M-621

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

M-621 150137

1044.970219.001

SAIC
Science Applications International Corporation
An Employee-Owned Company

February 19, 1997

U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
Oak Ridge, TN 37831-8758

Attention: Ms. Susan M. Cange
Site Manager - Maywood Site

Subject: Contract DE-AC05-91OR21950
MAYWOOD - FINAL MAYWOOD GROUNDWATER SAMPLING AND ANALYSIS PLAN

Dear Ms. Cange:

Enclosed are two copies of the Final Groundwater Sampling and Analysis Plan for the Maywood site. We have also provided two copies each of the Plan to EPA and NJDEP. By copy of this letter five bound copies and one unbound copy have been forwarded to BNI for record retention purposes.

All comments received from EPA have been addressed and were incorporated into the Plan. In addition, a separate comment response table has been provided for convenience. Copies of the comment response tables have been forwarded to EPA along with the documents.

If you have any questions or comments please contact me at 481-4703.

Sincerely,

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Heath M Cothron

Heather M. Cothron
Project Manager - Maywood Site

HMC:sh

Enclosures

cc: B. Seay, FSRD (w/o)
J. Japp, FSRD (w/e)
J. Darby, FSRD (w/e)
M. Redmon, BNI (w/3e)
C. Dirnbauer, BNI (w/e)
PDCC, BNI (w/2e)

	Name	Initials	Date
Originator	H. Cothron	HMC	2/19/97
Concurrence	N/A		
Approved	G.M. Stephens	gms	2/19/97
Administrative Record	☒ Yes	☐ No	

No. 1044.970219.001
Internal Distribution

B. Malek
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150137

FINAL
DOE/OR/21950-1020

GROUNDWATER SAMPLING AND ANALYSIS PLAN FOR THE MAYWOOD SITE

MAYWOOD, NEW JERSEY

FEBRUARY 1997

U.S. Department of Energy
Oak Ridge Operations Office
Formerly Utilized Sites Remedial Action Program

COMMENTS AND RESPONSES ON
THE GROUNDWATER SAMPLING ANALYSIS PLAN FOR THE MAYWOOD SITE
MAYWOOD, N. J. (October 1996)

Comments received 11/13/96, Angela Carpenter (USEPA)

COMMENT NO.	pp/§/¶	COMMENT	RESPONSE
General Comments			
1	Vertical Extent of Contamination	Some of the deepest wells installed on-site exhibit high levels of contamination of BTEX and/or chlorinated VOCs. Generally, the highest levels of contaminants are found in the deepest wells within bedrock. It is not clear why additional wells were not installed to determine the approximate vertical extent of groundwater contamination. Additional wells (which should be sampled with depth during installation) should be installed in order to effectively evaluate all remedial alternatives.	We agree with the reviewer that the depth of contamination is not defined. The two wells that exhibit the highest concentrations of VOCs, B38W14D and B38W15D, occur on the west side of the Ballod property and are screened in bedrock at 46 and 40 feet (ft), respectively. These are two of the deepest wells at the Maywood Site. The SAP will be revised to state that a single well will be drilled adjacent to the existing wells at the B38W14 location. After reaching bedrock, this well will be sampled at 5 ft intervals during drilling. The samples will be analyzed on-site for VOCs and the well screen set at the depth of maximum contamination unless that depth is 46 to 51 ft (the depth at which B38W14D is screened), in which case the well will be plugged and abandoned. Addition of this deep well will preclude the necessity of including sampling of a deep well in the optional Phase II of this SAP and that text will be deleted.

Comments received 11/13/96, Angela Carpenter (USEPA)

COMMENT NO.	pp/§/¶	COMMENT	RESPONSE
2	Surface Water Sampling	The goals of the proposed surface water sampling as well as the conceptual model for the contamination of the Westerly Brook culvert by site groundwater contamination are not clear. First, sampling of Westerly Brook downgradient of the facility has already exhibited significant levels of chlorinated VOC contamination. It is not clear what significant information will be gained by sampling those locations again. If temporal variability is to be assessed, more than two samples in two time intervals would be necessary. Also samples should be obtained during periods of low or base flow. In order to avoid false negatives or false positives, a minimum of three water samples should be obtained upstream and downstream. This information will provide critical data on the natural variability of the system. Also, sediment samples are a more reliable indicator of average or net impacts to a stream, so sediment samples should also be collected. A minimum of three upstream samples and 3 to 5 downstream sediment locations should be sampled. Surface water and sediment sampling should also be conducted in the Saddle River if Groundwater data indicates the plume has likely reached the river. The conceptual model for how chlorinated VOC contamination in groundwater is entering a presumably closed concrete culvert is not clear. Figure 1-13 appears to indicate that the conduit is open below the surface just east of Route 17. However, it is not clear why the conduit should be open at that location. Please provide some narrative discussion describing how and where DOE believes VOC-contaminated groundwater is entering the culvert.	The intention of sampling Westerly Brook is to correlate concentrations of VOCs in groundwater observed close to the stream with concentrations in the stream. It is not the intention to observe temporal trends, simply to get a "snap shot" of concentrations to compare to those in groundwater taken during the same time period. The reviewer is correct in her concern over false negatives/positives, especially as analysis will be conducted by a field laboratory. To resolve this issue, the same two sample locations will be visited and sampled three times during the field operations and only at baseflow conditions (at least 48 hours after rainfall). Sediment samples will not provide additional information for this project because the COCs are VOCs and will not tend to accumulate in sediments. Westerly Brook is culvertized from upstream of MISS to St Anne's Place. It is expected that, due to its age, the culvert may leak. The observations in historical monitoring data of low concentrations of VOCs in this stream suggest that this may be the case. Because baseflow in Westerly Brook is derived from groundwater it is reasonable to expect that some groundwater may leak into the culvert below MISS or Ballod. If this is not the case then one would not expect MISS or Ballod to be the sources for the VOC contamination in this stream and downstream concentrations should be lower than upstream. Sampling in the culvert will be logistically difficult and potentially costly (due mainly to health and safety concerns). Therefore, sampling will be conducted where the stream is easily accessible at the entrance and exit of the culvert. The text has been revised to include discussion of the possible mechanism for VOC-contaminated groundwater to enter the culvert. Text has been revised in Section 1.3.2.2 to provide a narrative or the conceptual model of discharge to the Westerly Brook.

Comments received 11/13/96, Angela Carpenter (USEPA)

COMMENT NO.	pp/§/¶	COMMENT	RESPONSE
Specific			
3	p. 1-30. ¶ 6, sentence 3	Sentence should be clarified to indicate that there is no known domestic well between MISS and the Saddle River. As written, the sentence implies that there are no known wells to the west for an indefinite distance.	Text revised as suggested.
4	p. 1-35. Passive Soil Sampling	What was the rationale for the approximately 125 foot spacing of soil sampling collectors? What are likely sources of undiscovered contamination (e.g.,underground storage tanks, miscellaneous spills etc.), and how large of a soil gas anomaly would be likely to result from such a source? These questions should be considered when developing the rationale for sample spacing.	The most likely sources of VOCs in groundwater at MISS are the former retention ponds and burial pits on MISS and Ballod. These former features have been documented and are relatively large (100 to 200 ft width). Thus, a 125 ft sample spacing, which is too large for identification of miscellaneous spills and underground storage tanks (USTs), is justified for this investigation. For the area being covered by the soil gas survey, a closer spacing would be cost prohibitive. The use of soil gas is intended to reduce the number of subsurface soil sample locations needed to define any soil contamination in the former retention ponds and waste pits.

Comments received 11/13/96, Angela Carpenter (USEPA)

COMMENT NO.	pp/§/¶	COMMENT	RESPONSE
5	Fig. 1-17. Off-site Decision Rules	The flow chart indicates what will be done if VOCs are found in the bedrock wells and not in overburden wells in each of the transects, but does not address what will be done if contamination is found both in the bedrock and overburden wells (but not in the soil gas probes). Please address this potential scenario in the work plan.	If groundwater contamination is detected in push-probes and wells, but not in soil gas analysis, then it will be concluded that the soil gas method is not suitable for tracking contamination in groundwater at this site. A similar conclusion can be made if soil contamination is detected in samples but not in the soil gas analysis. The strategy for site investigation has been derived to ensure that the nature and extent of VOC contamination in groundwater is defined in a cost effective manner. If VOC contamination is found in both overburden and bedrock monitoring wells during this investigation, then it is expected that the configuration of wells outlined in this SAP will define the extent of contamination. Thus the goal of the sampling will be fulfilled. Further sampling will only be needed if, on analysis of the results, the extent of contamination is not defined. We feel that this occurrence is unlikely based on the amount of sampling proposed, however, the SAP does include Phase II sampling in the unlikely event that further sampling is needed after completion of Phase I sampling.
6	p. 1-49, ¶ 2	This section acknowledges that the depth of contamination in groundwater has not been determined. Please refer to the General Comments for recommendations to address this data gap.	*See response to general comment #1.*

Comments received 11/13/96, Angela Carpenter (USEPA)

COMMENT NO.	pp/§/¶	COMMENT	RESPONSE
7	p. 1-49, Decision Error and Null Hypothesis	The standard nomenclature for these error decisions is that a Type I error is a False Negative error and a Type II error is a False positive error. Please refer to the Soil Screening Guidance (EPA 1996) for further information on a statistically driven, acceptable decision error approach to sampling. Please revise this paragraph and the next page accordingly.	*Soil Screening Guidance* (EPA 1996) refers to a Type I decision error as one where "one has incorrectly rejected the baseline condition (null hypothesis)." *Guidance for the Data Quality Objectives Process* (EPA 1994) defines a False Positive Decision Error as one where "the null hypothesis is rejected when it is true" and goes on to state that "A statistician usually refers to the false positive error as a "Type I" error." Following these guidance documents, the text in the document appears to be correct in meaning. The null hypothesis remains, in this case, as the site is contaminated until shown not to be [*Soil Screening Guidance* (EPA 1996)] and thus a Type I decision error would be a decision that the site is not contaminated when it is. The text has been revised to use the nomenclature of Type I and Type II errors for clarity.
8	p. 2-2, ¶ 2	If DNAPLs are found to be likely at the site, a 750-foot monitoring well should probably not be the first well installed. As stated earlier, any deep wells should be sampled iteratively with depth to identify the zones containing groundwater contamination. Jumping to a 750-foot well is likely to be overly aggressive and may create an unnecessary vertical conduit.	This is a typographical error and was meant to read 75 ft not 750 ft. Refer also to the response to general comment #1.
9	Page 2-11, Sampling Monitoring Wells	The stabilization criteria provided to indicate the completion of development may be overly stringent. While monitoring these parameters is a good idea, some flexibility should be built in to the plan in the event that one or two of the parameters don't stabilize to within the prescribe criteria. For example, if bailing is used to surge the well and remove fines, Eh and dissolved oxygen levels may be quite erratic. The goal of development should be to minimize turbidity and stabilize water quality over several cycles of development. A recent EPA guidance on Low Flow Sampling that outlines recommended low flow sampling procedures is enclosed.	The text has been revised to state that development will be considered complete when turbidity is minimized (± 10 percent over 3 successive samples) and water quality parameters are stabilized (pH ± 0.1 and conductivity ± 10 percent over 3 successive samples.

