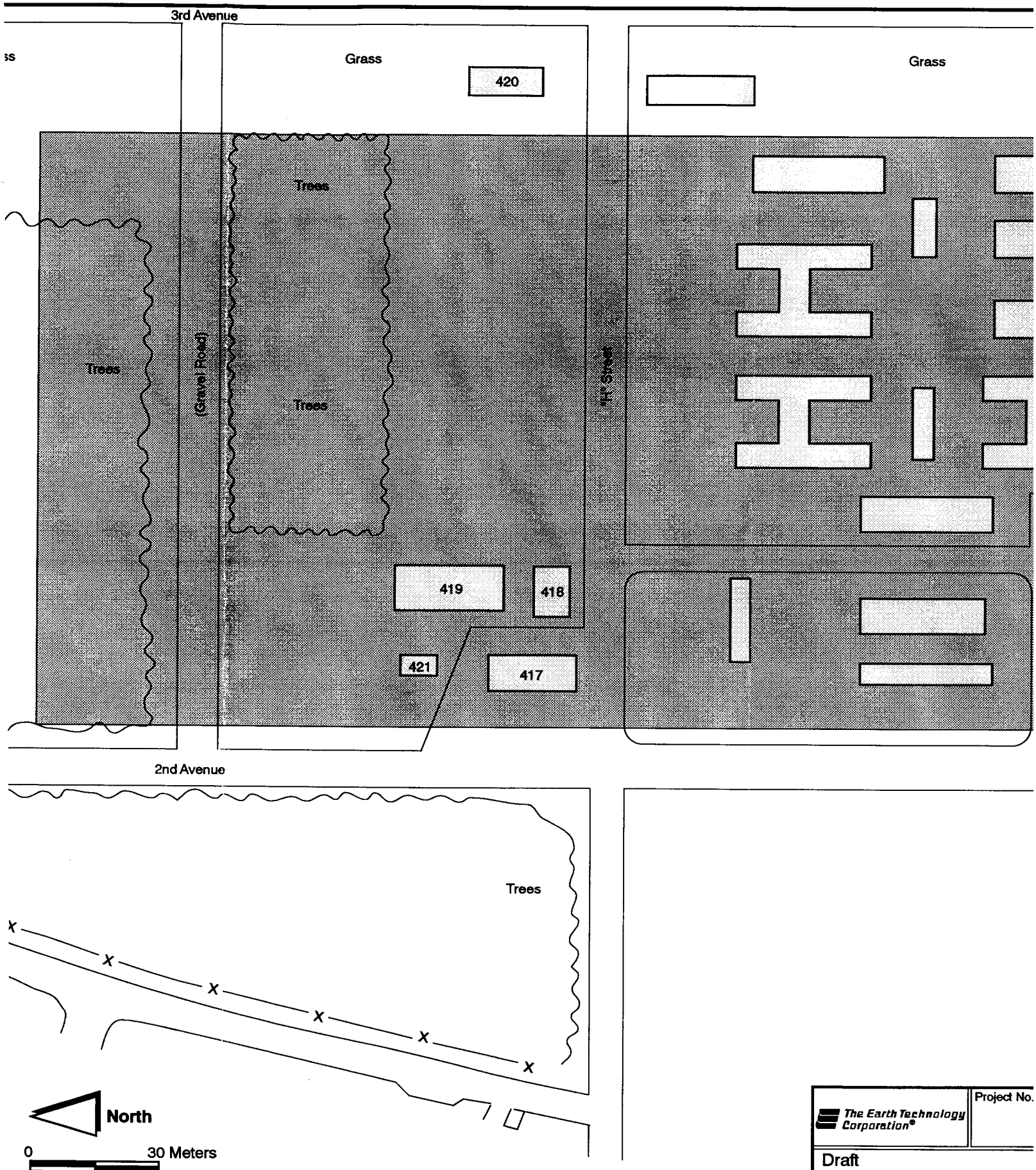
Based on the meteorological data there is a potential for the generation of leachate from past waste sites and a potential for storms to cause excessive runoff and erosion.

1.7.2 Geography

Alpena CRTC is located within the Central Lowland Physiographic Division of Michigan (Miller and Twenter, 1986). The facility is bordered on the north by Lake Winyah and on the west by the South Branch of the Thunder Bay River. A wide area of forested land borders the facility to the east; State Highway 32 borders the facility to the south. Thunder Bay River



931800 Site 9 Draft



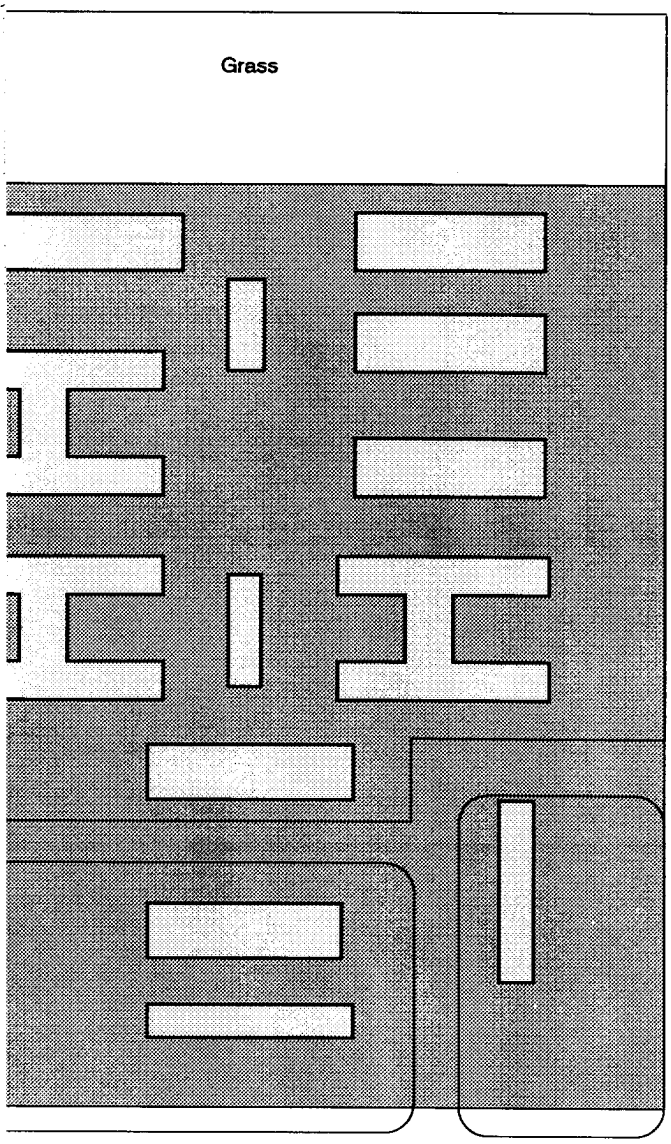
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Site 9 - Radar Site Locati

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Alpena, Michigan

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Site 9 - Radar Tower Site
Site Location Map

6-94

Figure 1-11

Table 1-3: Climatic Conditions For Alpena CRTC
MIANG, Alpena CRTC, Alpena, Michigan

	January	February	March	April	May	June	July	August	September	October	November	December
	Mean Monthly											
Temperature (F°)	19.1	18.6	26.8	39.7	50.9	60.9	66.6	64.8	57.2	47.3	35.3	24.9
Precipitation (IN)	1.79	1.51	1.95	2.27	2.91	3.04	2.73	2.98	3.15	2.54	2.34	1.94
Snowfall (IN)	22.5	15.3	14.0	4.0	0.3	0.0	0.0	0.0	trace	0.6	8.1	20.9

Source: NOAA, 1987
Period of Record: 1957 to 1986

State Forest is located south of Michigan State Highway 32, and Lake Huron is located to the east of the facility taxiways and airport runways, approximately 8 km (5 mi) southeast of the facility.

1.7.3 Topography

The topography of the facility is a result of glacial activity, sinkhole (karst) development, and anthropomorphic influences. Glacial activity has resulted in the deposition of lake deposits consisting of sand and clay on a relatively flat bedrock surface. A large sinkhole is located just southeast of the Small Arms Firing Range and is a very significant topographic feature. The sinkhole is approximately 122 m (400 ft) in diameter at the rim and approximately 23 m (75 ft) in diameter at the bottom. A detailed description of the hydrogeology and water quality of the sinkhole is presented in Section 3.6.

The general land surface elevations on facility vary between a low of 672 ft above mean sea level (msl) on Lake Winyah to a high of 688 ft msl near the Fire Station (Building 28). The sinkhole relief is 11 m (36 ft) with the land surface elevation at the rim approximately 208 m (682 ft) msl and the water surface elevation at the bottom approximately 197 m (646 ft) msl.

1.7.4 Soils

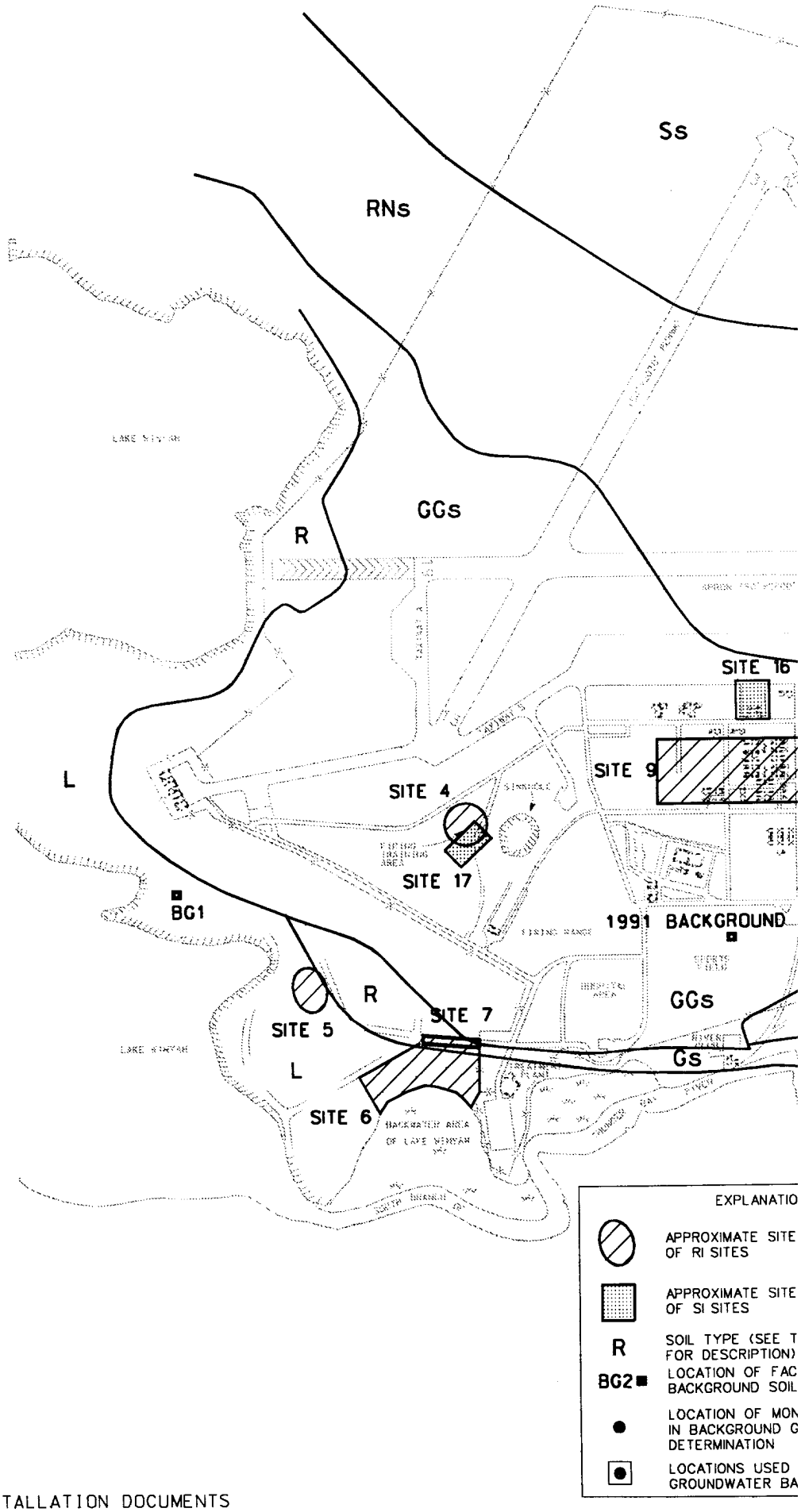
The soils of Alpena CRTC are typical of glaciated areas and consist of seven soil types (Wildermuth and others, 1924). Figure 1-12 illustrates the aerial distribution of the soils and Table 1-4 summarizes the soil types and their characteristics.

The soil types which cover the largest areas of the facility are the Grayling Sand and Rubicon Sand. These two sands are both composed of greyish-brown sand and yellow sand, but the Grayling Sand consists of coarse-grained sand with gravel while the Rubicon Sand consists of fine-grained sand. The Grayling Sand has very rapid drainage while the Rubicon Sand has fair to good drainage. The gravel zones of the Grayling Sand were observed in the SI soil borings and monitoring wells along a wide north-south trending area through the center of the facility corresponding to the wide area as shown in Figure 1-12 (Engineering-Science, 1989). The gravel zones were most prevalent in those borings and wells in Sites 3, 4, 8, and 9.

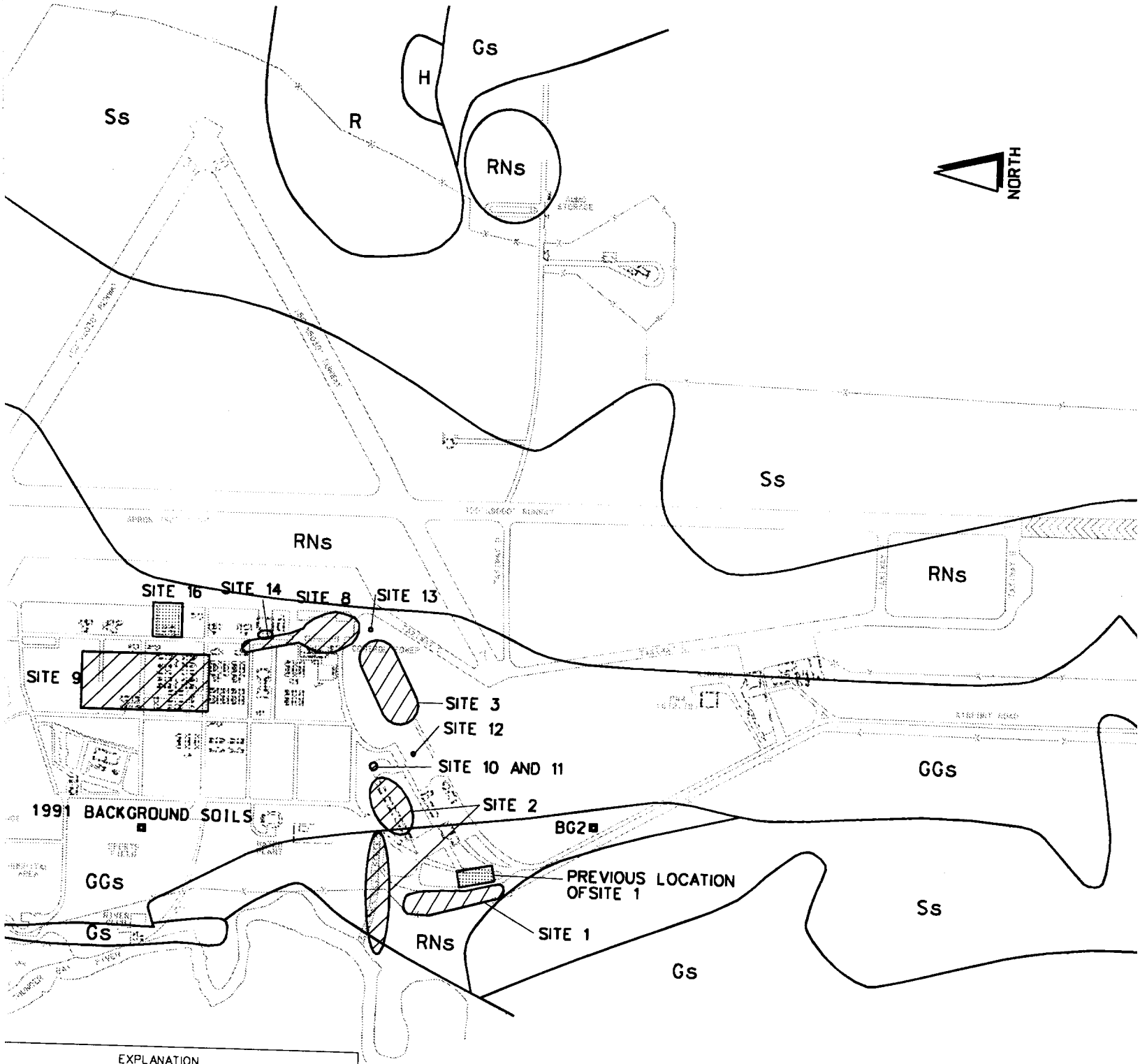
All but two sites included in the RI are located totally or partially in the Grayling Sand. Site 2 is located partially in the Rubicon Sand; Sites 5, 6, and 7 are located partially in the Rifle Peat and Lupton Muck. Very rapid drainage exists in the Grayling Sand (Sites 2, 3, 4, 8, and 9). Fair to good drainage exists in the Rubicon Sand (parts of Sites 2, 6, and 7). Poor drainage exists in the Lupton Muck and Rifle Peat (parts of Sites, 5, 6, and 7).

1.7.5 Surface Water Resources

Alpena CRTC is located within the Northwestern Lake Huron Water-Resources Subregion (Miller and Twenter, 1986). The southern shore of Lake Winyah, formed by a hydroelectric



SOURCE: WILDERMUTH, 1924 AND INSTALLATION DOCUMENTS



EXPLANATION

- APPROXIMATE SITE BOUNDARY OF RI SITES
- APPROXIMATE SITE BOUNDARY OF SI SITES
- R — SOIL TYPE (SEE TABLE 1-4 FOR DESCRIPTION)
- BG2■ — LOCATION OF FACILITY-WIDE BACKGROUND SOIL SAMPLES
- ● — LOCATION OF MONITORING WELLS USED IN BACKGROUND GROUNDWATER DETERMINATION
- ◉ — LOCATIONS USED FOR BOTH SOIL AND GROUNDWATER BACKGROUND DETERMINATION

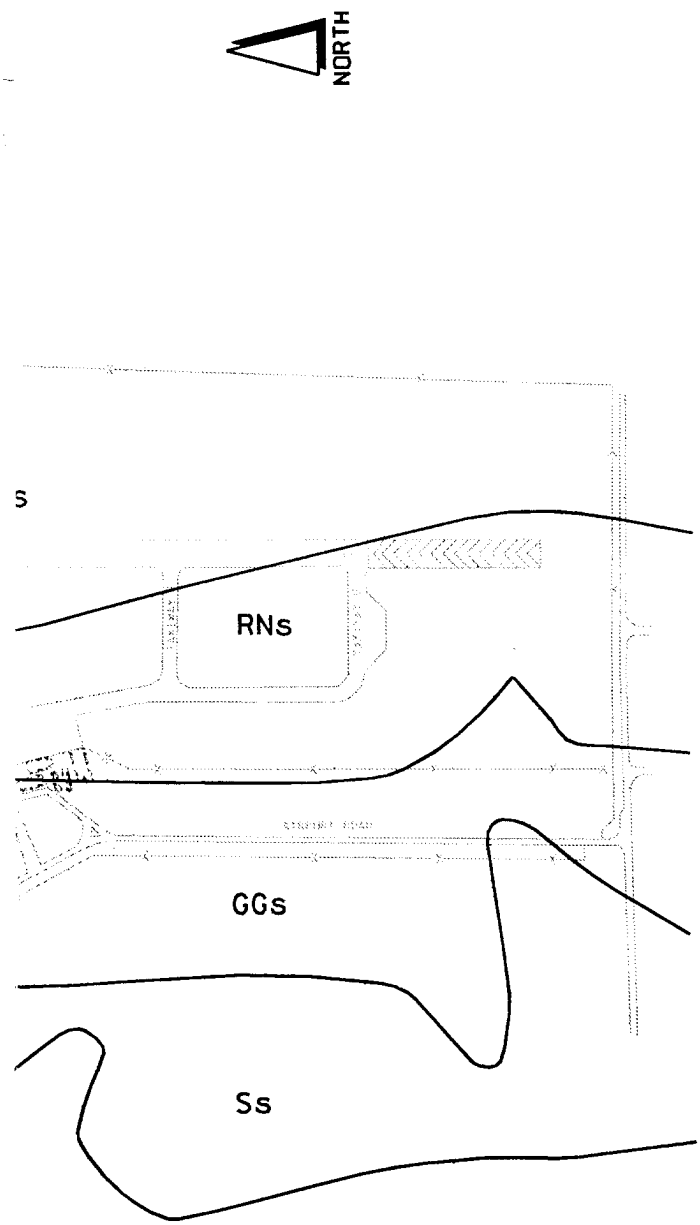
0 500 1000 FEET
SCALE

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Alpena
Alpena, M

LOCATIONS USED F
BACKGROUND SAMPL

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PROJECT NO. 928901

Alpena CRTC
Alpena, Michigan

LOCATIONS USED FOR BACKGROUND SAMPLES

5-95

FIGURE 1-12

Table 1-4 Alpena CRTC Soils
MIANG, Alpena CRTC, Alpena, Michigan

Symbol on Figure 3-1	Unit Name	Description	Characteristics
GGS	Grayling Sand	Greyish-brown sand and coarse yellow sand with gravel	Very rapid drainage
GS	Granby Sand	Shallow black mucky soil and wet pale yellow or grey sand	Slow drainage
H	Houghton Muck	Dark brown moderately decayed fibrous peat or muck	Occupies wet flats and beaver meadows
L	Lupton Muck	Dark brown, well decayed woody peat	Occupies wet flats and valley bottoms
R	Rifle Peat	Brown moderately decayed woody peat	Occupies wet flats and valley bottoms
RNs	Rubicon Sand	Greyish-brown sand and pale yellow sand	Fair to good drainage
Ss	Saugatuck Sand	Grey sand and dark "coffee" brown sandy "hardpan" over yellow sand	Fair drainage

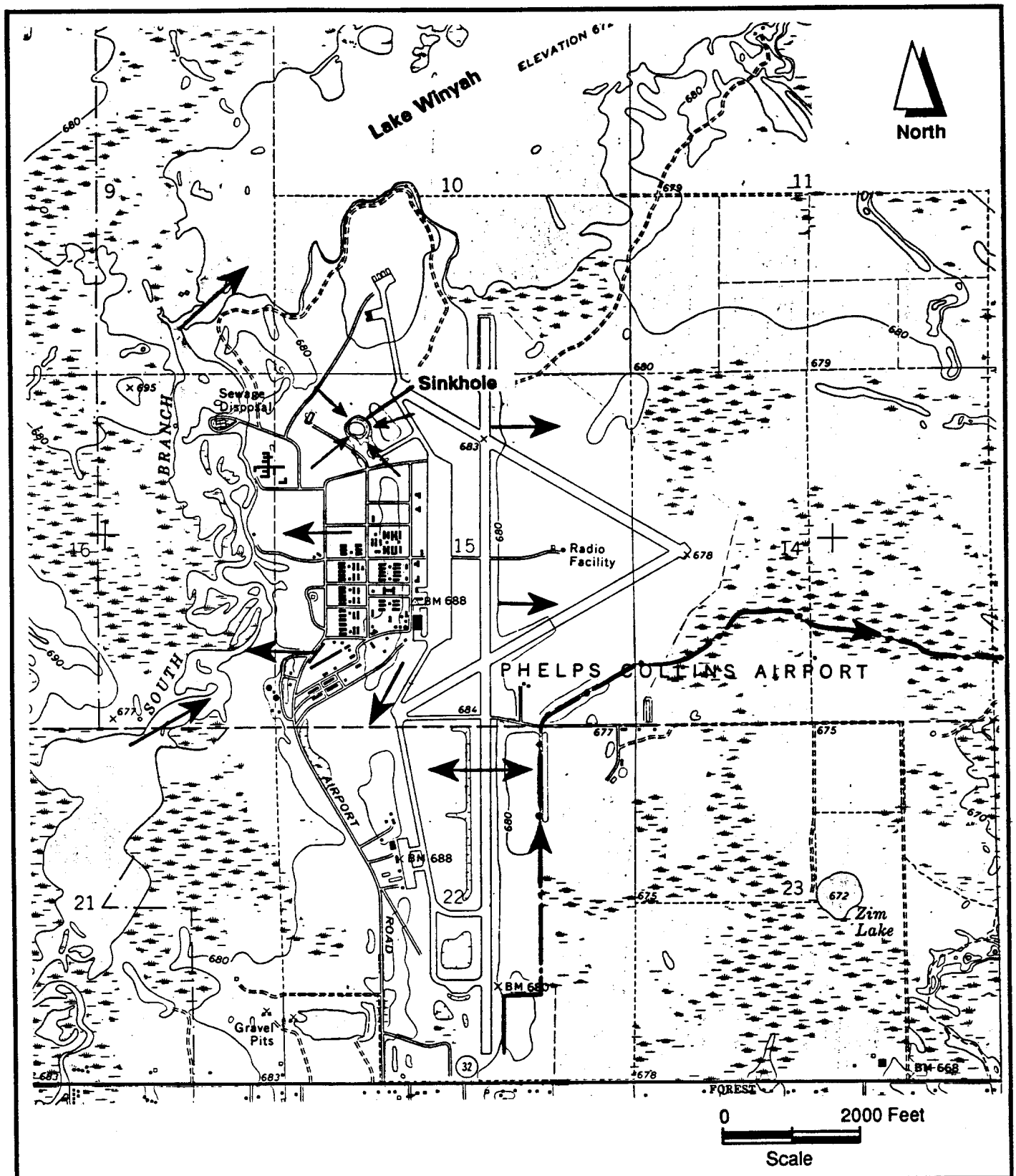
Source: Wieldermuth and others, 1924

dam on the Thunder Bay River, borders the facility on the north. The South Branch of the Thunder Bay River borders the facility on the west. From Lake Winyah, the Thunder Bay River flows southeast toward Lake Besser and on to Lake Huron.

Because a majority of the soils have fair to very rapid infiltration rates, there are few man-made surface drainage ditches for storm drains located on the facility. However, where drainage is a concern it is controlled by open ditches and by one storm drain located at the Motor Pool Area (Site 2) (Figure 1-13). A general north-south trending drainage divide exists along the main runway. Surface water originating east of the runway flows eastward to a main drainage ditch and on to the low-lying forest land off the facility. Surface water originating west of the runway flows westward to small ditches which direct the water to the river. A prominent ditch west of the facility motor pool drains surface water run-off toward the Thunder Bay River.

Surface drainage within the immediate vicinity of the sinkhole is controlled by two gullies. Surface water enters the sinkhole via two main outwash gullies. One gully is on the northeast side next to Site 4 (Third Fire Training Area) and the other is on the south side next to the old aircraft weapons firing pad. The sinkhole contains a small pond in the bottom. The water is approximately 1.5 m (5 ft) deep over most of the bottom but is approximately 6 m (20 ft) deep in the deepest part of the sinkhole.

The other surface water body on the facility is the lined wastewater treatment pond located at the wastewater treatment plant. The pond is used only as an emergency wastewater containment reservoir. The liner has been pierced along its edges by the growth of small trees and shrubs.



Explanation

Direction of surface water drainage

Source: Lake Winyah, Mich. U.S.G.S. Quadrangle and installation documents

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Surface Drainage Map

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Figure 1-13

931800 Surface Drainage

1.7.6 Surface Water Quality

The South Branch of the Thunder Bay River is classified as a warm water river by the MDNR. Minimum water quality standards of dissolved oxygen (5.0 milligrams per liter (mg/ℓ) and ammonia (0.02 mg/ℓ) are established for the river. The U.S. Geological Survey maintains a water discharge staff gauge downstream of the Alpena Power Company Four Mile Dam (approximately 8 km [5 mi] downstream of the facility), but water quality monitoring was discontinued in 1985 (Engineering-Science, 1990).

Surface water quality on the facility is generally good. The total dissolved solids for the South Branch of the Thunder Bay River adjacent to the facility ranges from 65 to 240 mg/ℓ. The pH ranges from 7.0 to 8.0 mg/ℓ, the chloride ranges from 8.6 to 9.4 mg/ℓ, and the sulfate ranges from 7.8 to 13 mg/ℓ (Engineering-Science, 1990).

The facility discharges effluent from its wastewater treatment plant into the South Branch of the Thunder Bay River just southwest of the plant. The effluent is monitored for suspended solids, biological oxygen demand, fecal coliform bacteria, residual chlorine, and total phosphates three times a week in compliance with the National Pollution Discharge Elimination System (NPDES) permit. The effluent is also sampled monthly for hazardous constituents. Minor amounts of trihalomethanes and VOCs have been detected in the effluent.

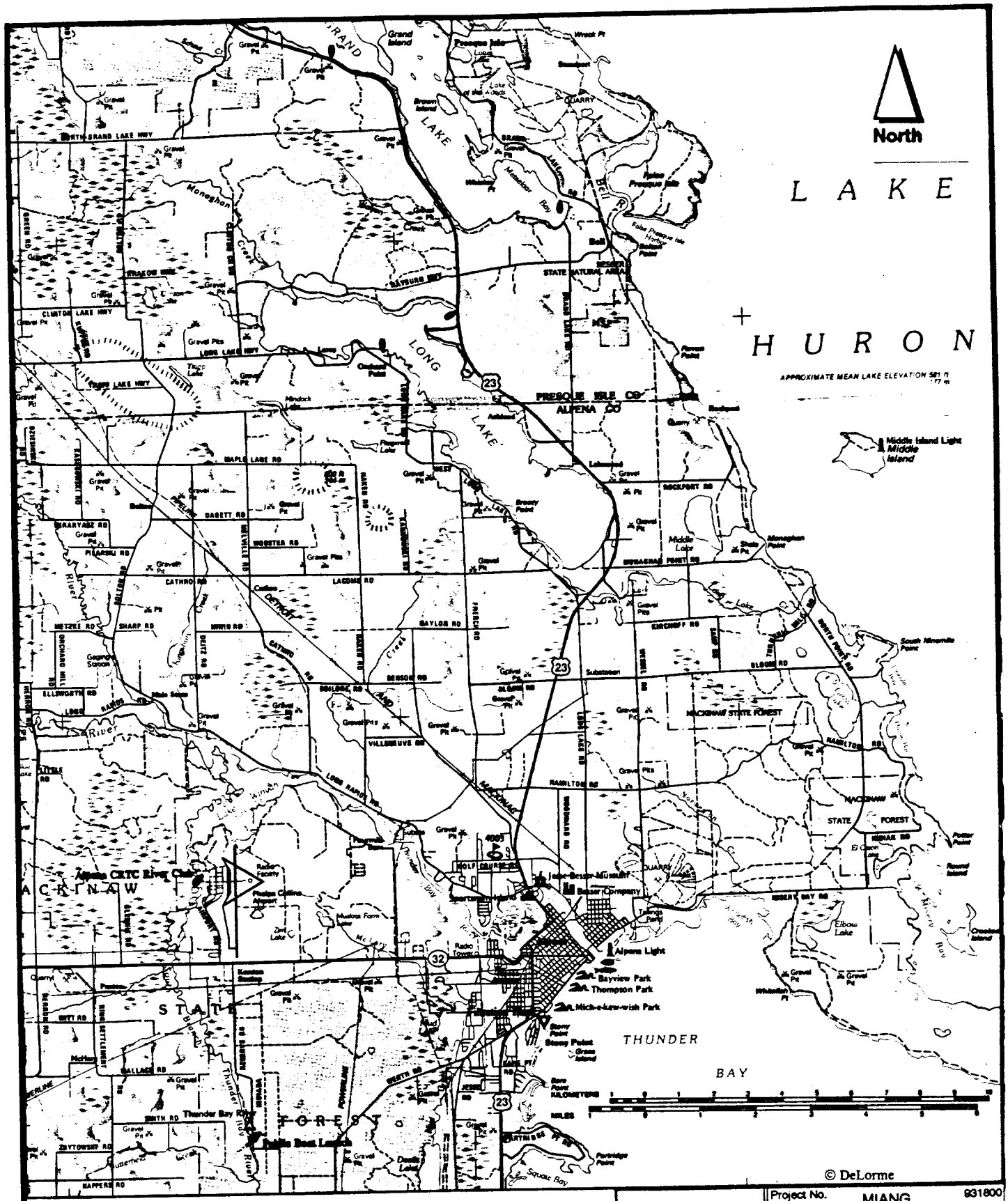
1.7.7 Surface Water Use

Surface water in the vicinity of the facility is used for recreation. The South Branch of the Thunder Bay River as well as Lake Winyah are used for boating and fishing. The Alpena CRTC River Club (located on Figure 1-14) provides facility personnel access to boating on the river. The nearest public boat ramp is located approximately 3.5 miles south of the facility at the Thunder Bay River State Forest campground off Indian Reserve Road. (MDNR, Personal Communication, 1994). The city of Alpena withdraws water from Lake Huron as its water supply. Alpena Township purchases water from the city of Alpena. The water supply intake is located approximately 2.4 km (1.5 mi) southwest of the mouth of the Thunder Bay River which is approximately 18 km (11 mi) downstream of the facility (Figure 1-14).

1.7.8 Regional Geology and Hydrogeology

The groundwater resources and hydrogeology of the Alpena CRTC and vicinity have been reported by Black (1983), Beck (1984), Grannemann and others (1984), The Hazards Materials Technical Center (1985), and Engineering-Science (1989). Groundwater is available from the following three hydrogeological units:

- The shallow aquifer
- The Traverse Group Limestone
- The Detroit River Group.



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Alpena, Michigan

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Surface Water Uses

Figure 1-14

Site 6 X-Sec 2 Draft

The shallow aquifer is unconfined while the Traverse Group Limestone and the Detroit River Group aquifers are reported to be confined (Engineering-Science, 1989). Table 1-5 summarizes the hydrogeologic units and their water-bearing characteristics.

Surficial Aquifer

Geologically, Alpena CRTC is located in the outcrop area of the lacustrine sand of northeast Michigan (Figure 1-15). The lacustrine sand is composed of quartz sand, pebbles and cobbles of limestone and rock fragments, and some lenses of reddish-brown clay. This unit varies in thickness from approximately 6 m (20 ft) thick at the north end of the facility near Lake Winyah to approximately 18 m (60 ft) thick at the southern end of the facility. In some locations on the facility these lacustrine sands directly overly the limestone aquifer and in other locations they are separated from the limestone aquifer by a grey clay aquitard. The site-specific relationships of the shallow aquifer to the limestone aquifer are discussed in greater detail in Section 3.1 and Sections 3.3 through 3.10.

Traverse Group Aquifer

The limestone aquifer is composed of carbonate rocks of the Devonian-aged Traverse Group (undifferentiated). Figure 1-16 shows the bedrock geology of the Michigan Basin. The rocks in the vicinity of the Alpena CRTC strike northwest and dip southwesterly at a very low angle towards the center of the Michigan Basin. A stratigraphic column of the northern lower Michigan Karst Area is presented in Figure 1-17. The Traverse Group Limestone is a middle-Devonian-aged limestone which is underlain by the Bell Shale (part of the Traverse Group) and overlain by the Antrim Shale. The Antrim Shale is the regional confining unit for the Traverse Group Limestone. Figure 1-18 illustrates the bedrock geologic map of the Alpena CRTC showing the geologic contact of the Traverse Group Limestone and the Antrim Shale. As illutrated on Figure 1-18, the Traverse Group aquifers regional confining unit, the Antrim Shale thins or is absent across the facility. One well on the facility (Production Well PW5, which is approximately 58 m [190 ft] deep) produces water from the Bell Shale, a unit which underlies the Traverse Group Limestones. The Traverse Group Limestones are generally grey fossiliferous limestones containing some chert, and are reported to be approximately 232 m (760 ft) thick (Black, 1983). Solution cavities in the limestone have been reported by water-well drillers in the area (Black, 1983). Additionally, Black (1983) reports naturally occurring hydrocarbons from these same rocks only 2 miles southwest of the Alpena CRTC.

Three water supply wells on the facility, PW1, PW2, and PW4, tap the limestone aquifer. Wells PW1, PW2, and PW4 are 18.6 m (61 ft), 20 m (65 ft), and 45.7 m (150 ft) deep, respectively. The limestone aquifer also outcrops below the Norway Point Dam and the Four Mile Dam along the Thunder Bay River east of the facility.

Detroit River Group Aquifer

Beneath the Traverse Group and the Rodgers City and Dundee limestone units is the Detroit River Group, a breccia composed of angular blocks of dolomite and limestone. The Detroit River Group contains saline groundwater. Three old flowing wells in the city of Alpena tap the Detroit River Group from depths of approximately 165 to 335 m (540 to 1,100 ft) below ground surface (bgs).

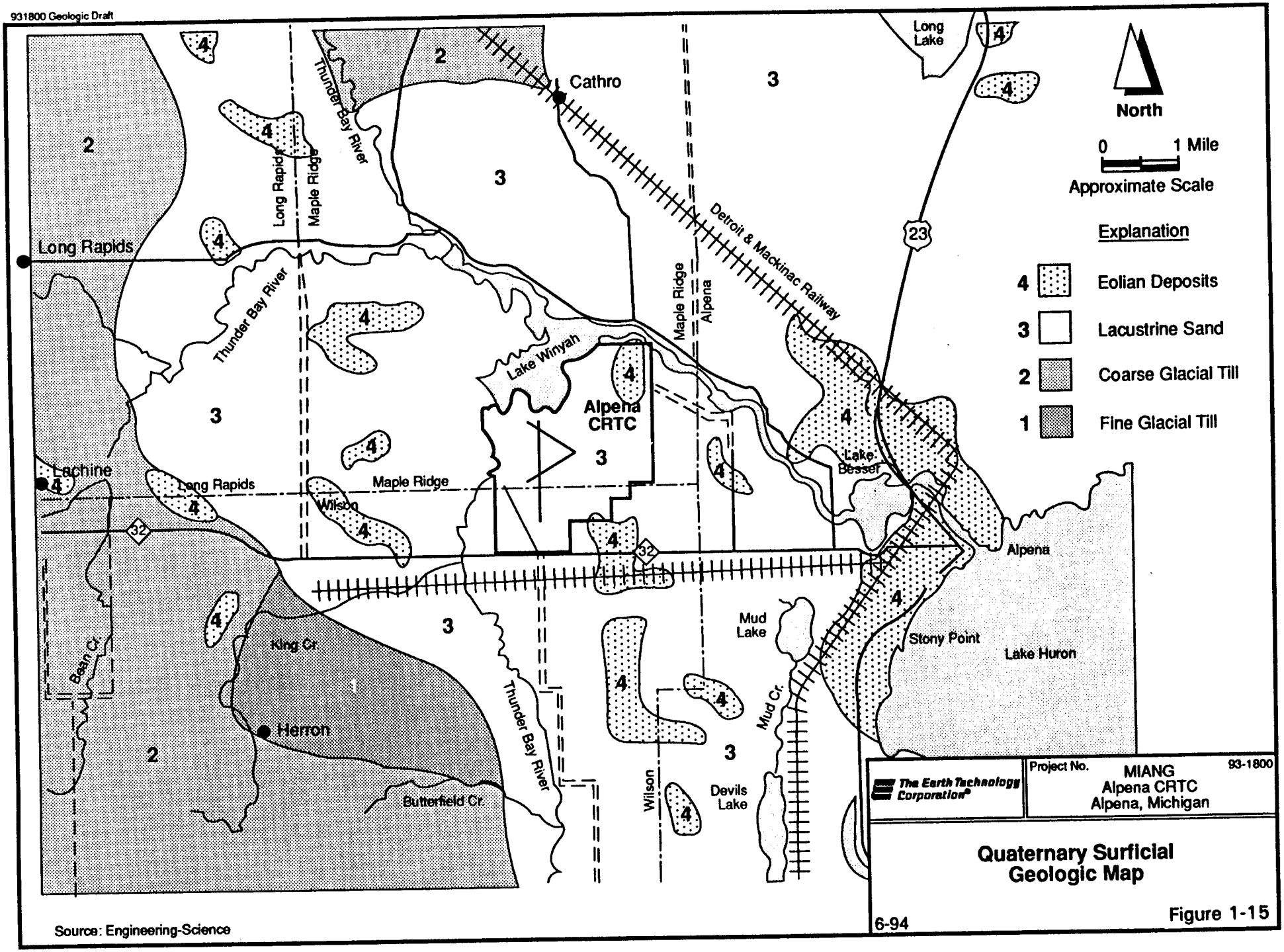
Table 1-5 Alpena CRTC, Alpena, Michigan, Hydrogeologic Units and Their Water-Bearing Characteristics

MIANG, Alpena CRTC, Alpena, Michigan

System	Series	Hydrogeologic Unit	Hydrogeologic Classification	Approximate Thickness (feet)	Dominant Lithology	Water-Bearing Characteristics
Quaternary	Pleistocene	Lacustrine Sand	Shallow Aquifer	20-60	Quartz sand, pebbles, cobbles, and clay	Typically readily transmits water. Estimated T range of 118 to 5,147 ft^2/dy.
Late Devonian	Chautauguan	Antrim Shale	Confined Aquifer	660	Shale, silty or sandy, calcareous or dolomitic	Does not readily transmit water. Fractured rock yields small amounts of water.
Middle Devonian	Senecan and Erian	Traverse Group (Undifferentiated)	Semi-confined Aquifer	830	Limestone, cherty sandy or silty, fossiliferous	Readily transmits water. Fractured rock and/or solution cavities may yield large amounts of water.
		(Bell Shale)	(Confined Aquifer)	N/A	(Shale)	(Yields small amounts of water where fractured)
	Erian	Rogers City Limestone Dundee Limestone	NC NC	475	Limestone, fossiliferous	Not used in area as source of water.
	Ulsterian	Detroit River Group (Undifferentiated)	Confined Aquifer (Saline)	1,450	Breccia, dolomitic and calcareous	Readily transmits water; yields saline and sulfur water; springs discharge into Lake Huron.

Note: T = Transmissivity
NC = Not Classified

Source: Farrand and Bell (1884), Black (1983), and Kimmel (1983).



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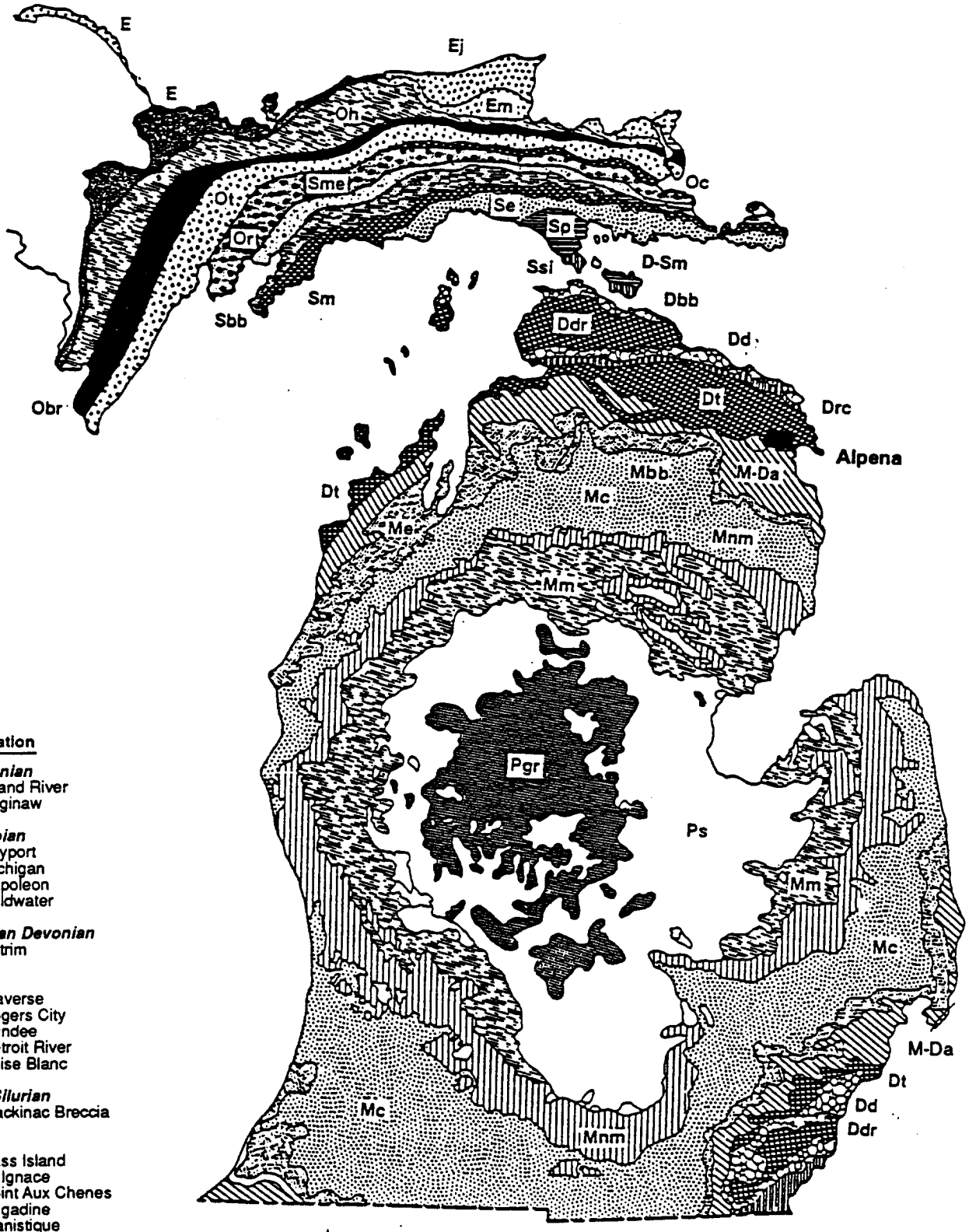
MIANG
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Quaternary Surficial Geologic Map

6-94

Figure 1-15

Source: Engineering-Science



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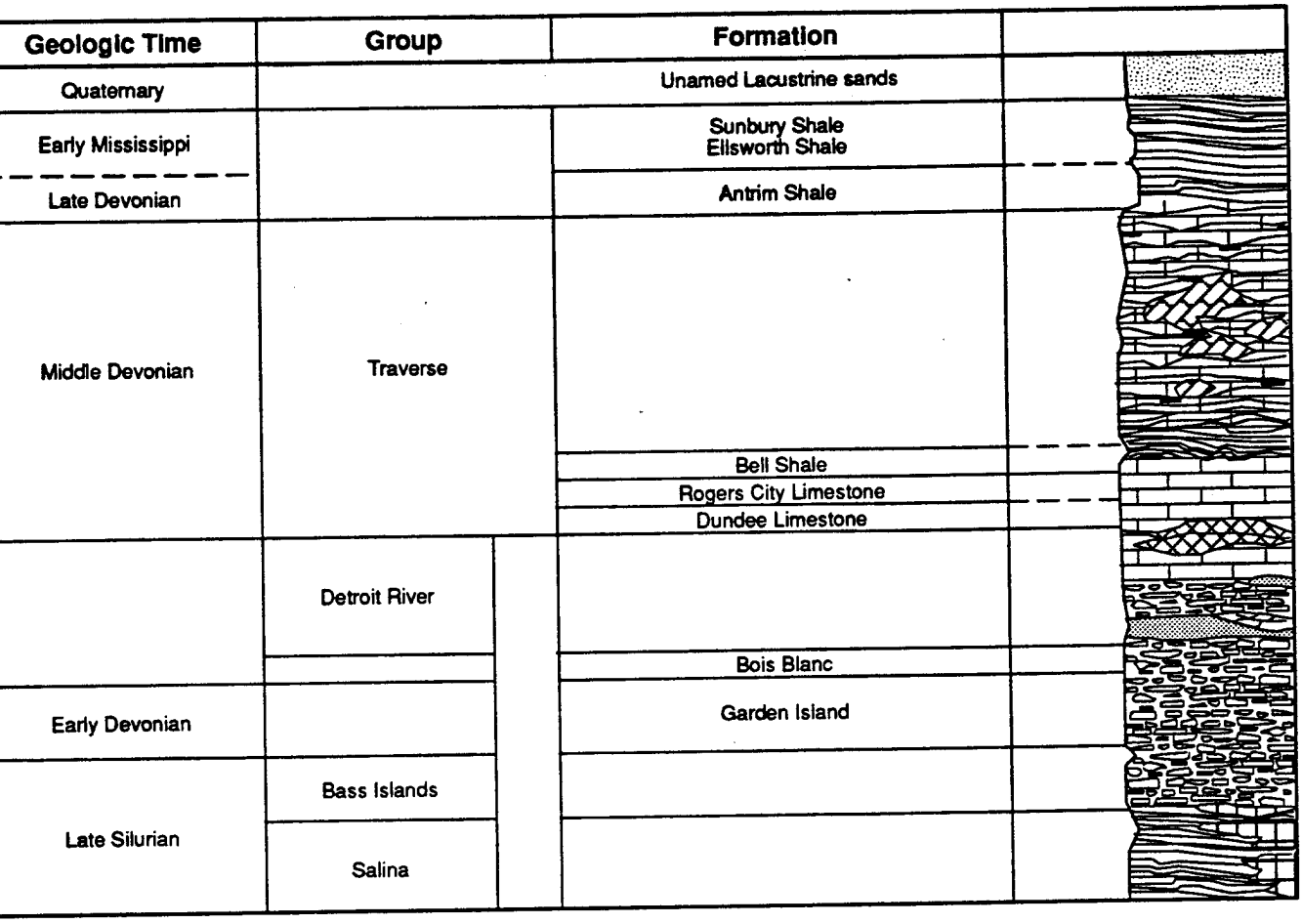
Bedrock Geologic Map of Michigan

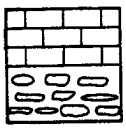
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Figure 1-16

931800 Mich Bedrock

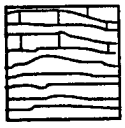
Geologic Time	Group	Formation
Quaternary		Unamed Lacustrine sands
Early Mississippi		Sunbury Shale Ellsworth Shale
Late Devonian		Antrim Shale
Middle Devonian	Traverse	Bell Shale Rogers City Limestone Dundee Limestone
	Detroit River	
		Bois Blanc
Early Devonian		Garden Island
Late Silurian	Bass Islands	
	Salina	





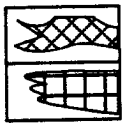
Limestone

Dolomite



Shaley

Shale



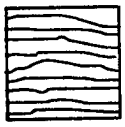
Gypsum or Anhydrite

Halite



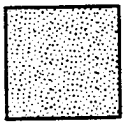
Reef

Cherty



Dolomitic

Sandy



Unconsolidated Sand

Source: Black, T.J. 1983, Techtonics, Structure, and Karst in Northern Lower Michigan, Michigan Basin Geological Society 1980 Field Conference.

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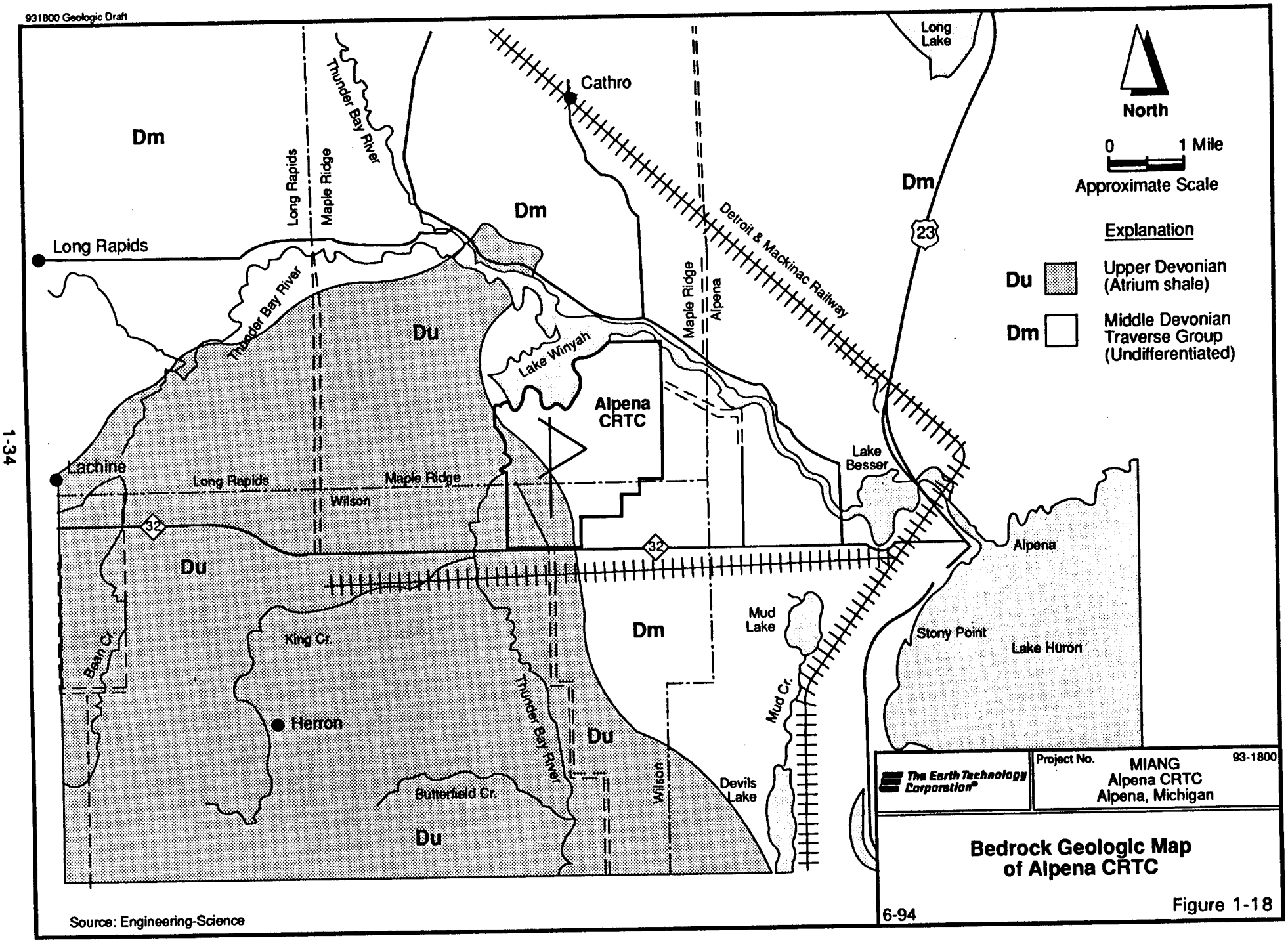
MIANG
Alpena CRTC
Alpena, Michigan

Stratigraphic Map of the Northern Lower Michigan Karst Area

6-94

Figure 1-17

931800 Stratigraphic


Dm
Du
Long Rapids
Maple Ridge
Thunder Bay River
Cathro
Long Lake
Detroit & Mackinac Railway
Alpena
Lake Winyah
Alpena CRTC
Lachine
Wilson
Lake Besser
Mud Lake
Stony Point
Lake Huron
Mud Cr.
King Cr.
Bean Cr.
Herron
Butterfield Cr.
Devils Lake
32
23
North
0 1 Mile
Approximate Scale
Explanation
Upper Devonian (Atrium shale)
Middle Devonian Traverse Group (Undifferentiated)
The Earth Technology Corporation
Project No. 93-1800
MIANG
Alpena CRTC
Alpena, Michigan
Bedrock Geologic Map of Alpena CRTC
6-94
Figure 1-18
Source: Engineering-Science

1.7.9 Facility-Wide Hydrogeology

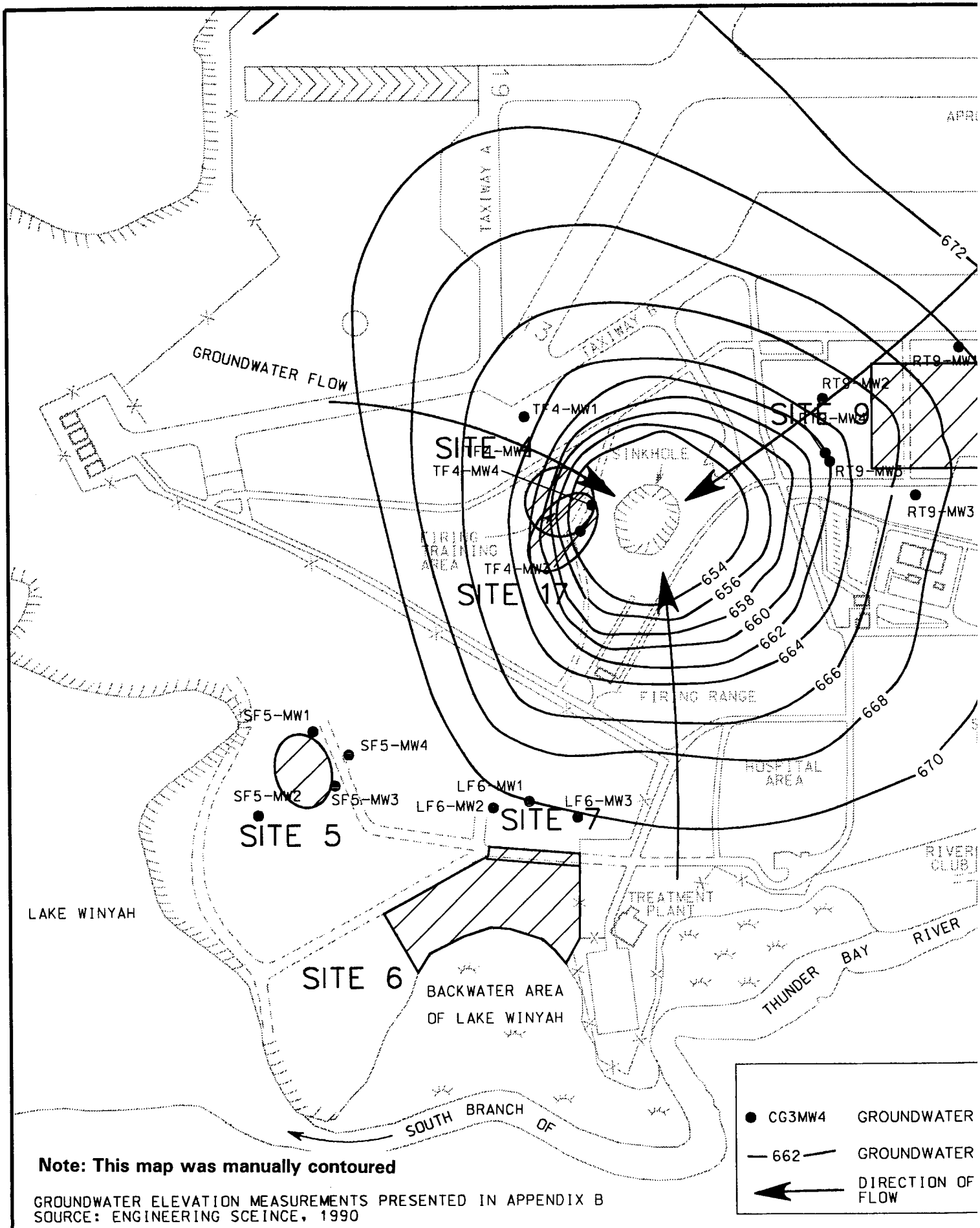
The hydrogeologic units of interest on the facility are the lacustrine sand (shallow aquifer), the Traverse Group Limestone, and the grey clay aquitard which sometimes occurs between the two aquifers. Hydrologically, the Alpena CRTC is located in the recharge area of the shallow aquifer. Recharge occurs as precipitation infiltrates directly into the permeable zones of the soil and migrates downward to the water table. The water table in the surficial aquifer is variable over the facility ranging from approximately 0.6 m (2 ft) bgs at Site 1 near the Thunder Bay River to approximately 7.6 to 9 m (25 to 30 ft) bgs at Site 4 just west of the runway in the center of the facility. Comparison of the historic water table maps for the surficial aquifer from November 1987, October 1991, and September 1993, (Figures 1-19, 1-20 and 1-21, respectively), show that the elevation of the water table has fluctuated throughout the past. However, the direction of groundwater flow has been consistently toward the sinkhole. Locally, in the vicinity of Sites 5 and 6, groundwater flows toward the Thunder Bay River and Lake Winyah. The magnitude of water table variation between 1987 and 1993 has been 0.3 to 0.9 m (1 to 3 ft), with the largest variation being in the vicinity of Sites 4, 5, and 6. This may be due to fluctuating lake levels which likely affect the position of the groundwater divide along Sites 5 and 6 and the influence of the sinkhole.

Figure 1-22 illustrates the inter-aquifer relationships and the influence of the sinkhole. Groundwater flow in the surficial aquifer is towards the sinkhole. The clay aquitard is discontinuous across the section. It is present near the Thunder Bay River and adjacent to the sinkhole. The clay is present at Site 3 and appears to thicken to the south. However, the clay is not present beneath Site 9. A west-east cross section (Figure 1-24) extending from the Thunder Bay River on the west to well HN8MW1 on the east side of the facility shows the presence of the perched zone at Site 1. The clay layer is not present across the section until well MP2MW5. The clay layer then appears to thicken eastward from MP2MW5. These relationships are illustrated further on Figure 1-25, a fence diagram which was constructed across the facility.

In April 1989, a significant hydrologic event occurred near the facility. In April 1989 Lake Winyah was lowered approximately 3 m (10 ft) by Alpena Power Company to allow the inspection of Norway Point Dam. This drop in the water level essentially drained Lake Winyah and the South Branch of Thunder Bay River which remained at the lower water levels until 1991. Although data were not collected to support this conclusion, the lowering of the lake/river probably increased flow from the shallow aquifer to these surface water bodies.

The hydraulic characteristics of the shallow aquifer were estimated from the results of several slug tests conducted during the SI (Engineering-Science, 1990). The hydraulic characteristics vary greatly across the facility. The hydraulic conductivity varies from an average low of 360 centimeters per day (cm/day) (4.17×10^{-3} cm/s) (12 feet per day [ft/day]) at Site 4 to an average high of 16,000 cm/day (0.19 cm/s) (526 ft/day) at Site 8. The transmissivity varies from an average low of 11 square meters per day (m^2/day) (118 square feet per day [ft^2/day]) at Site 4 to an average high of 579 m^2/day (6,237 ft^2/day) at Site 8. Aquifer slug test data and groundwater flow velocities are summarized in Table 1-6.

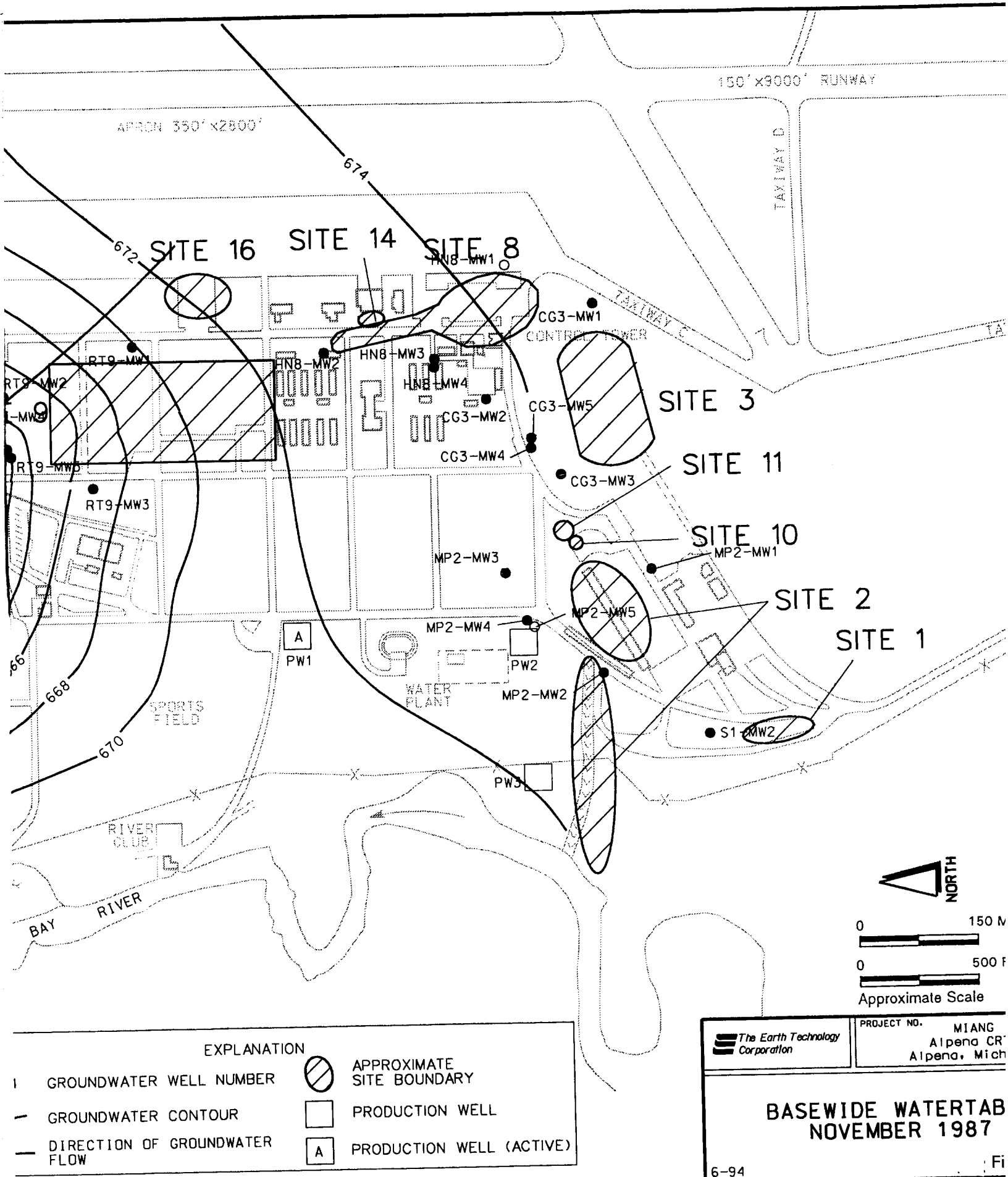
Groundwater flow directions within the Traverse Group Limestone are unknown. However, a posting (Figure 1-26) of wells tapping the limestone aquifer and their associated groundwater elevations by Engineering-Science (1989) shows that a gradient may exist to the

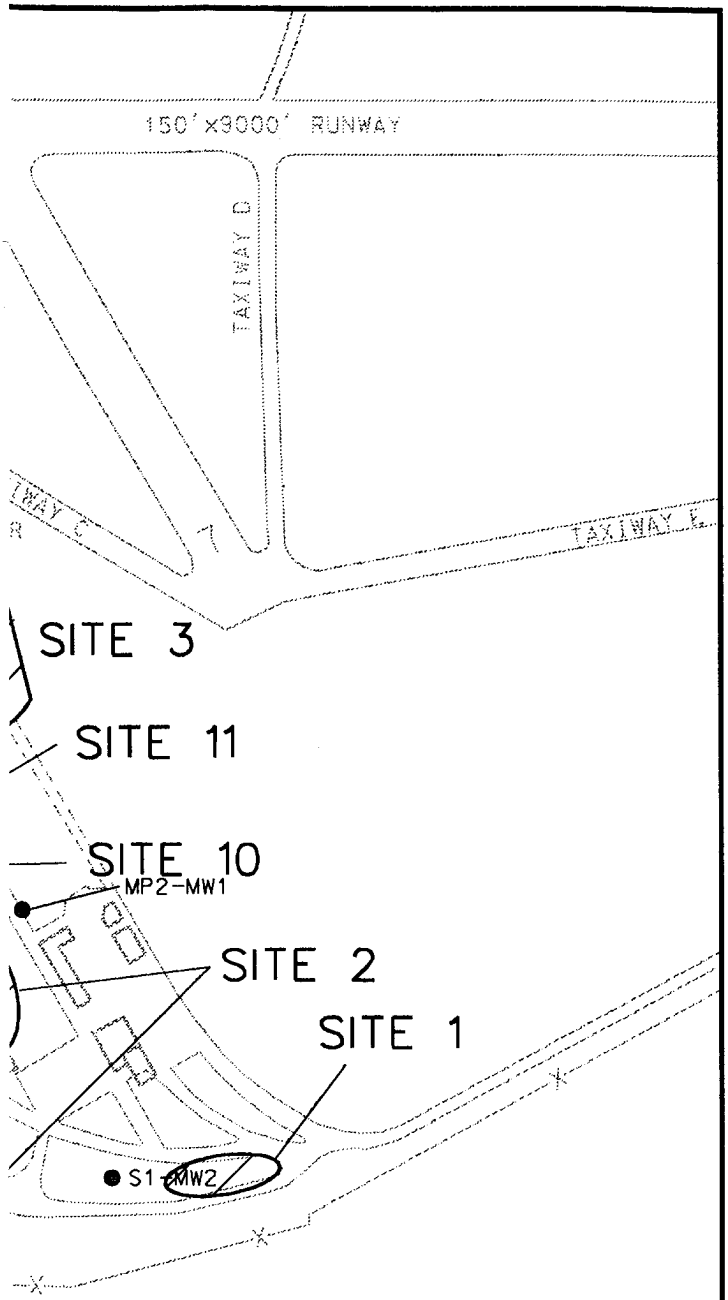


Note: This map was manually contoured

GROUNDWATER ELEVATION MEASUREMENTS PRESENTED IN APPENDIX B
SOURCE: ENGINEERING SCEINCE, 1990

VAX-DGN \ 928901 \ 890106RI \ A0418MPA.A06


150' x 9000' RUNWAY
APRON 350' x 2800'
TAXIWAY D
TAXIWAY E
674
672
668
670
SITE 16
SITE 14
SITE 8
SITE 3
SITE 11
SITE 10
SITE 2
SITE 1
HN8-MW1
HN8-MW2
HN8-MW3
HN8-MW4
CG3-MW1
CG3-MW2
CG3-MW3
CG3-MW4
CG3-MW5
RT9-MW1
RT9-MW2
RT9-MW3
RT9-MW5
MP2-MW1
MP2-MW2
MP2-MW3
MP2-MW4
MP2-MW5
S1-MW2
PW1
PW2
PW3
WATER PLANT
SPORTS FIELD
RIVER CLUB
BAY
RIVER
NORTH
0
150 M
0
500 F
Approximate Scale
EXPLANATION
GROUNDWATER WELL NUMBER
GROUNDWATER CONTOUR
DIRECTION OF GROUNDWATER FLOW
APPROXIMATE SITE BOUNDARY
PRODUCTION WELL
A
PRODUCTION WELL (ACTIVE)
The Earth Technology Corporation
PROJECT NO.
MIANG
Alpena CR
Alpena, Mich
BASEWIDE WATERTAB
NOVEMBER 1987
6-94
Fi



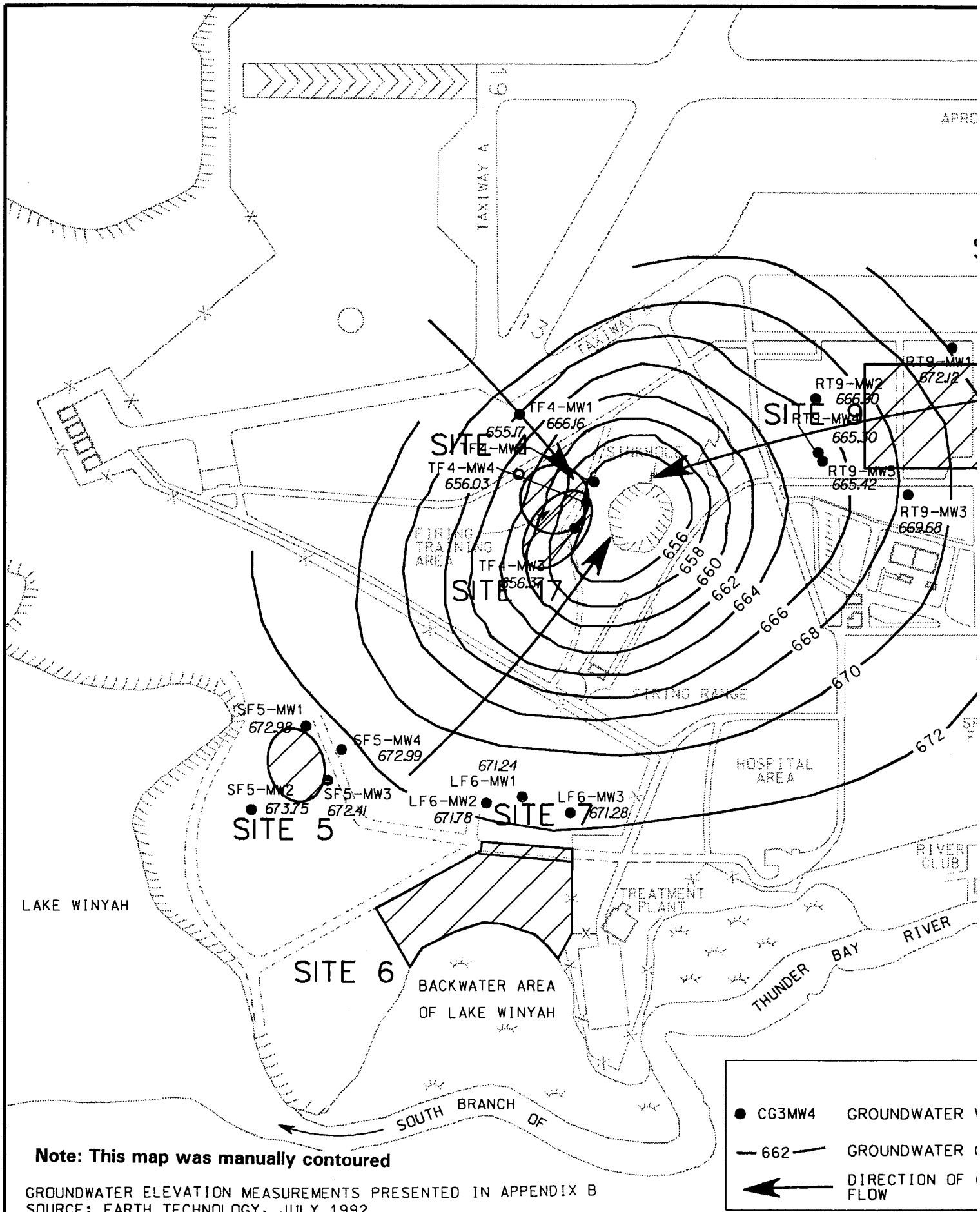
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PROJECT NO. 931800-02
MIANG
Alpena CRTC
Alpena, Michigan

BASEWIDE WATERTABLE NOVEMBER 1987

6-94

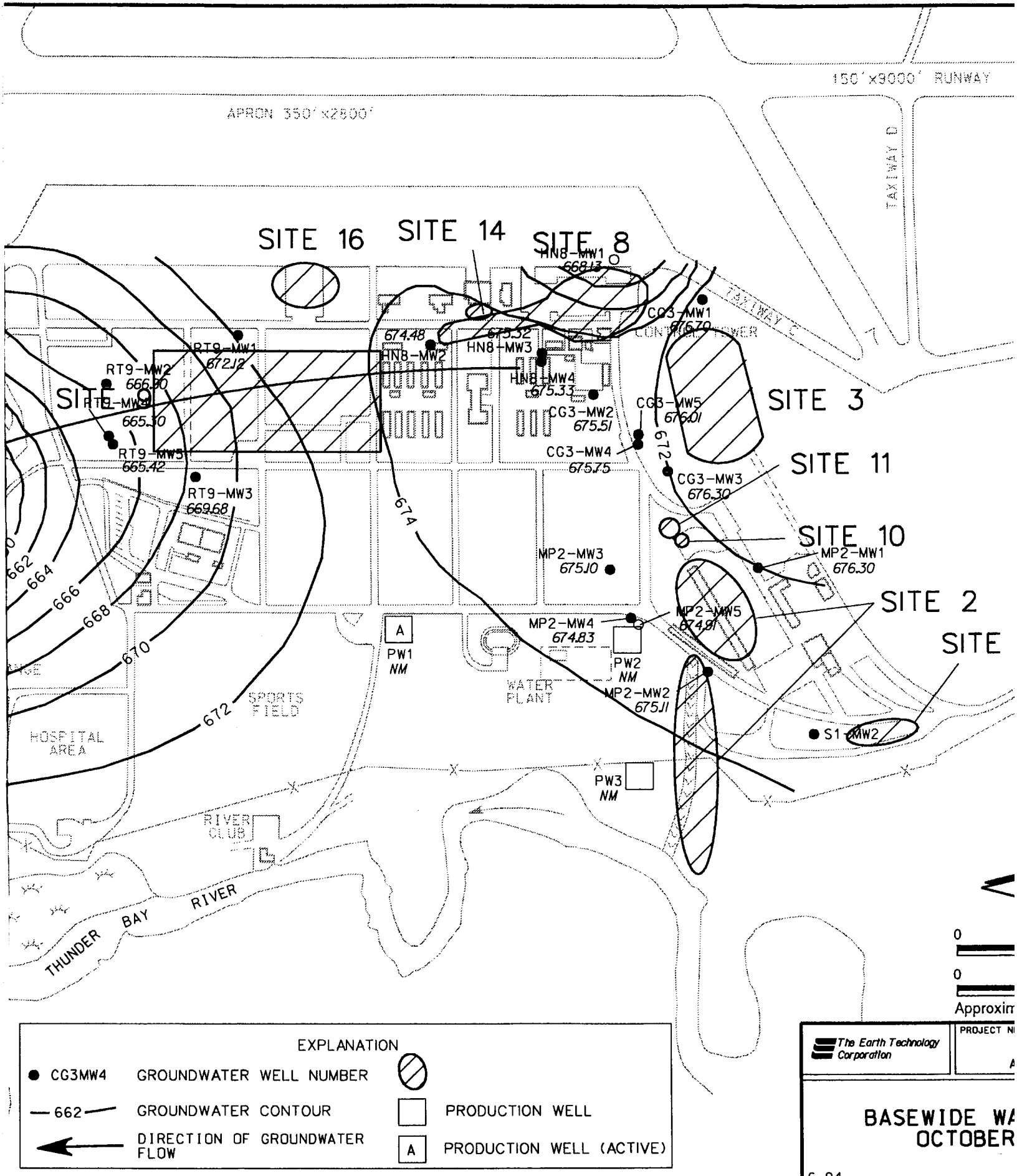
Figure 1-19

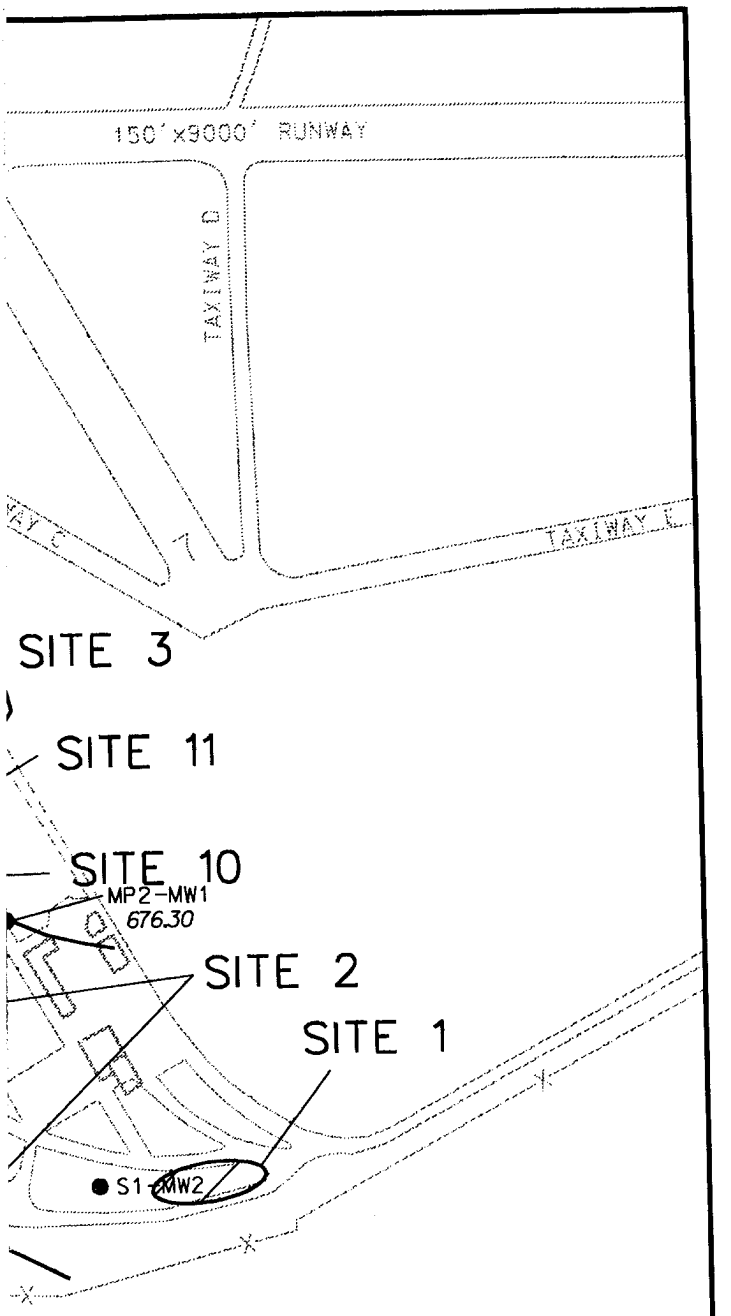


Note: This map was manually contoured

GROUNDWATER ELEVATION MEASUREMENTS PRESENTED IN APPENDIX B
SOURCE: EARTH TECHNOLOGY, JULY 1992

VAX-DGN \ 928901 \ 890106RI \ A0418MPA.A06


150' x 9000' RUNWAY
APRON 350' x 2500'
TAXIWAY D
TAXIWAY C
SITE 16
SITE 14
SITE 8
SITE 9
SITE 3
SITE 11
SITE 10
SITE 2
SITE
HN8-MW1 668.13
HN8-MW2 674.48
HN8-MW3 675.32
HN8-MW4 675.33
RT9-MW1 672.12
RT9-MW2 666.90
RT9-MW4 665.30
RT9-MW5 665.42
RT9-MW3 669.68
CG3-MW1 676.79
CG3-MW5 676.01
CG3-MW2 675.51
CG3-MW4 675.75
CG3-MW3 676.30
MP2-MW3 675.10
MP2-MW1 676.30
MP2-MW5 674.91
MP2-MW4 674.83
MP2-MW2 675.11
S1-MW2
PW1 NM
PW2 NM
PW3 NM
662
664
666
668
670
672
674
WATER PLANT
SPORTS FIELD
HOSPITAL AREA
RIVER CLUB
THUNDER BAY RIVER
EXPLANATION
CG3MW4 GROUNDWATER WELL NUMBER
662 GROUNDWATER CONTOUR
DIRECTION OF GROUNDWATER FLOW
PRODUCTION WELL
A PRODUCTION WELL (ACTIVE)
The Earth Technology Corporation
PROJECT NO
BASEWIDE WA
OCTOBER
6-94
0
0
Approxim



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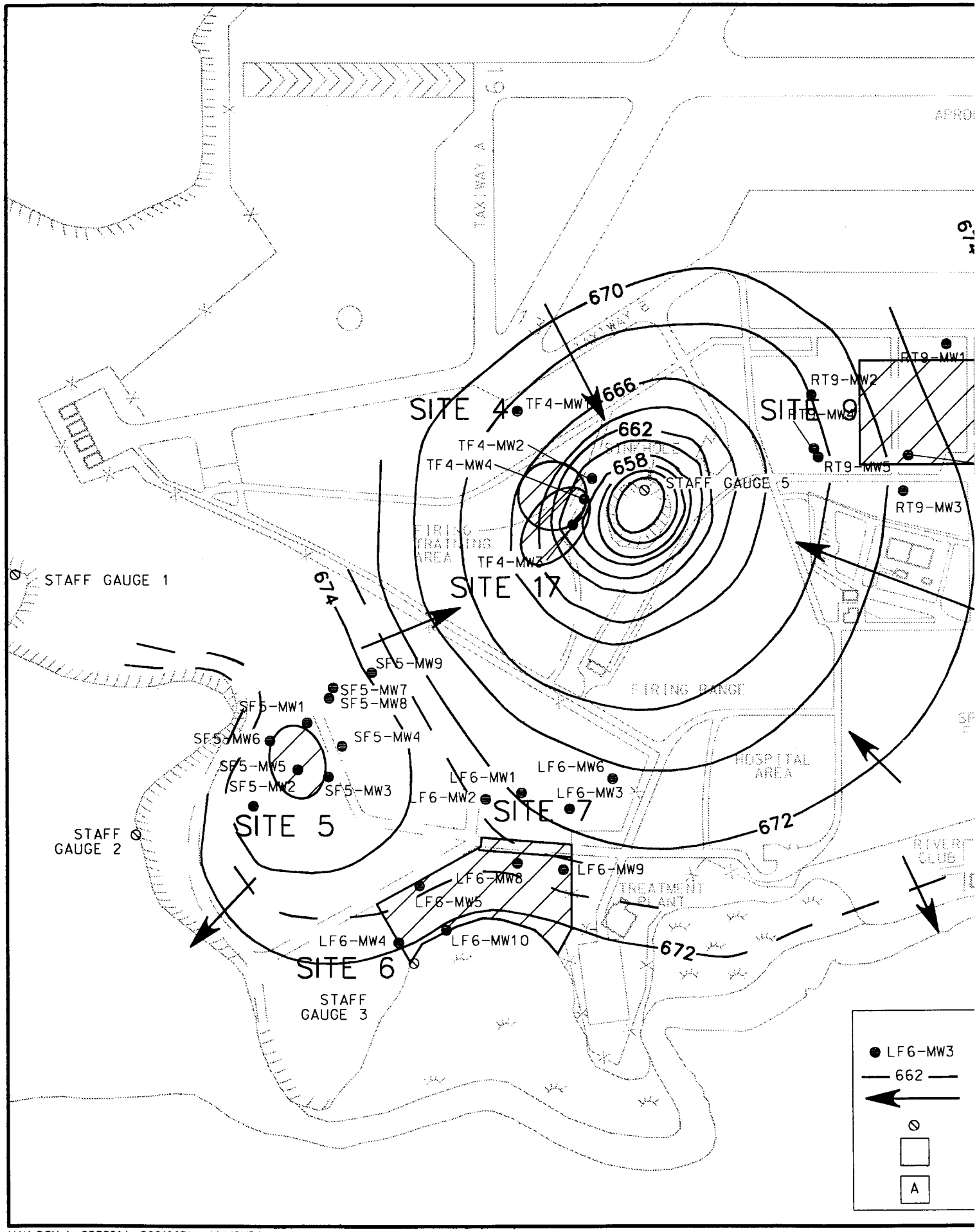
PROJECT NO. 931800-02

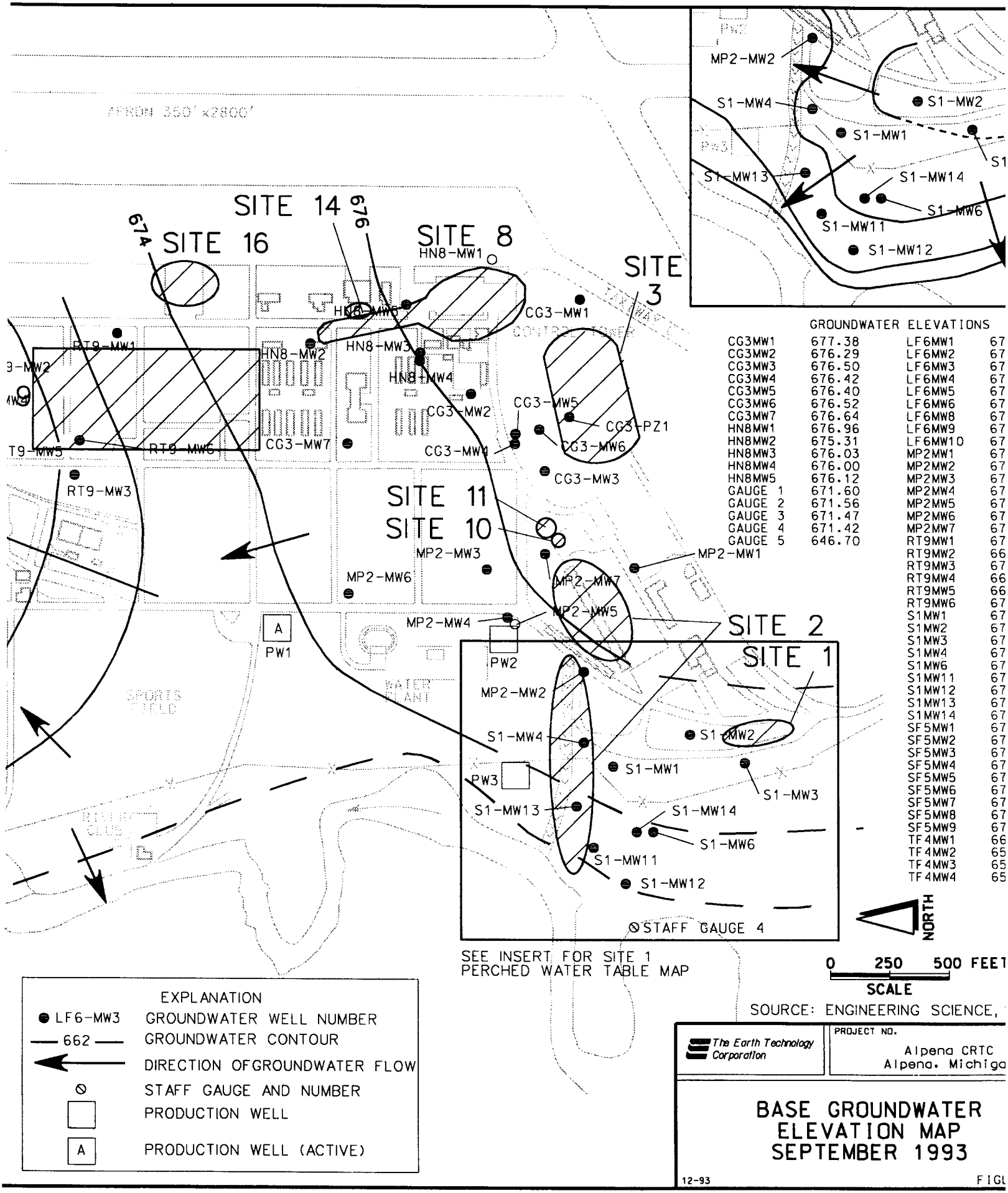
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Alpena, Michigan

BASEWIDE WATERTABLE OCTOBER 1991

Figure 1-20

6-94


SITE 4
TF4-MW1
TF4-MW2
TF4-MW4
TF4-MW3
SITE 9
RT9-MW1
RT9-MW2
RT9-MW4
RT9-MW5
RT9-MW3
STAFF GAUGE 5
SITE 17
STAFF GAUGE 1
SF5-MW9
SF5-MW7
SF5-MW8
SF5-MW1
SF5-MW6
SF5-MW4
SF5-MW5
SF5-MW2
SF5-MW3
SITE 5
STAFF GAUGE 2
LF6-MW1
LF6-MW6
LF6-MW2
LF6-MW3
SITE 7
LF6-MW8
LF6-MW9
LF6-MW5
LF6-MW4
LF6-MW10
SITE 6
STAFF GAUGE 3
670
666
662
658
674
672
672
FIRING RANGE
HOSPITAL AREA
TREATMENT PLANT
TAXIWAY A
TAXIWAY B
LF6-MW3
662
A



GROUNDWATER ELEVATIONS

CG3MW1	677.38	LF6MW1	67
CG3MW2	676.29	LF6MW2	67
CG3MW3	676.50	LF6MW3	67
CG3MW4	676.42	LF6MW4	67
CG3MW5	676.40	LF6MW5	67
CG3MW6	676.52	LF6MW6	67
CG3MW7	676.64	LF6MW8	67
HN8MW1	676.96	LF6MW9	67
HN8MW2	675.31	LF6MW10	67
HN8MW3	676.03	MP2MW1	67
HN8MW4	676.00	MP2MW2	67
HN8MW5	676.12	MP2MW3	67
GAUGE 1	671.60	MP2MW4	67
GAUGE 2	671.56	MP2MW5	67
GAUGE 3	671.47	MP2MW6	67
GAUGE 4	671.42	MP2MW7	67
GAUGE 5	646.70	RT9MW1	67
		RT9MW2	66
		RT9MW3	67
		RT9MW4	66
		RT9MW5	66
		RT9MW6	67
		S1MW1	67
		S1MW2	67
		S1MW3	67
		S1MW4	67
		S1MW6	67
		S1MW11	67
		S1MW12	67
		S1MW13	67
		S1MW14	67
		SF5MW1	67
		SF5MW2	67
		SF5MW3	67
		SF5MW4	67
		SF5MW5	67
		SF5MW6	67
		SF5MW7	67
		SF5MW8	67
		SF5MW9	67
		TF4MW1	66
		TF4MW2	65
		TF4MW3	65
		TF4MW4	65

SEE INSERT FOR SITE 1
PERCHED WATER TABLE MAP

EXPLANATION

- LF6-MW3 — GROUNDWATER WELL NUMBER
- 662 — GROUNDWATER CONTOUR
- DIRECTION OFGROUNDWATER FLOW
- STAFF GAUGE AND NUMBER
- PRODUCTION WELL
- A — PRODUCTION WELL (ACTIVE)

SOURCE: ENGINEERING SCIENCE,

The Earth Technology Corporation

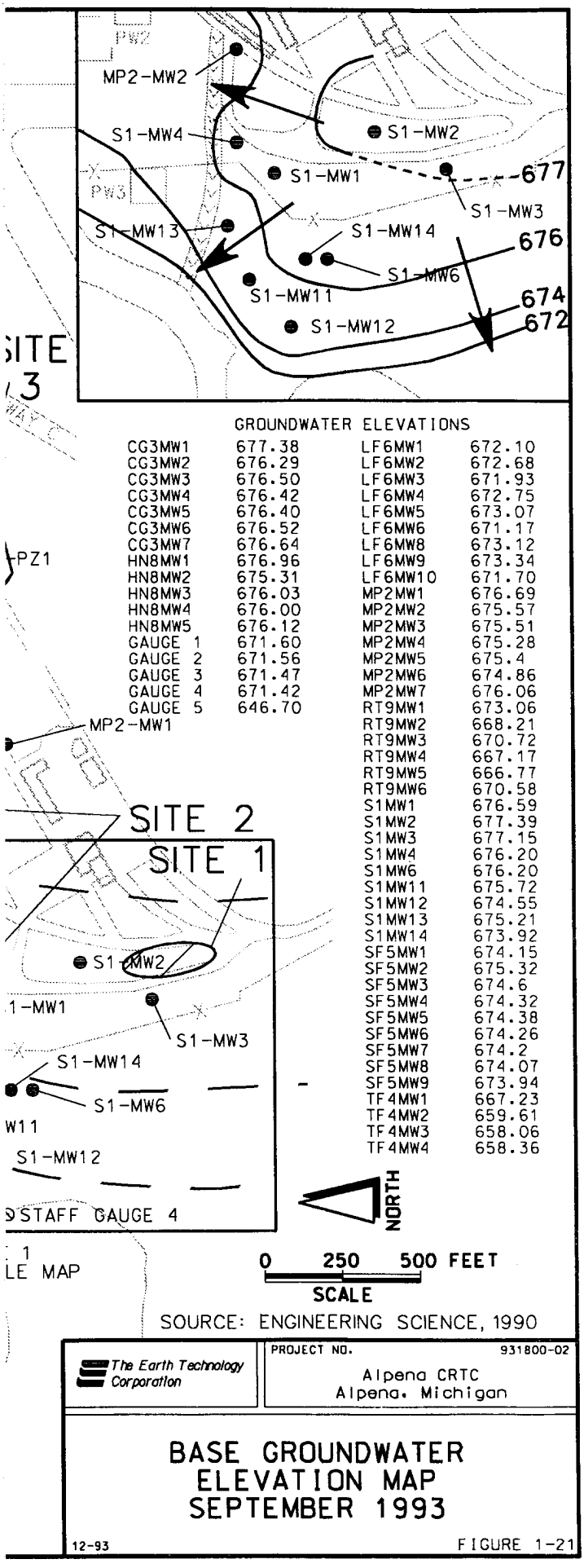
PROJECT NO.