150137

FINAL
DOE/OR/21950-1020

GROUNDWATER SAMPLING AND ANALYSIS PLAN FOR THE MAYWOOD SITE

MAYWOOD, NEW JERSEY

FEBRUARY 1997

prepared by
U.S. Department of Energy, Oak Ridge Operations Office, Formerly Utilized Sites Remedial Action Program

with technical assistance from
Science Applications International Corporation ESC-FUSRAP
under Contract No. DE-AC05-91OR21950

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
BNI	Bechtel National, Incorporated
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
°C	degrees Centigrade (Celsius)
COC	constituents of concern
CSS	Chemical Services Subcontractor
DCE	dichloroethylene
DOE	Department of Energy
DNAPL	dense non-aqueous phase liquids
DQO	data quality objective
EPA	Environmental Protection Agency
ESC	Environmental Studies Contractor
ET	Environmental Technology
FCN	Field Change Notices
FCR	Field Change Request
FE	Field Engineer
FS	Feasibility Study
ft	foot/feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GC/MS	gas chromatograph/mass spectrometer
GTSS	Geotechnical Services Subcontractor
ha	hectare(s)
HWP	Hazardous Work Permit
HQ	hazard quotient
IDW	investigation derived waste
IG	Instruction Guide
K_d	adsorption/distribution coefficient
kg	kilogram(s)
km	kilometer(s)
L	liter
μg	microgram(s)
m^3	cubic meter(s)
MCL	maximum contaminant level
MCW	Maywood Chemical Works
mg	milligram(s)
mi	mile(s)
MISS	Maywood Interim Storage Site
ml	milliliter
NJGWQS	New Jersey Groundwater Quality Standards
PCE	tetrachloroethylene
PID	photo ionization detector

ACRONYMS AND ABBREVIATIONS (Continued)

PMC	Project Management Contractor
PPE	personal protective equipment
PQL	Practical Quantitation Limit
PRG	preliminary remediation goal
QA	Quality Assurance
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RGO	Remedial Goal Option
RI	Remedial Investigation
SAFER	streamlined approach for environmental restoration
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SOP	standard operating procedure
SS	Site Superintendent
SSHR	Site Safety and Health Representative
SVOC	semi-volatile organic compounds
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
VOC	volatile organic compounds
WI	Work Instruction
yd^3	cubic yard(s)
U. S.	United States

1.0 INTRODUCTION

The site under investigation is located in Maywood, New Jersey (Figure 1-1). The site is comprised of the Maywood Interim Storage Site (MISS) and 85 neighboring properties that are collectively known as the Maywood site. The purpose of this document is to present an environmental sampling program that is designed to complete the characterization of groundwater and surface water at the Maywood Site. The Data Quality Objectives (DQOs) process from the United States (U. S.) Department of Energy's (DOE's) Streamlined Approach for Environmental Restoration (SAFER) and from the U. S. Environmental Protection Agency (EPA) have been combined in the development of this sampling and analysis plan (SAP).

Volatile organic compounds (VOCs) and some metals occur in groundwater at MISS, Ballod, and in residential areas downgradient of MISS that may be derived from past activities at Maywood. The former retention ponds that are located on MISS and Ballod properties have been identified as possible sources for groundwater constituents of concern (COCs) (BNI 1992a).

For onsite areas (Maywood and Ballod), the nature and extent of COCs in groundwater are characterized sufficiently. However, the nature and extent of VOCs in soils onsite are not characterized sufficiently to determine if these sites are likely sources of VOCs in groundwater. The nature and extent of VOCs and some metals in groundwater downgradient of these sites are also not known.

The Maywood site, known as the Maywood Chemical Works (MCW) on the National Priority List (NPL), is being addressed through two separate Remedial Investigation/Feasibility Study (RI/FS) reports. The RI/FS process evaluates the conditions at the site and evaluates possible cleanup alternatives. DOE is responsible for addressing those radioactive and nonradioactive contaminants associated with former thorium processing operations and are defined as Formerly Utilized Sites Remedial Action Program (FUSRAP) waste. The Stepan Company, which is situated on a portion of the former MCW property, is performing an RI/FS focusing on chemical contamination under both an administrative order of consent (EPA 1987a) and a unilateral administrative order (EPA 1991a). The Stepan Company is responsible for addressing nonradioactive chemical contaminants at Stepan Company, Sears, and adjacent properties that are not associated with past thorium processing operations. Although DOE and Stepan RI/FS activities are being conducted independently, the EPA oversight of both actions will ensure that sufficient coordination occurs between DOE and the Stepan Company to fully address the Maywood site.

A detailed site evaluation has already been completed at the Maywood site, and soil and groundwater COCs have been extensively characterized (BNI 1992a). The following conclusions about COCs in groundwater can be made:

- The distribution and migration of chemical COCs in groundwater at MISS can be explained by a relatively simple conceptual model. Essentially, COCs that are easily

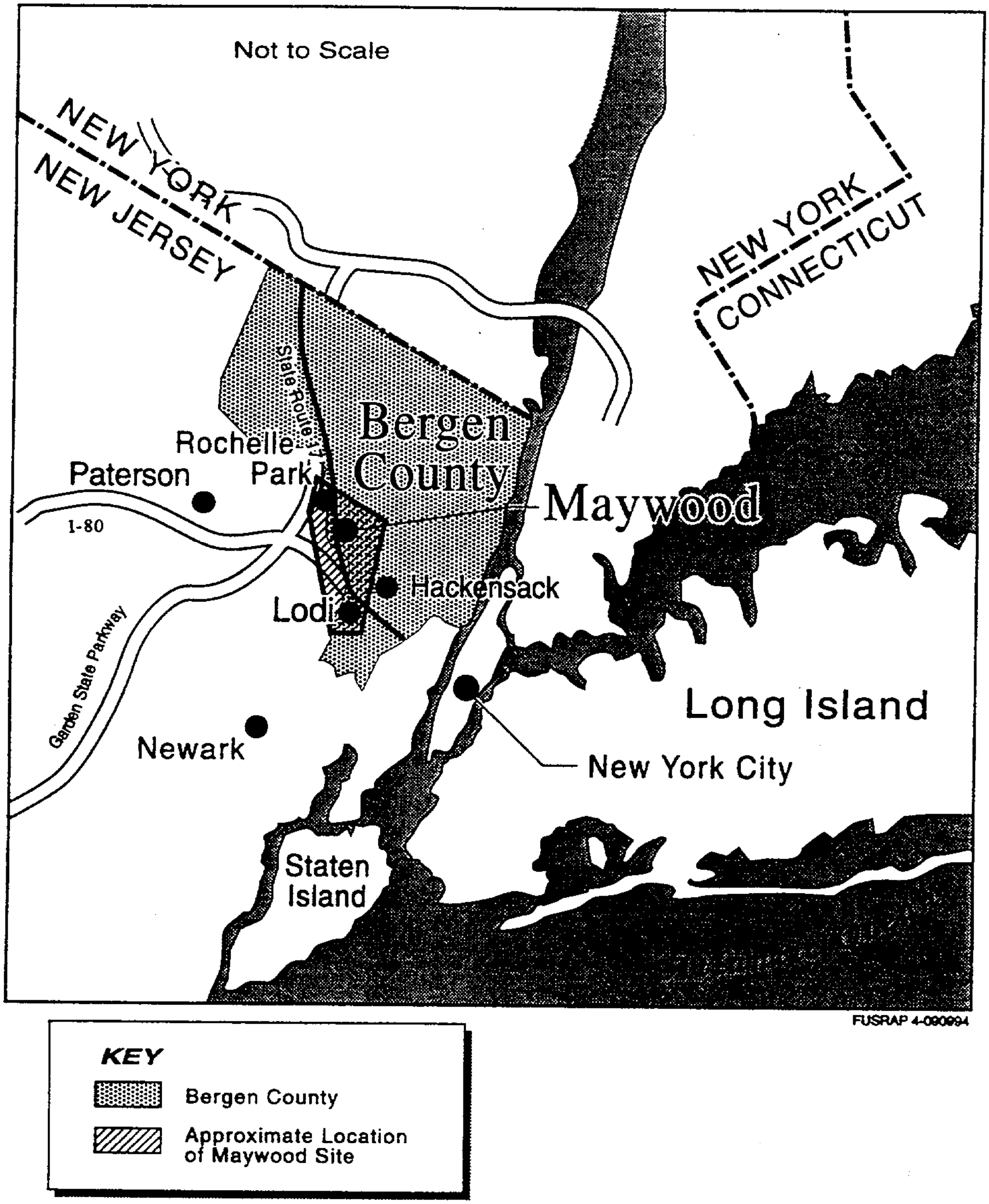


Figure 1-1. Location of Maywood, New Jersey

retarded have remained close to the potential sources (i.e., the retention ponds) and those that are not easily retarded have migrated away from the sources and now occur as COCs in groundwater in bedrock. Based on the conceptual model for groundwater flow presented in the RI Report (BNI 1992a), groundwater in bedrock west of the hydraulic divide that separates Westerly Brook water shed from Lodi Brook water shed, moves west from the Maywood site towards the Saddle River. It is anticipated that the Saddle River is a groundwater discharge zone and that, if COCs in bedrock groundwater derived from the Maywood site have reached this far west, they will discharge to the Saddle River.

- Radioactive COCs occurring in soil have not been detected in groundwater except for one well located to the east of the Sears property. There are no known radioactive COCs for groundwater.

- Easily retarded groundwater COCs that occur above Safe Drinking Water Act (SDWA) maximum containment levels (MCLs) are chromium, arsenic, and lead; these chemicals occur in groundwater close to the former retention ponds in the overburden but have not migrated to bedrock groundwater.

- Mobile groundwater COCs that exceed MCLs are manganese and VOCs. In addition, lithium occurs in elevated concentrations in groundwater at MISS. These chemicals have migrated from overburden groundwater into bedrock. Manganese exceeds MCLs in most bedrock wells, but this is attributed to natural phenomena. Lithium can be attributed to sources on MISS. Groundwater containing VOCs occurs beneath both MISS and Ballod. However, a source for these chemicals on MISS or ballod has not been defined.

- The extent of VOC and lithium contamination downgradient of Ballod has not been defined. Based on the hydrogeological conceptual model in the RI, the fate of mobile COCs (such as VOCs) in groundwater is likely to be downgradient transport in bedrock followed by discharge to Westerly Brook or the Saddle River.

Based on the conceptual model for contaminant fate and transport presented in the RI, the following data gaps remain for characterization of groundwater COCs at the Maywood Site: (1) the nature and extent of VOCs in soil on the MISS and Ballod properties, and (2) the extent of VOCs and potentially mobile metals (lithium and arsenic) in groundwater downgradient of MISS and Ballod. The focus of this investigation is, therefore, determining the potential for sources of COCs on MISS and Ballod and defining the distribution and migration of these COCs in groundwater, specifically VOCs, lithium, and arsenic at both the Maywood site and at neighboring properties downgradient of the site.

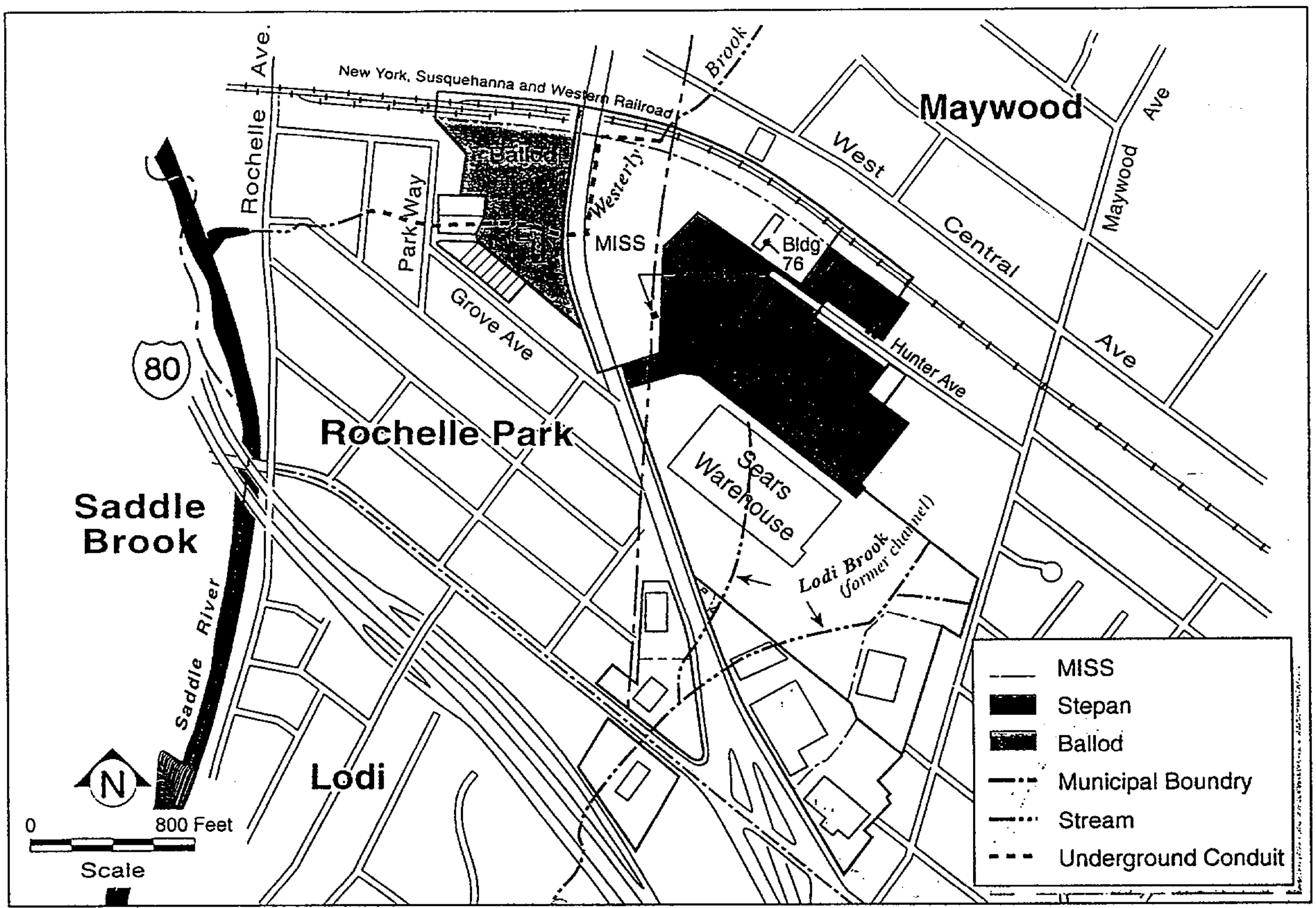
The following section provides background information about the Maywood site; summarizes what is known about the nature and extent of COCs considered as the focus of this particular investigation; identifies the purpose and scope of this investigation; discusses DOE's SAFER and how this approach will be implemented; and outlines the DQOs.

1.1 SITE BACKGROUND

The Maywood site is located in Bergen County, New Jersey approximately 20 kilometers (km) [12 miles (mi)] north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey (Figures 1-1 and 1-2). MCW was constructed in 1895. In 1916, the plant began extracting thorium and rare earths from monazite sand for use in manufacturing industrial products such as mantles for gas lanterns. The production of mantle-grade thorium nitrate was involved in the manufacturing process (Harris 1951). MCW also produced lithium compounds such as lithium hydroxide and lithium chloride (NRC 1981), rare earths, detergents, alkaloids, and essential oils in other process operations. In 1954, the Atomic Energy Commission (AEC) issued License R-103 to MCW, allowing it to continue to possess and distribute radioactive materials under the authority of the Atomic Energy Act of 1954. MCW stopped processing thorium in 1956 after approximately 40 years of production (BNI 1987a). The property was sold to the Stepan Company in 1959; the Stepan Company has never processed radioactive materials (BNI 1992a).

Recoverable wastes from thorium processing operations were stored in an unsheltered phosphate pile that was located between buildings in the main yard. Unrecoverable wastes from thorium processing operations (i.e., residues and tailings) were piped to a large pile on the perimeter of the MCW property (Cole et al. 1981). The pile, containing several tons of waste slurry, was surrounded by two earthen dikes (or retention ponds) west of the plant but remained exposed to weather (AEC 1957). In 1932, the disposal areas were separated from the plant and partially covered by the construction of New Jersey State Highway 17 (Figure 1-3). Lithium wastes were also believed to have been disposed of in the diked areas on the MCW site. MCW also reportedly placed waste from other process operations in the former retention ponds. A photographic analysis of the former MCW, published by EPA (Mata 1984), specifically identified areas of standing liquids, mounds of material, bare or graded ground, drums, tanks, and other features that could, potentially, represent sources of COCs. These data were also used to delineate boundaries of the retention ponds where little or no subsurface data were available. Subsurface radiological and geologic data collected from borings installed during the RI (BNI 1987a and BNI 1992a) indicate retention ponds were located on what is currently the MISS, Sears Distribution Center, and Ballod properties (Figure 1-3).

Six retention ponds were constructed between 1940 and 1983 (Figure 1-3). The earliest photograph, taken in 1940, shows that two retention ponds (D and E), located on what is now the Ballod property, and pond C, located on what is now the DOE-owned MISS property, were active. By 1951, photographs indicate that ponds D and E on the Ballod property were not in use. Pond C (MISS) was still in use and had been slightly enlarged. Photographs show that ponds A and B had been constructed and were in use by 1951. By 1954, ponds D and E on the



Base Map Source: USGS 7.5 Minute Hackensack, N.J. Topographic Map

FUS Maywood 091996

Fig. 1-2 Location of MISS, Ballod, and Stepan Properties of Maywood

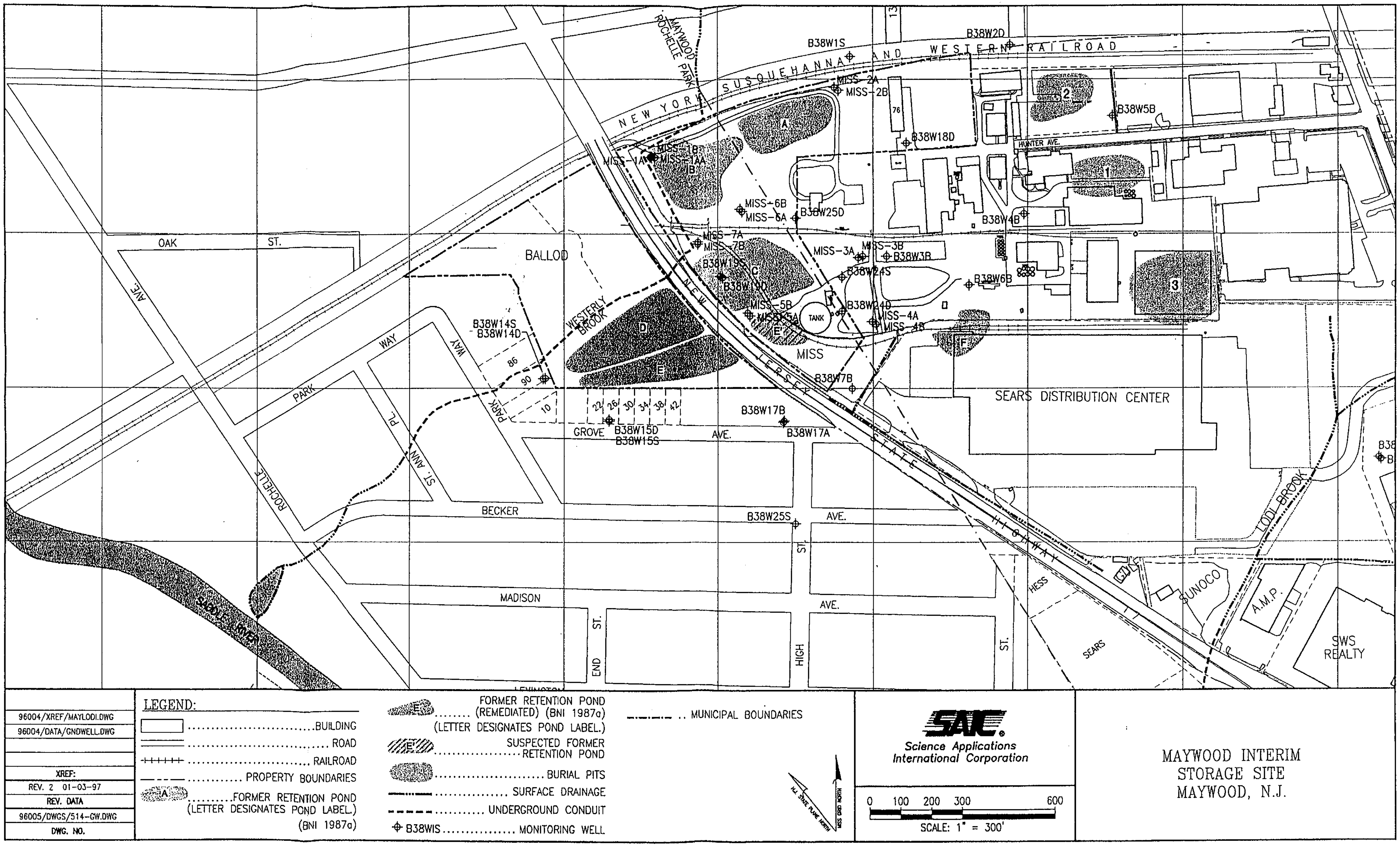


Figure 1-3. Location of Former Retention Ponds, Burial Pits and Groundwater Monitoring Wells at the Maywood Site

Ballod property showed indications of revegetation. Ponds A and C (on MISS) were still active, and pond B had been enlarged to nearly its maximum extent. Pond F on the northern portion of the Sears Distribution Center property had been constructed and appeared to contain standing liquids (BNI 1992a).