Alpena CRTC
Alpena, Michiga

BASE GROUNDWATER ELEVATION MAP SEPTEMBER 1993

12-93

FIGU



GROUNDWATER ELEVATIONS

CG3MW1	677.38	LF6MW1	672.10
CG3MW2	676.29	LF6MW2	672.68
CG3MW3	676.50	LF6MW3	671.93
CG3MW4	676.42	LF6MW4	672.75
CG3MW5	676.40	LF6MW5	673.07
CG3MW6	676.52	LF6MW6	671.17
CG3MW7	676.64	LF6MW8	673.12
HN8MW1	676.96	LF6MW9	673.34
HN8MW2	675.31	LF6MW10	671.70
HN8MW3	676.03	MP2MW1	676.69
HN8MW4	676.00	MP2MW2	675.57
HN8MW5	676.12	MP2MW3	675.51
GAUGE 1	671.60	MP2MW4	675.28
GAUGE 2	671.56	MP2MW5	675.4
GAUGE 3	671.47	MP2MW6	674.86
GAUGE 4	671.42	MP2MW7	676.06
GAUGE 5	646.70	RT9MW1	673.06
		RT9MW2	668.21
		RT9MW3	670.72
		RT9MW4	667.17
		RT9MW5	666.77
		RT9MW6	670.58
		S1MW1	676.59
		S1MW2	677.39
		S1MW3	677.15
		S1MW4	676.20
		S1MW6	676.20
		S1MW11	675.72
		S1MW12	674.55
		S1MW13	675.21
		S1MW14	673.92
		SF5MW1	674.15
		SF5MW2	675.32
		SF5MW3	674.6
		SF5MW4	674.32
		SF5MW5	674.38
		SF5MW6	674.26
		SF5MW7	674.2
		SF5MW8	674.07
		SF5MW9	673.94
		TF4MW1	667.23
		TF4MW2	659.61
		TF4MW3	658.06
		TF4MW4	658.36

SOURCE: ENGINEERING SCIENCE, 1990

The Earth Technology Corporation

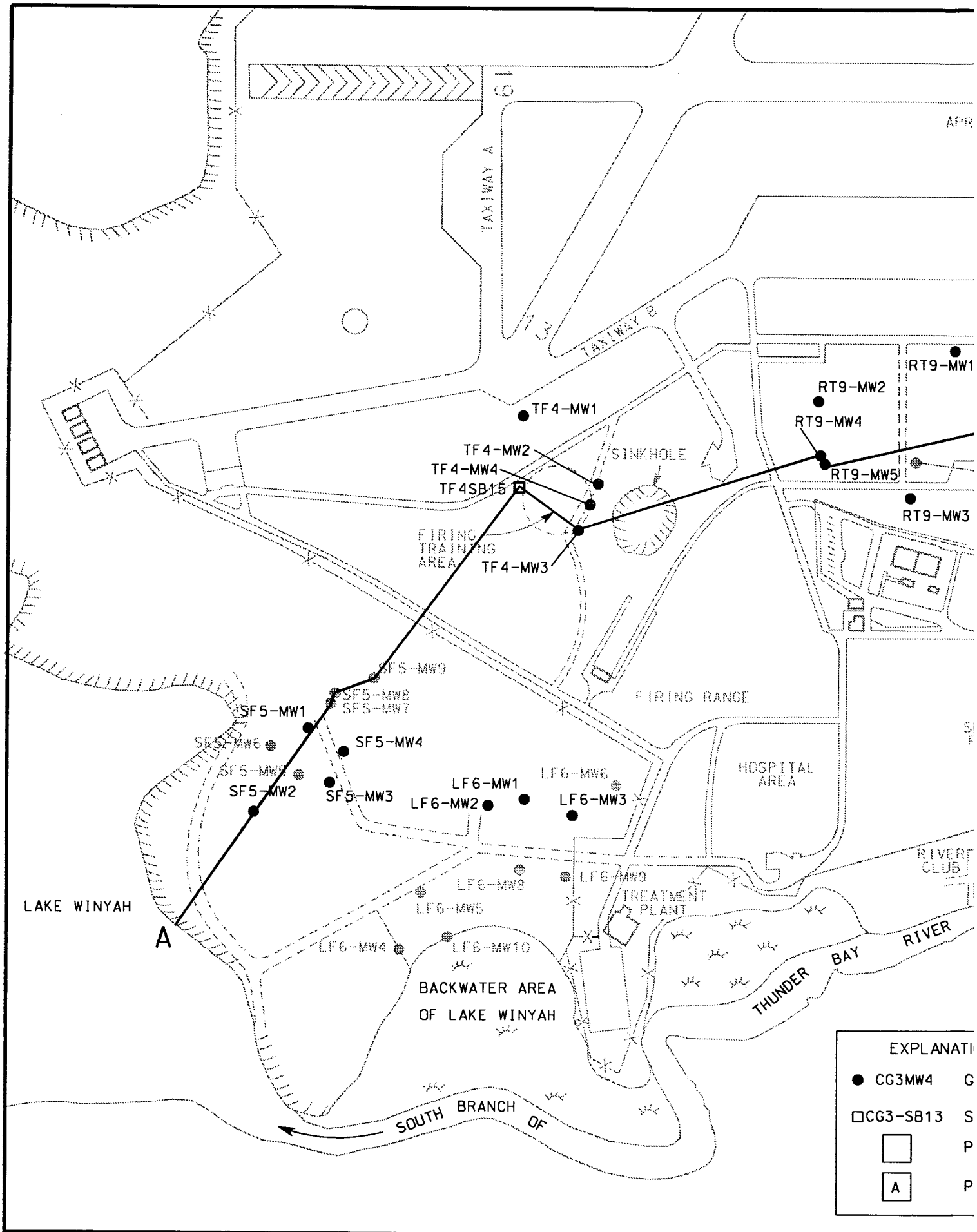
PROJECT NO. 931800-02

Alpena CRTC
Alpena, Michigan

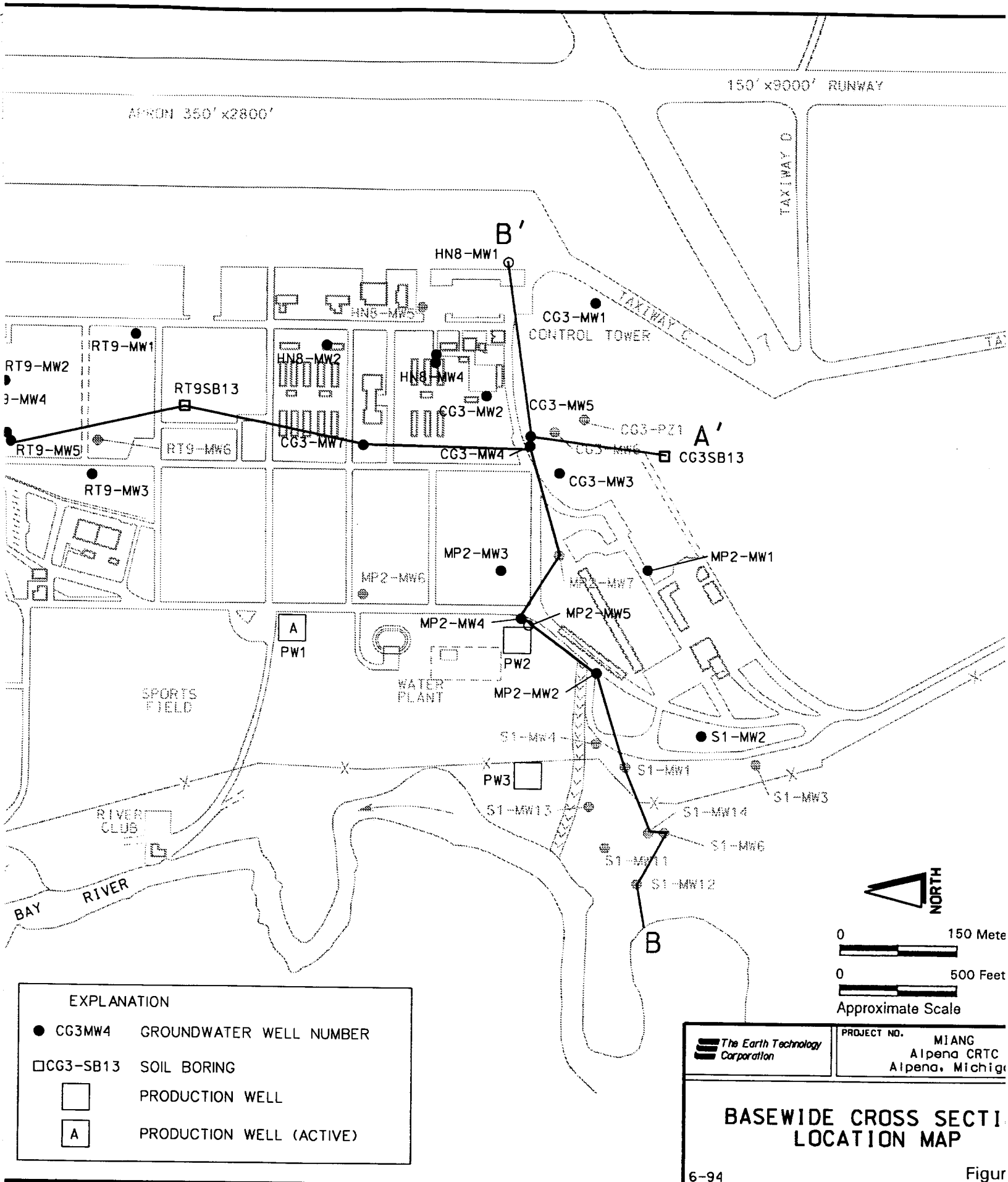
BASE GROUNDWATER ELEVATION MAP SEPTEMBER 1993

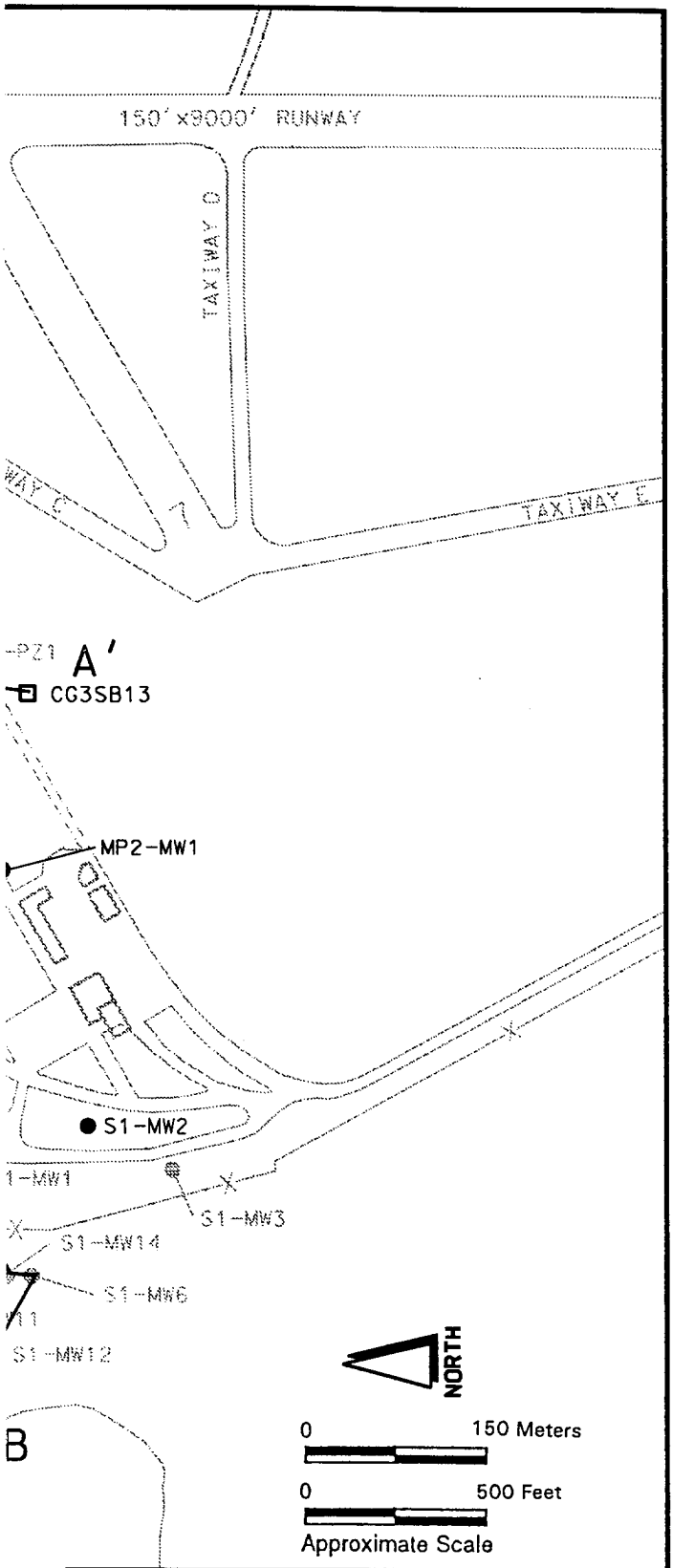
12-93

FIGURE 1-21



VAX-DGN \ 928901 \ 890106RI \ A0418MPA.A06


150' x 3000' RUNWAY
APRON 350' x 2800'
TAXIWAY C
TAXIWAY D
B'
HN8-MW1
HN8-MW5
CG3-MW1
CONTROL TOWER
RT9-MW1
RT9-MW2
HN8-MW2
HN8-MW4
RT9SB13
CG3-MW2
CG3-MW5
CG3-PZ1
A'
RT9-MW5
RT9-MW6
CG3-MW7
CG3-MW4
CG3SB13
RT9-MW3
CG3-MW3
MP2-MW3
MP2-MW1
MP2-MW6
MP2-MW7
MP2-MW4
MP2-MW5
A
PW1
PW2
WATER PLANT
MP2-MW2
SPORTS FIELD
S1-MW4
S1-MW2
S1-MW1
PW3
S1-MW3
S1-MW13
S1-MW14
S1-MW6
S1-MW11
S1-MW12
RIVER CLUB
BAY
RIVER
B
NORTH
0
150 Mete
0
500 Feet
Approximate Scale
EXPLANATION
CG3MW4 GROUNDWATER WELL NUMBER
CG3-SB13 SOIL BORING
PRODUCTION WELL
A PRODUCTION WELL (ACTIVE)
The Earth Technology Corporation
PROJECT NO.
MIANG
Alpena CRTC
Alpena, Michig
BASEWIDE CROSS SECTI
LOCATION MAP
6-94
Figur



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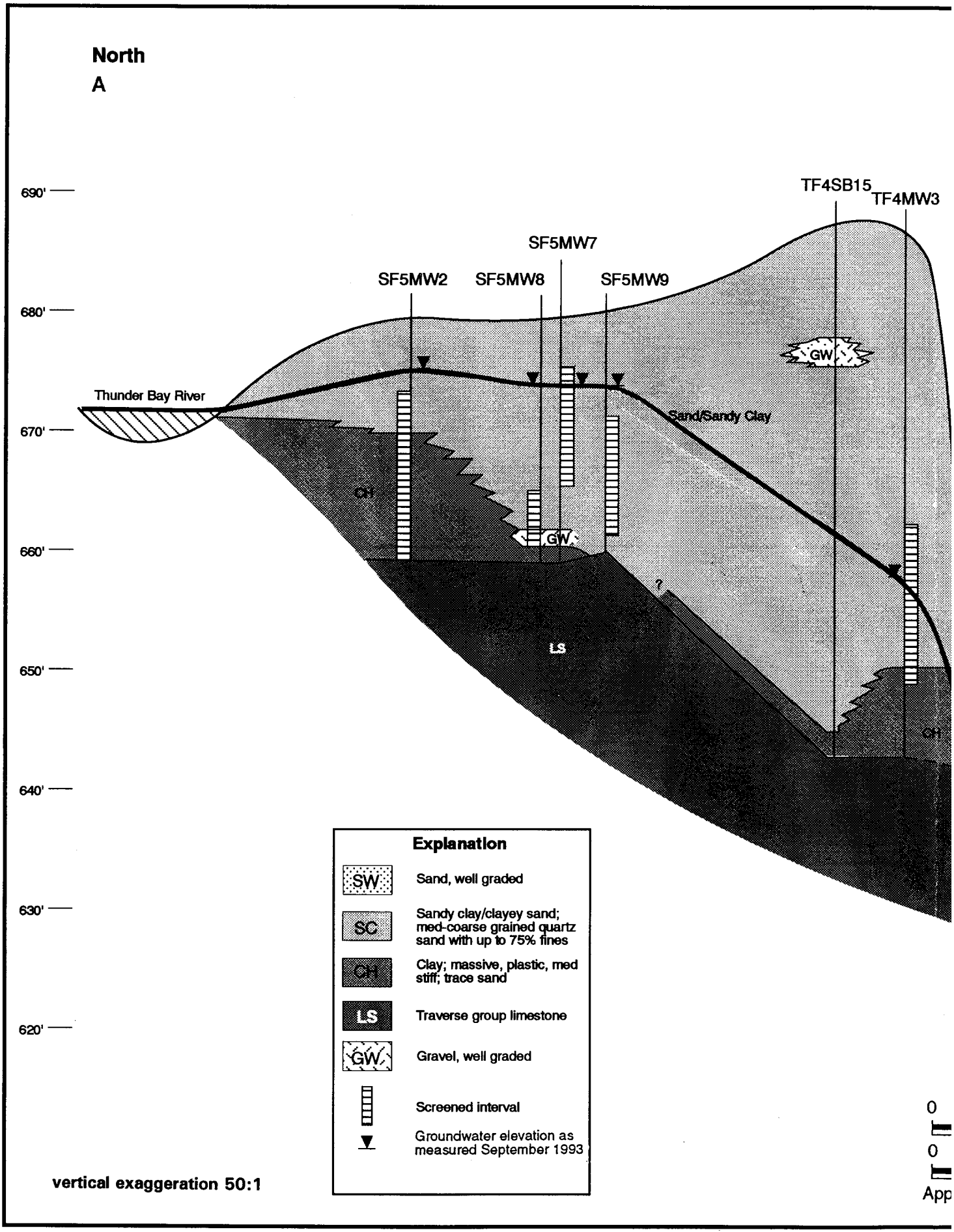
PROJECT NO. 931800-02

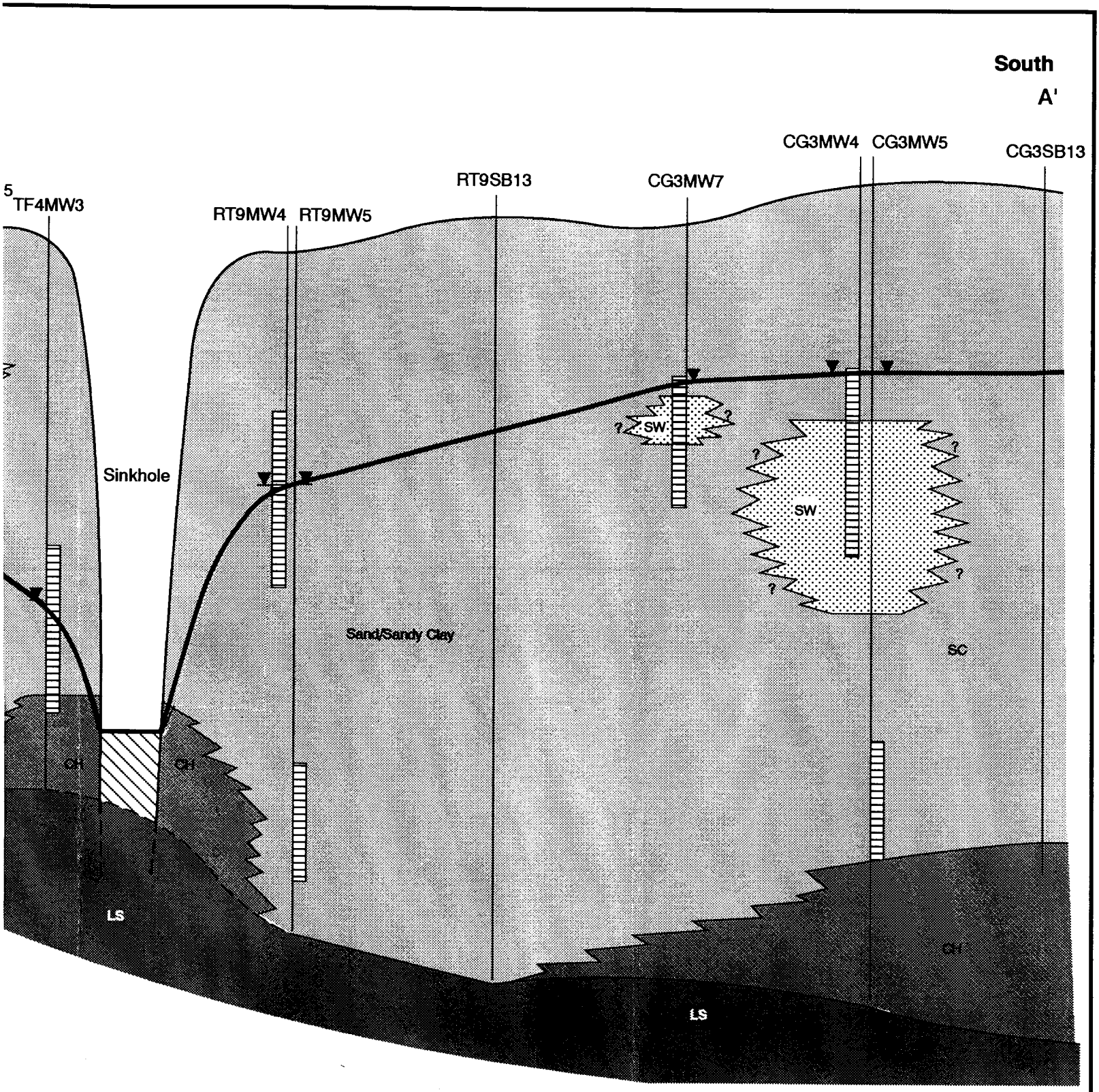
MIANG
Alpena CRTC
Alpena, Michigan

BASEWIDE CROSS SECTION LOCATION MAP

6-94

Figure 1-22


North
A
690'
680'
670'
660'
650'
640'
630'
620'
TF4SB15
TF4MW3
SF5MW7
SF5MW2
SF5MW8
SF5MW9
GW
Thunder Bay River
Sand/Sandy Clay
CH
GW
?
LS
CH
Explanation
SW
Sand, well graded
SC
Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
CH
Clay; massive, plastic, med stiff; trace sand
LS
Traverse group limestone
GW
Gravel, well graded
Screened interval
Groundwater elevation as measured September 1993
vertical exaggeration 50:1
N-S Basewide X-Sec Draft
0
0
App



0 500 Feet

0 150 Meters

Approximate Scale

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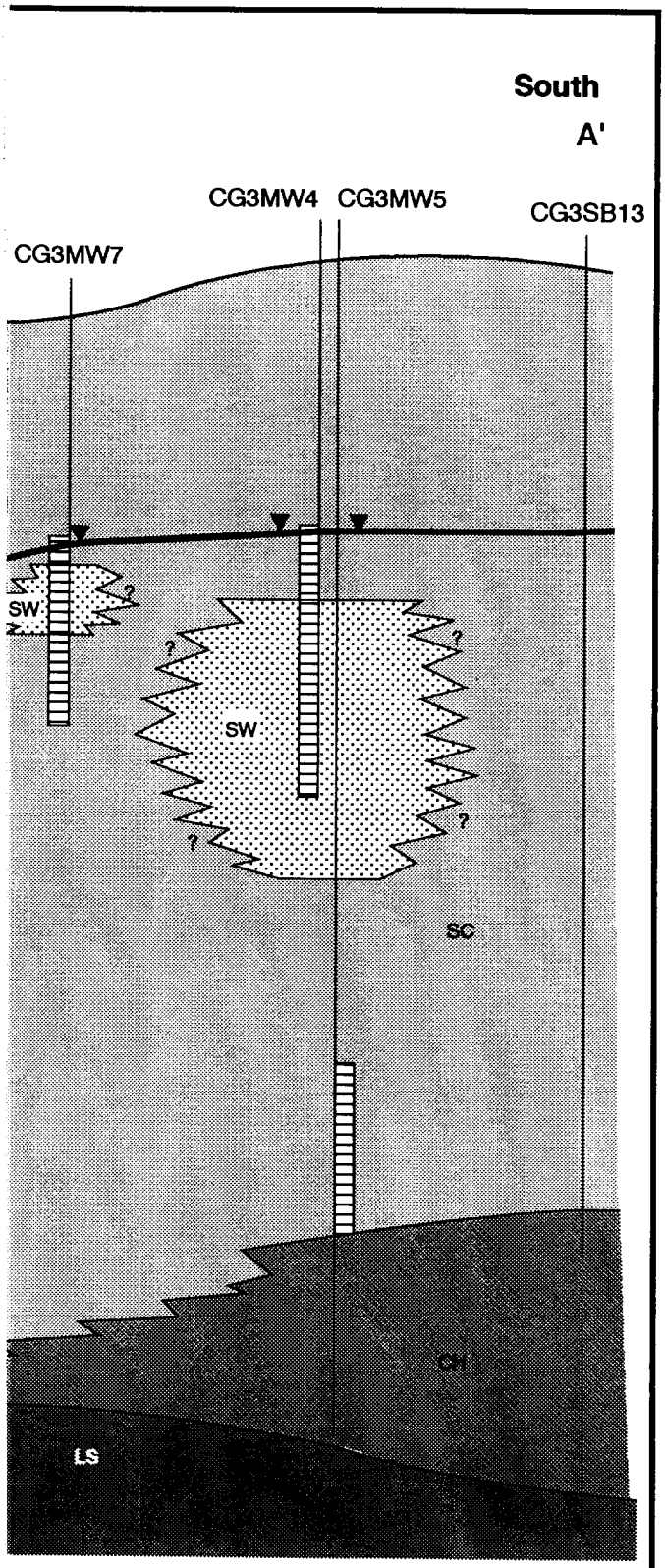
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Alpena CRTC
Alpena, Michigan

Draft

North - South Basewide Geologic Cross Section

6-94

Figure 1-23



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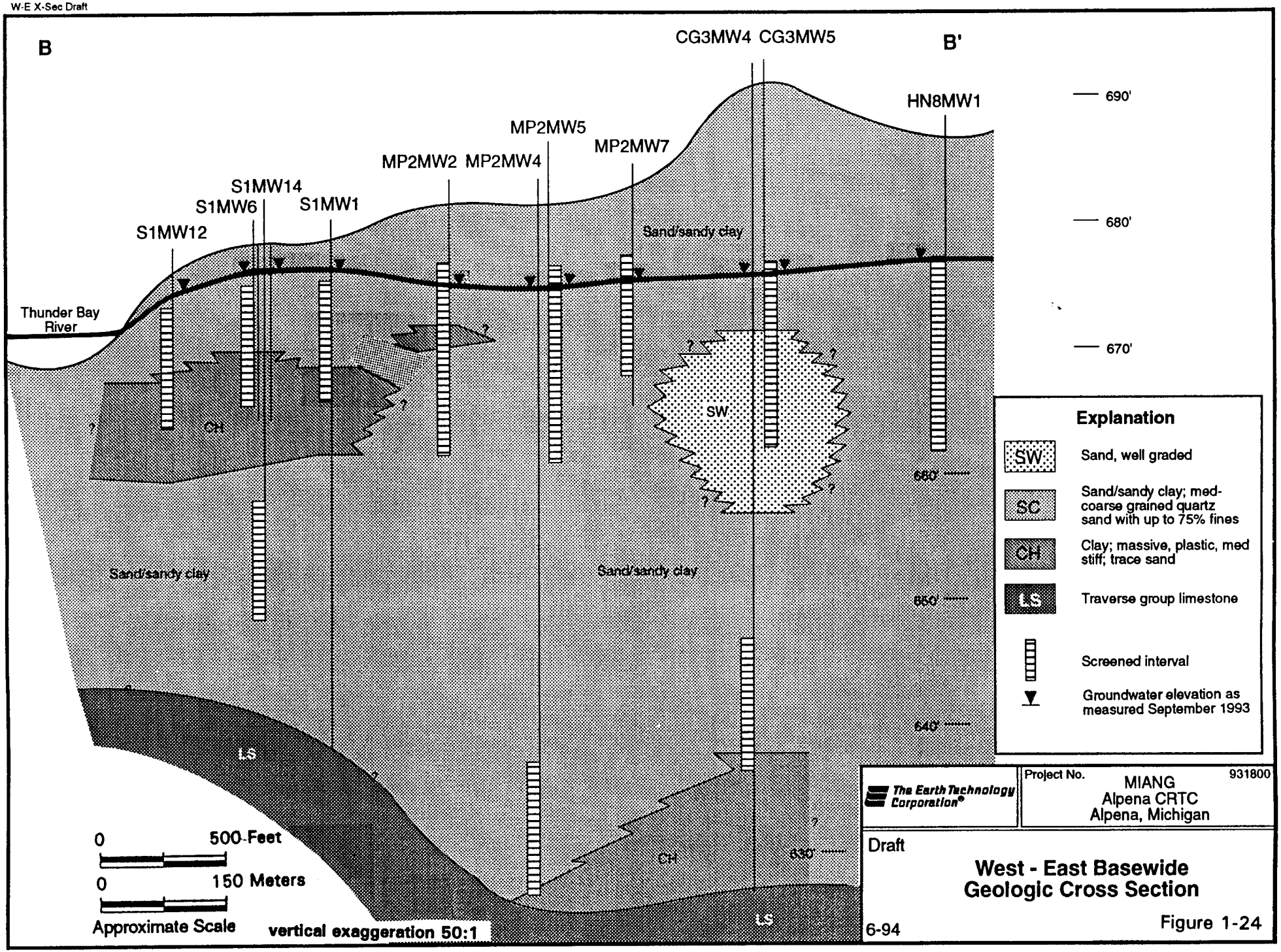
MIANG
Alpena CRTC
Alpena, Michigan

Draft

North - South Basewide Geologic Cross Section

6-94

Figure 1-23



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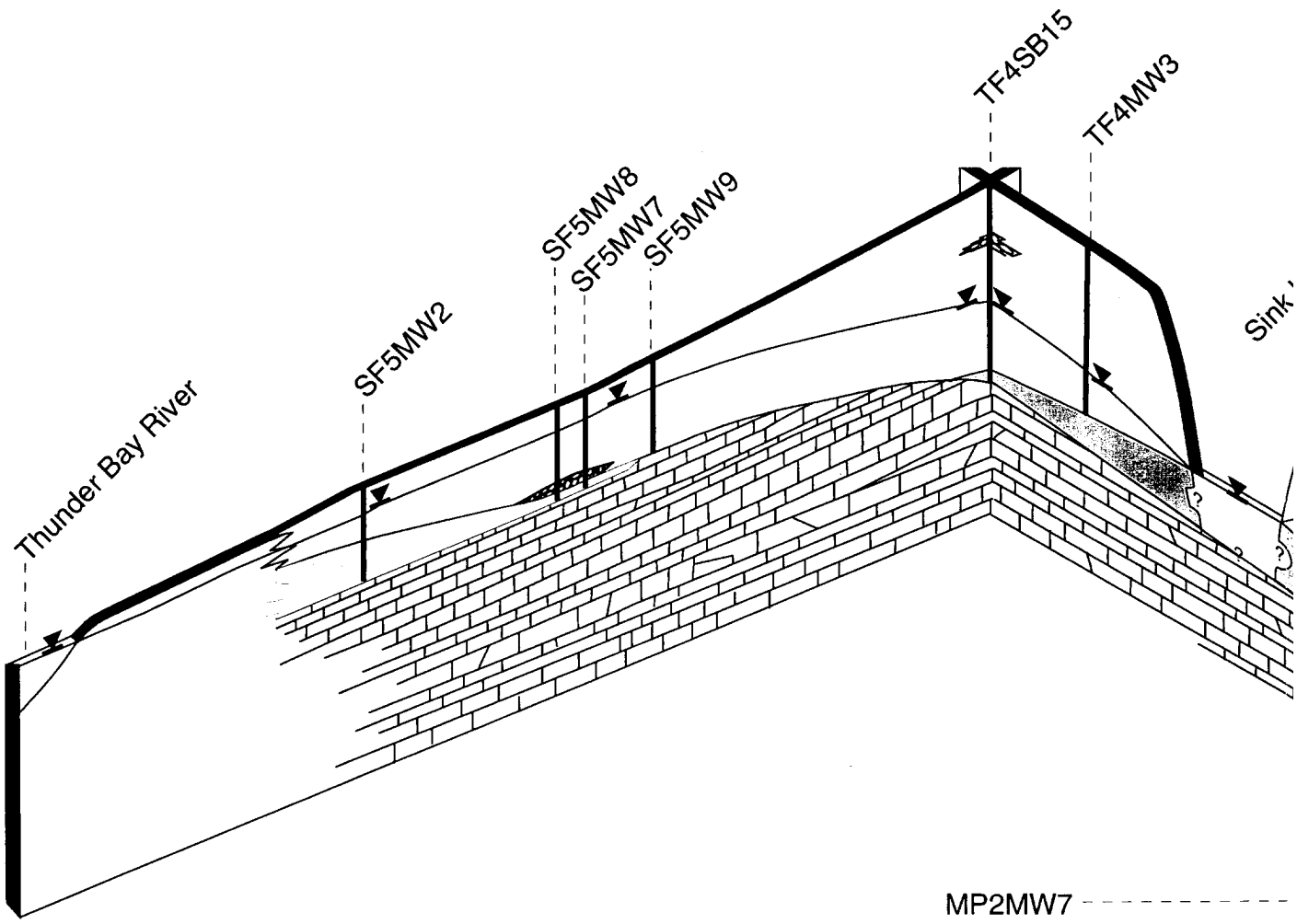
MIANG
Alpena CRTC
Alpena, Michigan

Draft

West - East Basewide Geologic Cross Section

6-94

Figure 1-24



MP2MW7 - - - - - - - - - - -

MP2MW5 - - - - - - - - - - -

MP2MW4 - - - - - - - - - - -

MP2MW2 - - - - - - - - - - -

S1MW1 - - - - - - - - - - - -

S1MW14 - - - - - - - - - - -

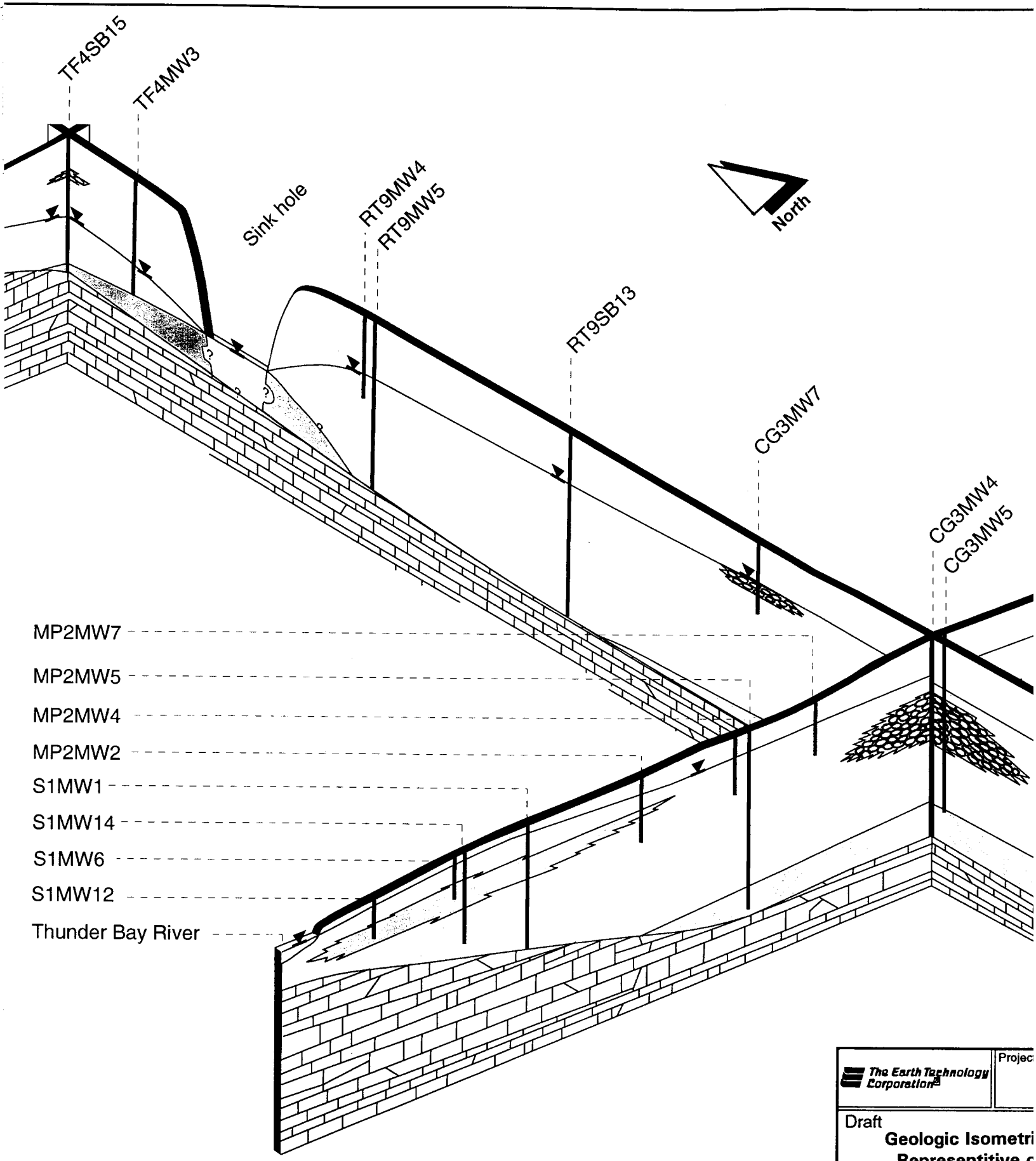
S1MW6 - - - - - - - - - - - -

S1MW12 - - - - - - - - - - -

Thunder Bay River - - - - -

Explanation

- Groundwater elevation as measured September 1993
- Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
- Clay; massive, plastic, med stiff; trace sand
- Gravel, well graded
- Traverse group limestone



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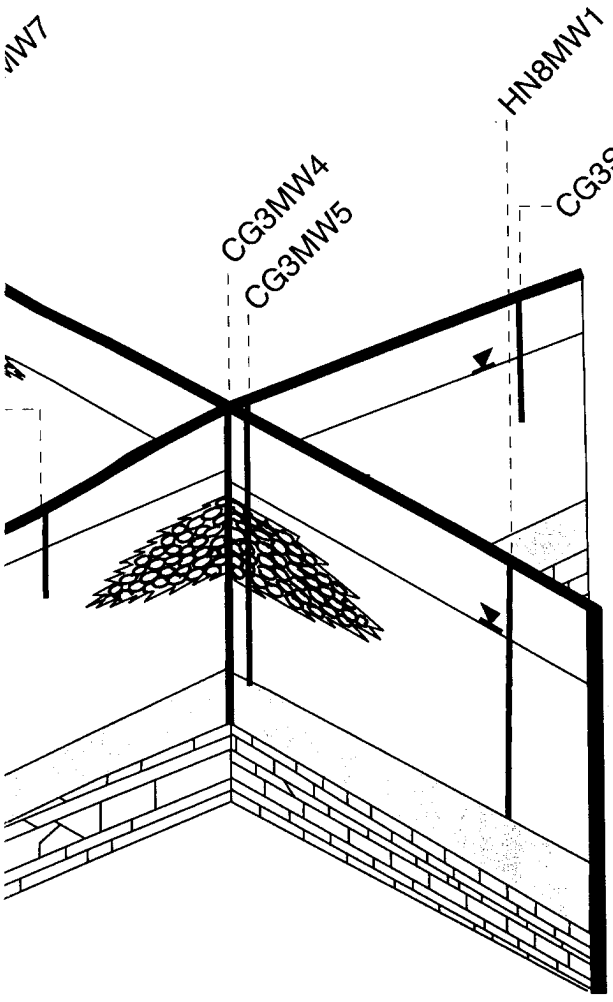
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Alpena CRTC
Alpena, Michigan

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Geologic Isometric Fence Diagram Representitive of Alpena CRTC

(Not To Scale)

Figure 1-25

Table 1-6 Shallow Aquifer Hydraulic Conductivity and Groundwater Velocity Values Alpena CRTC, MIANG Alpena, Michigan

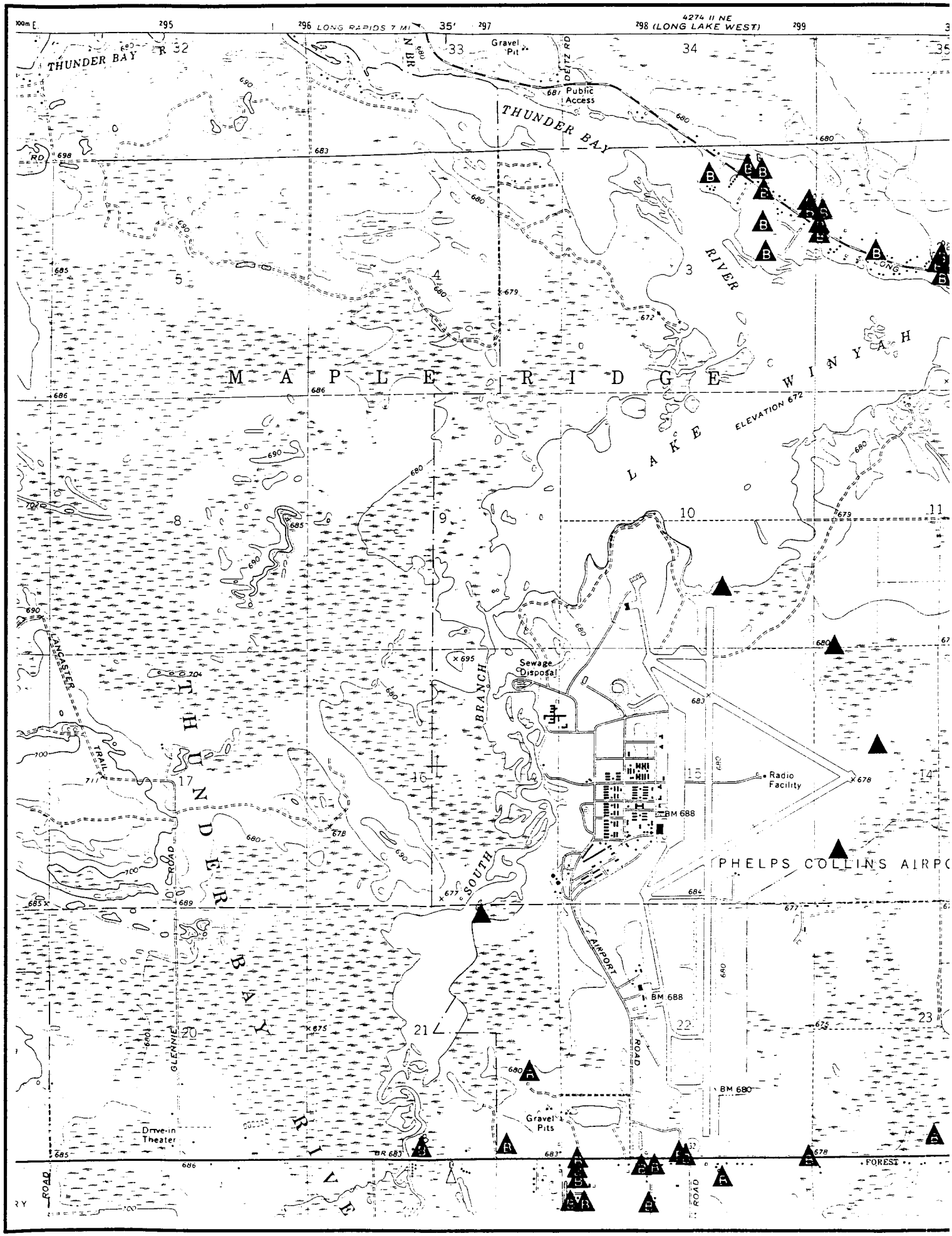
	Source	Average Hydraulic Conductivity (k in cm/sec)	Groundwater Flow Velocity [a] (v̄ in cm/sec)
Site 1			
S1-MW2	(b)	4.97×10^{-3}	1.99×10^{-4}
S1-MW3	(b)	3.86 x 10-3	1.54×10^{-4}
Site 2			
MP2-MW1	(c)	9.42×10^{-2}	7.55×10^{-4}
MP2-MW4	(c)	7.62×10^{-2}	6.10×10^{-4}
MP2-MW5	(c)	6.53×10^{-2}	5.22×10^{-4}
MP2-MW6	(b)	7.91×10^{-3}	6.33×10^{-5}
Site 3			
CG3-MW1	(c)	9.38×10^{-2}	3.74×10^{-4}
CG3-MW4	(c)	2.54×10^{-2}	1.02×10^{-4}
CG3-MW5	(c)	1.75×10^{-1}	7.02×10^{-4}
Site 4			
TF4-MW1	(c)	1.09×10^{-1}	1.58×10^{-3}
TF4-MW3	(c)	1.20×10^{-2}	2.82×10^{-4}
TF4-MW4	(c)	3.53×10^{-3}	1.13×10^{-4}
Site 5			
SF5-MW1	(c)	2.47×10^{-3}	2.82×10^{-5}
SF5-MW2	(c)	2.99×10^{-2}	3.60×10^{-4}
SF5-MW4	(c)	4.23×10^{-3}	1.49×10^{-3}
SF5-MW5	(b)	2.22×10^{-3}	2.64×10^{-5}
Sites 6 & 7			
LF6-MW1	(c)	1.27×10^{-2}	2.05×10^{-4}
LF6-MW2	(c)	8.11×10^{-2}	1.3×10^{-3}
LF6-MW3	(c)	1.52×10^{-2}	2.43×10^{-4}
LF6-MW4	(b)	1.94×10^{-4}	3.10×10^{-6}
LF6-MW6	(b)	3.28×10^{-4}	5.25×10^{-6}
Site 8			
HN8-MW1	(c)	4.16×10^{-1}	3.33×10^{-3}
HN8-MW3	(c)	7.37×10^{-2}	5.89×10^{-4}
HN8-MW4	(c)	6.67×10^{-2}	5.29×10^{-4}
Site 9			
RT9-MW1	(c)	4.09×10^{-2}	1.64×10^{-3}
RT9-MW4	(c)	2.54×10^{-2}	1.02×10^{-3}
RT9-MW5	(c)	1.17×10^{-1}	4.67×10^{-3}

[a] Equation used to calculate flow velocities is as follows:

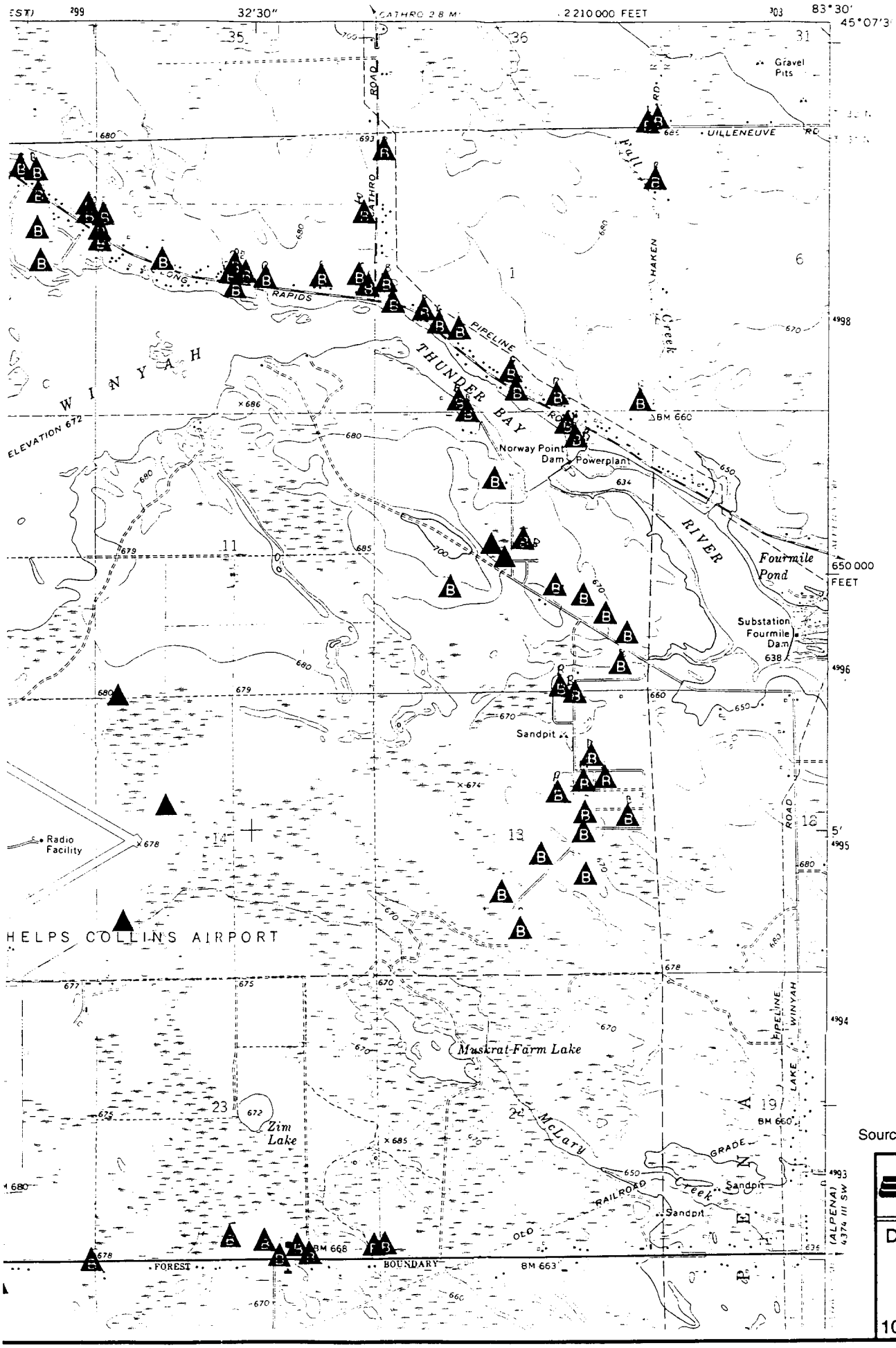
$$\bar{v} = \frac{K \frac{dh}{dl}}{n}$$

where $\bar{v}$ = *average groundwater flow velocity*
k = *average hydraulic conductivity*
$\frac{dh}{dl}$ = *average hydraulic gradient (taken from site specific hydrogeology discussions)*
and n = *average porosity (assumed to be* 0.25)

[b] this RI Report
[c] Engineering-Science, 1990



931800 Bedrock



Explanation

▲ Domestic well

Ⓑ Domestic well

0

0

Approximat

Source: Drillers logs obtained from A

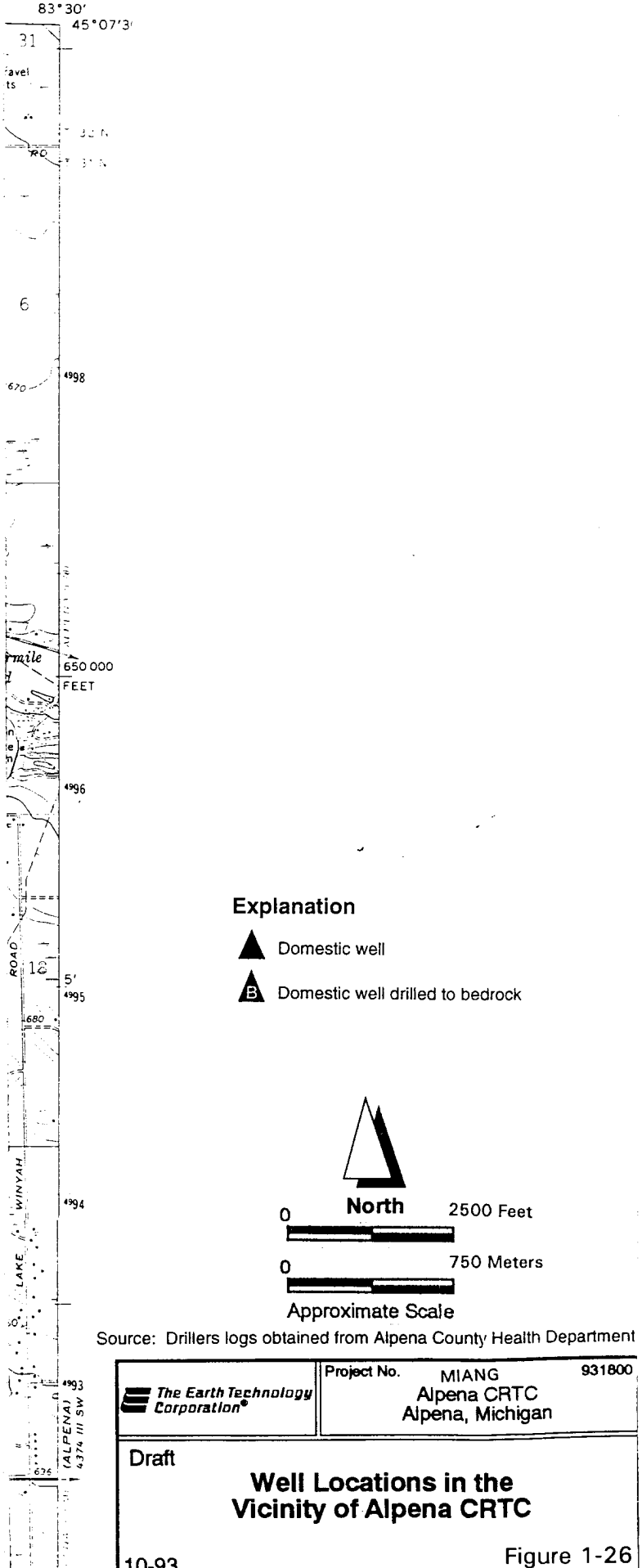
The Earth Technology Corporation

Project N

Draft

Well Locati
Vicinity of A

10-93



Source: Drillers logs obtained from Alpena County Health Department

The Earth Technology Corporation®

Project No. MIANG 931800
Alpena CRTC
Alpena, Michigan

Draft

Well Locations in the Vicinity of Alpena CRTC

10-93

Figure 1-26

east. However, care must be taken in interpreting groundwater elevations within the limestone aquifer. The fractured limestones contain many conduits which act as preferred flow pathways (Black, 1983). Therefore, the aquifer is heterogenous. For nonhomogeneous or anisotropic aquifer the direction of flow is not necessarily oriented perpendicular to the hydraulic gradient (Fetter, 1988). Additionally, the Detroit River Group aquifer, which lies below the Traverse Group, may have an impact on the hydrogeology.

The sinkhole may have a development history similar to that of other sinkholes in the area which have a vertical outlet to the Detroit River Group and saline groundwater. The rise and fall of sea level in the geologic past and the solution of limestones and evaporates within the Detroit River Group have been reported by Black (1983) as reasons for the collapse of rock formations within the Detroit River Group, the Dundee and Rogers City limestones, and upward into the Traverse Group Limestones.

This vertical collapse, expressed as sinkholes, may promote the downward flow of groundwater from the shallow and limestone aquifers into the Detroit River Group breccia and limestones. The discharge points for the Detroit River Group are believed to be saline and sulfur springs in the bottom of Lake Huron and El Cajon Bay northeast of the facility (Kimmel, 1983). Visible inflow into the sinkhole has routinely been observed at a rate of approximately 67,800 liters per day (ℓ/day) (17,900 gallons per day [gal/day]) (Engineering-Science, 1989). This suggests that the sinkhole is an outlet for groundwater flow to either the limestone aquifer and/or the Detroit River Group. The total volume of inflow is probably much greater. The exact direction of groundwater flow within the limestone aquifer has not been determined.

1.7.10 Summary of Environmental Setting

The environmental setting data for Alpena CRTC indicate the following data are important when evaluating the potential migration of contaminants:

- The average annual precipitation is 74 cm (29.15 in) and the estimated minimum net precipitation is 8 cm (3 in) per year. These data indicate that there is a potential for the generation of leachate from past waste sites.
- The facility soils are generally sandy and well drained.
- Where present, surface water drainage on the facility is controlled by open ditches which direct water east and west of the runway. Westward flowing water drains either into the South Branch of the Thunder Bay River or into the facility sinkhole.
- The shallow aquifer on the facility is unconfined lacustrine sand and consists mainly of quartz sand, pebbles, and cobbles.
- The facility is located in the recharge area of the lacustrine sand (shallow aquifer).
- A discontinuous clay aquitard exists on the facility between the shallow and limestone aquifers. This clay is not present beneath every site.

- The facility is located in a karst area where a sinkhole is present. The sinkhole may allow the direct hydraulic connection between the shallow aquifer and the underlying limestone aquifer.

- The generalized direction of groundwater flow within the limestone aquifer is not yet determined.

2.0 FIELD PROGRAM AND DATA QUALITY ASSESSMENT

2.1 INTRODUCTION

The RI field program completed by Earth Technology at Alpena CRTC during 1992-1993 is described in this section. Field activities included: geophysical surveys; test pit excavation; well abandonment; soil, gas, and groundwater screening; drilling soil borings; installing monitoring wells; soil, sediment, surface water, and groundwater sampling; and aquifer testing. The results of the field program for geophysical surveys, test pit excavations, and well abandonment is described in a Technical Memorandum (The Earth Technology Corporation, April 1993). The remaining activities are described in Section 2.2 through 2.9 of this RI report. The RI field program is summarized in Table 2-1. A data quality assessment for the field and analytical program is presented in Sections 2.10 through 2.12.

Changes to the field activities as outlined in the RI WP are documented in Appendix A, Field Change Requests. The shallow aquifer pump test, as outlined in the WP, was postponed pending further evaluation of the data needs for both the shallow and bedrock aquifer.

2.2 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATIONS

A number of techniques were used at Alpena CRTC to provide geologic and hydrogeologic data. Geophysical surveys and subsurface drilling of soil borings and monitoring wells provided geologic information for the overall facility and the individual sites. Hydrologic data were also obtained through geophysical surveys, static groundwater elevation measurements, and aquifer slug testing. These activities, with the exception of the geophysical surveys which are outlined in a Technical Memorandum (The Earth Technology Corporation, April 1993), and the procedures used for the proper completion of the field activities are described below.

2.2.1 Static Groundwater Measurements

Groundwater elevation measurements were collected at Sites 2 through 9 to confirm groundwater flow directions and to help estimate groundwater flow rates. Measurements were taken following piezometer installation at Site 1 to establish a general groundwater flow direction and to enable strategic placement of monitoring wells. A final round of water level measurements was taken after groundwater sampling was completed to establish an accurate water table contour map.

The groundwater level measurements were recorded at each piezometer and monitoring well with an electronic water level indicator. A surveyed notch or mark on the top of each polyvinyl chloride (PVC) casing in each monitoring well or piezometer served as a constant reference point. The surveyed data are presented in Appendix H, Surveying Data - August 1993. Measurements were recorded to the nearest 0.01 ft. These data are presented in Appendix B.

Table 2-1 Summary of Remedial Investigation Field Program
MIANG, Alpena CRTC, Alpena, Michigan

Activity	Background	Site 1	Site 2	Site 3	Site 4*	Site 5	Sites 6 & 7	Site 8	Site 9	Total
Soil Gas and Groundwater Screening										
SOV	0	2	30	0	0	0	0	24	33	89
Groundwater Screening Samples	0	9	13	0	0	16	8	12	15	73
Soil Borings	1	10	9	3	1	0	0	7	1	32
Piezometer Installation	0	3[f]	0	2[g]	0	0	0	0	0	5
Monitoring Well Installation	0	9	2	2	0	5	6	1	1	26
Aquifer Slug Tests	0	2	3	0	0	1	3	0	0	9
Geotechnical	0	1	1	1	2	0	2	0	0	7
Geophysics	0	0	1[c,d]	1[c,d]	1[c,d]	1[c,d]	2[c,d,e]	1[c,d]	1[c,d]	8
Test Pitting	0	0	0	0	0	0	7	0	0	7
Analytical Samples	**Background**	**Site 1**	**Site 2**	**Site 3**	**Site 4***	**Site 5**	**Sites 6 & 7**	**Site 8**	**Site 9**	**Total**
Onsite GC Screening of Soil Samples from Soil Borings	5	40	30	19	5	11	25	22	6	163
Onsite GC Screening of Groundwater Samples	0	7	1	3	0	1	5	0	2	19
Onsite GC Screening of Hydropunch Samples	0	19	3	6	0	4	3	0	3	38
Soil Samples from Soil Borings	5	20	22	12	0	0	0	14	0	73
Sediment	0	4	0	0	24	0	3	0	0	31
Groundwater	3[a]	9	7	7	4	9	9	5	6	59
Surface Water	0	0	0	0	8	0	0	0	0	8
TCLP	1[b]	1	1	1	0	1	1	0	1	7

[a] Samples taken from three production wells on base.
[b] Sample taken from decon area.
[c] EMI (Electromagnetic Induction) survey including both shallow and deep surveys.
[d] VES (Vertical Electric Soundings).
[e] Magnetic survey done at Site 6.
[f] All piezometers installed at Site 1 were later abandoned.
[g] Only 1 piezometer CG3PZ1 remains at Site 3. The other piezometer was abandoned.
* Includes sinkhole.

2.2.2 Surface Water Measurements

Five staff gauges were installed either along the banks of the Thunder Bay River or in the sinkhole to provide control for the collection of surface water elevation measurements. The staff gauges consist of 4-in wide, 5-ft long sections of enameled stadia board mounted to secured wooden supports and placed vertically into the underlying sediment. Reference elevations were tied to the stadia boards and are presented in Appendix H, Surveying Data - August 1993. Surface water elevations are presented in Appendix B.

2.2.3 Aquifer Testing

In order to estimate the hydraulic characteristics of the shallow groundwater aquifer underlying the facility, six of the 26 monitoring wells (S1MW2, S1MW3, MP2MW6, SF5MW5, LF6MW4, and LF6MW6) installed during the summer 1993 field events were slug tested. Slug tests are short-duration, single-well tests conducted by causing an instantaneous change in the water level of a well. Slug tests can either be falling-head (water level falling) or rising head (water level increasing). In both cases, water level recovery with respect to time is recorded. This information is then used to derive representative *in situ* values for the porous media in the immediate vicinity of the screened interval of the monitoring well.

Both falling-head and rising-head slug tests were performed for all six wells slug tested during the RI. Water levels were changed by suddenly introducing (falling-head) and then removing (rising-head) a 3-ft long, 1.66-in. outside diameter (OD) stainless steel cylinder or "slug." Changes in water level were measured at selected time intervals by a pressure transducer set in the well. Water level and time measurements were recorded by a HERMIT Model SE1000C Data Logger. Prior to the start of each test, the date, internal clock, test number, time intervals, and initial static recorder reading of the data logger were checked and adjusted if necessary. Both falling- and rising-head tests were stopped after the water level had recovered to at least 95 percent of the initial water level readings. The data were then reviewed in the field in order to assess quality.

Aquifer test conditions were analyzed with the aid of the Geraghty & Miller, Inc. AQTESOLV™ Version 1.00, an aquifer test computational program. AQTESOLV™ uses the Bouwer and Rice (1976) method to analyze slug tests conducted in an unconfined aquifer. Anomalies ("double straight line effect") that were observed in the measured rate of rise of the water level during the slug test were attributed to drainage of the gravel pack following lowering of the water level. Using methods described by Bouwer (1989), the apparent increase in conductivity caused by the gravel pack was eliminated by disregarding the early data points, and using only the second straight line portion of the plot for calculation of hydraulic conductivity. Using the results of the slug tests, transmissivities and Darcy flow velocities were calculated. Site-specific results are discussed in Section 3. Aquifer test field data and time-drawdown curves are provided in Appendix B.

2.2.4 Geotechnical Analyses

Seven soil samples, two from sites 4 and 6 and one each from sites 1, 2, and 3, were

collected for geotechnical analyses. Soil samples were collected by driving a 3-ft long, 3-in inside diameter (I.D.) Shelby tube sampler into the soil. The tubes were sealed at each end with glazing compound and covered with Teflon® caps. The caps were then taped to preserve soil moisture content. Each Shelby tube was submitted for laboratory analysis of the following parameters:

- Grain size
- Atterberg limits
- Specific gravity
- Hydraulic conductivity
- Moisture content/density
- Cation exchange capacity (CEC).

The results of the geotechnical analyses are presented in Appendix C.

2.2.5 Piezometer Installation

Five piezometers (three at Site 1 and two at Site 3) were installed into the shallow aquifer during the August/September 1993 drilling program. S1PZ1, S1PZ2, S1PZ3, and CG3PZ1 were installed to determine if free phase fuel was present floating on the groundwater at these locations. CG3PZ2 was installed at Site 3 to confirm the direction of groundwater flow. Detailed lithologic and construction logs are included in Appendix C.

The piezometers were constructed of 2-in. diameter, flush-joint, threaded, Schedule 40 (PVC screen and riser pipe accompanied with a 2-in. PVC end cap. Slot size for the piezometer screens was 0.010 in. Five-foot long sections were selected for all piezometers. The screened intervals were selected based on depth to the water table and the anticipated extent of the seasonal water table fluctuations.

All piezometers were backfilled using fine-to-medium grained silica sand to a depth of approximately 12 in above the top of the screen. A 1- to 2-ft thick layer of pelletized bentonite was placed on top of the sand pack and hydrated. In the permanent piezometer (CG3PZ1) the remaining annular space was filled with a cement/bentonite mixture. An expandable cap was placed on top of the riser pipe and locked. The ground surface at each piezometer was finished by installing a flushmount, 9-in. diameter steel "drive-over" box on top of the piezometers. The "drive-over" box was cemented in place. A 2-ft by 2-ft concrete pad was constructed surrounding the box. The piezometer was labeled by stenciling the piezometer name in a brass survey marker attached to the rim of the "drive-over" box. The remaining four piezometers were temporary and were pulled before the end of the RI field effort. The annular space in the abandoned piezometer locations was filled with bentonite hole plug to ground surface after the PVC screen and riser pipe were removed.

2.3 FIELD SCREENING SAMPLING AND ANALYSIS

Field screening activities consisted of two phases: an initial site screening consisting of on-site gas chromatograph (GC) analysis of soil gas and groundwater samples and a second phase also consisting of on-site GC analysis of soil and groundwater samples. Groundwater samples were collected at discrete depths during drilling operations using a Hydropunch® groundwater sampler or by using a bailer and collecting samples from the newly installed monitoring wells and piezometers. Target compounds during each type of screening activity included BTEX, total VOCs, and several of the more common chlorinated aliphatic compounds which were suspected at the facility (i.e. TCE).

2.3.1 Initial Site Screening Activities

EnviroSurv, Inc. was subcontracted by Earth Tech to perform the initial site screening activities for the facility. This initial phase of fieldwork was conducted to provide data to more accurately place soil borings and the monitoring wells. Field screening methods consisted of the collection and analysis of soil gas and groundwater samples. Sampling and analysis procedures followed the sampling guidelines established in DOE/HWP69RI, DOE/HWP100, and the Final RI WP (The Earth Technology Corporation, December 1992).

2.3.1.1 Sampling Methods - Initial Site Screening

All sampling conducted during the initial site screening event was accomplished using a truck-mounted hydraulic unit (Geoprobe®) capable of driving 3-ft long sections of hollow, threaded, 1-in OD, stainless steel (SS) rods into the soil. Modifications of the hardware attached to the probes allowed the collection of either soil gas or grab-type groundwater samples. The specific methods used to collect each medium are discussed below.

Soil Gas Sampling

Soil gas samples were collected from four sites (Sites 1, 2, 8, and 9) and analyzed for the presence of chlorinated solvents, BTEX, and total VOCs (as JP-4). A total of 89 soil gas samples were collected and analyzed in the field. Soil gas samples were initially taken in a fixed grid pattern of 15- to 50- to 150-ft spacings. As the on-site mobile laboratory results became available, subsequent sampling locations were modified based on these results.

The sampling probes were constructed of 0.5-in I.D. hardened steel in 3-ft lengths. The probe rods were driven into the soil by a hydraulic cylinder/percussion hammer unit and were removed by the same hydraulic system. Once the soil gas probe was driven to the desired sampling depth, "post-run" polypropylene tubing was attached to the lead rod via a threaded sample cap with o-ring (to prevent vacuum leakage). The dedicated sample line was then attached to the vacuum volume system located in the probe truck. A minimum of five tubing volumes were purged before a sample was collected in a 8.5-ounce (oz) glass gas-sample bulb with Teflon® stopcocks. Once filled, the sample bulbs were immediately delivered to the on-site laboratory for analysis.

Groundwater Screening Sampling

Seventy-three groundwater samples were collected at Sites 1, 2, 5, 6 & 7, 8, and 9 and analyzed for BTEX, total VOC (as JP-4), and chlorinated hydrocarbons using an on-site GC.

Samples were collected using hardware modified from soil gas sampling. Sections of 3-ft long sampling probes, constructed of 0.5 in I.D. hardened steel, were driven into the soil by a hydraulic/percussion hammer unit to the selected sampling depth. The lead probe contained thin vertical slots to allow water into the interior of the rods. Samples were collected using dedicated polyethylene tubing equipped with a reusable valve such that the tubing acts like one long bailer. The foot valve and rods were decontaminated between samples. Water enters the tubing by moving the assembly up and down in the rods. Once a sufficient sample volume of water is in the tubing, the tubing is withdrawn from the rods and the water poured into a 1.4-oz glass vial with a Teflon®-lined cap and delivered to the on-site laboratory.

2.3.1.2 Analytical Methods - Initial Site Screening

The soil gas and grab-type groundwater samples collected during the initial site screening activities were all analyzed for the same target compounds, using the same instrumentation, and using similar methods (direct injection of soil gas or headspace). This section provides a general description of the analytical instrumentation and target compounds for the headspace method, as well as a summary of analytical methods specific to the soil gas, soil, and groundwater samples. All analytical results are included in Appendix D.

Instrumentation and Target Compounds

Soil Gas Analysis

A Shimadzu 14A laboratory-grade GC equipped with both Flame Ionization and Electron Capture Detectors (FID/ECD) was used to analyze the soil gas samples. The analytical column used was a 30-meter (m) x 0.53-millimeter (mm) (98-ft x .02-in.) Restek R_tx-Volatiles megabore capillary column.

The method utilized for soil-gas analysis was Field Analytical Support Project (FASP) Method F080.010, "Volatile Organics in Soil Gas Using Electron Capture Detector - Direct Analysis." One modification was incorporated into the method by Envirosurv, Inc. to meet Hazardous Waste Remedial Actions Program (HAZWRAP) Level B quality control (QC) requirements. A FID was positioned in series behind the ECD so that the non-chlorinated target compounds benzene, toluene, ethylbenzene and total xylenes could be analyzed simultaneously. The analysis for total VOCs (as JP-4) required use of an alternate column, eliminating the ability to simultaneously analyze for the target chlorinated compounds.

The FID results for aromatic VOCs and ECD results for chlorinated compounds were determined by calculating the areas of individual chromatogram peaks. In addition to quantitation of individual target compounds, the total VOC concentration of JP-4 was calculated based on comparison with a pure product JP-4 standard. The reported results for

volatiles were quantitated using the response factors from an initial three-point calibration standard and continuing calibration standard injected at the beginning of each day. Quantitation limits for the target compounds and total VOCs (as JP-4) are as follows:

COMPOUND	DETECTION LIMIT
1,1-Dichloroethene (DCE)	0.50 microgram per liter ($\mu g/\ell$)
trans-1,2 DCE	0.50 $\mu g/\ell$
cis-1,2 - DCE	0.50 $\mu g/\ell$
1,1,1-TCA	0.050 $\mu g/\ell$
TCE	0.050 $\mu g/\ell$
Tetrachloroethylene (PCE)	0.050 $\mu g/\ell$
Benzene	50 $\mu g/\ell$
Toluene	50 $\mu g/\ell$
Ethylbenzene	50 $\mu g/\ell$
Total Xylenes	50 $\mu g/\ell$
Total VOCs (as JP-4)	20 parts per million (ppm)

Groundwater Screening Sample Analysis

The headspace analytical method used in this groundwater investigation was FASP Method F080.005. As previously mentioned, groundwater samples were collected and delivered to the on-site laboratory in 40 ml (1.4 oz) glass vials with Teflon®-lined caps. Samples were then prepared by withdrawing exactly 10 ml (0.3 oz) of water from the vial using a pipette. The remaining sample was shaken vigorously for one minute and allowed to equilibrate for 30 minutes under controlled temperature conditions in the mobile laboratory. A sample of the headspace existing in the vial was then injected into the GC for analysis. Analytical quantitation and instrumentation was the same as used in the soil-gas analysis. Analytical quantitation limits for the target compounds and total VOCs (as JP-4) are as follows.

COMPOUND	DETECTION LIMIT
1,1 DCE	0.5 parts per billion (ppb)
trans 1,2 DCE	0.5 ppb
cis - 1,2-DCE	1.0 ppb
1,1,1-TCA	0.05 ppb
TCE	0.05 ppb
PCE	0.05 ppb
Benzene	5.0 ppb
Toluene	5.0 ppb
Ethylbenzene	5.0 ppb
Total xylenes	5.0 ppb
Total VOC (as JP-4)	22 ppb

2.3.2 On-Site GC Screening of Soil and Groundwater Samples Collected During Drilling Operations

Soil samples were collected from the confirmation-round soil borings and analyzed on-site for their VOC content. These data were collected to assist the field team in selecting the soil samples to be shipped for analysis in a fixed-base laboratory. Hydropunch® groundwater samples were collected to assist in optimum placement of monitoring wells and determination of the proper screening depth. The on-site screening of the soil and groundwater samples was completed following HAZWRAP Level B QC protocols. The analytical results are included in Appendix E. The sampling and analytical methods which were employed are described in the following sections.

2.3.2.1 Soil Sampling Methods

Soils were collected and placed in pre-cleaned, 1.4-oz VOC vials. The vials were filled to approximately two-thirds of their capacity, capped, labeled, and hand delivered to the GC analyst. Upon receipt, the GC analyst filled the vials with deionized water until they were three-quarters full. The soil/water mixture was shaken vigorously for two minutes, placed in a water bath, and warmed to 40°C (104°F). The headspace in the VOC vial was withdrawn through the Teflon® septum using a syringe and injected into the portable GC.

2.3.2.2 Groundwater Sampling Methods

Groundwater samples were collected with either a Hydropunch® sampler for sampling at discrete depths, or with Teflon® or SS bailers for samples of groundwater from selected monitoring wells and piezometers. Groundwater samples were poured into a pre-cleaned, 1.4-oz VOC vial. The vials were filled completely with little or no headspace within the vial, capped, labeled, and hand delivered to the field GC analyst. Upon receipt, the GC analysts decanted approximately two-thirds of the volume and placed the vial with the remainder of the groundwater sample in a water bath of 40°C (104°F) to facilitate development of headspace within the vial. After approximately 15 to 20 minutes, the headspace in this VOC vial was withdrawn through the Teflon® septum using a syringe and injected into the portable GC.

2.3.2.3 Analytical Methods

On-site analysis was completed using a Photovac 10S Plus GC equipped with a 33-ft capillary column and Photo-Ionization Detector (PID). The analytical methods used during the soil screening are based upon Environmental Protection Agency (EPA) Method 3810 for soils and headspace analysis as found in EPA SW 846, Test Methods for Evaluating Solid Waste, 3rd Edition (November 1986). EPA methods 601 and 602 were followed for the groundwater screening analyses.

All samples collected for field GC analysis were analyzed for the compounds listed below. The estimated Method Detection Limits (MDL) are also listed below:

Compound	Soil MDL (ppb)	Groundwater MDL(ppb)
Benzene	1	1
Toluene	4	4
Ethylbenzene	4	4
O-Xylene	4	4
M, P-Xylene	4	4
TCE	1	1
PCE	1	1
DCE	1	1

QA/QC procedures included a daily three-point calibration and the analysis of blank and duplicate samples. The analytical results are included in Appendix E.

2.4 DECONTAMINATION PROCEDURES

Major equipment such as the drill rig, augers, and rods were decontaminated prior to beginning work at the facility. Decontamination consisted of washing the equipment with high -pressure hot water containing a laboratory-grade detergent (Liqu-nox) and rinsing the equipment with water. Wastewater generated during the decontamination process was collected in large polyethylene tanks. All wastewater generated during the decontamination procedures was containerized and disposed of as described in Section 2.9 .

Down-hole drilling equipment such as augers, bits, and rods were decontaminated as described above prior to each use. The drill rig was cleaned between sites and at the discretion of the field team leader. Sampling equipment, such as split spoons, stainless steel liners, etc. were decontaminated according to the following process:

- Washed with potable water/laboratory-grade detergent (Liqu-nox)
- Rinsed with potable water
- Rinsed with ASTM Type II water
- Rinsed with pesticide-grade methanol
- Air dried
- Wrapped in aluminum foil.

Groundwater sampling equipment such as bailers, hoses, hand-pump fittings, etc. were decontaminated as above with the exception that potable water was not used during the decontamination process. ASTM Type II water was substituted for potable water.

The hydraulic unit, rods, and sampling equipment used to collect the soilgas samples were decontaminated by washing the probes and other sampling equipment in a water/laboratory-grade detergent mix and rinsing with potable water.

2.5 SAMPLING FOR FIXED-BASE LABORATORY ANALYSIS

The RI field program at Alpena CRTC employed a number of sampling procedures to obtain samples for laboratory analysis. The procedures for the sampling activities are detailed in the following sections.

2.5.1 Soil Sampling Activities

Soil sampling was conducted using either a truck-mounted drill rig or a hand auger. Procedures for both types of sampling are described below. Collected soil samples were submitted to Compuchem Environmental Corporation for analysis of VOCs by SW846 5030/8010/8020, semivolatile organic compounds (SVOCs) by Contract Lab Program (CLP) 3/90, priority pollutant metals (PPMs) by CLP 2/88, and total petroleum hydrocarbons (TPH) by 418.1.

2.5.1.1 Soil Sampling (Drill Rig)

Soil samples were collected from soil borings drilled at Sites 1 through 9. All borings were advanced by a truck-mounted drilling rig (CME750) equipped with continuous-flight hollow-stem augers. Samples were collected at selected intervals using 3-in. diameter, 2-ft long stainless steel split spoons. Inside of the split spoon four 6-in. long stainless steel liners were placed. The drill rig, equipped with a hydraulic hammer assembly, was used to push the lined split spoons through the hollow stem augers into the soil. Once filled, the split spoons were retrieved and opened. Immediately upon opening the split spoon, the liners were split apart either by hand or by using a decontaminated stainless steel knife. The end of each liner was scanned with a PID meter and the reading recorded. A liner was then selected for potential shipment to the laboratory and capped to prevent VOC loss. Capping consisted of placing a 4-in. wide section of Teflon® tape between the liner and a tightly fitting plastic end cap. Samples were labeled and placed on ice per sample handling protocols listed in Table 2-2.

Soils contained in the remaining three liners were used for either field GC analysis or were used for field descriptions. Field descriptions were logged according to the Unified Soil Classifications System (USCS). Prior to leaving the field, all borings were backfilled with a cement/bentonite mixture or bentonite hole plug and the locations were surveyed by a land surveyor registered in the state of Michigan. Borehole logs for each boring are included in Appendix C. Sample locations and a discussion of the significance of the analytical results are included in Section 3.0.

Table 2-2 Container, Preservation, and Holding Times for Soil and Water MIANG, Alpena CRTC, Alpena, Michigan

Parameter	Matrix	Holding Time (From time of Collection)	Container	Preservative	Minimum Sample Size
Volatile Organics	Water	14 d	Four 40-mℓ vials with Teflon-lined caps	4 drops conc. HCl; 4°C	40 mℓ
	Soil	14 d	stainless steel core tube sealed on both ends	4°C	10 g
	Sediment	14 d	4-oz glass jar with Teflon-lined cap	4°C	10 g
Extractable organics	Water	7 d extraction 40 d analysis	1-ℓ glass with Teflon liner	4°C	1,000 mℓ
	Soil	14 d extraction 40 d analysis	Stainless steel core tube sealed on both ends	4°C	50 g
	Sediment	14 d extraction 40 d analysis	8-oz glass jar with Teflon-lined cap	4°C	50 g
Metals (other than mercury and hexavalent Chromium)	Water	180 d	Glass	HNO_3 to pH 2; 4°C	100 mℓ
	Soil	180 d	stainless steel core tube sealed on both ends		10 g
	Sediment	180 d	8-oz glass jar with Teflon-lined cap	4°C	10 g 10 g
Mercury	Water	28 d	Glass	HNO_3 to pH 2; 4°C	100 ml
	Soil	28 d	stainless steel core tube sealed on both ends		10 g
	Sediment	28 d	8-oz glass jar with Teflon-lined cap	4°C	10 g
hexavalent Chromium	Water	24 hours	Glass	HNO_3 to pH 2	100 mℓ
	Soil	24 hours	Stainless steel core tube sealed on both ends	4°C	10 g
	Sediment	24 hours	8-oz glass jar with Teflon-lined cap	4°C	10 g
Petroleum hydrocarbons (TPH) (418.1)	Water	28 d	1-ℓ glass	4°C HCl to pH <2	1,000 mℓ
	Soil	28 d	stainless steel core tube sealed on both ends	4°C	50 g
	Sediment	28 d	8-oz glass jar with Teflon-lined cap	4°C	50 g

d = days

2.5.1.2 Hand-augured Soil Sampling

In August/September 1993 hand-augured soil samples were collected from one location at the facility. A hand auger was used because of the presence of underground utility hazards. The hand-augured sample was collected using an Arts Manufacturing and Supply (AMS) soil recovery auger. The auger assembly was decontaminated prior to collecting each sample. These samples were labeled and immediately placed on ice per sample handling requirements listed in Table 2-2. Soil sampling forms are included in Appendix F of this report.

2.5.2 Surface Water/Sediment Sampling Activities

Surface water and sediment samples were collected at selected locations on the facility. Surface water samples were collected at eight locations within the sinkhole. Sediment samples were collected at nine locations within the sinkhole and at nine locations at or above the sinkhole shoreline, i.e., along seeps, drainage gullies, and deltas. Sediment samples were also collected at four locations at Site 1 and three locations at Site 6 along the southern branch of the Thunder Bay River.

Surface water samples were collected by directly filling the sample containers with surface water from the sinkhole. Samples for dissolved metals analyses were collected using a decontaminated Teflon® bailer and filtered using a disposable 0.000018-in. filter. Sediment samples were collected using the hand auger extension rods and an AMS sludge sampler head. The sediment was transferred from the auger to appropriate sampling jars using a stainless steel spoon. After the samples were collected they were labeled and placed on ice per sample handling requirements listed in Table 2-2. Sampling forms are included in Appendix F of this report.

2.5.3 Monitoring Well Installation, Development and Sampling

The procedures used for monitoring well installation, development, and sampling are included below. Collected groundwater samples were submitted to Compuchem Environmental Corporation for analysis of VOCs by SW846 5030/8010/8020, SVOCs by CLP 10/92, PPM by CLP 2/88, and TPH by 418.1.

2.5.3.1 Monitoring Well Installation

The locations at which monitoring wells were to be installed were selected after the initial field GC screening of groundwater samples and after confirmation of the hydraulic gradient at each site. The wells were installed using the hollow-stem auger method. All wells were constructed inside the hollow-stem augers to prevent collapse of the unconsolidated sand-rich soils. The augers were removed from the hole one section of auger at a time as the wells were constructed. Monitoring well casing, caps, and screen were constructed of threaded, flush joint, 2-in. diameter Schedule 40 PVC. Screen lengths were either 5- or 10-ft continuous sections of slotted screen containing 0.010-in. openings. Prior to placement of the well materials in the hole, the screen, cap, and casing were steam cleaned.

Once the well materials were positioned in the borehole such that the screened interval was either intersecting the water table or screening a particular interval in the water column, # 7 silica sand was placed in the annular space to a height approximately 2 ft above the top of the screen. A 2-ft thick bentonite pellet layer was placed above the sand and hydrated to form a seal. The remaining annular space was filled with a Type I Portland cement/bentonite mixture (approximately 95 percent cement to 5 percent bentonite) or bentonite pellets (in shallow wells) to a depth approximately 0.5 ft below grade. The ground surface at each well was finished by installing either 9-in. diameter, flush-mount, "drive-over" boxes on top of them or a 2-ft tall, locking, protective concrete casing. Locking, expandable caps were placed on each well casing and the ground surface at each well was finished by pouring a 2-ft by 2-ft or 2-ft diameter concrete pad around each well. The stick-up well casings were protected from mowing machines, etc. by three to four cement-filled guard posts secured in the ground around the well. Each well casing had a small notch cut in the top (for a survey reference marker) prior to well installation. Survey markers on flushmounts and the protective casing on stick-up wells were stenciled with well numbers during the survey operations. Monitoring well construction forms are included in Appendix C.

2.5.3.2 Monitoring Well Development

After installation, all 26 of the newly installed monitoring wells were developed to remove fine-grained sediments from the filter pack; to repair any damage done to the formation by the drilling operations; and to restore the natural hydraulic properties of the formation. A minimum of 24 hours was allowed to pass after the wells were installed before development began. A stainless steel bailer and/or a down-hole turbine pump manufactured by Grundfos® was used to surge the wells and remove stagnant water. Development proceeded until the groundwater removed from the wells became noticeably less turbid and the turbidity showed no signs of decreasing further. A minimum of 15 gal of water was removed from each well. Color, turbidity, odor, and other physical characteristics of the water were recorded during development. Additionally, measurement of pH, temperature, and conductivity were periodically recorded during development to indicate which wells required additional development. After pumping or bailing was discontinued the water level in each well was briefly monitored to provide an estimate of the groundwater recharge rate. All water removed from the wells during development was stored in polyethylene tanks and disposed of as stated in Section 2.9. Well development forms are included in Appendix G.

2.5.3.3 Groundwater Sampling

After development, the monitoring wells were allowed to recharge, were purged, and then sampled. The volume of water in each well casing was calculated prior to purging. As required in the Field Sampling Plan (FSP) (The Earth Technology Corporation, 1992) from 3 to 5 casing volumes were removed from each well during the purging process. A decontaminated Teflon® bailer or a peristaltic pump was used to remove the stagnant groundwater from each well. Degree of turbidity, odor, and other physical properties of the water were recorded during purging. Additionally, measurements of the pH, temperature, and conductivity of the groundwater were obtained before and after purging, and prior to sampling.

These data were collected to ensure a representative groundwater sample was being collected. After purging, and before sampling, the wells were allowed to recharge to greater than 80 percent of their pre-purging volume.

Groundwater samples were collected using a Teflon® bailer to fill the sample containers. The containers to be analyzed for VOCs were filled first, followed by the other containers required for organic analysis, and finally metals. Filtered metals were collected by positioning a disposable 0.000018-in. pore size filter on the end of the bailer and using a hand pump assembly to move the water through the filter. The samples were labeled and immediately placed on ice per sample handling procedures detailed in Table 2-2. Pre-preserved bottles (if appropriate) were used during the sampling process. Preservative types are listed in Table 2-2. Groundwater sampling forms are included in Appendix G.

2.5.4 Production Well Purging and Sampling Procedures

There are six facility water-supply wells, numbers PW1 through PW6, located at the Alpena CRTC. The location of these wells is shown in Section 1.4.1, Figure 1-2. Water-supply wells PW4, PW5, and PW6 are located in remote areas of the facility, up gradient from all known sources of contamination. These wells were not sampled during the RI. Three facility water-supply wells, numbers PW1, PW2, and PW3, were sampled during RI activities. These wells are located in the vicinity of the IRP sites. PW1 is located just north of the water plant while PW2 is located just south of the water plant. PW3 is in the wooded area west of Site 1 and adjacent to the drainage ditch at Site 2. PW1 is the only production well on the facility used as a source of drinking water. PW1 is 61 ft deep and reportedly extends 10 ft into the limestone aquifers. It is estimated to yield up to 300 gal per minute (gpm) (Engineering-Science, 1989). PW2 was installed to a depth of 65 ft and is screened in both the shallow and limestone aquifers with 10-ft long screened intervals. The upper screen is open to the middle portion of the shallow aquifer, and the lower screen is open to a stone and gravel layer in the limestone aquifer. PW3 was installed to a depth of 36 ft and is screened in the shallow aquifer.

Purging of the production wells was undertaken by facility employees. PW2 and PW3 are pumped from the same pump house; therefore, PW3 was purged and sampled before the purging of PW2 began. Purge volumes were estimated to be 21,600, 3,000, and 2,250 gal for PW1, PW2, and PW3, respectively. These volumes were assumed to be sufficient in order to obtain a true representative sample of groundwater. Field-purge and well-sampling forms are located in Appendix G.

Sampling was conducted by filling bottles, preserved if necessary, directly from an outflow port. This method was used for sample collection for the volumes necessary for VOCs, SVOCs, TPH, and PPM analyses. A second groundwater sample to be analyzed for PPM metals was also collected then field filtered. A Teflon® bailer was filled from the outflow port, fitted with a 0.000018-in. pore size filter and hand pumped to force water through the filter. Parameters recorded before and after the sampling of each well included temperature, conductivity, and pH.

2.6 BACKGROUND SAMPLING

Metals were previously identified as potential contaminants of concern in the soil at Alpena CRTC. To provide additional data on the background concentrations of metals in the soil, five soil samples were collected at two locations on the facility. The samples were collected using a drill rig and the sampling methods described in Section 2.5.1.1. Samples were collected from areas determined by facility Civil Engineering (CE) personnel to be relatively undisturbed by human activity. The locations of these soil samples, their relationship to the sites under investigation, and the analytical results for the background soil samples are discussed in Section 3.1. Soil sampling forms are included in Appendix F.

2.7 SAMPLE IDENTIFICATION

A numbering system was developed so that sample numbers recorded in the field would easily correspond to the analytical results received from the laboratory. The first digit is the facility identifier and will always be "P" for Phelps Collins (Note: Alpena CRTC is located at the former Phelps Collins Airport). The next one or two digits are the site identifier. In some cases the zero is omitted to save space.

- 01 – Site 1 Old POL Storage Area
- 02 – Site 2 Motor Pool
- 03 – Site 3 Former Site of County Garage
- 04 – Site 4 Third Fire Training Area (includes sinkhole)
- 05 – Site 5 Second Fire Training Area
- 06 – Sites 6 and 7, Former Solid Waste Landfill and First Fire Training Area
- 08 – Site 8 Former Site of Hangar 9
- 09 – Site 9 Radar Tower
- PW – Production Well

A letter will follow indicating the type of sample matrix.

- B – Soil Sample (from a soil boring)
- D – Sediment
- GW – Groundwater
- W – Surface Water

The sample matrix is followed by a one- or two-digit number indicating the station, boring, or well number. For example, one site may have five soil borings (B), in which case B5 would indicate the sample was taken from the fifth boring at the site. For example, a soil sample collected from 2 to 4 feet would read 0204. For soil samples the remaining three or four digits will indicate the depth the soil samples were collected. For the groundwater or surface water samples the last three or four digits in the sample number indicate from which sampling round a particular sample was collected.

Field screening samples were collected and are indicated by a letter after the station, boring, or well number such as P02B5A.

- P = Phelps Collins
- 02 = Site 2 Motor Pool
- B = Soil Boring
- W = Monitoring Well
- 5 = Boring or Well Number
- A = Unique Sample Identifier

Examples, one for fixed-base soil and groundwater, are given as follows:

P02B50002

"Phelps Collins Site 2, Soil Boring 5, Sample Depth 0 to 2 ft "

P02MW5GW4
P02MW5GW4F

"Phelps Collins Site 2, Monitoring Well 5, Fourth Round Groundwater Sampling," and "Phelps Collins Site 2, Monitoring Well 5, Fourth Round Groundwater sampling, Filtered Sample."

Quality control samples were labeled as follows:

- Equipment rinsates are designated as ER and numbered sequentially (i.e., ER1, ER2)
- Trip blanks are designated as TB and numbered sequentially (i.e., PTB1, PTB2)
- Field blanks are designated as FB and numbered sequentially (i.e., PFB1, PFB2). The source of the field blank, whether potable or ASTM Type II water, was recorded in the field logbook.

2.8 SURVEYING

The location and elevation of each staff gauge, soil boring, piezometer, monitoring well, surface soil, sediment, and surface water sample collected during the RI was accurately surveyed by a licensed surveyor. Horizontal locations were referenced to the coordinate system used by the Base CE personnel. Elevations were determined to the nearest 0.01 ft, referenced to msl (referenced to the United States Geodetic Survey Station Collins Number 1). The top of the monitoring well and piezometer casings were notched or marked to provide a reference point for the land surveyors and for subsequent water-level elevation measurements. All surveying information is provided in Appendix H.

2.9 DISPOSAL OF WASTES AND SOIL CUTTINGS FROM FIELD ACTIVITIES

Soil cuttings and development, purge, and decontamination water were generated during the field activities. All soil cuttings were placed on, and covered with, plastic at their place of origination until the completion of field activities. Soil cuttings from those borings containing toxicity characteristic leaching procedure (TCLP) compounds were submitted for TCLP analyses. TCLP analytical results are included in Appendix I. All cuttings were determined to be Resource Conservation Recovery Act (RCRA) non-hazardous. Those cuttings with concentrations below the MDNR action levels will be returned to the ground surface from where they were collected. Those cuttings with concentrations above the MDNR action levels will remain stockpiled for treatment of organics and stabilization/fixation of metals under the source removal action plan.

The wastewater was placed in 500- or 1,000-gal polyethylene tanks. Composite samples of the wastewater were submitted to Shealy Environmental Laboratories for analysis of those compounds requested by Alpena CRTC wastewater treatment personnel. The results were submitted and approval was granted for disposal of the water into the facility's sanitary/storm sewer system.

2.10 DATA QUALITY ASSESSMENT

A standardized QA/QC program was followed during the RI at the Alpena CRTC to ensure that analytical results accurately represent the environmental conditions at the sites. The RI was conducted using the HAZWRAP Level C (i.e., EPA Level III) QC requirements described in Requirements For Quality Control Of Analytical Data (DOE/HWP-65/RI, July 1990) and the guidelines and specifications described in the RI Work Plan.

The numbers of soil samples collected and selected laboratory QC (i.e., matrix spikes and duplicates) samples analyzed are summarized in Table 2-3. The QC checks and results are summarized below.

2.10.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data obtained from field and laboratory data collection activities

Table 2-3 Summary of Analytical Program
MIANG, Alpena CRTC, Alpena, Michigan

Sample Source	VOC SW5030/8010 & 8020[1]	SVOC CLP 3/90 (10/92)[2]	Priority Pollutant Metals[3] SW-846	Hexavalent Chromium SW-846-7196 A	TPH 418.1
Soil	72	72	72	69	72
Sediment	37	37	37	9	37
Water	75	75	75	0	75
Total	184	184	184	78	184
Field Duplicates	9_{soil}	9	9	9	9
	5_{Sed}	5	5	5	1
	7_{Water}	7	7	0	7
Equipment Rinsates	19	20	19	0	19
Field Blanks	7	7	7	0	7

NOTES: 1. Second column confirmation was performed for those samples containing compounds greater than detection levels.
2. Groundwater samples analyzed under CLP 10/92 statement of work for low concentration water.
3. Filtered and unfiltered water samples were collected.

to support specific decisions or regulatory actions. DQOs also establish numeric limits for the data to allow the data user to determine if the data collected are of sufficient quality for use in their intended application. The data collected during the RI field effort will be used to develop a risk evaluation and recommendations for (1) developing and implementing an immediate response plan if required, (2) taking no further action and preparing a DD, (3) initiating focused feasibility study and remedial measure, or (4) proceeding with the feasibility study. The following sections summarize the DQOs for precision, accuracy, representativeness, comparability, and completeness (PARCC) for data obtained during the RI.

2.10.1.1 Precision

Precision refers to the level of agreement among repeated measurements of the same characteristic, under a given set of conditions. Precision is expressed quantitatively as the measure of the variability of a group of measurements compared to their average value. Precision is defined as the reproductibility, or degree of agreement, among replicate measurements of the same quantity. For this project, the precision of the analytical and instrument measurement system was assessed through the collection and analysis of field duplicate samples and the performance of analytical replicates. The closer the numerical values of the measurements are to each other, the more precise the measurement. Analytical precision was expressed as the percentage of the difference between results of duplicate samples for a given compound or element. Precision was determined using matrix spike/matrix spike duplicate (MS/MSD) and duplicate sample analysis conducted on samples collected for VOC, SVOC, PPM , and TPH analysis during the Alpena CRTC, RI. The laboratory selected 1 sample in 20 and split the sample into 2 aliquots. MS/MSD samples

were prepared by routinely screening the first aliquot for the parameters of interest before analysis, while the remaining two aliquots were spiked with known quantities of parameters of interest before analysis. The Relative Percent Difference (RPD) between the spike results was calculated and used as an indication of the analytical precision for the VOC, SVOC, and TPH analyses performed. Duplicate samples for PPM analysis were prepared by subdividing 1sample of every 20 samples received and analyzing both samples of the duplicate pair. The RPD between the two detected concentrations was calculated and used as an indication of the analytical precision for the analyses performed. The objectives for precision are to have 90 percent of the values calculated within the specified RPD range of 20 percent.

Ten of 416 RPD water and 20 of 329 soil values calculated from the VOC analyses exceeded control limits of 20 percent for analytical precision. Control limits for VOC MS/MSDs are detailed in Table 2-4 and 2-5. Seventeen of 77 soil RPD values calculated from the SVOC analyses exceeded control limits of ± 20 percent for analytical precision. Control limits for SVOC MS/MSDs duplicates are detailed in Table 2-6 and 2-7. The 10/92 CLP SVOC statement of work (SOW) for low level waters does not require a matrix spike duplicate and therefore no values are presented for precision in Table 2-6. Seventeen of 95 RPD soil and 14 of 143 RPD water values calculated from PPM analysis were outside advisory control limits of ± 20 percent. Zero of 6 RPD soil values calculated from hexavalent chromium were outside advisory control limits of ± 20 percent. Control limits for MS/MSDs are detailed in Table 2-8 and 2-9. One of 25 RPD values calculated from the TPH analyses exceeded control limits of ± 20 percent for analytical precision. Control limits for TPH MS/MSDs are detailed in Table 2-10.

The majority of the RPD values which exceeded control limits for metals were close to the instrument detection limit where larger percent differences are expected. These results for soil are considered to have little impact on the environmental data quality and considered more likely to be the result of the matrix variability that could not be overcome by the sample mixing prior to the analysis of the samples. Water RPD values which exceeded control limits are most likely due to the unequal distribution of suspended minute particulates that could not be evenly distributed by well development procedures and mixing procedures since the analytical QC results do not indicate a systemic laboratory problem.

Field RPD values were calculated for compounds and elements detected above the Contract Required Quantitation Limits (CRQL) in one of the replicate pairs and only for those compounds and elements not considered to be common laboratory contaminants. The field replicate for each soil analysis was obtained from the adjacent sleeve. No relative percent difference values for soil were calculated for VOCs since no values above the CRQL were detected in the replicate pairs. SVOCs were not detected above the Contract Required Detection Limits (CRDL) in the replicate soil samples collected. Therefore, RPD values were not calculated for SVOCs. Nine replicate soil pairs were used to evaluate metals concentrations and to evaluate sample collection reproducibility and matrix variability at the Alpena CRTC. Thirteen of the 21 calculated soil RPD values were greater than 20 percent. The percent difference ranged between 40 percent and 100 percent. Seven RPD values for soil TPH were calculated. Six of the calculated values exceeded the control limit of ± 20 percent in the range of 50 to 200 percent. These results are considered to have little impact on the environmental data quality and may be the result of the variability of the soil matrix.

Table 2-4 Laboratory Quality Control Summary: MS/MSD Volatile Orginic Compounds Water Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8010	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Bromodichloromethane	18	89-110	42-172	18	0	9	4-6	20	9	0
Bromobenzene	18	91-100	60-90	18	0	9	2-5	20	9	0
Bromoform	18	100-111	13-159	18	0	9	9-23	20	8	0
Bromomethane	18	88-119	1-144	18	0	9	17-18	20	9	0
Bromochloromethane	18	91-99	4-133	18	0	9	1-4	20	9	0
Carbon tetrachloride	18	102-113	43-143	18	0	9	3-11	20	9	0
2-Chloroethlyvinyl ether	18	0-125	14-186	14	4	9	5-100	20	5	4
Chlorobenzene	18	100-116	38-150	14	0	9	15-20	20	9	0
Chloroethane	18	100-119	46-137	18	0	9	5-13	20	9	0
Chloroform	18	99-104	49-133	18	0	9	4-7	20	9	0
Chloromethane	18	81-119	1-193	18	0	9	5-15	20	9	0
2-Chlorotoluene	18	72-93	60-140	18	0	9	4-11	20	9	0
4-Chlorotoluene	18	74-91	60-140	18	0	9	3-6	20	9	0
1,2-Dibromoethane	18	70-97	24-191	18	0	9	2-5	20	9	0
Dibromochloromethane	18	65-118	24-191	18	0	9	2-9	20	9	0
1,2-Dichlorobenzene	18	75-102	1-208	18	0	9	7-45	20	7	2
1,3-Dichlorobenzene	18	83-102	7-187	18	0	9	7-17	20	9	0
1,4-Dichlorobenzene	18	84-109	42-143	18	0	9	7-22	20	7	2
1,1-Dichloroethane	18	104-106	47-132	18	0	9	2-7	20	9	0
1,2-Dichloroethane	18	101-108	51-147	18	0	9	2-12	20	9	0

Table 2-4 Laboratory Quality Control Summary: MS/MSD Volatile Orginic Compounds Water Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8010	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
1,1-Dichloroethene	18	106-125	28-167	18	0	9	4-9	20	9	0
trans-1,2-Dichloroethene	18	106-110	38-155	18	0	9	4-6	20	9	0
1,2-Dichloropropane	18	99-109	44-156	18	0	9	2-7	20	9	0
cis-1,3,Dichloropropene	18	94-110	22-178	18	0	9	4-6	20	9	0
trans-1,3,-Dichloropropene	18	90-111	22-17	18	0	9	4-6	20	9	0
Methylene Chloride	18	38-117	25-162	18	0	9	5-14	20	9	0
1,1,2,2-Tetrachloroethane	18	79-105	8-184	18	0	9	10-70	20	8	1
1,1,1,2-Tetrachloroethane	18	70-99	38-150	18	0	9	1-6	20	9	0
Tetrachloroethene	18	90-113	26-162	18	0	9	3-11	20	9	0
1,1,1-Trichloroethane	18	102-104	41-138	18	0	9	5-9	20	9	0
1,1,2-Trichloroethane	18	91-106	39-136	18	0	9	8-9	20	9	0
Trichloroethene	18	100-112	35-146	18	0	9	1-8	20	9	0
1,2,3,-Trichloropropane	18	79-110	60-140	18	0	9	1-27	20	8	1
Vinyl Chloride	18	100-113	26-163	18	0	9	0-6	20	9	0

Table 2-4 Laboratory Quality Control Summary: MS/MSD Volatile Orginic Compounds Water Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8020	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Benzene	18	76-104	39-150	18	0	9	5-19	20	9	0
Ethyl benzene	18	70-101	37-162	18	0	9	5-12	20	9	0
Chlorobenzene	18	64-100	38-150	18	0	9	4-8	20	9	0
Methyl-tert-butyl-ether	18	73-148	28-167	18	0	9	3-18	20	9	0
Toluene	18	70-100	46-148	18	0	9	5-14	20	9	0
1,4-Dimethylbenzene	18	79-101	55-135	18	0	9	6-14	20	9	0
1,3-Dimethylbenzene	18	86-101	55-135	18	0	9	8-12	20	9	0
1,2-Dimethylbenzene	18	88-104	55-135	18	0	9	8-12	20	9	0
1,2-Dichlorobenzene	18	68-84	1-208	18	0	9	10-12	20	9	0
1,3-Dichlorobenzene	18	83-93	7-187	18	0	9	1-16	20	9	0
Styrene	18	90-101	32-160	18	0	9	7-12	20	9	0
1,4-Dichlorobenzene	18	85-94	42-143	18	0	9	6-10	20	9	0

Table 2-5 Laboratory Quality Control Summary: MS/MSD Volatile Organic Compounds Soil Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8010	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Bromodichloromethane	14	93-146	42-172	14	0	7	0-20	20	7	0
Bromobenzene	14	81-97	60-140	14	0	7	2-18	20	7	0
Bromoform	14	81-146	13-159	14	0	7	21-40	20	6	1
Bromomethane	14	94-104	1-144	14	0	7	0-10	20	7	0
Bromochloromethane	14	100-128	4-133	14	0	7	3-7	20	7	0
Carbon tetrachloride	14	87-108	43-143	14	0	7	0-11	20	7	0
2-Chloroethlyvinyl eter	14	64-108	14-186	14	0	7	7-29	20	6	1
Chlorobenzene	14	89-100	38-150	14	0	7	9-12	20	7	0
Chloroethane	14	100-111	46-137	14	0	7	8-15	20	7	0
Chloroform	14	95-100	49-133	14	0	7	0-12	20	7	0
Chloromethane	14	93-113	1-193	14	0	7	4-56	20	6	1
2-Chlorotoluene	14	80-100	60-140	14	0	7	8-12	20	7	0
4-Chlorotoluene	14	81-100	60-140	14	0	7	5-16	20	7	0
Dibromomethane	14	50-170	42-172	14	0	7	0-25	20	6	1
1,2-Dibromoethane	14	81-121	24-191	14	0	7	7-19	20	7	0
Dibromochloromethane	14	108-113	24-191	14	0	7	15-26	20	6	1
1,2-Dichlorobenzene	14	81-110	1-208	14	0	7	3-31	20	6	1
1,3-Dichlorobenzene	14	27-92	42-143	13	1	7	3-27	20	5	2
1,4-Dichlorobenzene	14	89-95	42-143	14	0	7	3-31	20	6	1

wp/t2-5.775-6/16/95

Table 2-5 Laboratory Quality Control Summary: MS/MSD Volatile Organic Compounds Soil Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8010	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
1,1-Dichloroethane	14	69-100	47-132	14	0	7	3-10	20	7	0
1,2-Dichloroethane	14	100-128	51-147	14	0	7	3-16	20	7	0
1,1-Dichloroethene	14	68-111	28-167	14	0	7	7-15	20	7	0
trans-1,2-Dichloroethene	14	89-100	38-155	14	0	7	0-15	20	7	0
1,2-Dichloropropane	14	100-113	44-156	14	0	7	7-12	20	7	0
Methylene Chloride	14	28-282	46-148	8	6	7	3-26	20	6	1
cis-1,3-Dichloropropene	14	84-110	22-178	14	0	7	7-20	20	7	0
trans-1,3-Dichloropropene	14	98-112	22-178	14	0	7	6-21	20	7	0
1,1,2,2-Tetrachloroethane	14	85-129	8-184	14	0	7	5-21	20	6	1
1,1,1,2-Tetrachloroethane	14	89-100	38-150	14	0	7	9-12	20	7	0
Tetrachloroethene	14	77-100	26-162	14	0	7	3-12	20	7	0
1,1,1-Trichloroethane	14	85-111	41-138	14	0	7	5-8	20	7	0
1,1,2-Trichloroethane	14	108-129	39-136	14	0	7	5-28	20	7	0
Trichloroethene	14	97-105	35-146	14	0	7	0-12	20	7	0
1,2,3,-Trichloropropane	14	78-100	60-140	14	0	7	25-40	20	5	2
Vinyl Chloride	14	104-113	26-163	14	0	7	0-5	20	7	0

Table 2-5 Laboratory Quality Control Summary: MS/MSD Volatile Organic Compounds Soil Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW846-8020	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Ethyl benzene	14	76-89	38-150	14	0	7	5-16	20	7	0
Chlorobenzene	14	70-82	28-167	14	0	7	8-22	20	6	1
Methyl-tert-butyl-ether	14	100-136	25-162	14	0	7	5-28	20	5	2
Toluene	14	70-102	55-135	14	0	7	1-22	20	6	1
1,4-Dimethylbenzene	14	64-76	55-135	14	0	7	3-17	20	7	0
1,3-Dimethylbenzene	14	64-76	55-135	14	0	7	3-17	20	7	0
1,2-Dimethylbenzene	14	64-76	1-208	14	0	7	3-17	20	7	0
1,2-Dichlorobenzene	14	49-60	7-187	14	0	7	3-27	20	6	1
1,4-Dichlorobenzene	14	47-60	42-123	14	0	7	5-31	20	6	1
1,3-Dichlorobenzene	14	39-64	42-143	13	1	7	3-31	20	6	1
Styrene	14	50-75	32-160	14	0	7	10-25	20	6	1

Table 2-6 Laboratory Control Summary: MS/MSD Semivolatile Organic Compounds, Water Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
CLP 10/92	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits[1]	Number Outside Limits
Phenol	6	61-83	40-120	6	0	0		20		
bis(2-chloroethyl)ether	6	64-80	50-110	6	0	0		20		
2-Chlorophenol	6	61-81	50-110	6	0	0		20		
n-Nitroso-di-n-propylamine	6	60-84	50-110	6	0	0		20		
Hexachloroethane	6	58-64	20-110	6	0	0		20		
Isophorone	6	66-86	50-110	6	0	0		20		
1,2,4-Trichlorobenzene	6	57-73	40-100	6	0	0		20		
Naphthalene	6	66-80	30-110	6	0	0		20		
4-Chloroaniline	6	10-135	10-120	5	1	0		20		
2,4,6-Trichlorophenol	6	54-72	40-120	6	0	0		20		
2,4-Dinitrophenol	6	40-46	30-120	6	0	0		20		
Diethylphthalate	6	62-78	50-120	6	0	0		20		
n-Nitrosodiphenylamine	6	49-102	30-110	6	0	0		20		
Hexachlorobenzene	6	66-86	40-120	6	0	0		20		
Benzo(a)pyrene	6	52-74	50-120	6	0	0		20		

Note:
1) The 10/92 SOW for low-level semi-volatiles does not require matrix spike/matrix spike duplicate analysis and, therefore no data is presented in this table.

Table 2-7 Laboratory Control Summary: MS/MSD Semivolatile Organic Compounds, Soil Samples, MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
CLP 3/90	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Phenol	14	32-97	26-90	12	2	7	11-41	35	5	2
2-Chlorophenol	14	31-94	25-102	14	0	7	12-43	50	7	0
1,4-Dichlorobenzene	14	27-94	28-104	14	0	7	12-43	27	5	2
n-Nitroso-di-n-propylamine	14	34-86	41-126	12	2	7	12-41	38	6	1
1,2,4-Trichlorobenzene	14	38-99	38-107	14	0	7	8-48	23	5	2
4-Chloro-3-methylphenol	14	35-109	26-103	13	1	7	10-46	33	5	2
Arcenapthene	14	32-85	31-137	14	0	7	8-45	19	5	2
4-Nitrophenol	14	35-133	11-114	13	1	7	16-35	50	7	0
2,4-Dinitrotoluene	14	32-92	28-890	13	1	7	11-45	47	7	0
Pentachlorophenol	14	14-87	17-109	13	1	7	0-70	47	6	1
Pyrene	14	21-102	35-142	11	3	7	0-47	36	6	1

Table 2-8 Laboratory Control Summary: MS/MSD Metals, Water Samples
MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
CLP 10/92	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Antimony	22	86-124	75-125	22	0	11	8-200	20	10	1
Arsenic	22	81-106	75-125	22	0	11	21.1-200	20	8	3
Beryllim	22	89-107	75-125	22	0	11	0	20	11	0
Cadmium	22	88-108	75-125	22	0	11	0	20	11	0
Chromium	22	90-107	75-125	22	0	11	0	20	11	0
Copper	22	90-105	75-125	22	0	11	0-200	20	10	1
Mercury	22	96-102	75-125	22	0	11	0	20	11	0
Nickel	22	96-101	75-125	22	0	11	0	20	11	0
Lead	22	73-120	75-125	21	1	11	0	20	11	0
Selenium	22	28-149	75-125	17	5	11	0-200	20	9	2
Silver	22	89-102	75-125	22	0	11	0-200	20	10	1
Thallium	22	54-101	75-125	13	9	11	0-200	20	10	1
Zinc	22	84-105	75-125	22	0	11	44-200	20	6	5

Table 2-9 Laboratory Control Summary: MS/MSD Metals, Soil Samples
MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
SW 846	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
Antimony	14	52-102	75-125	7	7	7	0	20	7	0
Arsenic	14	97-128	75-125	13	1	7	0-72	20	3	4
Beryllim	14	76-116	75-125	14	0	7	0	20	7	0
Cadmium	14	65-85	75-125	9	5	7	0	20	7	0
Cobalt	1	85	75-125	1	0	1	200	20	0	1
Hexavalent chromium	12	102-124	75-125	12	0	6	2-20	20	6	0
Chromium	14	62-108	75-125	13	1	7	0-60	20	4	3
Copper	14	87-100	75-125	14	0	7	0-56	20	4	3
Mercury	14	93-111	75-125	14	0	7	0	20	7	0
Nickel	14	73-103	75-125	13	1	7	0-200	20	5	2
Lead	14	65-390	75-125	12	2	7	0-200	20	3	4
Selenium	14	77-117	75-125	14	0	7	0	20	7	0
Silver	14	78-102	75-125	14	0	7	0	20	7	0
Thallium	14	66-104	75-125	13	1	7	0	20	7	0
Zinc	14	14-105	75-125	13	1	7	0-47	20	6	1

Table 2-10 Laboratory Control Summary: MS/MSD TPH
MIANG, Alpena CRTC, Alpena, Michigan

	Accuracy					Precision				
EPA 418.1	Total No. Analyses	Percent Recovery Ranges	Percent Recovery Limits	Number Within Control Limits	Number Outside Control Limits	MSD Total No. Analyses	Range RPD	RPD Limits	Number Within Limits	Number Outside Limits
TPH	50	43-116	80-120	43	7	25	1-24	20	24	1

Duplicate water samples were obtained from the same source and split into different sample containers upon sampling. Four of 5 calculated relative percent difference values for VOC water duplicates exceeded control limits of ± 20 percent. Values calculated for 1,3-dimethylbenzene, 1,4-dimethylbenzene, benzene and ethylbenzene exceeded control limits in the range of 139 to 200 percent. SVOCs were not detected above the CRQL in the duplicate water samples collected for SVOCs.

Eighteen of the 29 calculated PPM water RPD values were greater than the ± 20 percent control. The percent differences for PPM water RPD values for metals analysis ranged between 139 and 200 percent.

One RPD value for water TPH was calculated. The calculated value TPH value exceeded the control limit of ± 20 percent with a value of 200 percent.

Based on an overall 93 percent of the RPD results meeting control limits and the acceptable laboratory QC results, the sample collection DQO for precision has been met. No corrective action was taken based on RPD values. A complete discussion of all replicate samples is presented in section J.2.4.

2.10.1.2 Accuracy

Accuracy is defined as the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement approaches the true value, or actual concentration, the more accurate the measurement. Analytical accuracy is expressed as the percent recovery of a compound or element that has been added to the environmental sample at a known concentration before analysis. Analytical accuracy was determined using MS/MSD and surrogate recovery data.

Objectives for accuracy were to have 90 percent of the data within the specified percent recovery levels for that compound or element. Laboratory accuracy was qualitatively assessed by evaluating the following laboratory QC information: sample holding times, method blank, tuning and mass calibration (GC/MS), internal standard (GC/MS only), Laboratory Control Sample (LCS) and method blank spike recovery, and initial and continuing calibration results calculated from all analyses conducted on environmental samples.

Percent Recoveries

Four of 832 water and 8 of 658 soil percent recoveries were outside the control limits for MS/MSD analyses conducted on the samples collected and analyzed for VOCs. Established control limits for VOC percent recovery values are presented in Table 2-4 and 2-5. Twenty-five of 611 water and 90 of 439 soil surrogate percent recoveries were outside the control limits for surrogate analysis. Established control limits for VOC percent recovery values are presented in Table 2-11. All supporting VOC QC information cited above was also qualitatively evaluated with respect to the analytical accuracy DQOs. Two hundred thirty six VOC data points were rejected for use because the data was qualified "R", indicating unreliable results due to surrogate or internal standard recoveries. Fifty-eight samples analyzed for VOCs were analyzed out of holding times. The majority of the samples were only 1 to 2 days out of holding times. A number of second column confirmation analyses were

Table 2-11 LABORATORY CONTROL SUMMARY: SURROGATE RECOVERY VOLATILE ORGANIC COMPOUNDS
MIANG, Alpena CRTC, Alpena, Michigan

	WATER					SOIL				
Surrogate	Total No. of Surrogate Analysis	Range of Outliers	Recovery Limits	Number Within Control Limits	Number outside Control Limits	Total No. of Surrogate Analysis	Range of Outliers	Recovery Limits	Number Within Control Limits	Number Outside Control Limits
TCFM 1	127	70-160	75-135	119	8	77	23-160	76-135	62	15
TCFM 2	81	150	75-135	80	1	79	42-160	76-135	64	15
BFB 1 (halogenated)	127	49-130	69-123	121	6	82	16-130	69-123	62	20
BFB 2 (halogenated)	81	56-130	69-123	77	4	79	33-68	69-123	60	19
BFB 1 (aromatic)	125	55-130	69-123	121	4	71	41-130	69-123	62	9
BFB 2 (aromatic)	70	58-65	69-123	68	2	51	43-67	69-123	39	12

* TCFM - Trichlorofluoromethane
BFB - Bromofluorobenzene

analyzed outside holding times. In the cases when second column confirmation analysis was outside holding times the data were qualified accordingly. These results are not considered to have an adverse impact on the environmental data quality.

Eleven of 154 soil and 1 of 105 water percent recovery values calculated were outside the control limits for the MS/MSD analyses conducted on the samples collected and analyzed for SVOCs. Established control limits for SVOC percent recovery values are presented in Table 2-6 and 2-7. Twenty-one of 738 water and 5 of 896 soil percent recovery values calculated were outside the control limits for the surrogate analysis conducted on the samples collected and analyzed for SVOCs. Established control limits for SVOC percent recovery values are presented in Table 2-12. All supporting SVOC QC information cited above was also qualitatively evaluated with respect to the analytical accuracy DQOs. No SVOC data points were rejected for use indicating unreliable results due to surrogate or internal standard recoveries. Numerous samples analyzed for SVOCs indicated detectable levels of common laboratory contaminants; these samples have been qualified "B" for blank contamination. These results are considered to have some impact on the environmental data quality.

Fourteen of 143 water and 16 of 95 soil PPM percent recovery values from the matrix spike analysis conducted on the samples exceeded recovery limits of 75 to 125 percent. Zero of 6 hexavalent chromium soil percent recovery values from the matrix spike analyses conducted on the water samples exceeded recovery limits of 75-125 percent. No water samples were analyzed for hexavalent chromium. Established control limits for metals percent recovery values are presented in Table 2-8 and 2-9. All supporting target analyte metals Quality Assurance (QA) information cited above were also qualitatively evaluated with respect to the analytical accuracy DQO. These results are not considered to have any adverse impact on the environmental data quality.

Seven of 25 percent recovery values for MS/MSD values obtained for TPH analysis were outside control limits listed in Table 2-10. All supporting TPH QA information cited above also was qualitatively evaluated with respect to the analytical accuracy DQO. All other QC criteria for TPH analysis were met.

A total of 202 of all 4,702 calculated percent recovery values exceeded control limits indicating that, on average, 96 percent accuracy was achieved. As a result, the DQO for accuracy was met. The outliers noted for VOC analysis ranged between 0 and 238 percent recovery. The SVOC outliers ranged from 33 to 133 percent exceeding the range of 10 to 140 percent recovery. All TPH outliers noted were mixed high and low with a range from 43 to 120 percent recovery. The outliers noted for PPM analysis were mixed high and low. The range of outliers noted for PPM was 14 to 390 percent exceeding control limits of 75 to 125 percent recovery. The above results are not considered to have an adverse impact on the environmental data quality.

Sampling accuracy was maximized by adherence to the strict QA program presented in the RI Quality Assurance Project Plan (QAPP). All procedures (i.e., soil boring installation, soil samples collection procedures, and health monitoring equipment calibration and operation) used during the RI were documented as standard operating procedures (SOPs). Field QA blanks (i.e., TB, FB, and equipment blanks) were prepared such that all samples represented

Table 2-12 LABORATORY CONTROL SUMMARY: SURROGATE RECOVERY SEMIVOLATILE ORGANIC COMPOUNDS

MIANG, Alpena CRTC, Alpena, Michigan

	WATER					SOIL				
Surrogate	Total No. of Surrogate Analysis	Range of Outliers	Recovery Limits	Number Within Control Limits	Number outside Control Limits	Total No. of Surrogate Analysis	Range of Outliers	Recovery Limits	Number Within Control Limits	Number Outside Control Limits
Nitrobenzene	123	0-27	40-110	121	2	112		23-120	112	0
2-Fluorobiphenyl	123	0-27	42-110	120	3	112	27	30-115	111	1
Terphenyl-d14	123	3-22	24-140	121	2	112	138-141	18-137	110	2
Phenol-d5	123	0	17-113	118	5	112		24-113	112	0
2-Fluorophenol	123	0-15	16-110	118	5	112		25-121	112	0
2,4,6-Trobromophenol	123	0-15	18-126	119	4	112	14-015	19-112	110	2
2-Chlorophenol-d4						112		20-130	112	0
1,2-Dichlorobenzene-d4						112		20-130	112	0

the particular site from which they were collected, and assessed any cross-contamination that may have occurred. The environmental samples associated with the appropriate field QA samples were qualified based on the potential contaminants contained in the field QA samples.

2.10.1.3 Representativeness

Representativeness is defined as the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling location, a process condition, or an environmental condition. Sample representativeness was ensured during the RI by collecting sufficient samples of a population medium, properly distributed with respect to location and time. Representativeness was assessed by reviewing the drilling and sample collection methods used during the Alpena CRTC RI and evaluating the RPD values calculated from the duplicate samples and the concentrations of interferents detected in the field and laboratory QC blanks. The reproducibility of a representative set of samples reflects the degree of heterogeneity of the sampled medium, as well as the effectiveness of the sampling techniques.

Soil samples were collected from nine sites. All borings were advanced with a truck-mounted drilling rig using continuous-flight hollow stem augers. A minimum of two soil samples were collected for laboratory analysis from each soil boring. One sample was collected from just below the ground surface and the second from unsaturated soils just above the water table. A third and fourth sample were sometimes collected based on PID results and/or lithology. Samples were obtained using a split-spoon sampler equipped with stainless steel liners. Blow counts recording relative soil density were noted. Split-spoon samples were field-logged according to the USCS and field-screened with a PID meter and field GC for VOC concentrations. The boring was backfilled with a cement/bentonite slurry. The borings were marked at the surface and surveyed. Soil cuttings were placed on plastic sheeting for later analysis as required for disposal by the MDNR. Surface water samples were collected by directly filling the sample containers with water. Filtered samples for metals analyses were collected using a decontaminated Teflon® bailer and a disposable 0.45 μm filter. Groundwater samples were obtained after development of each well. The monitoring wells were allowed to recharge, were purged, and then sampled. The volume of water in each well casing was calculated prior to purging. As required, 4 to 5 casing volumes were removed from each well during the purging process. A decontaminated Teflon® bailer was used to remove the stagnant groundwater from each well. Color, degree of turbidity, odor and other physical properties of the water were recorded during development. Additionally, measurement of the pH, temperature, and conductivity of the groundwater were obtained before and after purging, and prior to sampling. These data were collected to ensure a representative groundwater sample was collected.

Based on the evaluation of the factors described above and summarized in Appendix J, the samples collected during the RI are considered to be representative of the environmental conditions at the Alpena CRTC.

2.10.1.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another and is limited to the other PARCC parameters, because only when precision and accuracy are known can one data set be compared to another. To optimize comparability, only the specific methods and protocols that were specified in the RI QAPP were used to collect and analyze samples during the RI. By using consistent sampling and analysis procedures, all data sets are comparable within the nine sites at Alpena CRTC, among the nine sites, or among ANG facilities nationwide. This consistency ensures that remedial action decision and priorities are based on a consistent database.

All samples collected for VOC and SVOC analysis were analyzed using SW-846 8010/8020 methods (aqueous and soils) 3/90 CLP SOW (soils) and 10/92 Low Concentration SOW (water), respectively. Samples collected for PPM were analyzed using SW-846 3rd edition methods. Due to a laboratory mix-up some samples were analyzed for target analyte list metals by CLP methods. This resulted in some additional data being generated for some samples but the use of CLP methods is not considered to have affected the comparability of the data. TPH samples were analyzed by EPA Method 418.1

Based on the precision and accuracy assessment presented above, the data collected during the RI are considered to be comparable with the data collected during previous investigations.

2.10.1.5 Completeness

Completeness is defined as the percentage of useable data obtained from a measurement system. Data may be considered valid and useable even though all QC criteria have not been met. In these cases, data are valid within the constraints identified by data qualifiers. Project completeness was defined as the percentage of data points used to prepare the baseline risk assessment and upon which recommendations for site remediation are based. Objectives for project completeness were set at 90 percent. Values and concentrations reported for analysis conducted that are labeled with the qualifier "R" or "B" are excluded from use in the risk evaluation and remedial recommendations due to increased risk of indicating false positives or omitting compounds or elements that are present.

Based on the evaluation of the laboratory QC results for the 23,761 data points presented in Appendix L, these data were considered 93.6 percent complete, and as such, were used as the basis of all recommendations presented in this report. A total of 1,513 data points were rejected for use because the data was qualified "R" indicating unreliable results or "B" indicating possible contamination from an outside source. The data points which were qualified "R" or "B" were not used as the basis for recommendations or risk analysis presented in this report.

2.11 FIELD QUALITY CONTROL ASSESSMENT

Twenty-seven trip blanks, 7 field blanks, 20 equipment blanks, 14 duplicate soil and sediment samples, and 7 replicates for groundwater were collected and analyzed by the same SOPs and methods used for the 184 environmental samples. Table J-13 of Appendix J contains a cross-reference of the associated field QC blank samples.

2.11.1 Trip Blanks

Twenty-seven trip blanks were prepared and analyzed by Compuchem Environmental Corporation in North Carolina. The blanks were prepared in the labs using American Society for Testing and Materials (ASTM) Type II water. Trip blanks were used to check for cross-contamination during sample handling and shipping of VOC samples. The trip blanks were stored with the unused sample bottles and returned to the laboratory with each cooler containing environmental samples to be analyzed for VOCs. The trip blanks were found to contain low levels of methylene chloride at concentrations below the CRQL. Trip blanks 1, 6, 8, 10, 22, 23, 24, and 25 contained 1,3-dimethylbenzene and 1,4-dimethylbenzene at levels just above the CRQL. TB-07 contained 1,4-dichlorobenzene at 0.44 $\mu g/\ell$. Table J-14 of Appendix J summarizes the concentrations of the VOCs detected in the trip blanks collected during the RI field effort. The contamination detected in the trip blank can be attributed to several possible causes. Methylene chloride is a common laboratory contaminant and is frequently detected. The other contamination could be attributed to contamination from samples stored with the trip blank at the laboratory.

2.11.2 Field Blanks

Seven field blanks were collected to provide baseline analytical data for the water used for equipment decontamination. Field blanks were taken for the ASTM Type II water produced on site using a Barnstead® E-Pure system, and the potable water used in the steam cleaner and as decontamination water. Field blanks were collected by randomly selecting sample containers from the supply, filling them with water from the sample source, and then preserving as appropriate for the required analysis. The blanks were analyzed in the same manner as the associated environmental samples. Levels of bromenated compounds, methylene chloride, lead, arsenic, copper, nickel, and zinc were detected in selected field blanks prepared during the RI. FB-01 contained 2-propanone at 11$\mu g/\ell$. FB-02 contained bromodichloromethane at 2.9 $\mu g/\ell$, bromoform at 2.5$\mu g/\ell$, chloroform at 0.92 $\mu g/\ell$, dibromochloromethane at 4.1 $\mu g/\ell$, copper at 120 $\mu g/\ell$, lead at 8.4 $\mu g/\ell$,and zinc at 859 $\mu g/\ell$. FB-03 contained chloroform at 0.36 $\mu g/\ell$, dibromochloromethane at 3.3 $\mu g/\ell$, copper at 120 $\mu g/\ell$, bromodichloromethane at 1.5 $\mu g/\ell$, TPH at 1.6 $\mu g/\ell$, arsenic at 12.1 $\mu g/\ell$, and zinc at 13.3 $\mu g/\ell$. FB-04 contained chloroform at 0.46 $\mu g/\ell$, bromoform at 4.2 $\mu g/\ell$, dibromochloromethane at 11 $\mu g/\ell$, bromodichloromethane at 2.1 $\mu g/\ell$, and TPH at 1.1 $\mu g/\ell$. FB-05 contained zinc at 45 $\mu g/\ell$ and TPH at 0.7 $\mu g/\ell$. FB-04 contained 1,2-dichlorobenzene at 0.4 $\mu g/\ell$ and zinc at 5.3 $\mu g/\ell$. FB-07 contained TPH at 3.1 $\mu g/\ell$. Table J-15 of Appendix J summarizes the concentrations of elements detected in the field blanks collected at Alpena

CRTC. The Alpena CRTC RI was conducted in four sampling events. Separate field blanks were obtained for each sampling event. The low levels of compounds and elements detected in the field blanks are not considered to have contributed to any levels seen in the associated environmental samples.

2.11.3 Equipment Rinsate

Twenty equipment rinseates were prepared from rinseates of equipment used to obtain environmental samples. The equipment rinseates were prepared by pouring ASTM Type II water produced on site, through or over sampling equipment which had been decontaminated. The equipment rinseates were preserved as appropriate for the required analysis and analyzed using the same methods as the associated environmental samples. One equipment rinseate was not analyzed for VOCs, metals, or TPH due to laboratory error. VOCs such as methylene chloride, chloroform, ethyl benzene, and toluene were detected at concentrations below the CRDL in the equipment rinseates. SVOCs such as bis (2-ethylhexyl) phthalate, diethyl phthalate and phenol were detected in equipment rinseates at concentrations above the CRQL. ER-01, ER-03, and ER-05 contained bis(2-ethylhexyl)phthalate at 15.0 $\mu g/\ell$, 20 $\mu g/\ell$, and 21 $\mu g/\ell$, respectively. ER-05 also contained TPH at 2.0 $\mu g/\ell$. ER-07 contained TPH and zinc at 0.04 $\mu g/\ell$ and 51.9 $\mu g/\ell$. ER-08 contained toluene at 0.28 $\mu g/\ell$, lead at 8.5 $\mu g/\ell$, and TPH at 2.0 $\mu g/\ell$. ER-09 contained TPH at 2.0 $\mu g/\ell$, diethyl phthalate at 7.0 $\mu g/\ell$, zinc at 226 $\mu g/\ell$, 1,3-dimethylbenzene at 0.035 $\mu g/\ell$, and 1,4-dimethylbenzene at 0.035 $\mu g/\ell$. ER-10 contained bis (2-ethylhexyl)phthalate at 7.0 $\mu g/\ell$. ER-11 contained zinc at 73.3 $\mu g/\ell$, and TPH at 2.5 $\mu g/\ell$. ER-12 contained TPH at 0.30 $\mu g/\ell$. ER-13 contained zinc at 6.5 $\mu g/\ell$, and TPH at 1.1 $\mu g/\ell$. ER-14 contained bis(2-ethylhexyl)phthalate at 35 $\mu g/\ell$, and zinc at 16.8 $\mu g/\ell$. ER-15 contained TPH at 0.5 $\mu g/\ell$. ER-17 contained zinc at 5.3 $\mu g/\ell$, and TPH at 0.7 $\mu g/\ell$. ER-19 contained 1,3-dimethylbenzene and 1,4-dimethylbenzene at 0.041 $\mu g/\ell$, and zinc at 8.3 $\mu g/\ell$. ER-20 contained 1,3-dimethylbenzene and 1,4-dimethylbenzene at 0.062 $\mu g/\ell$, and zinc at 8.9 $\mu g/\ell$. ER-21 contained zinc at 5.4 $\mu g/\ell$, TPH at 0.80 $\mu g/\ell$, and dissolved zinc at 4.0 $\mu g/\ell$. Table J-16 of Appendix J summarizes the concentrations of elements detected in the equipment blanks collected on the facility.

2.11.4 Field Replicates/Duplicates

One replicate environmental sample was collected for every 10 environmental samples, as required by DOE/HWP-65. Sample collection reproducibility and media variability were measured in the laboratory by the analysis of field replicates. Nine soil duplicates, 5 sediment duplicates and 7 water replicates were collected. One soil duplicate, PC-MP2-SB6-SS01-03, was not analyzed by the laboratory due to the sample being lost after receipt by the laboratory. Sufficient soil duplicates were taken and analyzed to meet the required percentage of 10 percent. Field RPD values for the samples were calculated only for compounds and elements detected above the CRDLs in one replicate pair samples and only for those compounds and elements not considered to be common laboratory contaminants (e.g., methylene chloride). The RPD value of the detected compound or parameter was reviewed to assess the sample collection reproducibility and matrix variability. A total of 72 soil samples, 75 water samples, 37 sediment, 9 soil replicate samples, 5 replicate sediment samples, and 7 duplicate water samples were collected.

Table J-17 of Appendix J summarizes the concentrations of elements detected in the replicate environmental samples collected at the Alpena CRTC.

2.12 LABORATORY QUALITY CONTROL ASSESSMENT

All environmental samples collected at the facility were analyzed using the 3/90 EPA CLP SOW for soils and 10/92 SOW Low Concentration SOW for water and EPA solid waste test methods and general chemical methodology from the following references:

- *Statement of Work For Organic Analysis, Multi-Media, Multi-Concentration*, EPA Contract Laboratory Program, 3/90 10/92 (SVOCs).
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, September 1986, with 1989 revisions (VOCs, priority pollutant metals).
- *Methods for Chemical Analyses of Water and Wastes*, EPA 600/4-79-020, EPA 1983, with revisions.
- *Requirements for Quality Control of Analytical Data*, HAZWRAP, DOE/HWP-65/R1 6/90 (VOCs, SVOCs, priority pollutant metals, and TPH).

HAZWRAP Level C documentation was required and submitted by the laboratory for all analyses. All data were validated and qualified using the guidelines and specifications described in the following documents and modifications:

- *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses*, EPA Contract Laboratory Program, June 1991, (Region III modifications, June 1992) (SVOCs).
- *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses*, EPA Contract Laboratory Program, February 1988 (priority pollutant metals).
- *Requirements for Quality Control of Analytical Data*, Hazardous Waste Remedial Actions Program (DOE/HWP-65/R1), July 1990 (VOCs by GC).

In addition to the above guidelines additional steps were taken to make the data validation process clearer to the reviewer. In the validation process the "B" qualifier has been used to indicate potential contamination resulting from the laboratory process or field sampling. Sample results greater than the CRQL but less than five times the blank concentration are qualified "B". If the sample result is greater than the CRQL and greater than five times the blank concentration no qualification is required. The use of the "B" qualifier is consistently applied to VOCs analyzed by GC methods, inorganic analysis, CLP, SVOC, and TPH analysis. The proper application of the five-times and ten-times rule is used where applicable.

In the validation of CLP organic results the laboratory added "J" qualifier for sample results below the CRQL has been stripped from the data during the validation process. Since the

CRQLs are known, or can be easily calculated for soil samples, the use of the "J" qualifier for results below the CRQL does not provide useful information to the reviewer. The "J" qualifier has been used only in cases where specific QC requirements were not met. For compounds which were not detected above the CRQL an additional qualifier has been appended to the "U" qualifier to indicate QC concerns regarding the reported sample quantitation limits. A complete summary of all data obtained and the qualifiers applied to that data is presented in Appendix K.

2.12.1 Organic Analysis

Soil and water samples and field QC samples collected during the facility RI were submitted to Compuchem Environmental Corporation in North Carolina for VOC, SVOC metals and TPH analysis. An assessment of the data quality is presented in the following sections and Appendix J.

2.12.1.1 Volatile Organic Compound Analysis (SW-846 8010\8020)

Seventy-two soil samples, 37 sediment samples, 75 groundwater samples, and 47 field QC samples were collected during the RI and sent to Compuchem Environmental Corporation for VOC analysis. The data quality was evaluated using the guidelines in Section 2.12 pertaining to holding times, surrogate recovery, internal standards, initial and continuing calibration, method blanks, and MS/MSD results. Detailed summaries of the data qualification and evaluation are presented in Appendix K.

2.12.1.2 Semivolatile Organic Compound Analysis (CLP 3/90/10/92)

Seventy-two soil samples, 37 sediment samples, 75 groundwater samples, and 48 field QC samples were collected during the RI and sent to Compuchem Environmental Corporation for SVOC analysis. The data quality was evaluated using the guidelines in Section 2.12 pertaining to holding times, tuning and mass calibration results, initial and continuing calibration, internal standards, surrogate recovery, method blanks, blank spike recovery, and MS/MSD results. Detailed summaries of the data qualification and evaluation are presented in Appendix K.

2.12.1.3 Inorganic Analysis

Seventy-two soil samples, 37 sediment samples, 75 groundwater samples, and 47 field QC samples were collected during the RI and sent to Compuchem Environmental Corporation for inorganic PPM analysis using solid waste test methods. Sixty-nine soil and 9 sediment samples were also analyzed for hexavalent chromium. Soil, sediment, and water samples collected for antimony, arsenic, lead, selenium and thallium were analyzed using graphite furnace atomic absorption. Soil and sediment samples collected for analysis of mercury were analyzed using cold vapor generation. Beryllium, copper, cadmium, chromium, nickel, silver, and zinc were analyzed using inductively coupled plasma spectroscopy. The data quality was evaluated using the guidelines in Section 2.12 pertaining to holding times, initial and

continuing calibration, method blanks, interference check samples, spiked sample analysis, duplicate sample analysis, and laboratory check samples. Detailed summaries of the data qualification and evaluation are presented in Appendix K.

2.12.1.4 Total Petroleum Hydrocarbons

Seventy-two soil samples, 37 sediment samples, 75 groundwater samples, and 47 field QC samples were collected during the RI and sent to Compuchem Environmental Corporation for TPH analysis using EPA method 3550/418.1. The data quality was evaluated using the guidelines in section 2.12 pertaining to holding times, method blanks, blank spike recoveries, and MS/MSD results. Detailed summaries of the data qualification and evaluation are presented in Appendix K.

3.0 SIGNIFICANCE OF RESULTS

The results of the 1992-1993 RI program conducted for the Alpena CRTC are discussed in this section. Section 3.1 presents the work completed to determine the background concentrations of inorganics in the soil and groundwater contained in the shallow aquifer beneath the facility. Site-specific discussions for each of the eight sites under investigation are presented in Sections 3.2 through 3.9. A discussion of the analytical results obtained from the facility water supply wells is included in Section 3.10.

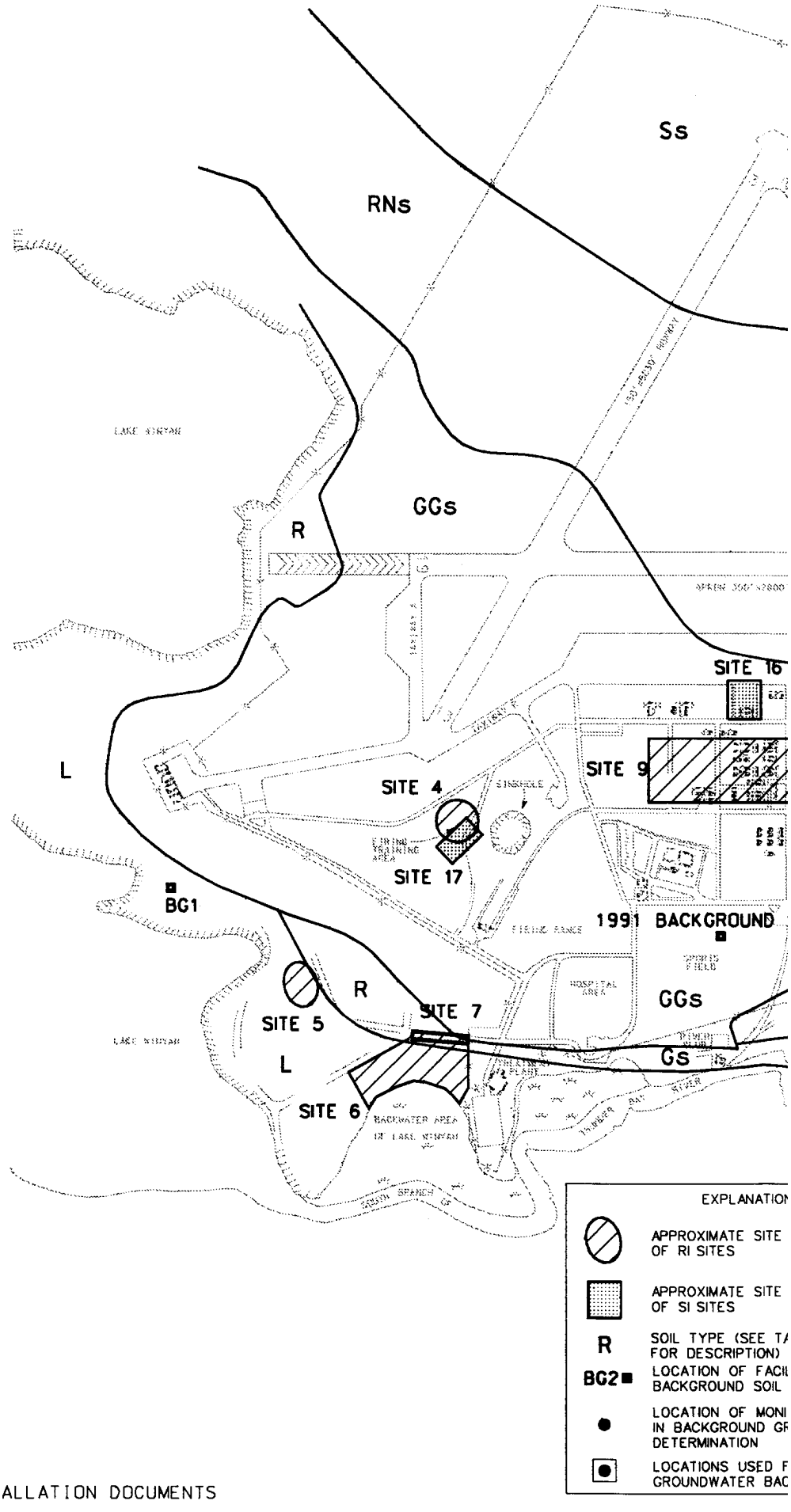
The data interpretations presented in Section 3 are based on the data collected during this investigation and previous investigations where applicable. The data tables included in Sections 3.2 through 3.9 present only those compounds or analytes for which a positive result was detected in at least one sample per site. The complete listing of the RI analytical results is contained in Appendix L. The analytical results from the October 1991 (Round III) groundwater sampling event are included in Appendix N, while the analytical results from the SI (Engineering-Science, 1990) (Earth Technology, 1992) are reproduced in Appendix O.

3.1 BACKGROUND SOIL AND GROUNDWATER SAMPLING

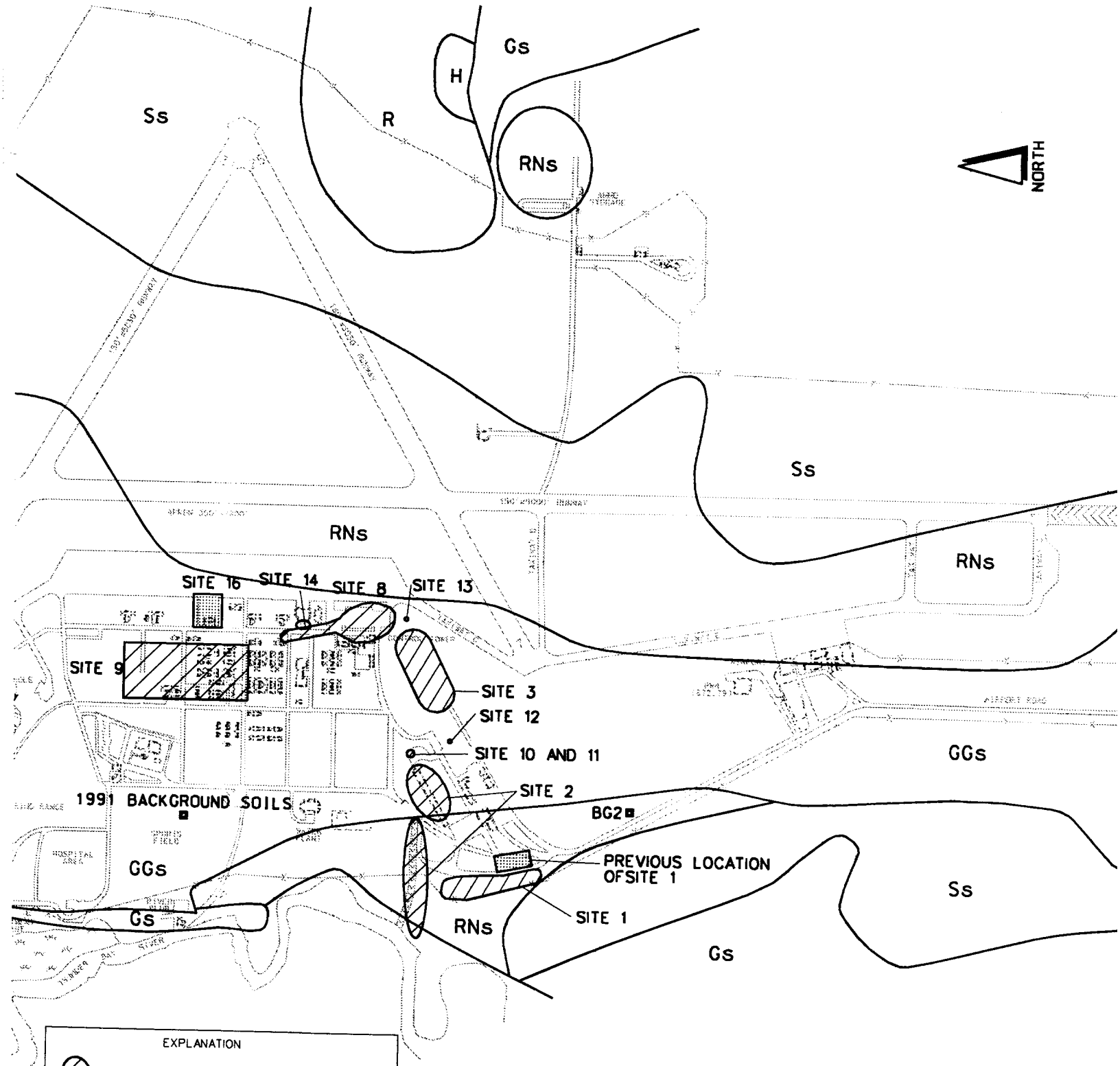
Some contaminants, metals in particular, may naturally occur within either the soil or groundwater at elevated levels. Because of this fact background soil and groundwater values for inorganic compounds were determined for the facility in order to determine which compounds actually exceeded MDNR allowable concentration levels.

The soils encountered at the facility consisted primarily of either a fine- to medium-grained quartz sand to a quartz sand with clay. Different soil types may have varying capacities to absorb certain contaminants; therefore, samples corresponding to both soil types were collected in order to obtain background levels of inorganics for each soil type. Background soil samples were collected from the Sports Field, sites 4, 6, and 8 (Figure 3-1).

A total of 20 soil samples were collected from the quartz sand soil type and analyzed for PPM. Analytical results were statistically analyzed to determine high outliers. Soil samples were also collected from two undisturbed areas (BG1 and BG2) in order to obtain samples of the quartz sand with clay soil type. Four soil samples were collected of the quartz sand with clay and were analyzed for PPM. Analytical results were also statistically analyzed for high outliers. The mean, variance, standard deviation, and coefficient of variation were statistically calculated. If the coefficient of variation was greater than 0.5 percent, the highest number was chosen as suspected outlier. If the suspected outlier was greater than three times the standard deviation of the mean of all the numbers, not including the suspected outlier, it was eliminated from that set of data. Once this criteria was achieved background values were calculated by adding the statistical mean to three times the standard deviation of that mean.



SOURCE: WILDERMUTH, 1924 AND INSTALLATION DOCUMENTS

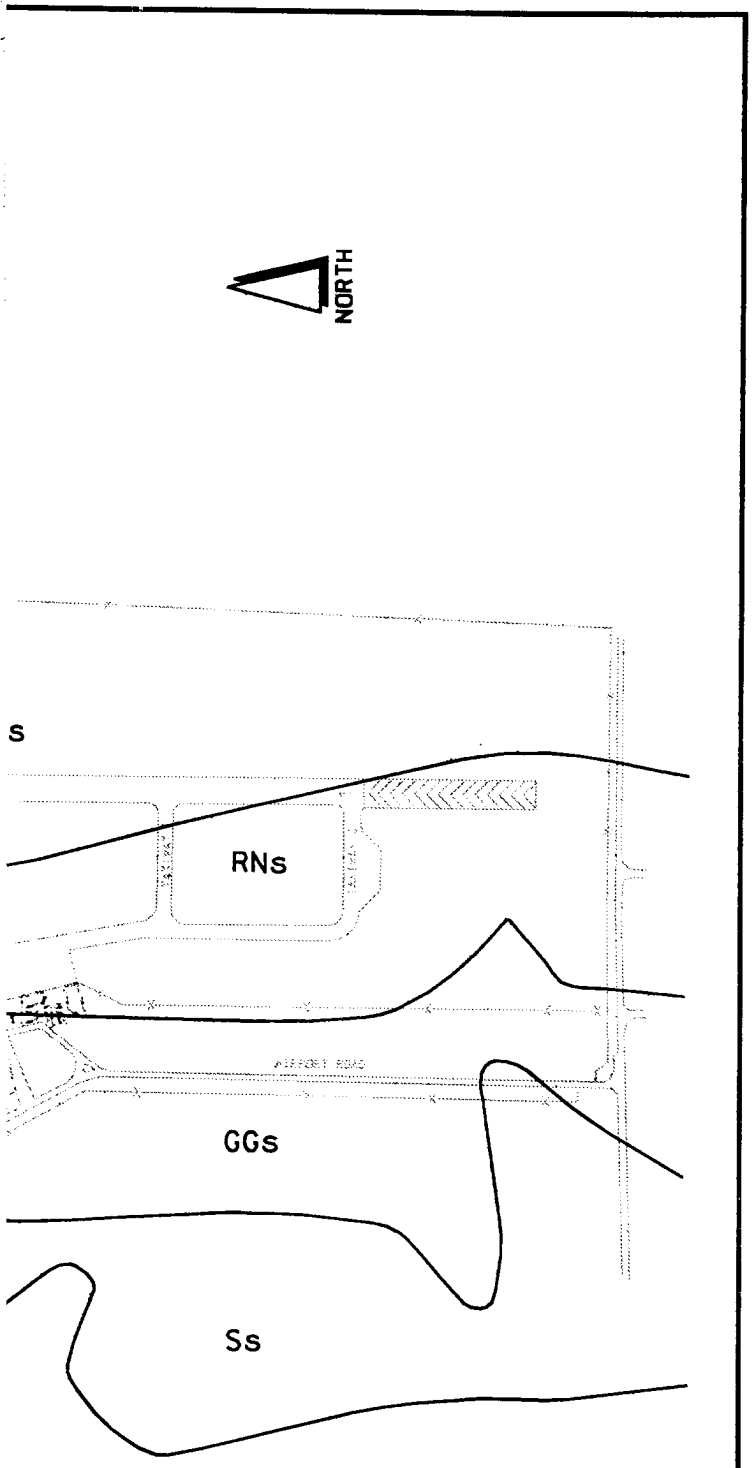


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PROJECT NO. 928901

Alpena CRTC
Alpena, Michigan

LOCATIONS USED FOR BACKGROUND SAMPLES

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FIGURE 3-1

The MDNR allows the use of local background concentrations for inorganics if those levels are higher than the MDNR Type A cleanup criteria. Upon completion of the statistical analysis it was determined that the inorganic concentration levels determined from the statistical analysis for both soil types were below the MDNR criteria. These values were discarded and the MDNR Type A default cleanup criteria were used. A complete discussion of the MDNR Act 307 cleanup criteria (Types A, B and C) and its application for this RI are presented in Section 4 of this report. Table 3-1 provides the concentrations for each inorganic compound of concern as set by the MDNR default criteria. A brief discussion regarding the statistical analytical results for calculated background values is included in Appendix M.

Up gradient groundwater monitoring wells were installed at each site under investigation. Groundwater samples were collected from each up gradient well during four separate sampling sequences and analyzed for fixed base laboratory analysis of VOCs, SVOCs, PPM, and TPH. Both filtered and nonfiltered (Round IV only) metal samples were collected. The analytical results from those monitoring wells were reviewed and evaluated. Those wells which contained elevated concentrations of organics were discarded from the background data set. The analytical results for inorganic compounds from those wells (both filtered and dissolved) which were determined to be free of organic contaminants were combined and used to determine statistical means for existing levels of inorganic compounds PPM. The listing of the wells used to determine background as well as the complete analytical results used to generate background are included in Appendix M. Analytical results for inorganic compounds which were below detection limits concentrations were assigned a value of one half the value of the contracted detection limit. The statistical analysis was completed by determining the mean and standard deviation.

Table 3-2 provides the analytical background concentrations for inorganic compounds determined from the above referenced procedure for inorganic compounds which may exist within the groundwater at the facility. Background soil and groundwater sample locations are provided in Figure 3-1.

3.2 SITE 1 POL STORAGE AREA

Field investigations to support the IRP at Site 1 began in 1985 with the completion of a soil gas survey. No additional environmental investigations were performed at the site until a SI was initiated for Site 1 in 1992. SI field activities, conducted in November 1992 and January 1993, included collection of soil gas and groundwater screening data and the drilling and sampling of three soil borings as documented in the Abbreviated SI Report (The Earth Technology Corporation, November 1993).

RI field activities recommended for Site 1 were included in the RI Work Plan Addendum (The Earth Technology Corporation, August 1993). These activities included: soil boring and sampling, monitoring-well installation, sampling and analysis, and aquifer slug testing.

Table 3-1 Soil Background Values for Inorganic Compounds
MIANG, Alpena CRTC, Alpena, Michigan

Compound	MDNR Type A Default Soil Cleanup Criteria (ppm)
Aluminum	6900
Arsenic	5.8
Barium	75
Cadmium	1.2
Cobalt	6.8
Chromium (total)	18
Copper	32
Cyanide	0.39
Iron	12000
Lead	21
Mercury	0.13
Lithium	9.8
Manganese	440
Nickel	20
Selenium	0.41
Silver	1.0
Zinc	47

3.2.1 Results of Previous Investigations

Figure 3-2 illustrates the concentration of total VOCs detected in the screening samples collected and analyzed during the November 1992 and January 1993 field events. As illustrated in Figure 3-2, the screening data indicate three separate areas containing relatively high concentrations (> 10,000 $\mu g/\ell$ of air) of hydrocarbons in the soil gas samples. The soil gas grid was altered in the field to focus on these three areas. These locations and their relationship to the layout of the preexisting POL Storage Area (Figure 1-4) are as follows:

- An area centered approximately 21 m (75 ft) east of the western boundary of the site corresponding to the location of a preexisting aboveground fuel storage tank (figure 1-4).
- An elongated area trending roughly north-south in the central portion of the site corresponding to the former fuels off-loading area.
- An area centered around Building 38 corresponding to the preexisting dispensers.

Also presented on Figure 3-2 are the locations of S1SB1, -SB2, and -SB3 which were drilled and sampled during the SI. One soil boring was drilled and soil samples were collected and analyzed for VOCs and TPH from each of the three areas exhibiting hydrocarbon

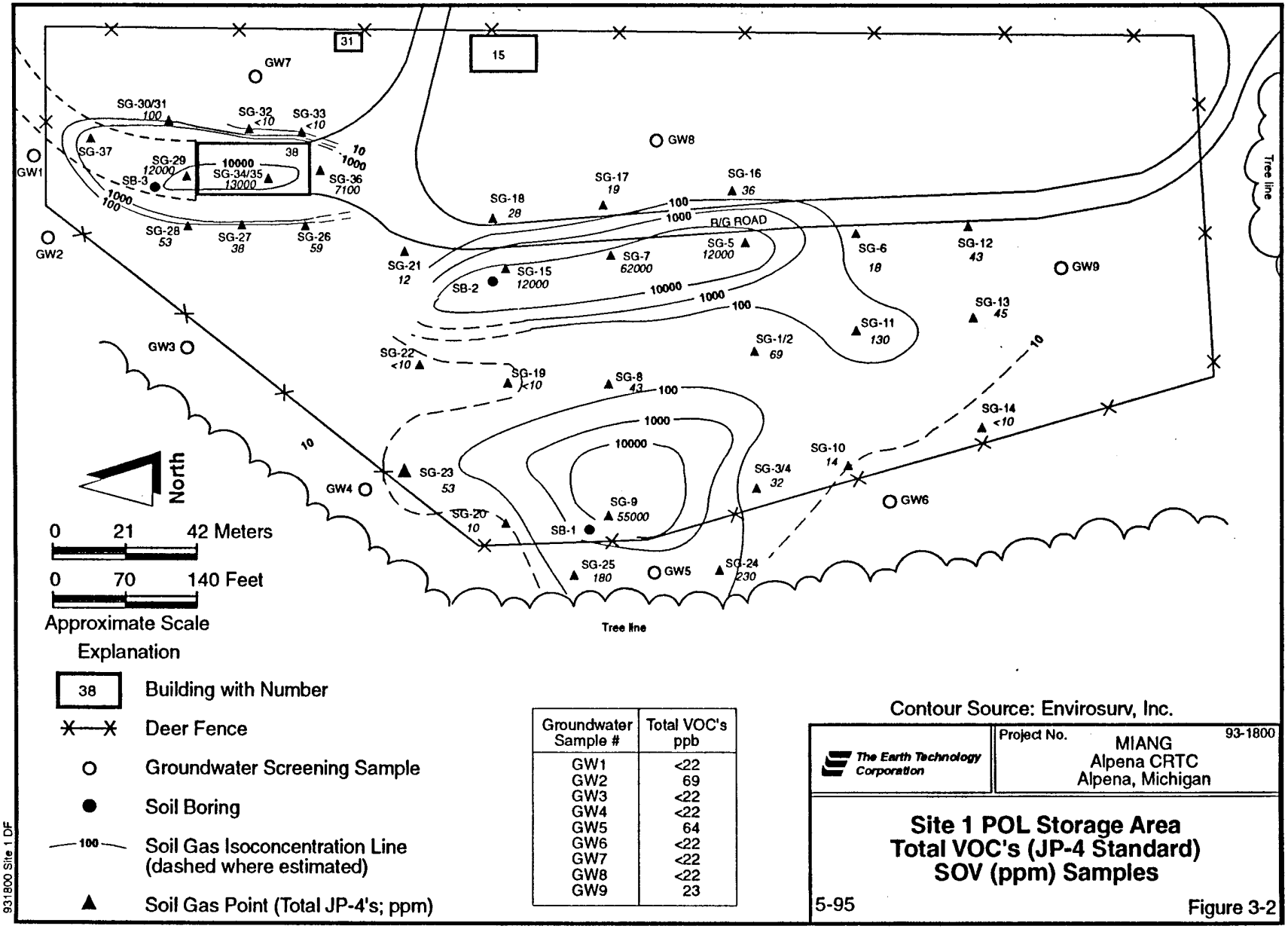
Table 3-2 Groundwater Background Values for Inorganic Compounds
MIANG, Alpena CRTC, Alpena Michigan

Compound	Mean Value (ppb)	Standard Deviation
Antimony	17.50	0.00
Antimony (Dissolved)	16.90	0.84
Arsenic	5.75	5.94
Arsenic (Dissolved)	1.85	1.78
Beryllium	0.62	0.31
Beryllium (Dissolved)	0.34	0.17
Cadmium	1.50	0.00
Cadmium (Dissolved)	1.72	0.24
Chromium (total)	13.00	19.74
Chromium (Dissolved)	3.77	0.24
Copper	23.36	29.87
Copper (Dissolved)	4.71	6.31
Lead	9.44	19.28
Lead (Dissolved)	0.89	0.38
Mercury	0.10	0.00
Mercury (Dissolved)	0.17	0.07
Nickel	15.71	16.44
Nickel (Dissolved)	7.95	1.39
Selenium	1.50	0.00
Selenium (Dissolved)	1.27	0.24
Silver	2.00	0.00
Silver (Dissolved)	1.27	0.24
Thallium	1.50	0.00
Thallium (Dissolved)	10.75	9.25
Zinc	39.48	51.07
Zinc (Dissolved)	5.51	8.38

contamination. Analytical results (The Earth Technology Corporation, November 1993) indicated that the following VOCs were present above Act 307 Type B cleanup criteria in S1SB1 at a depth of 2 to 3 ft: chlorobenzene (6200 ppb), ethylbenzene (7900 ppb) and styrene (7800 ppb). TPH was detected in soil samples from S1SB1 and S1SB2 at concentrations of 2200 ppm and 533 ppm respectively. The detection of these compounds above cleanup criteria prompted the RI for Site 1.

3.2.2 Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC is presented in Section 1.7.9 A discussion of the site-specific geology and hydrogeology is presented in the following subsections.



Explanation

- 38 — Building with Number
- Deer Fence
- Groundwater Screening Sample
- Soil Boring
- 100 — Soil Gas Isoconcentration Line (dashed where estimated)
- Soil Gas Point (Total JP-4's; ppm)

Groundwater Sample #	Total VOC's ppb
GW1	<22
GW2	69
GW3	<22
GW4	<22
GW5	64
GW6	<22
GW7	<22
GW8	<22
GW9	23

Contour Source: Envirosurv, Inc.

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Site 1 POL Storage Area
Total VOC's (JP-4 Standard)
SOV (ppm) Samples

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Figure 3-2

931800 Site 1 DF

3.2.2.1 Geology

Figure 3-3 presents the location of the east - west oriented geologic cross-section created from Site 2 across Site 1 to the Thunder Bay River. The cross-section is presented in Figure 3-4 and was constructed based on observations made during the drilling operations and recorded on the soil boring logs. As illustrated in Figure 3-4, the sediments of the shallow aquifer generally consist of three layers; a surficial sand, a clay unit, and a deeper sand unit overlying the limestone bedrock. The surficial sand unit consists of a 2.7- to 3.4-meter-thick (9- to 11-ft-thick) section of well-sorted, medium-grained quartz sand. A medium-stiff, plastic clay approximately 1.8 to 3 m (6 to 10 ft) thick exists below the surficial sand. The upper 0.6 to 1.2 m (2 to 4 ft) of the clay unit contains variable (approximately 10 to 30 percent) amounts of sand and sand lenses. As shown in Figure 3-4, this shallow clay layer thins towards Site 2 (MP2-MW2) and was not observed in the MP2MW4-MW5 well pair. From a review of the boring logs included in Appendix C, the shallow clay unit is found in every boring drilled to a depth below approximately 3 m (10 ft) bgs. A geotechnical sample of the clay was collected from location S1MW10 at depths between 4.3 and 4.7 m (14 and 15.5 ft). A vertical permeability of 1.8×10^{-4} cm/sec was measured on this sample.

Borings S1MW1 and S1MW14 were drilled through the clay unit and encountered a lower sand unit consisting of a medium- to coarse-grained quartz sand. These quartz sands occasionally contain minor amounts of small gravels. Three feet of grey sandy clay was drilled at location S1MW1 prior to refusal of the hollow stem augers at 12.2 m (40 ft) on what is interpreted to be limestone bedrock.

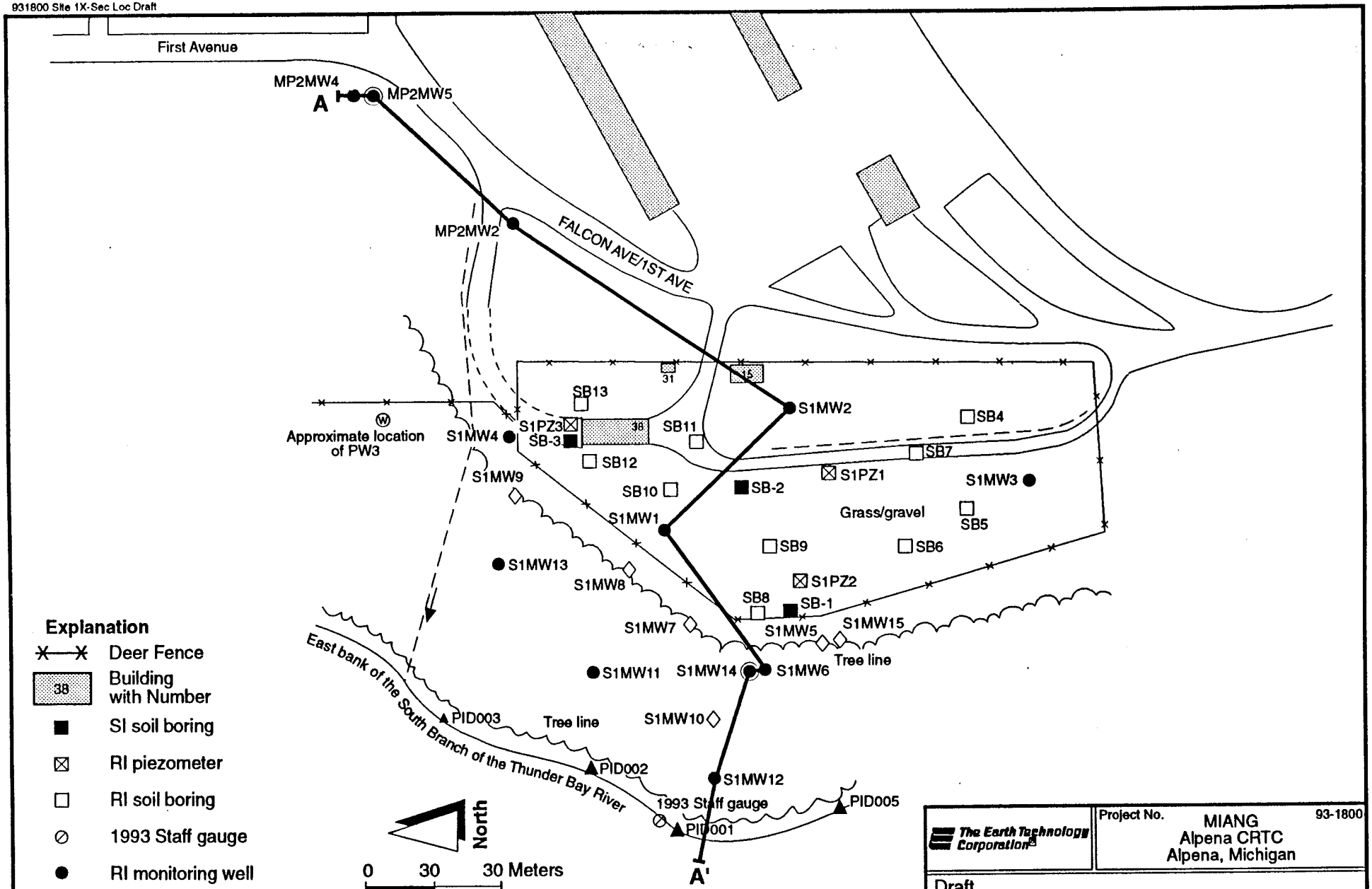
3.2.2.2 Hydrogeology

Eight shallow monitoring wells (S1MW1, MW2, MW3, MW4, MW6, MW11, MW12 and MW13) and one intermediate depth well (S1MW14) were installed at Site 1 to obtain hydrogeologic data and monitor groundwater quality beneath Site 1. Additional hydrogeologic data pertaining to the site comes from Site 2 groundwater elevations, the surface water elevations of the Thunder Bay River, and the slug tests performed in S1MW2 and S1MW3. Prior to installing permanent wells, piezometers S1PZ1, S1PZ2, and S1PZ3 were constructed at the site to:

- determine the presence or absence of floating, free-phase product in the three suspected source areas, and
- obtain a general indication of the groundwater flow direction.

The piezometers were checked with an electronic hydrocarbon/water interface probe 4 separate times over a period of approximately 3 weeks. No floating product was present in the piezometers.

The groundwater elevation measurements collected during September 1993 for Site 1 are included in Figure 1-21 which presents a groundwater elevation contour map of the surficial



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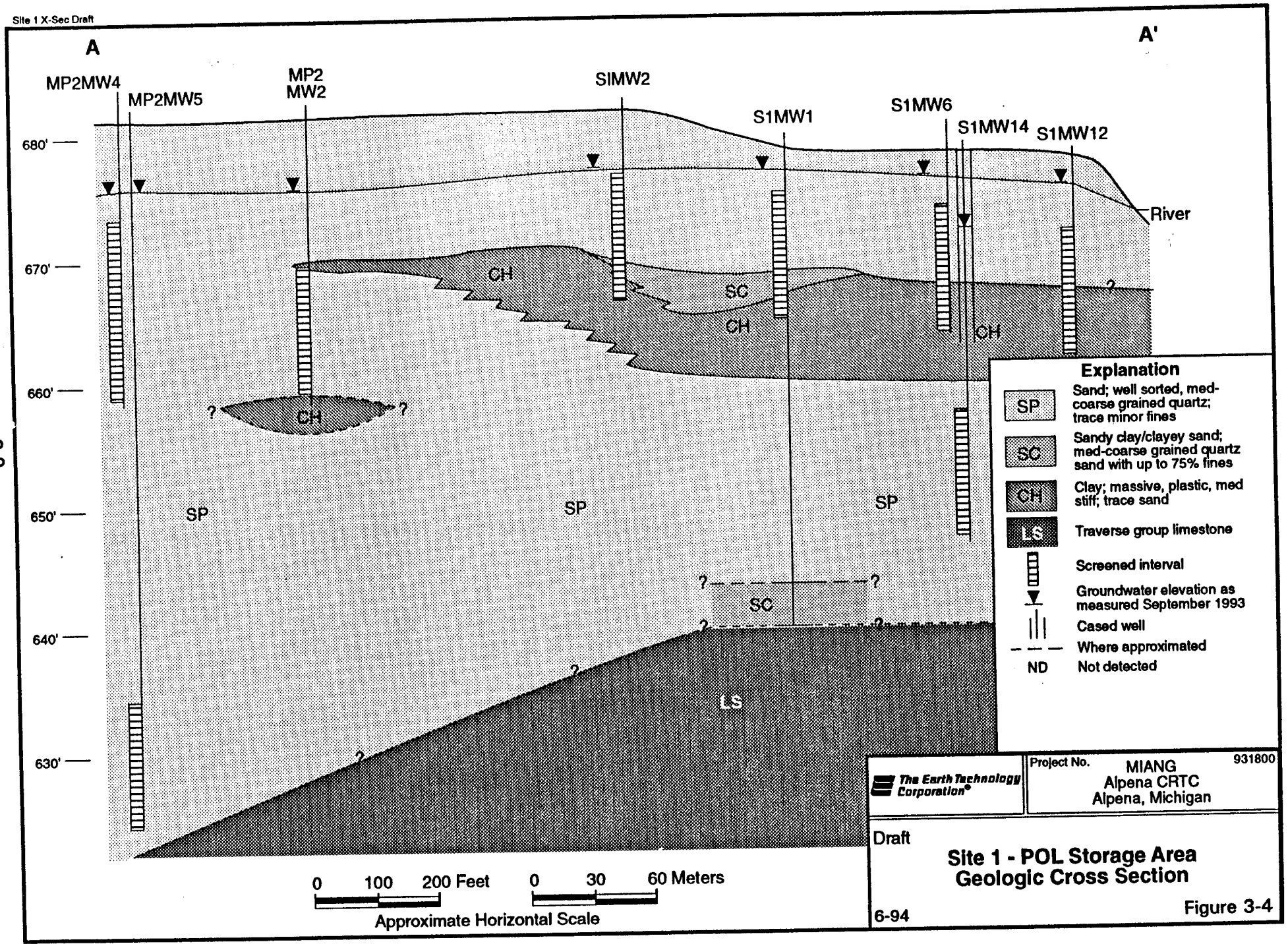
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Site 1 POL Storage Area
Cross Section A-A' Location Map

6-94

Figure 3-3



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Site 1 - POL Storage Area
Geologic Cross Section

6-94

Figure 3-4

aquifer existing for the facility. A groundwater elevation map of the perched aquifer for Site 1 is included in Figure 3-5. Groundwater beneath Site 1 occurs between 0.47 and 1.33 m (1.56 ft and 4.35 ft) below the ground surface and is apparently perched on top of the intermediate subsurface clay layer. A comparison of water level elevations between S1MW6 (groundwater elevation = 676.2 ft above msl) and S1MW14 (groundwater elevation = 673.92 ft above msl) supports the existence of the perched water table. The presence of the clay layer has also contributed to the mounding of water beneath the east-central portion of the site. As illustrated in Figure 3-5 groundwater in the perched zone flows northwest towards the Thunder Bay River and northeast towards Site 2. The hydraulic gradient within the perched zone varies from approximately 0.005 ft/ft in the central portion of the site to 0.017 ft/ft near the Thunder Bay River. The average gradient across the site is 0.01 ft/ft.

The hydraulic conductivity of the surficial aquifer was determined from slug tests run in S1MW2 and S1MW3. Two wells were selected for testing based on the similarity of the surficial geology/hydrogeology of the Site 1 wells. Hydraulic conductivities were calculated by the methods described in Section 2.2.3 and range from 3.86 X 10^{-3} cm/sec (10.94 ft/day) to 4.97 X 10^{-3} cm/sec (14.1 ft/day).

3.2.3 Screening Results and Boring and Well Placement Rationale

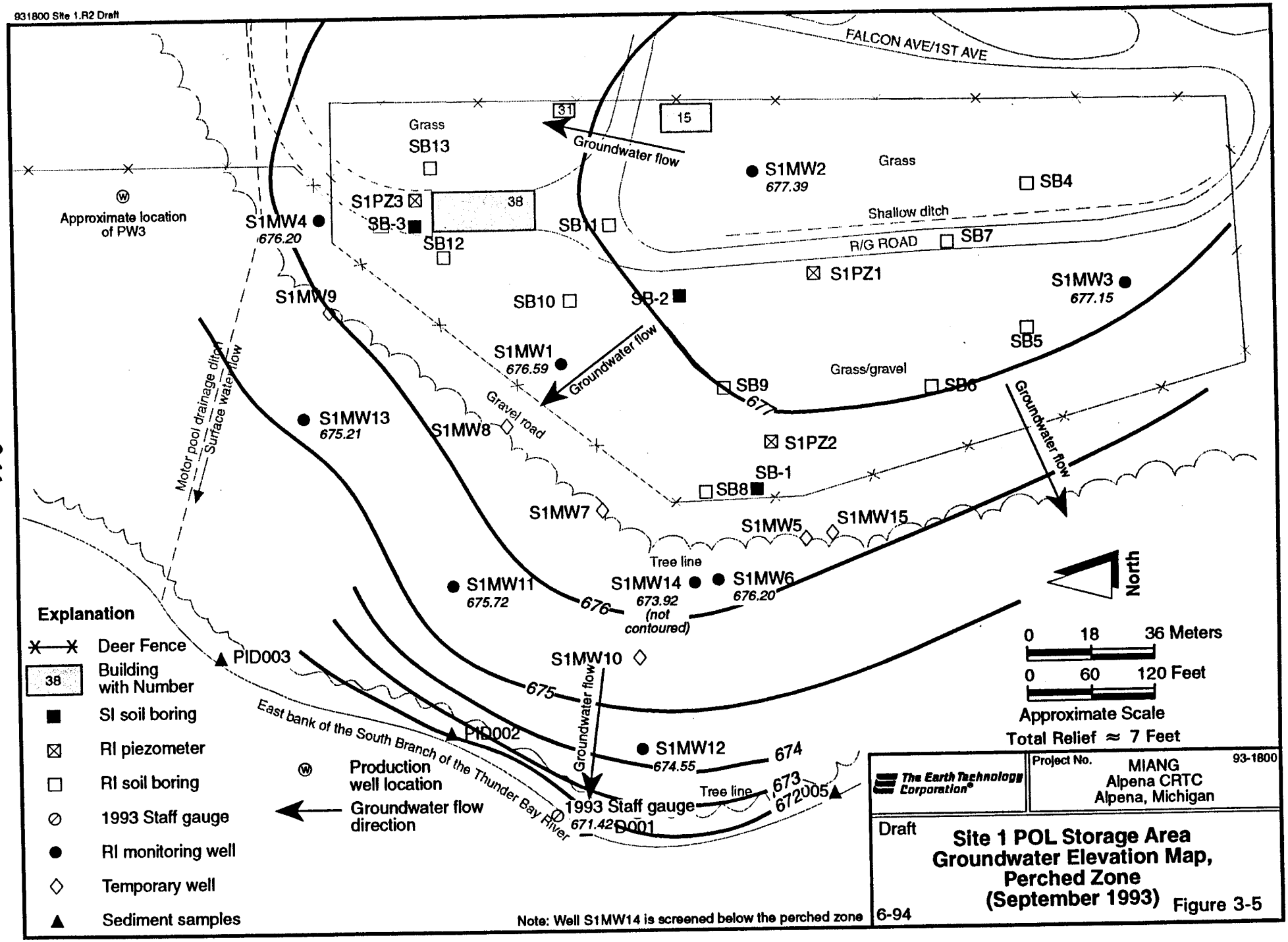
Initial site screening activities to support the SI were completed in November 1992 and January 1993. Activities at Site 1 consisted of the collection and analysis of soil gas and groundwater grab samples. Based primarily on these data, soil boring and well locations were then selected. Further on-site GC screening activities were conducted during the drilling operations conducted in August and September 1993.

3.2.3.1 Initial Site Screening

The isoconcentration map generated from the results of the initial site screening activities was presented previously in Figure 3-2. Analytical results are included in Appendix D.

3.2.3.2 Soil Boring and Monitoring Well Placement Rationale

Soil boring locations S1SB4 through S1SB13 were selected to provide analytical data regarding the nature and extent of soil contamination around and in the three source areas identified at the site during the SI (Earth Technology, 1993). These source areas relate to the former layout of the POL area, as shown in Figure 1-4. Monitoring well locations S1MW1 through S1MW4 were selected to monitor groundwater quality within and around the perimeter of the suspected source areas. Because access to the area between the road and the river was difficult, a row of temporary wells (S1MW5 through S1MW9) were installed along the gravel road north and west of the site. These temporary wells provided an indication of the extent of contamination along the road and allowed a determination to be made regarding the need for well locations in the wooded area. Soil and groundwater quality were analyzed from these temporary wells prior to selecting locations in the heavily wooded



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Site 1 POL Storage Area Groundwater Elevation Map, Perched Zone (September 1993)

Figure 3-5

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area between the gravel road and the river. Additional well locations (S1MW10 through S1MW13 and S1TW15) were added, based on screening results from the temporary wells, to define the extent of groundwater contamination down gradient of the site. S1MW14 was drilled to investigate groundwater quality in the lower zone of the shallow aquifer down gradient of the suspected source areas.

3.2.3.3 On-Site Screening During Drilling Operations

Forty soil and groundwater samples were collected and analyzed from the borings, piezometer and wells drilled at the site. The analytical results for these samples are presented in Appendix E. A review of these data indicate that all nine of the target compounds (including chlorinated hydrocarbons) were detected in one or more of the samples.

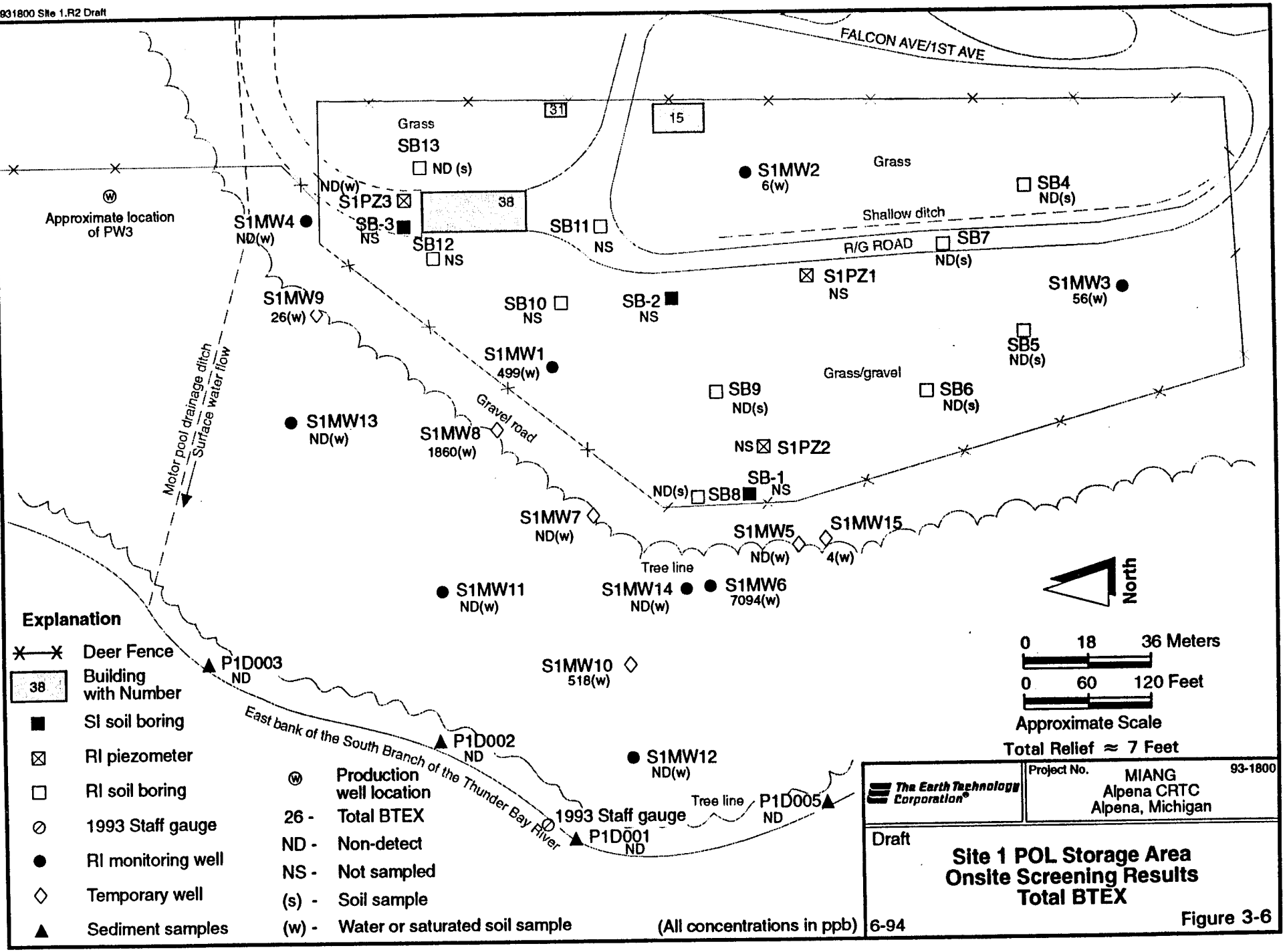
Figures 3-6 and 3-7 present the total BTEX screening results in map and cross-sectional view, respectively. The maximum occurrence of total BTEX from the screening samples at any one location is presented in Figure 3-6. Total BTEX concentrations detected in soil samples collected from below the water table are interpreted as indicating groundwater contamination. No soil samples collected from the soil borings S1SB4 through S1SB13, drilled within the suspected source areas, detected the presence of hydrocarbons (Figure 3-6). SISB10, -11, and -12 were not screened because of an insufficient quantity of VOC vials.

During the installation of monitoring wells S1MWI through S1MW3, S1MW6, S1MW8 through S1MW10, and SITW15 total BTEX was detected in groundwater or saturated zone soil samples at concentrations up to 7094 $\mu g/\ell$ of air. A review of Figure 3-7 suggests that the extent of total BTEX occurring within the groundwater appears to be delineated on the western and northern boundaries of the site by non-detections at locations S1MW4, and S1MW11 through S1MW13. Total BTEX concentrations detected in groundwater or saturated soil samples along the eastern and southern boundaries range from 4 to 56 $\mu g/\ell$ of air in S1MW2, S1MW3, and S1MW5. Analytical data regarding the vertical extent of BTEX occurrences are included in Figure 3-7. The lateral extent of BTEX occurrences in the perched zone appear to be delineated by non-detects in S1MW1 and S1MW12. Four Hydropunch® groundwater samples collected from below the shallow clay layer from locations S1MW1 and S1MW14 were all non-detect for BTEX compounds. These data suggest that contaminants contained in the perched aquifer are not migrating vertically through the clay layer.

Chlorinated hydrocarbons (TCE, PCE, and DCE) were detected in ten environmental samples during the onsite screening. However, the chlorinated compounds were not confirmed by the laboratory data.

3.2.4 Confirmation Results

Analytical results for the organic and inorganic compounds detected from the surface and subsurface soil, sediment, and groundwater samples collected during the RI field sampling are



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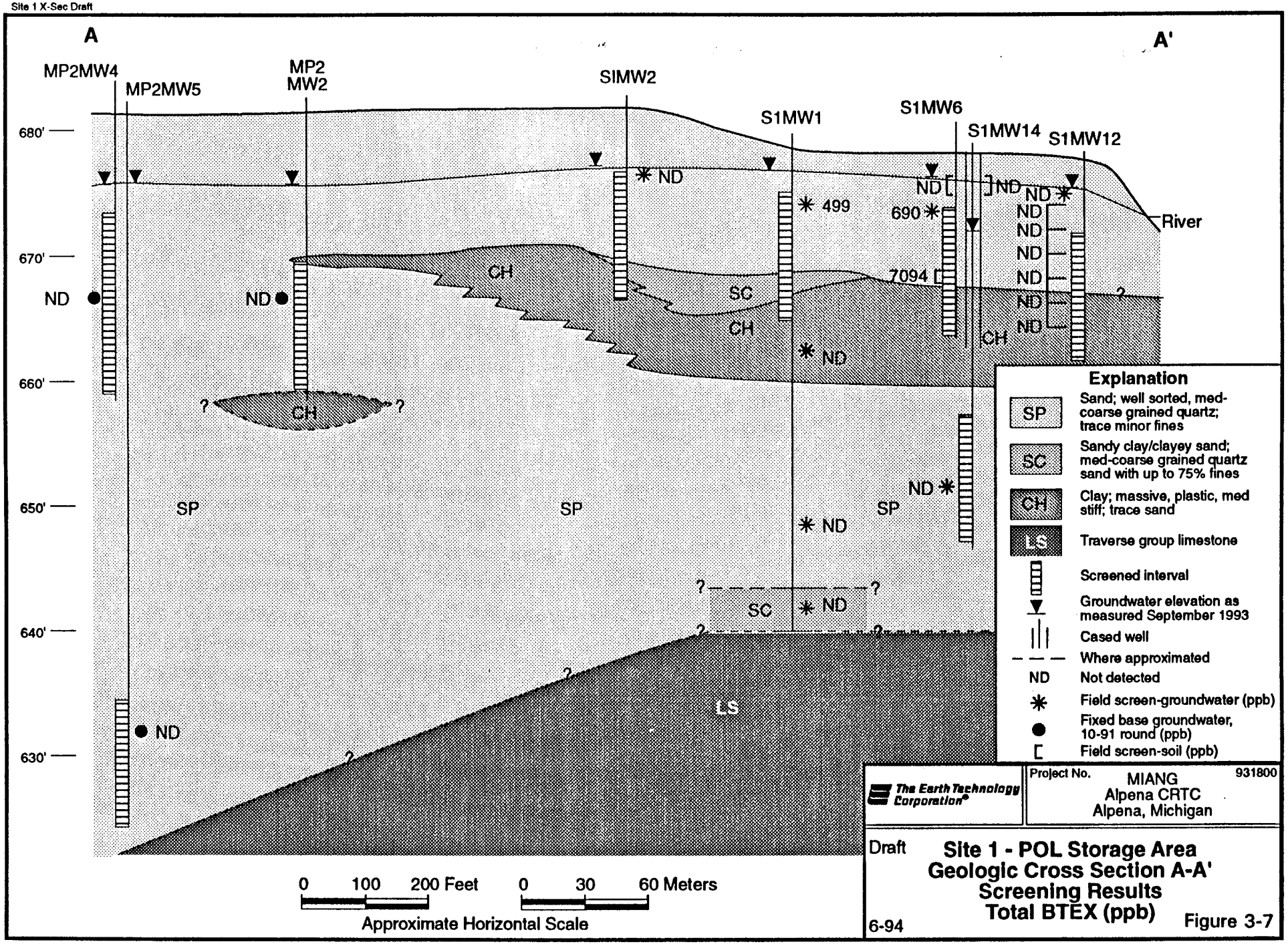
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Alpena, Michigan

Draft

Site 1 POL Storage Area
Onsite Screening Results
Total BTEX

6-94

Figure 3-6



The Earth Technology Corporation

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Alpena CRTC
Alpena, Michigan

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Site 1 - POL Storage Area
Geologic Cross Section A-A'
Screening Results
Total BTEX (ppb)

6-94

Figure 3-7

included in Tables 3-3 through 3-6. A presentation and discussion of the significance of these results including the occurrence of compounds exceeding Act 307 Type A or B cleanup criteria is included in the following subsections. A comparison of on-site GC results with the fixed base laboratory data will also be included in the discussions.

3.2.4.1 Surface Soil Sampling Results

Surface soils were collected from soil borings S1SB4 through S1B13 drilled at Site 1. The compounds and concentrations detected in the samples are presented in Table 3-3 and Figure 3-8. The detects include 1,1,1-TCA at 2.7 µg/kg, styrene at 0.045 µg/kg, 1,4-Dichlorobenzene at 0.017 µg/kg, and 4 detections of methylene chloride ranging from 0.05 to 9.3 µg/kg. These low numbers of detections are consistent with the on-site GC analytical results for VOC presented in Section 3.2.1. The SVOCs, 1,4-dichlorobenzene (DCB-1 detection) and bis (2-ethylhexyl) phthalate (2 detections) were quantified at concentrations ranging from 0.02 - 42 µg/kg. No organic compounds were detected in concentrations exceeding the Act 307 Type B cleanup criteria. TPH was detected in six samples ranging from 9.3 to 23.9 mg/kg.

As is also presented in Table 3-3, the inorganics arsenic, chromium, copper, lead, nickel and silver were detected in one or more surface soil samples. However, no analytes were quantified exceeding the Act 307 Type A default values.

3.2.4.2 Subsurface Soil Sampling Results

Subsurface soil analytical results for Site 1 are presented in Table 3-4 and Figure 3-8. These results are similar to the results obtained from the surface soils. The VOCs 1,1,1-TCA and methylene chloride were quantified in relatively few samples and at low concentrations (1.4 to 5.3 mg/kg). Again, these data are consistent with the results of the on-site GC results obtained during drilling (Section 3.2.3.1). The SVOCs 1,2 - and 1,4-DCB were detected in three samples in concentrations ranging from 0.06 to 3.80 µg/kg. No organic compounds were found in concentrations exceeding the Act 307 Type B cleanup criteria. However, SB-1 drilled during the SI had levels of chlorobenzene, ethylbenzene, and styrene in the soil (at a depth of 2 to 3 ft) in concentrations exceeding the Act 307 Type B cleanup criteria.

The inorganics arsenic, chromium, lead, and nickel were detected in one or more Site 1 subsurface soil samples. However, no analyte was quantified at a concentration exceeding the Act 307 Type A default values.

3.2.4.3 Sediment Sampling Results

Four sediment samples P1D001, P1D002, P1D003, and P1D005 (P1D004 is a field duplicate of P1D002) were collected from the east bank of the Thunder Bay River where the river is located adjacent to Site 1. Analytical results are presented in Table 3-5. Samples were collected from locations upstream (P1D005) and downstream of the site.