Disposal of liquids apparently ceased by 1965, and all of the retention ponds appeared in various stages of revegetation. Based on a 1970 photograph, the outlines of the retention ponds were barely visible at MISS. Pond D at the Ballod property had been cleared and was visible as bare earth. By 1974, all activity associated with the ponds had ceased, and the outlines of the retention berms were obscured by vegetation or disposal of solid materials (BNI 1992a).

In 1966, 6,400 cubic meters (m^3) [8,400 cubic yards (yd^3)] of residues and tailings were removed from the property west of Route 17 (Ballod), and placed in burial pit 1 on the Stepan property. In 1976, an additional 1,600 m^3 (2,100 yd^3) of material was removed from the same general area and placed in burial pit 2 on the Stepan property. Finally, in 1968, the Stepan Company excavated another 6,600 m^3 (8,600 yd^3) from the south end of the Ballod property and placed it in burial pit 3, also on the Stepan Property. This material was estimated to contain 16,300 kg (36,000 kilograms (kg) [36,000 pounds (lb)] of thorium material with an associated Th-232 activity concentration of 270 pCi/g (BNI 1992a).

During a subsequent removal action conducted by DOE in 1984 and 1985, most of the radioactive material from the former retention pond locations on the Ballod property was excavated and placed in an interim storage pile on MISS (BNI 1986b). The principle COCs in the former retention ponds are radionuclides. Other chemical constituents may be present, assuming that wastes from other MCW operations were placed in the ponds (BNI 1992a). Chemical constituents such as VOCs and metals have been identified in soils and groundwater at MISS (BNI 1986a, BNI 1987b, BNI 1989a, BNI 1992a, Ebasco 1987, Ebasco 1988). In addition, VOCs, in particular tetrachloroethylene (PCE) and the biological breakdown products of PCE [trichloroethylene (TCE), 1,2-dichloroethylene (DCE) 1,1-DCE, and vinyl chloride) have been identified in groundwater downgradient of MISS on the western edge of the Ballod property.

1.2 SITE DESCRIPTION

MISS is a 4.7-hectare (ha) (11.7-acre) fenced area that was once part of the original MCW property. DOE obtained the property from the Stepan Company in 1985. Currently, MISS contains two buildings (Building 76 and a pumphouse), temporary office trailers, a reservoir, and two rail spurs (Figures 1-2 and 1-4). It is bounded on the west by Route 17; on the north by a New York, Susquehanna, and Western Railroad line; and on the south and east by commercial and industrial properties (Figure 1-2). Residential properties are located north of the railroad line, within 275 m [300 yd] of MISS. The natural topography is generally flat, ranging from approximately 15 to 20 m (50 to 60 feet (ft)] above mean sea level. The highest elevations occur in the northeastern portion of the property. Small mounds and ditches, the result of process waste disposal by MCW, are present across the site (BNI 1992a).

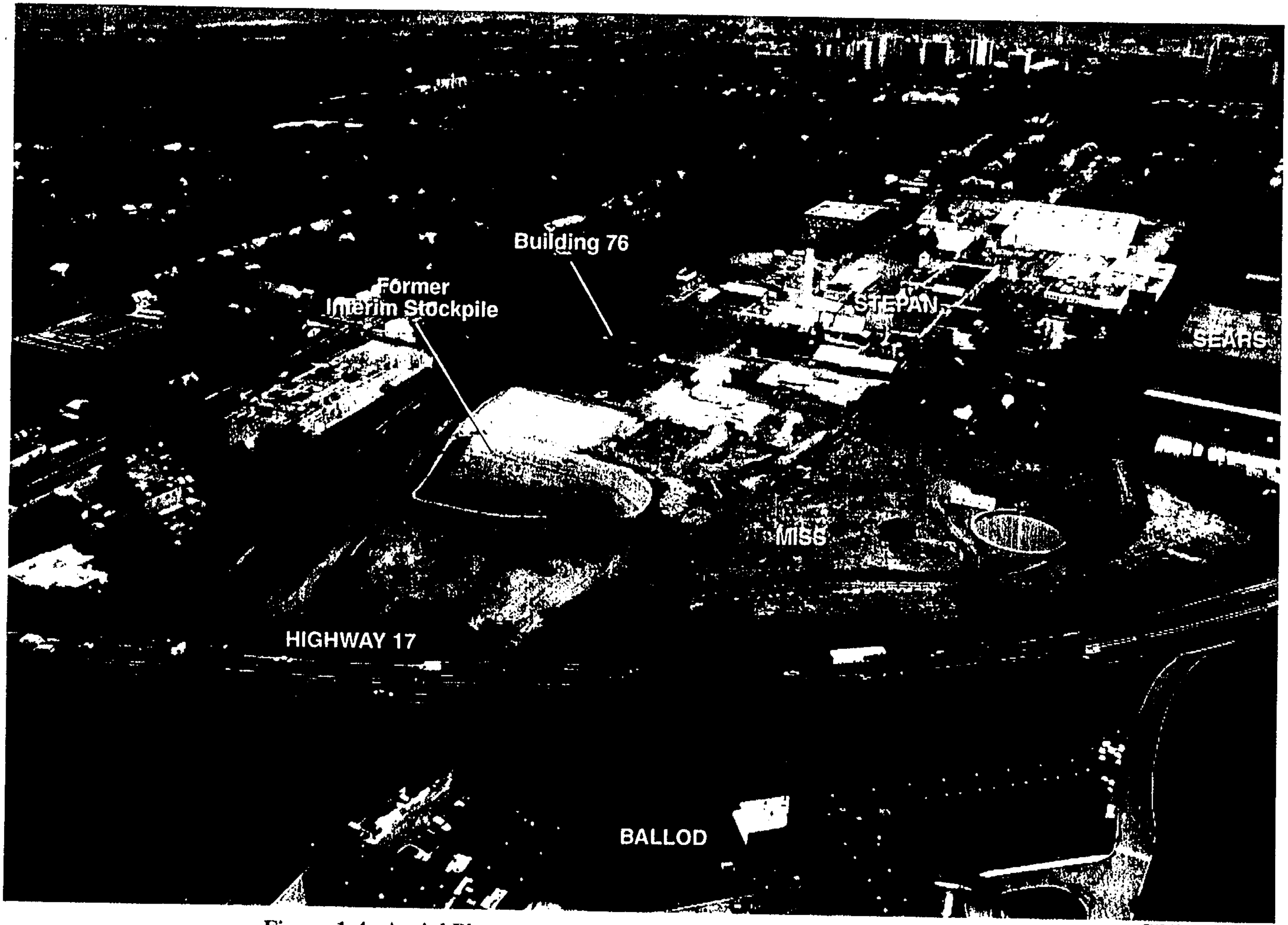


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Figure 1-4. Aerial Photograph of the Maywood Site Facing Approximately NE
(In center front of photograph are the Ballod Property and Highway 17. Behind Highway 17 are the MISS and Stepan properties. Part of the Sears Distribution Center is visible right of the Stepan property. Note: Since this photograph was taken, the storage pile has been removed.)

The interim storage pile at MISS at one time occupied approximately 0.8 ha (2 acres) and contained approximately 27,000 m^3 (35,000 yd^3) of soils and materials containing radiological COCs from removal actions conducted on vicinity properties and from remediation of the Ballod property (Figure 1-3). The interim storage pile was completely removed for disposal offsite in 1996.

1.3 PREVIOUS INVESTIGATIONS AND CURRENT SITE CONDITIONS

1.3.1 Previous Investigations

Data from the site evaluation, RI Report (BNI 1992a), and DOE's routine environmental surveillance (BNI 1994a, BNI 1995a, and BNI 1996b) were reviewed to develop an understanding of the nature and extent of VOCs and metals in the soil and groundwater at MISS. Almost all of the historical investigations have gathered data concerning the nature and extent of radiological COCs at the site and these radiological COCs are adequately characterized in soil and groundwater. For MISS and Ballod, the nature and extent of VOCs, metals, and radionuclides in groundwater is adequately characterized. However, the nature and extent of VOCs in soils onsite is not completely characterized, and the nature and extent of VOCs and lithium in downgradient groundwater is not known.

1.3.2 Current Site Conditions

The presence of chemical constituents at MISS has been suspected because the site was once part of the original MCW. Under the Federal Facilities Agreement negotiated between DOE and the EPA Region II office, DOE is responsible for cleanup of FUSRAP waste which is all radioactive and chemical contamination, whether commingled or not, occurring on the DOE-owned MISS; all radioactive contamination associated with thorium manufacturing or processing that is associated with MCW or originated from MISS; and commingled radioactive and chemical contamination related to processing at MCW or originating from MISS. Since DOE is the owner of the MISS facility and responsible for all contamination related to this property, only limited chemical sampling was performed during DOE's 1986 initial radiological characterization of MISS (BNI 1987a). Additional chemical sampling was performed for the RI (BNI 1992a); however, because groundwater contamination had not been fully assessed, VOC sources were not specifically targeted. In addition to soil sampling, the environmental surveillance program was initiated in 1985 to annually collect and analyze groundwater and surface water samples for VOCs, semi-volatile organic compounds (SVOCs), metals, and radiological constituents (BNI 1994a, BNI 1995a, and BNI 1996b).