Table 3-3 Data Summary Table: Surface Soil, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB10		SB11		SB12		SB13		SB20*		SB4	
Sample ID:		PC-P1-SB10-SS00-02		PC-P1-SB11-SS00-02		PC-P1-SB12-SS00-02		PC-P1-SB13-SS00-02		PC-P1-SB20-SS00-02		PC-P1-SB4-SS00-01	
Collection Date:		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93	
Sample Depth:		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft		0 ft-1 ft	
Associated Field QC Samples:		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER13	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,4-Dichlorobenzene	30 ppb	2	U	0.096	B	0.33	B	2	U	2.1	U	2	U
Styrene	24 ppb	1.6	U	0.024	B	0.054	B	1.7	U	1.7	U	1.6	U
HALOGENATED VOLATILES (8010)													
1,1,1-Trichloroethane	4000 ppb	2.7		0.89	B	0.48	B	3	U	0.36	B	0.26	B
Methylene Chloride	92 ppb	7.5		4.6	B	5		1.2	B	5.3	J	1.8	B
SEMI-VOLATILES (CLP 3/90)													
bis(2-Ethylhexyl)phthalate	92000 ppb	360	U	37		390	U	42	J	380	U	360	U
METALS (CLP 3/90)													
Arsenic	5800 ppb	440	UL	430	UL	550	()B	550	()	730	()B	430	U
Chromium[1]	18000 ppb	1100	UL	1100	UL	4400	L	3800		4400	L	1200	
Copper	20000 ppb	1700	U	1600	U	1800	U	1700	U	1800	U	1600	U
Lead	21000 ppb	410	K	440	K	3000	J	2500		3000	K	900	
Nickel	32000 ppb	3900	UL	3800	UL	4200	UL	3900	U	4200	()L	3800	U
Silver	1000 ppb	520	()	430	U	480	U	440	U	470	U	430	U
Total Petroleum Hydrocarbons	ppb	6300	BRL	6300	BRL	6300	BRL	23900		10400		9600	

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-P1-SB4-SS00-01
LAB: COMPUCHEM

[1]If Cr^{+6} was detected, it is listed as Cr^{+6}, otherwise the value listed is for total chromium.

Table 3-3 Data Summary Table: Surface Soil, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB5		SB6		SB7		SB8		SB9	
Sample ID:		PC-P1-SB5-SS00-02		PC-P1-SB6-SS00-02		PC-P1-SB7-SS00-02		PC-P1-SB8-SS00-02		PC-P1-SB9-SS00-02	
Collection Date:		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93	
Sample Depth:		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft	
Associated Field QC Samples:		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER15	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)											
1,4-Dichlorobenzene	30 ppb	1.9	U	0.11	U	2.2	UJ	0.17	U	0.017	
Styrene	24 ppb	1.5	U	1.6	U	1.8	UJ	0.045		1.6	U
HALOGENATED VOLATILES (8010)											
1,1,1-Trichloroethane	4000 ppb	2.8	UJ	0.053	B	0.48	B	0.13	B	2.9	U
Methylene Chloride	92 ppb	4.9	B	5.9	B	9.3	J	7	U	4.4	B
SEMI-VOLATILES (CLP 3/90)											
bis(2-Ethylhexyl)phthalate	92000 ppb	340	U	350	U	400	U	400	U	350	U
METALS (CLP 3/90)											
Arsenic	5800 ppb	410	U	430	U	480	U	660	()K	600	()
Chromium[1]	18000 ppb	2900		1100	U	1200	U	13300		5800	
Copper	32000 ppb	1500	U	1600	U	1800	U	10500		2200	()
Lead	21000 ppb	1300		410		1300		7100		2600	L
Nickel	20000 ppb	3600	U	3800	U	4200	U	12200		4500	
Silver	1000 ppb	410	U	430	U	480	U	480	U	430	U
Total Petroleum Hydrocarbons	ppb	6300	BRL	6300	BRL	9500		20100		17400	

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

[1]If Cr^{+6} was detected, it is listed as Cr^{+6}, otherwise the value listed is for total chromium.

Table 3-4 Data Summary Table: Subsurface Soil, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB10		SB11		SB13		SB4		SB5		SB6	
Sample ID:		PC-P1-SB10-SS03-04		PC-P1-SB11-SS03-04		PC-P1-SB13-SS03-04		PC-P1-SB4-SS02-03		PC-P1-SB5-SS03-04		PC-P1-SB6-SS03-04	
Collection Date:		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93	
Sample Depth:		3 ft-4 ft		3 ft-4 ft		3 ft-4 ft		2 ft-3 ft		3 ft-4 ft		3 ft-4 ft	
Associated Field QC Samples:		FB04,FB05,TB15,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER15		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	12000 ppb	1.6	U	1.6	U	1.8	U	1.7	U	1.5	U	3.8	J
1,4-Dichlorobenzene	30 ppb	2.1	U	2.1	U	2.2	U	2.1	U	0.65	B	2.1	U
Styrene	24 ppb	1.7	U	1.7	U	1.9	U	1.8	U	1.6	U	1.7	U
HALOGENATED VOLATILES (8010)													
1,1,1-Trichloroethane	4000 ppb	2.2		1.4		0.29	B	0.3	B	0.26	B	0.22	B
Methylene Chloride	92 ppb	10		8.7		4.7	J	5.4	B	2.5	B	5.1	J
METALS (CLP 3/90)													
Arsenic	5800 ppb	460	UL	870	()B	500	UL	470	U	440	U	470	U
Chromium[1]	18000 ppb	2100	L	3700	L	3700	L	2900		2700		1400	
Lead	21000 ppb	980	K	2300	J	1900	K	1600		1300		940	
Nickel	20000 ppb	4000	UL	4100	()L	4700	()L	4100	U	3800	U	4100	U
Total Petroleum Hydrocarbons	ppb	9500		6300	BRL	47400		12400		29700		6300	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]If Cr^{+6} was detected, it is listed as Cr^{+6}, otherwise the value listed is for total chromium.

Table 3-4 Data Summary Table: Subsurface Soil, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB7		SB8		SB9	
Sample ID:		PC-P1-SB7-SS03-04		PC-P1-SB8-SS03-04		PC-P1-SB9-SS03-04	
Collection Date:		24-AUG-93		24-AUG-93		24-AUG-93	
Sample Depth:		3 ft-4 ft		3 ft-4 ft		3 ft-4 ft	
Associated Field QC Samples:		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER13		FB04,FB05,TB16,ER15	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)							
1,2-Dichlorobenzene	12000 ppb	1.7	U	1.7	U	0.079	
1,4-Dichlorobenzene	30 ppb	0.06		2.1	U	0.47	U
Styrene	24 ppb	0.022		1.8	U	1.7	U
HALOGENATED VOLATILES (8010)							
1,1,1-Trichloroethane	4000 ppb	0.11	B	0.33	B	0.09	B
Methylene Chloride	92 ppb	5.8	B	7.7	U	3.9	B
METALS (CLP 3/90)							
Arsenic	5800 ppb	510	()	480	U	710	()
Chromium	18000 ppb	3500		1300		4700	
Lead	21000 ppb	1900		1000		3000	
Nickel	20000 ppb	4200	U	4200	U	4000	U
Total Petroleum Hydrocarbons	ppb	9700		14300		32500	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-5 Data Summary Table: Sediment, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD001		SD002		SD003		SD004*		SD005	
Sample ID:		PC-P1-SD001		PC-P1-SD002		PC-P1-SD003		PC-P1-SD004		PC-P1-SD005	
Collection Date:		13-SEP-93		13-SEP-93		13-SEP-93		13-SEP-93		13-SEP-93	
Associated Field QC:		FB07,TB25,ER19		FB07,TB25,ER19		FB07,TB25,ER19		FB07,TB25,ER19		FB07,TB25,ER19	
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
HALOGENATED VOLATILES (8010)											
1,1,1-Trichloroethane	ppb	3.5	U	3.1	U	3.5	U	2.7		3.3	
METALS (CLP 3/90)											
Arsenic	ppb	3000	J	8500	J	960	(J	3100	J	3400	J
Chromium	ppb	4000	J	3300	J	2800	J	3700	J	14700	J
Copper	ppb	2300	(J	4300	J	1900	U	6300	J	24000	J
Lead	ppb	2300	L	3900	L	1200	L	2300	L	4000	L
Nickel	ppb	4500	U	4000	U	4600	(	4300	U	11700	
Zinc	ppb	15700		12300		15300		19600		30300	
Total Petroleum Hydrocarbons	ppb	43900		84300		133000		41100		94800	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-P1-SD002
LAB: COMPUCHEM
No Act 307 criteria available for sediments.
(1)If Cr^{+6} was detected, it is listed as Cr^{+6}, otherwise the value listed is for total chromium.

Table 3-6 Data Summary Table: Groundwater, Site 1 - POL Area
MAING, Alpena CRTC, Alpena, Michigan

Locator:		MW1		MW11		MW12		MW13		MW14		MW2	
Sample ID:		PC-P1-MW1-GW4		PC-P1-MW11-GW4		PC-P1-MW12-GW4		PC-P1-MW13-GW4		PC-P1-MW14-GW4		PC-P1-MW2-GW4	
Collection Date:		15-SEP-93		14-SEP-93		14-SEP-93		14-SEP-93		15-SEP-93		09-SEP-93	
Associated Field QC:		FB07,TB27		FB07,TB26		FB07,TB26		FB07,TB26		FB07,TB27		FB07,TB23	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	600 ppb	0.15	U	0.15	U	0.15	U	0.15	U	0.15	U	0.3	B
1,2-Dimethylbenzene	13000 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichlorobenzene	600 ppb	0.74	J	0.2	U	0.2	U	0.14	B	0.2	U	0.13	B
1,3-Dimethylbenzene	13000 ppb	2.8		-		-		-		0.19		-	
1,4-Dichlorobenzene	1.5 ppb	0.15	U	0.15	U	0.28	B	0.66	B	0.15	U	0.47	B
Benzene	1.2 ppb	13		0.6		0.35	U	0.35	U	0.11		0.35	U
Chlorobenzene	130 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Ethylbenzene	74 ppb	5.9		0.2	U	0.2	U	0.2	U	0.22	B	0.2	U
Methyl-t-butyl ether	230 ppb	5	U	5	U	5	U	5	U	5	U	5	U
Styrene	1.2 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Toluene	790 ppb	0.14		0.25	U	0.15	B	0.22	B	0.2		0.25	U
HALOGENATED VOLATILES (8010)													
1,1,1-Trichloroethane	200 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Bromodichloromethane	0.56 ppb	0.4	U	0.4	U	0.4	U	0.4	U	0.63		0.4	U
Chloroform	5.6 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.68	J	0.35	U
Dibromochloromethane	0.42 ppb	0.3	U	0.3	U	0.3	U	0.3	U	1.9		0.3	U
Methylene Chloride	4.6 ppb	0.42	B	0.34	B	0.15	B	0.12	B	0.21	B	0.36	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-6 Data Summary Table: Groundwater, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			MW1		MW11		MW12		MW13		MW14		MW2	
Sample ID:			PC-P1-MW1-GW4		PC-P1-MW11-GW4		PC-P1-MW12-GW4		PC-P1-MW13-GW4		PC-P1-MW14-GW4		PC-P1-MW2-GW4	
Collection Date:			15-SEP-93		14-SEP-93		14-SEP-93		14-SEP-93		15-SEP-93		09-SEP-93	
Associated Field QC:			FB07,TB27		FB07,TB26		FB07,TB26		FB07,TB26		FB07,TB27		FB07,TB23	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
SEMI-VOLATILES (CLP 3/90)														
2,4-Dimethylphenol	350	ppb	0.6	J	5	U	5	U	5	U	5	U	5	U
2-Methylnaphthalene		ppb	5	U	5	U	5	U	5	U	5	U	5	U
Acenaphthene	1200	ppb	5	U	5	U	5	U	5	U	5	U	5	U
Dibenzofuran		ppb	5	U	5	U	5	U	5	U	5	U	5	U
Fluorene	840	ppb	5	U	5	U	5	U	5	U	5	U	5	U
Naphthalene	250	ppb	5	U	5	U	5	U	5	U	5	U	5	U
Phenol	4200	ppb	5	U	0.5	B	5	U	1		2	B	5	U
METALS (CLP 3/90)[1]														
Antimony, Dissolved[2]	2.4	ppb	35	U	39.2	()	35	U	35	U	35	U	35	U
Arsenic		ppb	7.7	()K	12.6		9.5	()K	10.9	K	4	U	4	U
Beryllium		ppb	4	U	4	U	4	U	4	U	4	U	1	U
Cadmium		ppb	5	U	5	U	5	U	5	U	5	U	3	U
Chromium		ppb	38		62.2		50.1		43.9		10	U	9.9	
Copper		ppb	88.9		31.1		15	U	35.6		15	U	5.1	
Copper, Dissolved	1000	ppb	4	U	4	U	4	U	4	U	4	U	6.3	()
Lead		ppb	34.3		20.5		12.7		19.3		2	U	2	U
Mercury		ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel		ppb	35	U	50.9		38.3	()	35	U	35	U	18	U
Selenium, Dissolved	35	ppb		R		R		R	4.9	()J		R	3	U
Zinc		ppb	64.5	J	99.5	J	89.2	J	67.1	J	7.5	()J	12.9	()J
Zinc, Dissolved	2300	ppb	4	U	4	U	4	U	4	U	4	U	25	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]Criteria are presented for dissolved metals only.
[2]Local background mean concentration is 16.90 ppb.

Table 3-6 Data Summary Table: Groundwater, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

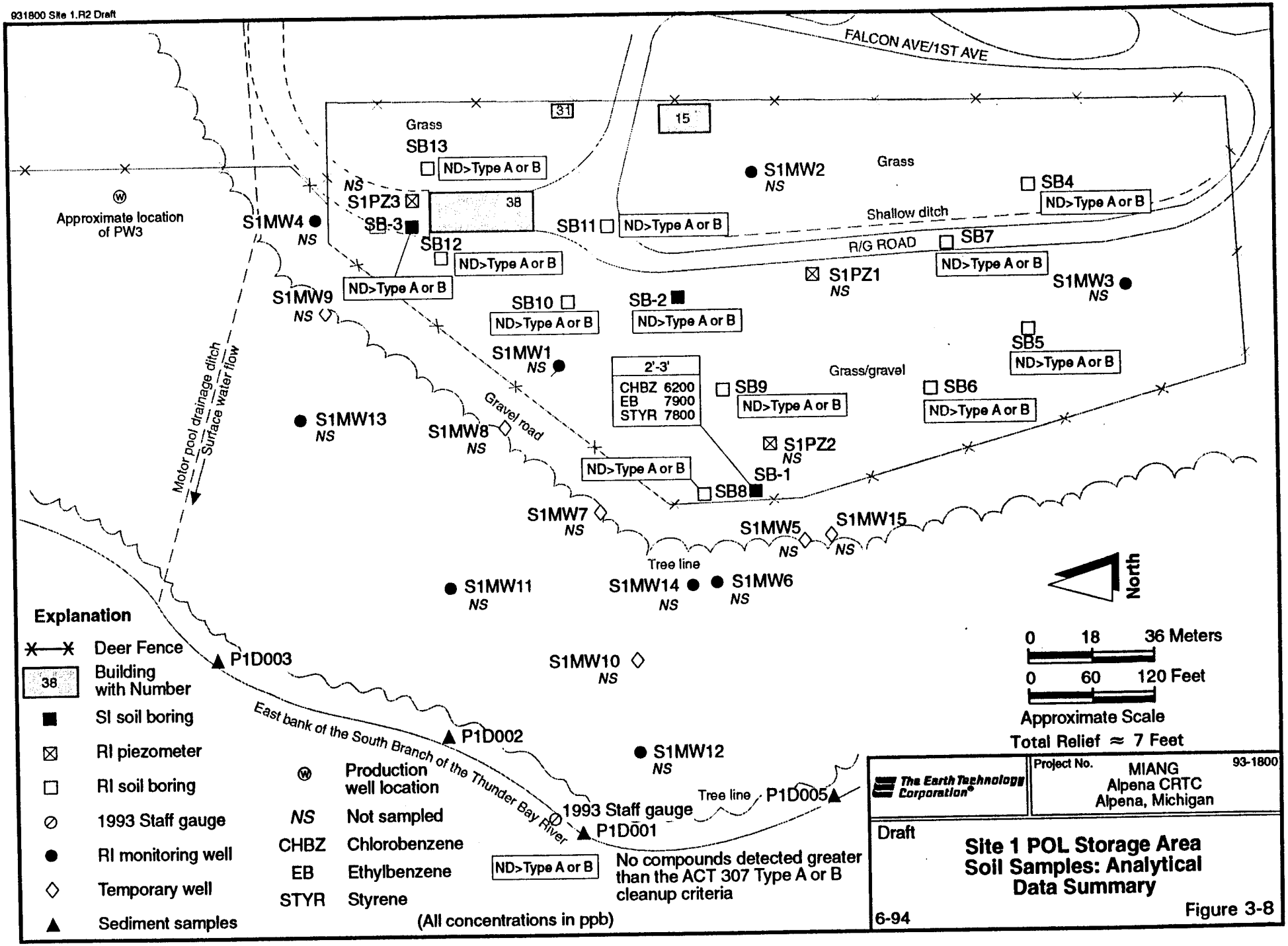
Locator:		MW3		MW4		MW6		MW3*	
Sample ID:		PC-P1-MW3-GW4		PC-P1-MW4-GW4		PC-P1-MW6-GW4		PC-FF7-MW3-GW4	
Collection Date:		10-SEP-93		10-SEP-93		15-SEP-93		15-SEP-93	
Associated Field QC:		FB07,TB24		FB07,TB24		FB07,TB28,ER21		FB07,TB28,ER21	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)									
1,2-Dichlorobenzene	600 ppb	0.75	B	0.19	B	8.5	J	0.15	U
1,2-Dimethylbenzene	13000 ppb	0.2	U	0.2	U	5.8	J	0.2	U
1,3-Dichlorobenzene	600 ppb	0.21	B	0.23	B	2.5		0.2	U
1,3-Dimethylbenzene	13000 ppb	-		-		61		0.087	
1,4-Dichlorobenzene	1.5 ppb	0.35	B	0.68	B	25			
Benzene	1.2 ppb	0.09		0.35	U	10		0.095	
Chlorobenzene	130 ppb	0.25	U	0.25	U	0.68		0.25	U
Ethylbenzene	74 ppb	0.2	U	0.12		56		0.2	U
Methyl-t-butyl ether	230 ppb	5	U	5	U	2.1	J	5	U
Styrene	1.2 ppb	0.25	U	0.25	U	8.5	J	0.25	U
Toluene	790 ppb	0.25	U	0.11	B	0.29	J	0.21	
HALOGENATED VOLATILES (8010)									
1,1,1-Trichloroethane	200 ppb	0.35	U	0.35	U	0.14		0.35	U
Bromodichloromethane	0.56 ppb	0.4	U	0.4	U	0.4	U	0.92	
Chloroform	5.6 ppb	0.17		0.35	U	0.14		0.75	J
Dibromochloromethane	0.42 ppb	0.3	U	0.3	U	0.3	U	2.3	
Methylene Chloride	4.6 ppb	0.42		0.37	B	0.4	B	0.24	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
* duplicate of PC-P1-MW14-GW4
[1]Criteria are presented for dissolved metals only.
[2]Local background mean concentration is 16.90 ppb.

Table 3-6 Data Summary Table: Groundwater, Site 1 - POL Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW3		MW4		MW6		MW3*	
Sample ID:		PC-P1-MW3-GW4		PC-P1-MW4-GW4		PC-P1-MW6-GW4		PC-FF7-MW3-GW4	
Collection Date:		10-SEP-93		10-SEP-93		15-SEP-93		15-SEP-93	
Associated Field QC:		FB07,TB24		FB07,TB24		FB07,TB28,ER21		FB07,TB28,ER21	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
SEMI-VOLATILES (CLP 3/90)									
2,4-Dimethylphenol	350 ppb	5	U	5	U	2	J	5	U
2-Methylnaphthalene	ppb	5	U	5	U	4		5	U
Acenaphthene	1200 ppb	5	U	5	U	3		5	U
Dibenzofuran	ppb	5	U	5	U	1		5	U
Fluorene	840 ppb	5	U	5	U	1		5	U
Naphthalene	250 ppb	5	U	5	U	12		5	U
Phenol	4200 ppb	5	U	5	U	5	U	5	U
METALS (CLP 3/90)[1]									
Antimony, Dissolved[2]	2.4 ppb	35	U	35	U	39.2	()	35	U
Arsenic	ppb	4	U	10.9	J	28.6	L	4	U
Beryllium	ppb	1	U	3.1		4	UL	4	U
Cadmium	ppb	3	U	5.7		5	UL	5	U
Chromium	ppb	8	U	96.2		119	L	10	U
Copper	ppb	5.7	()B	67.9		84.4	L	15	U
Copper, Dissolved	1000 ppb	4	U	5.1	()	4	U	4	U
Lead	ppb	2	U	31.2		60.3	L	2	U
Mercury	ppb	0.2	U	0.2	U	0.37	L	0.2	U
Nickel	ppb	18	U	69		93.5	L	35	U
Selenium, Dissolved	35 ppb	3	U	3	UL		R		R
Zinc	ppb	12.6	()B	131	J	147	J	11.7	()J
Zinc, Dissolved	2300 ppb	10.3	()	15.9	()	4	U	6	()

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
* duplicate of PC-P1-MW14-GW4
[1]Criteria are presented for dissolved metals only.
[2]Local background mean concentration is 16.90 ppb.



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Site 1 POL Storage Area Soil Samples: Analytical Data Summary

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Figure 3-8

1,1,1-TCA was detected from samples P1D004 and P1D005 at concentrations of 2.7 and 3.3 µg/kg, respectively. The inorganics arsenic, chromium, copper, lead, nickel, and zinc were detected in the sediment. Analytical results from P1D005 represent upstream or background concentrations of inorganics in the sediments. A comparison of the remaining samples to the upstream concentrations of inorganics found in P1D005 is presented in the following:

Analyte#	# of detections/ # of Samples	Range of Concentrations	P1D005 (mg/kg) Concentration
Arsenic	4/4	0.96 - 8.5	3.4
Chromium	4/4	2.8 - 3.7	14.7
Copper	3/4	2.3 - 6.3	24
Nickel	1/4	4.6	11.7
Zinc	4/4	12.3 - 19.6	30.3

As shown in this table only arsenic in Sample P1D002 exceeds the concentration detected in the upstream sample. These data suggest that past fuel handling activities at Site 1 have not resulted in elevated levels of inorganics in the sediments of the Thunder Bay River. Additionally, no other IRP Site exist upstream of Site 1 to impact the levels detected in the upstream sample (PID005) or the downstream samples.

3.2.4.4 Groundwater Sampling Results

Groundwater sampling analytical laboratory results are presented in Table 3-6.

Organic Compounds

A review of Table 3-6 indicates that 24 individual VOCs or SVOCs were detected in the groundwater samples collected from the nine wells installed at Site 1 (Figure 3-9). Organic compounds such as BTEX and PAHs likely associated with past fuel spills were detected in wells S1MW1, S1MW3, S1MW4, S1MW6, and S1MW11, (all completed in the perched aquifer) and in S1MW14 (completed in the lower zone of the unconfined, shallow aquifer). The distribution of these compounds exceeding Act 307 Type B cleanup criteria in the perched zone are limited to wells S1MW1 and S1MW6 which were installed down gradient of two of the three suspected source areas. Compounds detected above Act 307 Type B cleanup criteria are highlighted on this figure and include benzene, styrene, dibenzofuran, 1,4-dichlorobenzene, bromodichloromethane and dibromochloromethane. Results obtained from the perimeter wells (S1MW2 through S1MW4, S1MW11 through S1MW13) suggest the extent of groundwater contamination in the perched zone has been delineated.

To prevent cross-contamination of the lower portion of the shallow aquifer by contaminated groundwater from the perched zone, well S1MW14 was installed using

double casing. Surface casing was installed to a depth of 4.6 m (15 ft) bgs in this well. The surface casing prevents water from the perched zone from entering the well. S1MW14 was then completed through the casing into the lower sand zone of the shallow aquifer. Groundwater samples collected from S1MW14 contain dibromochloromethane and bromodichloromethane in concentrations exceeding the Type B criteria. These compounds are not commonly detected in fuels, and were not found in the groundwater analyses of the perched aquifer. Trace concentrations of benzene, toluene, and xylenes were also quantified in S1MW14. (These compounds were detected in the perched aquifer and suggest the clay layer separating the perched zone from the lower unconfined zone of the shallow aquifer may not be totally prohibiting the migration of contaminants vertically beneath the site.)

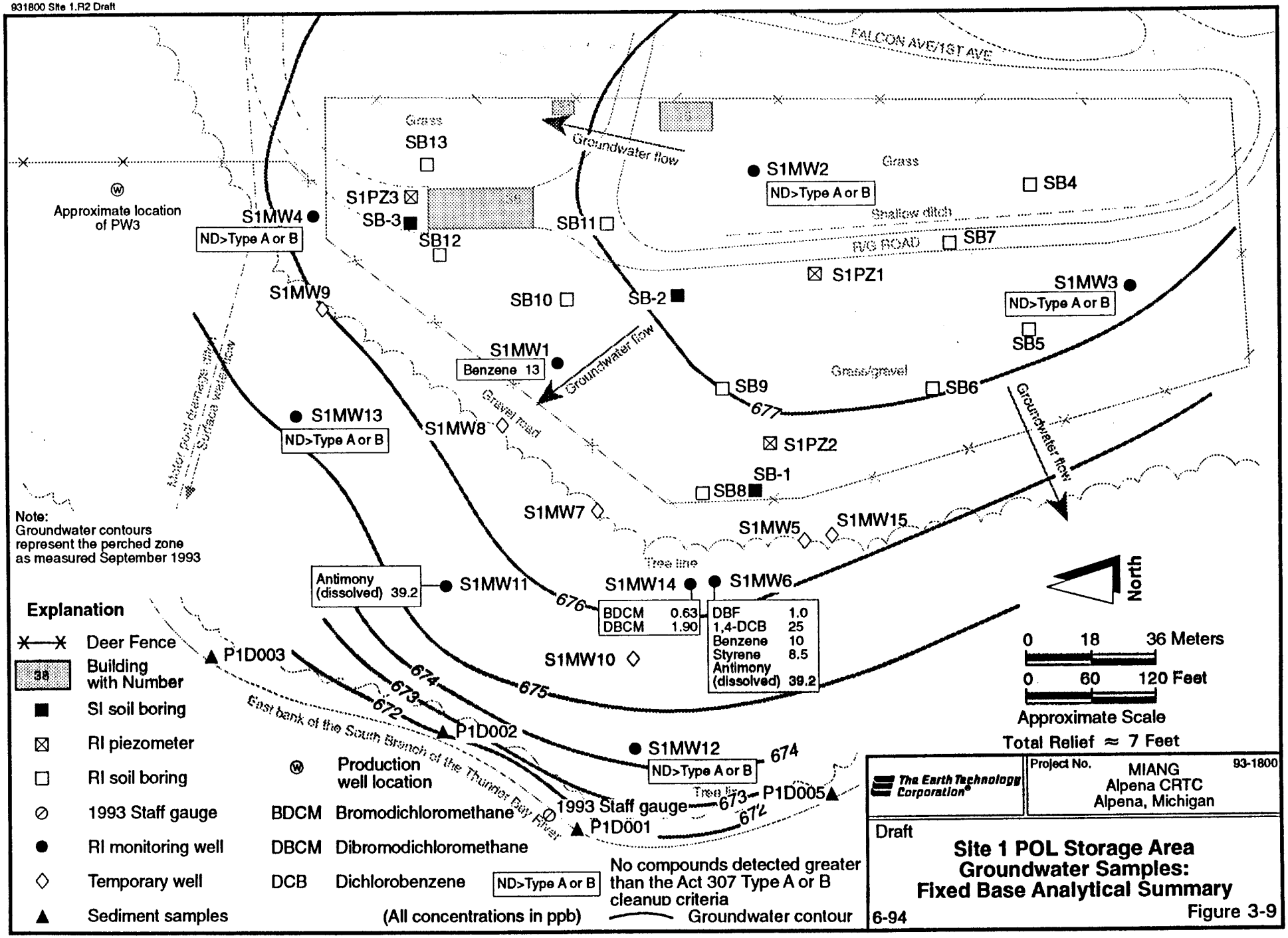
The on-site GC data for BTEX and total VOCs agree well with the results of the fixed base laboratory data. Occurrences of VOCs detected in the fixed base laboratory data (Figure 3-9) compare favorably in overall distribution to the on-site GC screening data presented in Section 3.2.2. However, the DCE, PCE and TCE detected in relatively high concentrations in the on-site GC data were not confirmed by the fixed base analytical data.

Inorganic Compounds

The inorganic analytical results for the filtered and unfiltered groundwater samples collected from Site 1 monitoring wells are presented in Table 3-6. A review of Table 3-6 indicates eleven individual inorganics were quantified and that a majority of the positive detections were found in the unfiltered samples. Only antimony (2 detections), copper (2 detections), selenium (1 detection) and zinc (2 detections) were quantified in the filtered samples. Inorganics were detected in concentrations exceeding Act 307 Type A cleanup criteria in the unfiltered samples from S1MW1, S1MW4, S1MW6, S1MW11, S1MW12, and S1MW13. However, these unfiltered samples were generally turbid and could likely not be used, as collected, for domestic purposes. Analytical results from the corresponding filtered samples from these wells all show the filtering process reduced concentrations to less than the Act 307 Type A cleanup criteria in all but two of the samples. Antimony was detected in two filtered samples in concentrations above Act 307 Type A cleanup criteria and in concentrations greater than the unfiltered samples. The concentrations of dissolved (filtered) inorganics exceeding Act 307 Type A cleanup criteria are included in Figure 3-9.

3.2.5 Summary and Conclusions

Petroleum-based fuels have been released into the subsurface environment from the aboveground storage tanks, fuels off-loading area and the dispensers previously located at Site 1. The following summarizes the results of the investigations conducted to date:



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Site 1 POL Storage Area
Groundwater Samples:
Fixed Base Analytical Summary

6-94

Figure 3-9

- Soils at Site 1 are predominant composed of quartz sand. An intermediate depth clay layer occurs at depths between approximately 10 and 20 ft bgs separating the shallow aquifer into a perched zone and a lower unconfined zone. No clay unit was observed at location S1MW1 directly overlying the limestone bedrock.

- Surface and subsurface soil samples collected from Site 1 are relatively free of chemicals of concern exceeding Act 307 Type B cleanup criteria. Soil samples from the 2 to 3 ft depth in S1SB1 contain chlorobenzene, ethylbenzene and styrene at concentrations exceeding Act 307 Type B cleanup criteria. These soils were collected in the west central portion of Site 1 in an area where several aboveground jet fuel storage tanks once stood. Additional soil samples are required to verify the extent of contamination in this area. No inorganics were detected in any soil samples in concentrations exceeding Act 307 Type A default values.

- Sampling results do not indicate that past fuel-handling activities at Site 1 have had an adverse impact on sediment quality in the Thunder Bay River.

- Free-phase hydrocarbons (i.e. JP-4) were not detected floating on top of the groundwater in the three piezometers installed within the suspected source areas at Site 1. However, VOCs, probably originating from petroleum-based fuels, were detected in both the perched and lower sand layers of the shallow aquifer. VOCs, particularly benzene, have been detected in concentrations exceeding Act 307 Type B cleanup criteria in the groundwater samples collected and analyzed from the perched zone of the shallow aquifer. The analytical data obtained from S1MW14 indicate that some vertical migration of VOCs through the clay layer has occurred. Sampling data collected during the RI indicate that the lower zone of the shallow aquifer does not contain organic compounds exceeding Act 307 Type B cleanup criteria that have likely originated from Site 1, but does contain bromodichloromethane and dibromochloromethane in concentrations exceeding Act 307 Type B cleanup criteria.

3.3 SITE 2 – MOTOR POOL AREA

The results for some of the field activities completed at Site 2 are contained in separate, stand-alone documents and will not be fully reproduced in this RI report. In chronological order these field events are:

- Surface geophysical (Electromagnetic Induction (EMI) and resistivity) surveys at Site 2 were conducted during September and October 1992 and are presented in the Final Draft Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, April 1993). The results of the geophysical survey are summarized in the Site 2 geology and hydrogeology discussions.

- Soil gas and groundwater screening data were collected for Site 2 in January 1993 and have been compiled and presented in the Internal Draft Soil Gas Survey and Groundwater Screening: Phase I of RI) (The Earth Technology Corporation, October 1993). Summary diagrams and data tables from this document are included in this RI report.

- Soil boring, monitoring well installation and aquifer testing, and soil and groundwater sampling and analysis comprised the remainder of the RI field activities at Site 2. These activities were conducted during the August and September 1993 RI field activities.

3.3.1 Results of Previous Investigations

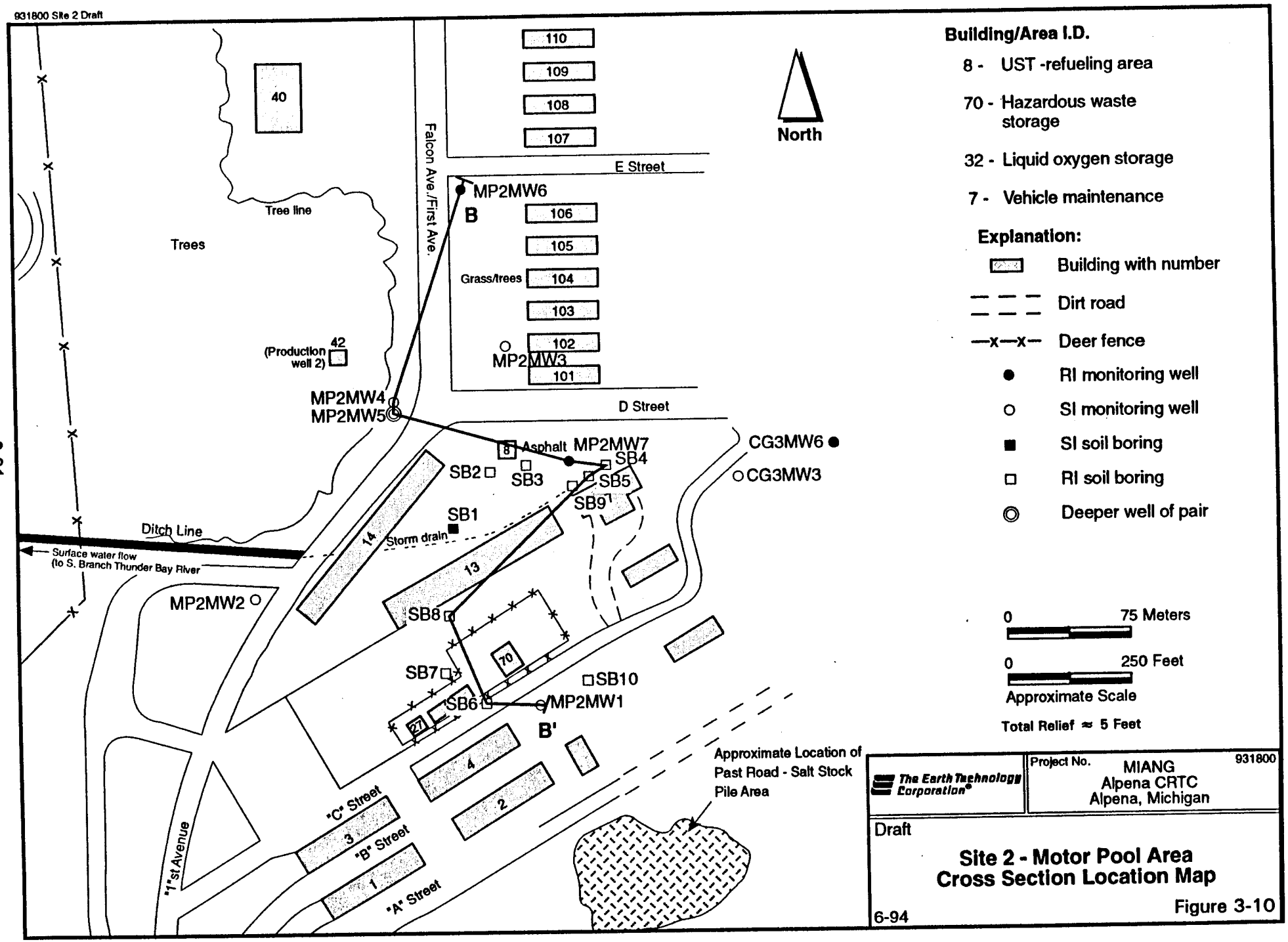
The results of the PA (Hazardous Materials Training Center, 1985) and SI (Engineering-Science, 1989) for Site 2 indicated several areas within the boundaries of Site 2 that required further investigations. Soils analyzed during the SI detected TPH in MP2MW1 at a concentration of 140 mg/kg. Soils in the drainage ditch running from the Motor Pool to the Thunder Bay River were recommended for a removal action. The SRAP (The Earth Technology Corporation, May 1994) addresses these soils. TPH was also detected at 460 mg/ℓ from MP2MW4 during the November 1987 round of groundwater sampling. Groundwater samples from MP2MW4 contained TPH at a concentration of 1.1 mg/ℓ during the August 1988 (Round II) and TPH below the detection limit in the October 1991 (Round III) sampling events. In addition, one of two soil borings drilled and sampled at IRP Site 11, located on the northeast corner of Building 7, contained TPH at a concentration of 130 mg/kg (The Earth Technology Corporation, November 1993).

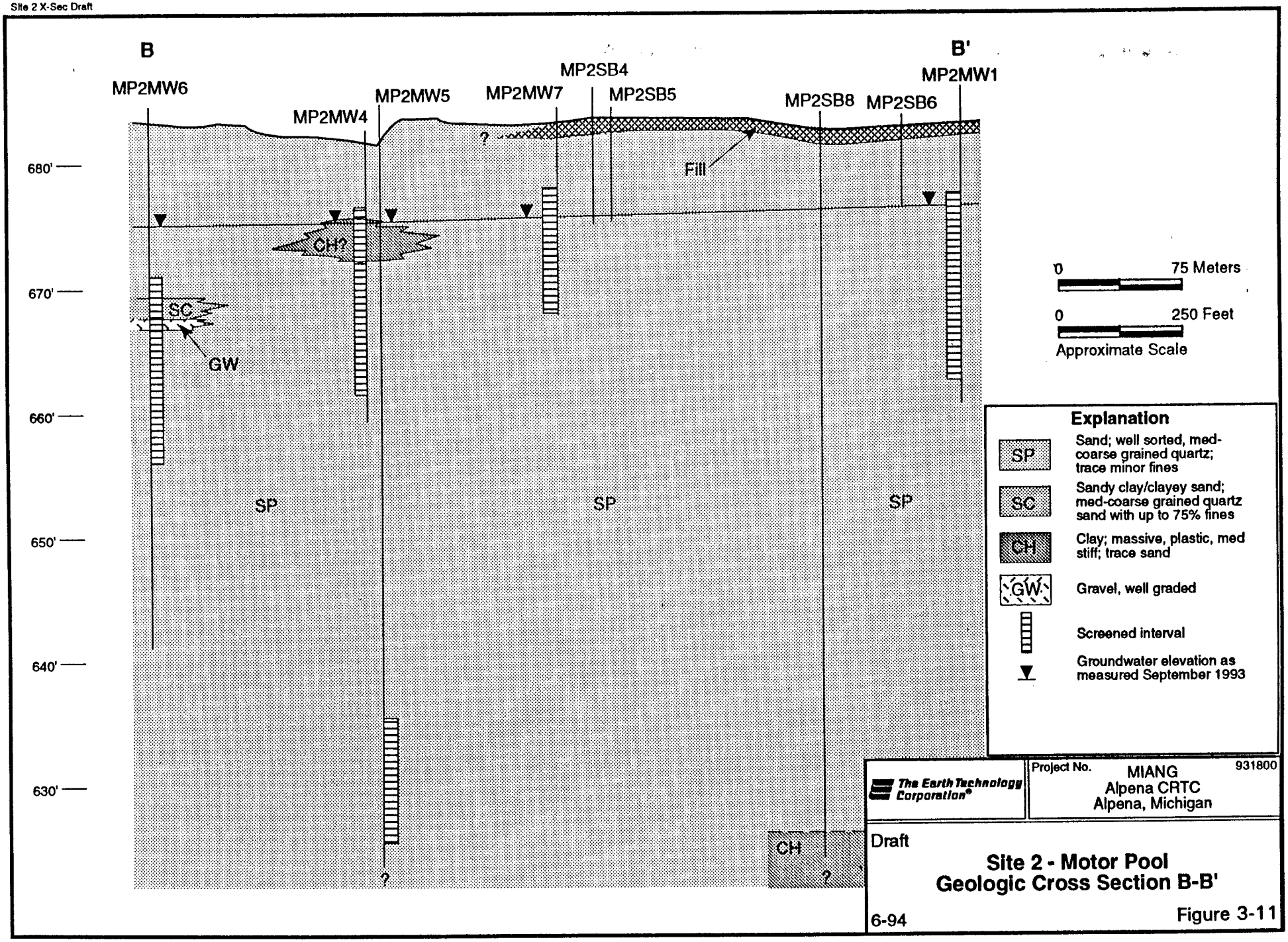
3.3.2 Site Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A site map illustrating sampling locations and the location of a cross-section constructed at Site 2 is presented in Figure 3-10. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.3.2.1 Geology

As presented in Figure 3-11, the subsurface materials underlying the Motor Pool Area consist mainly of massive, poorly-graded (well sorted) medium- to coarse-grained quartz sands containing trace to minor amounts of silt and clay. Beneath the sand layer (approximately


931800 Site 2 Draft
110
109
108
107
E Street
40
Tree line
Trees
Falcon Ave./First Ave.
MP2MW6
B
106
105
Grass/trees
104
103
102
MP2MW3
101
(Production well 2) 42
MP2MW4
MP2MW5
D Street
8
Asphalt
MP2MW7
SB4
SB2
SB3
SB5
SB9
SB1
Storm drain
CG3MW6
CG3MW3
Ditch Line
Surface water flow (to S. Branch Thunder Bay River
14
13
MP2MW2
SB8
70
SB7
SB10
SB6
MP2MW1
27
B'
4
2
3
1
"C" Street
"B" Street
"A" Street
"1"st Avenue
Approximate Location of Past Road - Salt Stock Pile Area
North
Building/Area I.D.
8 - UST -refueling area
70 - Hazardous waste storage
32 - Liquid oxygen storage
7 - Vehicle maintenance
Explanation:
Building with number
Dirt road
Deer fence
RI monitoring well
SI monitoring well
SI soil boring
RI soil boring
Deeper well of pair
0 75 Meters
0 250 Feet
Approximate Scale
Total Relief ≈ 5 Feet
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Site 2 - Motor Pool Area
Cross Section Location Map
6-94
Figure 3-10


B
B'
MP2MW6
MP2MW4
MP2MW5
MP2MW7
MP2SB4
MP2SB5
MP2SB8
MP2SB6
MP2MW1
680'
670'
660'
650'
640'
630'
CH?
SC
GW
Fill
SP
SP
SP
CH
?
?
0
75 Meters
0
250 Feet
Approximate Scale
Explanation
SP
Sand; well sorted, med-coarse grained quartz; trace minor fines
SC
Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
CH
Clay; massive, plastic, med stiff; trace sand
GW
Gravel, well graded
Screened interval
Groundwater elevation as measured September 1993
The Earth Technology Corporation
Project No.
931800
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Alpena CRTC
Alpena, Michigan
Draft
Site 2 - Motor Pool
Geologic Cross Section B-B'
6-94
Figure 3-11

17 m [55 ft] below grade) the sediments become clay-rich. A massive, medium-stiff, plastic clay was described in MP2SB8 at 17 m (55 ft) below grade. A sample of this clay was collected and analyzed for geotechnical parameters (Appendix C). The measured vertical permeability for this clay is 1.2 x 10^{-7}cm/sec (3.4 X 10^{-4} ft/day). The thickness of the clay unit beneath Site 2 is unknown. However, based on observations made in MP2SB8 it is at least 0.9 m (3 ft) thick and of sufficient clay content to be considered a good quality aquitard.

Data obtained from the surface geophysical surveys were inconclusive across most of Site 2 because of cultural influences. The survey across the western portion of Site 2 (drainage ditch area) was interpreted to contain thick clay (up to 4.9 m [16 ft] thick) beneath the site.

3.3.2.2 Hydrogeology

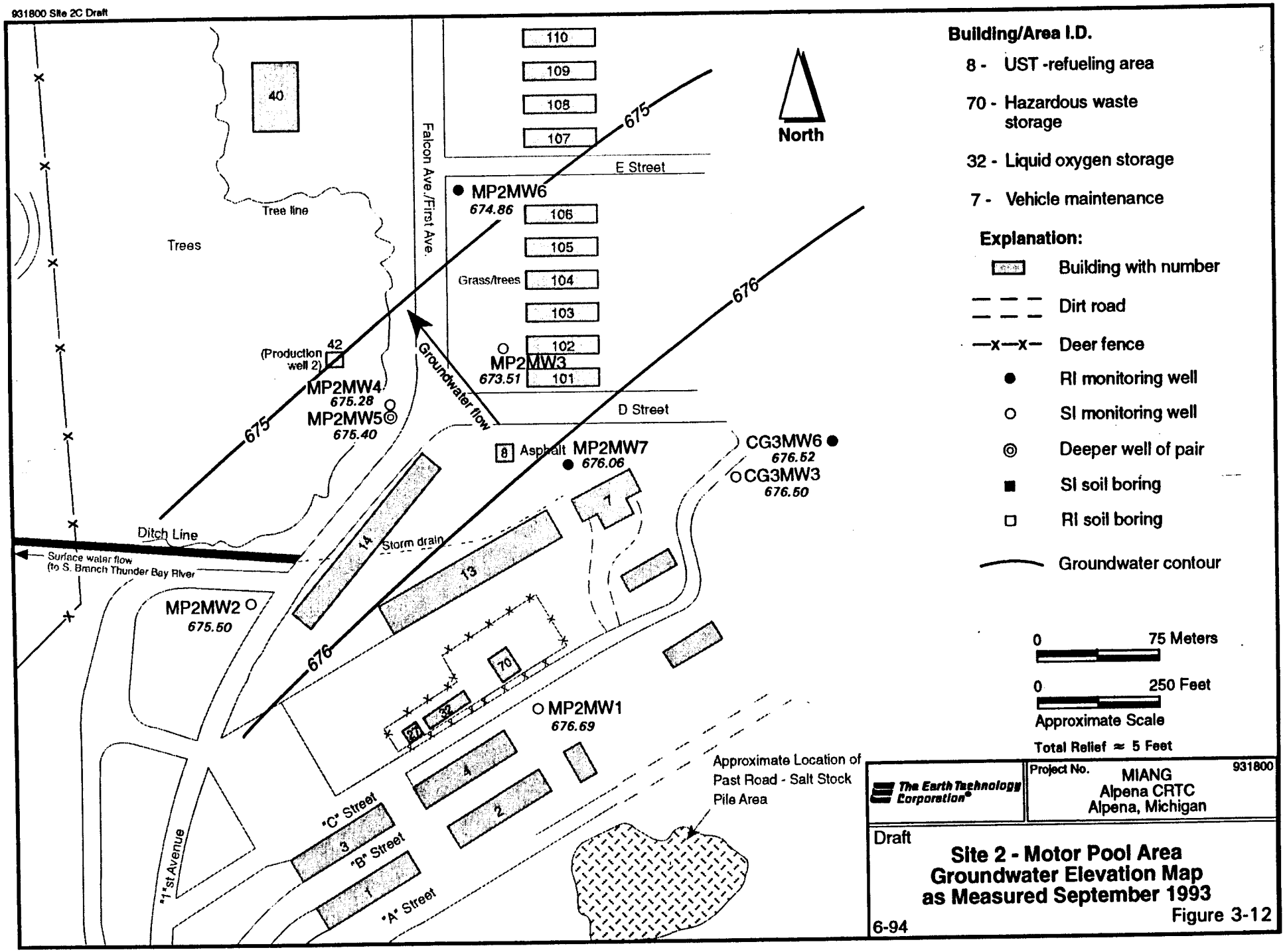
Seven shallow groundwater monitoring wells (MP2MW1 through MP2MW7) exist at Site 2. Wells MP2MW1 through MW5 were installed during the SI (Engineering-Science, 1990), while wells MP2MW6 and MW7 were installed during the RI field activities. Groundwater beneath Site 2 occurs within the surficial aquifer materials at depths ranging from 1.81 to 2.53 m (5.93 to 8.31 ft) bgs and at elevations ranging from 206.33 to 205.76 m (676.94 to 674.86 ft) above msl. As illustrated in Figures 1-19 through 1-21 and on Figure 3-12, flow within the surficial aquifer is directed towards the northwest at an average gradient of 0.002 ft/ft. Groundwater beneath Site 2 does not flow directly north towards the sinkhole. Instead, groundwater flows northwest suggesting a component of groundwater flow towards the Thunder Bay River. Monitoring well MP2MW6 was slug tested to provide an estimate of hydraulic conductivity in the surficial aquifer. These data were reduced using the methods of Bouwer and Rice (1976); Bouwer (1989) and yield a range of values from 5.07 X 10^{-3} cm/sec (14.4 ft/day) to 7.4 X 10^{-3} cm/sec (21 ft/day).

3.3.3 Screening Results and Boring and Well Placement Rationale

Initial site screening activities to support the RI were completed in January 1993. This consisted of the collection and on-site GC analysis of soil gas and groundwater grab samples. Based on the information presented in Section 3.3.1 and the results of the initial site screening activities, soil boring and monitoring well locations were then selected. The rationale used in selecting these locations is presented in Section 3.3.3.2. The on-site GC screening activities were conducted during the August and September 1993 drilling operations.

3.3.3.1 Initial Site Screening

A summary of the results of the initial site screening activities are presented in Figure 3-13. The complete results of this survey are included in Appendix D.



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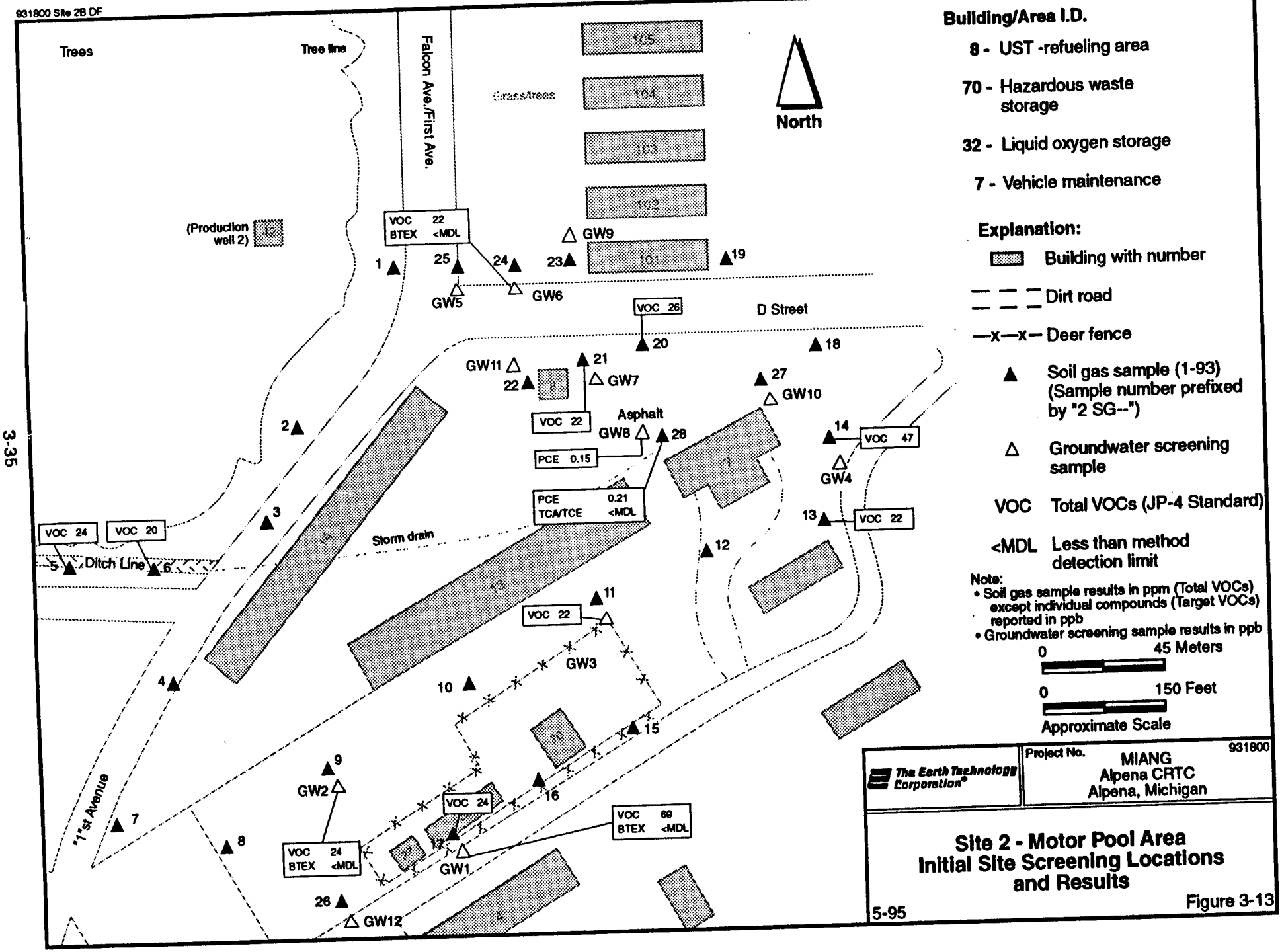
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Site 2 - Motor Pool Area
Groundwater Elevation Map
as Measured September 1993

Figure 3-12



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Site 2 - Motor Pool Area Initial Site Screening Locations and Results

5-95

Figure 3-13

Soil Organic Vapor

Thirty soil gas samples were collected from 28 locations (2SG-1 through 2SG-28) at Site 2. From 2 of these 28 locations (2SG-8 and -24) samples were collected at two distinct depths within the vadose zone to investigate whether vertical concentration gradients exist within the subsurface. No discernable gradients existed. A summary of the results follows:

- Target VOCs – Only one sample, 2SG-28, located north of Building 7 contained detectable amounts of the target VOCs. This sample contained 1,1,1-trichloroethane (TCA) at concentrations less than the method detection limit and TCE. PCE was also detected in this sample at a concentration of 0.21 ppb. No other target VOCs, including BTEX compounds, were detected during the sampling.

- Total VOCs (as JP-4) – Eight samples had detectable levels (greater than 20 ppm) of total VOCs. In all cases, however, concentrations were very low, ranging from 20 to 47 ppm. Sample 2SG-14 had the highest concentration of total VOCs. This sample is located east of Building 7 (Figure 3-13). Total VOCs were not detected in concentrations exceeding 22 ppm from any of the samples collected around the USTs at the refueling area.

Groundwater Samples

Thirteen groundwater samples were collected from twelve locations (2GW-1 through 2GW-12) within Site 2. Groundwater samples were collected from two depths, 2.7 to 3.6 m (9 to 12 ft) and 5.5 to 6.4 m (18 to 21 ft) at location 2GW-6. Concentrations of BTEX compounds less than the MDL (50 $\mu g/\ell$) were detected in the deeper sample that were not detected in the shallower sample. The results of the groundwater analyses are presented below:

- Target VOCs: Concentrations of BTEX compounds less than the MDL (50 $\mu g/\ell$) were detected in samples 2GW-1, -2, and -6 (2.7- to 3.6-meter [18- to 21-ft]) sample only. Additionally, 3 samples, 2GW-7, -8, and -9 contained very low concentrations (0.15 ppb or less) of PCE.

- Total VOCs (as JP-4): Seven samples contained total VOCs above the detection level of 22 $\mu g/\ell$. Sample 2GW-1 collected from near the liquid oxygen storage area contained the highest concentration, 69 $\mu g/\ell$, of total VOCs.

The distribution of target compounds in the subsurface is limited to two portions of the study area. Concentrations of BTEX less than the MDL (5 ppb) were detected in two samples, 2GW1 and 2GW2 northwest of MP2MW1, while relatively low concentrations of PCE and TCA/TCE were detected immediately northwest of Building 7 in 2SG28 and 2GW8. Total VOCs were detected in 11 samples at concentrations ranging from 20 to 67 $\mu g/\ell$. The highest concentration of total VOCs was observed in 2GW1 immediately northwest of MP2MW1.

3.3.3.2 Soil Boring and Monitoring Well Placement Rationale

Soil borings SB2 through SB10 were drilled and sampled within the suspected potential source areas at Site 2 (Building 7 and the USTs) and in locations where additional data were required to fill data gaps identified in Section 3.3.1. Monitoring well location MP2MW6 was selected based on preliminary groundwater modeling which traced the migration of a dissolved phase hydrocarbon plume (detected during the November, 1987 groundwater sampling event) to this location. This modeling effort was implemented based on the results of the RI Kickoff meeting (October 1991) where it was agreed to attempt to locate the hydrocarbon plume and install a well in the most likely location. MP2MW7 was installed to monitor groundwater quality down gradient of Building 7 where chlorinated hydrocarbons such as PCE were detected during the initial site screening.

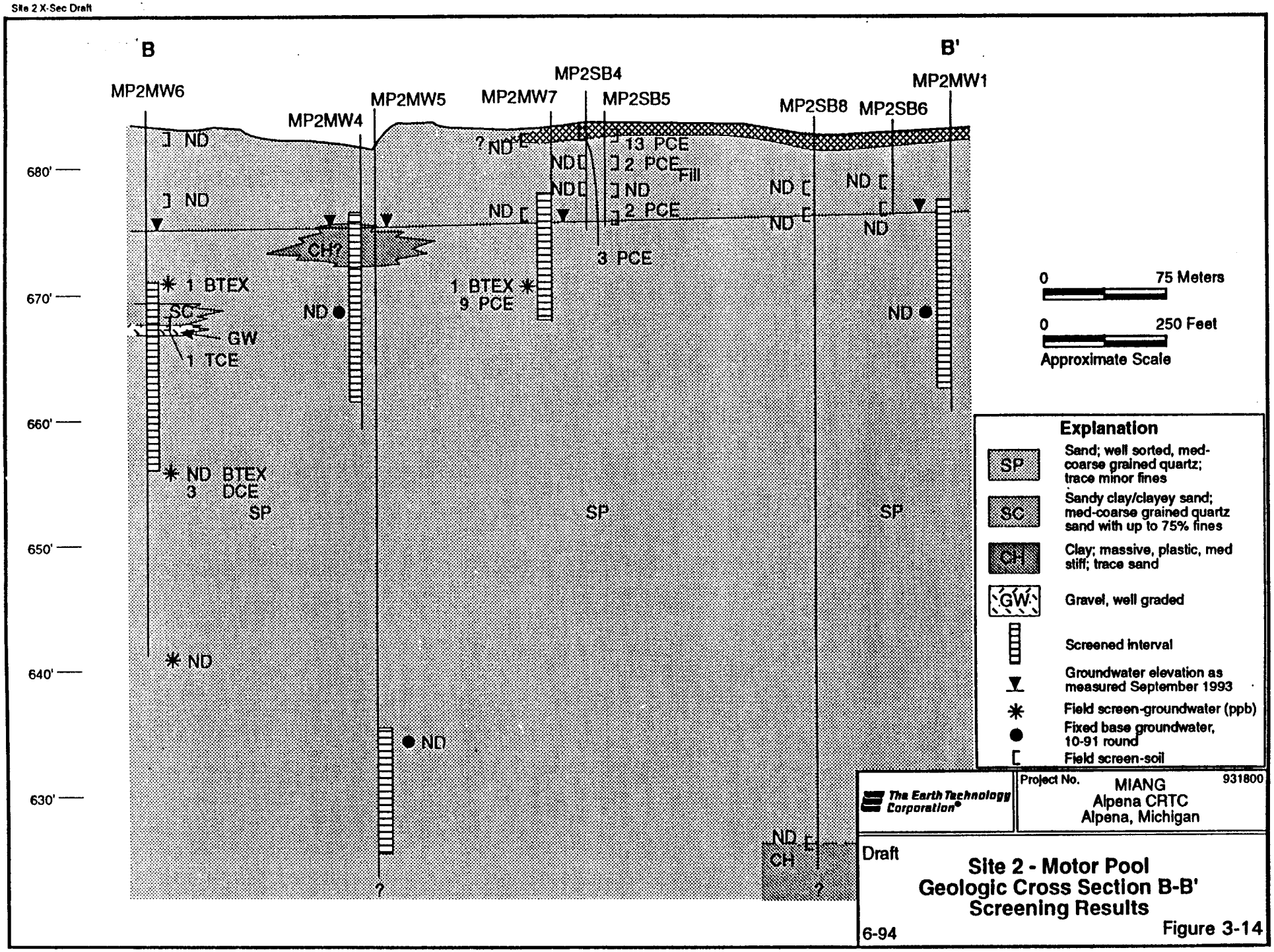
3.3.3.3 On-Site Screening During Drilling Operations

During the RI drilling operations 30 soil and 4 groundwater samples were collected and analyzed using the on-site GC. The analytical results for these samples are presented in Appendix E. A review of the Site 2 data indicates that only DCE, TCE, PCE and benzene were detected in site environmental samples. In general, these compounds were detected infrequently and at a maximum concentration of only 13 $\mu g/\ell$ of air.

Figure 3-14 presents some of the on-site GC screening data for Site 2 in cross-sectional view. No VOCs were detected in samples collected from the area around well MP2MW1, or from the borings drilled and sampled near the USTs. PCE in concentrations ranging from 1-13 $\mu g/\ell$ of air was detected in 6 of the 12 soil samples collected from borings MP2SB4, -SB5 and -SB9. These borings were drilled by the floor drain in front of the vehicle maintenance shop (Building 7). PCE was also detected in the groundwater sample collected from well MP2MW7. Samples containing trace levels of VOCs (1-3 $\mu g/\ell$) were also collected from location MP2MW6.

3.3.4 Confirmation Results

Analytical results for the soil and groundwater samples collected during the RI field sampling are included in Tables 3-7 through 3-9. A presentation and discussion of the significance of these results, including the occurrence of compounds exceeding Act 307 Type A and B cleanup criteria, is included in the following subsections. Comparisons of on-site GC screening results with the fixed base laboratory results and the most current (fourth) round of groundwater sampling results with the historic data are included in the discussions.



The Earth Technology Corporation

Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan

Draft

Site 2 - Motor Pool
Geologic Cross Section B-B'
Screening Results

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Figure 3-14

Table 3-7 Data Summary Table: Surface Soil, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB10		SB6*		SB7		SB8	
Sample ID:		PC-MP2-SB10-SS00-01		PC-MP2-SB6-SS00-02		PC-MP2-SB7-SS00-02		PC-MP2-SB8-SS00-02	
Collection Date:		13-SEP-93		15-AUG-93		15-AUG-93		14-AUG-93	
Sample Depth:		0 ft-1 ft		0 ft-2 ft		0 ft-2 ft		0 ft-2 ft	
Associated Field QC Samples:		FB07,TB25,ER19		FB03,FB06,TB12,ER09		FB03,FB06,TB12,ER09		FB03,FB06,TB12,ER10	
ACT 307 Criteria	**UNITS**	**RESULT**	**QUAL**	**RESULT**	**QUAL**	**RESULT**	**QUAL**	**RESULT**	**QUAL**
HALOGENATED VOLATILES (8010)									
Methylene Chloride	92 ppb	3.8	B	17		4.4	B	1.3	B
SEMI-VOLATILES (CLP 3/90)									
Benzo(b)fluoranthene	1800 ppb	340	U	52	J	350	U	340	U
Benzo(K)fluoranthene	18000 ppb	340	U	52	J	350	U	340	U
Fluoranthene	17000 ppb	340	U	51		350	U	340	U
Pyrene	10000 ppb	340	U	40		350	U	340	U
bis(2-Ethylhexyl)phthalate	92000 ppb	340	U	360	U	350	U	78	
METALS (CLP 3/90)									
Arsenic	5800 ppb	1100	J	1900	B	690	()B	2500	B
Chromium[1]	18000 ppb	3600	J	5000		1900		10200	
Copper	32000 ppb	3300	J	5100		1600	U	4700	
Lead	21000 ppb	1300	L	3100	J	1400	B	11800	B
Nickel	20000 ppb	3700	()	3800	U	3700	U	8700	
Zinc	47000 ppb	19200		20300	B	9500	B	21700	B
Total Petroleum Hydrocarbons	ppb	2,520		2,120		12.1		45.8	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-BG1-SB2-SS02-03
LAB: COMPUCHEM
[1]If Cr^{+6} was detected, it is listed as Cr^{+6}, otherwise the value listed is for total chromium.

Table 3-8 Data Summary Table: Subsurface Soil, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB10*		SB10**		SB2		SB2		SB3		SB3***	
Sample ID:		PC-MP2-SB10-SS03-04		PC-MP2-SB10-SS08-10		PC-MP2-SB2-SS00-02		PC-MP2-SB2-SS04-05		PC-MP2-SB3-SS00-02		PC-MP2-SB3-SS04-05	
Collection Date:		13-SEP-93		13-SEP-93		17-AUG-93		17-AUG-93		17-AUG-93		17-AUG-93	
Sample Depth:		3 ft-4 ft		8 ft-10 ft		0 ft-2 ft		4 ft-5 ft		0 ft-2 ft		4 ft-5 ft	
Associated Field QC Samples:		FB07,TB25,ER19		FB07,TB25,ER19		FB03,FB06,TB14,ER14		FB03,FB06,TB14		FB03,FB06,TB14,ER10		FB03,FB06,TB14,ER10	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	12000 ppb	0.12	U	1.4	U	1.5	U	1.4	U	1.4	U	1.4	U
1,2-Dimethylbenzene	5600 ppb	1.2	U	0.14	B	1.3	U	1.2	U	1.2	U	1.2	U
Styrene	24 ppb	1.5	U	1.5	U	1.6	U	1.5	U	1.5	U	1.5	U
Toluene	16000 ppb	0.15	B	0.17	B	5.6	U	5.5	U	5.3	U	5.5	U
HALOGENATED VOLATILES (8010)													
1,1,1Trichloroethane	4000 ppb	2.8	U	2.8	U	0.36	B	0.38	B	2.8	U	0.5	B
METALS (CLP 3/90)													
Arsenic	5800 ppb	750	()J	410	U	580	()B	480	()B	490	()B	600	()B
Chromium	18000 ppb	2500	J	2800	J	1300	L	3800	L	1700	L	3300	L
Copper	32000 ppb	1800	()J	1900	()J	2100	()J	1800	()J	1500	J	1800	()J
Lead	21000 ppb	1100	L	2900	L	6000	K	1000	K	1300	J	1400	J
Nickel	20000 ppb	3600	U	3600	U	3900	()L	3600	UL	4300	L	5300	L
Selenium	410 ppb	310	U	310	U	320	UL	310	UL	310	U	310	U
Zinc	47000 ppb	15300		12700		13000	B	4500	B	5500	B	5500	B
Total Petroleum Hydrocarbons	ppb	40600		67000		11100		53100		15400		42600	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-MP2-SB10-SS08-10
** Duplicate of PC-MP2-SB10-SS03-04
*** Duplicate of PC-MP2-SB3-SS05-07
LAB: COMPUCHEM

Table 3-8 Data Summary Table: Subsurface Soil, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB3***		SB4		SB4		SB4		SB5		SB5	
Sample ID:		PC-MP2-SB3-SS05-07		PC-MP2-SB4-SS00-02		PC-MP2-SB4-SS03-04		PC-MP2-SB4-SS04-05		PC-MP2-SB5-SS00-02		PC-MP2-SB5-SS04-05	
Collection Date:		17-AUG-93		17-AUG-93		14-AUG-93		17-AUG-93		17-AUG-93		17-AUG-93	
Sample Depth:		5 ft-7 ft		0 ft-2 ft		3 ft-4 ft		4 ft-5 ft		0 ft-2 ft		4 ft-5 ft	
Associated Field QC Samples:		FB03,FB06,TB14,ER10		FB03,FB06,TB14		FB03,FB06,TB14		FB03,FB06,TB13,ER10		FB03,FB06,TB14		FB03,FB06,TB14	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	12000 ppb	1.4	U	1.5	U	1.5	UJ	1.4	U	1.5	UJ	1.4	U
1,2-Dimethylbenzene	5600 ppb	1.2	U	1.3	U	1.3	UJ	1.2	U	1.3	UJ	1.2	U
Styrene	24 ppb	1.5	U	1.6	U	1.6	UJ	1.5	U	1.6	UJ	1.5	U
Toluene	16000 ppb	0.17		5.5	U	0.53	B	5.5	U	5.6	UJ	5.4	U
HALOGENATED VOLATILES (8010)													
1,1,1-Trichloroethane	4000 ppb	0.38	B	0.41	B	2.8	UJ	2.8	U	0.34	B	0.4	B
METALS (CLP 3/90)													
Arsenic	5800 ppb	490	()B	890	()B	790	()B	410	UL	680	()B	410	()B
Chromium	18000 ppb	2700	L	3400	L	2500		3100	L	5100	L	2500	L
Copper	32000 ppb	1500	U	1600	U	1600	U	2000	()J	2100	()J	1700	()J
Lead	21000 ppb	820	K	1900	K	1000	B	1200	K	2500	J	1200	J
Nickel	20000 ppb	3600	UL	4900	L	3700	U	5000	L	6900	L	4000	()L
Selenium	410 ppb	310	U	310	UL	310	U	310	UL	320	UL	300	U
Zinc	47000 ppb	2900	B	6900	B	13500	B	6000	B	8500	B	3500	B
Total Petroleum Hydrocarbons	ppb	12000		26800		13500		9400		23200		193000	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
*** Duplicate of PC-Mp2-SB3-SS04-05
LAB: COMPUCHEM

wp/t3-8.540- 6/14/95

Table 3-8 Data Summary Table: Subsurface Soil, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB6		SB7		SB8		SB9*		SB9**	
Sample ID:		PC-MP2-SB6-SS05-06		PC-MP2-SB7-SS05-06		PC-MP2-SB8-SS05-06		PC-MP2-SB9-SS03-04		PC-MP2-SB9-SS04-06	
Collection Date:		15-AUG-93		14-AUG-93		14-AUG-93		16-AUG-93		16-AUG-93	
Sample Depth:		5 ft-6 ft		5 ft-6 ft		5 ft-6 ft		3 ft-4 ft		4 ft-6 ft	
Associated Field QC Samples:		FB03,FB06,TB12,ER09		FB03,FB06,TB12,ER09		FB03,FB06,TB12,ER10		FB03,FB06,TB13,ER10		FB03,FB06,TB13,ER10	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)											
1,2-Dichlorobenzene	12000 ppb	1.5	U	1.5	U	0.032		1.5	UJ	2.5	
1,2-Dimethylbenzene	5600 ppb	0.11		1.3	U	0.12		1.3	UJ	1.2	U
Styrene	24 ppb	0.036		1.6	U	1.6	U	1.6	UJ	1.5	U
Toluene	16000 ppb	0.69	B	0.25	B	0.18	B	5.5	UJ	5.5	U
HALOGENATED VOLATILES (8010)											
1,1,1-Trichloroethane	4000 ppb	2.8	UJ	0.087		0.19		0.053	B	2.8	U
METALS (CLP 3/90)											
Arsenic	5800 ppb	610	()B	710	()B	580	()B	620	()B	570	()B
Chromium	18000 ppb	2100		4100		3700		2700		3100	
Copper	32000 ppb	1600	U	2400	()	1600	U	2100	()	1600	U
Lead	21000 ppb	940	B	1100	B	2500	B	840	B	1000	B
Nickel	20000 ppb	3600	U	3800	U	3700	U	3600	U	3700	U
Selenium	410 ppb	310	U	320	U	310	U	330	()L	320	U
Zinc	47000 ppb	6700	B	9600	B	10000	B	5400	B	4600	B
Total Petroleum Hydrocarbons	ppb	43500		26400		54000		18200		49400	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
R Data is unreliable
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-MP2-SB9-SS04-06
** Duplicate of PC-MP2-SB9-SS03-04

LAB: COMPUCHEM

Table 3-9 Data Summary Table: Groundwater, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW1		MW2		MW3		MW4		MW5**		MW6	
Sample ID:		PC-MP2-MW1-GW4		PC-MP2-MW2-GW4		PC-MP2-MW3-GW4		PC-MP2-MW4-GW4		PC-MP2-MW5-GW4		PC-MP2-MW6-GW4	
Collection Date:		10-AUG-93		15-AUG-93		16-AUG-93		16-AUG-93		12-AUG-93		09-SEP-93	
Associated Field QC:		FB01,TB07		FB06,TB12		FB06,TB12		FB06,TB12		FB06,FB07,TB09		FB07,TB23	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,3-Dimethylbenzene	13000 ppb	-		-		-		-		-		0.055	
Toluene	790 ppb	0.22	B	0.087	B	0.17	B	0.21	B		R	0.15	
HALOGENATED VOLATILES (8010)													
Chloroform	5.8 ppb	0.35	U	0.35	U	0.35	U	0.35	U		R	0.35	U
Methylene Chloride	4.6 ppb	0.17		1	U	1	U	1	U		R	0.4	
Tetrachloroethylene	0.7 ppb	0.3	U	0.3	U	0.3	U	0.3	U		R	0.3	U
Trichloroethylene	2.2 ppb	0.3	U	0.3	U	0.3	U	0.3	U		R	0.3	U
SEMI-VOLATILES (CLP 3/90)													
Di-n-butyl phthalate	840 ppb	5	U	5	U	0.5		5	U	5	U	5	U
Diethyl phthalate	5200 ppb	5	U	1	J	2	J	2	J	5	U	5	U
Dimethyl phthalate	70000 ppb	5	U	5	U	5	U	5	U	5	U	5	U
Phenol	4200 ppb	5	U	5	U	0.7	B	5	U	5	U	0.9	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
** Duplicate of PC-MP2-MW9-GW4
LAB: COMPUCHEM

Table 3-9 Data Summary Table: Groundwater, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			MW1		MW2		MW3		MW4		MW5**		MW6	
Sample ID:			PC-MP2-MW1-GW4		PC-MP2-MW2-GW4		PC-MP2-MW3-GW4		PC-MP2-MW4-GW4		PC-MP2-MW5-GW4		PC-MP2-MW6-GW4	
Collection Date:			10-AUG-93		15-AUG-93		16-AUG-93		16-AUG-93		12-AUG-93		09-SEP-93	
Associated Field QC:			FB01,TB07		FB06,TB12		FB06,TB12		FB06,TB12		FB06,FB07,TB09		FB07,TB23	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)[1]														
Arsenic		ppb	14.7	K	4	U	4	U	4	U	4	U	4	()J
Arsenic, Dissolved[2]	0.02	ppb	7.2	()	14.7	B	4	U	4	U	4	U	4	UL
Copper		ppb	27.8		4.5	()B	4	U	4	U	4	U	4	U
Copper, Dissolved	1000	ppb	4	U	4	U	4	U	4	U	4	U	4	U
Lead		ppb	4.5		2	U	2	U	2	U	2	UL	2	U
Lead, Dissolved	4	ppb	2	U	4.1	B	2	U	2	U	2	UL	2	UL
Silver		ppb	4	U	4	U	4	U	4	U	4	U	5.4	()J
Zinc		ppb	43.5		100		4	U	193		254		9.7	()B
Zinc, Dissolved	2300	ppb	19.1	()	4	U	4	U	4	U	5.1	()B	5.6	()
Total Petroleum Hydrocarbons		ppb	2500	B	5600	B	600	B	400	B	1100	B	2300	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
[1]Criteria are presented for dissolved metals only.
[2]Local background mean concentration is 1.85 ppb.
** Duplicate of PC-MP2-MW2-GW4
LAB: COMPUCHEM

Table 3-9 Data Summary Table: Groundwater, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW7		MW9**		MW1***	
Sample ID:		PC-MP2-MW7-GW4		PC-MP2-MW9-GW4		PC-FF7-MW1-GW4	
Collection Date:		09-SEP-93		16-AUG-93		09-SEP-93	
Associated Field QC:		FB07,TB23		FB06,TB07,ER12		FB07,TB23,ER18	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)							
1,3-Dimethylbenzene	280 ppb	-		-		-	
Toluene	790 ppb	0.18		0.26	B	0.25	U
HALOGENATED VOLATILES (8010)							
Chloroform	5.6 ppb	0.35	U	0.18	U	0.35	U
Methylene Chloride	4.6 ppb	0.42	B	0.052		0.32	B
Tetrachloroethylene	0.7 ppb	6.3		0.3	U	0.09	
Trichloroethylene	2.2 ppb	0.36		0.3	U	0.12	
SEMI-VOLATILES (CLP 3/90)							
Di-n-butyl phthalate	840 ppb	1	B	5	U	1	B
Diethyl phthalate	5200 ppb	1		3	J	5	U
Dimethyl phthalate	70000 ppb	5	U	0.6	J	5	U
Phenol	4200 ppb	3		5	U	0.6	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
** PC-MP2-MW9-GW4 is a duplicate of PC-MP-MW5-GW4
*** PC-FF7-MW1-GW4 is a duplicate of PC-MP2-MW6-GW4

Table 3-9 Data Summary Table: Groundwater, Site 2 - Motor Pool
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW7		MW9		MW1	
Sample ID:		PC-MP2-MW7-GW4		PC-MP2-MW9-GW4		PC-FF7-MW1-GW4	
Collection Date:		09-SEP-93		16-AUG-93		09-SEP-93	
Associated Field QC:		FB07,TB23		FB06,TB07,ER12		FB07,TB23,ER18	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)							
Arsenic	ppb	4	U	4	U	4	U
Arsenic, Dissolved 1.85	ppb	4	UL	6.1	()B	4	U
Copper	ppb	4	U	4.5	()B	4	U
Copper, Dissolved 1000	ppb	5.7		4	U	4	U
Lead	ppb	2	UL	2	U	2	U
Lead, Dissolved 4	ppb	2	UL	2	U	2.3	()L
Silver	ppb	4	U	4	U	4	U
Zinc	ppb	23.8	J	245		4	U
Zinc, Dissolved 2300	ppb	4.1	()	10.4	()	15.3	()
Total Petroleum Hydrocarbons	ppb	250	BRL	400		250	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
** PC-MP2-MW9-GW4 is a duplicate of PC-MP-MW5-GW4
*** PC-FF7-MW1-GW4 is a duplicate of PC-MP2-MW6-GW4
[1] Criteria are presented for dissolved metals only
[2] Local background mean concentration is 1.85 ppb

3.3.4.1 Soil Sampling Results

Tables 3-7 and 3-8 present the soil analytical results for Site 2. Because locations MP2SB2, -SB3, -SB4, -SB5 and -SB9 were asphalt covered, surface soil samples were only collected from borings MP2SB6, -SB7, -SB8 and -SB10. All compounds found in the soils exceeding Act 307 Type A or B cleanup criteria are presented in Figure 3-15.

Surface Soil Results

A review of the analytical results presented in Table 3-7, indicate that, in general, VOCs and SVOCs were detected infrequently and at relatively low concentrations in the Site 2 surface soils. Methylene chloride, quantified in MP2SB6 at a concentration of 17 µg/kg, was the only VOC detected. The SVOCs from the PAH group such as pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and chyrsene were detected in two samples at a maximum individual concentration of 52 µg/kg. No organic compounds were detected in concentrations exceeding Act 307 Type B cleanup criteria. TPH was detected in four Site 2 surface soil samples at concentrations ranging from 12.1 to 2,520 mg/kg.

Arsenic, chromium, copper, lead, nickel and zinc were detected in one or more of the surface soil samples. However, only one analyte, lead, from one sample was found at a concentration exceeding Act 307 Type B cleanup criteria. Lead was detected in the surface soil sample collected from MP2SB6 (located northwest of MP2MW1 in Figure 3-15) at a concentration of 31 mg/kg.

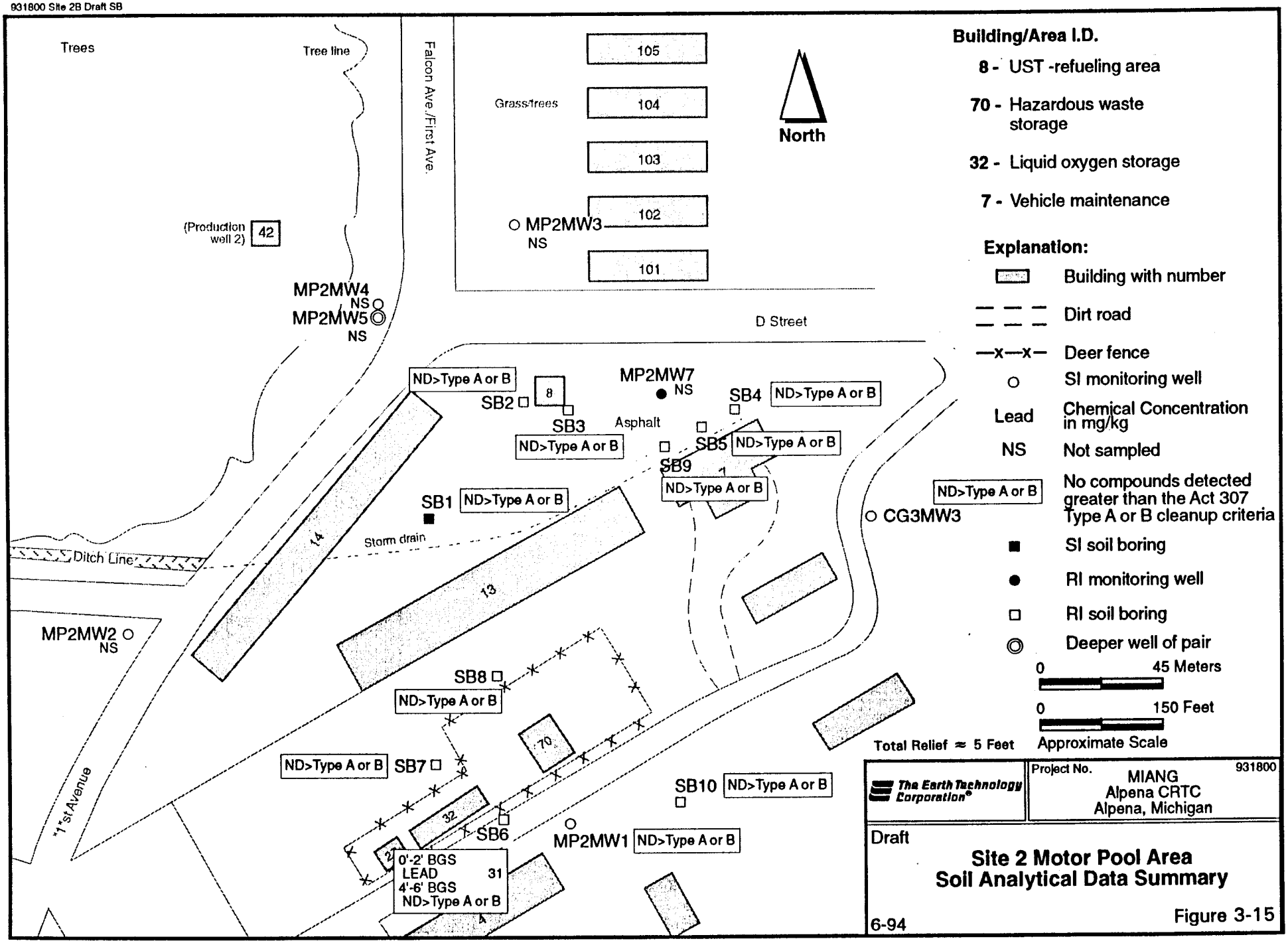
Subsurface Soil Results

1,1,1-TCA, 1,2-DCB, ortho-xylene (1,2-dimethylbenzene), toluene, and styrene were each detected in samples collected from the Site 2 subsurface soil samples. All compounds were found in concentrations ranging from 0.03 to 2.50 µg/kg and all in concentrations below Act 307 Type B cleanup criteria. TPH was detected in 18 of the Site 2 subsurface soil samples at concentrations ranging from 9.4 to 193 mg/kg. Chromium, copper, lead, nickel, selenium and zinc were also quantified in one or more samples. No inorganics were detected in concentrations exceeding Act 307 Type A cleanup criteria.

3.3.4.2 Groundwater Results

Analytical results for the fourth round of groundwater samples collected at Site 2 are presented in Table 3-9. The analytical data from the previous three rounds of sampling is included in Appendices N and O. A summary figure illustrating the distribution of organic and inorganic compounds detected above their respective Act 307 criteria within all four rounds of groundwater analytical data is presented as Figure 3-16.

A review of the groundwater analytical data indicates that although organic compounds are present in Site 2 monitoring wells, few compounds were detected in concentrations exceeding the Act 307 Type A or B cleanup criteria. Organic compounds detected during the fourth round of sampling include BTEX, phenol, phthalate esters, PCE, TCE, chloroform, and



Building/Area I.D.

8 - UST -refueling area

70 - Hazardous waste storage

32 - Liquid oxygen storage

7 - Vehicle maintenance

Explanation:

- Building with number
- Dirt road
- Deer fence
- SI monitoring well
- Lead — Chemical Concentration in mg/kg
- NS — Not sampled
- ND>Type A or B — No compounds detected greater than the Act 307 Type A or B cleanup criteria
- SI soil boring
- RI monitoring well
- RI soil boring
- Deeper well of pair

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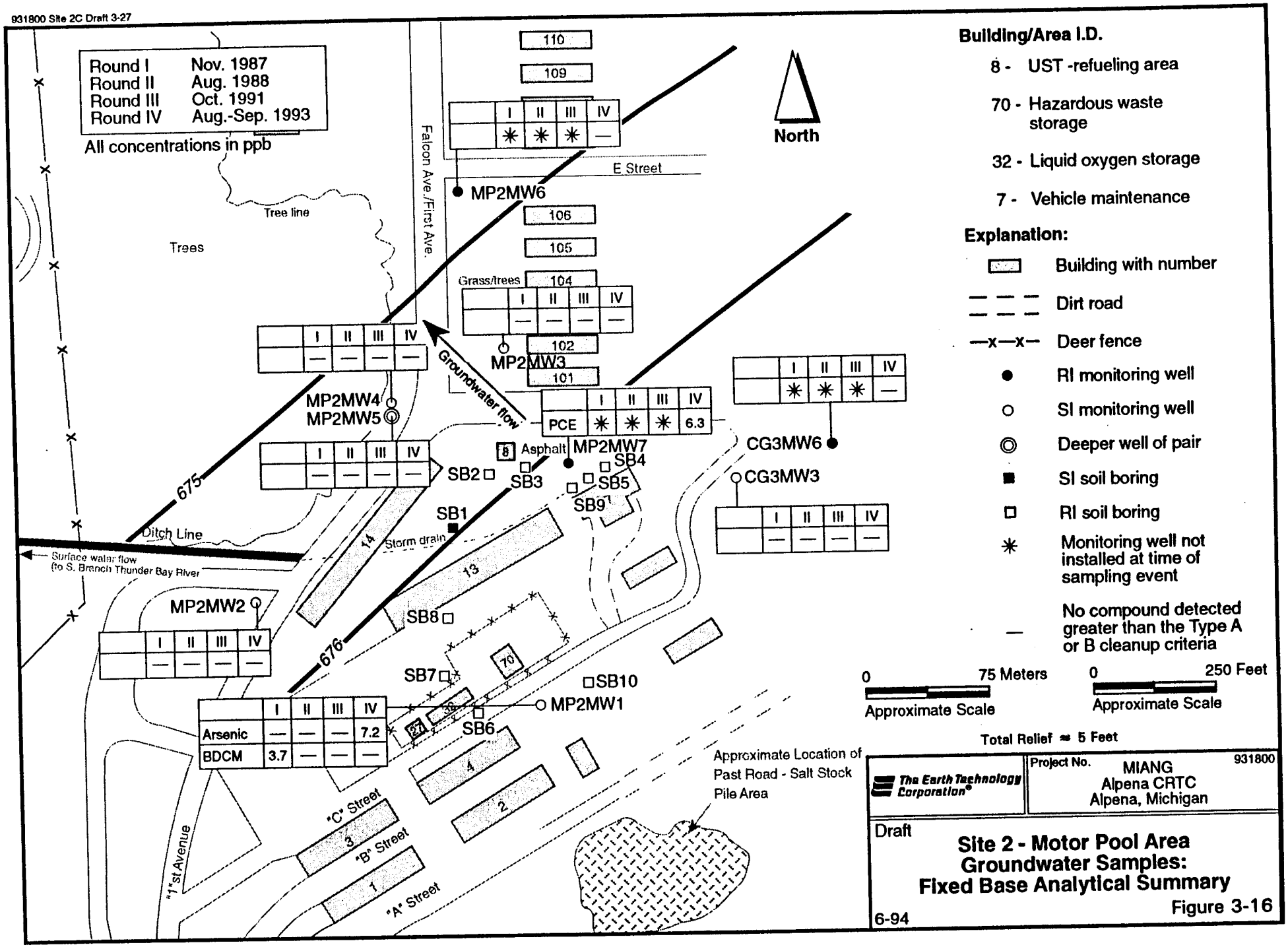
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Site 2 Motor Pool Area Soil Analytical Data Summary

6-94

Figure 3-15



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Site 2 - Motor Pool Area
Groundwater Samples:
Fixed Base Analytical Summary

6-94

Figure 3-16

methylene chloride. PCE, quantified at 6.3 $\mu g/\ell$ in the groundwater sample collected from MP2MW7, was the only organic compound detected in concentrations exceeding the Act 307 Type B cleanup criteria.

The inorganic analytical results for the summer 1993 (Round IV) samples filtered and unfiltered groundwater, collected from Site 2 monitoring wells, are presented in Table 3-9. A review of Table 3-9 shows that antimony, arsenic, copper, lead, and zinc were quantified and that a majority of the positive detections were found in the unfiltered samples. Arsenic and/or lead were detected in the unfiltered samples from wells MP2MW1 and MP2MW6. However, these unfiltered samples were turbid and could not be used as collected for domestic purposes. Only arsenic, copper, and zinc were quantified in the dissolved (filtered) samples. Arsenic was detected in concentrations exceeding Act 307 Type A cleanup criteria in the unfiltered and filtered samples collected from MP2MW1 (Figure 3-16).

During the three previous rounds of groundwater sampling, trihalomethanes and chloroform were detected in MP2MW1, while TPH was detected in MP2MW1 and MW4. Bromodichloromethane (3.7 $\mu g/\ell$) in samples collected from MP2MW1 was the only organic or inorganic compound detected during the November 1987, August 1988, or October 1991 sampling rounds above Act 307 Type A or B cleanup criteria.

3.3.5 Summary and Conclusions

The following summarizes the findings of the subsurface investigations conducted at Site 2:

- Shallow aquifer materials beneath Site 2 are composed of quartz sand. The sand section is approximately 16.8 m (55 ft) thick. Below the sand is a clay aquitard at least 0.9 m (3 ft) in thickness which separates the shallow aquifer from the limestone bedrock aquifer.

- Source areas at the site investigated by the soil sampling program include the vehicle maintenance shop (Building 7), the USTs, and the area around MP2MW1. The onsite screening results indicate soil samples collected from in front of Building 7 (borings MP2 SB4,5, and 9) contain very low concentrations of PCE. These low concentrations of PCE were not confirmed. Only one soil sample contained a compound exceeding the Act 307 Type A or B cleanup criteria. Lead was detected in the surface soil from MP2SB6 at a concentration of 31 mg/kg.

- Groundwater occurs at depths between 5 and 8 ft bgs beneath Site 2 and flows northwest. Analytical results from the fourth round of groundwater sampling indicate only 2 compounds detected above Act 307 Type A or B cleanup criteria. PCE was detected down gradient of Building 7 at a concentration of 6.3 $\mu g/\ell$ from MP2MW7 and arsenic (dissolved) was detected from MP2MW1 at a concentration of 7.1 $\mu g/\ell$.

3.4 SITE 3 – FORMER SITE OF COUNTY GARAGE

Several RI field activities were initiated to support the RI at Site 3. The results for many of the field efforts are contained in separate, stand-alone documents and will not be fully reproduced in the RI Report. The activities conducted at Site 3 are:

- Surface geophysical surveys were conducted at Site 3 during September and October 1992. During this same field event seven existing monitoring wells, determined to be improperly constructed, were abandoned at the site. Complete results are presented in the Final Draft, Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, April 1993). Summaries of the geophysical survey results are included in the Site 3 geology and hydrogeology discussions.

- Soil borings, monitoring well installation, soil and groundwater sampling and analysis were conducted during August and September 1993 and are presented in the following subsections.

3.4.1 Results of Previous Investigations

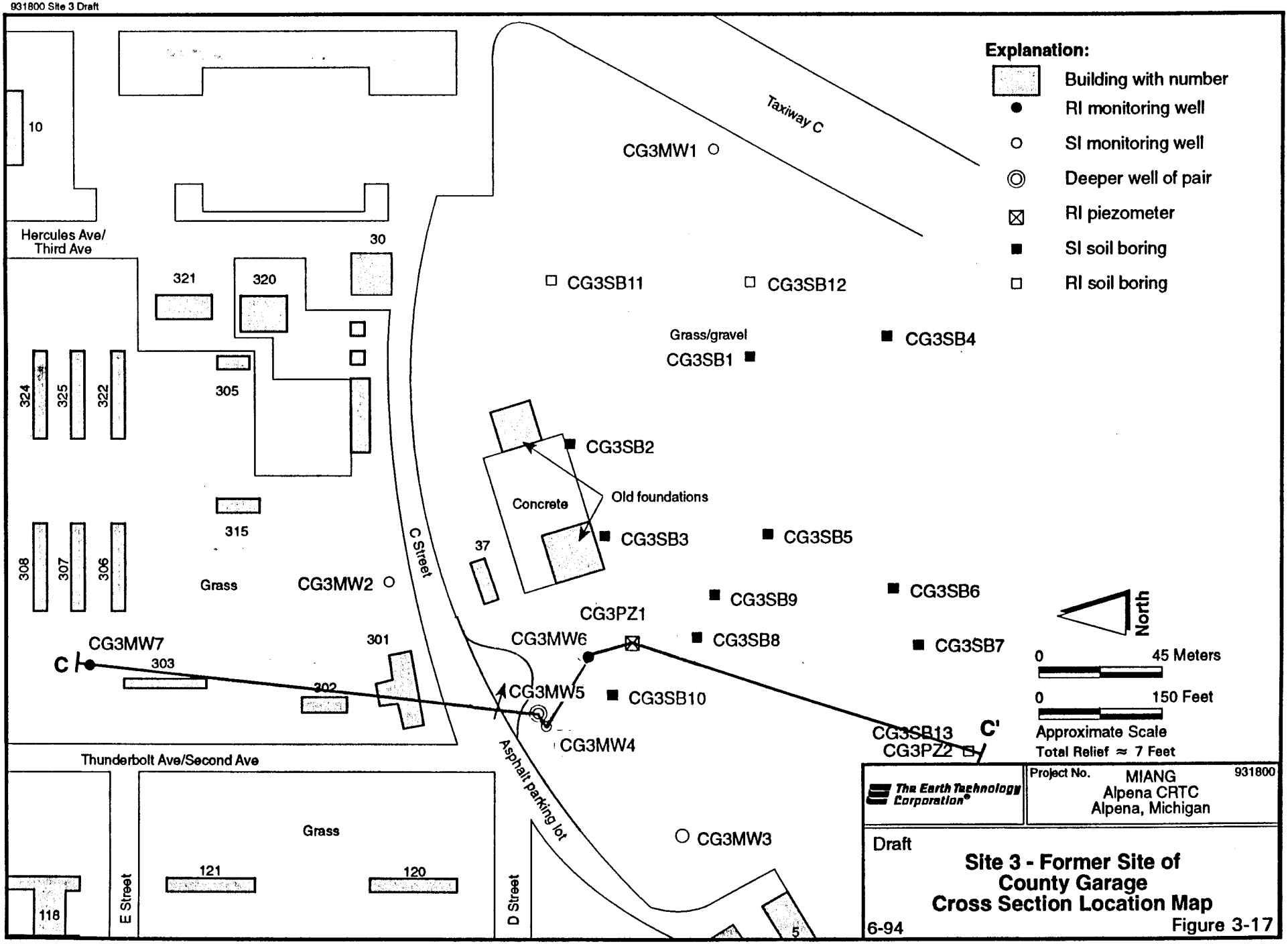
The SI and RI soil and groundwater sampling locations are presented in Figure 3-17. VOCs and TPH were detected in Site 3 surface and subsurface soils collected during the SI (Engineering-Science, 1990) from borings CG3SB1, CG3SB7, and CG3SB8. A strong hydrocarbon odor and sheen was noted on the drill cuttings during the October 1992 abandonment of 2 of the 7 existing Site 3 wells. These wells were located immediately north and west of CG3SB8. TPH was detected at a concentration of 180 mg/ℓ in the November 1987 round of groundwater samples obtained from CG3MW5. Analytical results from the second (August 1988) and third (October 1991) rounds of groundwater sampling did not detect the presence of TPH in this well or indicate the presence of other chemicals of concern in Site 3 groundwater samples.

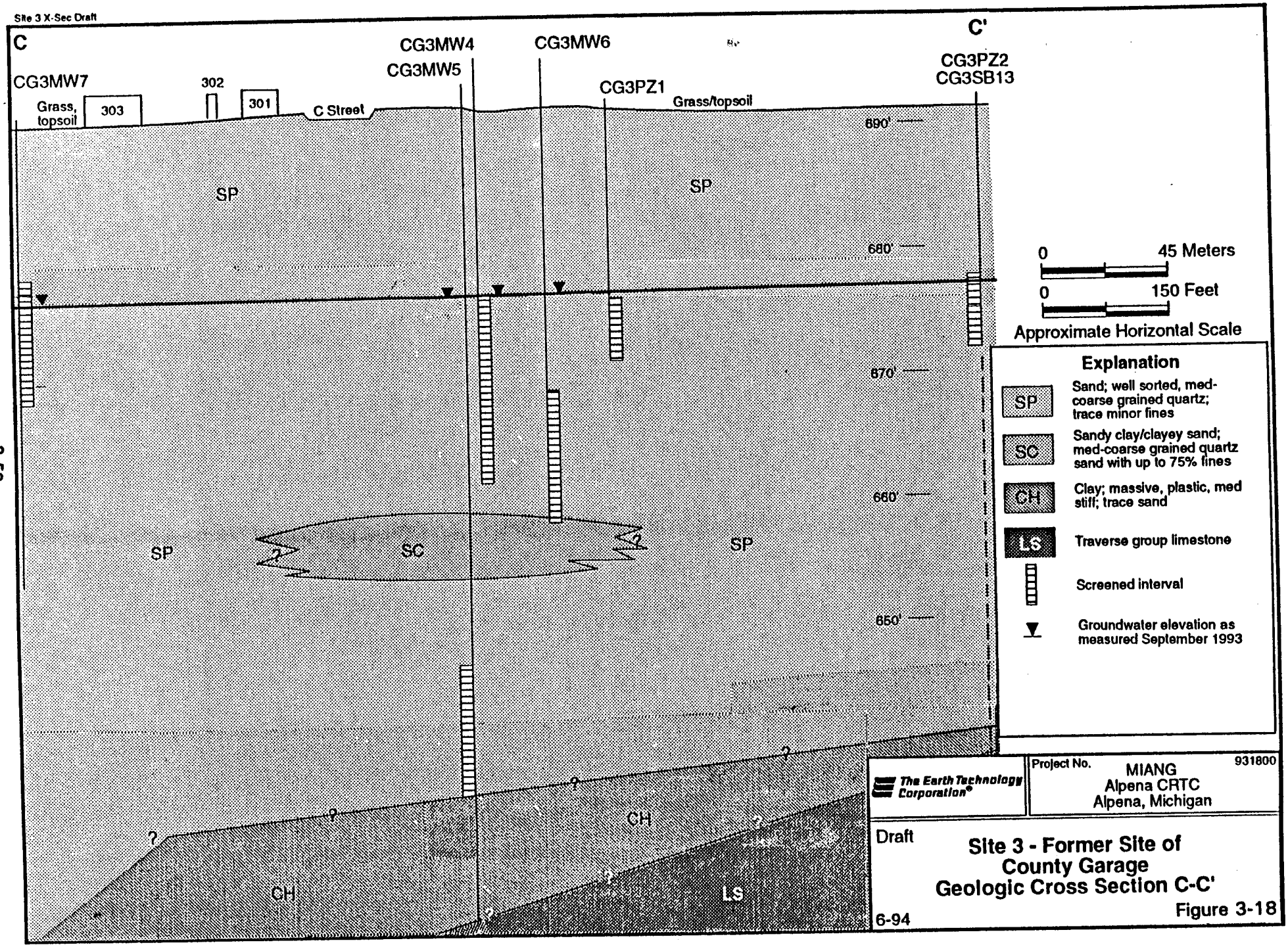
3.4.2 Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.4.2.1 Geology

Figure 3-17 also presents the location of a north to south geologic cross-section constructed across Site 3. The cross-section itself is presented as Figure 3-18. As illustrated in Figure 3-18, the shallow aquifer beneath the site is composed mainly of well-sorted, medium-grained quartz sand which overlies a medium-stiff plastic clay. The unconsolidated sand is approximately 17 m (55 ft) thick. The clay unit extends approximately 3 m (10 ft) below the


Explanation:
Building with number
RI monitoring well
SI monitoring well
Deeper well of pair
RI piezometer
SI soil boring
RI soil boring
Taxiway C
CG3MW1
Hercules Ave/
Third Ave
10
30
321
320
CG3SB11
CG3SB12
Grass/gravel
CG3SB4
CG3SB1
324
325
322
305
CG3SB2
Concrete
Old foundations
315
37
CG3SB3
CG3SB5
308
307
306
Grass
CG3MW2
C Street
CG3SB9
CG3SB6
CG3PZ1
CG3MW7
C
303
301
CG3MW6
CG3SB8
CG3SB7
302
CG3MW5
CG3SB10
CG3MW4
CG3SB13
CG3PZ2
C'
Thunderbolt Ave/Second Ave
Asphalt parking lot
Grass
CG3MW3
121
120
118
E Street
D Street
5
North
0
45 Meters
0
150 Feet
Approximate Scale
Total Relief ≈ 7 Feet
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931800
Alpena CRTC
Alpena, Michigan
Draft
Site 3 - Former Site of
County Garage
Cross Section Location Map
6-94
Figure 3-17


C
C'
CG3MW7
CG3MW4
CG3MW5
CG3MW6
CG3PZ1
CG3PZ2
CG3SB13
302
303
301
Grass, topsoil
C Street
Grass/topsoil
690'
680'
670'
660'
650'
SP
SC
CH
LS
?
0
45 Meters
0
150 Feet
Approximate Horizontal Scale
Explanation
Sand; well sorted, med-coarse grained quartz; trace minor fines
Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
Clay; massive, plastic, med stiff; trace sand
Traverse group limestone
Screened interval
Groundwater elevation as measured September 1993
The Earth Technology Corporation
Project No.
931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 3 - Former Site of County Garage
Geologic Cross Section C-C'
Figure 3-18
6-94

base of the sand to a depth of approximately 20 m (65 ft). Lying directly below the clay unit is the limestone bedrock which was encountered at a depth of 20 m (65 ft) bgs in CG3MW5. Geophysical surveys (EMI and electrical resistivity surveys) results conducted at Site 3 compare well to the observations made during drilling operations. The clay/sandy clay was interpreted from the geophysical surveys to be present at a depth of 19 m (62 ft) bgs and was interpreted to be approximately 4.6 m (15 ft) thick.

A sample of the clay (16.2 to 16.8 m [53 to 55 ft] below grade) was collected from boring CG3SB13 and submitted for geotechnical analysis. According to the geotechnical results presented in Appendix C, this sample has a low vertical hydraulic conductivity of 2.1 X 10^{-6} cm/sec (5.9 X 10^{-3} ft/day) indicating it is of sufficient clay content to be considered a good-quality aquitard. Only CG3MW5 and -SB13 were drilled deep enough to encounter the clay unit underlying Site 3. These locations are separated by approximately 152 m (500 ft) suggesting the clay aquitard may be continuous beneath Site 3.

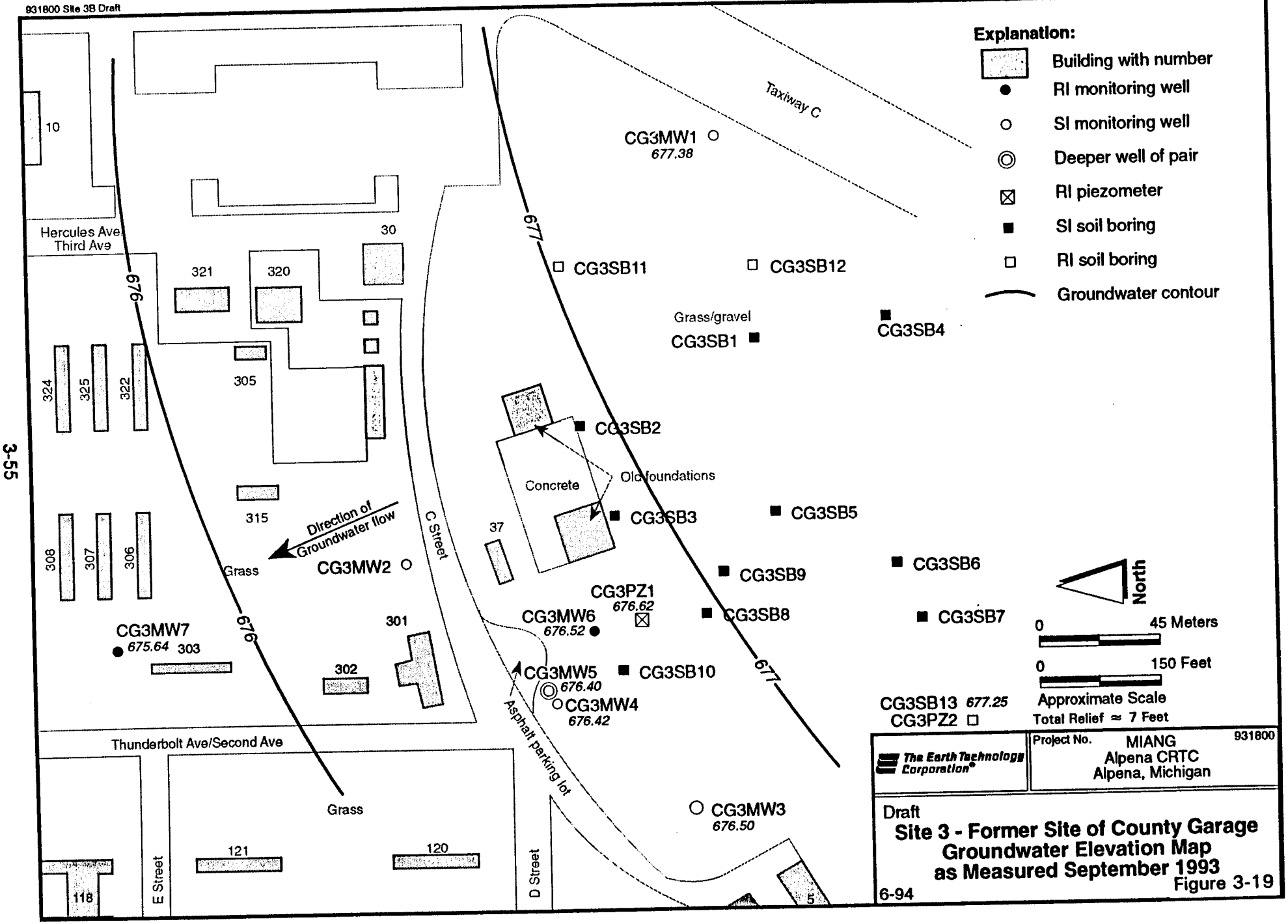
3.4.2.2 Hydrogeology

Seven monitoring wells and one piezometer (CG3MW1 through CG3MW7 and CG3PZ1) exist at Site 3. Wells CG3MW1 through -MW5 were installed during the SI (Engineering-Science, 1990), while wells CG3MW6, CG3MW7, and piezometer CG3PZ1 were installed during the RI field activities. Groundwater at Site 3 occurs within the surficial aquifer at depths ranging from 10.58 to 18.52 ft bgs and from 675.64 to 677.38 ft below msl. As illustrated in Figures 1-19 through 1-21, and 3-19, the groundwater flow direction at Site 3 is north towards the sinkhole. The average hydraulic gradient across Site 3 is approximately 0.0003 m/m (0.001 ft/ft). Wells CG3MW4 and CG3MW5 are a nested well pair with CG3MW4 being screened in the upper part of the surficial aquifer and CG3MW5 screened in the lower portion of the surficial aquifer. A hydraulic head difference of 0.006 m (0.02 ft) was measured between the two wells (September 1993). These measurements suggest there are no appreciable vertical hydraulic gradients existing within the shallow aquifer beneath Site 3.

Piezometer CG3PZ1 was installed to determine if free-phase hydrocarbons were present floating on the groundwater beneath Site 3. No evidence of free-phase hydrocarbons was detected in this piezometer during the summer 1993 field event.

3.4.3 Screening Results and Boring and Well Placement Rationale

No initial site screening was conducted during the January 1993 RI activities for Site 3. Soil and groundwater screening was conducted during drilling activities in August and September 1993 to aid in the selection of screen intervals for the monitoring wells and to aid in the selection of soil samples for fixed-base laboratory analysis.



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Alpena, Michigan

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Site 3 - Former Site of County Garage
Groundwater Elevation Map
as Measured September 1993

6-94

Figure 3-19

3.4.3.1 Soil Boring and Monitoring Well Placement Rationale

Initial site screening data were not available prior to beginning the summer 1993 RI field activities to guide the placement of soil borings and monitoring wells. The locations for borings CG3SB11 through 13 were selected to more fully delineate the extent of VOCs detected in borings CG3SB1 and -SB7. Monitoring well CG3MW6 was installed to monitor groundwater quality down gradient of the suspected source area at Site 3, while well location CG3MW7 was selected based on preliminary groundwater modeling results which traced the migration of a groundwater hydrocarbon plume detected during the November 1987 sampling event (Round I) to this area.

3.4.3.2 On-Site Screening During Drilling Operations

Nineteen soil and 9 groundwater samples were collected and analyzed from the piezometer, borings and monitoring wells drilled at the site. The analytical results for these samples are presented in Appendix E. The distribution of some of these compounds is illustrated in cross-sectional view in Figure 3-20. A review of the data indicate no vadose zone soils (depths less than approximately 4.6 m [15 ft] bgs) contain detectable levels of target VOCs. One saturated zone soil sample and two Hydropunch® groundwater samples collected from locations CG3PZ1 and CG3MW6 did contain VOCs at concentrations ranging from 2 to 150 $\mu g/\ell$.

3.4.4 Confirmation Results

Analytical results for the soil and groundwater samples collected and analyzed during the RI field activities are presented in Tables 3-10 through 3-12. A presentation and discussion of the significance of these results including the occurrence of compounds exceeding the Act 307 Type A and B cleanup criteria is included in the following subsections.

3.4.4.1 Surface and Subsurface Soil Results

Soil borings CG3SB1 through CG3SB10 were drilled and sampled during the SI (Engineering-Science 1990). The SI analytical results are presented in Appendix O. Site 3 soil samples were collected from borings CG3SB11, CG3SB12 and CG3SB13 during the RI field activities. Soil analytical results for these samples are included in Tables 3-10 and 3-11. A summary of the soil analytical results exceeding Act 307 Type A and B cleanup criteria for all (SI and RI) samples are presented in Figure 3-21.

Surface Soils

No surface soil samples were collected during the SI. Three surface soil samples, and one duplicate sample, were collected from Site 3 during the RI. The samples were collected from borings CG3SB11 through -SB13. A review of the analytical results presented in Table 3-11 shows that only methylene chloride (1 detection; 4.2 $\mu g/kg$) and ortho-xylene (1 detection;

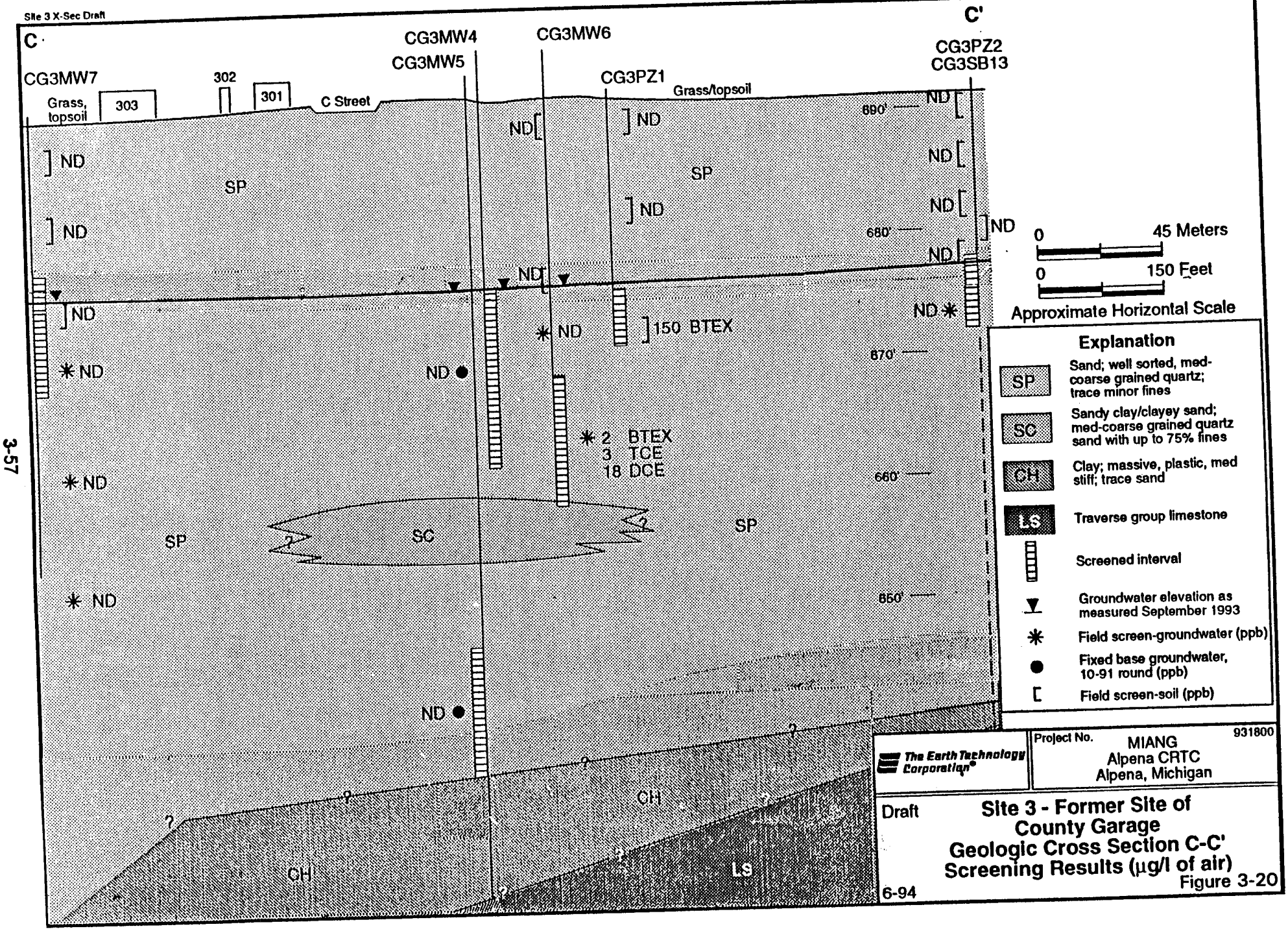

Site 3 X-Sec Draft
C
C'
CG3MW7
CG3MW4
CG3MW5
CG3MW6
CG3PZ1
CG3PZ2
CG3SB13
302
303
301
Grass, topsoil
C Street
Grass/topsoil
SP
SC
CH
LS
ND
150 BTEX
2 BTEX
3 TCE
18 DCE
890'
680'
670'
660'
650'
0 45 Meters
0 150 Feet
Approximate Horizontal Scale
Explanation
Sand; well sorted, med-coarse grained quartz; trace minor fines
Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
Clay; massive, plastic, med stiff; trace sand
Traverse group limestone
Screened interval
Groundwater elevation as measured September 1993
Field screen-groundwater (ppb)
Fixed base groundwater, 10-91 round (ppb)
Field screen-soil (ppb)
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 3 - Former Site of County Garage
Geologic Cross Section C-C'
Screening Results (µg/l of air)
6-94
Figure 3-20

Table 3-10 Data Summary Table: Surface Soil, Site 3-Former Site of County Garage
Alpena CRTC, Alpena, Michigan

Locator:	SB11		SB12		SB13		SB13**		SB20*	
Sample ID:	PC-CG3-SB11-SS00-02		PC-CG3-SB12-SS00-02		PC-CG3-SB13-SS00-02		PC-CG3-SB13-SS02-04		PC-CG3-SB20-SS-00-02	
Collection Date:	26-AUG-93		26-AUG-93		26-AUG-93		26-AUG-93		26-AUG-93	
Associated Field QC Samples:	FB04,FB05,TB18,ER16		FB04,FB05,TB18,ER16		FB04,FB05,TB13,ER10		FB04,FB05,TB13,ER10		FB04,FB05,TB13,ER10	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)										
1,2-Dichlorobenzene 12000 ug/kg	1.5	U	1.5	UJ	0.07		1.5	U	4.3	U
1,2-Dimethylbenzene 5600 ug/kg	1.3	U	1.3	UJ	0.18		1.3	U	1.3	U
1,4-Dichlorobenzene 30 ug/kg	0.15	J	1.9	UJ	0.25	B	1.9	U	1.9	U
Toluene 16000 ug/kg	0.12	B	5.6	UJ	0.18		5.6	U	5.6	U
HALOGENATED VOLATILES (8010)										
Methylene chloride 92 ug/kg	4.2	J	4.5	B	3.1	B	2.6	U	9.3	B
SEMI-VOLATILES (CLP 3/90)										
Anthracene 140000 ug/kg	340	U	340	U	340	U	340	U	76	
Benzo(a)anthracene 1800 ug/kg	340	U	340	U	340	U	340	U	290	
Benzo(a)pyrene 180 ug/kg	340	U	340	U	340	U	340	U	170	
Benzo(b)fluoranthene 1800 ug/kg	340	U	340	U	340	U	340	U	430	
Benzo(ghi)perylene 930000 ug/kg	340	U	340	U	340	U	340	U	140	
Benzo(k)fluoranthene 18000 ug/kg	340	U	340	U	340	U	340	U	430	
Carbazole ug/kg	340	U	340	U	340	U	340	U	60	
Chrysene 180000 ug/kg	340	U	340	U	340	U	340	U	250	
Fluoranthene 17000 ug/kg	340	U	340	U	340	U	340	U	640	
Fluorene 17000 ug/kg	340	U	340	U	340	U	340	U	39	
Indeno(1,2,3-c,d)pyrene 1800 ug/kg	340	U	340	U	340	U	340	U	160	
Phenanthrene 500 ug/kg	340	U	340	U	340	U	340	U	440	
Pyrene 10000 ug/kg	340	U	340	U	340	U	340	U	420	
bis(2-Ethylhexyl)phthalate 92000 ug/kg	340	U	340	U	340	U	37		340	U
METALS (CLP)										
Arsenic 5800 mg/kg	0.42	U	0.42	U	0.6	()	0.68	()	1.5	L
Chromium 18000 mg/kg	2.9		2.4		5		4.9		7	
Copper 20000 mg/kg	1.6	U	1.6	U	1.9	()	1.9	()	6.6	J
Lead 21000 mg/kg	3.8		2.1		2.1		5.5		13.5	J
Nickel 20000 mg/kg	3.7	U	3.7	U	3.7	()	3.7	U	3.7	
Total Petroleum Hydrocarbons mg/kg	18		13.5		6.3	BRL	9.9		382	

Only those analytes detected in one or more samples are shown

() Value is between IDL and the CRDL
B Compound or analyte detected in field or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
* Field Replicate of PC-CG3-SB11-SS0-02
** Field Replicate of PC-CG3-SB13-SS00-02

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Table 3-11 Data Summary Table: Subsurface Soil, Site 3-Former Site of County Garage
Alpena CRTC, Alpena, Michigan

Locator:		SB11		SB11		SB12		SB12		SB13	
Sample ID:		PC-CG3-SB11-SS04-06		PC-CG3-SB11-SS10-12		PC-CG3-SB12-SS04-06		PC-CG3-SB12-SS10-12		PC-CG3-SB13-SS04-06	
Collection Date:		26-AUG-93		26-AUG-93		26-AUG-93		26-AUG-93		26-AUG-93	
Associated Field QC Samples:		FB04,FB05,TB19,ER10		FB04,FB05,TB18,ER16		FB04,FB05,TB19,ER10		FB04,FB05,TB18,ER16		FB04,FB05,TB19,ER10	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)											
1,3-Dimethylbenzene	5600 ug/kg	3.3	U	3.3	U	3.3	U	3.4	U	3.3	U
HALOGENATED VOLATILES (8010)											
1,1,2,2Tetrachloroethane	3.6 ug/kg	0.62	U	0.63	UJ	0.62	U	0.63	U	0.33	J
1,2,3Trichloropropane	800 ug/kg	0.93	U	0.94	UJ	0.93	U	0.95	U	0.50	J
Trichloroethylene	44 ug/kg	0.82	U	0.83	UJ	0.82	U	0.84	U	0.2	J
SEMI-VOLATILES (CLP 3/90)											
2-Methylnaphthalene	220 ug/kg	340	U	340	U	340	U	340	U	340	U
Acenaphthene	24000 ug/kg	340	U	340	U	340	U	340	U	340	U
Anthracene	140000 ug/kg	340	U	340	U	340	U	340	U	340	U
Benzo(a)anthracene	1800 ug/kg	340	U	340	U	340	U	340	U	340	U
Benzo(a)pyrene	180 ug/kg	340	U	340	U	340	U	340	U	340	U
Benzo(b)fluoranthene	1800 ug/kg	340	U	340	U	340	U	340	U	340	U
Benzo(ghi)perylene	ug/kg	340	U	340	U	340	U	340	U	340	U
Benzo(k)fluoranthene	1800 ug/kg	340	U	340	U	340	U	340	U	340	U
Carbazole	ug/kg	340	U	340	U	340	U	340	U	340	U
Chrysene	180000 ug/kg	340	U	340	U	340	U	340	U	340	U
Dibenzofuran	ug/kg	340	U	340	U	340	U	340	U	340	U
Fluoranthene	17000 ug/kg	340	U	340	U	340	U	340	U	340	U
Fluorene	17000 ug/kg	340	U	340	U	340	U	340	U	340	U
Indeno(1,2,3-cd)pyrene	1800 ug/kg	340	U	340	U	340	U	340	U	340	U
Naphthalene	5000 ug/kg	340	U	340	U	340	U	340	U	340	U
Phenanthrene	500 ug/kg	340	U	340	U	340	U	340	U	340	U
Pyrene	10000 ug/kg	340	U	210		340	U	45		340	U
bis(2-Ethylhexyl)phthalate	92000 ug/kg	340	U								
METALS (CLP)											
Arsenic	5800 mg/kg	0.48	(L)	0.42	U	0.41	UL	0.42	U	0.41	UL
Chromium	18000 mg/kg	3.2		2.2		2.9		2.6		3.1	
Copper	20000 mg/kg	2.7	J	1.6	U	2.7	J	1.6	U	3.1	J
Lead	21000 mg/kg	0.84	J	0.92		0.93	J	1.2		0.98	J
Total Petroleum Hydrocarbons	mg/kg	7.2		6.3	BRL	6.3	BRL	39.2		31.3	

Only those analytes detected in one or more samples are shown

() Value is between IDL and the CRDL

B Compound or analyte detected in field or lab blank

J Concentration is estimated - QC criteria not attained.

K Concentration or quantitation limit is biased high - QC criteria not attained.

L Concentration or quantitation limit is biased low- QC criteria not attained.

U Compound was analyzed for but not detected, result is sample quantitation limit.

R Data is unreliable

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Table 3-11 Data Summary Table: Subsurface Soil, Site 3-Former Site of County Garage
Alpena CRTC, Alpena, Michigan

Locator:		SB13		SB13	
Sample ID:		PC-CG3-SB13-SS08-10		PC-CG3-SB13-SS10-12	
Collection Date:		26-AUG-93		26-AUG-93	
Associated Field QC Samples:		FB04,FB05,TB19,ER10		FB04,FB05,TB19,ER10	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)					
1,3-Dimethylbenzene	5600 ug/kg	0.013		3.3	U
HALOGENATED VOLATILES (8010)					
1,1,2,2-Tetrachloroethane	3.8 ug/kg	0.62	U	0.63	U
1,2,3-Trichloropropane	800 ug/kg	0.93	U	0.94	U
Trichloroethylene	44 ug/kg	0.82	U	0.03	B
SEMI-VOLATILES (CLP 3/90)					
2-Methylnaphthalene	220 ug/kg	49		340	U
Acenaphthene	24000 ug/kg	190		340	U
Anthracene	140000 ug/kg	310		340	U
Benzo(a)anthracene	1800 ug/kg	520		340	U
Benzo(a)pyrene	180 ug/kg	350		340	U
Benzo(b)fluoranthene	1800 ug/kg	770		340	U
Benzo(ghi)perylene	ug/kg	110		340	U
Benzo(k)fluoranthene	18000 ug/kg	770		340	U
Carbazole	ug/kg	230		340	U
Chrysene	180000 ug/kg	530		340	U
Dibenzofuran	ug/kg	150	J	340	U
Fluoranthene	17000 ug/kg	1400		340	U
Fluorene	17000 ug/kg	220		340	U
Indeno(1,2,3-c,d)pyrene	1800 ug/kg	190		340	U
Naphthalene	5000 ug/kg	170		340	U
Phenanthrene	500 ug/kg	1500		340	U
Pyrene	10000 ug/kg	1000		340	U
bis(2-Ethylhexyl)phthalate	92000 ug/kg	340	U	340	U
METALS (CLP)					
Arsenic	5800 mg/kg	0.49	(L)	0.41	U
Chromium	18000 mg/kg	2.8		2.7	
Copper	20000 mg/kg	2.7	J	1.6	U
Lead	21000 mg/kg	1.2	J	1.2	
Total Petroleum Hydrocarbons	mg/kg	38.8		6.3	BRL

Only those analytes detected in one or more samples are shown

( ) Value is between IDL and the CRDL
B Compound or analyte detected in field or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
U Compound was analyzed for but not detected, result is sample quantitation limit.
R Data is unreliable

COMPUCHEM 1993

Table 3-12 Data Summary Table: Groundwater, Site 3 - Former Site of County Garage
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	MW1		MW2		MW3		MW4		MW5*		MW6	
Sample ID:	PC-CG3-MW1-GW4		PC-CG3-MW2-GW4		PC-CG3-MW3-GW4		PC-CG3-MW4-GW4		PC-CG3-MW5-GW4		PC-CG3-MW6-GW4	
Collection Date:	15-AUG-93		25-AUG-93		25-AUG-93		25-AUG-93		26-AUG-93		10-SEP-93	
Associated Field QC:	FB06,TB12,ER08		FB05,TB17,ER14		FB05,TB17,ER14		FB05,TB17,ER14		FB05,TB18,ER14		FB07,TB24	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)												
Benzene 1.2 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.51	
Ethylbenzene 74 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	1.4	
Styrene 1.2 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
HALOGENATED VOLATILES (8010)												
1,1,1,2Tetrachloroethane 1.3 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Chloroethane 9.1 ppb	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloroform 5.6 ppb	0.17		0.35	U	0.35	U	0.32		0.35	U	0.35	U
Methyl Chloride 2.7 ppb	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methylene Chloride 4.6 ppb	0.077		0.13	B	0.27	B	0.43	B	0.31	B	0.28	
Tetrachloroethylene 0.7 ppb	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
Trichloroethylene 2.2 ppb	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
SEMI-VOLATILES (CLP 3/90)												
Di-n-butyl phthalate 840 ppb	5	U	0.8		0.8		0.8		5	U	5	U
Diethyl phthalate 5200 ppb	7	J	5	U	5	U	5	U	5	U	0.5	
Dimethyl phthalate 70000 ppb	1	J	5	U	5	U	5	U	5	U	5	U
Phenol 4200 ppb	5	U	5	U	1	B	0.5	B	5	U	5	U

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-GC3-MW9-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

wp/t3-12.540- 6/14/95

Table 3-12 Data Summary Table: Groundwater, Site 3 - Former Site of County Garage
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW1		MW2		MW3		MW4		MW5*		MW6	
Sample ID:		PC-CG3-MW1-GW4		PC-CG3-MW2-GW4		PC-CG3-MW3-GW4		PC-CG3-MW4-GW4		PC-CG3-MW5-GW4		PC-CG3-MW6-GW4	
Collection Date:		15-AUG-93		25-AUG-93		25-AUG-93		25-AUG-93		26-AUG-93		10-SEP-93	
Associated Field QC:		FB06,TB12,ER08		FB05,TB17,ER14		FB05,TB17,ER14		FB05,TB17,ER14		FB05,TB18,ER14		FB07,TB24	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)[1]													
Arsenic	ppb	4	U	4	U	4	U	4	U	4	UL	9.9	()J
Cadmium	ppb	3	U	3	U	3	U	3	U	3	U	4.6	
Chromium	ppb	8	U	8	U	8	U	8	U	8	U	21.1	
Copper	ppb	4	U	4	U	5.3	()B	4	U	4	U	25.4	
Lead	ppb	2	U	2	U	2	U	2	U	2	U	12.9	
Lead, Dissolved	4 ppb	2	()	2	U	2	U	2	UL	2	UL	2	UL
Nickel	ppb	18	U	18	U	18	U	18	U	18	U	18.6	()
Selenium	ppb	3	U	3	U	3	U	4.4	()	3	U	17.2	B
Zinc	ppb	4	U	4	U	18.5	()B	6.8	()B	8.8	()B	55.9	J
Zinc, Dissolved	2300 ppb	4	U	12.7	()B	5	()B	23.8	B	20.9	B	5.9	()
Total Petroleum Hydrocarbons	ppb	1800	B	900	B	250	BRL	250	BRL	1000	B	800	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-GC3-MW9-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

Table 3-12 Data Summary Table: Groundwater, Site 3 - Former Site of County Garage
MIANG, Alpena CRTC, Alpena, Michigan

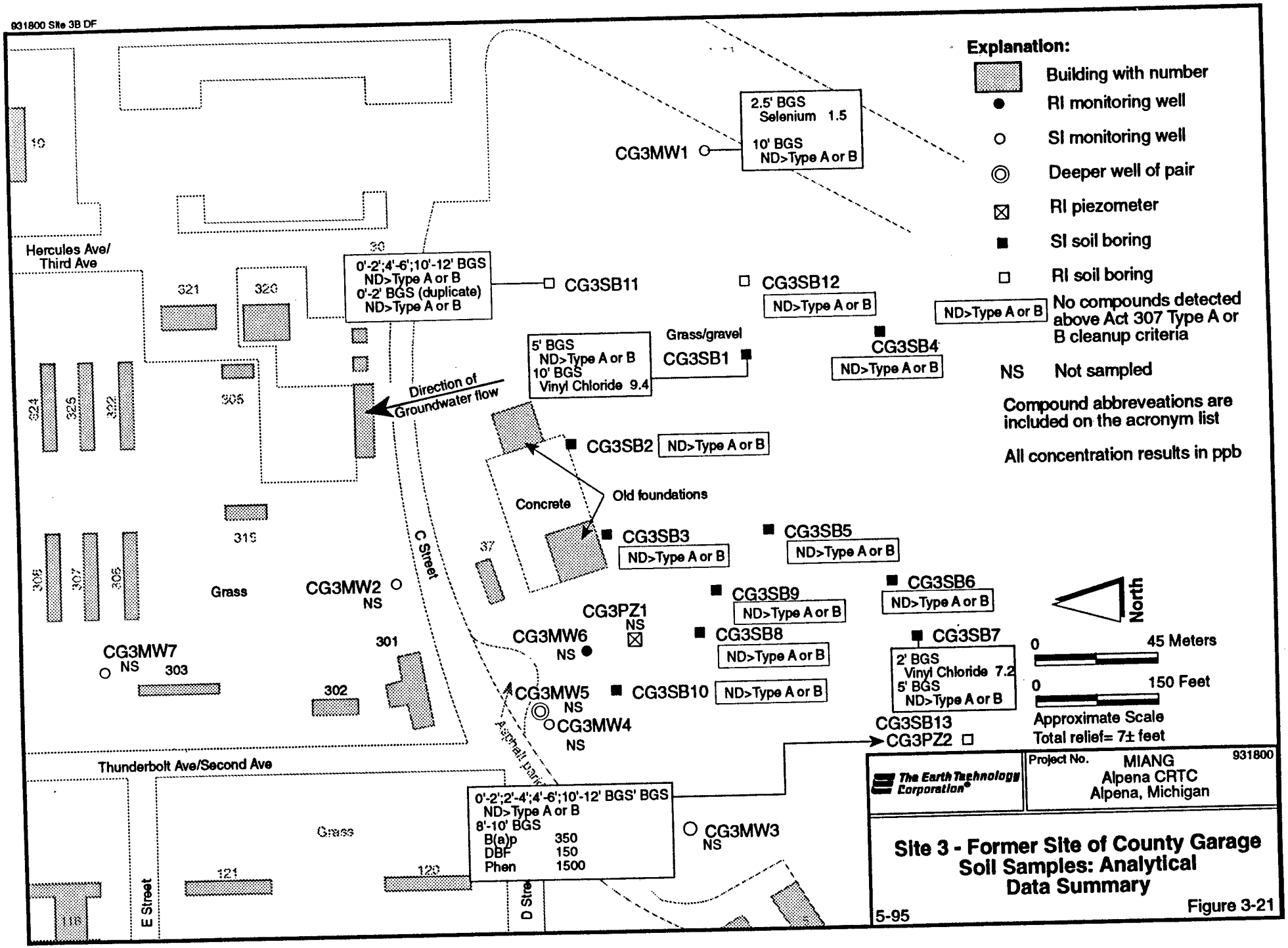
Locator:	MW7		MW9**	
Sample ID:	PC-CG3-MW7-GW4		PC-CG3-MW9-GW4	
Collection Date:	13-SEP-93		26-AUG-93	
Associated Field QC:	FB07,TB25		FB05,TB17,ER14	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)				
Benzene 1.2 ppb	0.35	U	0.35	U
Ethylbenzene 74 ppb	0.2	U	0.2	U
Styrene 1.2 ppb	0.11		0.25	U
HALOGENATED VOLATILES (8010)				
1,1,1,2-Tetrachloroethane 1.3 ppb	0.35	U	0.18	
Chloroethane 9.1 ppb	0.5	U	0.14	
Chloroform 5.6 ppb	0.63		0.13	
Methyl Chloride 2.7 ppb	0.5	U	0.14	
Methylene Chloride 4.6 ppb	0.31	B	0.35	B
Tetrachloroethylene 0.7 ppb	0.3	U	0.079	
Trichloroethylene 2.2 ppb	0.3	U	0.07	
SEMI-VOLATILES (CLP 3/90)				
Di-n-butyl phthalate 840 ppb	5	U	5	U
Diethyl phthalate 5200 ppb	5	U	5	U
Dimethyl phthalate 70000 ppb	5	U	5	U
Phenol 4200 ppb	0.8		0.8	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
** Duplicate of PC-CG3-MW5-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

Table 3-12 Data Summary Table: Groundwater, Site 3 - Former Site of County Garage
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			MW7		MW9**	
Sample ID:			PC-CG3-MW7-GW4		PC-CG3-MW9-GW4	
Collection Date:			13-SEP-93		26-AUG-93	
Associated Field QC:			FB07,TB25		FB05,TB17,ER14	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)[1]						
Arsenic		ppb	4	U	4	UL
Cadmium		ppb	5	U	3	U
Chromium		ppb	10	U	8	U
Copper		ppb	15	U	4	U
Lead		ppb	2	U	2	U
Lead, Dissolved	4	ppb	2	U	2	UL
Nickel		ppb	35	U	18	U
Selenium		ppb	5.3	B	3	U
Zinc		ppb	10.9	(J	73.2	B
Zinc, Dissolved	2300	ppb	4	U	21.8	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
** Duplicate of PC-CG3-MW5-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only


931800 Site 3B DF
Explanation:
Building with number
RI monitoring well
SI monitoring well
Deeper well of pair
RI piezometer
SI soil boring
RI soil boring
No compounds detected above Act 307 Type A or B cleanup criteria
NS Not sampled
Compound abbreveations are included on the acronym list
All concentration results in ppb
2.5' BGS Selenium 1.5
10' BGS ND>Type A or B
CG3MW1
Hercules Ave/ Third Ave
0'-2';4'-6';10'-12' BGS ND>Type A or B
0'-2' BGS (duplicate) ND>Type A or B
CG3SB11
CG3SB12
ND>Type A or B
ND>Type A or B
CG3SB4
ND>Type A or B
5' BGS ND>Type A or B
10' BGS Vinyl Chloride 9.4
Grass/gravel
CG3SB1
Direction of Groundwater flow
CG3SB2 ND>Type A or B
Concrete
Old foundations
CG3SB3 ND>Type A or B
CG3SB5 ND>Type A or B
C Street
Grass
CG3MW2 NS
CG3PZ1 NS
CG3SB9 ND>Type A or B
CG3SB6 ND>Type A or B
CG3MW6 NS
CG3SB8 ND>Type A or B
CG3SB7
2' BGS Vinyl Chloride 7.2
5' BGS ND>Type A or B
CG3MW7 NS
CG3MW5 NS
CG3SB10 ND>Type A or B
CG3MW4 NS
CG3SB13
CG3PZ2
North
0 45 Meters
0 150 Feet
Approximate Scale
Total relief= 7± feet
Thunderbolt Ave/Second Ave
0'-2';2'-4';4'-6';10'-12' BGS' BGS ND>Type A or B
8'-10' BGS
B(a)p 350
DBF 150
Phen 1500
CG3MW3 NS
Grass
E Street
D Street
Asphalt parking
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Site 3 - Former Site of County Garage
Soil Samples: Analytical
Data Summary
5-95
Figure 3-21

0.18 µg/kg) were found in the surface soils. No VOCs were detected in concentrations exceeding Act 307 Type B cleanup criteria. Fifteen individual SVOCs were detected in the soils including many compounds from the PAH group. No SVOCs were detected above Act 307 Type B cleanup criteria. TPH was detected in two of the four samples in concentrations of 13.5 and 18 mg/kg. Arsenic, chromium, copper, lead, and nickel were all found in one or more surface soil samples. However, none of these metals were detected in concentrations exceeding Act 307 Type A cleanup criteria. 1,2-Dichlorobenzene, toluene, and 1,4-dichlorobenzene were detected in SB13-SS00-02. Soil boring SB11-SS00-02 contains 1,4-dichlorobenzene.

Subsurface Soils

The subsurface soil samples collected and analyzed during the SI (Appendix O) and during the RI (Table 3-11) were used to evaluate the nature and extent of soil contamination of Site 3. A variety of organic compounds were detected in the Site 3 subsurface soils including vinyl chloride, BTEX, and PAHs. However, a review of these data indicate only a few compounds were quantified in concentrations exceeding the Act 307 Type B cleanup criteria (Figure 3-21). These compounds are vinyl chloride (CG3SB1 and CG3SB7) and SVOCs belonging to the PAH group of chemicals. As presented in Figure 3-21, the detections of vinyl chloride found within site soils during the SI are limited in areal extent. PAHs exceeding Act 307 Type B cleanup criteria were detected in the 8 to 10 ft sample collected from CG3SB13, but were not found in the other 3 subsurface soil samples collected from CG3SB13, or from borings around CG3SB13. Although not present in concentrations exceeding Act 307 Type B cleanup criteria, toluene, ethylbenzene and xylenes were found in the 15 ft sample from SB8. This sample was collected from the approximate depth of the water table at Site 3 and likely indicates groundwater rather than soil contamination. The 5 ft sample from this same boring did not contain VOCs or SVOCs. TPH was detected in the subsurface soils in concentrations ranging from 7.2 to 4600 mg/kg.

Of the metals found in Site 3 subsurface soils only selenium (1.5 mg/kg) in a soil sample collected in 1987 during the SI from CG3MW1 was quantified at a concentration exceeding Act 307 Type A cleanup criteria.

3.4.4.2 Groundwater Results

Analytical results obtained for the seven Site 3 monitoring wells sampled during the summer 1993 (Round IV) are presented in Table 3-12. The analytical data from the previous three rounds of sampling are included in Appendices N and O.

A review of the summer 1993 (Round IV) data indicate chloroform, methylene chloride, dimethyl and diethyl phthalate, benzene, ethylbenzene, styrene, phenol, 1,1,1,2-PCA, chloroethane, chloromethane, PCE, and TCE were each detected in one or more of the groundwater samples. Although detected, none of these compounds were quantified in concentrations exceeding Act 307 Type B cleanup criteria.

The inorganic analytical results for the fourth round of filtered and unfiltered groundwater samples collected from Site 3 monitoring wells are presented in Table 3-12. Arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc were quantified in site groundwater samples and a majority of the positive detections were found in the unfiltered samples. Only arsenic, copper, and zinc were quantified in the filtered samples. These same metals were detected exceeding Act 307 Type A cleanup criteria in the unfiltered samples from CG3MW6. However, these unfiltered samples were generally turbid and this groundwater could likely not be used as collected for domestic purposes. Analytical results from the corresponding filtered sample shows the filtering process reduced the arsenic, copper, and zinc concentrations to less than the Act 307 Type A cleanup criteria in these samples.

Chloromethane, TPH, and various inorganics were detected during the November 1987, August 1988, or October 1991 rounds of groundwater sampling. Only manganese detected at a concentration of 550 $\mu g/\ell$ in the samples collected from well CG3MW5 was found at concentrations exceeding the Act 307 Type A or B cleanup criteria during the previous rounds of sampling.

3.4.5 Summary and Conclusions

The following summarizes the findings of the subsurface investigations conducted at Site 3:

- Shallow aquifer materials beneath Site 3 are composed of quartz sand. The sand section is approximately 16.8 m (55 ft) thick. Below this sand lies a clay aquitard up to 3 m (10 ft) in thickness separating the shallow aquifer from the limestone bedrock aquifer.

- Vinyl chloride, benzo(a)pyrene, and phenanthrene were detected in Site 3 subsurface soils in concentrations exceeding Act 307 Type B cleanup criteria. The occurrences of compounds exceeding Act 307 criteria appear to be of limited areal and vertical extent. Only one inorganic from one sample (selenium) was detected at concentrations exceeding Act 307 Type A cleanup criteria.

- Groundwater occurs at depths between approximately 3.4 and 5.8 m (11 and 19 ft) bgs beneath Site 3 and flows northwest. Analytical results from the summer 1993 (Round IV) of groundwater sampling indicate no compounds were detected in concentrations exceeding Act 307 B cleanup criteria. Also, no inorganics were detected in the Round IV filtered groundwater samples in concentrations exceeding the Act 307 Type A cleanup criteria.

3.5 SITE 4 THIRD FIRE TRAINING AREA

Several field events have been conducted to support the RI at Site 4. The results for some of these field efforts are contained in separate, stand-alone documents and will not be fully reproduced in this RI report. The following activities were completed at Site 4:

- Surface geophysical surveys were conducted at Site 4 during September and October 1992. Complete results are presented in the Final Draft Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, April 1993). Summaries of the geophysical results are included in the Site 4 geology and hydrogeology sections.

- Soil samples were collected and analyzed at Site 4 in January 1993. These data were collected to provide additional data necessary to complete the SRAP (The Earth Technology Corporation, May 1994).

3.5.1 Results of Previous Investigations

The results of the PA (Hazardous Materials Technical Center, 1985) and the SI (Engineering-Science, 1990) recommended two areas at Site 4 for further investigation: soil at and surrounding Site 4, and the sinkhole directly adjacent to Site 4.

As stated previously, the soil at Site 4 has been recommended for a removal action. Chemicals detected in Site 4 soils exceeding the Act 307 Type B cleanup criteria include benzene and several SVOCs such as naphthalene and 2-methylnaphthalene.

The 1990 SI Report presented data suggesting that past fire training exercises may have had a negative impact on the surface water and sediment quality in the sinkhole. The surface water samples obtained from the springs discharging into the sinkhole contained low concentrations of petroleum hydrocarbons. Sediment samples contained TPH in relatively high concentrations from the base of the drainage gully leading from Site 4 to the sinkhole (230 mg/kg) and from the deepest part of the sinkhole (4,100 mg/kg). Toluene was also detected from the bottom sediments at a concentration of 130 μg/kg.

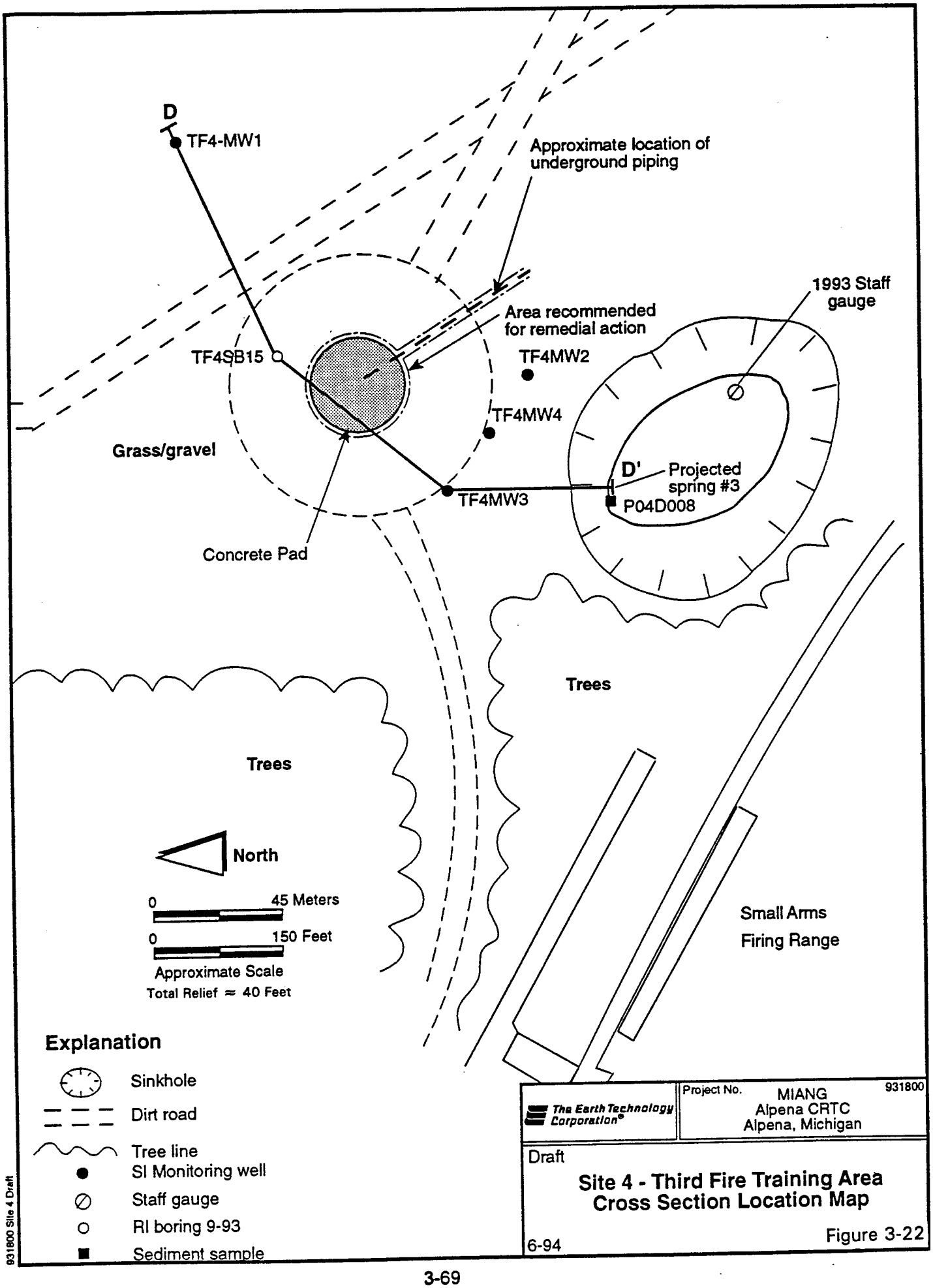
Results from groundwater sampling completed in November 1987 (Round I) and in August 1988 (Round II) indicated that the FTA has had little measurable adverse impact on groundwater quality in the shallow aquifer beneath Site 4. These results were confirmed during the October 1991 (Round III) sampling.

3.5.2 Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC is presented in Section 1.7.9. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.5.2.1 Geology

The location of a north-south oriented geologic cross-section constructed across Site 4 is shown in Figure 3-22. The cross-section is presented in Figure 3-23, and illustrates the


D
TF4-MW1
Approximate location of underground piping
1993 Staff gauge
Area recommended for remedial action
TF4SB15
TF4MW2
TF4MW4
Grass/gravel
D'
Projected spring #3
P04D008
TF4MW3
Concrete Pad
Trees
Trees
North
0 45 Meters
0 150 Feet
Approximate Scale
Total Relief ≈ 40 Feet
Small Arms Firing Range
Explanation
Sinkhole
Dirt road
Tree line
SI Monitoring well
Staff gauge
RI boring 9-93
Sediment sample
The Earth Technology Corporation®
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 4 - Third Fire Training Area
Cross Section Location Map
6-94
Figure 3-22
931800 Site 4 Draft

subsurface relationships observed during the field investigations. As shown on the cross-section, the subsurface material underlying the Third FTA consists mainly of massive, poorly graded (well sorted), medium- to coarse-grained, quartz sand containing trace to minor amounts of silt and/or clay. This sand unit is present to a depth of approximately 35 ft bgs, based on results obtained from the borings or wells drilled at Site 4 which fully penetrate the shallow aquifer. The sand unit is underlain by a sandy clay/clay unit ranging in thickness from 2 to 5 ft. Results of geotechnical analysis (Appendix C) completed on this unit obtained from boring TF4SB15 indicate this unit is actually a clayey silty sand and has a measured vertical permeability of 1.4×10^{-5} cm/sec. Limestone bedrock was encountered beneath the sandy clay/clay in TF4SB15, -MW2, and -MW3 at depths ranging from 38 to 42 ft bgs. The geophysical surveys indicated the top of a sandy clay unit, 34 ft bgs, and limestone at a depth of 39 ft bgs, to be in good agreement with the results obtained during the drilling operations.

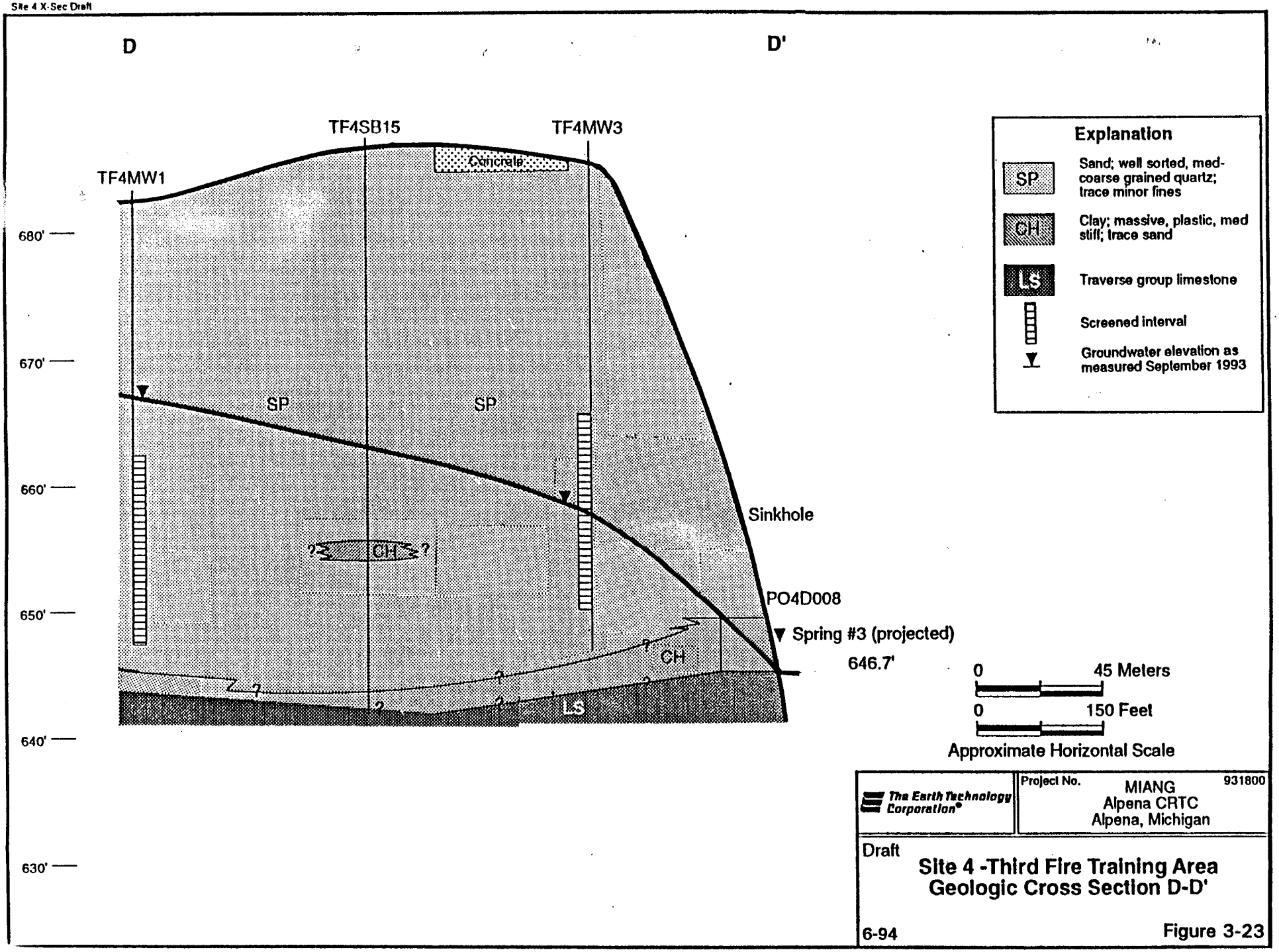
3.5.2.2 Hydrogeology

Four monitoring wells (TF4MW1 through TF4MW4) were installed at Site 4 during the SI field effort. Previous rounds of groundwater elevation measurements have shown the water table occurs within the shallow aquifer at depths ranging from 21 to 25 ft bgs. As illustrated in Figure 3-24, flow within the shallow aquifer is directed to the south-southwest (towards the sinkhole) beneath the site at an average hydraulic gradient of 0.0012.

Figures 1-19 through 1-21, 3-23, and 3-24 illustrate the hydraulic relationship between the shallow aquifer and the sinkhole. The sinkhole is a discharge point for the groundwater contained in the shallow aquifer. The surface water elevation of the sinkhole is assumed to be the same as the groundwater elevation of the limestone aquifer at this particular location. When groundwater reaches the sinkhole, it emerges from springs at the bottom of the sinkhole. The elevations of the springs are generally 5 to 7 ft above the elevation of the sinkhole surface water (Figure 3-23). Figure 3-25 shows the distribution of these springs around the base of the sinkhole. Springs are generally absent along the northwestern edge of the sinkhole and are more common along the southern and eastern edges of the sinkhole. Spring elevations, as shown in Figure 3-23 appear to correlate with the top of the sandy clay/clay unit described in the subsurface beneath Site 4. This suggests that some groundwater within the shallow aquifer is moving horizontally along the sand/sandy clay/clay unit boundary and discharging into the sinkhole rather than being transmitted vertically through the sandy clay unit into the limestone.

3.5.3 Screening Results

No initial site screening was conducted at Site 4. On-site GC screening was conducted for the soil samples collected from TF4SB15.



The Earth Technology Corporation

Project No. 931800

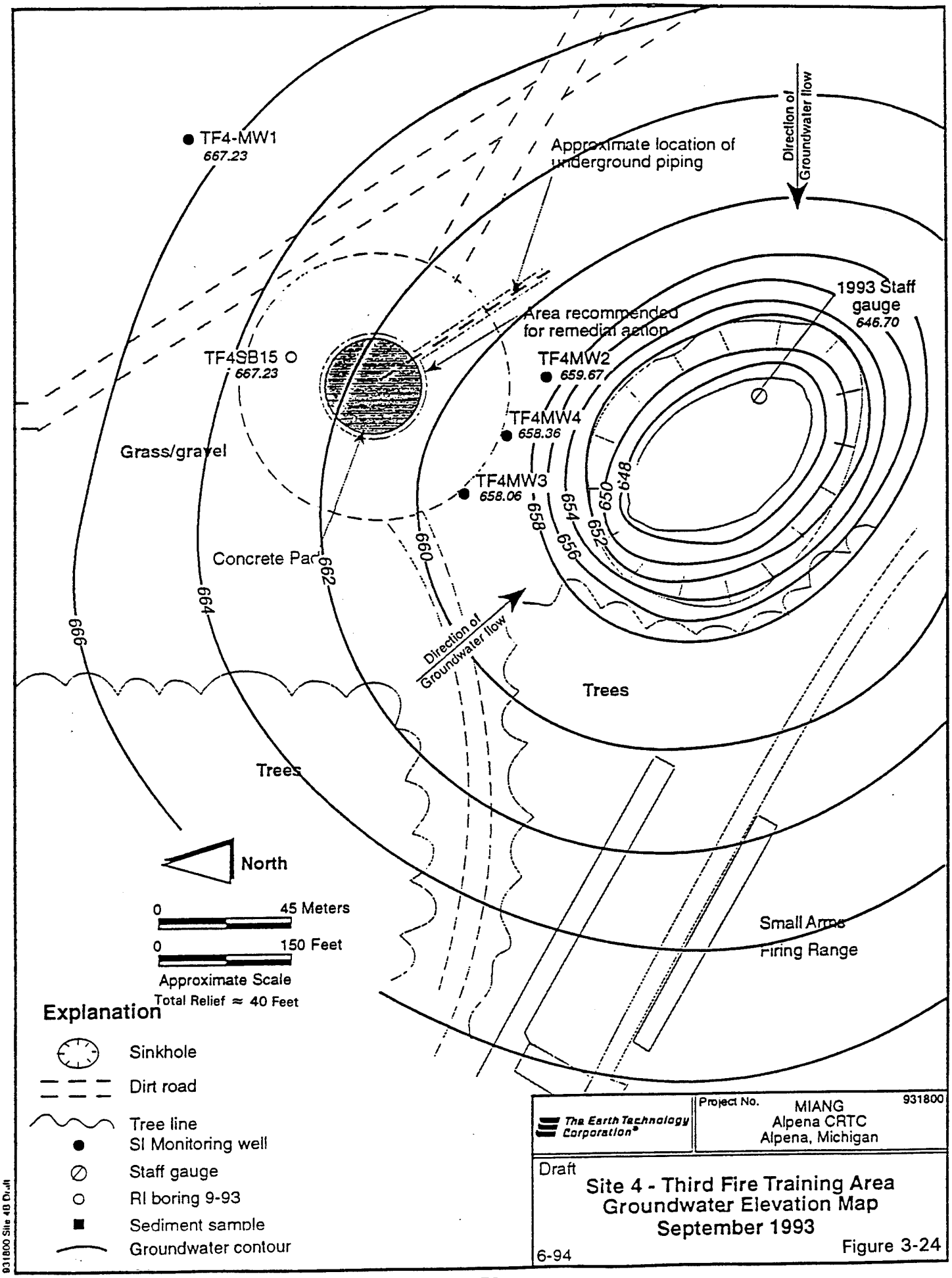
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Alpena, Michigan

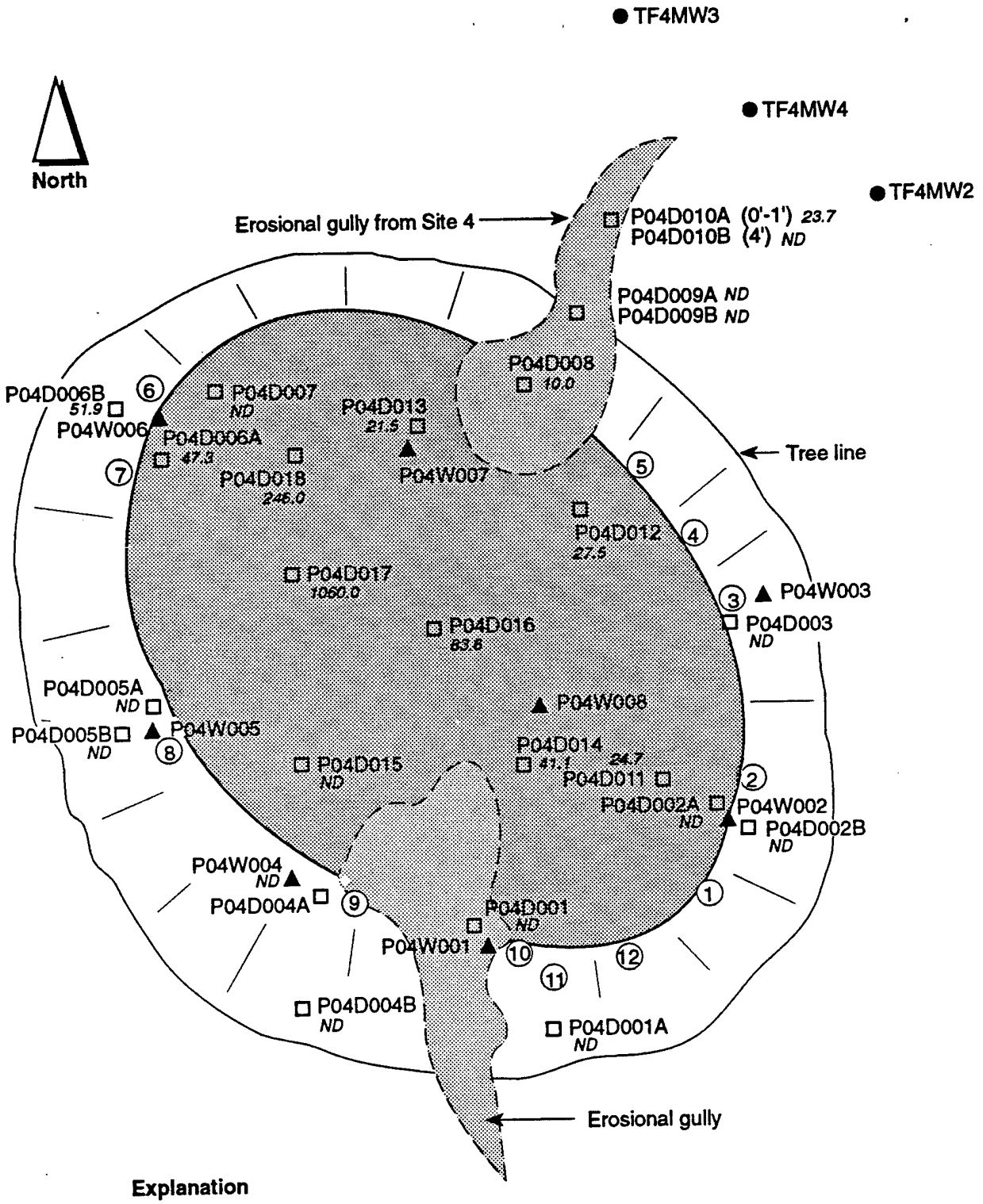
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Site 4 -Third Fire Training Area
Geologic Cross Section D-D'

6-94

Figure 3-23


TF4-MW1
667.23
Approximate location of underground piping
Direction of Groundwater flow
1993 Staff gauge
646.70
Area recommended for remedial action
TF4SB15
667.23
TF4MW2
659.67
TF4MW4
658.36
TF4MW3
658.06
Grass/gravel
Concrete Pad
Direction of Groundwater flow
Trees
Trees
Small Arms Firing Range
North
0 45 Meters
0 150 Feet
Approximate Scale
Total Relief ≈ 40 Feet
Explanation
Sinkhole
Dirt road
Tree line
SI Monitoring well
Staff gauge
RI boring 9-93
Sediment sample
Groundwater contour
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 4 - Third Fire Training Area
Groundwater Elevation Map
September 1993
6-94
Figure 3-24



Explanation

- Sand delta/erosional gully
- Slope
- □ Sediment sample
- (1) Spring location
- ▲ Surface water sample
- *ND* Non detect
- *21.5* TPH concentration in mg/kg

Total Relief ≈ 40 Feet

The Earth Technology Corporation®

Project No. 931800

MIANG
Alpena CRTC
Alpena, Michigan

Draft

Sinkhole Sediment Analytical Summary for TPH

6-94

Figure 3-25

Site 4 Sinkhole Draft

3.5.3.1 Soil Boring Placement Rationale

Data regarding the existence of the clay layer between the site and the sinkhole was obtained during the SI by the drilling and installation of wells TF4MW2, -MW3, and -MW4. Boring TF4SB15 was drilled during the RI to investigate the clay layer on the northern side of the site. Based on the hydrogeologic data available prior to the initiation of field work, it was determined that no additional shallow aquifer groundwater monitoring wells were needed at the site.

3.5.3.2 On-Site Screening During Drilling Operations

Soil boring (TF4SB15) was drilled at Site 4 during the RI confirmation activities. Five soil samples were collected from this boring. No VOCs were detected during the field GC analysis from any of the five samples (Appendix E).

3.5.4 Confirmation Results

Analytical results for the organic and inorganic compounds detected from the sediment, surface water, and groundwater samples collected during the RI field sampling are included in Tables 3-13 through 3-15, respectively. A presentation and discussion of the significance of these results including the occurrence of compounds exceeding Act 307 Type A or B cleanup criteria is included in the following subsections.

3.5.4.1 Sediment Sampling Results

Sediment samples were collected at the head and mouth of the six major springs (locations P04D001 through P04D006) feeding the sinkhole. Sample locations P04D008 through P04D010 were collected from within the large gully on the north side of the sinkhole which is suspected to have channelled runoff from the Third FTA to the sinkhole. Sediment sample locations P04D007, and P04D011 through P04D018 were located within the sinkhole. Sediment sample locations and their associated TPH concentrations are presented in Figure 3-25.

As presented in Table 3-13, 2,2'-oxybis (1-chloropropane), methyl-t-butyl ether, chloroform, di-n-butyl-phthalate, 4-methylphenol (2 detections), TCE, toluene, and methylene chloride (9 detections) were each quantified in at least one sediment sample. There are no Act 307 chemical-specific criteria which specifically address sediment quality. Excluding the methylene chloride detections, only sample number TF4D106B contained more than one individual organic compound.

TPH was detected in 12 of the 28 samples in concentrations ranging from 10 to 1060 mg/kg, with the highest concentration detected in P04D017. This sample was collected from the

Table 3-13 Data Summary Table: Sediment, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD001		SD001A		SD002A		SD002B		SD003		SD004A	
Sample ID:		PC-TF4-SD001		PC-TF4-SD001A		PC-TF4-SD002A		PC-TF4-SD002B		PC-TF4-SD003		PC-TF4-SD004A	
Collection Date:		29-JUL-93		29-JUL-93		29-JUL-93		29-JUL-93		29-JUL-93		30-JUL-93	
Associated Field QC:		FB01,FB02,TB02,ER01		FB01,FB02,TB02,ER01		FB01,FB02,TB02,ER01		FB01,FB02,TB02,ER01		FB01,FB02,TB02,ER01		FB01,FB02,TB03,ER01	
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
Methyl-t-butyl ether	ppb	24	U	16	U	18	U	16	U	15	U	14	U
Toluene	ppb	12	U	7.6	U	8.5	U	7.7	U	7.2	U	7	U
HALOGENATED VOLATILES (8010)													
Chloroform	ppb	1.1	B	0.95	B	1.5	B	0.98	B	1	B	0.95	B
Methylene Chloride	ppb	1.9	B	4.2		3	L	5.6		12		4.9	
Trichloroethylene	ppb	1.8	U	1.1	U	1.3	UL	1.2	U	1.1	U	1.1	U
SEMI-VOLATILES (CLP 3/90)													
2,2'-Oxybis(1-Chloropropane)	ppb	730	U	470	U	530	U	470	U	440	U	430	U
4-Methylphenol	ppb	730	U	470	U	130	J	470	U	440	U	430	U
Di-n-butyl phthalate	ppb	730	U	470	U	56		470	U	440	U	430	U
METALS (CLP 3/90)													
Arsenic	ppb	2300		790	()	770	()L	600	()	780	()	530	()
Chromium	ppb	10000		3800		3200		4000		4600		3100	
Lead	ppb	4500	B	930	B	1300	B	900	B	3000	B	1900	B
Nickel	ppb	4500	()J	2600	U	2900	U	2600	U	2400	U	2400	U
Selenium	ppb	1100		430	U	480	U	430	U	420	()L	390	U
Total Petroleum Hydrocarbons	ppb	6300	BRL	6300	BRL	6300	BRL	6300	BRL	6300	BRL	6300	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
No Act 307 criteria available for sediments

wp/t3-13.540- 6/14/95

Table 3-13 Data Summary Table: Sediment, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD004B*		SD005A		SD005B		SD006A		SD006B**		SD007	
Sample ID:		PC-TF4-SD004B		PC-TF4-SD005A		PC-TF4-SD005B		PC-TF4-SD006A		PC-TF4-SD006B		PC-TF4-SD007	
Collection Date:		30-JUL-93		30-JUL-93		30-JUL-93		30-JUL-93		30-JUL-93		31-JUL-93	
Associated Field QC:		FB01,FB02,TB03,ER01		FB01,FB02,TB03,ER01		FB01,FB02,TB03,ER01		FB01,FB02,TB03,ER03		FB01,FB02,TB03,ER03		FB01,FB02,TB04,ER03	
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
Methyl-t-butyl ether	ppb	14	U	21	U	15	U	15	U	16	U	15	U
Toluene	ppb	7	U	10	U	7.5	U	7.1	U	7.6	U	7.1	U
HALOGENATED VOLATILES (8010)													
Chloroform	ppb	1.1	B	1.1	B	0.95	B	0.57	B	0.74	B	0.82	B
Methylene Chloride	ppb	4		18	B	16		2.9	B	2.7	B	4.7	B
Trichloroethylene	ppb	1.1	U	1.5	U	1.1	U	0.089	J	1.1	U	1.1	U
SEMI-VOLATILES (CLP 3/90)													
2,2'-Oxybis(1-Chloropropane)	ppb	430	U	630	U	430	U	430	U	470	U	430	U
4-Methylphenol	ppb	430	U	630	U	430	U	430	U	470	U	430	U
Di-n-butyl phthalate	ppb	430	U	630	U	430	U	430	U	470	U	430	U
METALS (CLP 3/90)													
Arsenic	ppb	1100	()	1200	()	540	U	1700		1300	()	530	U
Chromium	ppb	3500		6300		4100		4100		3600		2400	
Lead	ppb	1600		8100	B	1600	B	3800	B	1200	B	930	B
Nickel	ppb	2400	U	3500	U	2400	U	2400	U	2600	U	2400	U
Selenium	ppb	400	UL	720	()L	400	U	400	U	430	U	400	U
Total Petroleum Hydrocarbons	ppb	6300	BRL	6300	BRL	6300	BRL	47300		51900		6300	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-TF4-SD104B
** Duplicate of PC-TF4-SD106B
LAB: COMPUCHEM
No Act 307 criteria available for sediments

Table 3-13 Data Summary Table: Sediment, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD008		SD009A		SD009B		SD010A		SD010B		SD011	
Sample ID:		PC-TF4-SD008		PC-TF4-SD009A		PC-TF4-SD009B		PC-TF4-SD010A		PC-TF4-SD010B		PC-TF4-SD011	
Collection Date:		31-JUL-93		31-JUL-93		31-JUL-93		31-JUL-93		31-JUL-93		01-AUG-93	
Associated Field QC:		FB01,FB02,TB04,ER03		FB01,FB02,TB04,ER03		FB01,FB02,TB04,ER03		FB01,FB02,TB04,ER03		FB01,FB02,TB04,ER03		FB01,FB02,TB05,ER03	
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
Methyl-t-butyl ether	ppb	14	U	11	UJ	14	U	17	UJ	11	UJ	14	U
Toluene	ppb	7	U	5.5	UJ	6.7	U	8.2	UJ	0.082	J	7	U
HALOGENATED VOLATILES (8010)													
Chloroform	ppb	0.72	B	0.68	B	0.74	B	0.82	B	0.54	B	1.2	B
Methylene Chloride	ppb	4	U	1.9		1.3	U	1.5	U	2.7	B	2	B
Trichloroethylene	ppb	1.1	U	0.83	U	1	U	1.2	U	0.83	R	1.1	U
SEMI-VOLATILES (CLP 3/90)													
2,2'-Oxybis(1-Chloropropane)	ppb	430	U	340	U	410	U	500	U	340	U	430	U
4-Methylphenol	ppb	430	U	340	U	410	U	500	U	340	U	430	U
Di-n-butyl phthalate	ppb	430	U	340	U	410	U	500	U	340	U	430	U
METALS (CLP 3/90)													
Arsenic	ppb	530	U	610	()L	900	()	850	()L	650	()L	530	UJ
Chromium	ppb	3900		2900		5600		4400		2400		2900	
Lead	ppb	4600	B	3900	B	1100	B	14500	B	3400	B	770	B
Nickel	ppb	2400	U	1900	U	4500	()J	3000	()J	2500	()J	4600	U
Selenium	ppb	390	U	310	U	380	U	460	U	310	UL	400	U
Total Petroleum Hydrocarbons	ppb	10000		6300	BRL	6300	BRL	23700		63000	BRL	24700	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
No Act 307 criteria available for sediments

Table 3-13 Data Summary Table: Sediment, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD012		SD013		SD014		SD015*		SD016		SD017	
Sample ID:		PC-TF4-SD012		PC-TF4-SD013		PC-TF4-SD014		PC-TF4-SD015		PC-TF4-SD016		PC-TF4-SD017	
Collection Date:		01-AUG-93		01-AUG-93		01-AUG-93		01-AUG-93		01-AUG-93		01-AUG-93	
Associated Field QC:													
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
Methyl-t-butyl ether	ppb	15	U	15	U	3.8		15	U	21	U	73	UJ
Toluene	ppb	7.4	U	7.3	U	7.1	U	7.1	U	10	U	35	UJ
HALOGENATED VOLATILES (8010)													
Chloroform	ppb	1	B	1.1	B	1.2	B	0.96	B	0.92	B	3.2	J
Methylene Chloride	ppb	2.1	B	4.9	B	4.1	UJ	1.3	U	5.9	U	0.77	B
Trichloroethylene	ppb	1.1	U	1.1	U	1.1	U	1.1	U	1.5	U	5.3	UJ
SEMI-VOLATILES (CLP 3/90)													
2,2'-Oxybis(1-Chloropropane)	ppb	450	U	450	U	430	U	440	U	630	U	1800	U
4-Methylphenol	ppb	450	U	450	U	430	U	440	U	630	U	1800	U
Di-n-butyl phthalate	ppb	450	U	450	U	430	U	440	U	630	U	1800	U
METALS (CLP 3/90)													
Arsenic	ppb	830	()J	710	()J	680	()J	530	U	950	()J	15600	J
Chromium	ppb	2400		3300		3300		2800		4800		32200	
Lead	ppb	1700	B	1300	B	2300	B	770	B	2200	B	7300	B
Nickel	ppb	4900	U	4800	U	4600	U	2400	U	6700	U	23500	U
Selenium	ppb	420	U	410	U	400	UL	400	UL	580	U	3300	()
Total Petroleum Hydrocarbons	ppb	27500		21500		41100		22300		83600		1060000	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1;2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-TF4-SD115
LAB: COMPUCHEM
No Act 307 criteria available for sediments

Table 3-13 Data Summary Table: Sediment, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SD018		SD104B*		SD106B**		SD115***	
Sample ID:		PC-TF4-SD018		PC-TF4-SD104B		PC-TF4-SD106B		PC-TF4-SD115	
Collection Date:		01-AUG-93		30-JUL-93		30-JUL-93		01-AUG-93	
Associated Field QC:									
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)									
Methyl-t-butyl ether	ppb	35	U	15	U	16	U	15	U
Toluene	ppb	17	U	7.2	U	7.9	U	7.1	U
HALOGENATED VOLATILES (8010)									
Chloroform	ppb	2.1	B	1.1	B	0.99	B	1.2	B
Methylene Chloride	ppb	6.2		3.3	B	3.9	B	6.9	B
Trichloroethylene	ppb	2.6	U	1.1	U	1.2	U	1.1	U
SEMI-VOLATILES (CLP 3/90)									
2,2'-Oxybis(1-Chloropropane)	ppb	900	U	440	U	120		430	U
4-Methylphenol	ppb	900	U	440	U	54	J	430	U
Di-n-butyl phthalate	ppb	900	U	440	U	490	U	430	U
METALS (CLP 3/90)									
Arsenic	ppb	3700	J	850	()	1300	()	530	J
Chromium	ppb	12300		3800		4200		2100	
Lead	ppb	1600	B	1400	B	1900	B	800	B
Nickel	ppb	11200	U	2600	()J	2700	U	4600	U
Selenium	ppb	1200	()	400	U	450	U	400	U
Total Petroleum Hydrocarbons	ppb	246000		6300	BRL	593000		10300	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-TF4-SD004B
** Duplicate of PC-TF4-SD006B
*** Duplicate of PC-TF4-SD0015
LAB: COMPUCHEM
No Act 307 critieria available for sediments

Table 3-14 Data Summary Table: Surfacewater, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SW001		SW002		SW003		SW004		SW005		SW006	
Sample ID:		PC-TF4-SW001		PC-TF4-SW002		PC-TF4-SW003		PC-TF4-SW004		PC-TF4-SW005		PC-TF4-SW006	
Collection Date:		28-JUL-93		28-JUL-93		28-JUL-93		28-JUL-93		30-JUL-93		30-JUL-93	
Associated Field QC:		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB03,ER02		FB01,TB03,ER02	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	7 ppb	1	B	0.15	U	0.15	U	0.15	U	0.15	U	0.16	
1,2-Dimethylbenzene	59 ppb	0.17		0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Chlorobenzene	71 ppb	0.085		0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Ethylbenzene	31 ppb	0.11		0.15		0.2	U	0.16		0.2	U	0.2	U
Styrene	19 ppb	0.19		0.14	J	0.25	U	0.25	U	0.25	U	0.25	U
HALOGENATED VOLATILES (8010)													
1,2-Dichloropropane	64 ppb	0.3	U	0.3	U	0.3	U	0.062		0.3	U	0.3	U
Chloroform	43 ppb	0.13		0.35	U	0.35	U	0.78	J	0.18		0.2	
Methyl Chloride	NA ppb	0.5	U	0.5	U	0.5	U	0.07	J	0.5	U	0.5	U
Methylene Chloride	59 ppb	0.29	B	0.32	B	0.17	B	1	J	0.18	B	0.33	B
Tetrachloroethylene	22 ppb	0.3	U	0.3	U	0.3	U	0.048		0.3	U	0.3	U
Trichloroethylene	94 ppb	0.3	U	0.3	U	0.3	U	0.062	J	0.3	U	1.2	
SEMI-VOLATILES (CLP 3/90)													
Di-n-butyl phthalate	NA ppb	5	U	5	U	1		0.6		5	U	5	U
Diethyl phthalate	125000 ppb	5	U	0.8		2		0.8		5	U	5	U
Phenol	1100 ppb	5	U	0.9		3		2		5	U	5	U
bis(2-Ethylhexyl)phthalate	59 ppb	10		0.6		0.8		3		0.9	B	1	B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB: COMPUCHEM
NA - Not Available

Table 3-14 Data Summary Table: Surfacewater, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SW001		SW002		SW003		SW004		SW005		SW006	
Sample ID:		PC-TF4-SW001		PC-TF4-SW002		PC-TF4-SW003		PC-TF4-SW004		PC-TF4-SW005		PC-TF4-SW006	
Collection Date:		28-JUL-93		28-JUL-93		28-JUL-93		28-JUL-93		30-JUL-93		30-JUL-93	
Associated Field QC:		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB01,ER02		FB01,TB03,ER02		FB01,TB03,ER02	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)[1]													
Arsenic	ppb	4	U	4	U	10.1	J	4	U	4	U	6.3	()J
Arsenic, Dissolved	1.4 ppb	4	U	4	U	4	U	4	U	4	U	4	U
Chromium	ppb	8	U	8	U	59.5		8	U	8	U	8	U
Copper	ppb	4.6	()B	5	()B	25.7		4	U	4	U	4	U
Lead	ppb	2	U	2	U	4.2		2.2	()	2	U	2	UL
Nickel	ppb	18	U	18	U	21.9	()	18	U	18	U	18	U
Selenium, Dissolved	5 ppb	3	UL	3	UL	3	UL	3	UL	3	UL	5.6	J
Zinc	ppb	4	U	8.6	()	50		17	()	4	U	4	U
Zinc, Dissolved	81 ppb	12.8	()J	7.4	()J	8.7	()J	11.4	()J	5.9	()J	7.2	()J
Total Petroleum Hydrocarbons	NA ppb	250	BRL	250	BRL	400		700		250	BRL	250	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB: COMPUCHEM
NA - Not Available

Table 3-14 Data Summary Table: Surfacewater, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SW007		SW008		SW106	
Sample ID:		PC-TF4-SW007		PC-TF4-SW008		PC-TF4-SW106	
Collection Date:		30-JUL-93		30-JUL-93		30-JUL-93	
Associated Field QC:		FB01,TB03,ER02		FB01,TB03,ER02		TB01	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)							
1,2-Dichlorobenzene	7 ppb	0.15	U	0.15	U	1	J
1,2-Dimethylbenzene	59 ppb	0.2	U	0.2	U	0.2	U
Chlorobenzene	71 ppb	0.25	U	0.25	U	0.25	U
Ethylbenzene	31 ppb	0.2	U	0.2	U	0.2	U
Styrene	19 ppb	0.25	U	0.25	U	0.25	U
HALOGENATED VOLATILES (8010)							
1,2-Dichloropropane	64 ppb	0.3	U	0.3	U	0.3	U
Chloroform	43 ppb	0.29	B	0.49		0.28	
Methyl Chloride	ppb	0.5	U	0.5	U	0.5	U
Methylene Chloride	59 ppb	0.15	B	0.34	B	0.37	B
Tetrachloroethylene	22 ppb	0.3	U	0.3	U	0.3	U
Trichloroethylene	94 ppb	0.3	U	0.095		1.2	
SEMI-VOLATILES (CLP 3/90)							
Di-n-butyl phthalate	ppb	5	U	5	U	5	U
Diethyl phthalate	125000 ppb	0.5		5	U	5	U
Phenol	1100 ppb	5	U	0.5		5	U
bis(2-Ethylhexyl)phthalate	59 ppb	2	B	5	U	5	U

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

Table 3-14 Data Summary Table: Surfacewater, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			SW007		SW008		SW106	
Sample ID:			PC-TF4-SW007		PC-TF4-SW008		PC-TF4-SW106	
Collection Date:			30-JUL-93		30-JUL-93		30-JUL-93	
Associated Field QC:			FB01,TB03,ER02		FB01,TB03,ER02		TB01	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)								
Arsenic		ppb	4	U	4	U	5.3	()J
Arsenic, Dissolved	1.4	ppb	4	U	4	U	4.4	()J
Copper		ppb	4	U	5.4	()B	4	U
Lead		ppb	2	U	2	U	2	U
Nickel		ppb	18	U	18	U	18	U
Selenium, Dissolved	5	ppb	3	UL	3	UL	3	UL
Zinc		ppb	4	U	4	U	4	U
Zinc, Dissolved	81	ppb	7.3	()J	5	()J	6.7	()J
Total Petroleum Hydrocarbons		ppb	250	BRL	250	BRL	250	BRL

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

Table 3-15 Data Summary Table: Groundwater, Site 4 - Third Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW1*		MW2		MW3		MW4		MW8**	
Sample ID:		PC-TF4-MW1-GW4		PC-TF4-MW2-GW4		PC-TF4-MW3-GW4		PC-TF4-MW4-GW4		PC-TF4-MW8-GW4	
Collection Date:		17-AUG-93		11-AUG-93		11-AUG-93		12-AUG-93		17-AUG-93	
Associated Field QC:		FB06,TB13		FB06,TB08		FB06,TB08		FB06,TB09		FB06,TB12,ER08	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)											
1,3-Dimethylbenzene	ppb		R	0.034		-		0.066		-	
Ethylbenzene	74 ppb		R	0.2	U	0.2	U	0.1			R
HALOGENATED VOLATILES (8010)											
Methylene Chloride	4.6 ppb		R	0.053		0.062		0.063			R
SEMI-VOLATILES (CLP 3/90)											
Diethyl phthalate	5200 ppb	5	U	0.5	J	5	U	5	U	5	U
Phenol	4200 ppb	0.8		5	U	5	U	5	U	5	U
bis(2-Ethylhexyl)phthalate	2.5 ppb	5	U	3	B	2	B	0.9	B	4	
METALS (CLP 3/90)[1]											
Arsenic	ppb	15.6	L	4.8	()K	19		4	U	23	L
Beryllium	ppb	1.4	()	1	U	2.9		1	U	1.5	()
Cadmium	ppb	3	U	3	U	8.1		3	U	3	U
Chromium	ppb	61.1		16.5		88		23.3		67.2	
Copper	ppb	79.9	J	18.6	()B	120		22.5	()B	91.2	J
Lead	ppb	56.6		16.4		50.6		17.6	L	62.7	
Nickel	ppb	56		18	U	90.5		18	U	59.6	
Zinc	ppb	137		34.6		246		61.3		163	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-TF4-MW8-GW4
** Duplicate of PC-TF4-MW8-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only

same general location as sample PC-TF4-SD9 (Engineering-Science 1990) which contained toluene (130 µg/kg) and TPH (4100 mg/kg). Chloroform at 3.2 µg/kg was the only organic compound detected in P04D017.

Arsenic, chromium, lead, nickel, and selenium were also each detected in one or more sediment samples. Concentrations ranged from 0.42 to 32.2 mg/kg. The highest concentrations of arsenic, chromium, and selenium were detected in sample P04D017. Lead was detected in only P04D004B in a concentration of 1.6 mg/kg, while nickel was quantified in 5 samples in concentrations ranging from 2.5 to 4.5 mg/kg.

3.5.4.2 Surface Water Sampling Results

Surface water samples P04W001 through -W006 were collected from the six largest springs which discharge from the shallow aquifer into the sinkhole, while P04W007 and P04W008 were collected from the surface of the sinkhole itself. The sampling locations are presented in Figure 3-25.

A variety of organic compounds were detected in the surface water samples collected from the water surface of the sinkhole and the springs discharging into the sinkhole. TCE, PCE, ethylbenzene, xylene, styrene, chlorobenzene, phenol, chloroform, 1,2-DCB, 1,2-dichloropropane, phthalate esters, chloromethane, and methylene chloride were each detected in one or more of the surface water samples collected from the sinkhole. No analyte was detected in a concentration exceeding the Act 307 Type B GSI criteria. In addition, the inorganics chromium, copper, nickel, and zinc were each detected in one or more of the unfiltered (total) surface water samples, while arsenic, selenium, and zinc were each detected in the filtered (dissolved) samples. Chromium and copper, at concentrations of 59.5 and 25.7 µg/ℓ, respectively, (were detected the unfiltered sample from P04W003). These concentrations exceed the Act 307 Type B GSI criteria for these analytes. No dissolved inorganics were detected above Act 307 Type B GSI criteria.

The hydraulic relationship between the sinkhole and the shallow aquifer was presented in Section 3.5.2. A majority of the IRP sites are up gradient and assumed to be hydraulically connected to the sinkhole based on the groundwater flow direction.

3.5.4.3 Groundwater Sampling Results

As illustrated in Figure 3-24, well TF4MW1 is located up gradient of Site 4. Wells TF4MW2, -MW3, and -MW4 are located down gradient of Site 4, well-positioned to monitor groundwater contamination in the shallow aquifer, if present.

Organic compounds detected during the summer 1993 round of groundwater sampling include phenol, ethylbenzene, m-xylene (dimethylbenzene), phthalate esters, and methylene chloride. Of these detections only bis (2-Ethylhexyl) phthalate (4 µg/ℓ) was detected in the data set at a concentration greater than 1 µg/ℓ. No organic compounds were detected in concentrations exceeding the Act 307 Type B cleanup criteria. TPH was not detected in these samples.

The inorganics arsenic, beryllium, cadmium, chromium, copper, lead, nickel, and zinc were detected in the unfiltered (total) groundwater samples collected from Site 4 monitoring wells. Arsenic, cadmium, and lead were detected in these unfiltered samples from all four monitoring well in concentrations exceeding Act 307 Type A cleanup criteria. However, these unfiltered samples were generally turbid and could likely not be used as collected for domestic purposes. No inorganics were detected in the corresponding filtered (dissolved) samples.

The summer 1993 round of groundwater sampling data are very consistent with the previous three rounds of data (see Appendices N and O). Throughout all rounds of sampling no organic or inorganic compounds have been quantified in concentrations exceeding the Act 307 Type A or B cleanup criteria, except for the unfiltered metal samples.

3.5.5 Summary and Conclusions

Past fire training exercises have had an adverse impact on vadose zone soils beneath Site 4. The nature and extent of soil contamination was assessed during previous investigations performed at the site. These soils are included in a SRAP (The Earth Technology Corporation, May 1994). The findings of the RI are summarized in the following:

- Shallow aquifer materials beneath the site consist of approximately 10.7 to 12.2 m (35 to 40 ft) of medium- to coarse-grained quartz sand. A thin layer (.6 to 1.5 m [2 to 5 ft] thick) sandy clay/clayey sand exists at the base of the shallow aquifer and separates this unit from the limestone bedrock.

- Site 4 wells are well-located to monitor groundwater quality in the shallow aquifer. Through four rounds of groundwater sampling, no organic compounds have been detected in the wells which exceed the Act 307 Type B cleanup criteria. In addition, no inorganics exceeding the Act 307 Type A cleanup criteria have been quantified in the filtered groundwater samples collected from these wells.

- Sediment samples collected and analyzed from locations by the springs, and in the erosional gully leading to the sinkhole from Site 4, have contained only trace concentrations of organic compounds. TPH was detected in these samples in concentrations ranging from 25 to 51.9 mg/kg. Some of the sediment samples collected from the bottom of the sinkhole itself contain relatively high concentrations of TPH (25 to 1060 mg/kg). Surface water samples from the springs and sinkhole contain trace concentrations of a variety of organic compounds. Only copper and chromium were detected in the unfiltered surface water samples in concentrations exceeding the Act 307 Type B GSI criteria. Taken together, these data indicate that there is evidence that fuel-related contaminants have at one time entered the sinkhole. The TPH detected in the bottom sediments may be the only remaining evidence of this

contamination. The summer 1993 surface water and sediment sampling conducted from the springs shows that no organic and inorganic compounds exceeding the Act 307 Type B GSI values have been detected entering the sinkhole from the shallow aquifer.

3.6 SITE 5 – SECOND FIRE TRAINING AREA

Several field activities were initiated to support the RI at Site 5. The results for some of the activities are contained in separate, stand-alone documents and will not be fully reproduced in this RI report. RI activities conducted at Site 5 include the following:

- Surface geophysical surveys (EMI and electrical resistivity) were conducted at Site 5 during September and October 1992. Complete results of the surveys are presented in the Final Draft, Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, March 1993). Summaries of the geophysical survey results are included in the Site 5 geology and hydrogeology discussions.

- Surface and subsurface soil sampling and analysis were completed at Site 5. These data are included in the Third Round Groundwater Sampling, Soil Background Sampling, and Removal Investigation Technical Memorandum (Earth Technology, July 1992). Additional soil analytical data were collected in January 1993 for a potential Removal Action. These data are included in Appendix L.

- Groundwater screening data were collected for Site 5 in January 1993. Results from these activities are presented in Section 3.6.3 of this RI report.

- Soil borings, monitoring well installation, sampling and analysis, and aquifer slug tests were completed during August and September 1993. These activities are presented in Section 3.6.4 of this RI report.

3.6.1 Results of Previous Investigations

The soil vapor monitoring, soil boring and sampling, and monitoring well installation and groundwater sampling program conducted during the SI identified areas within the subsurface soils containing BTEX and TPH (Engineering-Science, 1990). BTEX, trans-1,2 - DCE and TPH were detected in groundwater samples obtained during the November 1987 (Round I) sampling event. Benzene in concentrations exceeding Act 307 Type B cleanup criteria from site groundwater samples was confirmed during the August 1988 (Round II) and October 1991 (Round III) groundwater sampling events.

Additional SOV and soil sampling and analysis were conducted to define the nature and extent of soil contamination at the site. The Site 5 soils were initially scheduled for a removal action and were included in previous versions of the SRAP (The Earth Technology Corporation, August 1993). Data previously presented in the SRAP regarding the Site 5 soils is included in the RI report as part of Appendix L.