1.3.2.1 Soils

VOCs

The thirty-four borehole locations for the MISS onsite chemical sampling program are shown in Figure 1-5 (also refer to the Maywood RI Report, Table 4-18). From these borings, a total of seventy-three soil samples were collected and analyzed for VOCs. The analytical results are summarized in Table 1-1. Sampling depths ranged from near surface [0 to 0.6 m (0

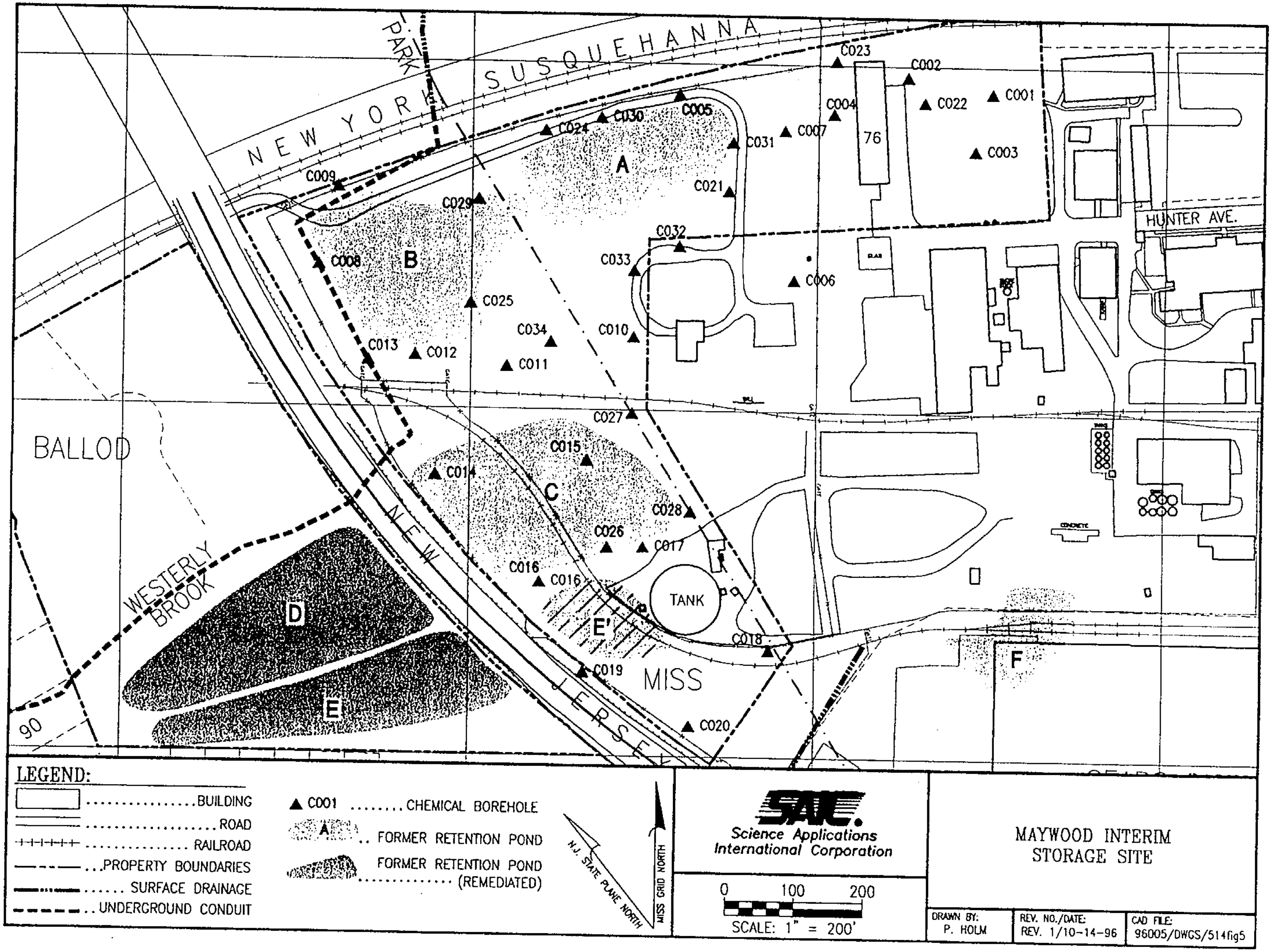

Figure 1-5. Location of Chemical Boreholes on MISS

Table 1-1. Summary of VOC Concentrations in Soil, MISS Onsite

Constituent	Times Detected[a]	Concentration Range (μg/kg)	Quantitation Limit Range (μg/kg)	Mean Baseline Concentration (μg/kg)	Occurrences Above Mean Baseline	Total Above-Baseline in Rad. Area / Total Above-Baseline (percent)	Percentage of Detections Above Mean Baseline
1,1,1-Trichloroethane	2	3-5	6-12	6.3	0	0	0
2-butanone	9	3-170	11-23	12.0	4	25	5
Acrolein	2	8-12	11-23	12.3	0	0	0
Carbon disulfide	13	1-29	6-20	6.3	3	67	3
Toluene	21	1-160	6-12	4.8	10	60	14
Xylenes (total)	4	2-4	6-12	6.3	0	0	0
Chloromethane	1	1-9	11-23	12.3	0	0	0
Benzene	2	2-21	6-12	6.3	1	0	1
Acrylonitrile	1	6	11-23	12.3	0	0	0
1,2-DCE (total)	1	2	6-12	6.3	0	0	0
TCE	3	1-5	6-12	6.3	0	0	0

Concentration units - μg/kg

[a] Data include results that are unqualified and those that are estimated. Total number of samples analyzed = 73.

Source: BNI 1992a

to 2 ft)] to a maximum of 6.6 m (21.5 ft) in borehole C004. Eleven VOCs were detected; four compounds were found at concentrations above mean reference baseline: benzene, 2-butanone, carbon disulfide, and toluene. Toluene was detected with the greatest frequency (10 out of 73 samples) (BNI 1992a). PCE, the main VOC COC for groundwater, has not been detected in soils.

The coexistence of VOCs with areas and intervals of potential radioactive constituents was evaluated during this investigation by comparing the chemical data with gamma log results from the same borehole. In general, the low concentrations of VOCs onsite were detected both with radioactive COCs and non-radioactive COCs (BNI 1992a). The low frequency of detection and low concentrations found at MISS could be a result of sampling locations that were targeted more for defining radiological COCs, or that VOCs were not residually present in the soils.

Metals

Seventy soil samples from the thirty-four boreholes were analyzed for metals. Twenty-three metals were detected; twenty-two were detected above background. A summary of the metals data for MISS soil with comparison to background data is shown in Table 1-2. Most of the metals occur within a parcel that extends from an area east of Building 76 (represented by boreholes C001, C003, and C022) to an area west of the storage pile (roughly represented by boreholes C025 and C029). Several boreholes that are peripheral to the storage pile (C031, C010, C006, and C029) and to the east of Building 76 (boreholes C001, C003, and C022) exhibited some of the highest concentrations of metals. These wells also contain some of the highest concentrations of radiological COCs in soils. Arsenic, chromium, copper, lead, lithium, and nickel were detected at least once at levels an order of magnitude above measured background (Table 1-2). These metals also occurred at concentrations above measured background in a second, smaller area, represented by boreholes C026, C027, and C028, south of the storage pile (Figure 1-5). Lithium is associated with lithium wastes that are known to have been buried onsite. The extent of lithium in soils is widespread across the site as shown in Figure 1-6 (BNI 1992a).

The coexistence of metals with radiological constituents was evaluated by the collection of chemical soil samples from areas of known radiological COCs, based on a gamma log survey. Only lead and selenium were detected frequently in areas associated with radiological COCs.

In summary, the presence of certain metals at MISS is possibly associated with the processing of monazite sands and disposal of lithium wastes at MCW. Most of the metal COCs were found in an area extending east of Building 76 and west of the storage pile. Only limited correlation between the detection of specific metals and specific areas and depth intervals of radioactive COCs were found.

1.3.2.2 Groundwater

The distribution and migration of COCs in groundwater at MISS and Ballod can be explained by a relatively simple conceptual model. Essentially, COCs that are easily retarded have remained close to the potential sources (e.g., the retention ponds) and those that are not easily retarded have migrated away from the sources and now occur as COCs in groundwater

Table 1-2. Summary of Metal Concentrations in Soil, MISS Onsite

Constituent	Times Detected[a]	Concentration Range (μg/kg)	Detection Limit Range (μg/kg)	Mean Background Concentration[b] (μg/kg)	Occurrences Above Mean Background	Above-Background in Rad. Areas / Total Above-Background (percent)	Total Above-Background (percent)
Aluminum	60	1,260-55,700	ND[c]	7,448	11	18	16
Antimony	12	3.0-30.3	3.0-7.6	4.7	8	50	11
Arsenic	69	0.52-1,060	ND	3.3	32	31	47
Barium	70	15.3-310	ND	44.6	39	33	56
Beryllium	66	0.10-5.3	0.189-0.64	0.56	14	14	20
Boron	5	23.7-114	15.2-31.2	23.6	5	20	7
Cadmium	5	0.97-2.3	0.46-1.70	0.71	5	40	7
Calcium	70	507-216,000	ND	1,210	58	33	83
Chromium	51	1.0-1,510	0.85-0.98	12.8	35	34	50
Cobalt	62	1.0-269	1.3-1.8	7.6	8	50	11
Copper	62	3.0-224	ND	17.9	38	39	54
Iron	66	381-35,400	ND	14,448	2	50	3
Lead	60	2.2-580	ND	39	28	36	40
Lithium	37	17.4-2,290	15.2-25.5	23.6	32	19	46
Magnesium	70	137-6,500	ND	1,841	10	30	14
Manganese	67	11.4-588	ND	466	1	100	1
Nickel	70	2.8-135	ND	8/8	26	27	37
Potassium	66	167-1,690	144-276	405	39	21	56
Selenium	15	0.41-3.40	0.29-7.3	0.45	13	54	19
Silver	27	0.84-2.8	0.69-3.6	3.6	0	0	0
Sodium	69	33.3-28,300	19	62.2	61	33	87
Vanadium	65	1.8-30.6	0.83-9.7	20.2	4	75	6
Zinc	47	13.1-491	ND	50.5	22	32	31

Concentration units - μg/kg

[a] Data include results that are unqualified and those that are estimated. Total number of samples ananlyzed = 70.

[b] Where a constituent was nondetectabe, the minimum detection limit was reported, and the detection limit was factored into the determination of the mean background concentration. Background concentrations were determined by analysis of samples from four locations judged representative of background conditions for the Maywood Site.

[c] ND - No data; no detection limits reported.

Note-Metals not listed were not detected.

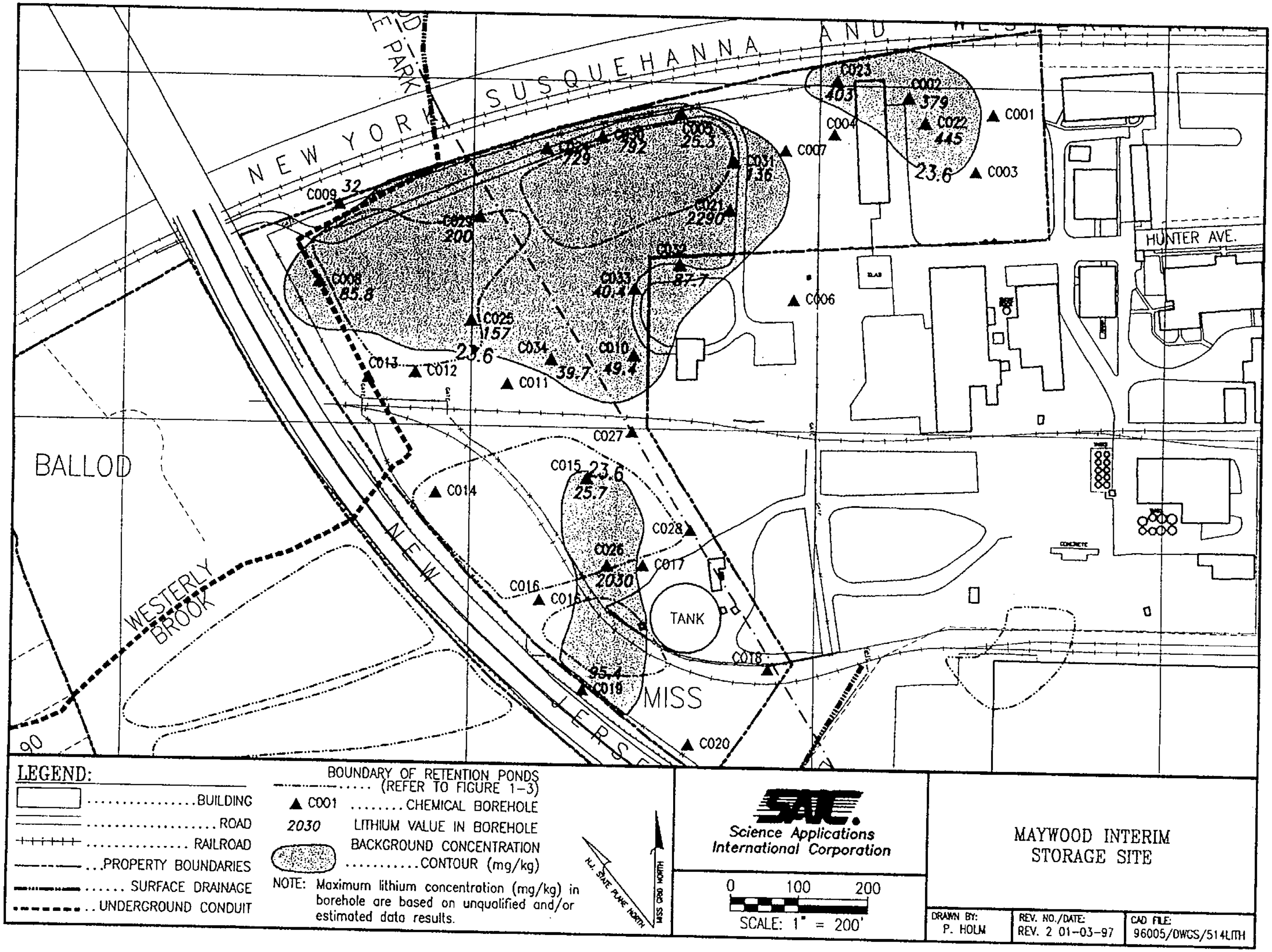

Figure 1-6. Total Lithium in Soils at MISS

in both the overburden and bedrock aquifers. Based on the conceptual model for groundwater flow presented in the RI Report (BNI 1992a), groundwater in bedrock west of the hydraulic divide that separates Westerly Brook water shed and the Lodi Brook water shed, moves west from MISS towards the Saddle River. It is anticipated that the Saddle River is a groundwater discharge zone and that, if COCs in bedrock groundwater derived from the Maywood site have reached this far west, they will discharge to the Saddle River.

Easily retarded groundwater COCs that occur above SDWA MCLs are chromium, arsenic, and lead; and these chemicals occur in groundwater close to the former retention ponds in the overburden but have not migrated to bedrock groundwater (Figure 1-7). In addition, arsenic, an element that is usually mobile, exceeds SDWA MCLs only in the overburden groundwater close to the former ponds. This implies that arsenic is retarded at MISS. Mobile chemicals that exceed MCLs are lithium, boron, and VOCs; these chemicals have migrated from retention ponds into the bedrock groundwater (Figures 1-7 and 1-8).

Figure 1-3 shows the distribution of groundwater monitoring wells at MISS. Figures 1-9 through 1-12 present results of groundwater monitoring. Tables 1-3 and 1-4 presents the results of the most recently reported data from groundwater monitoring in May 1995. The following information is also based on the conclusions of the RI (BNI 1992a) and subsequent groundwater monitoring (BNI 1994a, BNI 1995a, and BNI 1996b).

VOCs

PCE is the main VOC COC and is generally mobile in the absence of organic matter in the soil. PCE occurs primarily in bedrock wells, MISS-1B, -4B, -5B, -7B, B3814D, B3815D, and in shallow wells B3814S, B3815S, and MISS-7A located west of the hydraulic divide that separates Westerly Brook from Lodi Brook (Figure 1-9). In general, concentrations of VOCs have increased since the introduction of low flow sampling in 1994. This would be expected, and the results are probably more representative of true groundwater concentrations, as this method causes less turbulence in the groundwater during sampling. With the exception of MISS 5B, the VOC suite is composed of PCE and its breakdown products, TCE, and vinyl chloride. In only one sample in 1995 (B38W14D) was the concentration of PCE greater than 1 percent of solubility (Table 1-5) which may indicate the presence of DNAPL containing PCE. Benzene, toluene, ethylbenzene, and xylene (BTEX) COCs occur in MISS-5B; however, the concentrations are low (83 micrograms per liter (μg/L) to 170 μg/L).

VOCs at MISS were detected in the bedrock wells and further downgradient (Ballod property) in both bedrock and overburden wells. The presence of VOCs in shallow groundwater may be related to the former ponds on Ballod or transport of VOCs from upgradient sources in the bedrock then into the shallow groundwater with ultimate discharge to surface water (Figure 1-8). Surface water from Westerly Brook had low concentrations of PCE breakdown products.

The wells with the highest concentrations of PCE are located the furthest downgradient and sources for these COCs on MISS and/or Ballod have not been defined. The extent of the PCE concentrations downgradient from MISS and Ballod has not been defined. The RI's site conceptual model for groundwater flow at MISS includes flow in the bedrock aquifer towards

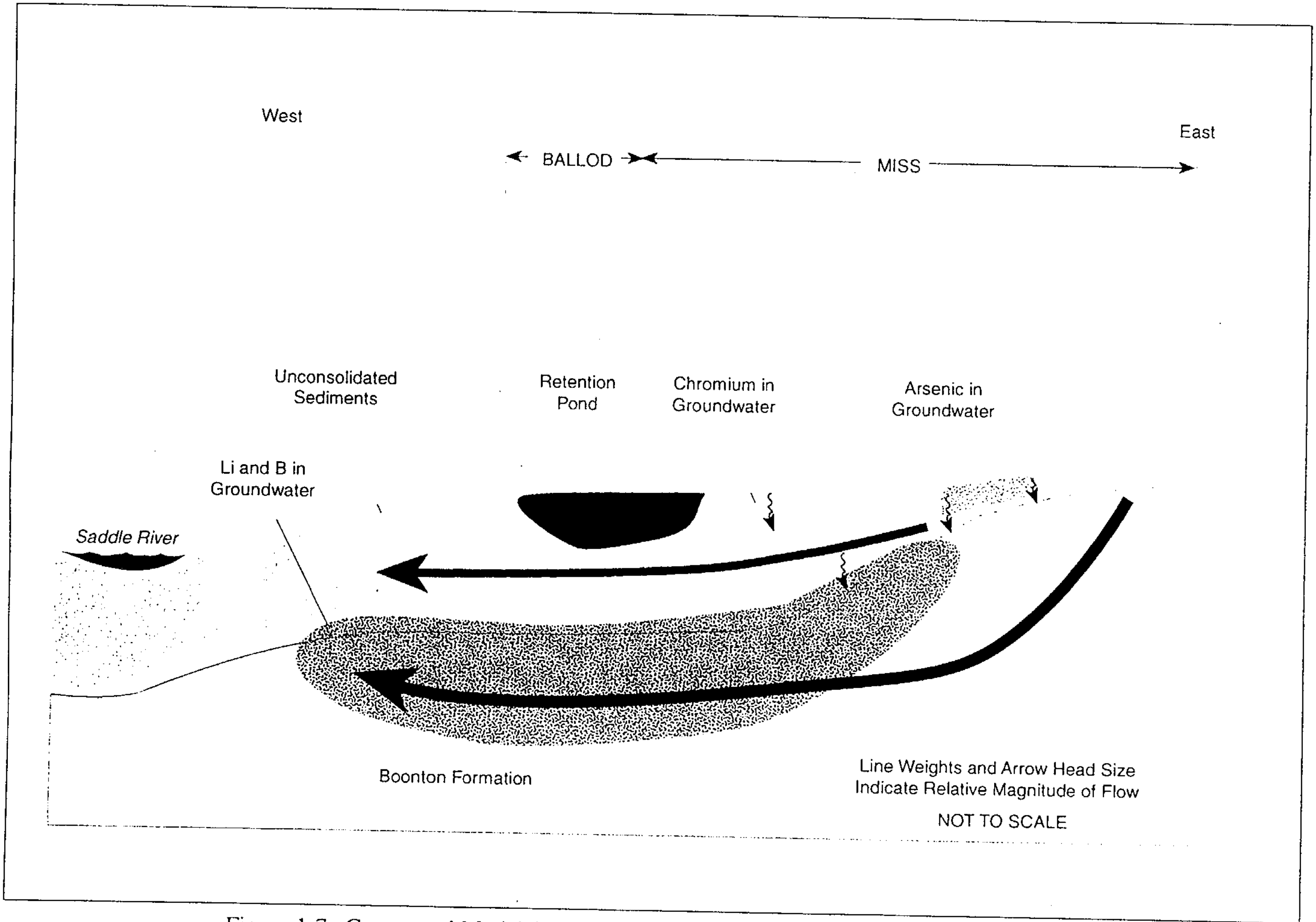

Figure 1-7. Conceptual Model for Metal Occurence in Groundwater at MISS and Ballod