3.6.2 Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.6.2.1 Geology

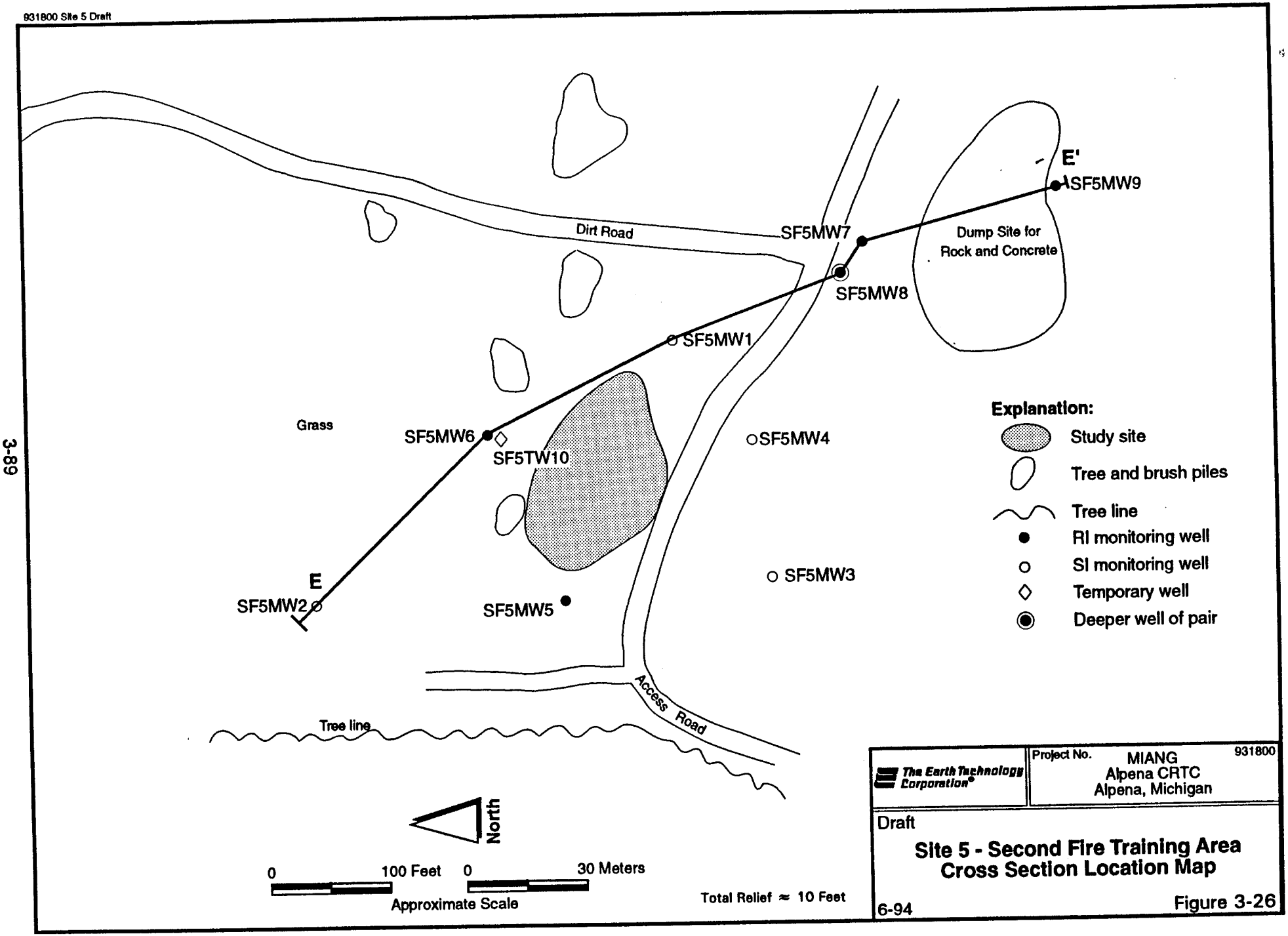
The location of a geologic cross section created for Site 5 is shown in Figure 3-26. The cross-section itself is presented as Figure 3-27. Subsurface relationships illustrated by Figure 3-27 show the shallow aquifer beneath Site 5 is approximately 6 m (20 ft) thick and consists of sediments ranging from clay to fine gravel in size and material. Beneath the northern and western portions of the site (in the vicinity of SF5MW2), clay-sized materials are generally found. East and south of SF5MW2 the soils change in composition and become sand-rich.

A 0.3 to 0.6m (1- to 2-ft) thick clay layer was observed during drilling operations in SF5MW3 and SF5MW4 occurring between the shallow aquifer and the limestone bedrock. Measured hydraulic conductivities for these clay samples ranged from 2.0×10^{-8} cm/sec to 5.8×10^{-7} cm/sec (Engineering-Science, 1990). However, a basal clay layer separating the shallow aquifer from the limestone bedrock was not discovered in all borings drilled during the RI. Instead of a clay layer, lenses of fine-gravel or gravelly sand were described at locations SF5MW6 and SF5MW7 prior to refusal of the hollow stem augers on the limestone bedrock. Limestone bedrock was encountered during the RI drilling operation at a depth of approximately 20 ft bgs at locations SF5MW6 and -MW7.

Results obtained from the surface geophysical surveys correlate well with the boring logs. Groundwater was interpreted to be 5 ft bgs, while limestone was interpreted from the geophysical surveys to be at a depth of approximately 22 to 23 ft bgs.

3.6.2.2 Hydrogeology

Nine monitoring wells (SF5MW1 through SF5MW9) exist at Site 5. Wells SF5MW1 through SF5MW4 were installed during the SI (Engineering-Science, 1990) while wells SF5MW5 through SF5MW9 were installed during the RI field activities. Groundwater beneath Site 5 occurs within the surficial aquifer at depths ranging from 1.82 to 2.34 m (5.97 to 7.67 ft) bgs and from 673.94 to 675.32 ft above msl. Groundwater flow within the shallow aquifer is directed towards the southeast at an average hydraulic gradient of 0.003 ft/ft in the vicinity



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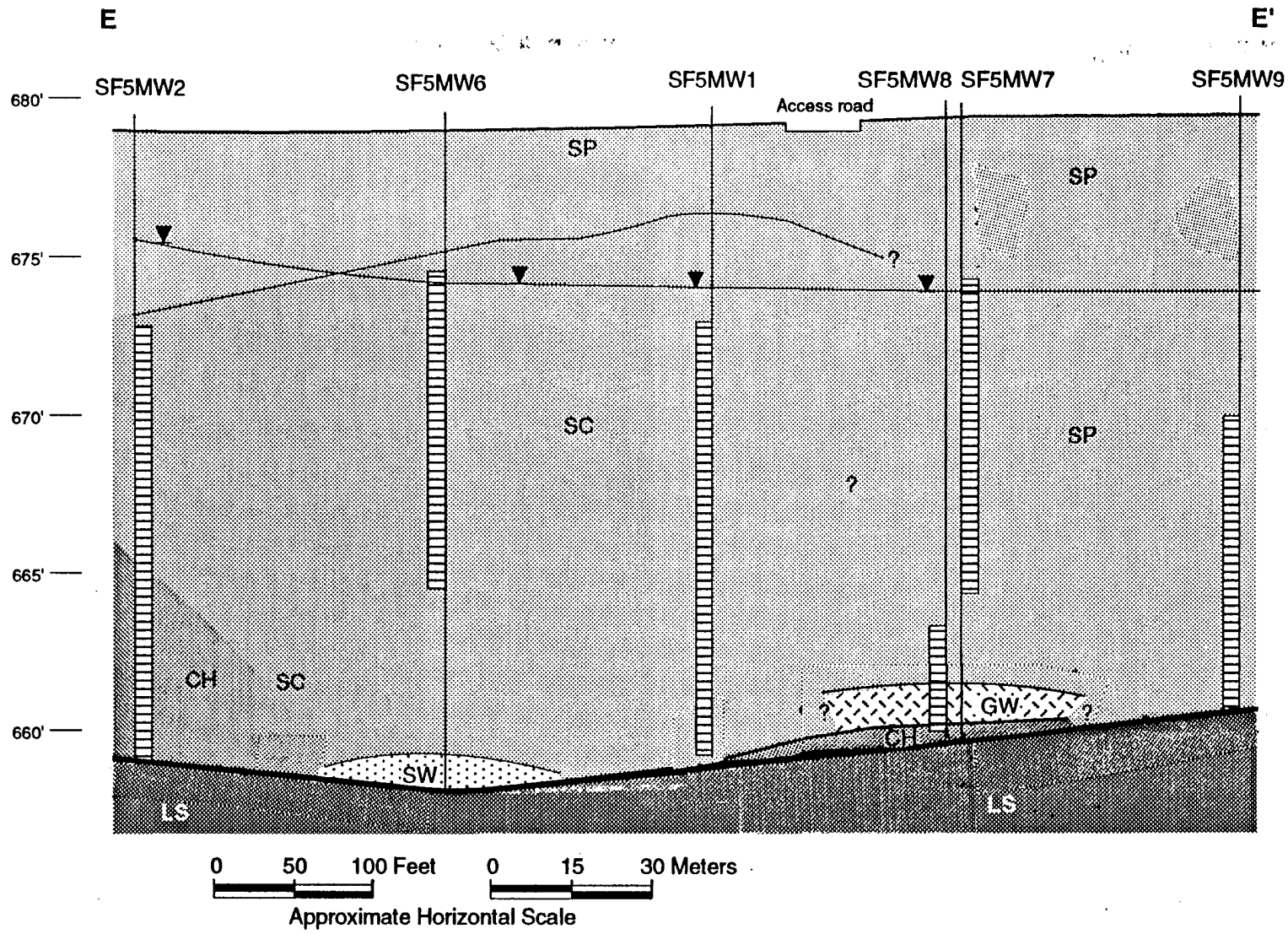
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Alpena, Michigan

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Site 5 - Second Fire Training Area
Cross Section Location Map

6-94

Figure 3-26



Explanation

SP	Sand; well sorted, med-coarse grained quartz; trace minor fines	SW	Sand, well graded
SC	Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines	GW	Gravel, well sorted
CH	Clay; massive, plastic, med stiff; trace sand	LS	Traverse group limestone

Screened interval

Groundwater elevation as measured September 1993

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Site 5 - Second Fire Training Area
Geologic Cross Section E-E'

6-94

Figure 3-27

of wells SF5MW4, MW7, and MW8. However, as can be seen on the September 1993 groundwater elevation map (Figure 1-21), a groundwater divide exists to the west/northwest of SF5MW2. A site-specific groundwater flow map is presented in Figure 3-28. The existence of this divide west of the site is likely dependent on the surface water elevation of Lake Winyah and may be seasonal in nature. Groundwater elevation measurements collected during the October 1991 (Round III) sampling event show groundwater flow beneath Site 5 was directed to the north, toward Lake Winyah.

A slug test was performed on SF5MW5. The slug test data were analyzed using the Bouwer and Rice method (Bouwer and Rice, 1976; Bouwer, 1989) in conjunction with AQTESOLV (Geraghty & Miller, 1991) which is a computer software program for aquifer test analysis. A hydraulic conductivity of 2.22×10^{-3} cm/sec was calculated from slug testing of the aquifer.

3.6.3 Screening Results and Boring and Well Placement Rationale

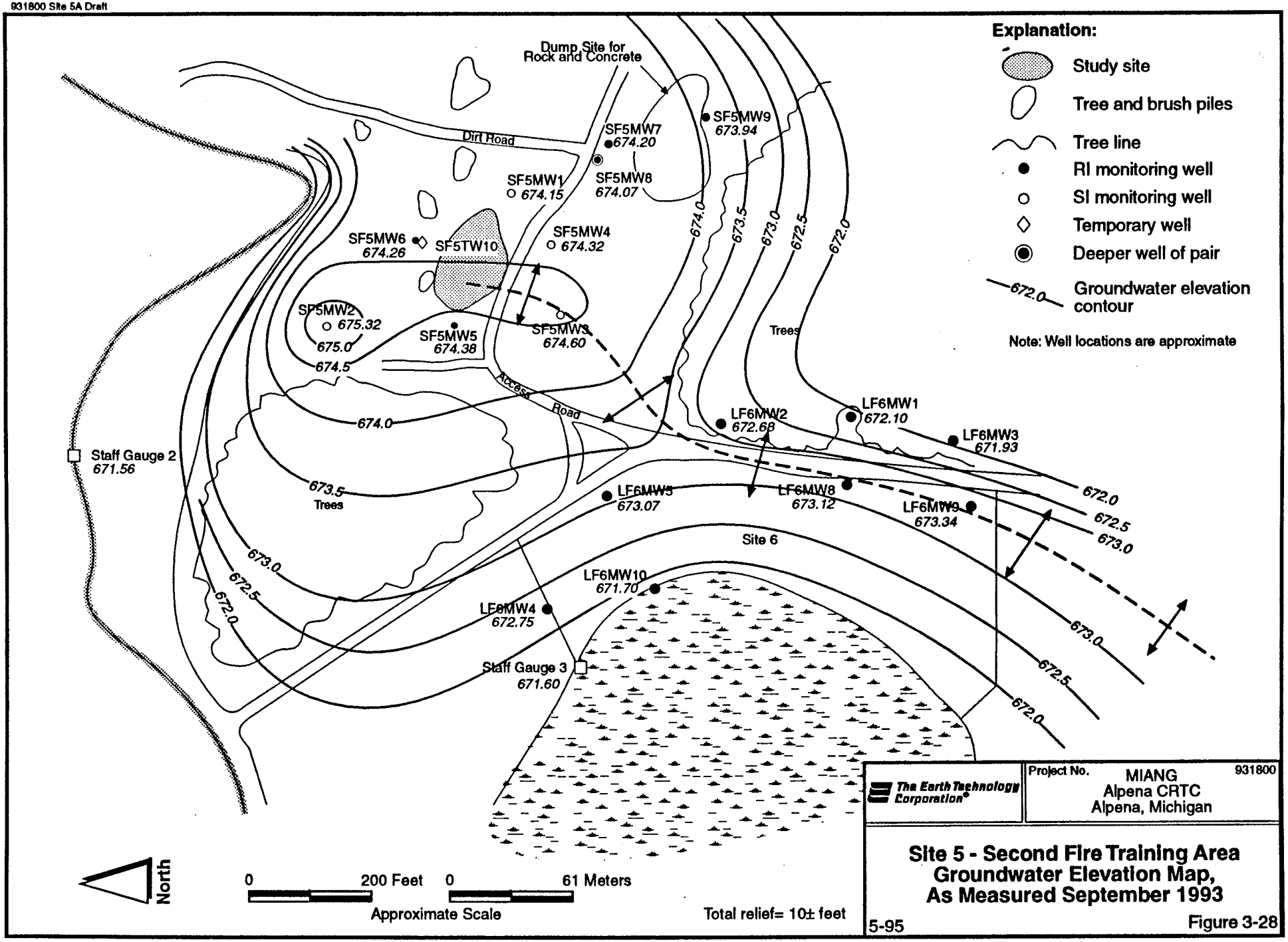
Initial site screening activities at Site 5 consisted of the collection and analysis of groundwater grab samples (The Earth Technology Corporation, October 1993). The complete results of this survey are included in Appendix D. Further on-site GC analysis of soil and groundwater samples were conducted in August and September 1993 during the second phase of field activities. The results of these activities are presented in Appendix E. Summaries of these two field events are presented below.

3.6.3.1 Initial Site Screening

Initial site screening locations and analytical results are presented in Figure 3-29. These data were collected in January 1993. All positive detections of total VOCs and other target compounds are illustrated on this figure. Sixteen groundwater samples from locations 5GW-1 through 5GW-16 were collected at Site 5. All samples were collected from the upper portions of the shallow aquifer. The results of this sampling are summarized below:

- Target VOCs – Target VOCs were detected from only one sample, 5GW-16, which is located in the middle of the suspected burn area. Sample 5GW-16 contains relatively high concentrations of BTEX (1400 $\mu g/\ell$ of benzene, for example) and relatively low concentrations of TCE and PCE (0.02 and 0.15 $\mu g/\ell$, respectively).

- Total VOCs (as JP-4) – Four groundwater screening samples contained total VOCs; 5GW-5, -9, -15, and -16. Concentrations of VOCs in 5GW-5, -9, and -15 were relatively low, ranging from 22 to 39 $\mu g/\ell$, while the concentration of total VOCs in 5GW-16 was 25,000 $\mu g/\ell$.



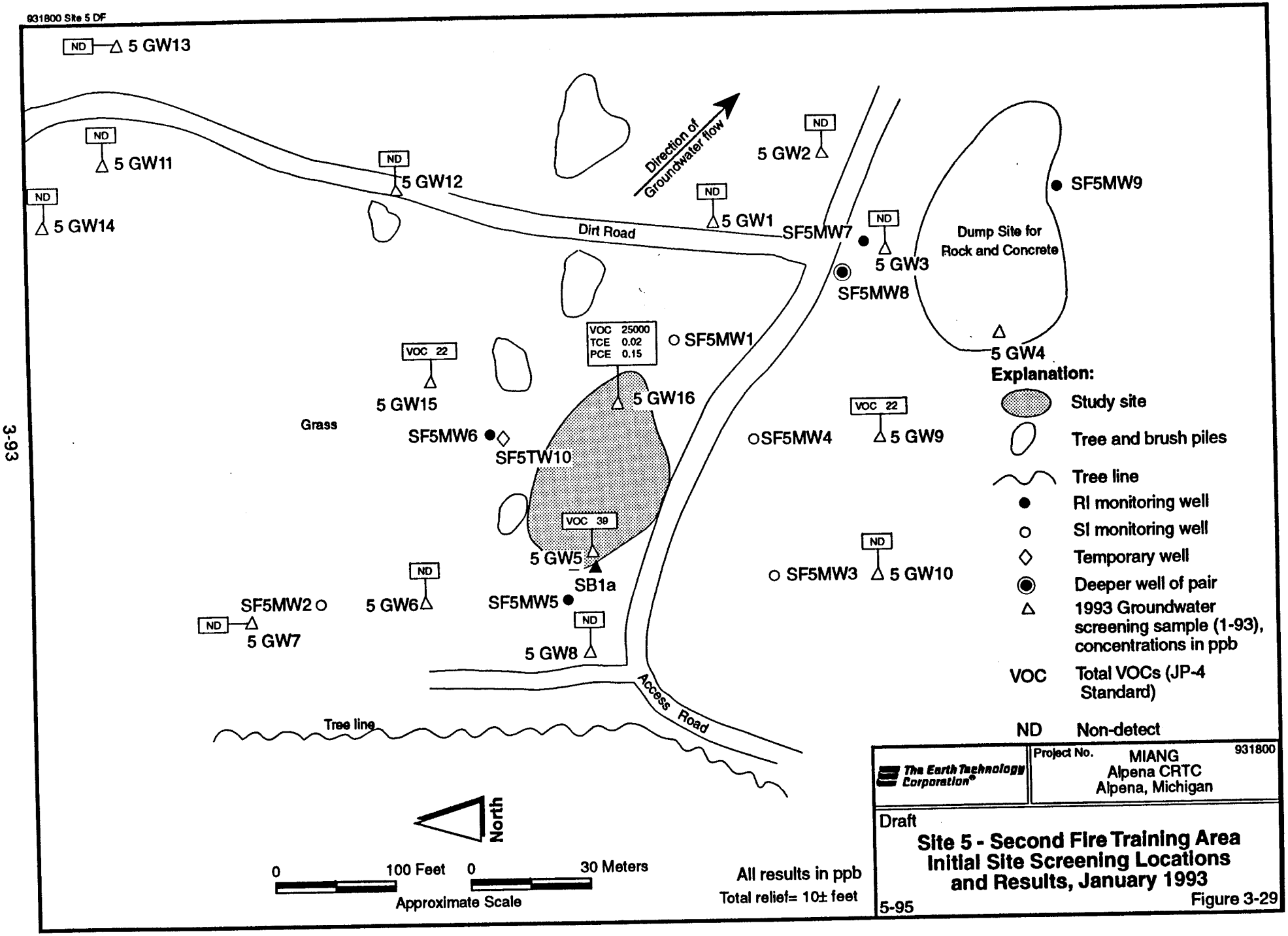
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Site 5 - Second Fire Training Area Groundwater Elevation Map, As Measured September 1993

5-95

Figure 3-28



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Site 5 - Second Fire Training Area Initial Site Screening Locations and Results, January 1993

5-95

Figure 3-29

3.6.3.2 Monitoring Well Placement Rationale

Monitoring wells SF5MW5 and -MW6 were constructed as water table wells to monitor groundwater quality in the shallow aquifer north and west of the site. Groundwater samples from SF5MW1 contain VOCs exceeding the Act 307 Type B cleanup criteria. Therefore, the remainder of the new wells (SF5MW7 through MW9) were installed down gradient (southeast) of the site between SF5MW1 and the sinkhole.

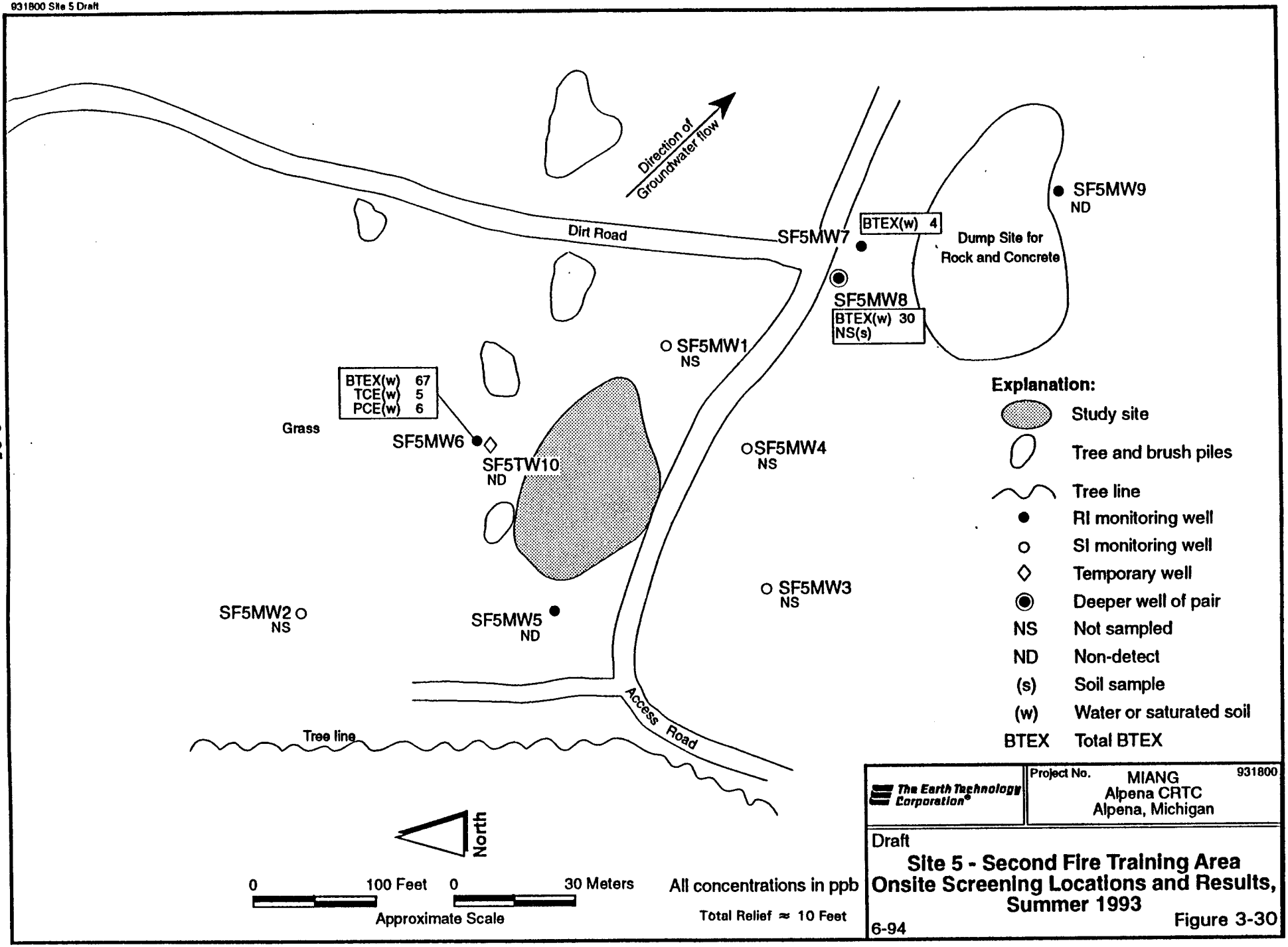
3.6.3.3 On-site Screening During Drilling Operations

A total of 22 soil and groundwater samples were collected and analyzed using an on-site GC from 4 monitoring wells and 1 temporary well installed at Site 5 during the RI drilling operations. The maximum concentration of VOCs detected from the on-site GC analyses per location is presented in Figure 3-30. To illustrate the vertical distribution of VOCs in the subsurface, these screening results were placed on the Site 5 cross-section (Figure 3-27) and presented as Figure 3-31. As shown in Figures 3-30 and 3-31, VOC detections are limited to locations SF5MW6, -MW7, and -MW8, and the lower portions of the shallow aquifer were more likely to contain detectable quantities of VOCs than groundwater samples collected and analyzed from nearer the water table.

Four soil samples were collected from location SF5MW7. No VOCs were detected from the 0 to 2 ft bgs, 4 to 6 ft bgs and 9 ft bgs samples. However, low concentrations of benzene (3 and 4 $\mu g/\ell$ of air) were detected in the sample (P5MW7D). The detection of benzene at 6 m (20 ft) bgs in this sample was interpreted to indicate contaminants are migrating vertically through the water column. Therefore, SF5MW7 was installed with a screened interval intersecting the water table 1.5 to 4.6 m (5 to 15 ft) bgs and a second well SF5MW8 was installed at the same location with a screened interval from 4.6 to 6 m (15 to 20 ft) bgs. A Hydropunch® groundwater sample collected from SF5MW8 at a depth of 5.8 m (19 ft) bgs contained cis-1,2-DCE and benzene at concentrations of 8 and 30 $\mu g/\ell$, respectively. These data support the assumption that contaminants are vertically segregated within the water column beneath Site 5. The water column was sampled down gradient of the MW7/MW8 well pair at location SF5MW9 from depths of 2.7, 4.3, and 5.5 m (9, 14, and 18 ft) bgs. No VOCs were detected from these samples. VOCs (concentrations ranging from 5 to 24 $\mu g/\ell$) were also detected in a gravelly sand sample collected at 6.4 m (21 ft) bgs from location SF5MW6. A temporary well, SF5TW10, was drilled and a Hydropunch® groundwater sample collected from a depth of 6 m (20 ft) bgs to verify the soil sampling results from MW6. No VOCs were detected from the TW10 water sample.

3.6.4 Confirmation Results

Analytical results for the organic and inorganic compounds detected from the groundwater samples collected during the RI field sampling are included in Table 3-16. A presentation and discussion of the significance of these results including the occurrence of compounds exceeding Act Type A or B cleanup criteria is included in the following subsections.



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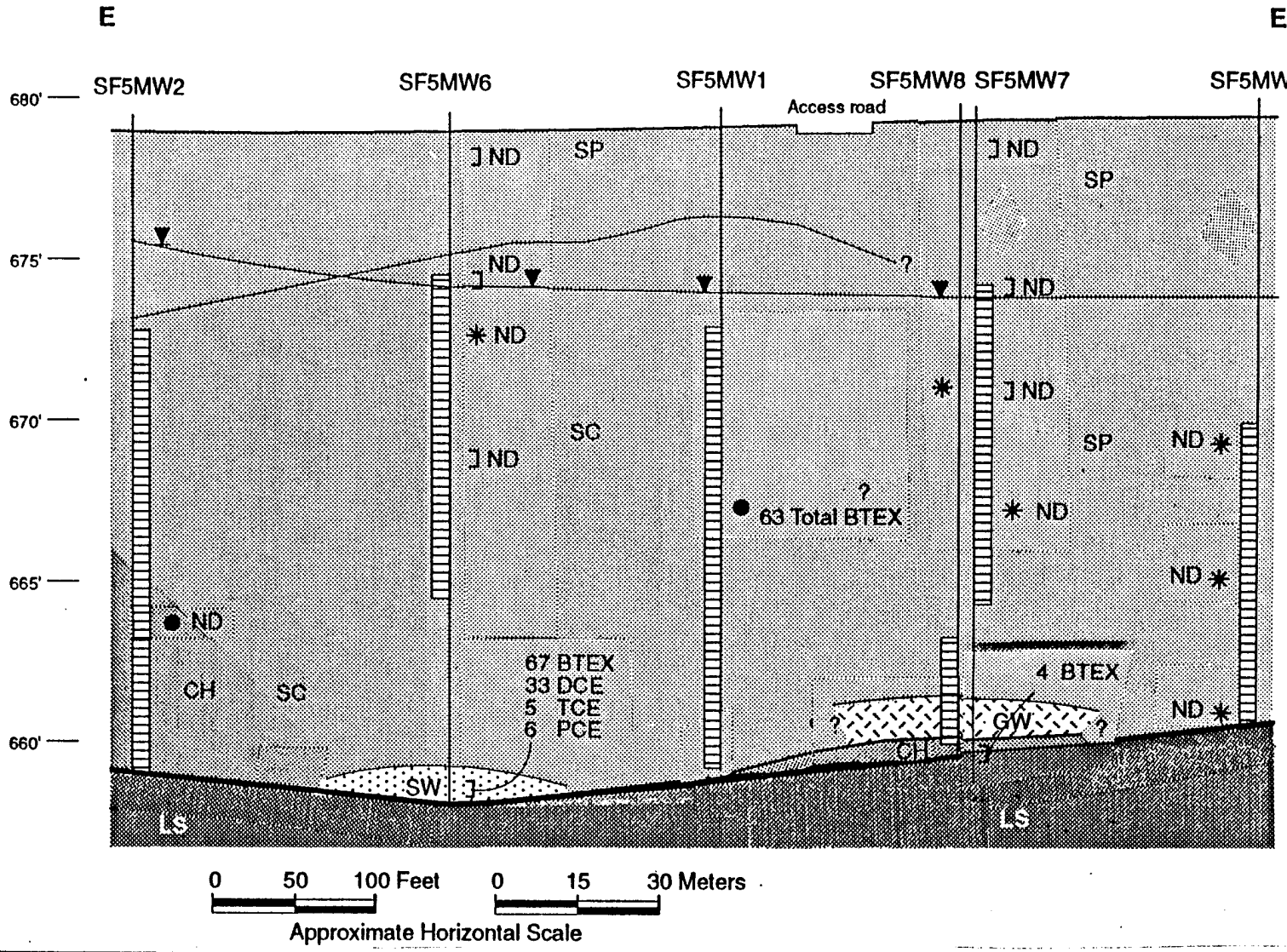
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Site 5 - Second Fire Training Area
Onsite Screening Locations and Results, Summer 1993

6-94

Figure 3-30



Explanation

- SP — Sand; well sorted, med-coarse grained quartz; trace minor fines
- SC — Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
- CH — Clay; massive, plastic, med stiff; trace sand
- SW — Sand, well graded
- GW — Gravel, well sorted
- LS — Traverse group limestone
- Screened interval
- Groundwater elevation as measured September 1993
- Field screen-groundwater (ppb)
- Fixed base groundwater, 10-91 round (ppb)
- Field screen-soil (ppb)

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Site 5 - Second Fire Training Area
Geologic Cross Section E-E'
Screening Results

6-94

Figure 3-31

Table 3-16 Data Summary Table: Groundwater, Site 5 - Second Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	MW1		MW2		MW3		MW4		MW5		MW6	
Sample ID:	PC-SF5-MW1-GW4		PC-SF5-MW2-GW4		PC-SF5-MW3-GW4		PC-SF5-MW4-GW4		PC-SF5-MW5-GW4		PC-SF5-MW6-GW4	
Collection Date:	15-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		29-AUG-93		29-AUG-93	
Associated Field QC:	FB06,TB12		FB05,TB17,ER14		FB06,TB10,ER08		FB05,TB17,ER14		FB05,FB07,TB20,ER17		FB05,FB07,TB20,ER17	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)												
1,2-Dichlorobenzene 600 ppb	4.7		2.2	B	0.15	U	0.28	B	0.15	U	0.15	U
1,2-Dimethylbenzene 280 ppb	0.88		0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
1,3-Dichlorobenzene 600 ppb	2.9	J	0.2	U	0.2	U	0.2	U	0.54		0.2	U
1,3-Dimethylbenzene 280 ppb	8		-		-		-		-		-	
1,4-Dichlorobenzene 1.5 ppb	3.5		0.15	U	0.15	U	0.15	U	0.15	U	0.15	U
Benzene 1.2 ppb	52		0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Chlorobenzene 130 ppb	0.41	J	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Ethylbenzene 74 ppb	0.68		0.088	B	0.2	U	0.098	B	0.2	U	0.2	U
Styrene 1.2 ppb	1.5	J	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Toluene 780 ppb	0.11	B	0.14	B	0.11	B	0.23	B	0.25	U	0.24	
HALOGENATED VOLATILES (8010)												
1,2-Dichloroethane 0.38 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Methylene Chloride 4.6 ppb	0.026		0.11	B	0.31		0.44	B	0.74	B	0.45	J
Trichloroethylene 2.2 ppb	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

wp/t3-16.540- 6/14/95

Table 3-16 Data Summary Table: Groundwater, Site 5 - Second Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW1		MW2		MW3		MW4		MW5		MW6	
Sample ID:		PC-SF5-MW1-GW4		PC-SF5-MW2-GW4		PC-SF5-MW3-GW4		PC-SF5-MW4-GW4		PC-SF5-MW5-GW4		PC-SF5-MW6-GW4	
Collection Date:		15-AUG-93		24-AUG-93		24-AUG-93		24-AUG-93		29-AUG-93		29-AUG-93	
Associated Field QC:		FB06,TB12		FB05,TB17,ER14		FB06,TB10,ER08		FB05,TB17,ER14		FB05,FB07,TB20,ER17		FB05,FB07,TB20,ER17	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
SEMI-VOLATILES (CLP 3/90)													
2,4-Dimethylphenol	350 ppb	4	J	5	U	5	U	5	U	5	U	5	U
Di-n-butyl phthalate	840 ppb	15	U	0.7		1	B	0.7		5	U	5	U
Diethyl phthalate	5200 ppb	15	U	5	U	1		5	U	5	U	0.6	
Dimethyl phthalate	70000 ppb	15	U	5	U	0.6		5	U	5	U	5	U
Phenol	4200 ppb	2		0.7	B	4		5	U	5	U	5	U
METALS (CLP 3/90)													
Arsenic	ppb	20.5		4	UL	4	U	4	U	4	U	4.3	()L
Chromium	ppb	8	U	8	U	8	U	8	U	8	U	9.8	()
Copper	ppb	4	U	5.9	()B	6.8	()B	4	U	4.4	()B	10.1	()B
Lead	ppb	6.5		2	UL	2	U	2	U	2	U	2	U
Nickel	ppb	18	U	18	U	18	U	18	U	18	U	18	U
Selenium, Dissolved	35 ppb	3	U	3	UL	3	U	3	UL	3	U	3	UL
Zinc	ppb	14.8	()B	33.6	B	74.5	B	13	()B	7.1	()B	33.6	B
Zinc, Dissolved	2300 ppb	4.2	()B	27.9	B	83.5	J	65.3	B	6.8		9.4	()B

Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]Criteria are presented for dissolved metals only.

Table 3-16 Data Summary Table: Groundwater, Site 5 - Second Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	MW7		MW8		MW9	
Sample ID:	PC-SF5-MW7-GW4		PC-SF5-MW8-GW4		PC-SF5-MW9-GW4	
Collection Date:	29-AUG-93		13-SEP-93		13-SEP-93	
Associated Field QC:	FB05,FB07,TB20,ER17		FB07,TB25,ER20		FB07,TB25	
AT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)						
1,2-Dichlorobenzene 600 ppb	0.15	U	0.43	B	0.11	B
1,2-Dimethylbenzene 13000 ppb	0.2	U	0.13	J	0.2	U
1,3-Dichlorobenzene 600 ppb	0.2	U	0.15	B	0.2	U
1,3-Dimethylbenzene 13000 ppb	0.5	U	0.5	U	0.5	U
1,4-Dichlorobenzene 1.5 ppb	0.15	U	0.38	B	0.15	U
Benzene 1.2 ppb	0.35	U	41		0.26	
Chlorobenzene 130 ppb	0.25	U	0.25	U	0.25	U
Ethylbenzene 680 ppb	0.2	U	0.49	J	0.2	U
Styrene 1.2 ppb	0.25	U	0.67	J	0.25	U
Toluene 1500 ppb	0.25	U	0.39	B	0.18	B
HALOGENATED VOLATILES (8010)						
1,2-Dichloroethane 0.38 ppb	0.25	U	0.44		0.25	U
Methylene Chloride 4.6 ppb	0.39	B	0.28	B	0.3	B
Trichloroethylene 2.2 ppb	0.21		0.63		0.3	U
SEMI-VOLATILES (CLP 3/90)						
2,4-Dimethylphenol 350 ppb	5	U	5	U	5	U
Di-n-butyl phthalate 840 ppb	5	U	0.5		0.5	
Diethyl phthalate 5200 ppb	0.5		5	U	5	U
Dimethyl phthalate 70000 ppb	5	U	5	U	5	U
Phenol 4200 ppb	5	U	5	U	0.5	B

Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-16 Data Summary Table: Groundwater, Site 5 - Second Fire Training Area
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW7		MW8		MW9	
Sample ID:		PC-SF5-MW7-GW4		PC-SF5-MW8-GW4		PC-SF5-MW9-GW4	
Collection Date:		29-AUG-93		13-SEP-93		13-SEP-93	
Associated Field QC:		FB05,FB07,TB20,ER17		FB07,TB25,ER20		FB07,TB25	
AT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)							
Arsenic	ppb	4	U	7		10.5	L
Chromium	ppb	8	U	10	U	81.7	L
Copper	ppb	4	U	15	U	73.3	L
Lead	ppb	2	U	2	UL	44.1	L
Nickel	ppb	18	U	35	U	69.9	L
Selenium, Dissolved	35 ppb	3	UL	3	R	7.3	J
Zinc	ppb	14.7	()B	33.1	J	259	J
Zinc, Dissolved	2300 ppb	18.2	()B	61		38.6	

Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]Criteria are presented for dissolved metals only.

Soil Results

Benzene, lead, and arsenic were detected above Act 307 Type A or B cleanup criteria in the surface and shallow subsurface soils of Site 5. These data are included in Appendix L of this report.

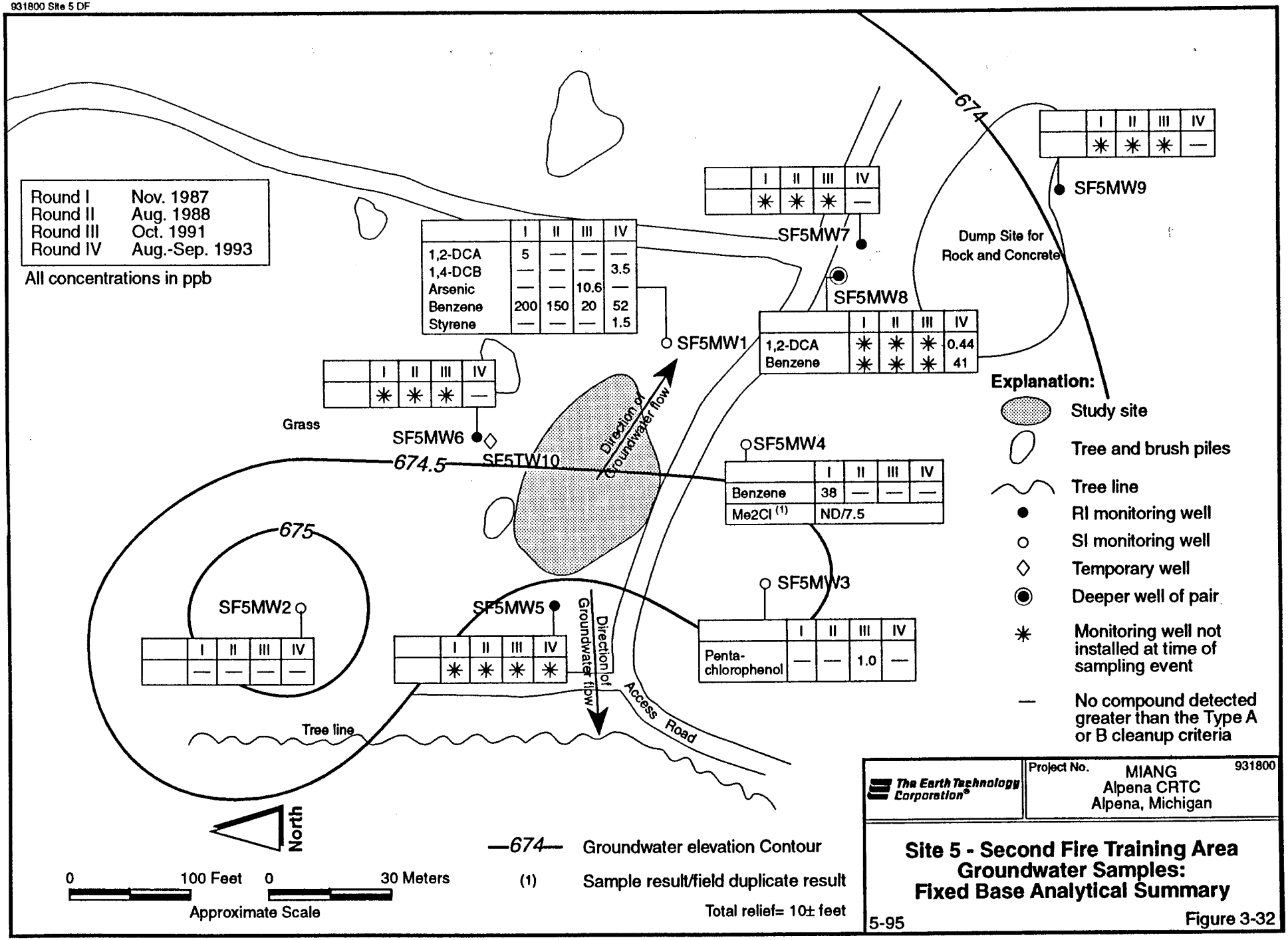
Groundwater Results

A review of the summer 1993 (Round IV) analytical results indicate a wide variety of organic compounds including BTEX, TCE, chlorobenzene, styrene, phenol, 2,4-dimethylphenol, 1,2-DCA, methylene chloride, chloroform, DCB isomers, and phthalate esters were each detected in one or more of the groundwater samples collected from Site 5 monitoring wells. Samples collected from wells SF5MW2, -MW4, -MW5, and -MW7 contained 1 or 2 individual compounds. All organic compounds detected in these wells were reported at concentrations below 1 $\mu g/\ell$. VOCs commonly detected in petroleum-based fuels (BTEX) were quantified in samples originating from wells SF5MW1, -MW6, -MW8, and MW9. Benzene concentrations reported for groundwater samples collected down gradient of the site range from 0.26 $\mu g/\ell$ in MW9 to 52 $\mu g/\ell$ in MW1 and exceed the Act 307 Type B cleanup criteria in wells SF5MW1 and -MW8. In addition to benzene, styrene, 1,4-DCB, and 1,2-DCA were detected from either MW1 or MW8 in concentrations exceeding Act 307 Type B cleanup criteria. TPH was not reported in any of the Round IV groundwater samples.

Arsenic, chromium, copper, lead, nickel, and zinc were detected in the total (unfiltered) groundwater samples collected during the summer 1993 (Round IV) groundwater sampling event. Arsenic and/or lead were detected in the unfiltered samples from wells SF5MW1, -MW6, -MW8, or -MW9 in concentrations exceeding the Act 307 Type A cleanup criteria. However, these unfiltered samples were generally turbid and could likely not be used (as collected) for domestic purposes. Only selenium and zinc were detected in one or more of the dissolved (filtered) samples. All filtered inorganic detections were quantified in concentrations below the Act 307 Type A cleanup criteria.

As stated in Section 3.6.3.2, on-site screening data obtained from wells SF5MW7 (screened 1.5 to 4.6 m [5 to 15 ft] bgs) and SF5MW8 (screened 4.6 to 6 m [15 to 20 ft] bgs) suggest contaminated groundwater in the shallow aquifer is moving vertically down through the water column. The fixed based analytical results obtained from these two wells support the interpretation that vertical movement of contaminated groundwater is occurring beneath the site. SF5MW7 is relatively free of VOCs, while SF5MW8 contains benzene, for example, at a concentration of 41 $\mu g/\ell$.

The distribution of organic compounds and inorganics detected during the four rounds of groundwater sampling exceeding the Act 307 Type A or B cleanup criteria are shown in Figure 3-32. The list of detected analytes and the concentrations at which these analytes were detected for SF5MW1 through MW4 are generally consistent over the four rounds of sampling. Organic compounds, particularly benzene, have been detected in each of the four rounds of sampling in well SF5MW1 in concentrations ranging from 20 to 200 $\mu g/\ell$. Both the


Round I Nov. 1987
Round II Aug. 1988
Round III Oct. 1991
Round IV Aug.-Sep. 1993
All concentrations in ppb
SF5MW9
SF5MW7
SF5MW8
SF5MW1
SF5MW6
SF5TW10
SF5MW4
SF5MW3
SF5MW2
SF5MW5
1,2-DCA 5 — — —
1,4-DCB — — — 3.5
Arsenic — — 10.6 —
Benzene 200 150 20 52
Styrene — — — 1.5
1,2-DCA * * * 0.44
Benzene * * * 41
Benzene 38 — — —
Me2Cl (1) ND/7.5
Penta-chlorophenol — — 1.0 —
674
674.5
675
Dump Site for Rock and Concrete
Grass
Tree line
Access Road
Direction of Groundwater flow
Direction of Groundwater flow
Explanation:
Study site
Tree and brush piles
Tree line
RI monitoring well
SI monitoring well
Temporary well
Deeper well of pair
Monitoring well not installed at time of sampling event
— No compound detected greater than the Type A or B cleanup criteria
North
0 100 Feet 0 30 Meters
Approximate Scale
—674— Groundwater elevation Contour
(1) Sample result/field duplicate result
Total relief= 10± feet
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Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Site 5 - Second Fire Training Area
Groundwater Samples:
Fixed Base Analytical Summary
5-95
Figure 3-32

arsenic (dissolved) detected from SF5MW1 and pentachlorophenol detected from SF5MW3 during the October 1991 (Round III) sampling were not confirmed during the previous two rounds or sampling of the summer 1993 sampling event.

3.6.5 Summary and Conclusions

Past fire training exercises have likely led to the release of burned or partially burned fuels and/or solvents into the soils and groundwater at Site 5. Benzene and lead were detected in soils collected from this area at concentrations exceeding Act 307 Type A and B cleanup criteria. The following summarizes the findings of the subsurface investigations conducted at Site 5:

- Approximately 20 ft of soil, ranging in composition from clay to sandy gravel, comprises the shallow aquifer beneath Site 5. Groundwater is encountered at a depth of 5 to 8 ft bgs and flows southeast towards the sinkhole and west towards the river. The presence of a clay layer between the shallow aquifer and the limestone bedrock was not confirmed at all the locations sampled beneath Site 5.

- Benzene, lead, and arsenic were detected above Act 307 Type A or B cleanup criteria in the surface and subsurface soils at Site 5 during previous investigations.

- Groundwater samples collected from the shallow aquifer contain organic compounds, particularly benzene, in concentrations exceeding the Act 307 Type B cleanup criteria. Data collected during the RI field investigations suggests that there is vertical movement downward of contaminants within the shallow aquifer beneath the site.

3.7 Site 6 - Former Solid Waste Landfill and Site 7 - First Fire Training Area

Several field events were conducted to support the RI at Sites 6 and 7. The results for these field events are included in several stand-alone documents and will only be summarized in this report. In chronological order, the field events are:

- Surface geophysical surveys (EMI, resistivity and magnetics) and test pit excavation were conducted at Site 6 during September and October 1992. Complete results of the surveys are presented in Final Draft, Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, March 1993). Summaries of the geophysical survey are included in the Site 6 geology and hydrogeology discussions, while the test pitting results are included in this report under a discussion of previous investigations.

- Groundwater screening data were collected for Sites 6 and 7 in January 1993. Results from these activities are presented in Section 3.7.3 of this RI report.

- Soil borings, monitoring well installation, groundwater and sediment sampling and analysis, and aquifer slug testing were conducted during August and September 1993. These activities are presented in Section 3.7.2 through 3.7.4 of this RI report.

3.7.1 Results of Previous Investigations

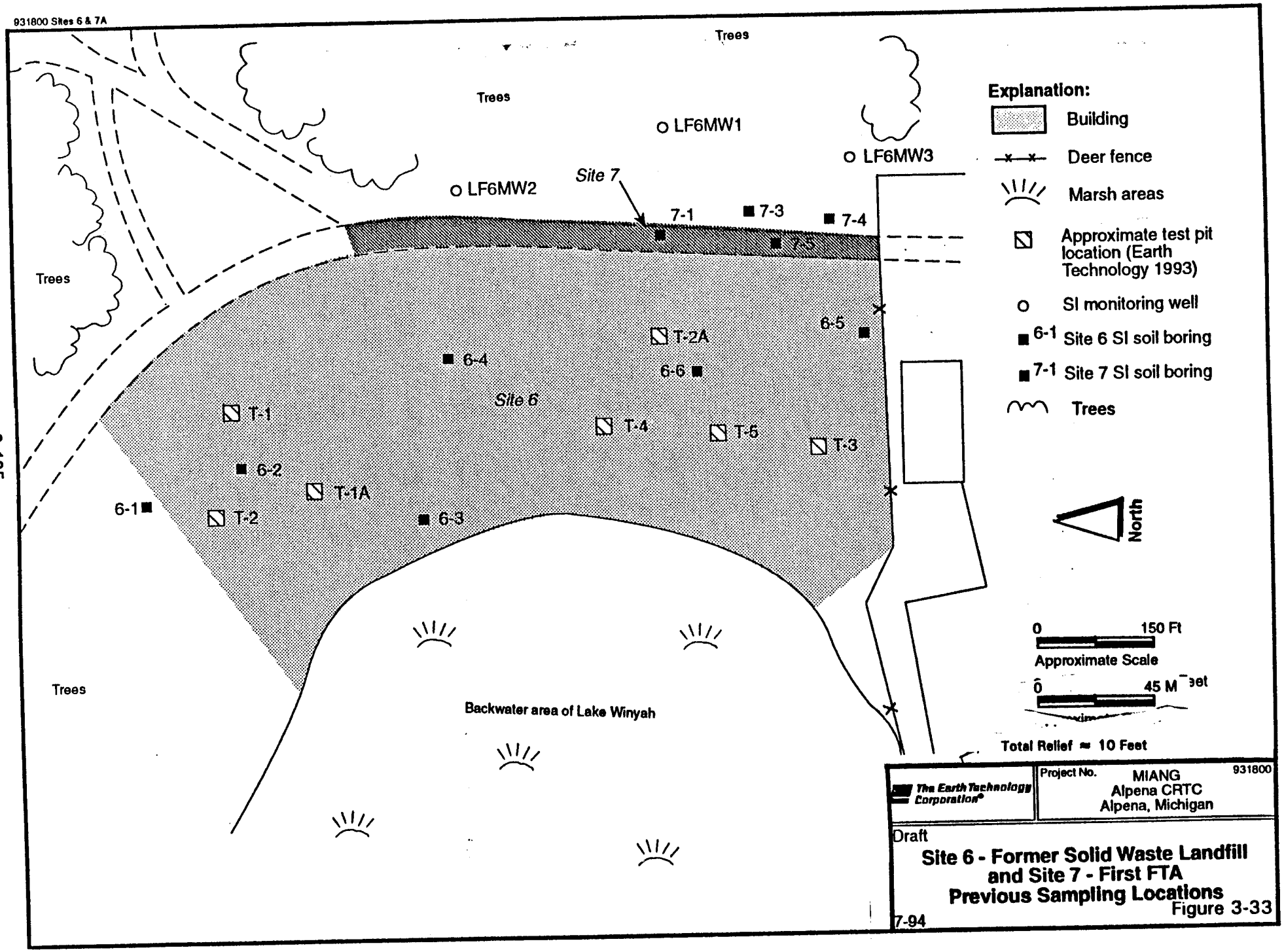
The results of the PA (Hazardous Materials Training Center, 1985) recommended Sites 6 and 7 for additional investigations, while the SI Report (Engineering-Science, 1990) presented the results of a soil vapor monitoring survey, magnetic survey, soil, sediment, surface water and groundwater sampling program completed for the sites. The results reported from the SI indicated only limited evidence of surface or subsurface soil contamination. Groundwater samples collected from either LF6MW1, or LF6MW3 contained either carbon tetrachloride, TCE, PCE, benzene, toluene, and/or ethylbenzene in either first (November 1987) or second (August 1988) rounds of groundwater sampling. The October 1991 (Round III) sampling event confirmed the presence of benzene, toluene, carbon tetrachloride, and TCE in LF6MW3. SI sampling locations are presented in Figure 3-33 along with test pit locations T-1 through T-5. The test pits were excavated at locations which correlated well with suspected buried drum locations as identified by the RI magnetometer survey. Although metallic objects were recovered during the test pitting that may have represented old drums, a majority of the material uncovered during excavation consisted of construction debris and domestic refuse typical of solid waste landfills.

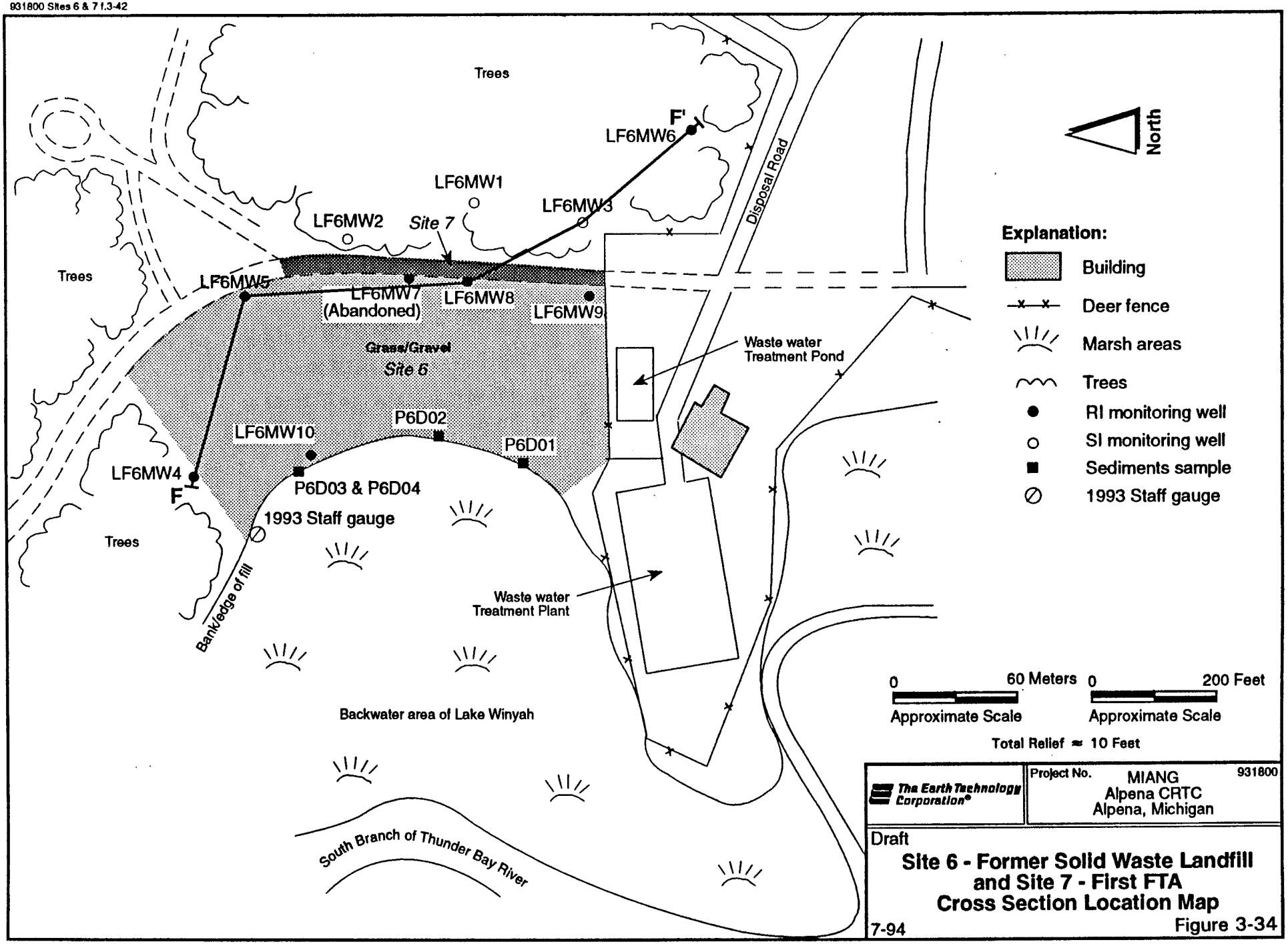
3.7.2 Site Geology and Hydrogeology

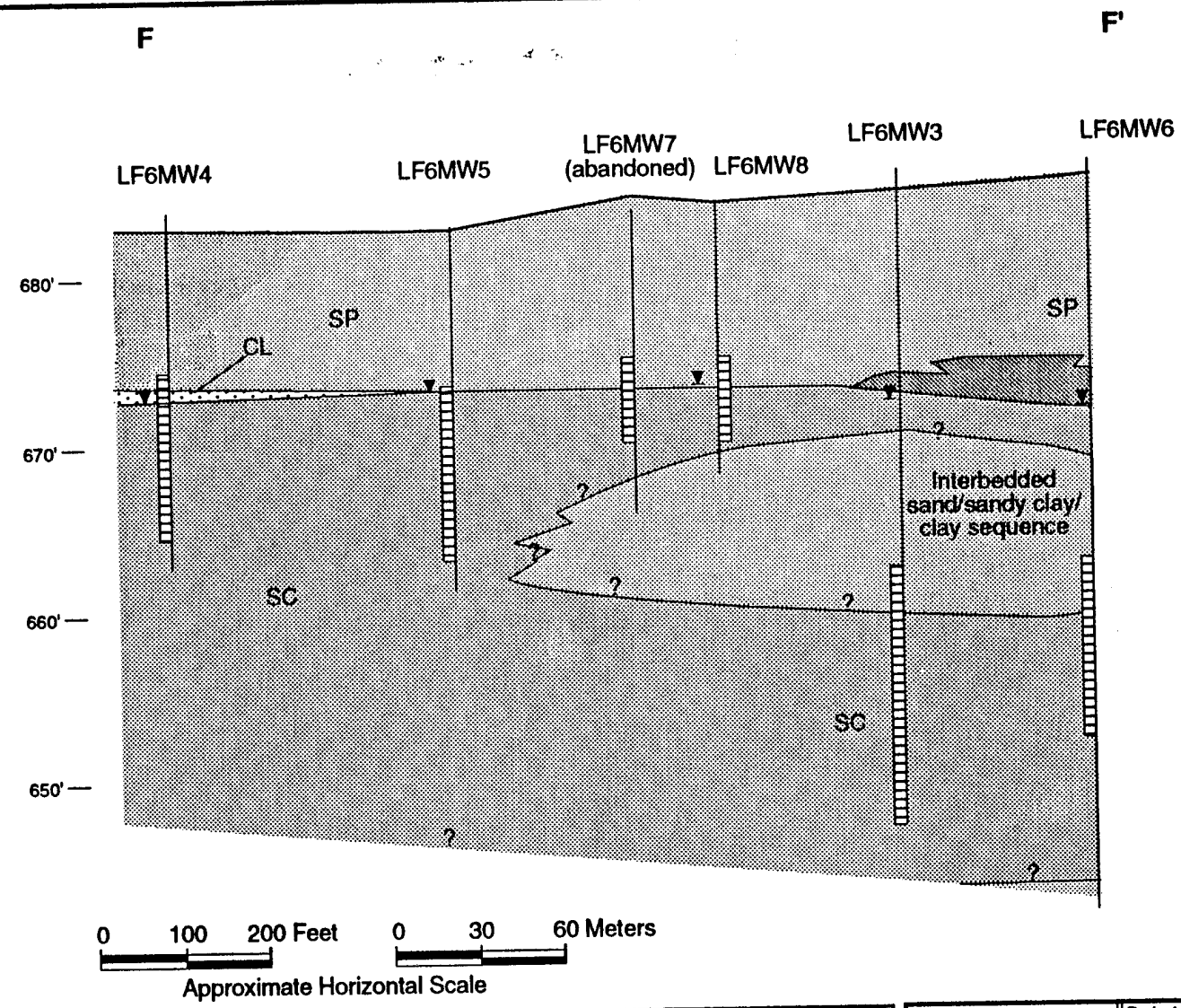
The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.7.2.1 Geology

The location of a geologic cross-section constructed across Site 6 is presented in Figure 3-34. The cross-section, as presented in Figure 3-35, shows that the native, shallow aquifer materials existing beneath Sites 6 and 7 generally consist of a three-layered sequence: an upper sand unit, an intermediate thin-bedded clay and sand unit, and a lower sand unit. Approximately 3 m (10 ft) of well-sorted, medium-grained quartz sand comprises the upper sand unit. Underlying the upper sand unit over most of the site is a zone of thinly interbedded, sand/sandy-clay/ and clay that varies from approximately 4.6 m (15 ft) thick at location LF6MW4 to approximately 9.1 m (30 ft) thick at location LF6MW6. Individual sand/sandy clay/clay units within this zone range from approximately 0.15 to 0.6 m (0.5 to 2 ft) in thickness. Where this intermediate zone of clay and sand has been fully penetrated


931800 Sites 6 & 7A
Trees
Trees
Trees
Trees
Trees
LF6MW1
LF6MW2
LF6MW3
Site 7
7-1
7-3
7-4
7-5
6-5
T-2A
6-4
6-6
Site 6
T-1
T-4
T-5
T-3
6-2
T-1A
6-1
T-2
6-3
Backwater area of Lake Winyah
Explanation:
Building
Deer fence
Marsh areas
Approximate test pit location (Earth Technology 1993)
SI monitoring well
6-1 Site 6 SI soil boring
7-1 Site 7 SI soil boring
Trees
North
0 150 Ft
Approximate Scale
0 45 Meter
Total Relief ≈ 10 Feet
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 6 - Former Solid Waste Landfill and Site 7 - First FTA
Previous Sampling Locations
Figure 3-33
7-94


Trees
F'
LF6MW6
LF6MW1
LF6MW2
Site 7
LF6MW3
Disposal Road
North
Explanation:
Building
Deer fence
Marsh areas
Trees
RI monitoring well
SI monitoring well
Sediments sample
1993 Staff gauge
Trees
LF6MW5
LF6MW7
(Abandoned)
LF6MW8
LF6MW9
Grass/Gravel
Site 6
Waste water
Treatment Pond
LF6MW10
P6D02
P6D01
LF6MW4
F
P6D03 & P6D04
1993 Staff gauge
Trees
Bank/edge of fill
Waste water
Treatment Plant
Backwater area of Lake Winyah
South Branch of Thunder Bay River
0
60 Meters
Approximate Scale
0
200 Feet
Approximate Scale
Total Relief ≈ 10 Feet
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Alpena CRTC
Alpena, Michigan
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Site 6 - Former Solid Waste Landfill
and Site 7 - First FTA
Cross Section Location Map
7-94
Figure 3-34



Explanation

SP	Sand; well sorted, med-coarse grained quartz; trace minor fines	GW	Gravel, well sorted	▼	Groundwater elevation as measured September 1993
SC	Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines		Screened interval		
CH	Clay; massive, plastic, med stiff; trace sand				

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Alpena, Michigan

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Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Geologic Cross Section F-F'

6-94

Figure 3-35

(see LF6MW3), a lower sand layer has been found. The limestone bedrock was encountered at depths ranging from 8.2 m (27 ft) bgs at LF6MW2 to 12.8 m (42 ft) bgs at LF6MW6. No clay layer occurring between the shallow aquifer and the limestone bedrock was logged during the drilling of LF6MW6.

One sample of a silt with clay encountered from 5.2 to 5.8 m (17 to 19 ft) bgs in LF6MW7 was collected and submitted for geotechnical analysis. This sample was obtained from the interbedded sand/sandy clay/clay unit. According to the geotechnical resullts presented in Appendix C, vertical hydraulic conductivity values measured on the samples range from 3.5 X 10^{-5} cm/sec (0.099 ft/day) to 8.2 X 10^{-6} cm/sec (0.023 ft/day). These data suggest that individual units within the interbedded sand/sandy clay/clay unit have sufficiently low vertical hydraulic conductivities to be considered good aquitards. However, they are likely not thick nor laterally extensive enough to be considered aquitards capable of prohibiting the downward movement of groundwater.

3.7.2.2 Hydrogeology

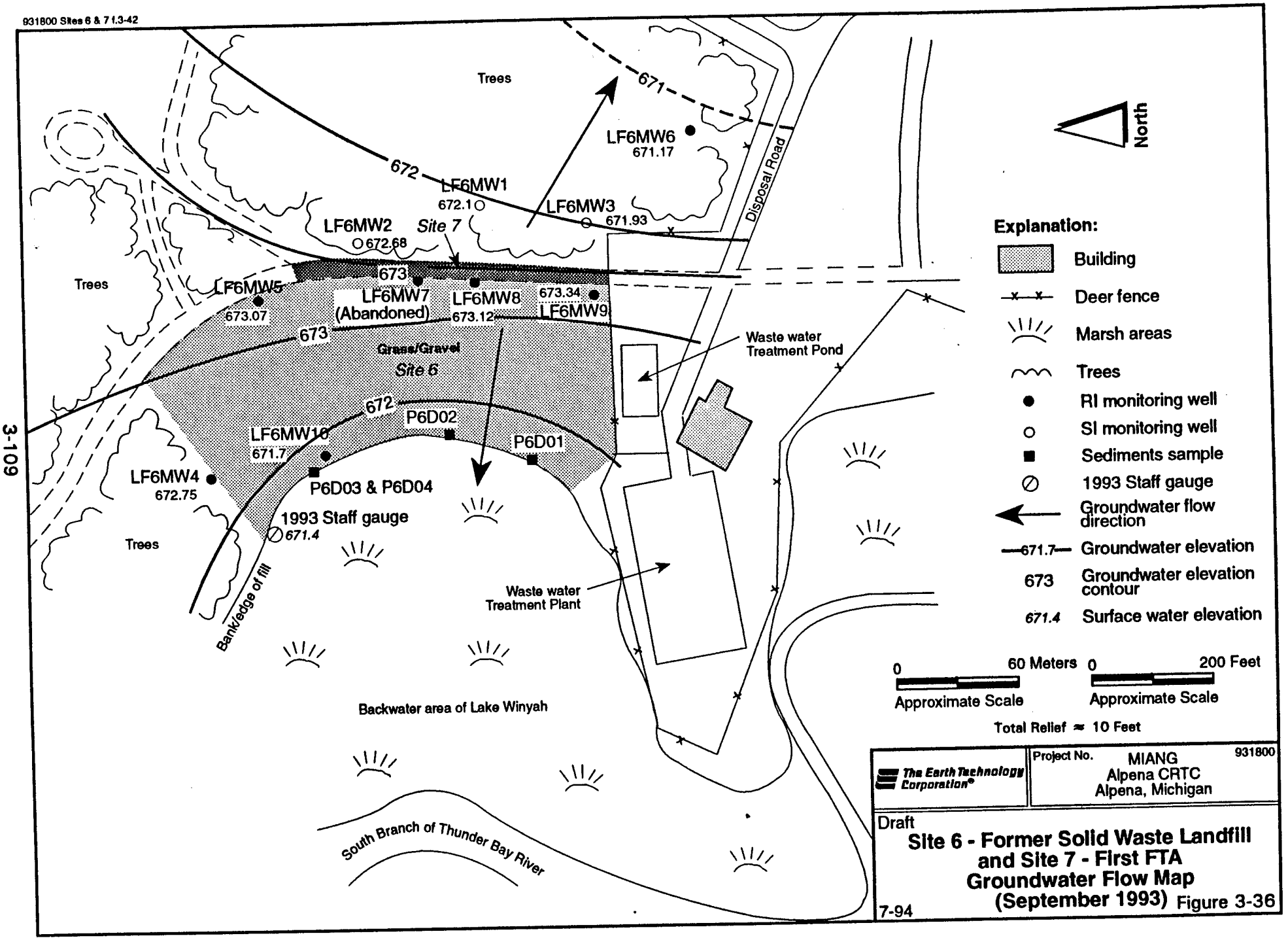
Nine monitoring wells have been installed at Sites 6 and 7; LF6MW1 through LF6MW6 and LF6MW8 through LF6MW10. Three of these wells, LF6MW1 through LF6MW3 were installed during the SI (Engineering-Science, 1990) while the remaining six wells LF6MW4, -MW5, -MW6, -MW8, -MW9, and -MW10 were installed in August and September of 1993 during the RI field activities. LF6MW7 was also installed during RI activities, but the screened interval for this well was placed adjacent to a relatively clay-rich portion of the shallow aquifer. The well was subsequently abandoned because the well would not recharge sufficiently during development and sampling.

Groundwater occurs beneath Sites 6 and 7 at depths ranging from 10.64 to 18.44 ft bgs and from 671.17 to 673.34 ft above msl. As shown on the cross-section (Figure 3-35) groundwater is encountered roughly at the top of the interbedded sand/sandy clay/clay unit. Groundwater flow beneath the sites (Figure 3-36) is influenced by both the river and the sinkhole. Groundwater within the shallow aquifer in the vicinity of wells LF6MW1, -MW2, -MW3 and -MW6 is flowing to the southeast towards the sinkhole. Groundwater flow is directed to the northwest towards the backwater area of Lake Winyah as interpreted from groundwater elevation measurements collected from wells LF6MW4, 5, and MW10. The average hydraulic gradient across Site 6 has been measured as 0.004 ft/ft.

Three slug tests were performed in Site 6 and 7 monitoring wells. Two tests were completed in LF6MW6 (slug in and slug out) and a slug in test in LF6MW4. The data were analyzed using the Bouwer and Rice method (1976; Bouwer, 1989) in conjunction with AQTESOLV™ (Geraghty & Miller, 1991). Slug test data and calculations are presented in Appendix B. An average hydraulic conductivity of 2.8 x 10^{-4} cm/sec was calculated from measurements collected during the slug testing.

3.7.3 Screening Results

Initial site screening activities to support the RI were completed in January 1993. These



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Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Groundwater Flow Map (September 1993) Figure 3-36

7-94

activities consisted of the collection and analysis of groundwater screening samples. The complete results of this survey are included in Appendix D. Further on-site GC screening activities were completed in August and September 1993 during the second phase of field activities to determine the placement of the appropriate screen intervals for the monitoring wells. The results of the on-site screening activities completed during drilling operations are presented in Appendix E.

3.7.3.1 Initial Site Screening

Eight groundwater samples numbered LF6GW-1 through LF6GW-8 were collected at this site from the locations shown in Figure 3-37.

- Target VOCs – Four samples contained BTEX. Of the four samples, only LF6GW-1 contained greater than trace concentrations of BTEX. This sample contains benzene at a concentration of 270 ppb. In addition to BTEX, the sample also contained TCE (1.3 ppb) and concentrations of PCE less than the MDL (0.05 ppb). No other detections of chlorinated hydrocarbons were observed in the data set.

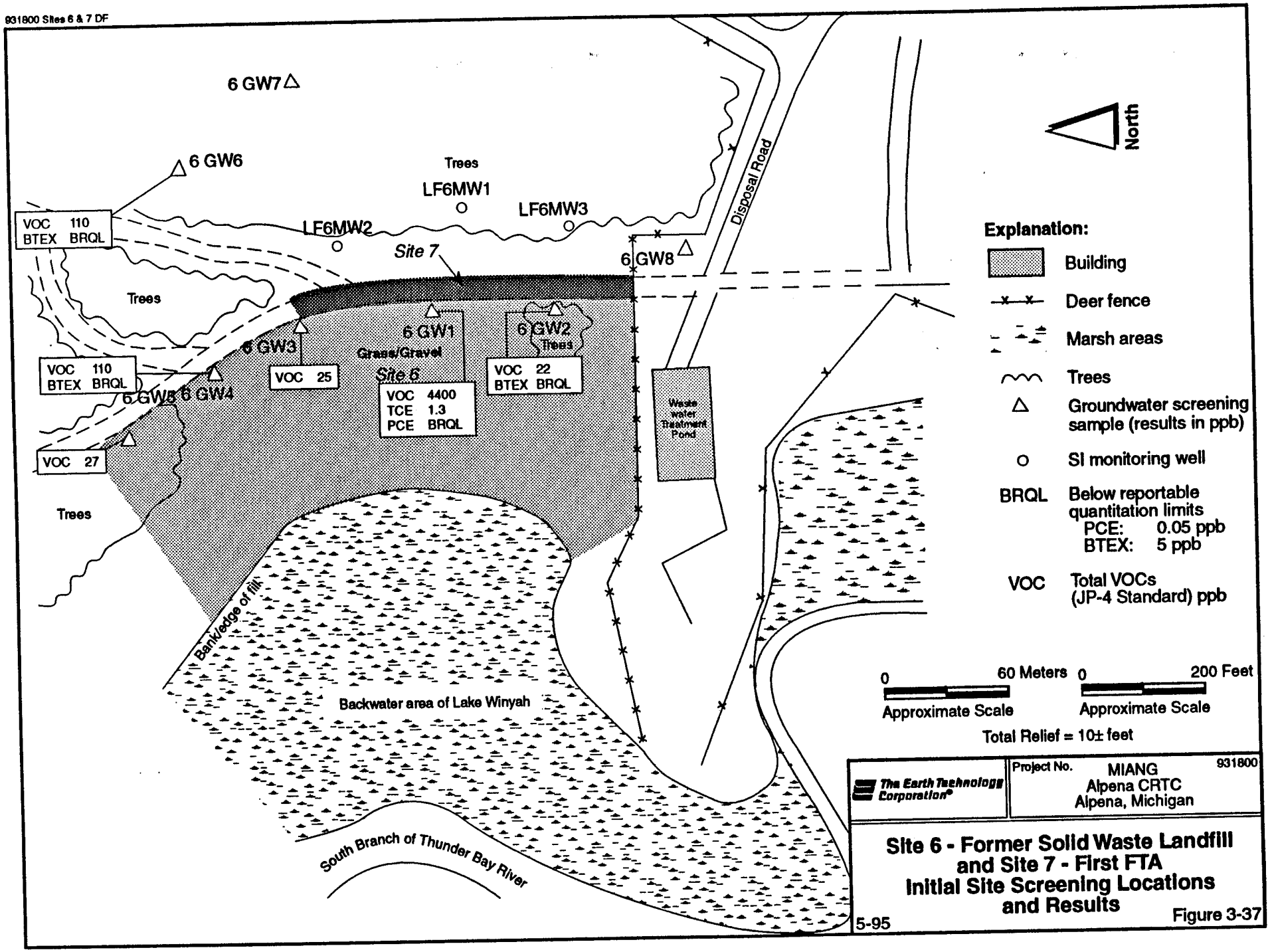
- Total VOCs (as JP-4) – Six samples (all but LF6MW7 and LF6MW8) contained total VOCs in concentrations ranging from 22 to 4400 ppb.

3.7.3.2 Monitoring Well Placement Rationale

Monitoring well locations were selected at Sites 6 and 7 based on the results of the initial site screening data and the results of the previous rounds of groundwater sampling. LF6MW4 was installed at what was assumed to be an up gradient location, while wells LF6MW5, -MW7, -MW8, and -MW9 were installed to monitor the extent of groundwater contamination which was detected during the initial site screening. LF6MW6 was installed down gradient of the site to determine the extent of contaminants detected during the previous three rounds of sampling quantified in LF6MW3. The location of LF6MW10 was selected to monitor water quality within the shallow aquifer as it flows through the landfill into the backwaters of Lake Winyah.

3.7.3.3 On-Site Screening During Drilling Operations

Twenty-three soil, 3 hand-augered saturated soil, and 8 groundwater samples were collected during the RI field operations conducted at Sites 6 and 7 and analyzed using the on-site GC. Figures 3-38 and 3-39 present the screening results obtained during the on-site GC analysis for Site 6 in map and cross-section view, respectively. As presented on these two figures, VOCs were detected in screening samples collected from locations LF6MW5, MW8, MW10, and LF6HAC. The analytical results are summarized below:



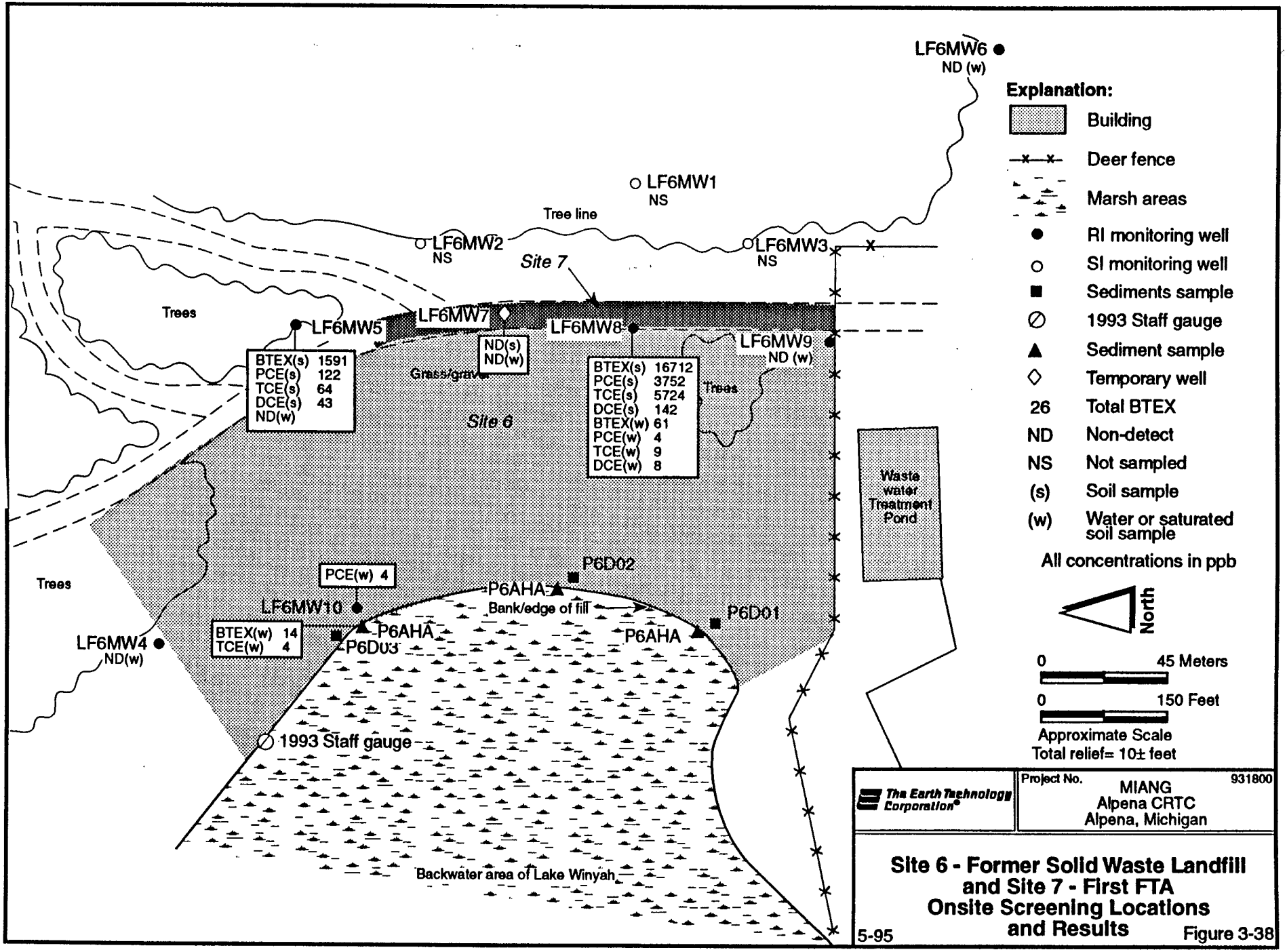
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Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Initial Site Screening Locations and Results

5-95

Figure 3-37



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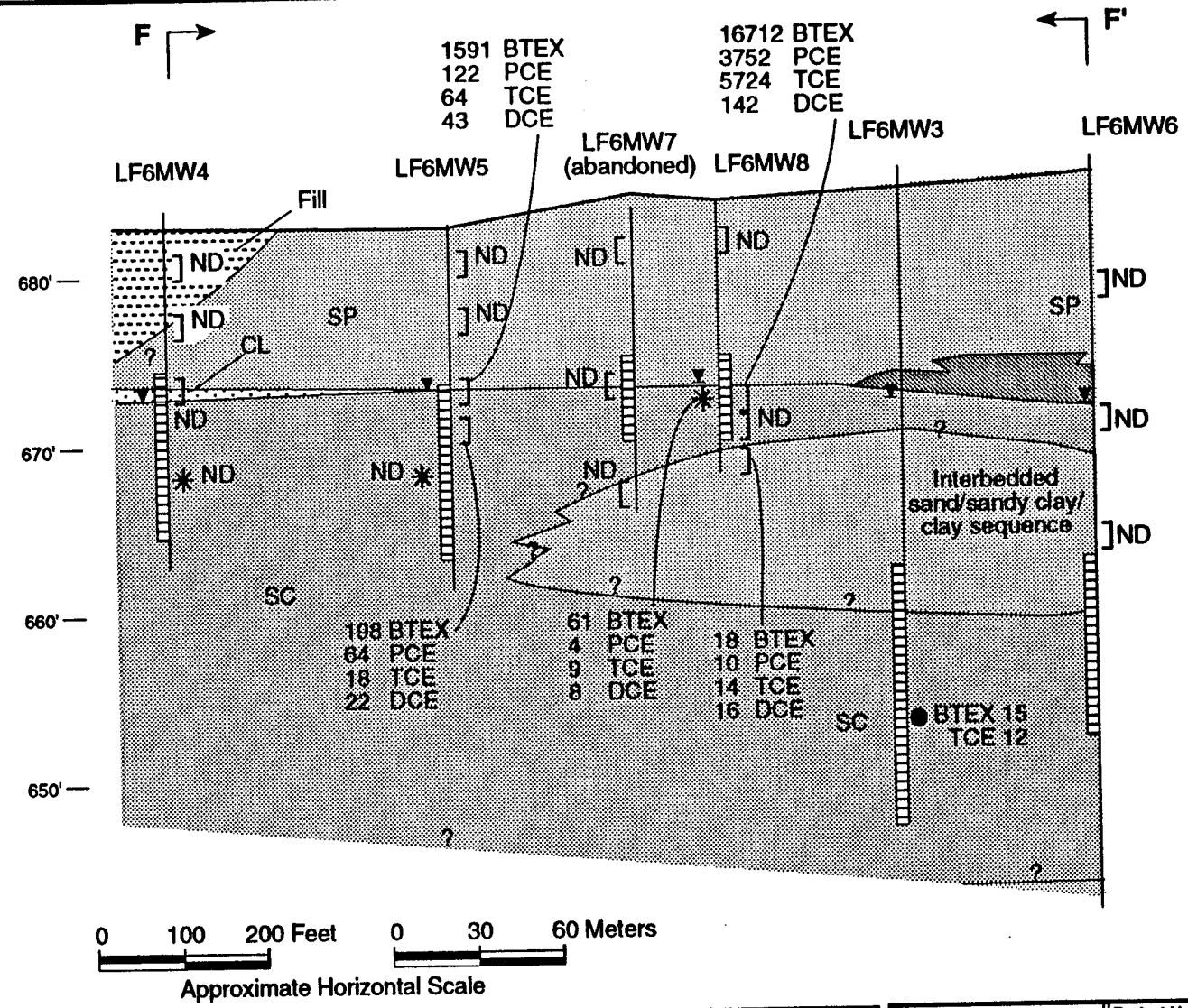
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan

Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Onsite Screening Locations and Results

5-95

Figure 3-38

Site 6 X-Sec 2 DF



Explanation

SP — Sand; well sorted, med-coarse grained quartz; trace minor fines	GW — Gravel, well sorted	▼ Groundwater elevation as measured September 1993	
SC — Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines	Screened interval	● Fixed base groundwater, 10-91 round (ppb)	
CH — Clay; massive, plastic, med stiff; trace sand	✱ Field screen-groundwater (ppb)	[Field screen-soil (ppb)	

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Alpena, Michigan

Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Geologic Cross Section F-F' Screening Results

5-95

Figure 3-39

- Samples collected and analyzed from vadose zone soils did not contain detectable concentrations of VOCs.

- Groundwater elevation measurements collected during the RI fieldwork indicated groundwater was flowing towards the backwaters of Lake Winyah. Three hand-augered, saturated zone soil samples (P6D01, P6D02, and P6D03) were collected along the toe of the western slope of the landfill and analyzed in the field lab to determine if shallow groundwater flowing into the backwaters contained detectable VOCs. Of the three samples only LF6AHC (P6AHC) contained VOCs; TCE and ethylbenzene at concentrations of 4 and 12 $\mu g/\ell$ of air, respectively. During the installation of LF6MW10 a soil sample was collected from the approximate depth of the water table. This sample contained PCE at a concentration of 4 $\mu g/\ell$ of air.

- VOCs in the on-site screening samples were also quantified in saturated zone soil or groundwater samples collected from locations LF6MW5 and -MW8. Figure 3-39 presents the depths and concentrations of the sampling conducted in these wells. BTEX, TCE, PCE, cis- and trans-DCE were all detected from these samples in relatively high concentrations (maximum 16,712 $\mu g/\ell$ of air-total BTEX) for Site 6 and 7 sediment and groundwater sample.

3.7.4 Confirmation Results

Analytical results obtained from the fixed base laboratory for Site 6 and 7 sediment and groundwater samples are presented in Tables 3-17 and 3-18. Soil, surface water, sediment, and groundwater analytical results obtained during the SI and the third round of groundwater sampling are presented in Appendices N and O.

3.7.4.1 Soil Results

No confirmation soil samples were collected during the RI field efforts because the existing data were judged sufficient to describe the nature and extent of soil contamination present at the sites. Soil analytical results for samples collected from the 8 previously completed soil borings (Engineering-Science 1990) exceeding the current Act 307 Type A or B cleanup criteria are shown in Figure 3-40. A review of the SI sampling results indicates that organic compounds are generally absent from the data set, and that no organic compounds were detected exceeding the Act 307 Type B cleanup criteria. The metals lead, selenium, and zinc were detected in one or more site soil samples at concentrations which exceed the Act 307 Type A default values.

3.7.4.2 Sediment Results

Three sediment samples, P6D001 through P6D003 (P6D004 is a field duplicate of P6D003) were collected within the backwaters of Lake Winyah adjacent to the toe of the landfill slope. These sampling locations and analytical summaries are presented in Figure 3-41. The

Table 3-17 Data Summary Table: Sediment, Site 6 - Former Solid Waste Landfill
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	SD1		SD2		SD3*		SD4**	
Sample ID:	PC-LF6-SD1		PC-LF6-SD2		PC-LF6-SD3		PC-LF6-SD4	
Collection Date:	17-AUG-93		17-AUG-93		17-AUG-93		17-AUG-93	
Associated Field QC:	FB03,FB06,TB14,ER11		FB03,FB06,TB14,ER11		FB03,FB06,TB14,ER11		FB03,FB06,TB14,ER11	
	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
SEMI-VOLATILES (CLP 3/90)									
Anthracene	ppb	1100	U	-		470	U	460	
Benzo(a)anthracene	ppb	1100	U	-		470	U	450	
Benzo(a)pyrene	ppb	1100	U	-		470	U	320	
Benzo(b)fluoranthene	ppb	1100	U	-		470	U	690	
Benzo(ghi)perylene	ppb	1100	U	-		470	U	61	
Benzo(K)fluoranthene	ppb	1100	U	-		470	U	690	
Butyl benzyl phthalate	ppb	1100	U	-		55		66	
Carbazole	ppb	1100	U	-		470	U	88	
Chrysene	ppb	1100	U	-		470	U	430	
Di-n-butyl phthalate	ppb	1100	U	-		470	U	64	
Fluoranthene	ppb	1100	U	-		470	U	650	
Indeno(1,2,3-cd)pyrene	ppb	1100	U	-		470	U	120	
Phenanthrene	ppb	1100	U	-		470	U	460	
Pyrene	ppb	1100	U	-		470	U	420	
METALS (CLP 3/90)									
Chromium	ppb	4900	L	15900		7600	L	5000	L
Copper	ppb	6200	()J	16400	()	11800	J	13800	J
Lead	ppb	5300	K	177000	J	19100	J	62600	J
Nickel	ppb	11100	UL	25500	U	7900	L	5300	UL
Selenium	ppb	950	UL	2300	()	430	UL	970	B
Total Petroleum Hydrocarbons	ppb	93400		994000		175000		450000	

B Compound or analyte detected in field blank or lab blank
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-LF6-SD4
** Duplicate of PC-LF6-SD3
LAB: COMPUCHEM
No Act 307 criteria available for sediments

Table 3-18 Data Summary Table: Groundwater, Site 6 - Former Solid Waste Landfill
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	MW1		MW10		MW2		MW3		MW4		MW5	
Sample ID:	PC-LF6-MW1-GW4		PC-LF6-MW10-GW4		PC-LF6-MW2-GW4		PC-LF6-MW3-GW4		PC-LF6-MW4-GW4		PC-LF6-MW5-GW4	
Collection Date:	12-SEP-93		16-SEP-93		11-AUG-93		26-AUG-93		30-AUG-93		30-AUG-93	
Associated Field QC:	FB06,TB09		FB07,TB28		FB06,TB08		FB05,TB18,ER14		FB05,TB20,ER17,FB07		FB05,TB20,ER17,FB07	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)												
1,2-Dimethylbenzene 280 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	UJ
1,3-Dimethylbenzene 280 ppb	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Benzene 1.2 ppb	0.35	U	0.35	U	0.072		0.35	U	0.35	U	0.35	UJ
Chlorobenzene 130 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	UJ
Ethylbenzene 74 ppb	0.2	U	0.2	U	0.16		0.2	U	0.2	U	0.74	J
Toluene 790 ppb	0.16	B	0.25	U	0.15	B	0.25	U	0.25	U	0.25	UJ
HALOGENATED VOLATILES (8010)												
1,1,1-Trichloroethane 200 ppb	0.35	U	0.3		0.35	U	0.35	U	0.35	U	0.35	UJ
1,2-Dichloropropane 0.52 ppb	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
Carbon Tetrachloride 0.27 ppb	0.35	U	0.35	U	0.35	U	1.1		0.35	U	0.35	U
Chloroform 5.8 ppb	0.35	U	0.35	U	0.35	U	0.14		0.35	U	0.35	UJ
Methylene Chloride 4.6 ppb	0.075		0.1	B	0.027		0.17	U	0.34	B	0.35	B
Trichloroethylene 2.2 ppb	0.3	U	0.3	U	0.3	U	1.7		0.3	U	0.3	UJ
SEMI-VOLATILES (CLP 3/90)												
Butyl benzyl phthalate 1100 ppb	5	U	5	U	5	U	5	U	5	U	5	U
Di-n-butyl phthalate 840 ppb	5	U	5	U	5	U	0.8	B	5	U	5	U
Diethyl phthalate 5200 ppb	5	U	5	U	5	U	0.7	B	2		2	
Phenol 4200 ppb	5	U	5	U	5	U	3	B	3		5	U

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-18 Data Summary Table: Groundwater, Site 6 - Former Solid Waste Landfill
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW1		MW10		MW2		MW3		MW4		MW5	
Sample ID:		PC-LF6-MW1-GW4		PC-LF6-MW10-GW4		PC-LF6-MW2-GW4		PC-LF6-MW3-GW4		PC-LF6-MW4-GW4		PC-LF6-MW5-GW4	
Collection Date:		12-SEP-93		16-SEP-93		11-AUG-93		26-AUG-93		30-AUG-93		30-AUG-93	
Associated Field QC:		FB06,TB09		FB07,TB28		FB06,TB08		FB05,TB18,ER14		FB05,TB20,ER17,FB07		FB05,TB20,ER17,FB07	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)													
Antimony	ppb	35	U	45	U	48.4	()B	35	U	39.2	()L	35	U
Arsenic	ppb	4	U	10.9		4	U	4	UL	4	U	4	UL
Beryllium	ppb	1	U	4	U	1	U	1	U	1	U	1	U
Cadmium	ppb	3	U	5	U	3	U	3	U	3	U	3	U
Chromium	ppb	8	U	60.5		8	U	8	U	8	U	8	U
Copper	ppb	4	U	57.8		4	U	4.2	()B	8.2	()B	4.9	()B
Copper, Dissolved	1300 ppb	4	U	4	U	4	U	4	U	4	U	4	U
Lead	ppb	2	U	127		2	U	2.1	()L	2	U	2	U
Mercury	ppb	0.2	U	0.36		0.2	U	0.2	U	0.2	U	0.2	U
Nickel	ppb	18	U	37.1		18	U	18	U	18	U	18	U
Selenium	ppb	3	U	3	UL	3	UL	3	U	3	U	3	U
Zinc	ppb	4	U	258	J	6.9	()B	4.3	()B	20.4	B	11.6	()B
Zinc, Dissolved	2300 ppb	4	U	4.8	()	4	U	4	UJ	8.8	()B	10	()B

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

wp/t3-18.540- 6/15/95

Table 3-18 Data Summary Table: Groundwater, Site 6 - Former Solid Waste Landfill
MIANG, Alpena CRTC, Alpena, Michigan

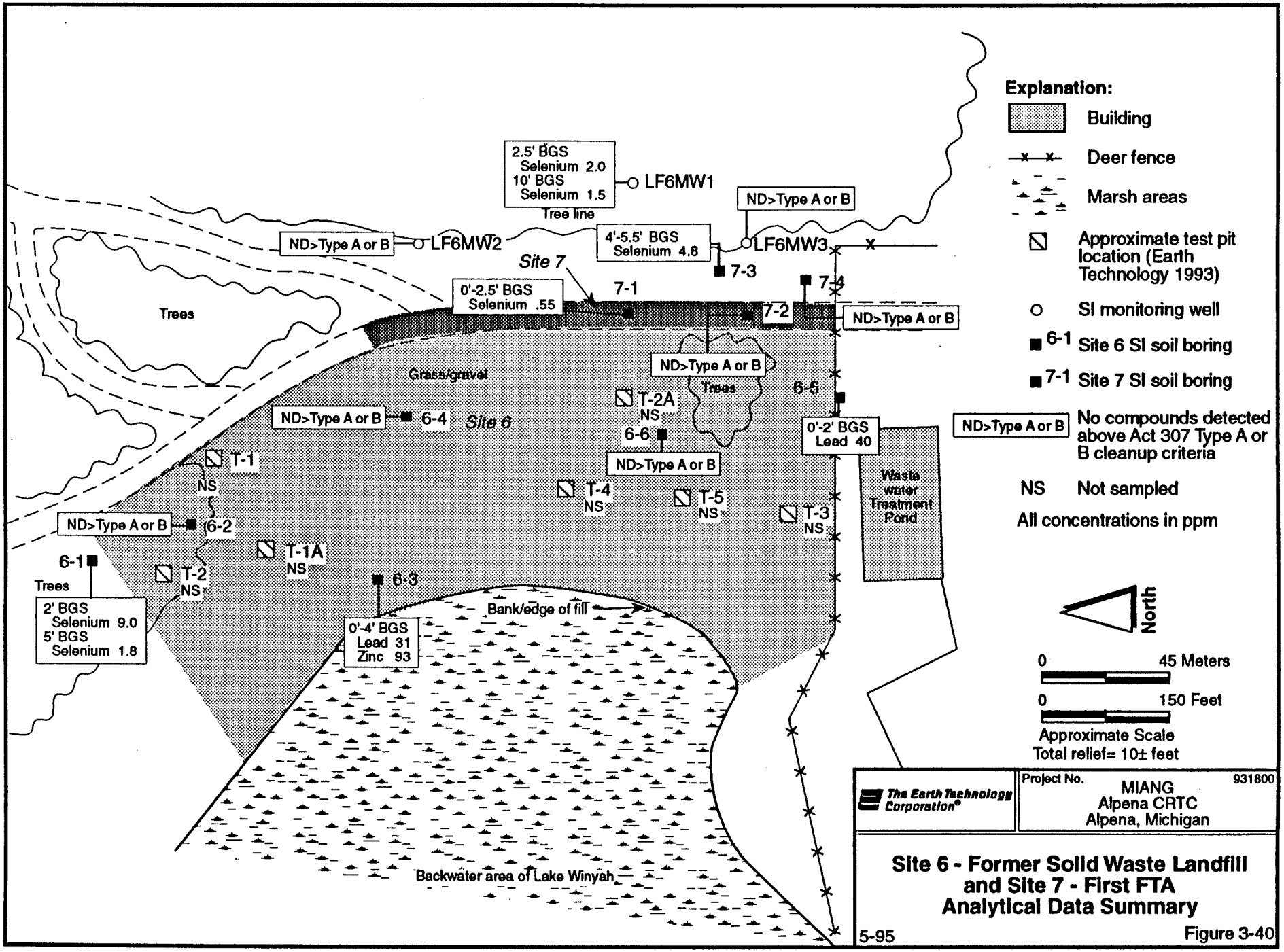
Locator:		MW6		MW8		MW9	
Sample ID:		PC-LF6-MW6-GW4		PC-LF6-MW8-GW4		PC-LF6-MW9-GW4	
Collection Date:		30-AUG-93		08-SEP-93		08-SEP-93	
Associated Field QC:		FB05,TB20,FB07		FB07,TB22		FB07,TB22	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)							
1,2-Dimethylbenzene	280 ppb	0.2	U	0.26		0.2	U
1,3-Dimethylbenzene	280 ppb	-		1.7		-	
Benzene	1.2 ppb	0.35	U	0.35	U	0.35	U
Chlorobenzene	130 ppb	0.25	U	0.17		0.25	U
Ethylbenzene	74 ppb	0.2	U	4.7		0.2	U
Toluene	790 ppb	0.25	U	0.24		0.25	U
HALOGENATED VOLATILES (8010)							
1,1,1-Trichloroethane	200 ppb	0.35	U	0.35	U	0.35	U
1,2-Dichloropropane	0.52 ppb	0.25		0.3	U	0.3	U
Carbon Tetrachloride	0.27 ppb	0.35	U	0.35	U	0.35	U
Chloroform	5.6 ppb	0.35	U	0.35	U	0.35	U
Methylene Chloride	4.6 ppb	0.21	U	0.42	B	0.68	B
Trichloroethylene	2.2 ppb	0.3	U	0.3	U	0.3	U
SEMI-VOLATILES (CLP 3/90)							
Butyl benzyl phthalate	1100 ppb	5	U	2		5	U
Di-n-butyl phthalate	840 ppb	5	U	1	J	1	J
Diethyl phthalate	5200 ppb	0.6		0.9		1	
Phenol	4200 ppb	5	U	2		3	

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-18 Data Summary Table: Groundwater, Site 6 - Former Solid Waste Landfill
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		MW6		MW8		MW9	
Sample ID:		PC-LF6-MW6-GW4		PC-LF6-MW8-GW4		PC-LF6-MW9-GW4	
Collection Date:		30-AUG-93		08-SEP-93		08-SEP-93	
Associated Field QC:		FB05,TB20,FB07		FB07,TB22		FB07,TB22	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
METALS (CLP 3/90)							
Antimony	ppb	35.2	()B	35	U	42.4	()B
Arsenic	ppb	4	UL	13.4	J	8.2	()J
Beryllium	ppb	1	U	2.4		1.8	
Cadmium	ppb	3	U	5.4		5.5	
Chromium	ppb	8	U	75.9		62	
Copper	ppb	5.2	()B	53.3		44.4	
Copper, Dissolved	1300 ppb	4	U	8.2	()	8.9	()
Lead	ppb	2	UL	38.2		23.9	
Mercury	ppb	0.2	U	0.2	U	0.2	U
Nickel	ppb	18	U	43.1		46.8	
Selenium	ppb	3	U	77.1	J	24.5	B
Zinc	ppb	67.7	B	167	J	123	J
Zinc, Dissolved	2300 ppb	38.2	B	4	U	4.7	()

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM



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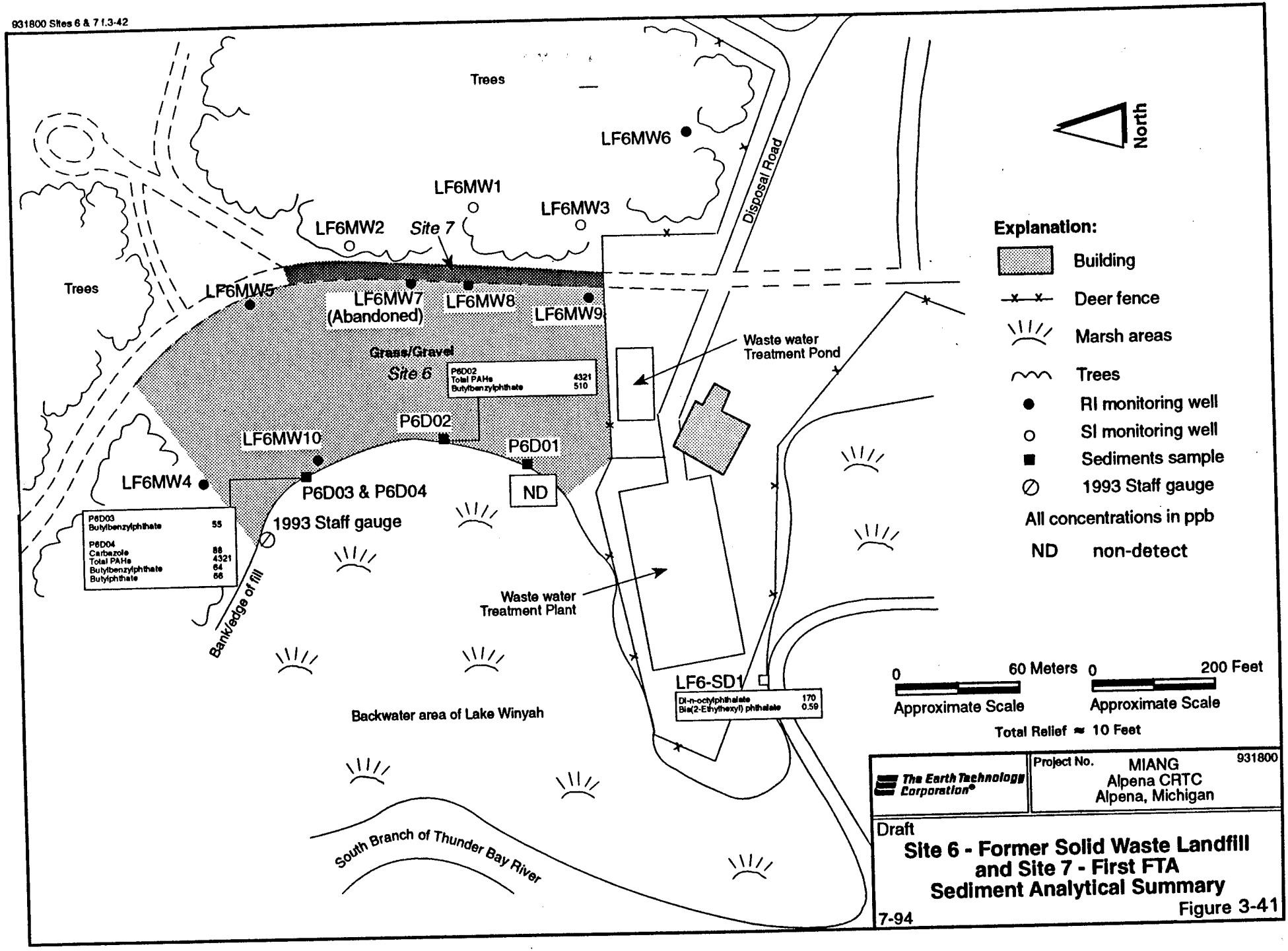
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Alpena, Michigan

Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Analytical Data Summary

5-95

Figure 3-40



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Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Sediment Analytical Summary

7-94

Figure 3-41

analytical results indicate SVOCs, mainly PAHs such as anthracene, pyrene, etc., were detected in the P6D002 and P6D004. No Michigan Environmental Response Act (MERA) criteria exist for sediment quality.