FUS Mayw'd 101896 VOC

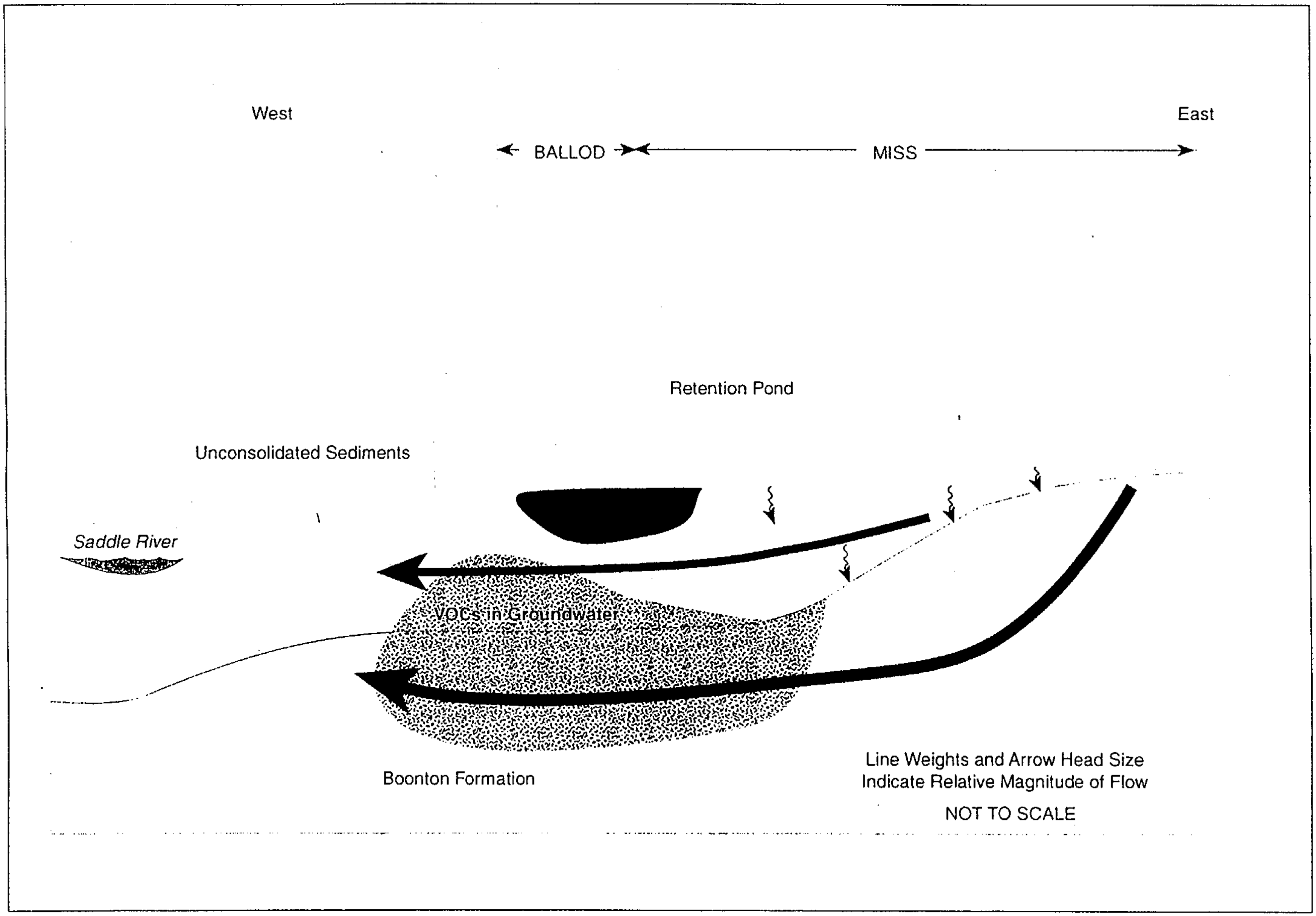

Figure 1-8. Conceptual Model for VOC Occurence in Groundwater at MISS and Ballod

FUS Mayw'd 091796 VOC

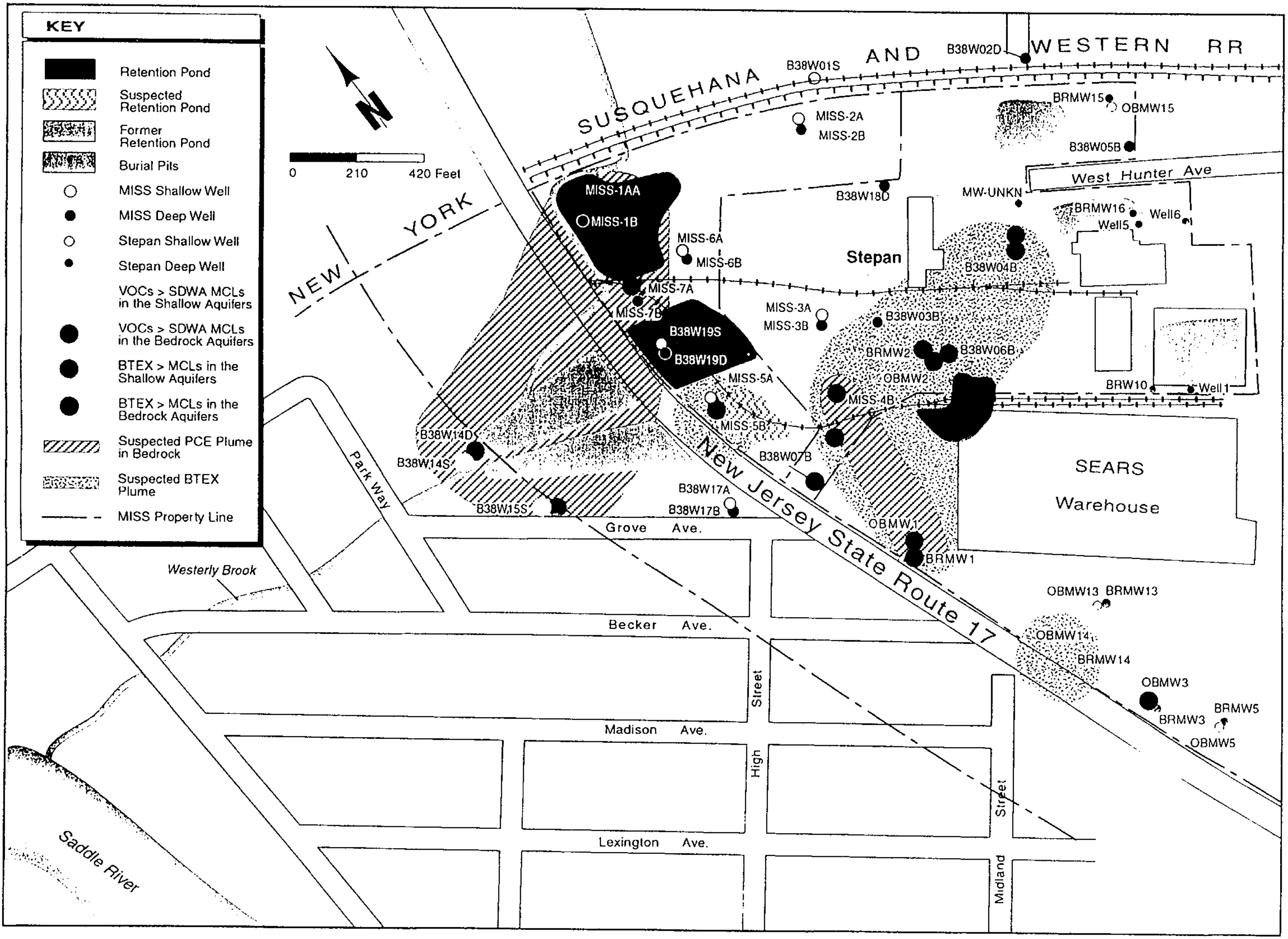

Figure 1-9. VOC Occurrence in Groundwater at Maywood (Shallow and Deep Differentiated)