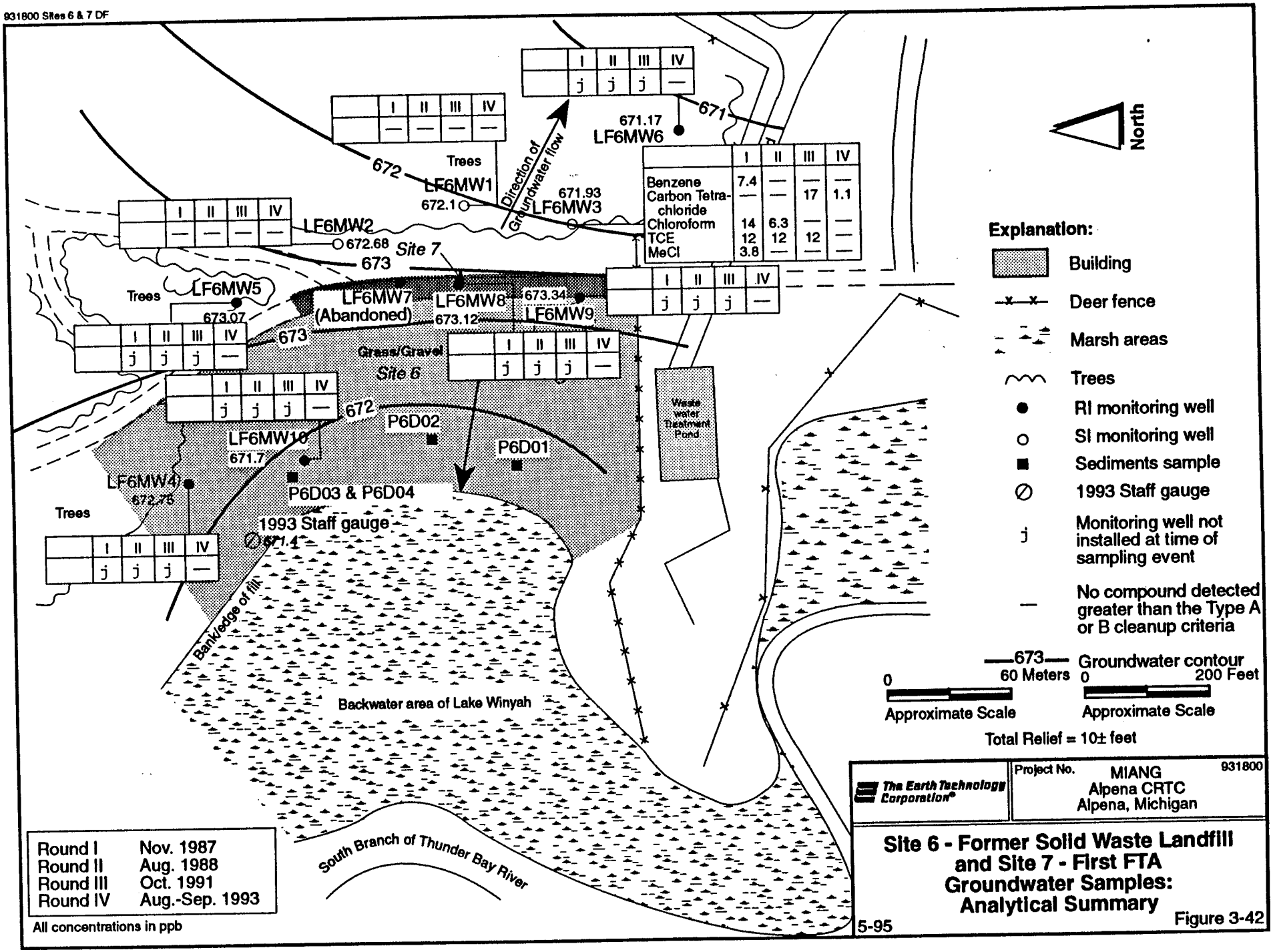
3.7.4.3 Groundwater Results

A review of the summer 1993 (Round IV) analytical results indicate a wide variety of organic compounds including BTEX, TCE, 1,1,1-TCA, chlorobenzene, phenol, 1,2-dichloropropane, carbon tetrachloride, methylene chloride, chloroform, and phthalate esters were detected in one or more of the groundwater samples collected from the Site 6 and 7 monitoring wells. VOCs commonly detected in petroleum-based fuels (BTEX) were quantified in samples originating from wells LF6MW2, -MW5, and -MW8, while chlorinated solvents such as TCE and carbon tetrachloride were detected in wells LF6MW3, -MW8, and -MW10. Phenol was found in groundwater samples from LF6MW4, -MW8, and -MW9. In general, samples from all 9 of the wells contained at least one organic compound. However, a majority of the detections were quantified in concentrations below the Act 307 Type B cleanup criteria. Only carbon tetrachloride, detected in the groundwater sample from LF6MW3 at a concentration of 1.10 $\mu g/\ell$ exceeded the Act 307 Type B cleanup criteria. Analytical results obtained from groundwater samples of LF6MW6, located down gradient of LF6MW3, did not contain detectable amounts of carbon tetrachloride. TPH was not detected in the groundwater samples collected and analyzed from Sites 6 and 7.

Results obtained during the field screening activities from two wells, LF6MW5 and -MW8 do not compare well with the fixed based analytical results. Relatively high concentrations of VOCs detected from saturated zone soil and groundwater samples obtained during the field screening were not confirmed by the fixed based groundwater analysis. Both wells were screened in subsurface intervals which contained relatively high concentrations of VOCs based on screening samples (Figure 3-39). Although many of the target VOCs analyzed for during the on-site GC analysis were detected in the fixed base analytical data, in general, much lower concentrations were reported by the fixed based laboratory.

Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc were each detected in one or more of the total (unfiltered) groundwater samples collected during the summer 1993 (Round IV) groundwater sampling. Of these analytes, antimony, arsenic, cadmium, lead, and selenium were detected in one or more of the unfiltered samples in concentrations exceeding the Act 307 Type A cleanup criteria. However, these unfiltered samples were generally turbid and could likely not be used (as collected) for domestic purposes. Only copper and zinc were detected in the dissolved (filtered) samples. All inorganic detections quantified in the filtered samples were present in concentrations below the Act 307 Type A cleanup criteria.

The distribution of organic compounds and inorganics detected during any one of the four rounds of groundwater sampling in concentrations exceeding the Act 307 Type A or B cleanup criteria are shown in Figure 3-42. Analytical results obtained from groundwater samples collected from the existing monitoring wells (LF6MW1 through LF6MW3) are generally consistent over the four rounds of sampling. Organic compounds, such as TCE and carbon


North
Explanation:
Building
Deer fence
Marsh areas
Trees
RI monitoring well
SI monitoring well
Sediments sample
1993 Staff gauge
Monitoring well not installed at time of sampling event
No compound detected greater than the Type A or B cleanup criteria
673 Groundwater contour
0 60 Meters
Approximate Scale
0 200 Feet
Approximate Scale
Total Relief = 10± feet
LF6MW1
672.1
LF6MW2
672.68
LF6MW3
671.93
LF6MW4
672.75
LF6MW5
673.07
LF6MW6
671.17
LF6MW7 (Abandoned)
LF6MW8
673.12
LF6MW9
673.34
LF6MW10
671.7
Site 7
Site 6
Grass/Gravel
Trees
672
673
671
P6D01
P6D02
P6D03 & P6D04
1993 Staff gauge
671.4
Waste water Treatment Pond
Direction of Groundwater flow
Bank/edge of fill
Backwater area of Lake Winyah
South Branch of Thunder Bay River
Benzene 7.4
Carbon Tetrachloride 17 1.1
Chloroform 14 6.3
TCE 12 12 12
MeCl 3.8
Round I Nov. 1987
Round II Aug. 1988
Round III Oct. 1991
Round IV Aug.-Sep. 1993
All concentrations in ppb
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Site 6 - Former Solid Waste Landfill and Site 7 - First FTA Groundwater Samples: Analytical Summary
5-95
Figure 3-42

tetrachloride, have been detected exceeding the Act 307 Type B cleanup criteria in one or more rounds from groundwater collected from wells LF6MW1 and -MW3. When compared to the initial three rounds of sampling results, the fourth round data suggest contaminant levels are dissipating in samples collected from LF6MW3. No inorganics have been detected in the filtered groundwater samples exceeding the Act 307 Type A cleanup criteria.

3.7.5 Summary and Conclusions

Past waste disposal practices and fire training exercises at Sites 6 and 7 have probably led to the release of waste POL and/or solvents into the soils and groundwater. The following paragraphs summarize the findings of the subsurface investigations conducted at Sites 6 and 7:

- Native soils are generally sandy to a depth of approximately 2.7 m (9 ft) bgs. An interbedded sand/sandy clay/clay unit approximately 3 m (10 ft) thick separates the upper sand unit from a lower sand unit. The shallow aquifer water table is roughly coincident with the top of the interbedded sand/sandy clay/clay unit. Groundwater within the shallow aquifer beneath Sites 6 and 7 flows west towards the river and southeast towards the sinkhole. Bedrock occurs beneath the site in depths ranging from 8.2 to 12.8 m (27 to 42 ft) bgs. The presence of a clay layer between the shallow aquifer and the limestone bedrock was not confirmed.

- Only lead, selenium, and zinc were detected in concentrations exceeding Act 307 Type A cleanup criteria from the soil samples collected and analyzed during the SI (Engineering-Science 1990).

- Sediment samples collected from the backwaters of Lake Winyah located adjacent to the landfill contain PAHs and other SVOCs. No organic or inorganic chemical-specific ARARs exist under MERA defining sediment quality. These organic compounds have likely originated from the landfill and may be remnants of waste oils or construction debris such as asphalt pieces.

- A groundwater divide exists beneath Sites 6 and 7. Groundwater quality is being monitored on either side of this divide. The results of the sampling and analysis indicate that although organic compounds and inorganics are being detected in the groundwater samples, only one well, LF6MW3, contains or has contained compounds exceeding the Act 307 Type A or B cleanup criteria. The analytical results suggest that the extent of contamination down gradient of LF6MW3 has been delineated. Fixed based analytical results compare poorly with the initial site screening analytical results and the screening data collected from wells LF6MW5 and LF6MW8. The soils beneath these locations are relatively sand-rich until the water table is reached. Beneath the water table these soils become more clay-rich. A review of the screening data also indicates that contaminants are not present until the water table is reached. It is possible that the contaminants are adsorbed onto the clays, immobilizing

these organic compounds. The fact that the confirmation water samples were relatively free of hydrocarbons suggests that these compounds are relatively immobile and are not being partitioned into the water phase.

3.8 SITE 8 - FORMER SITE OF HANGAR 9

Several field events have been conducted to support the RI at Site 8. The results for these field events are presented in several stand-alone documents and will only be summarized in this RI Report. In chronological order, these field events are as follows:

- Soil gas and groundwater screening data were collected for Site 8 in January 1993 and have been compiled and presented in the Internal Draft Soil Gas Survey and Ground Water Screening: Phase I of RI (The Earth Technology Corporation, October 1993). Summary diagrams and data tables from this document are included in Section 3.8.3 of this RI report.

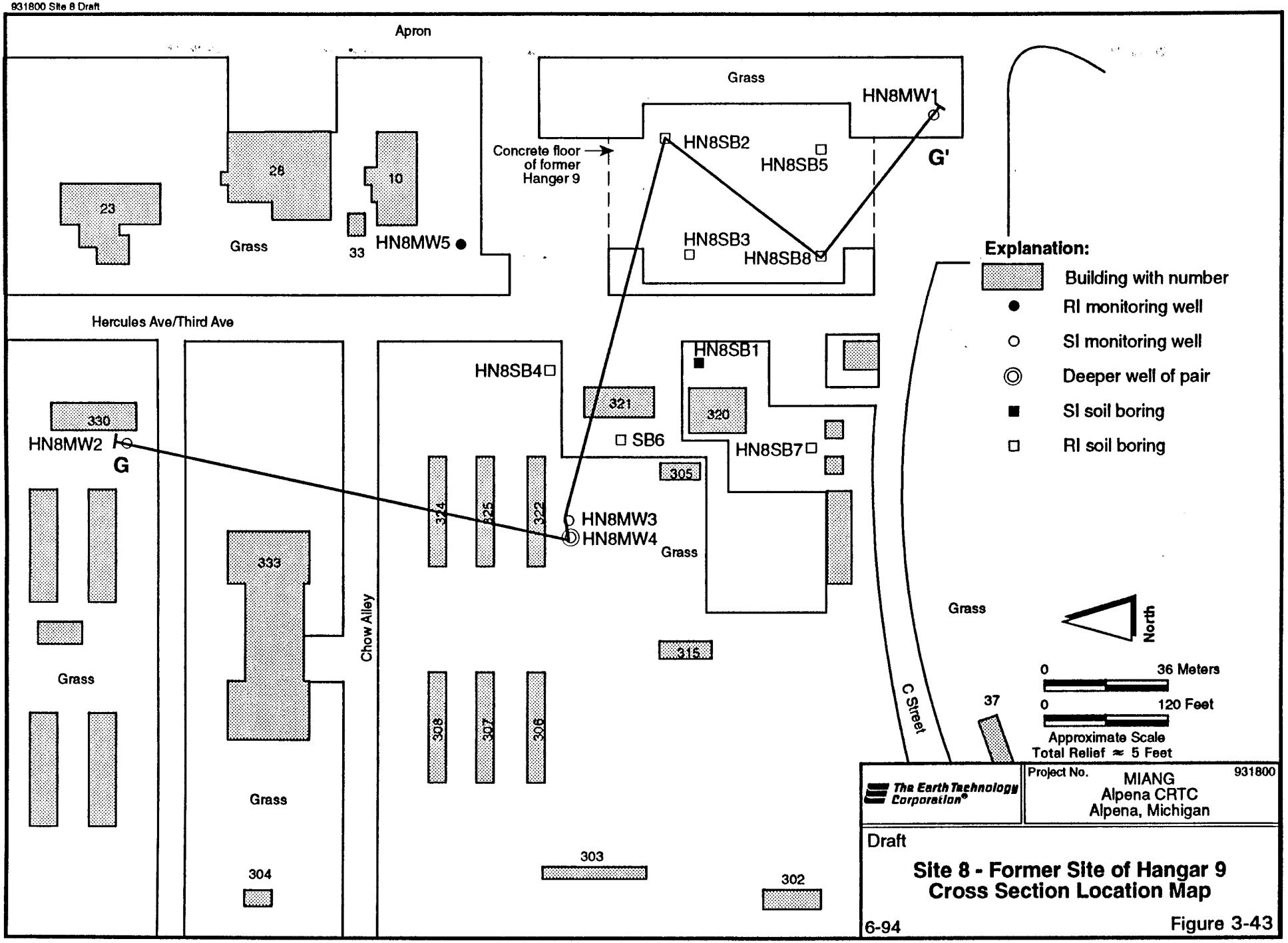
- Soil borings, monitoring well installation, soil and groundwater sampling and analysis comprised the remainder of the RI field activities at Site 8. These activities were completed during the August and September 1993 RI field activities.

3.8.1 Results of Previous Investigations

Site 8 was identified by soil vapor monitoring conducted in the vicinity of the site during the Phase III studies (Lockheed Engineering, 1987). Soil borings and monitoring wells were installed and soil and groundwater samples collected during the SI (Engineering-Science, 1990). Results obtained from two soil sampling locations indicated no VOCs were present in the samples. TPH and metals were detected in the soil samples. Of the four wells installed and sampled during the SI, PCE was reported from groundwater samples collected from in monitoring well HN8MW3 during the November 1987 (Round I) groundwater sampling event at a concentration of 3.8 $\mu g/\ell$. The August 1988 sampling (Round II) did not confirm the presence of PCE in well HN8MW3. However, the October 1991 sampling (Round III) confirmed the PCE (5.2 $\mu g/\ell$) in groundwater samples collected from HN8MW3.

3.8.2 Site 8 – Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A site map illustrating sampling locations and the location of a cross-section constructed at Site 8 is presented in Figure 3-43. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.


Apron
Grass
HN8MW1
HN8SB2
HN8SB5
G'
Concrete floor of former Hanger 9
28
10
23
Grass
33
HN8MW5
HN8SB3
HN8SB8
Explanation:
Building with number
RI monitoring well
SI monitoring well
Deeper well of pair
SI soil boring
RI soil boring
Hercules Ave/Third Ave
HN8SB4
HN8SB1
321
320
330
HN8MW2
G
SB6
HN8SB7
305
324
325
322
HN8MW3
HN8MW4
Grass
333
Chow Alley
315
Grass
Grass
C Street
37
North
0
36 Meters
0
120 Feet
Approximate Scale
Total Relief ≈ 5 Feet
308
307
306
Grass
303
304
302
The Earth Technology Corporation
Project No.
931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 8 - Former Site of Hangar 9
Cross Section Location Map
6-94
Figure 3-43

3.8.2.1 Site 8 – Geology

A geologic cross section (Figure 3-44) was constructed from north to south across Site 8 and illustrates the subsurface relationships observed and reported on the boring logs during the field investigations. As shown on this cross section, the subsurface material underlying the site consists mainly of a massive, poorly-graded (well sorted), medium- to coarse-grained, quartz sand containing trace to minor amounts of gravel, silt and/or clay. Gravel lenses ranging in thickness from 0.5 to 2 ft were encountered in borings HN8MW2, HN8MW3, HN8SB2, and HN8SB8 drilled at the site. No clay layer was described in boring HN8SB2 occurring between the shallow aquifer materials and the limestone bedrock. A 1-ft thick reddish clay was described in boring HN8MW4 prior to encountering the limestone (Engineering-Science, 1990). The top of the limestone bedrock was encountered during the drilling operations at a depth of 18.9 m (62 ft) bgs beneath Site 8. The geophysical data determined the limestone to be at a depth of 19.8 m (65 ft) bgs, in good agreement with the results obtained during drilling.

3.8.2.2 Site 8 – Hydrogeology

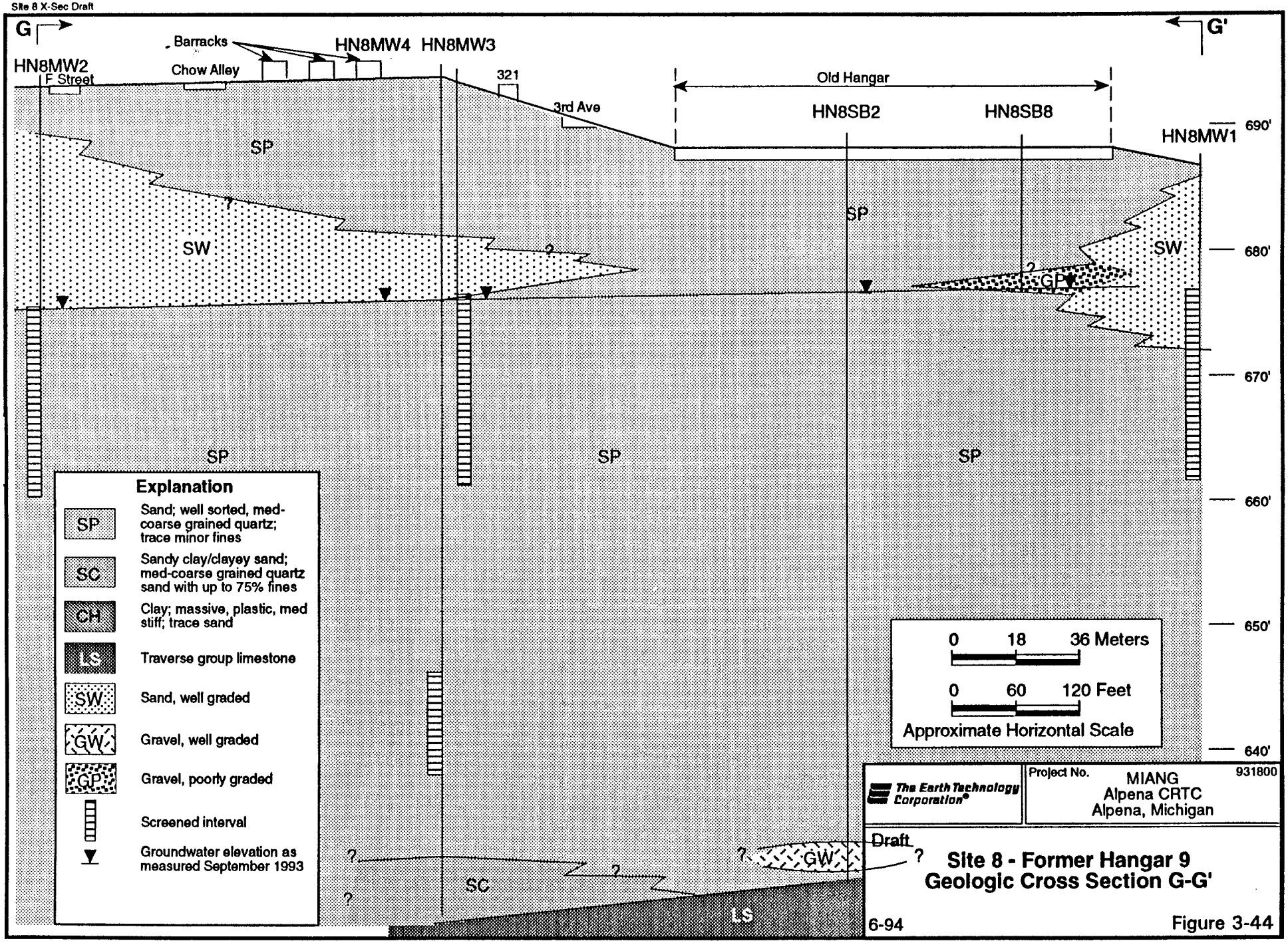
Five monitoring wells (HN8MW1 through HN8MW5) exist at Site 8. Wells HN8MW1 though MW4 were installed during the SI (Engineering-Science, 1990), while well HN8MW5 was installed down gradient of the floor of the old Hangar 9 during the RI field activities. Groundwater beneath Site 8 occurs within the shallow aquifer at depths ranging from 3.1 to 5.4 m (10.19 to 17.75 ft) bgs and from 206.3 to 205.8 m (676.96 to 675.31 ft) above msl. As illustrated in Figures 1-19 through 1-21 and Figure 3-45, flow within the shallow aquifer is directed northwest towards the sinkhole at an average hydraulic gradient of 0.002 ft/ft. A 0.03 ft difference in hydraulic head (September 1993 measurements) exists between wells HN8MW3 (screened in the upper portion of the shallow aquifer) and HN8MW4 (screened in the lower portion of the shallow aquifer). These wells are located approximately 10 ft from each other. The small hydraulic head difference measured between these wells indicates that there is a negligible vertical gradient within the shallow aquifer in the vicinity of Site 8.

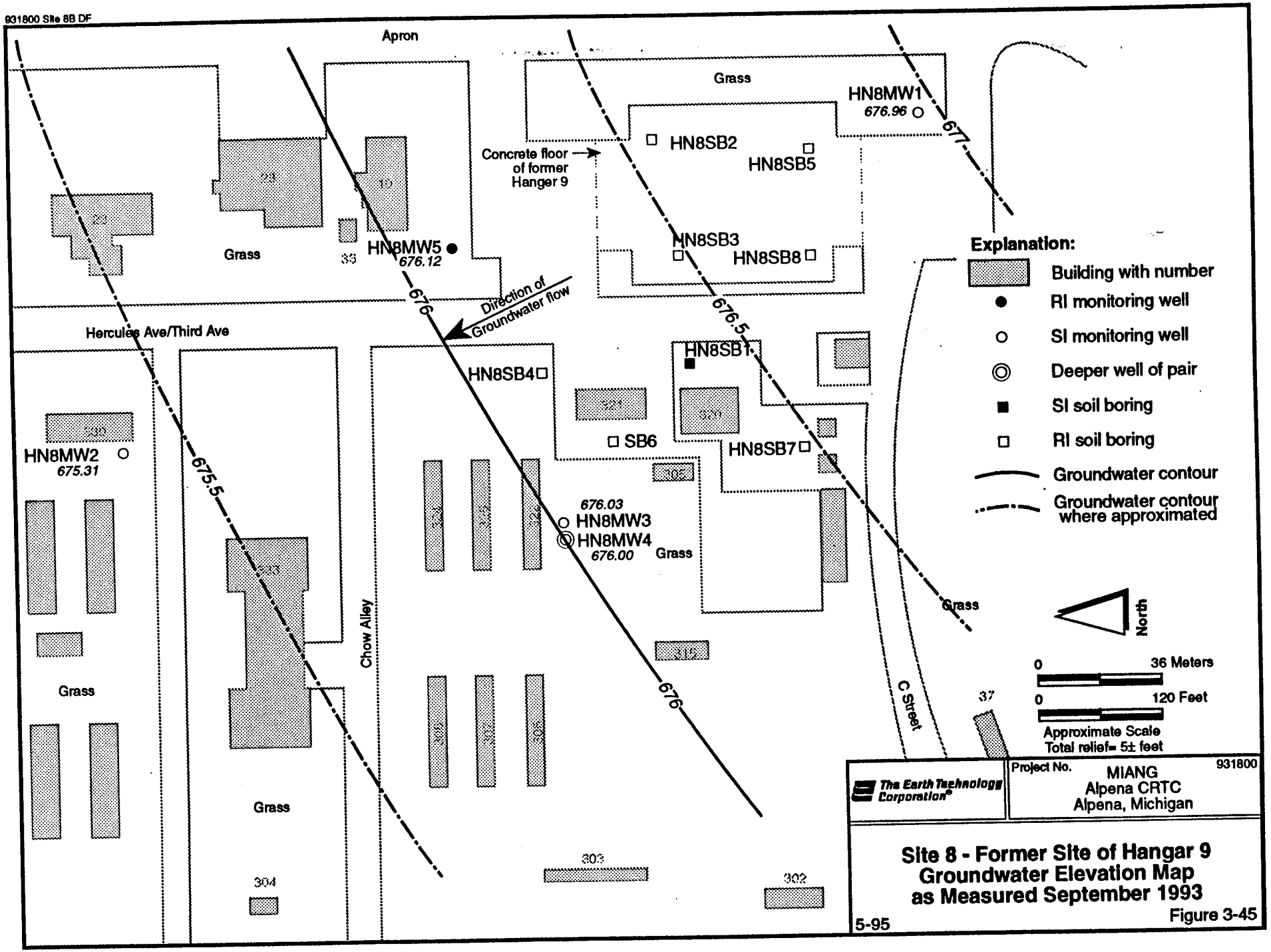
3.8.3 Screening Results

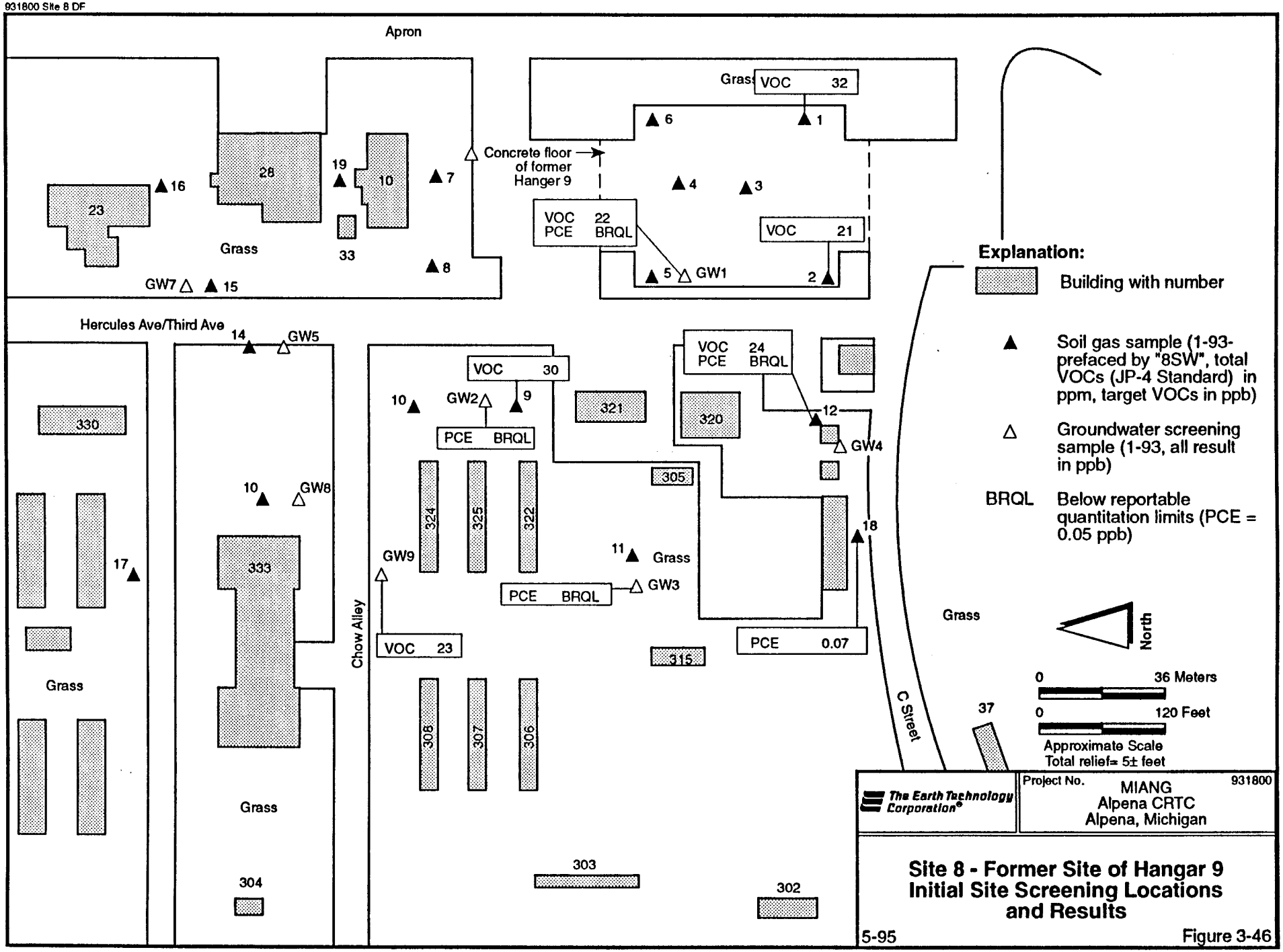
Initial site screening activities at Site 8 consisted of the collection and analysis of SOV and groundwater grab samples (The Earth Technology Corporation, October 1993). The complete results of this survey are included in Appendix D. Additionally, on-site GC analysis of soil and groundwater samples were conducted in August and September 1993 during the RI drilling activities. These analytical results are presented in Appendix E.

3.8.3.1 Initial Site Screening Results

Twenty-four soil gas samples were collected from 19 locations in and around Site 8. The sampling locations are presented in Figure 3-46. Samples were collected from successive depths at three locations; 8SG-1, -6, and -17. The analytical results from this sampling


Site 8 X-Sec Draft
G
G'
Barracks
HN8MW4
HN8MW3
HN8MW2
F Street
Chow Alley
321
3rd Ave
Old Hangar
HN8SB2
HN8SB8
HN8MW1
690'
680'
670'
660'
650'
640'
SP
SW
GP
SC
GW
LS
?
Explanation
SP Sand; well sorted, med-coarse grained quartz; trace minor fines
SC Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
CH Clay; massive, plastic, med stiff; trace sand
LS Traverse group limestone
SW Sand, well graded
GW Gravel, well graded
GP Gravel, poorly graded
Screened interval
Groundwater elevation as measured September 1993
0 18 36 Meters
0 60 120 Feet
Approximate Horizontal Scale
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 8 - Former Hangar 9
Geologic Cross Section G-G'
6-94
Figure 3-44


Apron
Grass
HN8MW1
676.96
HN8SB2
HN8SB5
Concrete floor of former Hanger 9
HN8SB3
HN8SB8
HN8MW5
676.12
Grass
Direction of Groundwater flow
Hercules Ave/Third Ave
HN8SB4
HN8SB1
HN8MW2
675.31
SB6
HN8SB7
676.03
HN8MW3
HN8MW4
676.00
Grass
Chow Alley
Grass
Grass
C Street
Grass
676
675.5
676.5
677
Explanation:
Building with number
RI monitoring well
SI monitoring well
Deeper well of pair
SI soil boring
RI soil boring
Groundwater contour
Groundwater contour where approximated
North
0 36 Meters
0 120 Feet
Approximate Scale
Total relief= 5± feet
The Earth Technology Corporation
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Site 8 - Former Site of Hangar 9
Groundwater Elevation Map
as Measured September 1993
5-95
Figure 3-45



The Earth Technology Corporation®

Project No. 931800

MIANG
Alpena CRTC
Alpena, Michigan

Site 8 - Former Site of Hangar 9 Initial Site Screening Locations and Results

5-95

Figure 3-46

indicate that VOC concentrations do not show significant variation with depth within the vadose zone.

SOV

- Target VOCs – Target VOCs were not detected in any of the Site 8 soil gas samples. Concentrations of PCE less than the MDL of 0.05 $\mu g/\ell$ were detected in 8SG-12.

- Total VOCs – Five of the 24 soil gas samples contained total VOCs in concentrations greater than the MDL of 20 ppm. However, all of the 5 positive detections are considered to be relatively low concentrations, ranging from 20 to 32 ppm.

Groundwater Samples

Twelve groundwater samples were collected from 9 locations within Site 8. These locations are presented in Figure 3-46. Groundwater samples were collected from two depths within the water column at 8GW-1, -3, and -9. Results are summarized below and in Figure 3-46.

- Target VOCs – No significantly high concentrations of target VOCs were detected in the groundwater samples. Only PCE was detected in the groundwater samples. Concentrations of PCE less than the MDL (0.05 ppb) PCE were detected in 8GW-1 (11 to 14 ft and 20 to 23 ft sample), 8GW-2, and 8GW-3 (14 to 17 ft sample only), while 0.07 ppb of PCE were detected in 8GW-4.

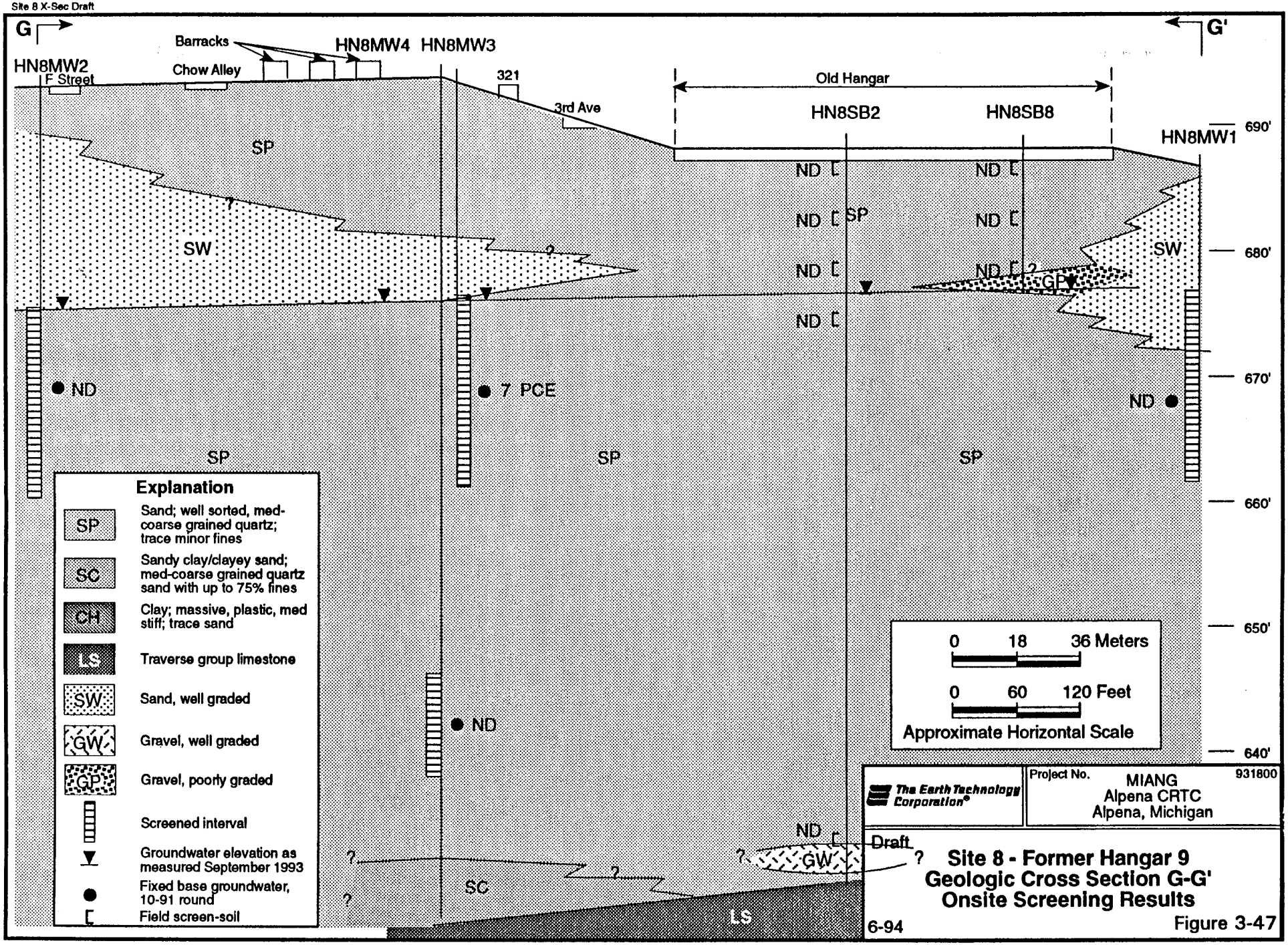
- Total VOCs (as JP-4) – Total VOCs were detected in 2 samples; 8GW-1 (20 to 23 ft) at 22 ppb, and 8GW-9 (26 to 29 ft) at 23 ppb.

3.8.3.2 Soil Boring and Monitoring Well Placement Rationale

Soil borings HN8SB2 through HN8SB8 were drilled in and around the most probable source areas identified at Site 8. These areas include Building 320 and the floor drains on the old foundation of Hangar 9. Monitoring well HN8MW5 was installed down gradient (north-northwest) of the old Hangar 9 foundation.

3.8.3.3 On-Site Screening During Drilling Operations

During the RI drilling operations 22 soil samples were collected and analyzed using the on-site GC. The analytical results for these samples are presented in Appendix E. A review of the Site 8 data indicates that no target compounds were detected. Figure 3-47 presents some of the screening data for Site 8 in cross-sectional view.


Site 8 X-Sec Draft
G
G'
Barracks
HN8MW4
HN8MW3
HN8MW2
Chow Alley
F Street
321
3rd Ave
Old Hangar
HN8SB2
HN8SB8
HN8MW1
690'
680'
670'
660'
650'
640'
SP
SW
GP
ND
7 PCE
SC
GW
LS
Explanation
Sand; well sorted, med-coarse grained quartz; trace minor fines
Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
Clay; massive, plastic, med stiff; trace sand
Traverse group limestone
Sand, well graded
Gravel, well graded
Gravel, poorly graded
Screened interval
Groundwater elevation as measured September 1993
Fixed base groundwater, 10-91 round
Field screen-soil
0 18 36 Meters
0 60 120 Feet
Approximate Horizontal Scale
The Earth Technology Corporation®
Project No. 931800
MIANG
Alpena CRTC
Alpena, Michigan
Draft
Site 8 - Former Hangar 9
Geologic Cross Section G-G'
Onsite Screening Results
6-94
Figure 3-47

3.8.4 Confirmation Results

Analytical results for the soil and groundwater collected during the RI field sampling are included in Tables 3-19, 3-20, and 3-21. A presentation and discussion of the significance of these results, including the occurrence of compounds exceeding Act 307, Type A or B cleanup criteria is included in the following subsections.

3.8.4.1 Soil Sampling Results

Subsurface soils from HN8SB1 and HN8MW1 were collected and analyzed during the SI (Engineering-Science 1990) activities. Both surface and subsurface soil samples were collected during the RI field activities. Surface soil samples were not collected for borings HN8SB2, -SB3, and -SB8 because these borings were drilled through the concrete floor of the old hangar. Samples collected from HN8SB5 arrived at the laboratory unusable. Soil boring HN8SB8 was drilled and sampled to replace HN8SB5.

Surface Soil Results

A review of the analytical results in Table 3-19 shows that benzene, MTBE, 1,1,1-TCA methylene chloride, 1,2-DCB, benzo(b)fluoranthene, and bis (2-ethylhexyl) phthalate were detected in the Site 8 surface soil samples. No organic compounds were present in the soil samples at concentrations above Act 307 Type B cleanup criteria. TPH was detected in concentrations ranging from 13.8 to 11,000 mg/kg. Antimony, arsenic, chromium, copper, lead, nickel, selenium, and zinc were each detected in one or more of the Site 8 surface soil samples. Only one soil boring, HN8SB6 contained any detections of metals above the Act 307 Type A cleanup criteria. Antimony and lead were detected in the surface sample collected from HN8SB6 at concentrations of 5.1 and 42.6 mg/kg, respectively. Figure 3-48 presents the distribution of and the occurrence of compounds exceeding the Act 307 cleanup criteria within the surface and subsurface soil samples collected and analyzed from Site 8.

Subsurface Soil Results

Ethylbenzene, toluene, MTBE, chlorobenzene, 1,2-DCB, bromodichloromethane, and di-n-butyl phthalate were each detected in one or more of the subsurface soil samples collected from Site 8 (Table 3-20). None of the organic compounds were detected in the subsurface soils in concentrations exceeding Act 307 Type B cleanup criteria. TPH was detected in the samples in concentrations ranging from 8.2 to 147 mg/kg. The inorganics arsenic, beryllium, chromium (trivalent and hexavalent chromium), copper, lead, nickel, and zinc were each detected in one or more of the site subsurface soils. None of these inorganics were quantified in concentrations exceeding the Act 307 Type A cleanup criteria.

3.8.4.2 Groundwater Results

Analytical results for the summer 1993 (Round IV) groundwater sampling event completed for Site 8 monitoring wells are presented in Table 3-21. Toluene, ethylbenzene, PCE, diethyl and

Table 3-19 Data Summary Table: Surface Soil, Site 8 - Former Site of Hangar 9
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	SB4	SB6	SB7
Sample ID:	PC-HN8-SB4-SS00-02	PC-HN8-SB6-SS00-02	PC-HN8-SB7-SS00-02
Collection Date:	13-AUG-93	15-AUG-93	15-AUG-93
Sample Depth:	0 ft-2 ft	0 ft-2 ft	0 ft-2 ft
Associated Field QC Samples:	FB03,FB06,TB10,ER07	FB03,FB06,TB12,ER09	FB03,FB06,TB12,ER09

	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)								
1,2-Dichlorobenzene	12000	ppb	0.041	J	1.5	U	1.5	U
Benzene	24	ppb	0.06		1.5	U	1.5	U
Methyl-t-butyl ether	4600	ppb	2.4		11	U	12	U
HALOGENATED VOLATILES (8010)								
1,1,1-Trichloroethane	4000	ppb	0.059	J	0.26	B	2.9	UJ
Methylene Chloride	92	ppb	0.31	B	8.4	J	5.1	B
SEMI-VOLATILES (CLP 3/90)								
Benzo(b)fluoranthene	180	ppb	340	U	48		350	U
Chrysene	180	ppb	340	U	74		350	U
bis(2-Ethylhexyl)phthalate	92000	ppb	340	U	52		350	U
METALS (CLP 3/90)								
Antimony	4614	ppb	4700	UL	5100	()L	4800	UL
Arsenic	5800	ppb	630	()J	2500	B	620	()B
Chromium	18000	ppb	3900		2900		7000	
Copper	32000	ppb	1600	U	3900		1900	()
Lead	21000	ppb	2200	J	42600	J	1700	B
Selenium	410	ppb	310	U	340	()	320	U
Total Petroleum Hydrocarbons		ppb	13800		11000000		22700	

B Compound or analyte detected in field blank or lab blank
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-20 Data Summary Table: Subsurface Soil, Site 8 - Former Site of Hangar 9
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB2*		SB2**		SB2		SB3		SB3		SB4	
Sample ID:		PC-HN8-SB2-SS01-02		PC-HN8-SB2-SS02-03		PC-HN8-SB2-SS09-10		PC-HN8-SB3-SS01-02		PC-HN8-SB3-SS09-11		PC-HN8-SB4-SS12-14	
Collection Date:		13-AUG-93		13-AUG-93		13-AUG-93		13-AUG-93		13-AUG-93		13-AUG-93	
Sample Depth:		1 ft-2 ft		2 ft-3 ft		9 ft-10 ft		1 ft-2 ft		9 ft-11 ft		12 ft-14 ft	
Associated Field QC Samples:		FB03,FB06,TB10,ER07		FB03,FB06,TB10,ER07		FB03,FB06,TB10,ER07		FB03,FB06,TB10,ER07		FB03,FB06,TB10,ER07		FB03,FB06,TB10,ER07	
	ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	12000 ppb	1.5	U	0.072	U	1.4	U	0.056	J	0.25	U	1.5	U
Chlorobenzene	2800 ppb	0.14		1.9	U	1.9	U	0.12		1.9	U	1.9	U
Ethylbenzene	1500 ppb	0.052	J	1.9	U	1.9	U	0.1	J	0.025	J	1.9	U
Methyl-t-butyl ether	4600 ppb	11	U	11	U	11	U	11	U	11	U	0.61	
Toluene	16000 ppb	0.21	B	0.21	B	0.25	B	0.28	J	0.063	J	0.19	B
HALOGENATED VOLATILES (8010)													
Bromodichloromethane	11 ppb	1	U	1	U	0.27	J	1	R	1	UJ	1.1	UJ
SEMI-VOLATILES (CLP 3/90)													
Di-n-butyl phthalate	17000 ppb	340	U	340	U	340	U	340	U	340	U	350	U
METALS (CLP 3/90)													
Arsenic	5800 ppb	880	()J	440	()J	520	()J	600	()J	1200	J	560	()J
Chromium	18000 ppb	6500		4200		3300		5200		2900		2700	
Chromium, Hexavalent	ppb	10	BRL	10	BRL	12		10	BRL	10	BRL	10	BRL
Copper	32000 ppb	1600	U	1600	U	1600	U	1600	U	1500	U	1600	U
Lead	21000 ppb	1800	J	1200	J	900	J	1600	J	790	J	890	J
Nickel	20000 ppb	4300		3600	U	3600	U	3900	()	3600	U	3700	U
Total Petroleum Hydrocarbons	ppb	29900		11300		11400		14600		6300	BRL	7300	B

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-HN8-SB2-SS02-03
** Duplicate of PC-HN8-SB2-SS01-02
LAB: COMPUCHEM

Table 3-20 Data Summary Table: Subsurface Soil, Site 8 - Former Site of Hangar 9
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			SB6		SB7		SB8		SB8		SB8	
Sample ID:			PC-HN8-SB6-SS12-13		PC-HN8-SB7-SS12-13		PC-HN8-SB8-SS01-02		PC-HN8-SB8-SS09-10		PC-HN8-SB8-SS10-12	
Collection Date:			15-AUG-93		15-AUG-93		17-AUG-93		17-AUG-93		17-AUG-93	
Sample Depth:			12 ft-13 ft		12 ft-13 ft		1 ft-2 ft		9 ft-10 ft		10 ft-12 ft	
Associated Field QC Samples:			FB03,FB06,TB12,ER09		FB03,FB06,TB12,ER09		FB03,FB06,TB13,ER10		FB03,FB06,TB13,ER10		FB03,FB06,TB13,ER10	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)												
1,2-Dichlorobenzene	12000	ppb	1.5	U	1.5	U	1.4	U	1.4	U	1.4	U
Chlorobenzene	2600	ppb	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Ethylbenzene	1500	ppb	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Methyl-t-butyl ether	4600	ppb	11	U	11	U	11	U	11	U	11	U
Toluene	16000	ppb	5.5	UJ	0.21	B	5.5	U	5.5	U	5.5	U
HALOGENATED VOLATILES (8010)												
Bromodichloromethane	11	ppb	1	U	1	U	1	U	1	U	1	U
SEMI-VOLATILES (CLP 3/90)												
Di-n-butyl phthalate	17000	ppb	340	U	340	U	340	U	36	J	340	U
METALS (CLP 3/90)												
Arsenic	5800	ppb	1200	B	520	()B	1200	B	430	()B	560	()B
Chromium	18000	ppb	1700		2200		3100		2200		2900	
Chromium, Hexavalent		ppb	10	BRL	10	BRL	10	BRL	10	BRL	10	BRL
Copper	32000	ppb	1600	U	2100	()	2800		1500	U	1800	()
Lead	21000	ppb	720	B	1000	B	1100	B	760	B	880	B
Nickel	20000	ppb	3600	U	3600	U	3600	U	3600	U	3600	U
Total Petroleum Hydrocarbons		ppb	147000		12000		23100		16400		11200	

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-21 Data Summary Table: Groundwater, Site 8 - Former Site of Hangar 9
MIANG, Alpena CRTC, Alpena, Michigan

Locator:	MW1		MW2		MW3		MW4		MW5		MW9*	
Sample ID:	PC-HN8-MW1-GW4		PC-HN8-MW2-GW4		PC-HN8-MW3-GW4		PC-HN8-MW4-GW4		PC-HN8-MW5-GW4		PC-HN8-MW9-GW4	
Collection Date:	15-AUG-93		29-AUG-93		29-AUG-93		29-AUG-93		14-SEP-93		29-AUG-93	
Associated Field QC:	FB06,TB12,ER08		FB05,FB07,TB20,ER17		FB05,FB07,TB20,ER17		FB05,FB07,TB20,ER17		FB07,TB26,ER20		FB05,FB07,TB19,ER17	
ACT 307 Criteria UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)												
Benzene 1.2 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
1,2-Dichlorobenzene 600 ppb	0.15	U	0.15	U	0.15	U	0.15	U	0.14	B	2.2	
Ethylbenzene 74 ppb	0.2	U	0.11		0.2	U	0.2	U	0.12		0.2	U
Toluene 790 ppb	0.24		0.24	B	0.25	U	0.2		0.17	B	0.15	B
HALOGENATED VOLATILES (8010)												
Tetrachloroethylene 0.7 ppb	0.3	U	0.3	U	1.2	J	0.3	U	0.3	U	0.3	U
SEMI-VOLATILES (CLP 3/90)												
Diethyl phthalate 5200 ppb	5	J	5	U	0.6		0.7		5	U	5	U
Dimethyl phthalate 70000 ppb	1	J	5	U	5	U	5	U	5	U	5	U
METALS (CLP 3/90)[1]												
Arsenic ppb	4	U	4	UL	4	UL	4	UL	13.3		4	UL
Chromium ppb	8	U	8	U	8	U	8	U	46.3		8	U
Copper ppb	4	U	4	U	4	U	4	U	55.6		4	U
Lead ppb	2	U	2	U	2	U	2	U	44		2	U
Mercury ppb												
Nickel ppb	18	U	18	U	18	U	18	U	61.3		18	U
Selenium, Dissolved 35 ppb	3	U	3	UL	3	U	3	UL	6.2	J	3	UL
Zinc ppb	4	U	9.2	()B	7.9	()B	15.3	()B	137	J	6.7	()B
Zinc, Dissolved 230 ppb	4	U	15.9	()B	6.8	()B	6.2	()B	4	U	11.8	()B

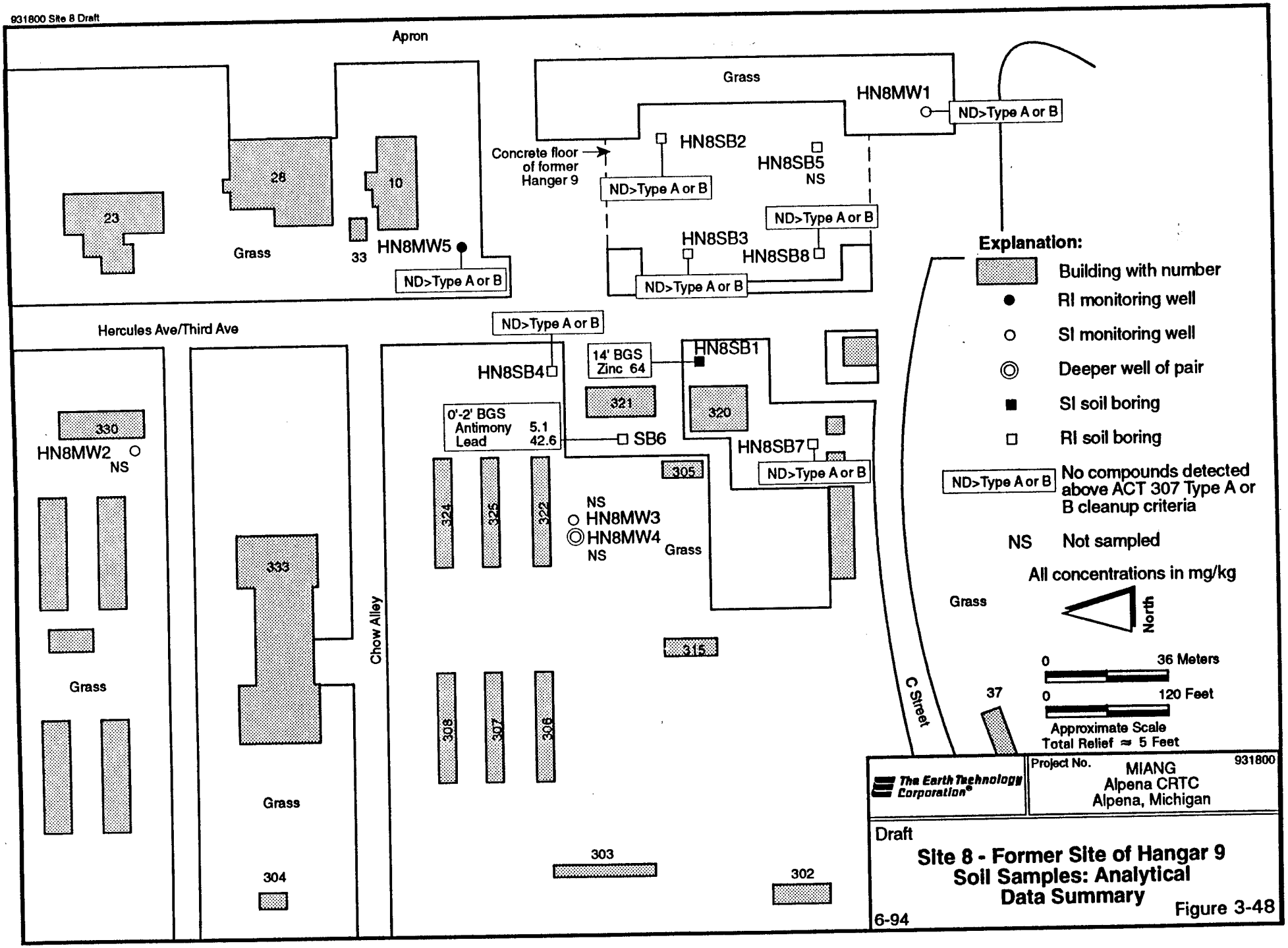
B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-HN8-MW4-GW4
** Duplicate of PC-HN8-MW5-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only.

Table 3-21 Data Summary Table: Groundwater, Site 8 - Former Site of Hangar 9
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Locator:	MW2**
Sample ID:	PC-FF7-MW2-GW4
Collection Date:	14-SEP-93
Associated Field QC:	FB07,TB25,ER20

ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
Benzene 1.2	ppb	0.094											
1,2-Dichlorobenzene 600	ppb	1.5	U										
Ethylbenzene 74	ppb	0.2	U										
Toluene 790	ppb	0.36	B										
HALOGENATED VOLATILES (8010)													
Tetrachloroethylene 0.7	ppb	0.3	U										
SEMI-VOLATILES (CLP 3/90)													
Diethyl phthalate 5200	ppb	5	U										
Dimethyl phthalate 70000	ppb	5	U										
METALS (CLP 3/90)[1]													
Arsenic	ppb	17.4											
Chromium	ppb	52.2											
Copper	ppb	66.7											
Lead	ppb	58.5											
Mercury	ppb	0.23											
Nickel	ppb	74.7											
Selenium, Dissolved 35	ppb		R										
Zinc	ppb	156	J										
Zinc, Dissolved 230	ppb	27.8											

B Compound or analyte detected in field blank or lab blank
BRL Below Reportable Limit
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
* Duplicate of PC-HN8-MW4-GW4
** Duplicate of PC-HN8-MW5-GW4
LAB: COMPUCHEM
[1]Criteria are presented for dissolved metals only.


Apron
Grass
HN8MW1
ND>Type A or B
Concrete floor of former Hanger 9
HN8SB2
HN8SB5
NS
ND>Type A or B
ND>Type A or B
HN8SB3
HN8SB8
ND>Type A or B
28
10
23
Grass
33
HN8MW5
ND>Type A or B
Hercules Ave/Third Ave
ND>Type A or B
HN8SB4
14' BGS
Zinc 64
HN8SB1
321
320
0'-2' BGS
Antimony 5.1
Lead 42.6
SB6
HN8SB7
ND>Type A or B
305
330
HN8MW2
NS
324
325
322
NS
HN8MW3
HN8MW4
NS
Grass
333
Chow Alley
315
C Street
37
Grass
308
307
306
Grass
304
303
302
Explanation:
Building with number
RI monitoring well
SI monitoring well
Deeper well of pair
SI soil boring
RI soil boring
ND>Type A or B
No compounds detected above ACT 307 Type A or B cleanup criteria
NS
Not sampled
All concentrations in mg/kg
North
0
36 Meters
0
120 Feet
Approximate Scale
Total Relief ≈ 5 Feet
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Site 8 - Former Site of Hangar 9
Soil Samples: Analytical
Data Summary
6-94
Figure 3-48

dimethyl phthalate, and 1,2-DCB were the only organic compounds detected in the Site 8 monitoring wells during the summer 1993 (Round IV) groundwater sampling event. PCE, detected in HN8MW3 at a concentration of 1.2 $\mu g/\ell$, was the only organic compound quantified above Act 307 Type B cleanup criteria. TPH was not detected from any of the groundwater samples collected during the summer of 1993 sampling.

Arsenic, chromium, copper, lead, nickel, and zinc were each detected in the unfiltered groundwater samples collected from HN8MW5. Of these detections, arsenic and lead were quantified in concentrations exceeding the Act 307 Type A cleanup criteria. However, the samples collected from this well were slightly turbid and could not be used (as collected) for domestic purposes. No inorganics were detected in the filtered samples exceeding Act 307 Type A cleanup criteria.

Figure 3-49 presents a summary of the compounds detected during all four rounds of groundwater sampling exceeding the Act 307 Type A or B cleanup criteria. As shown in Figure 3-56, only groundwater samples collected from HN8MW3 contain any compounds exceeding these regulatory limits. PCE was detected at concentrations of 3.8 $\mu g/\ell$ (Round I), 7.1 $\mu g/\ell$ (Round III) and 1.2 $\mu g/\ell$ (Round IV) in groundwater samples collected from HN8MW3. No inorganics were detected in the four rounds of filtered groundwater samples at concentrations above Act 307 Type A cleanup criteria.

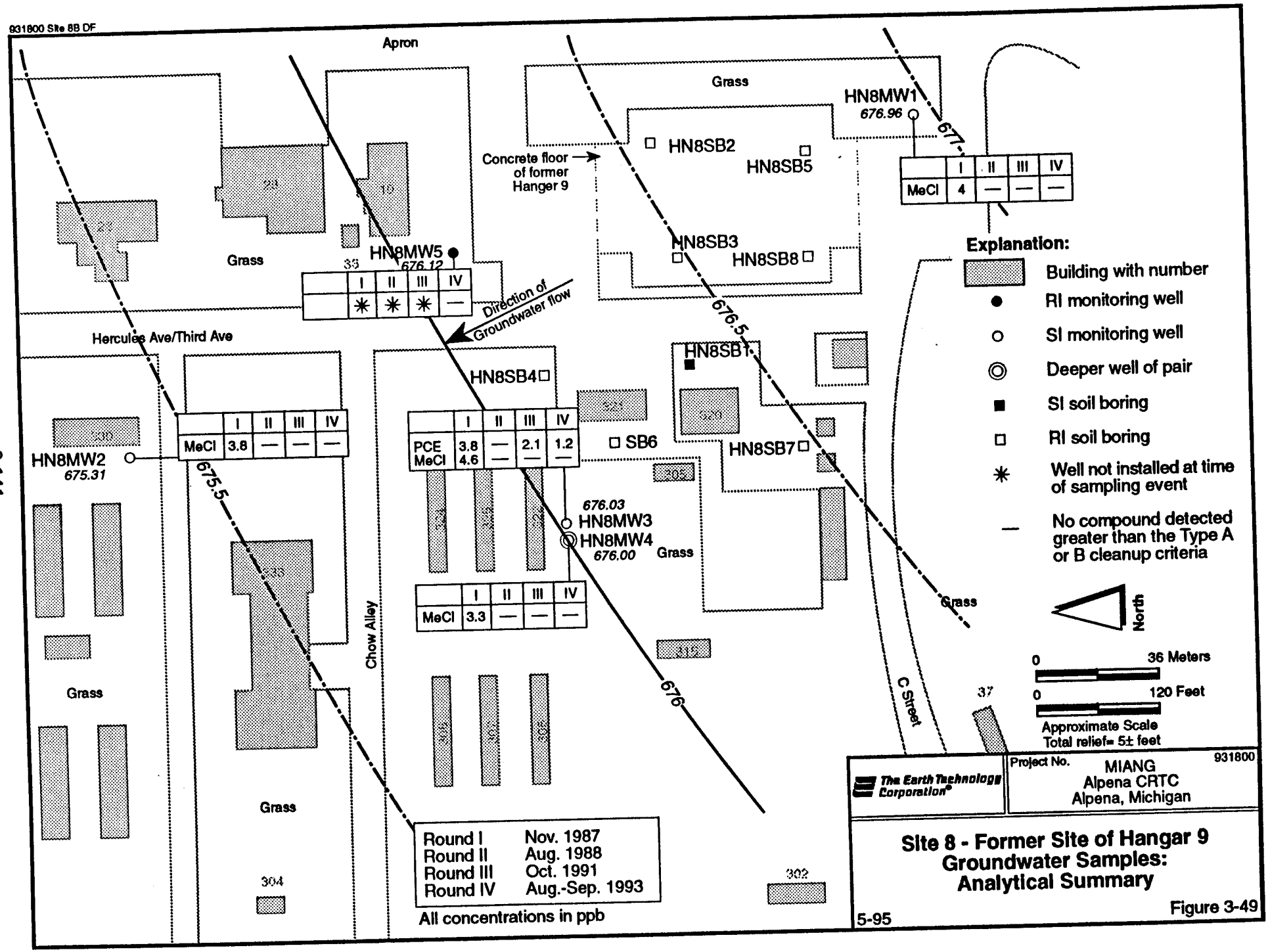
3.8.5 Summary and Conclusions

RI sampling activities completed at Site 8 were focused on soil and groundwater beneath the floor of the former Hangar 9 and the area surrounding Building 320. The following summarizes the findings of the subsurface investigations completed at Site 8:

- Sediments comprising the shallow aquifer beneath the site consist of a relatively uniform medium- to coarse-grained, quartz sand containing minor gravel and/or gravel lenses overlying the limestone bedrock. The shallow aquifer is approximately 60 ft thick beneath Site 8. An evaluation of the data collected during the field investigations shows that there is no well-defined clay layer separating the shallow aquifer from the bedrock.

- No organic compounds were detected in site surface or subsurface soils in concentrations exceeding the Act 307 Type B cleanup criteria. Only antimony and lead were detected in the surface soil sample collected from HN8SB6 in concentrations exceeding the Act 307 Type A cleanup criteria. No other inorganics were detected from site surface or subsurface soil samples in concentrations exceeding the Act 307 Type A cleanup criteria.

- Groundwater flow in the shallow aquifer beneath the site is to the northwest towards the sinkhole. PCE has been detected in groundwater samples collected from HN8MW3 during the summer 1993 (Round IV) sampling and during



	I	II	III	IV
MeCl	4	—	—	—

	I	II	III	IV
MeCl	3.8	—	—	—

	I	II	III	IV
PCE	3.8	—	2.1	1.2
MeCl	4.6	—	—	—

	I	II	III	IV
MeCl	3.3	—	—	—

	I	II	III	IV
	✱	✱	✱	—

previous rounds of groundwater sampling in concentrations exceeding the Act 307 Type B cleanup criteria. No inorganic compounds have been detected in the filtered groundwater samples exceeding the Act 307 Type A cleanup criteria during the four rounds of sampling.

3.9 SITE 9 – RADAR TOWER SITE

Several field events have been completed to support the RI at Site 9. The results for these field events are presented in several stand-alone documents and will only be summarized in this RI Report. In chronological order, these field events are as follows:

- Surface geophysical surveys (EMI and resistivity) were completed at Site 9 during September and October 1992. Complete results of the surveys are presented in the Final Draft, Geophysical Survey, Test Pit Excavation, and Well Abandonment Technical Memorandum (The Earth Technology Corporation, 1993). Summaries of the geophysical survey results are included in the Site 9 geology and hydrogeology discussions.

- An SOV survey and soil boring and sampling activities were conducted during November 1992 and have been compiled and presented in the Internal Draft Soil Gas Survey and Ground Water Screening: Phase I of RI (The Earth Technology Corporation, October 1993). Summary diagrams and data tables from this document are included in this RI report.

- Groundwater screening data were collected for Site 9 in January 1993 and have been compiled and presented in the Internal Draft Soil Gas Survey and Ground Water Screening: Phase I of RI (The Earth Technology Corporation, October 1993). Summary diagrams and data tables from this document are also included in this RI report.

- Soil borings, monitoring well installation, soil and groundwater sampling and analysis comprised the remainder of the RI field activities at Site 9. These activities were completed during August and September 1993 RI field activities.

3.9.1 Results of Previous Investigations

The results of the PA (Hazardous Materials Training Center, 1985) and SI (Engineering-Science, 1990) for Site 9 indicated the need for additional investigations at Site 9. Results of an SOV survey performed during the Phase III studies (EPA, February 1987) indicated the presence of PCE, TCE, and toluene at several locations within Site 9. Analytical results obtained during the SI (Engineering-Science 1990) revealed the presence of PCE in one soil sample collected from near the Aerospace Ground Equipment (AGE) Shop - Building 417. PCE

and TCE were detected in groundwater sample collected from site monitoring wells during the November 1987 (Round I) and August 1988 (Round II) sampling events. The PCE detections were confirmed during the October 1991 (Round III) round of groundwater sampling (The Earth Technology Corporation, July 1992).

3.9.2 Geology and Hydrogeology

The geology and hydrogeology of the Alpena CRTC was presented in Section 1.7.9. A discussion of the site-specific geology and hydrogeology is presented in the following subsections.

3.9.2.1 Geology

The location of a geologic cross-section created for Site 9 is shown in Figure 3-50. The cross-section is presented in Figure 3-51. The subsurface materials underlying site 9 consist of a uniform, medium- to coarse-grained, well sorted, quartz sand that contains trace to minor amounts of fine gravel. Limestone bedrock was encountered at 55 and 61 ft bgs in well RT9MW5 and boring RT9SB13, respectively. No clay was encountered at RT9MW5 prior to refusal of the augers on top of the bedrock, but a 1 to 2 ft thick zone of sandy clay was observed prior to refusal of the augers at location RT9SB13.

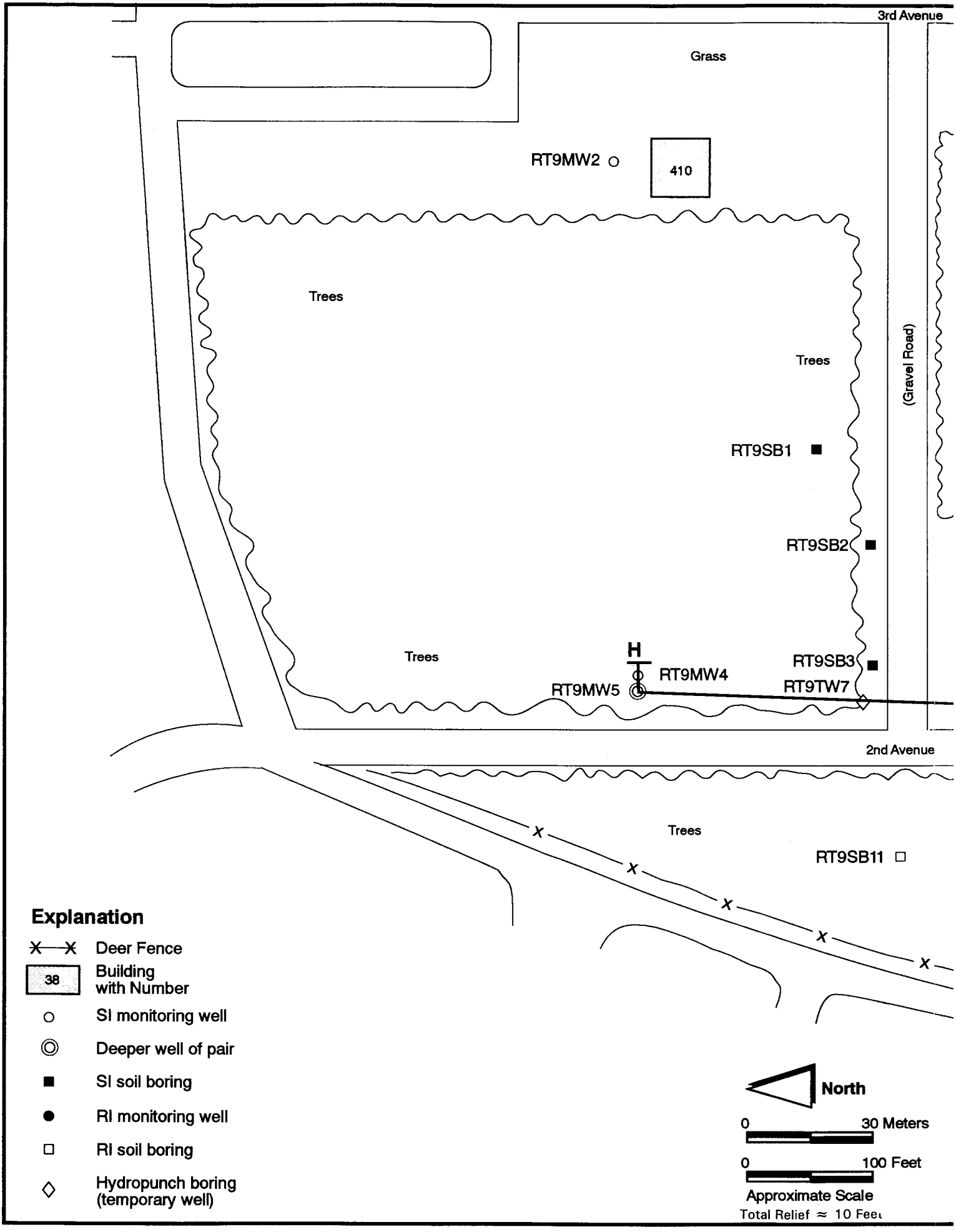
3.9.2.2 Hydrogeology

There are monitoring wells (RT9MW1 through RT9MW6) at Site 9. Wells RT9MW1 through RT9MW5 were installed during the SI (Engineering-Science, 1990), while RT9MW6 was installed during the August and September 1993 RI field activities. Groundwater within the shallow aquifer beneath Site 9 occurs at depths ranging from 14.42 to 24.64 ft bgs which corresponds to elevations ranging from 666.77 to 673.06 ft above msl. The September 1993 and historic groundwater elevation data sets (Figure 1-19 through 1-21, and Figure 3-52) all show that flow within the shallow aquifer is directed north towards the sinkhole. The average hydraulic gradient for the September 1993 data set is 0.01 ft/ft.

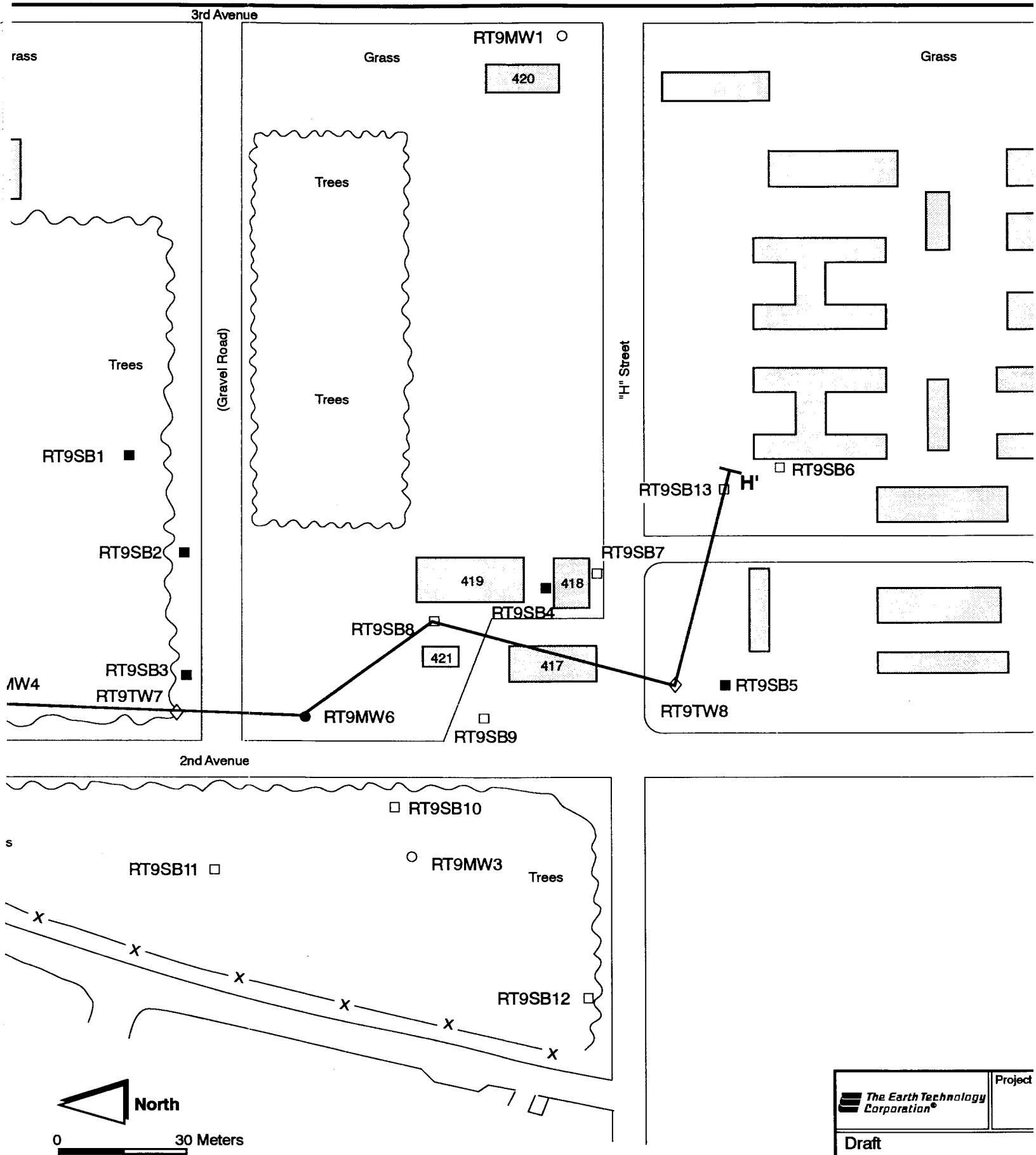
A component of vertical flow may exist within the shallow aquifer beneath Site 9. Wells RT9MW4 and RT9MW5 are a shallow screen/deep screen shallow aquifer well pair. RT9MW4 is screened from 15-30 ft bgs, while RT9MW5 is screened from 50-60 ft bgs. The September 1993 groundwater elevation data (Appendix B) show a 0.40 ft difference in hydraulic head (groundwater elevation) between the wells, with the gradient directed downward.

3.9.3 Screening Results

Initial site screening activities to support the RI were completed in November 1992 and January 1993. Activities at Site 9 consisted of the collection and analysis of SOV and



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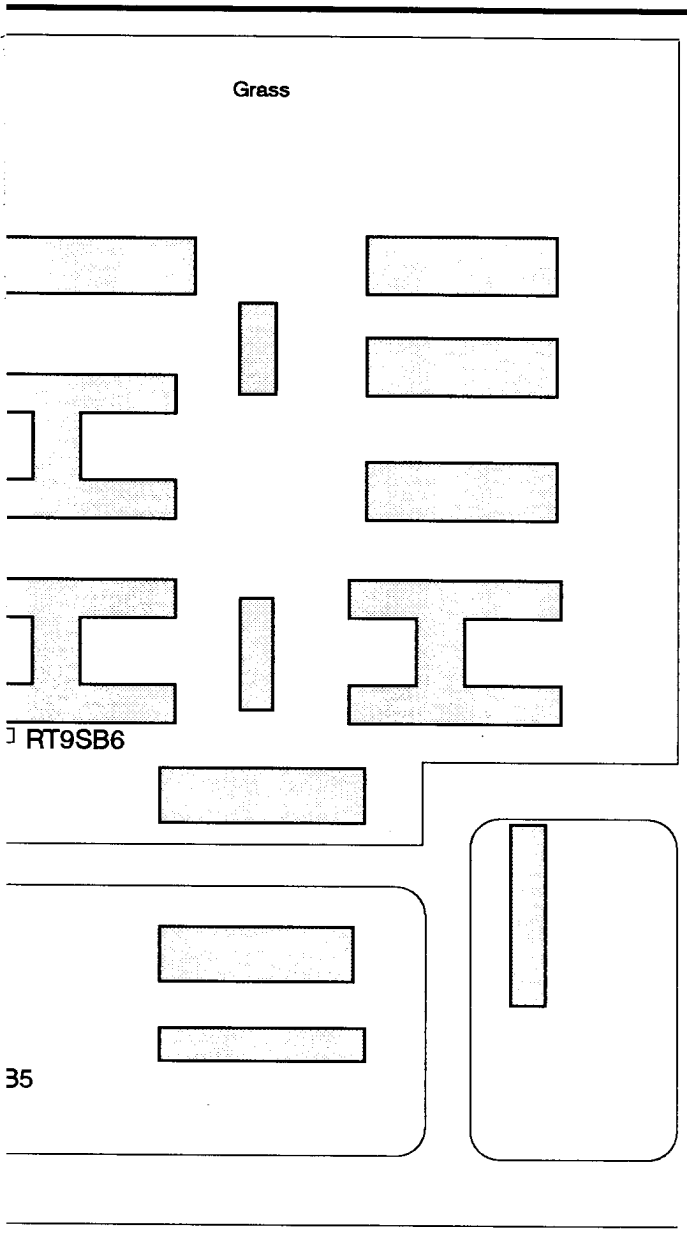
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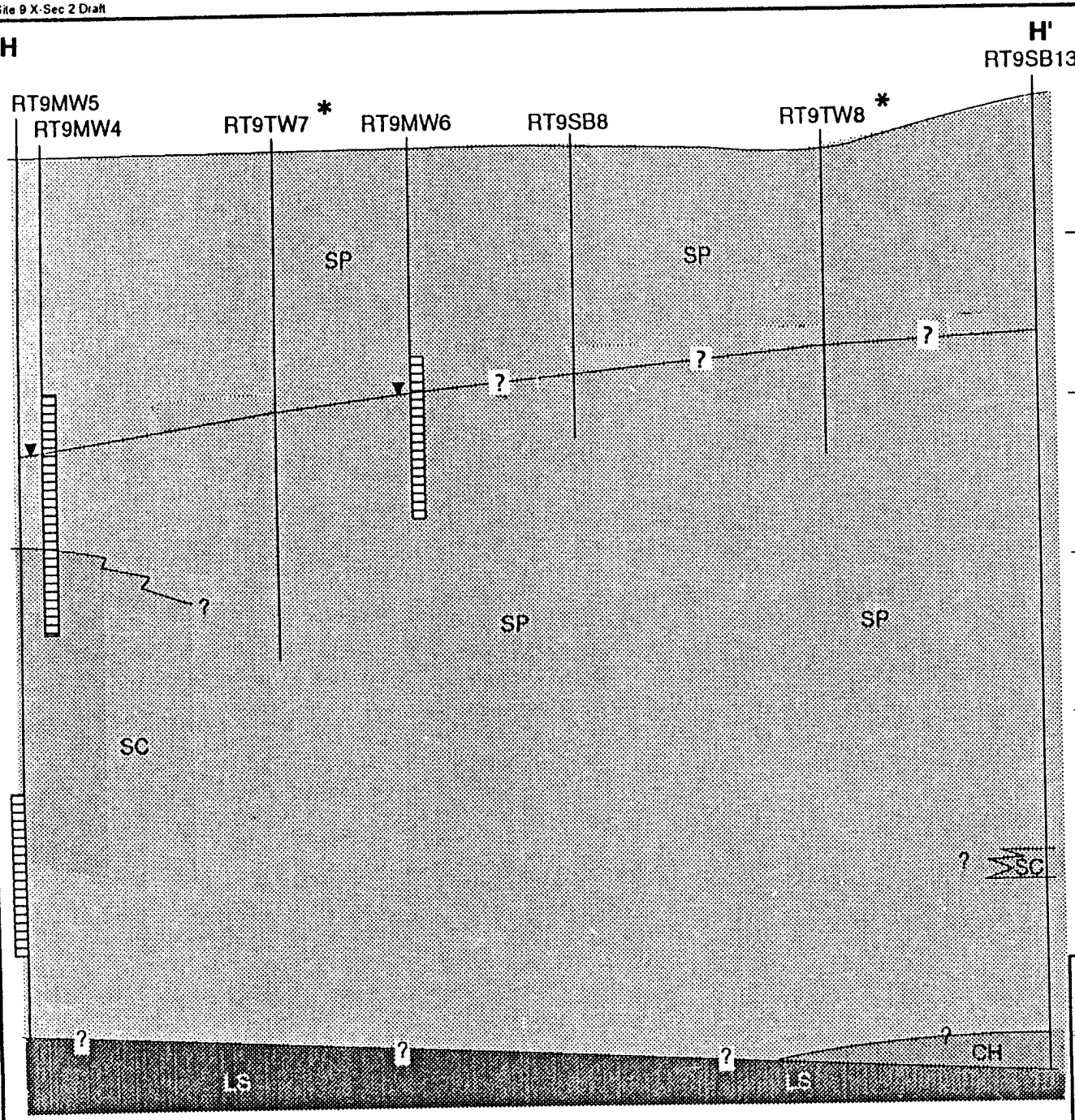
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Site 9 - Radar Tower Site
Cross Section Location Map

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Figure 3-50



0 30 60 Meters

0 100 200 Feet

Approximate Horizontal Scale

Explanation

SP	Sand; well sorted, med-coarse grained quartz; trace minor fines
SC	Sandy clay/clayey sand; med-coarse grained quartz sand with up to 75% fines
CH	Clay; massive, plastic, med stiff; trace sand
LS	Traverse group limestone
	Screened interval
▼	Groundwater elevation as measured September 1993
?	Approximated
*	Temporary well (abandoned)

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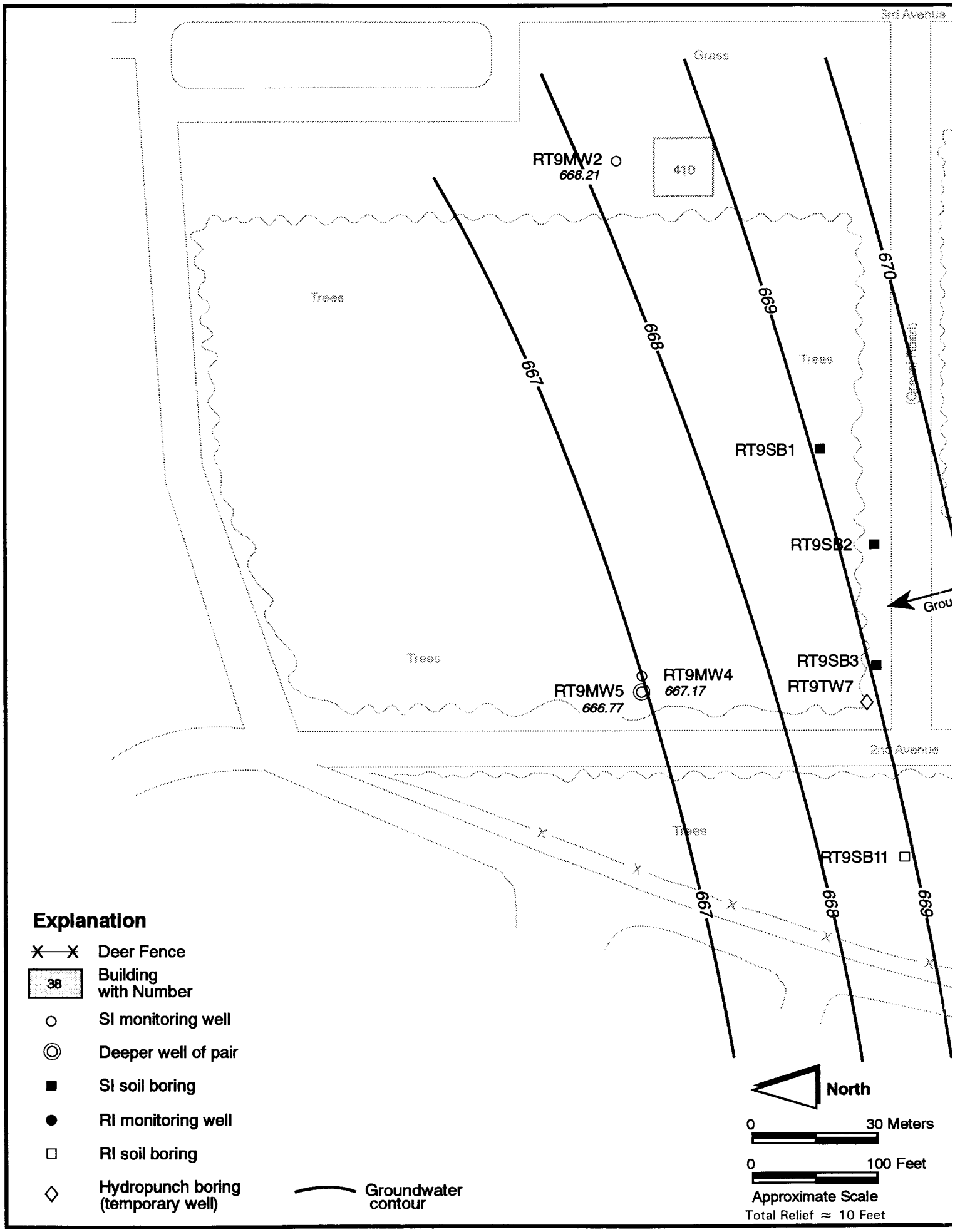
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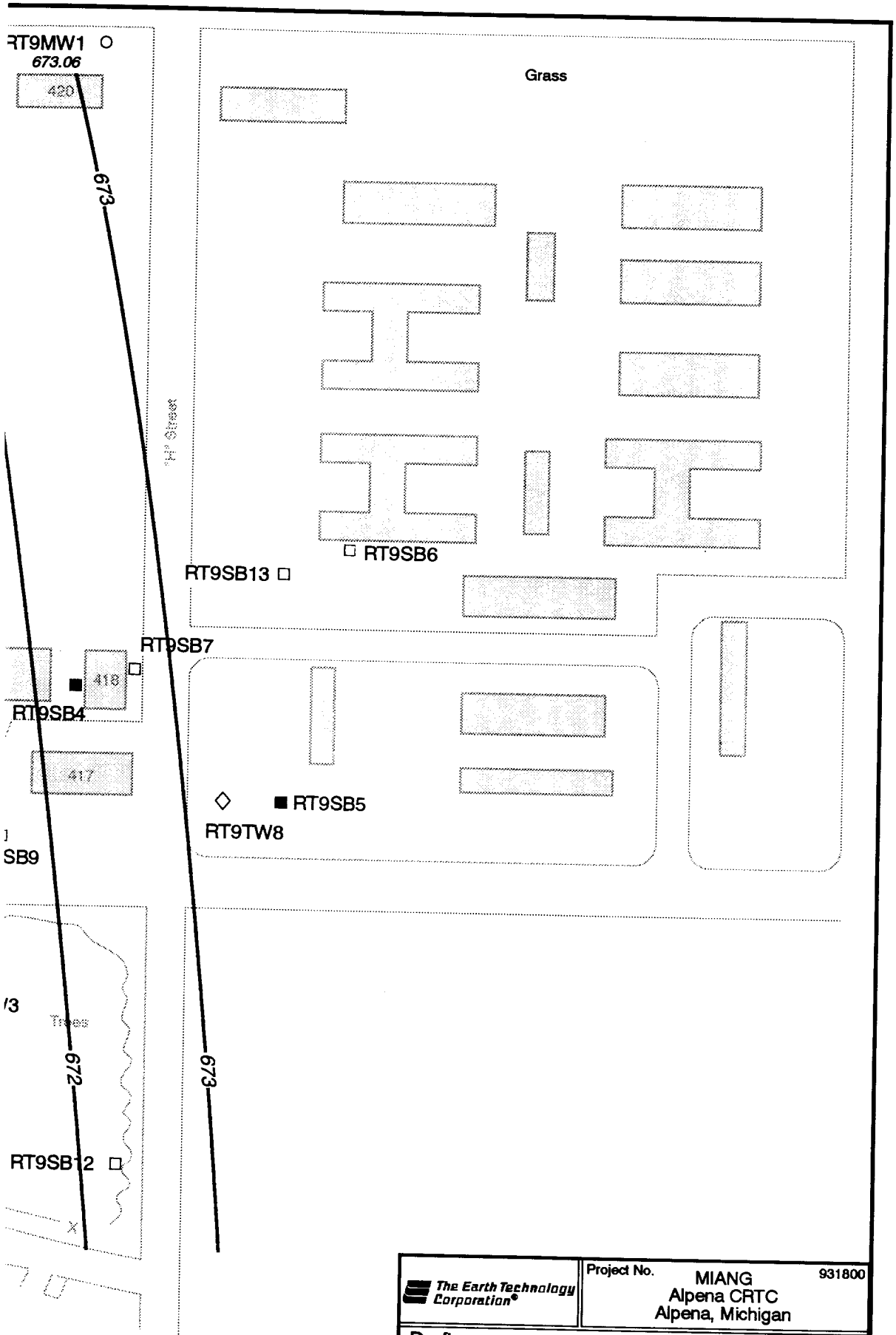
Site 9 - Radar Tower Site
Geologic Cross Section H-H'

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Figure 3-51



931800 Site 9B Draft



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Site 9 - Radar Tower Site
Groundwater Elevation Map
as Measured September 1993

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Figure 3-52

groundwater grab samples. The complete results of this survey are included in Appendix D. Additional on-site GC screening activities were performed in August and September 1993 during the RI drilling activities. The results of these activities are presented in Appendix E.

3.9.3.1 Initial Site Screening

The analytical results obtained from the SOV and groundwater screening surveys are summarized in the following subsections.

SOV Survey

Previous investigations have identified chlorinated solvents as the primary chemicals of concern at Site 9. A total of 33 SOV samples were collected at Site 9 (Figure 3-53). At the onset of the investigation a soil gas profile was taken from 3 depths beneath Site 9 to establish an appropriate sampling depth for each portion of the site. Based on these initial results the remaining SOV samples were collected from a depth of 9 ft with the exception of sample point 17 which was sampled at 18 ft.

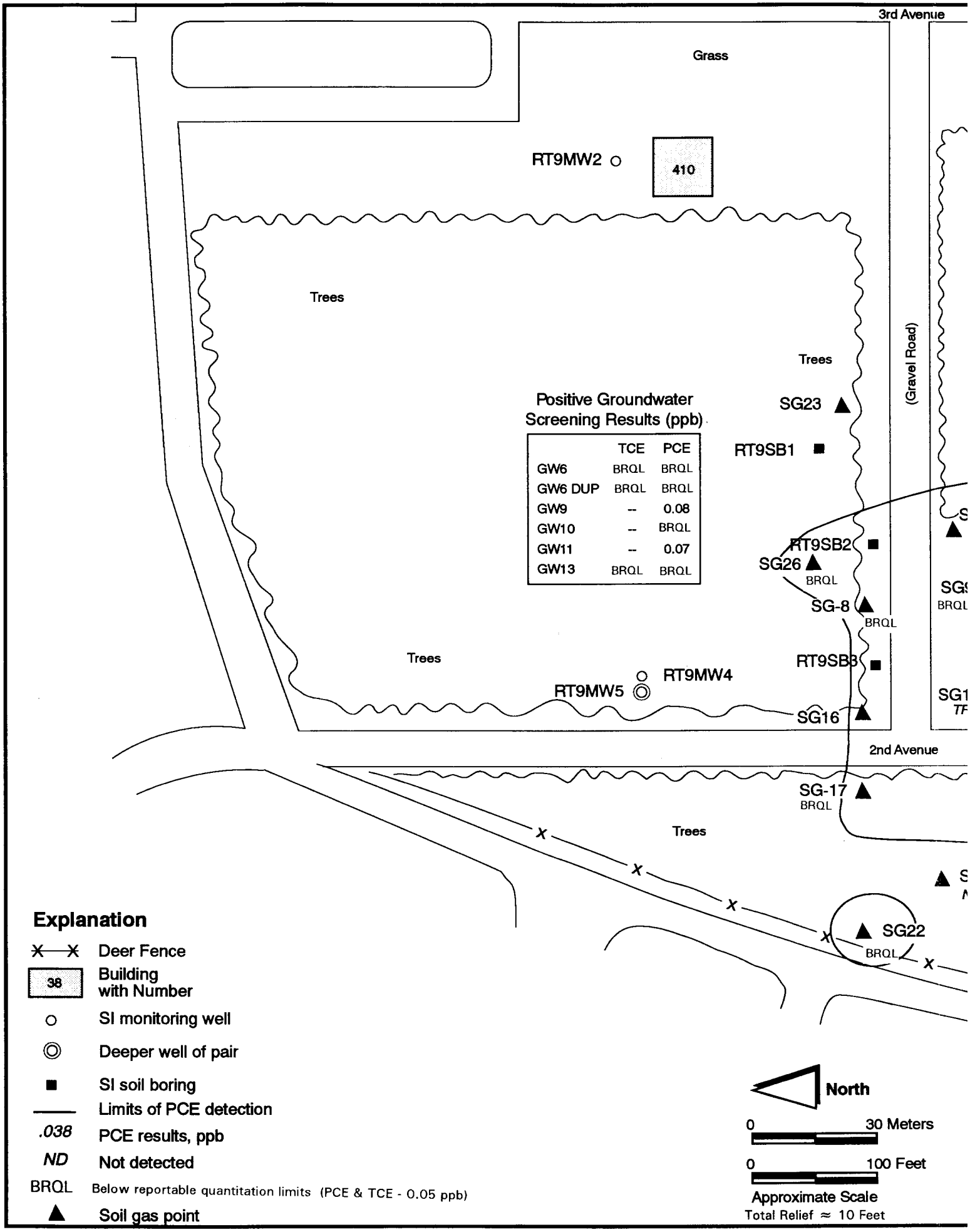
- Target VOCs – Concentrations of PCE less than the MDL (0.05 $\mu g/\ell$) were detected in soil gas samples collected around Building 417 (Figure 3-53). Sample locations SG-10 and SG-11 were the only locations which indicated the presence of chlorinated solvents above the method detection limit. PCE was detected at both locations at concentrations of 0.038 and 0.005 ppb, respectively.

- Total VOCs (as JP-4) – Samples SG-13, -14, -20, -21, and -25 were analyzed for JP-4 volatiles due to the presence of the aboveground fuel tank and old tank pit excavation. Analytical results indicated no detections for JP-4 volatile compounds at any of the five sample locations.

Groundwater Samples

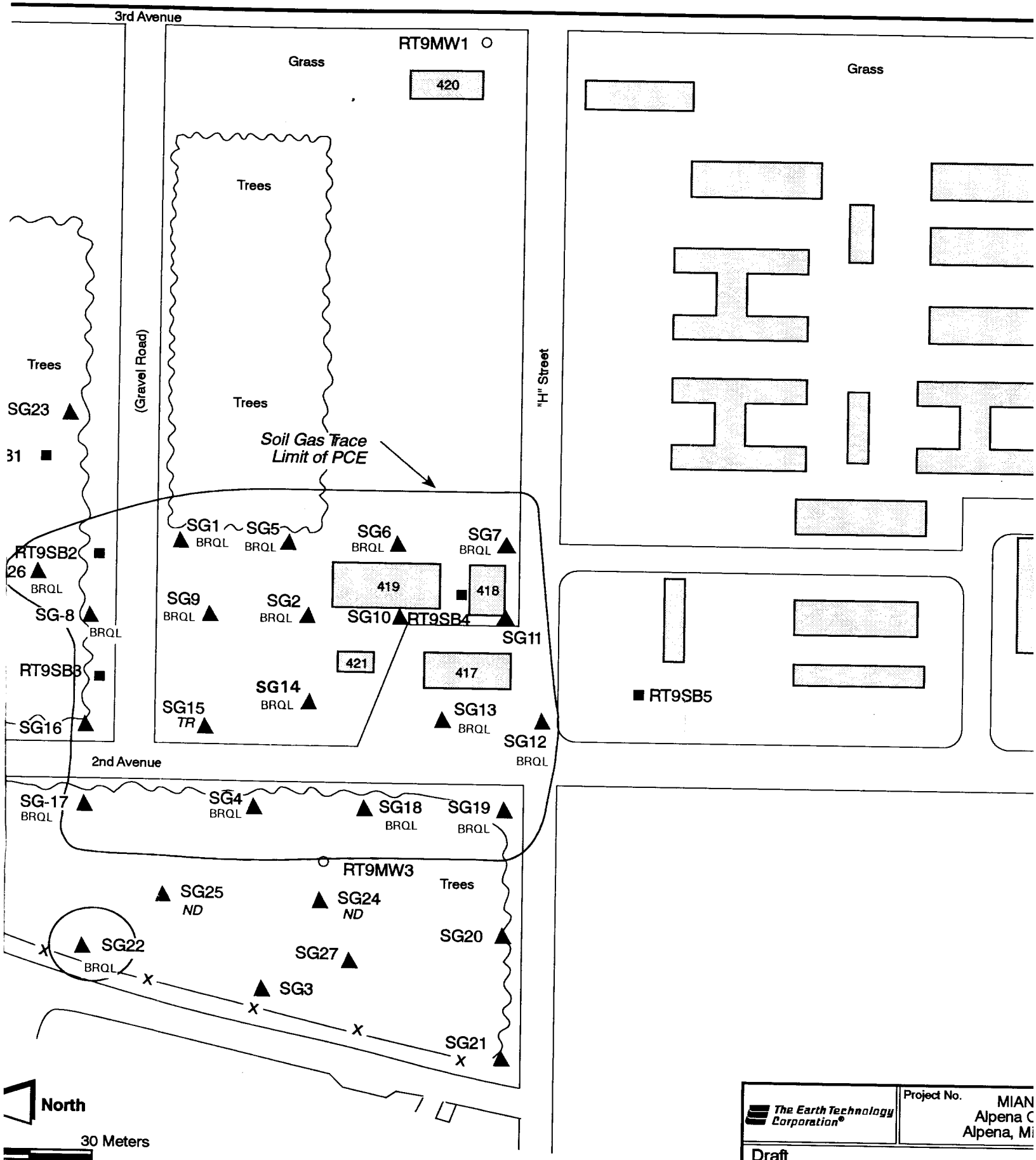
Groundwater samples were collected and analyzed from 15 locations (9GW-1 through 9GW-15) at Site 9 (Figure 3-53). A summary of these results is as follows:

- Target VOCs – TCE and/or PCE was detected in groundwater samples GW-6, GW-9, GW-10, GW-11, and GW-13 at concentrations less than the MDL (0.05 ppb) to 0.08 ppb. PCE was detected in groundwater samples collected from RT9MW4 during the October 1991 (Round III) groundwater sampling event (The Earth Technology Corporation, July 1992) at 8.4 ppb. Screening data indicate the extent of groundwater containing PCE around MW4 has been delineated, as PCE was detected in shallow groundwater samples from GW2, GW8, GW14 and GW15. The chlorinated hydrocarbons detected in GW-6 are probably not associated with the TCE or PCE detections around Building 417 and 419.



	TCE	PCE
GW6	BRQL	BRQL
GW6 DUP	BRQL	BRQL
GW9	--	0.08
GW10	--	BRQL
GW11	--	0.07
GW13	BRQL	BRQL

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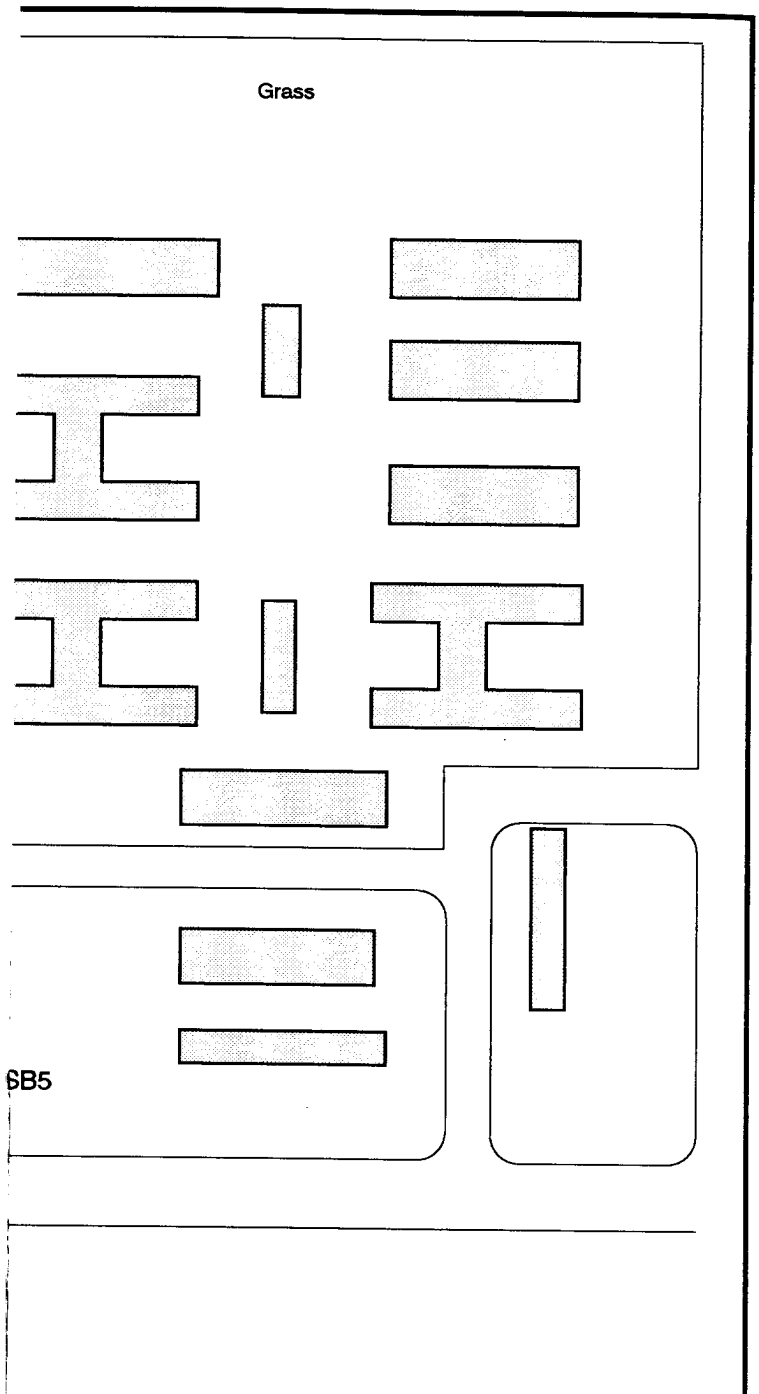
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Site 9 - Radar Tower Site
Initial Screening Locations
and Results

6-94

Figure 3-53

3.9.3.2 Soil Boring and Monitoring Well Placement Rationale

Soil boring RT9SB13 was drilled approximately 200 ft southeast of Building 417 to investigate the lower clay layer beneath the site. Monitoring well RT9MW6 was installed down gradient of Building 417 within the area where the initial groundwater screening results indicated the presence of PCE. Additional temporary wells were installed at Site 9 based on data collected during the RI drilling operations and on-site screening analysis.

3.9.3.3 On-Site Screening During Drilling Operations

During the RI drilling operations 6 soil samples and 6 groundwater samples were collected and analyzed using the on-site GC. Figures 3-54 and 3-55 presents the on-site screening data for Site 9 in map and cross-sectional view.

A review of the Site 9 data indicate that only 1 vadose zone soil contained VOCs. This sample was collected from RT9MW6 at a depth of 4 to 4.6 m (13 to 15 ft) bgs. PCE was present in this sample at a concentration of 4 $\mu g/\ell$.

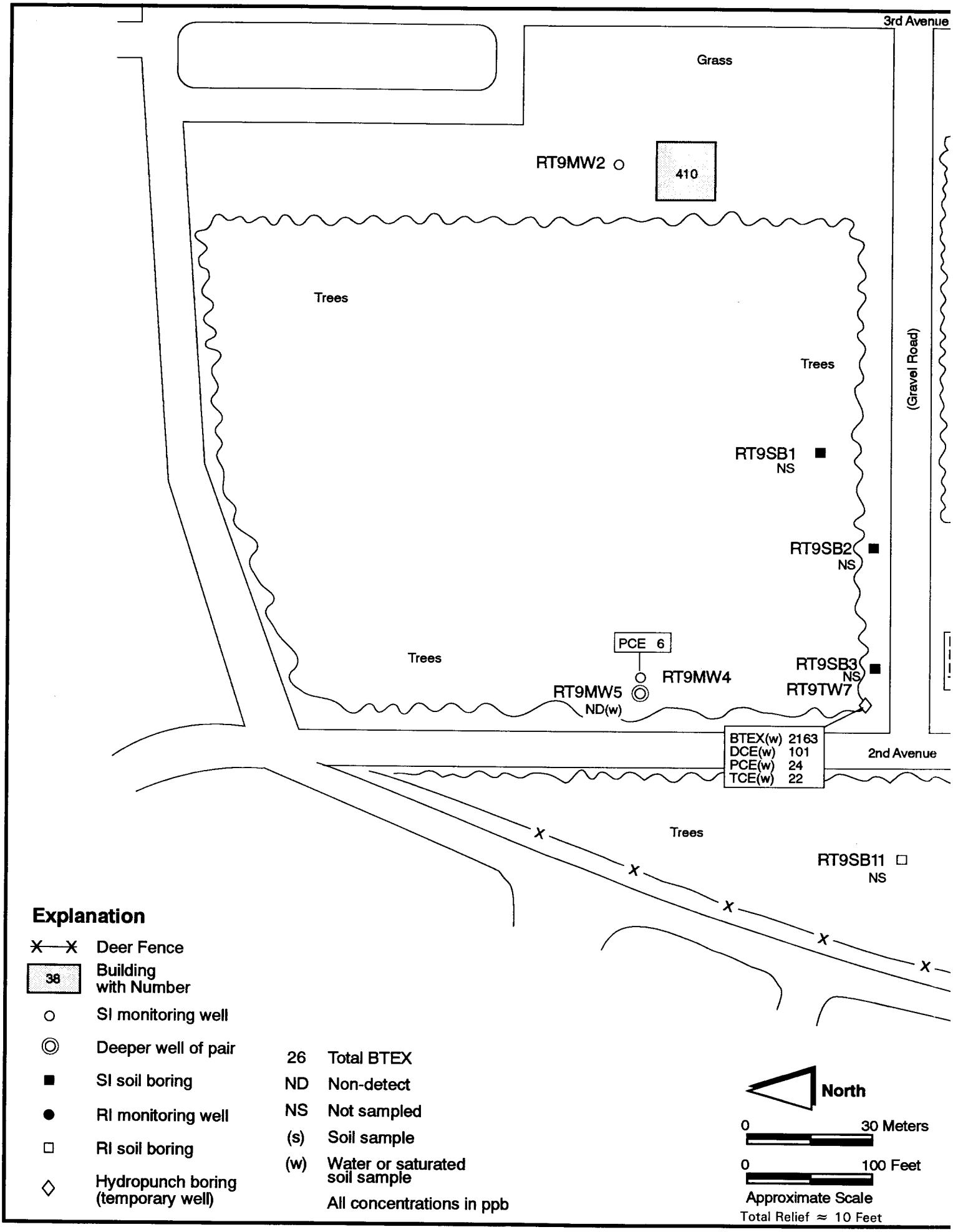
Results for analyses completed on groundwater samples collected from the site indicate groundwater samples do contain higher concentrations of VOCs than do the soil samples. As illustrated in Figure 3-55, BTEX, PCE, TCE, and DCE were each detected in relatively high concentrations from Hydropunch® groundwater samples collected from RT9MW6 and -TW7. A groundwater sample collected using Hydropunch® from RT9TW8 located to the south (up gradient) of Building 417 contained only trace concentrations of BTEX (4 $\mu g/\ell$) and DCE (3 $\mu g/\ell$). The analytical data, as presented in Figure 3-55 suggest that the hydrocarbons detected in the groundwater samples originated from the area surrounding Building 417. Additionally, screening samples collected from the RT9MW4/MW5 well pair (down gradient of TW7) indicate the extent of the BTEX detected in the groundwater down gradient of Building 417 has been delineated.

3.9.4 Confirmation Results

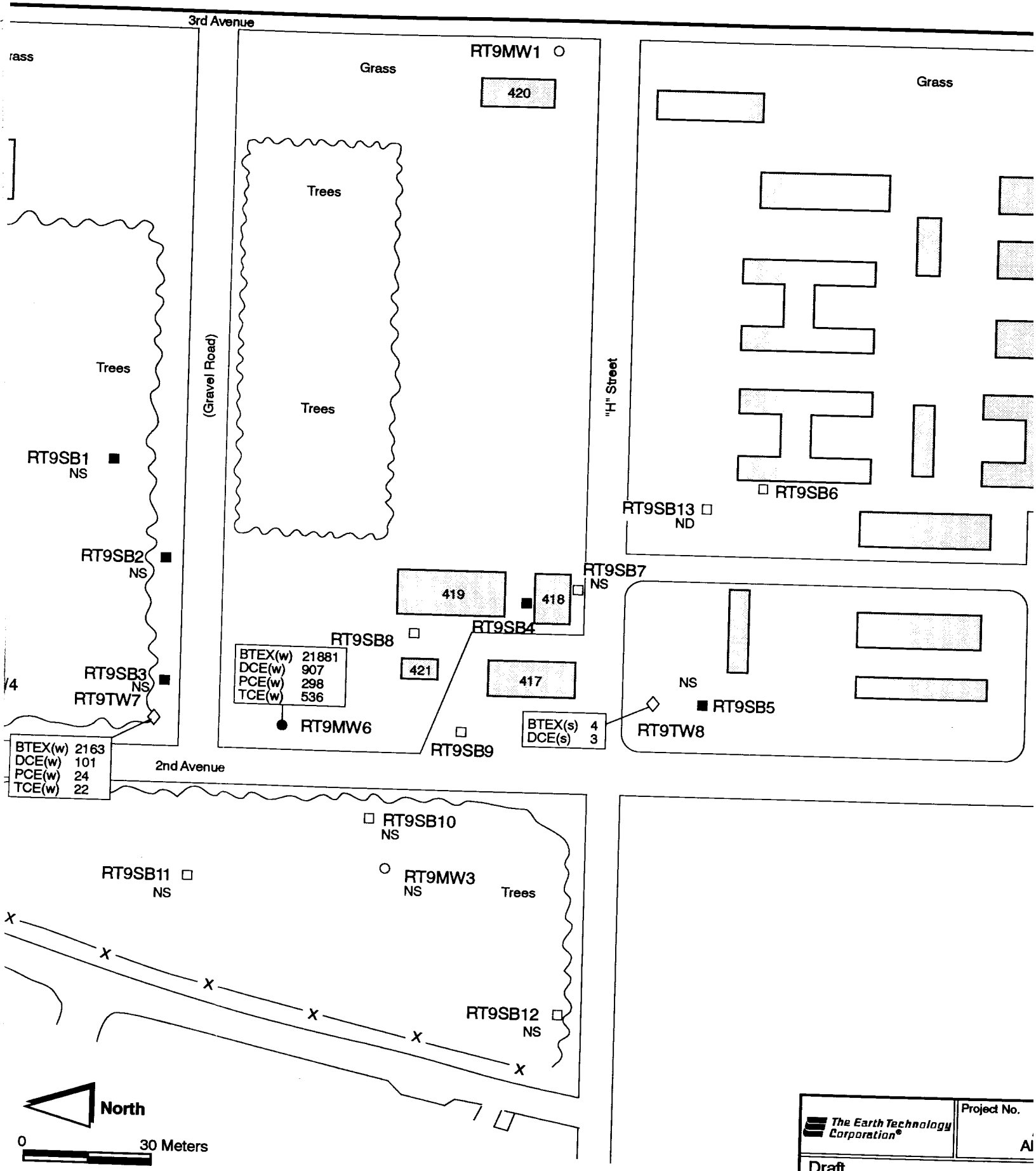
Analytical results for the soil and groundwater samples collected during the November 1992 and summer 1993 field events are presented in Tables 3-22, 3-23, and 3-24. A presentation and discussion of the significance of these results including the occurrence of compounds exceeding Act 307 Type A or B cleanup criteria are included in the following subsections.

3.9.4.1 Surface Soil Analytical Results

Surface soil samples were not collected from the borings (RT9SB1 through RT9SB6) drilled and sampled during the SI (Engineering-Science 1990). Six surface soil samples from borings RT9SB7 through -SB12 were collected during the RI field activities. The sampling locations are presented in Figure 3-56, which also shows the occurrences of organic and inorganic compounds exceeding the Act 307 Type A or B cleanup criteria for Site 9 surface and



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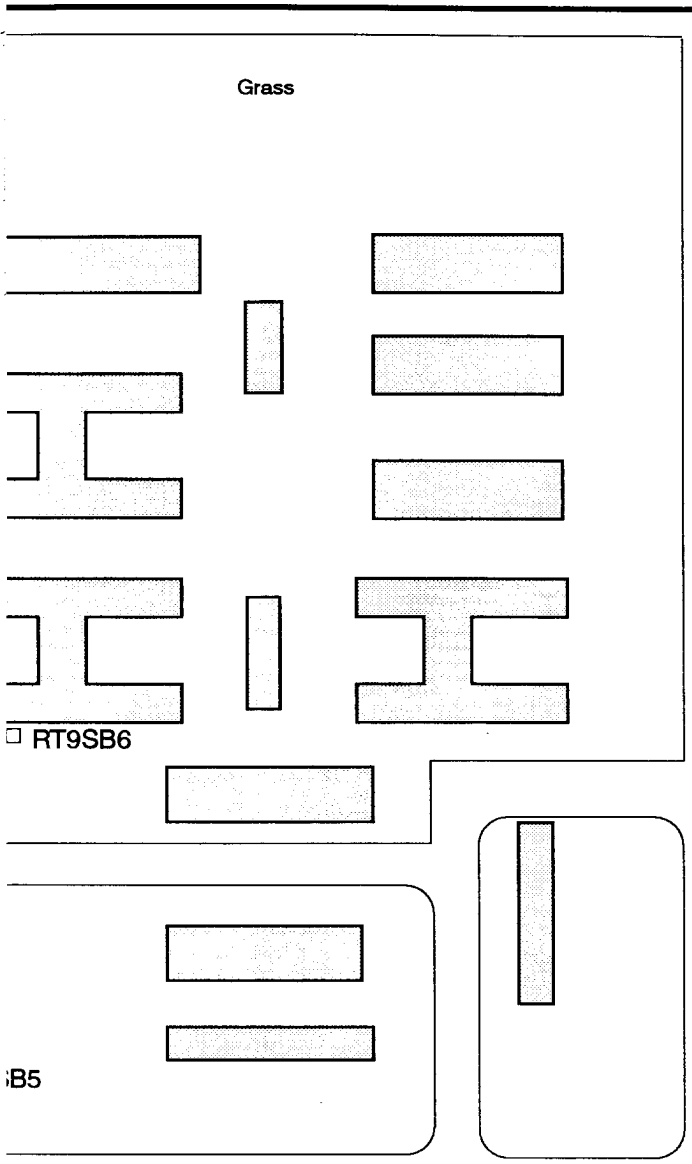
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Site 9 - Radar To Onsite Screening and Resu

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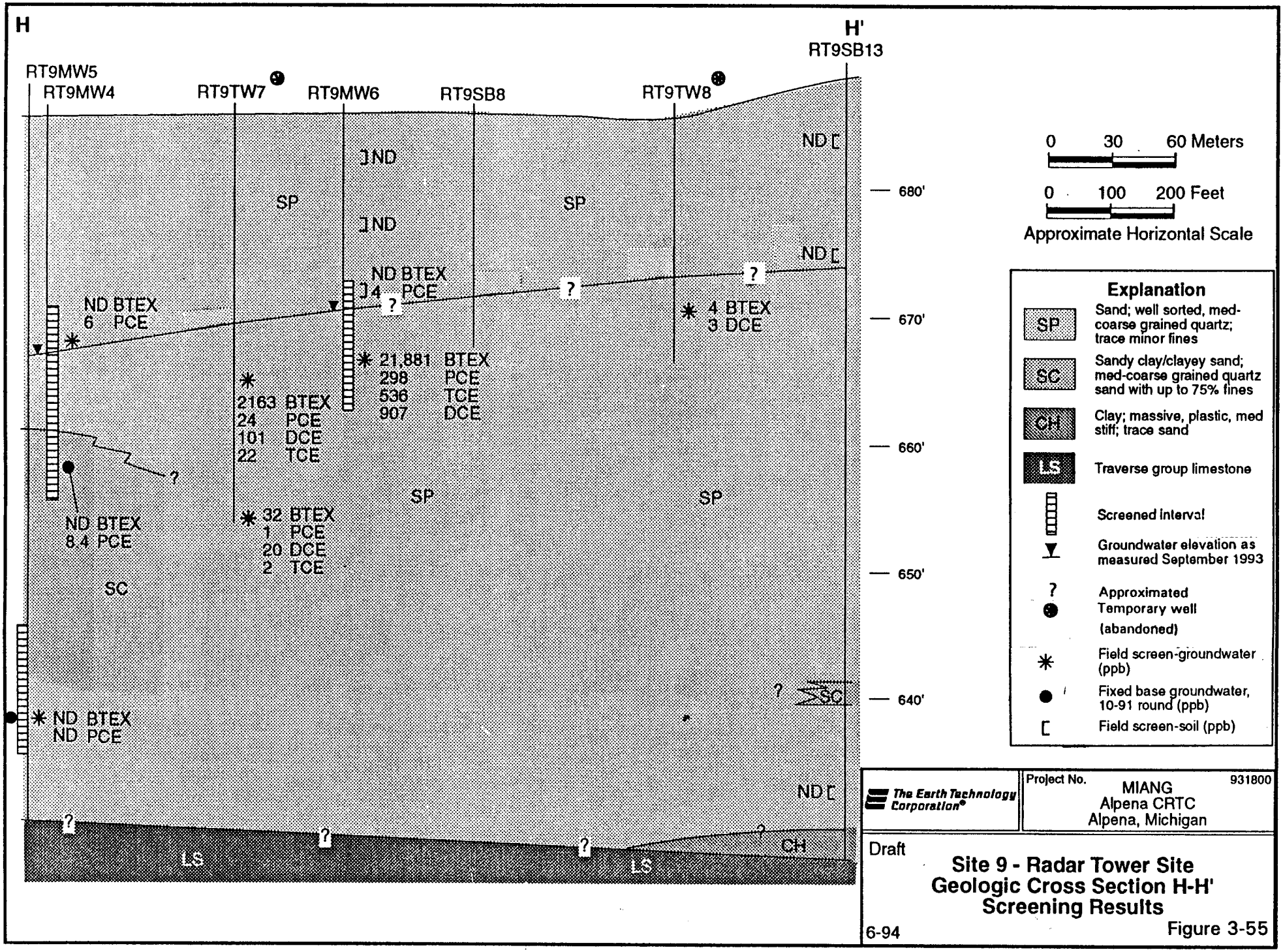
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Site 9 - Radar Tower Site
Onsite Screening Locations and Results

Figure 3-54



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Site 9 - Radar Tower Site
Geologic Cross Section H-H'
Screening Results

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Figure 3-55

Table 3-22 Data Summary Table: Surface Soil, Site 9 - Radar Tower Site
MIANG, Alpena CRTC, Alpena, Michigan

Locator:			SB10		SB11		SB12		SB7		SB8		SB9	
Sample ID:			PC-RT9-SB10-SS01-02		PC-RT9-SB11-SS01-02		PC-RT9-SB12-SS01-02		PC-RT9-SB7-SS01-02		PC-RT9-SB8-SS01-02		PC-RT9-SB9-SS01-02	
Collection Date:			12-NOV-92		12-NOV-92		13-NOV-92		12-NOV-92		12-NOV-92		12-NOV-92	
Sample Depth:			1 ft-2 ft		1 ft-2 ft		1 ft-2 ft		1 ft-2 ft		1 ft-2 ft		1 ft-2 ft	
Associated Field QC Samples:			EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02		EB02,TB05,FB01,FB02		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02	
	ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)														
1,4-Dichlorobenzene	30	ppb	1.9	U	0.099		2.6		1.9	U	1.1	B	1.9	U
Methyl-t-butyl ether	4600	ppb	11	U	0.56	J	12	U	12	U	11	U	12	U
SEMI-VOLATILES (CLP 3/90)														
bis(2-Ethylhexyl)phthalate	92000	ppb	340	UJ	150	J	52	J	350	UJ	340	UJ	350	UJ
METALS (CLP 3/90)														
Arsenic	5800	ppb	650	()B	520	()B	750	B	650	()B	710	()B	1100	
Cadmium	1200	ppb	520	U	590		540	U	520	U	520	U	530	U
Chromium	18000	ppb	3700		4100		5400		5300		3600		3300	
Copper	32000	ppb	2600	U	2600	U	7800		2600	U	2600	U	2700	U
Lead	21000	ppb	1200		1200		2600		1700		1400		1700	
Total Petroleum Hydrocarbons		ppb	21500		14100		14500		20000		19600		20500	

B Compound or analyte detected in field blank or lab blank
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-23 Data Summary Table: Subsurface Soil, Site 9 - Radar Tower Site
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		SB10		SB11		SB12		SB7		SB7		SB7	
Sample ID:		PC-RT9-SB10-SS10-12		PC-RT9-SB11-SS12-14		PC-RT9-SB12-SS05-07		PC-RT9-SB7-SS05-07		PC-RT9-SB7-SS15-17		PC-RT9-SB7-SS21-22	
Collection Date:		12-NOV-92		12-NOV-92		13-NOV-92		12-NOV-92		12-NOV-92		12-NOV-92	
Sample Depth:		10 ft-12 ft		12 ft-14 ft		5 ft-7 ft		5 ft-7 ft		15 ft-17 ft		21 ft-22 ft	
Associated Field QC Samples:		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02		EB02,TB05,FB01,FB02		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	12000 ppb	1.4	U	1.4	U	0.92	B	0.08	B	0.19	B	0.14	B
1,4-Dichlorobenzene	30 ppb	1.9		1.8	U	1.8	U	1.9	U	0.55	B	0.2	B
Chlorobenzene	2600 ppb	1.9	U	1.8	U	1.8	U	1.9	U	1.9	U	1.6	
Methyl-t-butyl ether	4600 ppb	5.2	B	0.54		11	U	11	U	11	U	11	U
HALOGENATED VOLATILES (8010)													
1,1,1-Trichloroethane	4000 ppb	0.13		2.8	U	2.7	U	0.17	B	0.098	B	0.2	B
Methylene Chloride	92 ppb	1.7	B	5.3	B	3.1	U	2.2	B	9.3	J	4.8	B
SEMI-VOLATILES (CLP 3/90)													
bis(2-Ethylhexyl)phthalate	92000 ppb	340	U	35	J	79		340	UJ	340	UJ	340	U
METALS (CLP 3/90)													
Chromium	18000 ppb	1800		2000		4200		5300		2900		2200	
Copper	32000 ppb	2600	U	2500	U	2700		2600	U	2600	U	2600	U
Lead	21000 ppb	830		850		1300		1400		870		780	
Total Petroleum Hydrocarbons	ppb	19400		14000		8700		21400		18300		13600	

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-23 Data Summary Table: Subsurface Soil, Site 9 - Radar Tower Site
MIANG, Alpena CRTC, Alpena, Michigan

		SB8		SB9	
Locator:					
Sample ID:		PC-RT9-SB8-SS15-17		PC-RT9-SB9-SS15-17	
Collection Date:		12-NOV-92		12-NOV-92	
Sample Depth:		15 ft-17 ft		15 ft-17 ft	
Associated Field QC Samples:		EB01,TB03,FB01,FB02		EB01,TB03,FB01,FB02	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)					
1,2-Dichlorobenzene	12000 ppb	0.11	B	2.1	
1,4-Dichlorobenzene	30 ppb	0.77	B	2.1	U
Chlorobenzene	2600 ppb	1.9	U	2.1	U
Methyl-t-butyl ether	4600 ppb	11	U	13	U
HALOGENATED VOLATILES (8010)					
1,1,1-Trichloroethane	4000 ppb	0.11	B	3.1	UJ
Methylene Chloride	92 ppb	2.9	B	1.5	B
SEMI-VOLATILES (CLP 3/90)					
bis(2-Ethylhexyl)phthalate	92000 ppb	340	UJ	130	J
METALS (CLP 3/90)					
Chromium	18000 ppb	1800		2800	
Copper	32000 ppb	2600	U	2900	U
Lead	21000 ppb	670		1000	
Total Petroleum Hydrocarbons	ppb	18500		15100	

B Compound or analyte detected in field blank or lab blank
BRL Below reportable limit
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

Table 3-24 Data Summary Table: Groundwater, Site 9 - Radar Tower Site
MIANG, Alpena CRTC, Alpena, Michigan

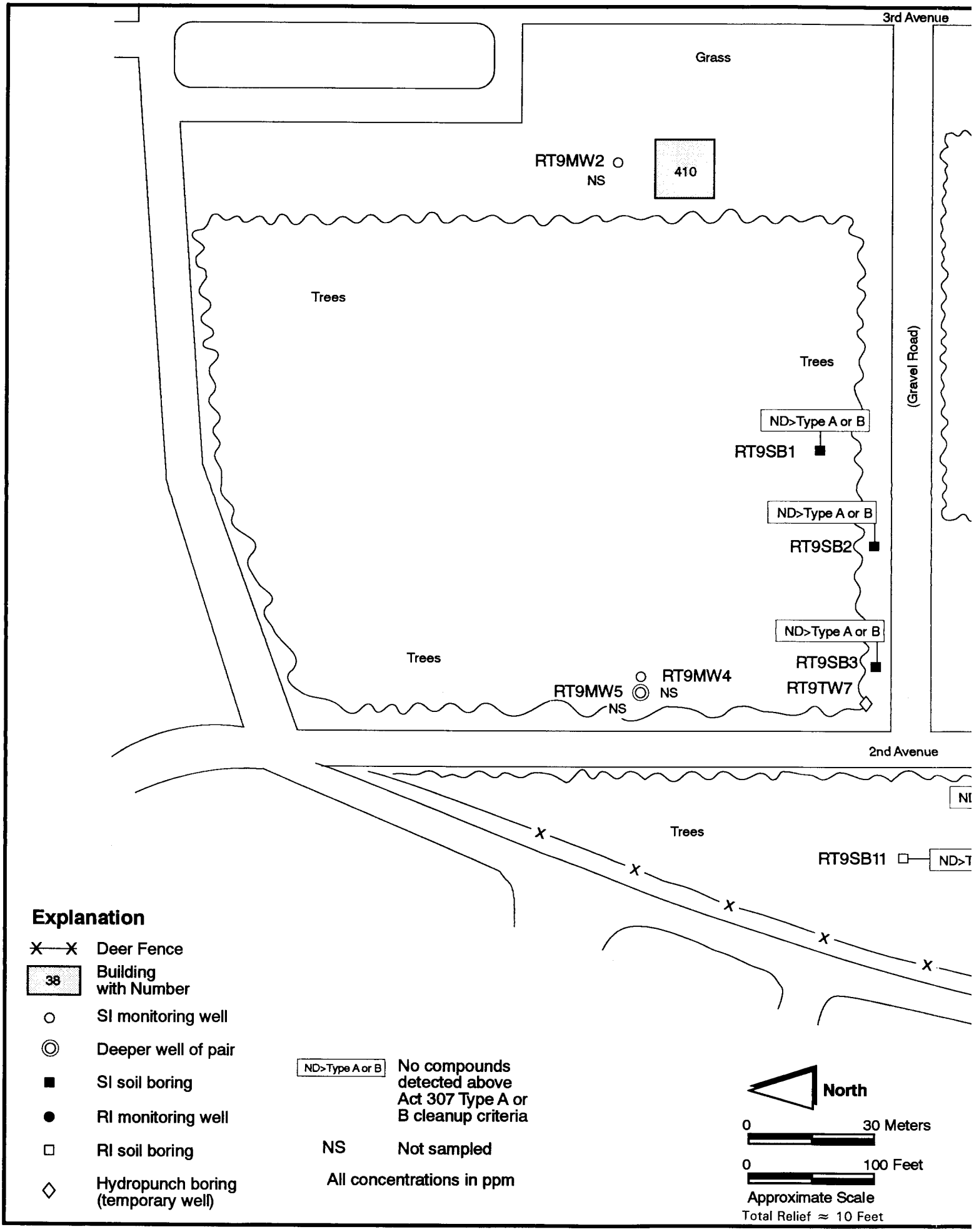
Locator:		MW1		MW2		MW3		MW4		MW5		MW6	
Sample ID:		PC-RT9-MW1-GW4		PC-RT9-MW2-GW4		PC-RT9-MW3-GW4		PC-RT9-MW4-GW4		PC-RT9-MW5-GW4		PC-RT9-MW6-GW4	
Collection Date:		27-AUG-93		27-AUG-93		27-AUG-93		08-SEP-93		26-AUG-93		15-SEP-93	
Associated Field QC:		FB05,TB19,ER17		FB05,TB19,ER14		FB05,TB19,ER14		FB07,TB22,ER18		FB05,FB07,TB19,TB27,ER14		FB07,TB27	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)													
1,2-Dichlorobenzene	600 ppb	0.15	U	0.15	U	0.15	U	0.15	U	0.15	U	3.6	
1,2-Dimethylbenzene	280 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	860	E
1,3-Dimethylbenzene	280 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	800	
1,4-Dichlorobenzene	1.5 ppb	0.15	U	0.15	U	0.15	U	0.15	U	0.18	B	18	
1,4-Dimethylbenzene	280 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	510	J
Benzene	1.2 ppb	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	3.9	J
Chlorobenzene	130 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.93	
Ethylbenzene	74 ppb	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	1.4	J
Methyl-t-butyl ether	230 ppb	5	U	5	U	5	U	5	U	5	U	1.3	J
Styrene	1.2 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.78	
Toluene	790 ppb	0.25	U	0.25	U	0.25	U	0.25	U	0.22	B	3.1	
HALOGENATED VOLATILES (8010)													
Chloroform	5.6 ppb	0.35	U	0.16		0.35	U	0.35	U	0.13		0.35	UJ
Methylene Chloride	4.6 ppb	0.26	B	0.53	J	0.23	B	0.81	B	0.83	B	0.19	B
Tetrachloroethylene	0.7 ppb	1	J	0.3	U	0.3	U	1.7		0.3	U	1.5	
Trichloroethylene	2.2 ppb	0.6	J	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U

B Compound or analyte detected in field blank or lab blank
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM

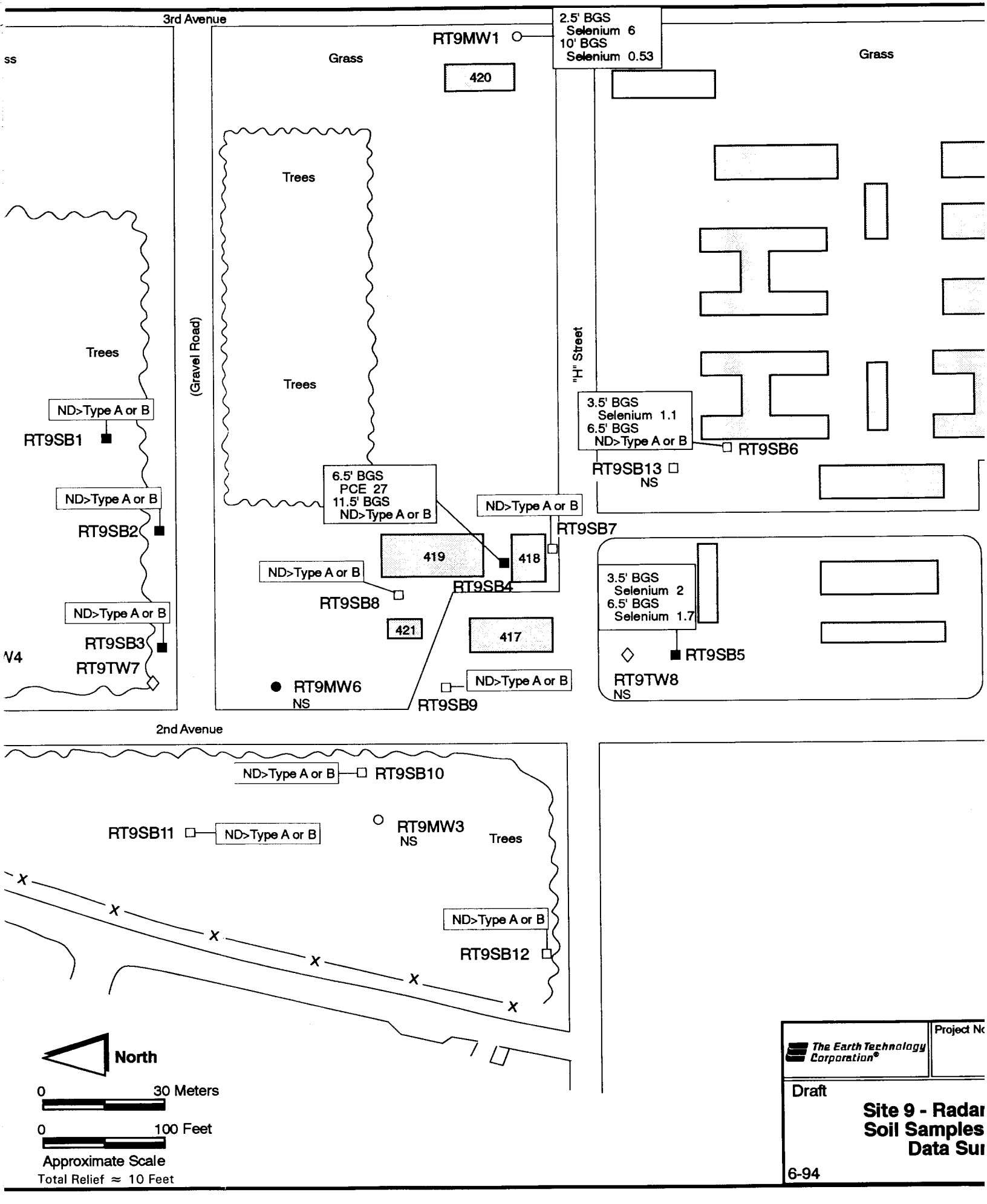
Table 3-24 Data Summary Table: Groundwater, Site 9 - Radar Tower Site
MIANG, Alpena CRTC, Alpena, Michigan

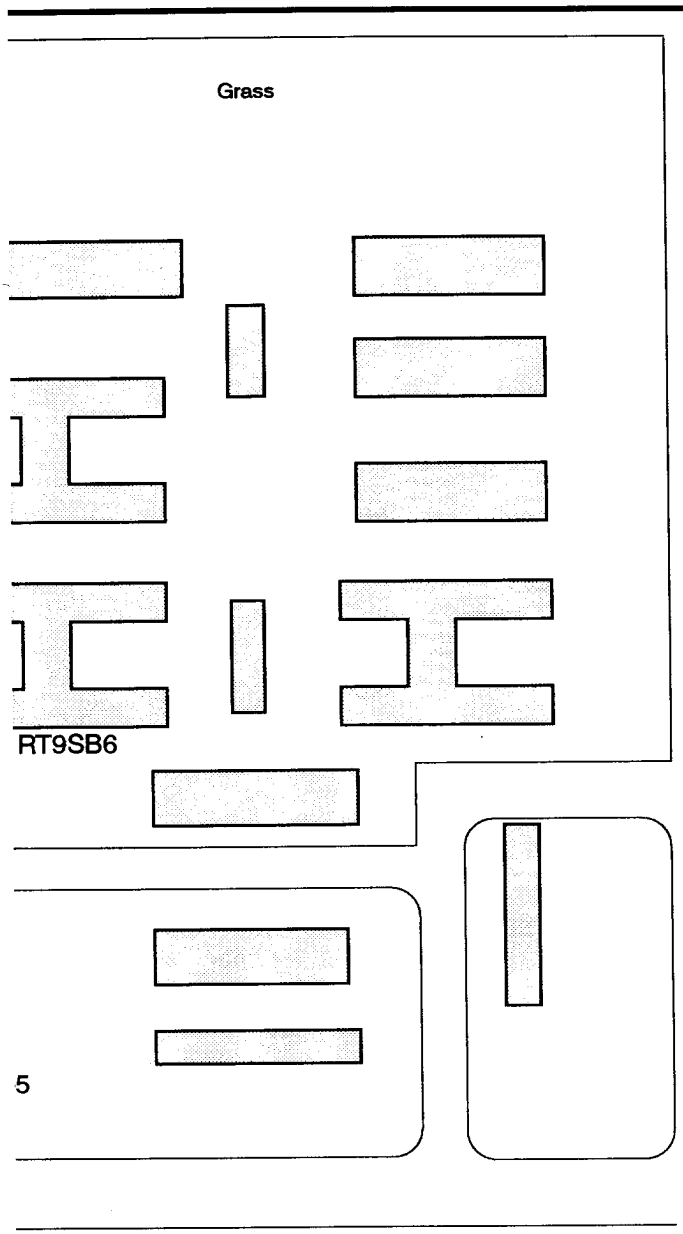
Locator:		MW1		MW2		MW3		MW4		MW5		MW6	
Sample ID:		PC-RT9-MW1-GW4		PC-RT9-MW2-GW4		PC-RT9-MW3-GW4		PC-RT9-MW4-GW4		PC-RT9-MW5-GW4		PC-RT9-MW6-GW4	
Collection Date:		27-AUG-93		27-AUG-93		27-AUG-93		08-SEP-93		26-AUG-93		15-SEP-93	
Associated Field QC:		FB05,TB19,ER17		FB05,TB19,ER14		FB05,TB19,ER14		FB07,TB22,ER18		FB05,FB07,TB19,TB27,ER14		FB07,TB27	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
SEMI-VOLATILES (CLP 3/90)													
2,4-Dimethylphenol	350 ppb	5	U	5	U	5	U	5	U	5	U	25	J
2-Methylnaphthalene	NA ppb	5	U	5	U	5	U	5	U	5	U	47	
4-Methylphenol	35 ppb	5	U	5	U	5	U	5	U	5	U	2	
Acenaphthene	1200 ppb	5	U	5	U	5	U	5	U	5	U	1	
Fluorene	840 ppb	5	U	5	U	5	U	5	U	5	U	0.8	
Naphthalene	250 ppb	5	U	5	U	5	U	5	U	5	U	48	
Phenanthrene	25 ppb	5	U	5	U	5	U	5	U	5	U	0.8	
METALS (CLP 3/90)[1]													
Arsenic	ppb	45.9	()L	30.9	L	25.5	L	23	J	4	UL	10.8	K
Beryllium	ppb	1	U	1	()B	1	()B	2.7	()	1	U	4	U
Chromium	ppb	8.2		42.7		32.7		78.8		8	U	25.2	
Copper	ppb	61.7		56.8		62.6		90.1		4	U	57.8	
Copper, Dissolved	1000 ppb	4	U	4	U	4	U	5.7	()	4	U	4	U
Lead	ppb	64.6		68.6		55.1		89		2	U	267	
Lead, Dissolved	4 ppb	2	UL	2	UL	2	UL	2	UL	2	UL	15.9	
Nickel	ppb	18	U	41.7		38.2	()	74.7		18	U	35	U
Zinc	ppb	32	B	103	B	77.8	B	176	J	4	U	67.2	J
Zinc, Dissolved	2300 ppb	4.4	()B	10.6	()B	4	U	5.6	()	4	U	6.3	()

B Compound or analyte detected in field blank or lab blank
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]Criteria are presented for dissolved metals only
NA - Not Available



931800 Site 9 Draft


3rd Avenue
ss
RT9MW1
2.5' BGS
Selenium 6
10' BGS
Selenium 0.53
Grass
420
Grass
Trees
Trees
Trees
(Gravel Road)
"H" Street
ND>Type A or B
RT9SB1
ND>Type A or B
RT9SB2
ND>Type A or B
RT9SB3
RT9TW7
V4
3.5' BGS
Selenium 1.1
6.5' BGS
ND>Type A or B
RT9SB6
RT9SB13
NS
6.5' BGS
PCE 27
11.5' BGS
ND>Type A or B
ND>Type A or B
RT9SB7
419
418
ND>Type A or B
RT9SB8
RT9SB4
421
417
3.5' BGS
Selenium 2
6.5' BGS
Selenium 1.7
RT9SB5
RT9TW8
NS
RT9MW6
NS
ND>Type A or B
RT9SB9
2nd Avenue
ND>Type A or B
RT9SB10
RT9SB11
ND>Type A or B
RT9MW3
NS
Trees
ND>Type A or B
RT9SB12
North
0
30 Meters
0
100 Feet
Approximate Scale
Total Relief ≈ 10 Feet
The Earth Technology Corporation®
Project No
Draft
Site 9 - Radar
Soil Samples
Data Sur
6-94



The Earth Technology Corporation®

Project No. 931800

MIANG
Alpena CRTC
Alpena, Michigan

Draft

Site 9 - Radar Tower Site
Soil Samples: Analytical Data Summary

6-94

Figure 3-56

subsurface soils. The organic compounds MTBE, 1,4-DCB, and bis (2-Ethylhexyl) phthalate were each detected in one or more of the samples in concentrations ranging from 0.10 to 150 J µg/kg. No organic compounds were detected in the surface soils in concentrations exceeding the Act 307 Type B cleanup criteria. TPH was detected in the soil samples in concentrations ranging from 14.1 to 21.5 mg/kg. Inorganics including arsenic, cadmium, chromium, copper and lead were also detected in the surface soils. None of these metals were detected in concentrations exceeding the Act 307 Type A cleanup criteria established for the facility.

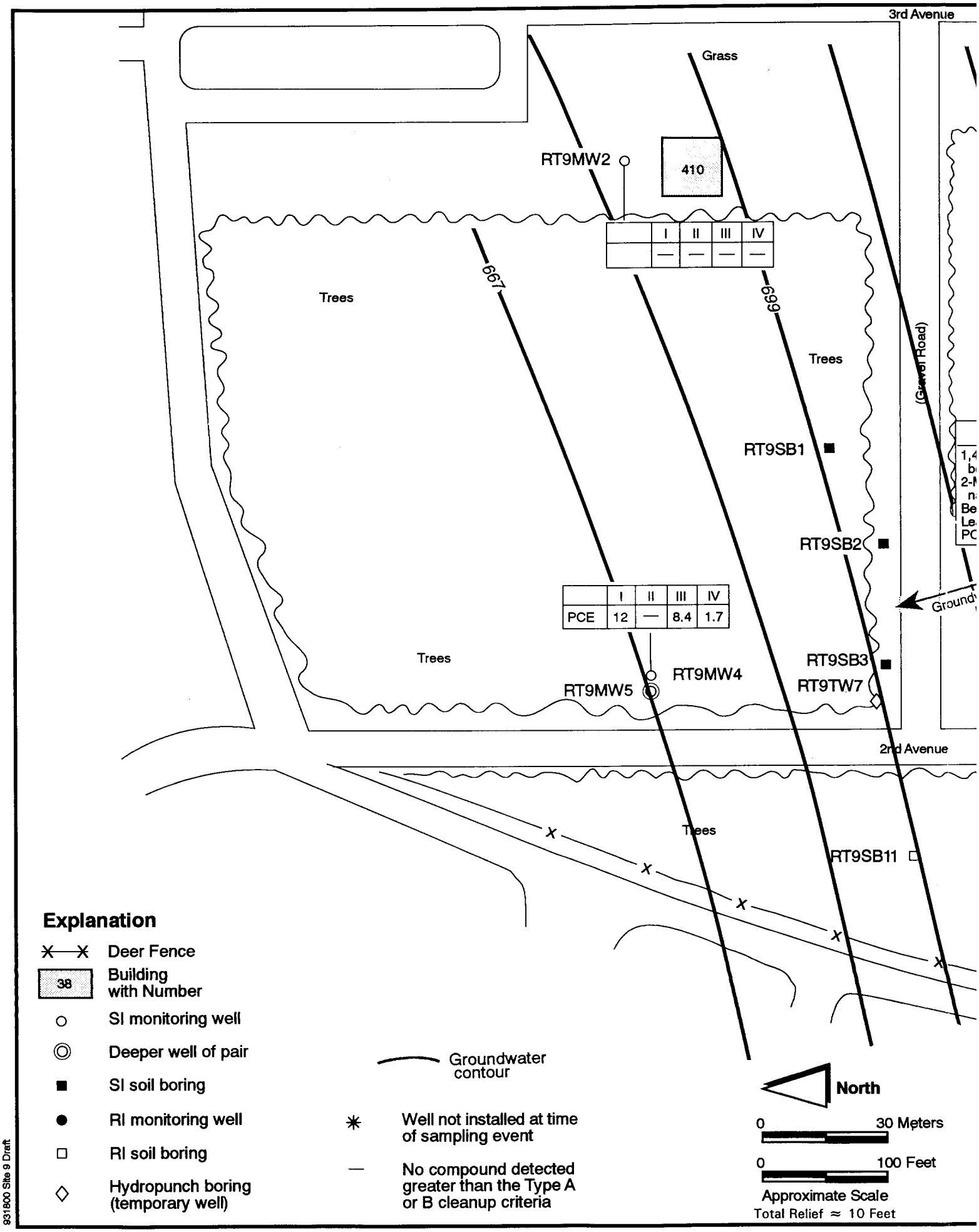
3.9.4.2 Subsurface Soil Analytical Results

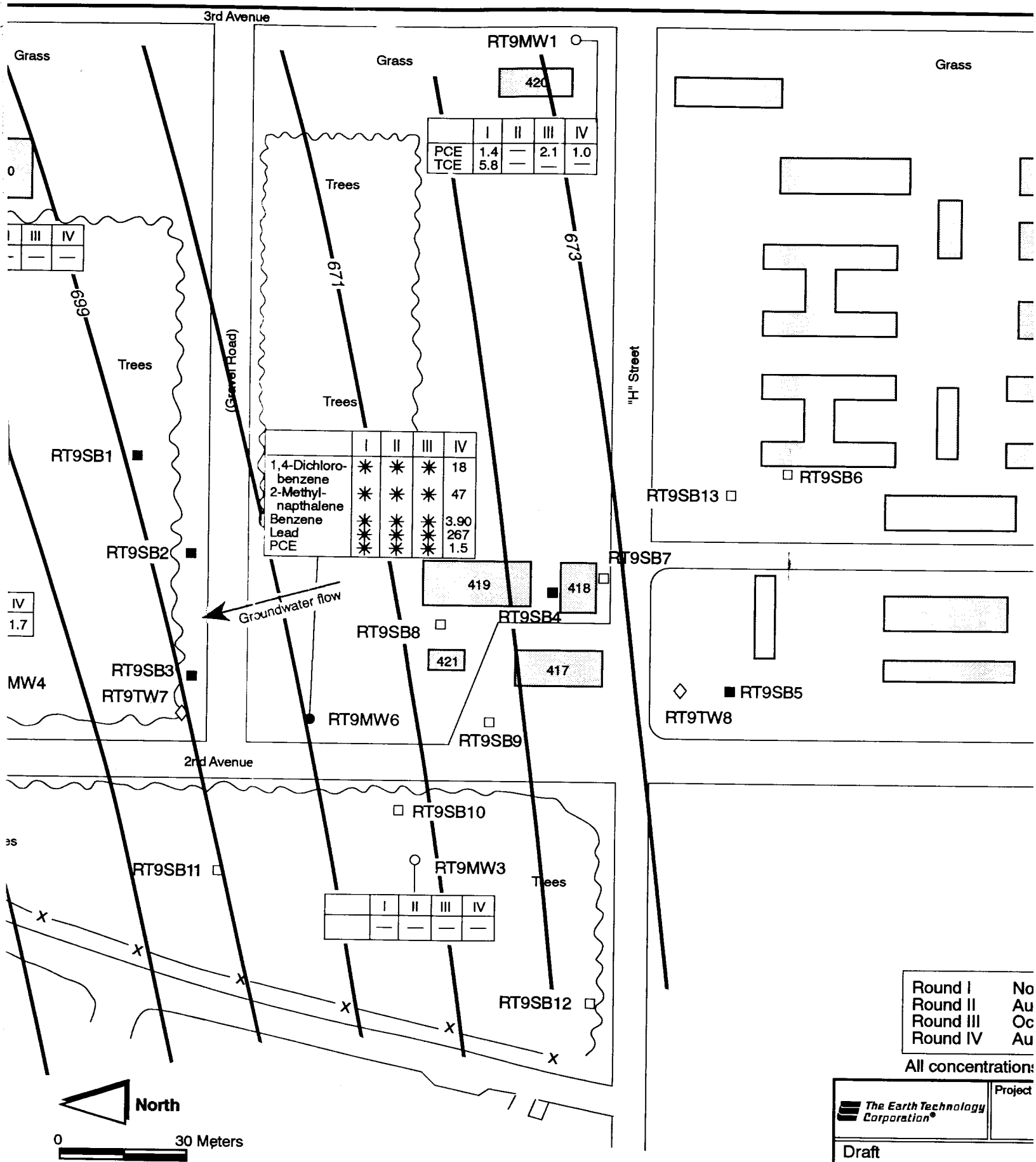
Fourteen subsurface soil samples were collected and analyzed during the SI (Engineering-Science 1990) from borings RT9SB1 through -SB6 and RT9MW1. An additional 6 subsurface soils were collected during the RI field activities from borings RT9SB7 through -SB12. A figure illustrating the occurrence of organic and inorganic compounds exceeding the Act 307 Type A or B criteria is presented as Figure 3-56. The organic compounds PCE, 1,1,1-TCA, 1,4-DCB, MTBE, chlorobenzene, methylene chloride, and bis (2-Ethylhexyl) phthalate were detected in these samples. Only PCE in the 6.5 ft bgs sample collected from RT9SB4 was quantified in concentrations exceeding Act 307 Type B cleanup criteria. This boring is located immediately southeast of Building 417 (Figure 3-56). TPH was quantified in these samples in concentrations ranging from the detection limit to 21.4 mg/kg. The inorganics arsenic, beryllium, cadmium, chromium, copper, lead, nickel, and zinc were also detected in the soils. No inorganics were detected in concentrations exceeding Act 307 Type A cleanup criteria.

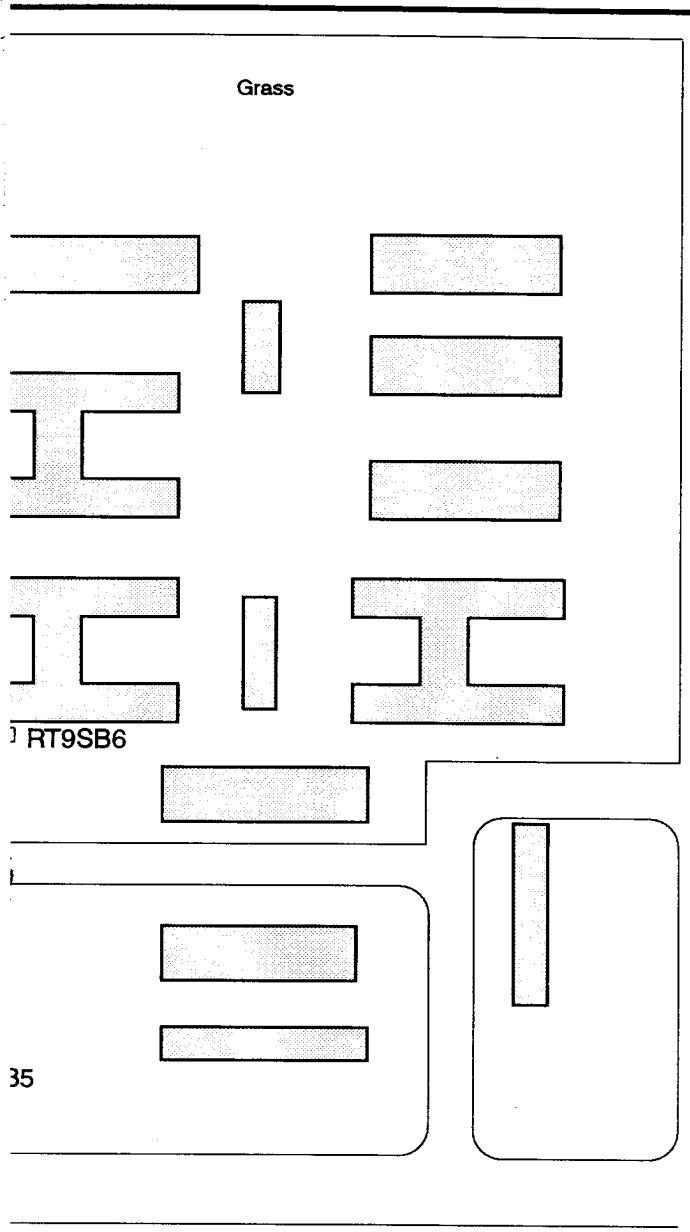
3.9.4.3 Groundwater Analytical Results

Groundwater samples were collected and analyzed from the 5 existing monitoring wells (RT9MW1 through -MW5) and one newly installed well (RT9MW6) during the summer 1993 (Round IV) sampling. A variety of VOCs including BTEX, MTBE, PCE, TCE, styrene, methylene chloride, and chloroform were detected during this sampling event. However, a majority of these compounds were quantified in concentrations below the Act 307 Type B cleanup criteria. PCE (1.5 µg/ℓ) and benzene (3.9 µg/ℓ) were detected in groundwater samples collected from RT9MW6, while PCE in concentrations of 1.0 and 1.7 µg/ℓ was detected in groundwater samples collected from RT9MW2 and -MW4, respectively. These detections were quantified in concentrations exceeding Act 307 Type B cleanup criteria. Additionally, the SVOCs naphthalene, 2-methylnaphthalene, 4-methylphenol, 2,4-dimethylphenol, phenanthrene, acenaphthene, and DCB isomers were also found in groundwater samples collected from Site 9 monitoring wells. A figure illustrating the occurrence of organic and inorganic compounds within the groundwater samples exceeding the Act 307 Type A or B cleanup criteria is presented as Figure 3-57. Of these compounds, 1,4-DCB and 2-methylnaphthalene, both occurring in groundwater samples collected from RT9MW6 were quantified in concentrations exceeding Act 307 Type B cleanup criteria (Figure 3-57).

Arsenic, beryllium, chromium, copper, lead, nickel, and zinc were detected in the unfiltered (total) groundwater samples collected from Site 9 monitoring wells during the summer 1993


3rd Avenue
Grass
RT9MW2
410
I II III IV
— — — —
667
669
Trees
Trees
(Gravel Road)
RT9SB1
RT9SB2
I II III IV
PCE 12 — 8.4 1.7
Trees
RT9MW4
RT9MW5
RT9SB3
RT9TW7
2nd Avenue
Trees
RT9SB11
Explanation
Deer Fence
38 Building with Number
SI monitoring well
Deeper well of pair
SI soil boring
RI monitoring well
RI soil boring
Hydropunch boring (temporary well)
Groundwater contour
Well not installed at time of sampling event
— No compound detected greater than the Type A or B cleanup criteria
North
0 30 Meters
0 100 Feet
Approximate Scale
Total Relief ≈ 10 Feet
931800 Site 9 Draft


3rd Avenue
Grass
Grass
Grass
RT9MW1
420
I II III IV
PCE 1.4 — 2.1 1.0
TCE 5.8 — — —
Trees
671
673
699
Trees
Trees
(Gravel Road)
"H" Street
I III IV
— —
IV
1.7
MW4
I II III IV
1,4-Dichloro-benzene * * * 18
2-Methyl-napthalene * * * 47
Benzene * * * 3.90
Lead * * * 267
PCE * * * 1.5
RT9SB1
RT9SB2
RT9SB3
RT9TW7
RT9SB6
RT9SB13
RT9SB7
419
418
RT9SB4
RT9SB8
421
417
Groundwater flow
RT9MW6
RT9SB9
RT9SB5
RT9TW8
2nd Avenue
RT9SB10
RT9SB11
RT9MW3
I II III IV
— — — —
Trees
RT9SB12
North
0 30 Meters
0 100 Feet
Approximate Scale
Total Relief ≈ 10 Feet
Round I No
Round II Au
Round III Oc
Round IV Au
All concentrations
The Earth Technology Corporation®
Project
Draft
Site 9 - Rada
Groundwate
Analytical
6-94



Round I	Nov. 1987
Round II	Aug. 1988
Round III	Oct. 1991
Round IV	Aug.-Sep. 1993

All concentrations in ppb

The Earth Technology Corporation®

Project No. 931800

MIANG
Alpena CRTC
Alpena, Michigan

Draft

Site 9 - Radar Tower Site Groundwater Samples: Analytical Summary

Figure 3-57

field activities. Copper, lead, and zinc were detected in the corresponding filtered (dissolved) samples, while of these compounds only lead (15.9 µg/ℓ) was quantified in the filtered sample obtained from RT9MW6 at a concentration exceeding the Act 307 Type A cleanup criteria.

The analytical results obtained from the summer 1993 groundwater sampling event (Round IV) compare favorably to the analytical results obtained from the three previous rounds (Figure 3-57). PCE has been detected in RT9MW4 during previous rounds of sampling. The summer 1993 (Round IV) results suggest the PCE concentrations in RT9MW4 are dissipating.

3.9.5 Summary and Conclusions

RI activities conducted at Site 9 concentrated on the area surrounding the AGE shop. The following summarizes the major findings from the subsurface investigations performed at Site 9:

- Sediments comprising the shallow aquifer beneath the site consist of a relatively uniform medium- to coarse-grained quartz sand overlying the limestone bedrock. The shallow aquifer is approximately 60 ft thick beneath Site 9. An evaluation of the data collected during the field investigations suggests there is no well-defined clay layer separating the shallow aquifer from the bedrock.

- Analytical results show the surface and subsurface soils are relatively free of chemicals of concern exceeding Act 307 Type A or B cleanup criteria. Only PCE, detected at 27 µg/kg from one subsurface soil sample was present in concentrations exceeding Act 307 Type B cleanup criteria.

- Groundwater flow in the shallow aquifer beneath the site is to the north towards the sinkhole. PCE has been detected in the summer 1993 and in previous rounds of groundwater sampling in concentrations exceeding the Act 307 Type B cleanup criteria. Fuel-related groundwater contamination was detected in RT9MW6 during the RI sampling and analysis. Benzene, 2-methylnaphthalene, lead, and 1,4-DCB were detected in groundwater samples collected from RT9MW6. These compounds have likely originated from minor spills which have occurred during routine fuel handling and/or maintenance activities conducted at the AGE shop (Building 417). The on-site GC screening data and the fixed based analytical data suggest the extent of groundwater contamination existing at Site 9 has been delineated. However, a majority of these compounds were quantified in concentrations below the Act 307 Type B cleanup criteria.

3.10 PRODUCTION WELLS

Six production wells (PW1 through PW6) exist on the facility. The locations of these wells are presented as Figure 3-58. Also included in this figure are analytical results for all compounds which were detected in concentrations exceeding the Act 307 Type A (if applicable) or B cleanup criteria during one or more of the previous four rounds of groundwater sampling. A summary of the production well information including well depths, uses, average discharge rates, etc. is presented as Table 3-25.

Production well PW1 has been the water supply well for the facility since 1942. The Alpena CRTC is used solely as a training facility. Average daily water use for the facility is approximately 189,000 ℓ (50,000 gal) per day (Base Water Treatment Plant Supervisor, personnel communication, January, 1993). The largest influx of people, and therefore water use, occurs during the March to September time period. On an average summer day PW1 supplies approximately 302,000 ℓ (80,000 gal) of water for the facility. During the off-peak training months (October to February), average daily yield is approximately 76,000 ℓ (20,000 gal) per day. Production wells PW2 and PW3 are no longer in use. Use of the wells was discontinued due to the presence of organic compounds in the water. However, PW2 is the alternate or standby well and would be used if well PW1 was unable to be used. Production wells PW4, 5, and 6 are still in use, but supply only a small quantity of water to isolated areas of the facility.

The analytical results for the summer 1993 groundwater sampling event (Round IV) are presented in Table 3-26, while additional historic groundwater sampling data is included in Appendices N and O. The available information, including the analytical results, for each production well is summarized below.

3.10.1 Production Well 1

Production well PW1 was drilled to a depth of 18.6 m (61 ft) and is completed in open hole. The screened interval or open hole is from 15.8 to 18.6 m (52 to 61 ft) bgs. PW1 is completed in the top portion of the Traverse Group Limestone and has an estimated discharge capacity of 1,135 liters per minute (ℓpm) (300 gallons per minute [gpm]). PW1 is located in Building No. 42, 152 m (500 ft) north of the water treatment plant.

Well PW1 is completed in the limestone aquifer, but is located down gradient of groundwater flow in the shallow aquifer coming from IRP sites 2 and 3. No casing leaks were reported during a camera survey completed in PW1 by facility personnel (Engineering-Science, 1990).

Organic compounds detected during the summer 1993 (Round IV) groundwater sampling event include 1,3- and 1,4-dimethylbenzene (o- and p-xylene, respectively), methylene chloride, diethyl phthalate, and phenol. None of these compounds were detected in concentrations exceeding the Act 307 Type B cleanup criteria. A review of the three previous rounds of groundwater analytical data (see Figure 3-58) shows that only analyte, was

RI SITES

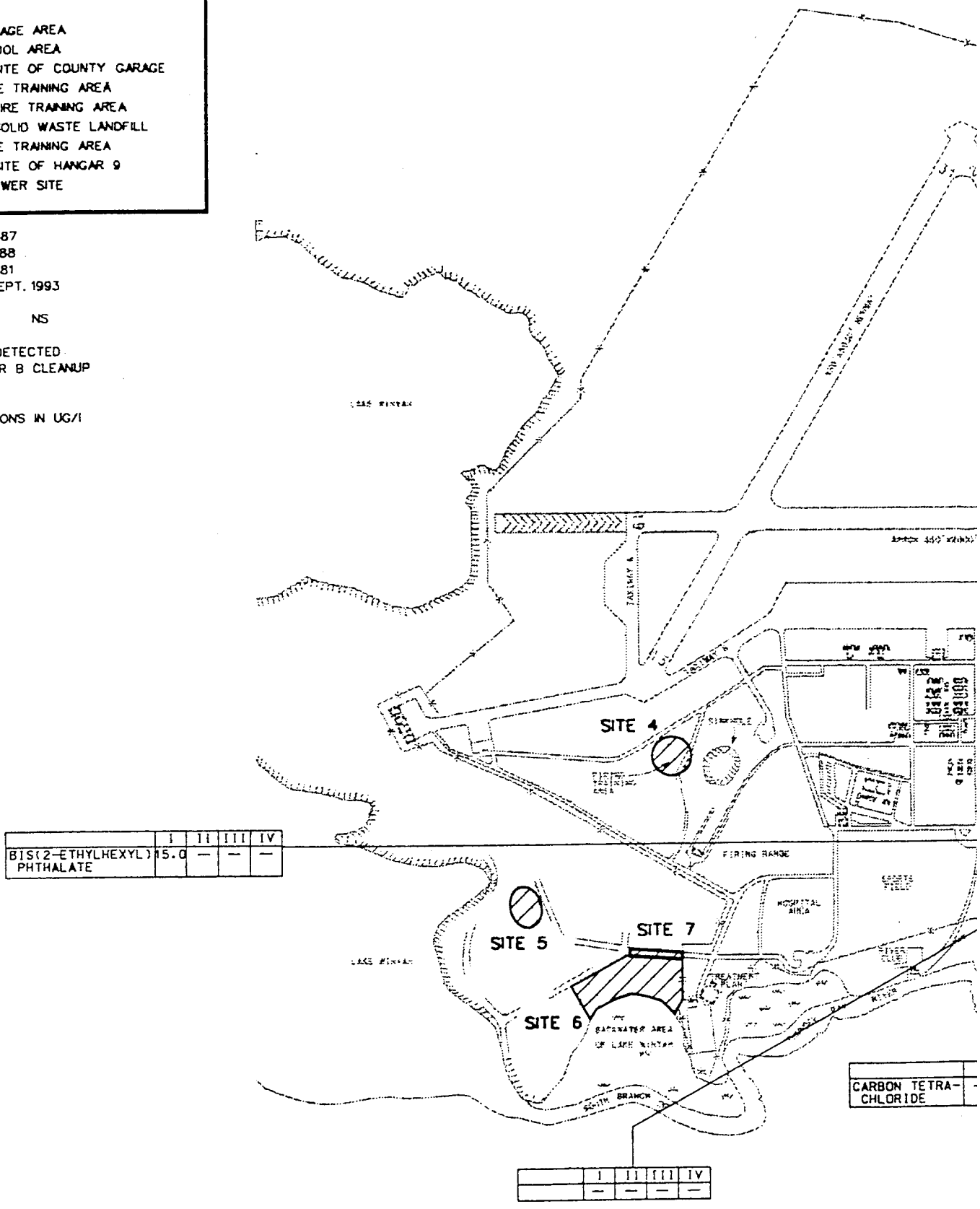
SITE 1 POL STORAGE AREA
SITE 2 MOTOR POOL AREA
SITE 3 FORMER SITE OF COUNTY GARAGE
SITE 4 THIRD FIRE TRAINING AREA
SITE 5 SECOND FIRE TRAINING AREA
SITE 6 FORMER SOLID WASTE LANDFILL
SITE 7 FIRST FIRE TRAINING AREA
SITE 8 FORMER SITE OF HANGAR 9
SITE 9 RADAR TOWER SITE

ROUND I NOV. 1987
ROUND II AUG. 1988
ROUND III OCT. 1981
ROUND IV AUG.-SEPT. 1993

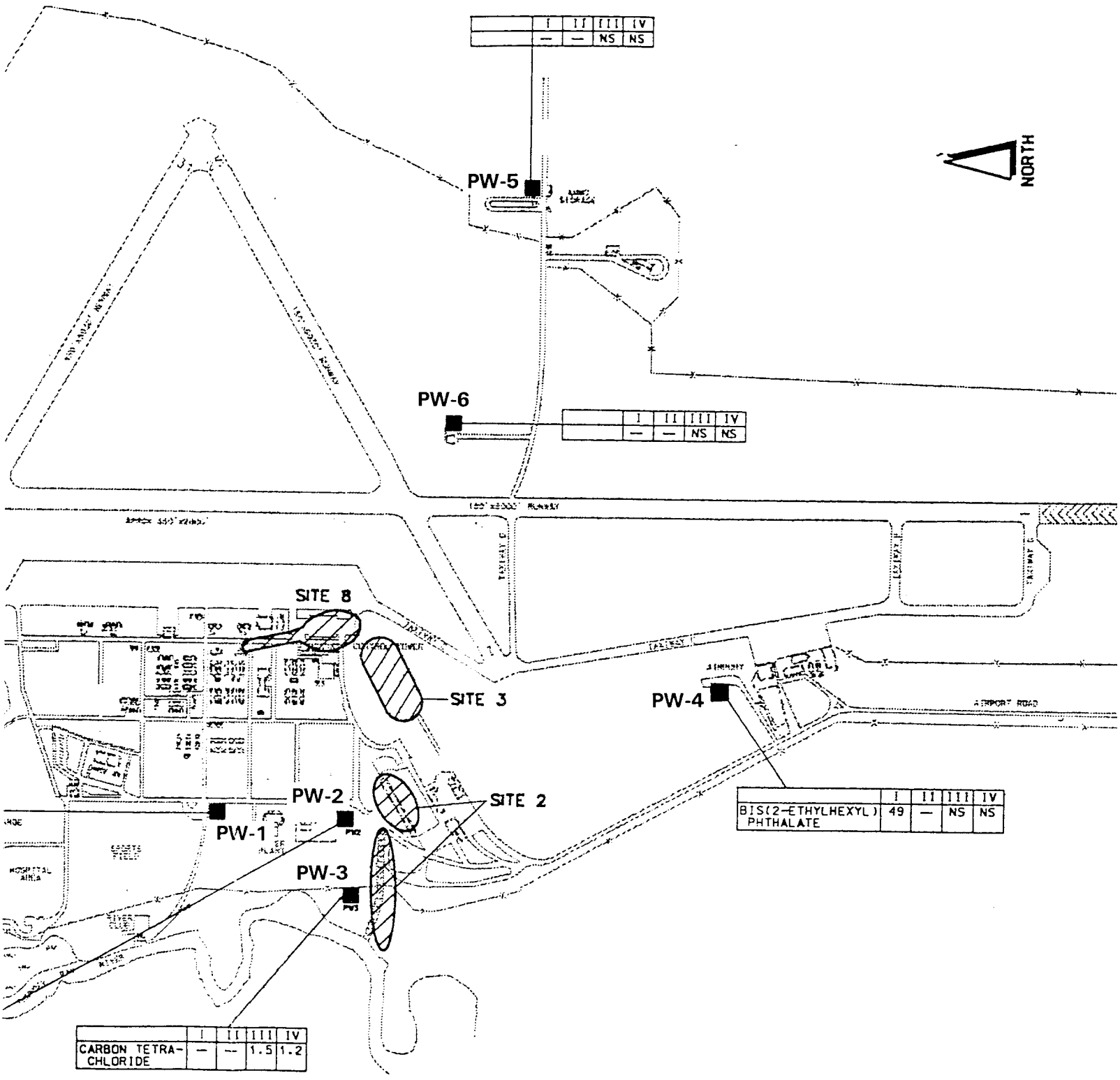
NOT SAMPLED NS

NO COMPOUNDS DETECTED ABOVE TYPE A OR B CLEANUP CRITERIA

ALL CONCENTRATIONS IN UG/I



Productio



Production Well

0 300 Meters

0 1000 Feet

Approximate Scale

The Earth Technology Corporation

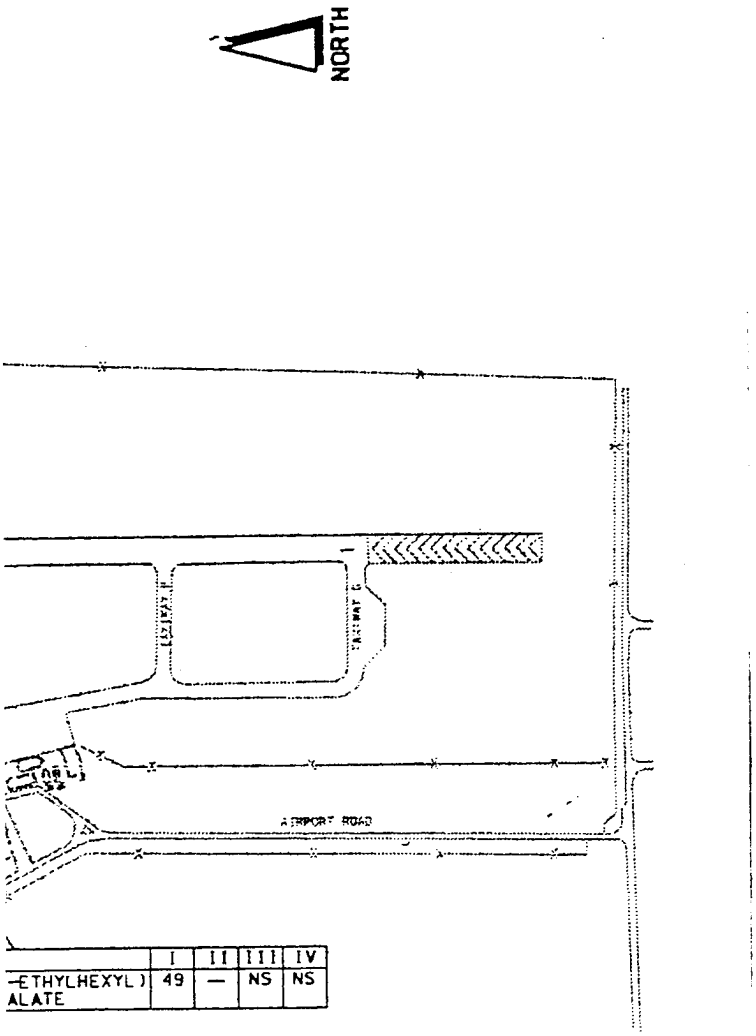
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PRODUCTION
ANALYTICAL DAT

12-93



	I	II	III	IV
-ETHYLHEXYL) ALATE	49	—	NS	NS

The Earth Technology Corporation

PROJECT NO. 928901

Alpena CRTC
Alpena, Michigan

DRAFT

PRODUCTION WELLS: ANALYTICAL DATA SUMMARY

12-93

Figure 3-58

Table 3-25 Production Well Summary, MIANG, Alpena CRTC, Alpena, Michigan

Production Well Number	1	2	3	4	5	6
Installation Date	1942	1942	1942	1952	1965	1979
Location	Building 42 500' north of water supply treatment plant	Building 41 500' south of water supply treatment plant	S.W. of Site 2 motor pool 750' southwest of water supply treatment plant	Building 4016 320' northeast of base main gate	north of ammo storage building east of runway	west of ammo storage building, east of runway
Base Useage	main supply of potable water	not used	not used	potable source watering plants, lawn & sewage	potable source watering plants & lawn & sewage	potable supply for radar building east of runway
Estimated Discharge Capacity (gpm)	300	255	77	110	12	10
Screen Type	Open Hole	Stainless Steel	Stainless Steel	Open Hole	Open Hole	Stainless Steel
Screen Internal Ft Bgs	52' - 61'	30' - 40', 56' - 66'	26' - 36'	140' - 150'	135' - 190'	15' - 25'
Lithological Unit Screened	Traverse Group Limestone	Shallow Sandy Aquifer, LS	Shallow Aquifer	Traverse Group Limestone	Bell Shale	Shallow Sandy Aquifer
Total Depth	61'	68'	36'	150'	190'	25'
Depth to Bedrock	52'	60'	N/A	N/A	N/A	N/A

Source: Engineering Sciences, November, 1990.
Base wastewater treatment plant personal (personal communication, December 1993)
NA – Not Available

Table 3-26 Data Summary Table: Groundwater, Production Wells
MIANG, Alpena CRTC, Alpena, Michigan

Locator:		PW1		PW2		PW3	
Sample ID:		PC-PW-PW1-GW4		PC-PW-PW2-GW4		PC-PW-PW3-GW4	
Collection Date:		10-AUG-93		10-AUG-93		10-AUG-93	
Associated Field QC:		FB01,TB07,ER05		FB01,TB07,ER05		TB07	
ACT 307 Criteria	UNITS	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
AROMATIC VOLATILES (8020)							
1,3-Dimethylbenzene	13000 ppb	0.028		-		-	
Ethylbenzene	74 ppb	0.2	U	0.092	J	0.2	U
HALOGENATED VOLATILES (8010)							
Carbon Tetrachloride	0.27 ppb	0.35	U	0.35	U	1.2	
Chloroform	5.6 ppb	0.35	U	0.35	U	0.28	
Methylene Chloride	4.6 ppb	0.28		0.37		0.16	U
SEMI-VOLATILES (CLP 3/90)							
Diethyl phthalate	5200 ppb	0.9	J	5	U	5	U
Phenol	4200 ppb	2	J	5	U	5	U
METALS (CLP 3/90)[1]							
Arsenic	ppb	6.4	()J	4	U	4	U
Lead	ppb	2	U	2	U	2.7	()
Zinc	ppb	15.7	()	16.4	()	111	
Zinc, Dissolved	2300 ppb	8.6	()	8.9	()	112	
Total Petroleum Hydrocarbons	NA ppb	300		700		4000	

B Compound or analyte detected in field blank or lab blank
E Indicates analyte concentration exceeds the calibrated range of the GCMS
J Concentration is estimated - QC criteria not attained.
K Concentration or quantitation limit is biased high - QC criteria not attained.
L Concentration or quantitation limit is biased low- QC criteria not attained.
R Data is unreliable
U Compound was analyzed for but not detected, result is sample quantitation limit.
( ) Value is between IDL and CRDL
Criteria for 1,2/1,3/1,4-Dimethylbenzene relates to Total Xylenes.
LAB:COMPUCHEM
[1]Criteria are presented for dissolved metals only
NA - Not Available

quantified at a concentration exceeding the Act 307 Type B cleanup criteria. Bis (2-ethylhexyl phthalate was detected in a concentration of 15 µg/ℓ in the November 1987 (Round I) groundwater analytical data.

Arsenic in the total (unfiltered) sample at a concentration of 6.4 J µg/ℓ, and zinc in the dissolved (filtered) and total (unfiltered) samples at concentrations of 8.6 and 15.7 µg/ℓ, respectively were the only inorganics detected in the groundwater sample collected from PW1 during the summer 1993 (Round IV) sampling. Arsenic was not detected in the corresponding filtered sample from the Round IV data, but was detected in a dissolved (filtered) sample during the November 1987 (Round I) sampling event at a concentration of 5 µg/ℓ. Arsenic was not quantified in the dissolved (filtered) groundwater samples collected during the August 1988 (Round II) or October 1991 (Round III) sampling.

The Act 307 Type A site-specific background criteria were created for this RI Report from facility wells completed in the shallow, unconfined aquifer. Well PW1 is completed in the limestone bedrock aquifer. Therefore the Type A background criteria do not apply for the inorganic analytical results obtained from PW1. There is insufficient data available from the facility to quantify local background chemistry for the limestone aquifer.

Groundwater samples from PW1 were collected from a sampling port located on the wellhead. This water is piped to the water plant, located in Building 40, where it is treated prior to being piped through the facility water supply system. The water is chlorinated and then pumped into a 189,000-ℓ (50,000-gal) tank. Suspended solids are allowed to settle from the water before it spills over into a second 189,000-ℓ (50,000-gal) tank. Water from the second tank is then distributed throughout the facility. Inorganic groundwater analytical results obtained from samples collected from the wellhead may not correspond directly to the inorganic concentrations as the water enters the supply system because the treatment process may affect the concentrations of metals in the water. No samples of the water entering the water distribution system were collected and analyzed as part of this RI.

3.10.2 Production Well 2

Production well PW2 was drilled to a depth of 65 ft bgs. The well was installed to a depth of 65 ft, extending through the shallow aquifer and encountering the Traverse Group Limestone at 18.3 m (60 ft) bgs. PW2 is screened at two different intervals, 9.1 to 12.2 m (30 to 40 ft) bgs within the shallow aquifer and from 17 to 20 m (56 to 66 ft) bgs within the Traverse Group Limestone. The hydraulic relationship between the shallow and limestone aquifers has not been established for the facility. Having a well constructed open to both aquifers may permit groundwater from one of the aquifers to flow through the well casing or filter pack (if present) and enter the other aquifer. Well PW2 is down gradient to the groundwater flow in the shallow aquifer with respect to IRP Site 2. The estimated discharge capacity for PW2 is 965 ℓpm (255 gpm). PW2 is located in Building 41, which is located approximately 152 m (500 ft) south of the water treatment plant.

Ethylbenzene (0.92 µg/ℓ) and methylene chloride (0.37 µg/ℓ) were both detected in PW2 during the summer 1993 (Round IV) groundwater sampling event. Neither compound was detected in concentrations exceeding the Act 307 Type B cleanup criteria. In addition, no organic compounds were detected in the three previous rounds of groundwater analytical data in concentrations exceeding the Act 307 Type B cleanup criteria.

Zinc in the dissolved (filtered) and total (unfiltered) samples at concentrations of 8.9 and 16.4 µg/ℓ, respectively were the only inorganics detected in the groundwater sample collected from PW2 during the summer 1993 (Round IV) sampling. Arsenic was quantified in the filtered (dissolved) groundwater sample collected during the November 1987 (Round I) data at a concentration of 6 µg/ℓ, but was not detected in the three subsequent rounds of sampling.

The Act 307 Type A cleanup criteria were created from wells completed in the shallow unconfined aquifer. Because well PW2 is partially completed in the limestone bedrock aquifer these Type A cleanup criteria do not apply for the inorganic analytical results obtained from PW2. There is insufficient data available from the facility to quantify local background chemistry for the limestone aquifer.

3.10.3 Production Well 3

Production well PW3 was installed to a depth of 11 m (36 ft) bgs and is screened within the shallow aquifer from 8 m to 11 m (26 ft to 36 ft) bgs. Estimated discharge capacity for PW3 is 291 ℓpm (77 gpm). PW3 is located approximately 229 m (750 ft) southwest of the water supply treatment plant. Well PW3 is located - down gradient to the flow of groundwater in respect to IRP Site 1.

Carbon tetrachloride (1.2 µg/ℓ) and chloroform (0.28 µg/ℓ) were the only organic compounds detected in groundwater samples collected during the summer 1993 (Round IV) groundwater sampling event from PW3. The detection of carbon tetrachloride exceeds the Act 307 Type B cleanup criteria. Chloroform and chloromethane were detected in samples collected from this well during the November 1987 (Round I) sampling, while chloroform, carbon tetrachloride, butyl benzyl phthalate, and di-n-butyl phthalate were all detected during the October 1991 (Round III) sampling event. Of the data obtained during the three previous rounds of sampling only the carbon tetrachloride detected during Round III sampling was present at concentrations exceeding the Act 307 Type B cleanup criteria (see Figure 3-58).

Zinc in the dissolved (filtered) and total (unfiltered) samples at concentrations of 111 and 112 µg/ℓ, respectively and lead (total) of 2.7 µg/ℓ were the only inorganics detected in the groundwater sample collected from PW3 during the summer 1993 (Round IV) sampling. No inorganics were detected in fourth round groundwater sample collected from PW3 at a concentration exceeding the Act 307 Type A cleanup criteria. No inorganics were detected in the three previous rounds of groundwater sampling from PW3 in concentrations exceeding the Act 307 Type A cleanup criteria.

3.10.4 Production Well 4

Production well PW4 was installed to a depth of 45.7 m (150 ft) bgs within the Traverse Group Limestone and is used as a water supply for the communications buildings. It is completed in an open hole with the open interval between 45.7 m and 42.7 m (140 ft and 150 ft) bgs. Estimated discharge rates for PW4 is 416.4 ℓpm (110 gpm). PW4 is located in Building 4016, 97.5 m (320 ft) northeast of the facility main gate.

Well PW4 was only sampled during the initial two rounds of sampling. Bis (2-Ethylhexyl) phthalate and chloromethane were detected in the November 1987 (Round I) groundwater sampling event at concentrations of 49 and 4.3 μg/ℓ from this well. No organic compounds or inorganics were detected in concentrations exceeding the Act 307 Type A or B criteria in the groundwater samples collected from PW4.

3.10.5 Production Well 5

Production well PW5 was installed to a depth of 57.9 m (190 ft) bgs and is used as the water supply for the munitions area located east of the runways. It is completed in an open hole with the screened interval between 41.1 and 57.9 m (135 and 190 ft) bgs. PW5 is completed within the Bell Shale and has an estimated discharge capacity of 45.4 ℓpm (12 gpm).

Well PW5 was only sampled during the initial two rounds of sampling. Chloromethane were detected in the November 1987 (Round I) groundwater sampling event at a concentration of 9 μg/ℓ from this well. No organic compounds or inorganics were detected in concentrations exceeding the Act 307 Type A or B cleanup criteria in the groundwater samples collected from PW4.

3.10.6 Production Well 6

Production well PW6 was installed within the shallow aquifer and is used as a water supply for the radar building east of the runways. PW6 was installed to a depth of 7.6 m (25 ft) bgs and is screened from 4.6 to 7.6 m (15 to 25 ft) below ground surface. Estimated discharge capacity for PW6 is 38 ℓpm (10 gpm).

Well PW6 was only sampled during the initial two rounds of sampling. Chloromethane were detected in the November 1987 (Round I) groundwater sampling event at a concentration of 6.3 μg/ℓ from this well. No organic compounds or inorganics were detected in concentrations exceeding the Act 307 Type A or B cleanup criteria in the groundwater samples collected from PW6.