FUS-Maywd GW 101896

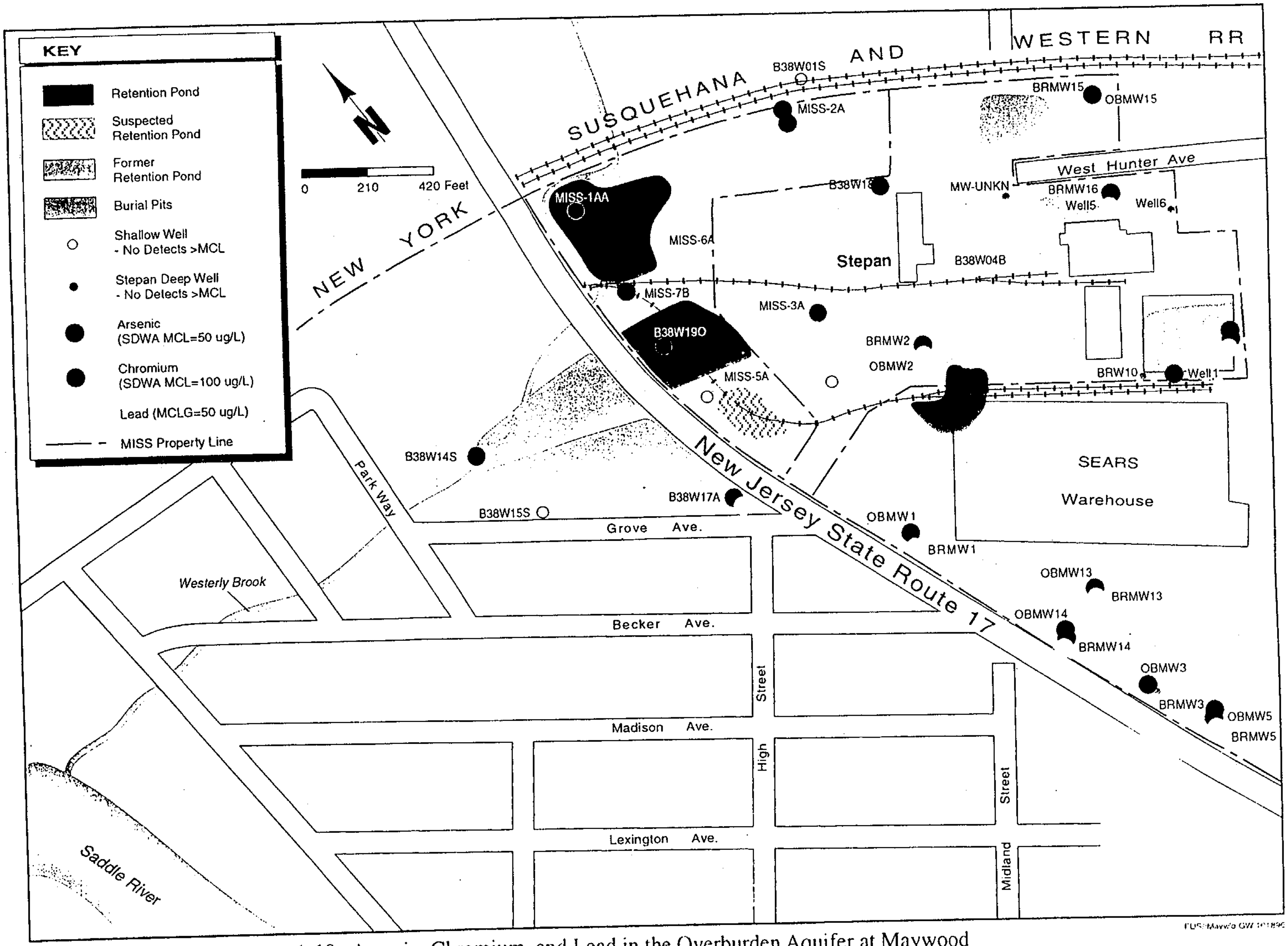

Figure 1-10. Arsenic, Chromium, and Lead in the Overburden Aquifer at Maywood

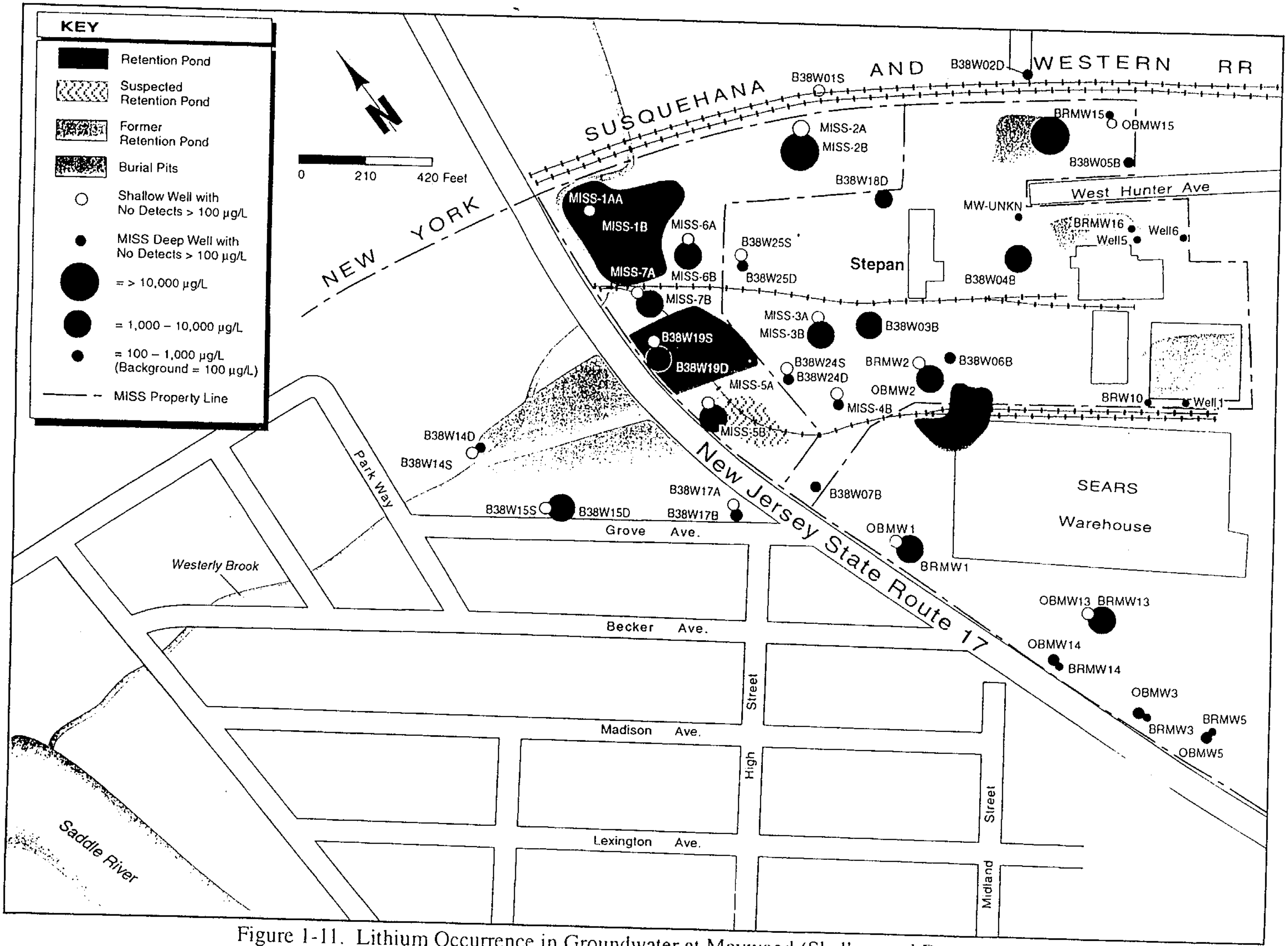

Figure 1-11. Lithium Occurrence in Groundwater at Maywood (Shallow and Deep)

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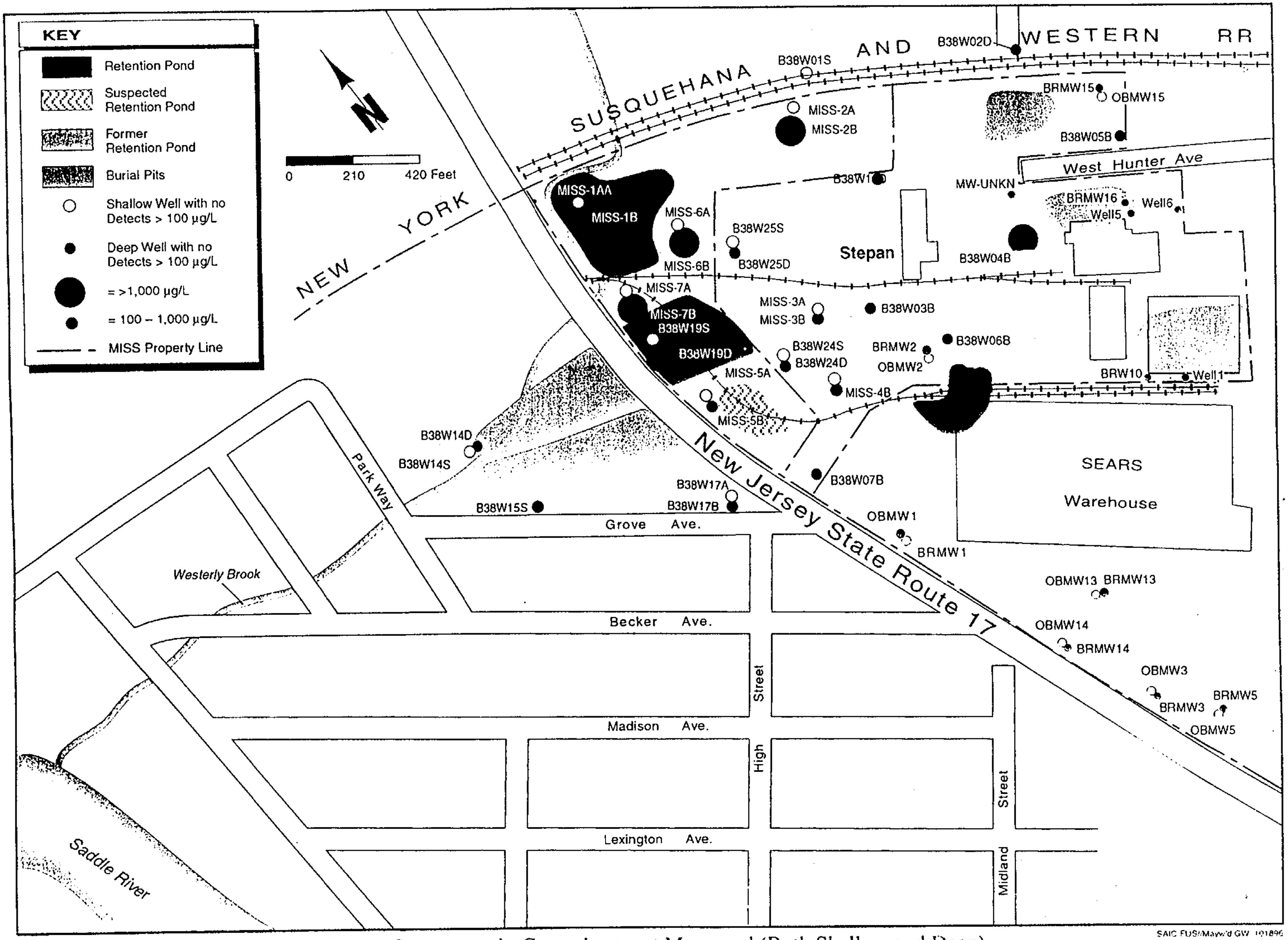


Figure 1-12. Boron Occurrence in Groundwater at Maywood (Both Shallow and Deep)

Table 1-3. Summary of VOC Concentrations in Groundwater at the Maywood Site

Analyte	B38W14D	B38W14S	B38W15D	B38W15S	B38W15S dup	B38W17B	B38W18D	B38W19D	B38W24D	B38W24S	B38W25S dup	MISS01B	MISS02B	MISS05B	MISS07B
1,1,1-Trichloroethane	6	7	7												
1,1-Dichloroethane	4	2	6	4	4										
1,1-Dichloroethene	7	7	9									3			2
1,2-Dichloroethene (total)	93	53	160	6	10										8
1,2-Dichloropropane	1			(J)		2 (J)									
4-Methyl-2-pentanone														2 (J)	
Acetone	4 (J)			6		8 (J)	6		7 (J)	6 (J)			4 (J)		
Benzene								1			12		1	89 (J)	
Chloroform		3													
Tetrachloroethene	1,100	640	1,500									20			45
Trichloroethene	250	140	270									2			3
Vinyl chloride				4	5	2 (J)									
Methylene chloride											1				

Notes:

- 1995 data only
- Values in µg/L
- J = reported as an estimated value
- *Source: BNI 1996b*

Table 1-4. Summary of Metal Concentrations in Groundwater at the Maywood Site

Analyte	B38W01S	B38W02D	B38W14D	B38W14S	B38W15D	B38W15S	B38W15S Dup	B38W17A	B38W17B
Aluminum	225	78.6	38.1	48	18	170	247	29.6	34.6
Antimony	1.5 UJ	1.5 UJ	1.5 UJ	1.5 UJ	1.5	1.5	1.5	1.5 UJ	1.5 UJ
Arsenic	1.8	1.8	1.8	1.8	1.8	4.8	4.9	1.8	1.8
Barium	13.1	298	73.6	61.6	22.3	46.1	50.9	36.4	71.8
Beryllium	3.1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Boron	444	125	108	142	338	608	566	156	382
Cadmium	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Calcium	371000	73700	77400	70800	58700 J	80500 J	75100 J	57300	223000
Chromium	4.2	4.2	4.2	35.9	4.2	4.2	4.2	56.6	4.2
Cobalt	4.7	3.3	3.3	3.3	3.3	3.3	3.3	3.3	4.6
Copper	3.1	3.1	5.7	4.1	3.1	9.3	6.4	3.1	3.1
Iron	22100	72.4	32.4	324	57.7 U	1720	1450	688	6570
Lead	1.5	1.5	2.8 J	2.9 J	1.5	2	2.4	2.8 J	1.5
Magnesium	27600	3020	19500	20000	22700 J	27700 J	25300 J	5610	22800
Manganese	2340	1240	5.3	7.9	638 J	1970 J	2170 J	55.9	4020
Molybdenum	7.1	9.7	16.6	18.1	7.1	7.1	7.1	18.9	7.1
Nickel	10.3	10.3	10.3	10.3	10.3	10.3	10.3	167	10.3
Potassium	44600	1060	3750	2850	43300 J	168000 J	154000 J	13900	73200
Selecnium	1.2 UJ	1.2 UJ	1.2 UJ	1.2 UJ	1.2	1.2	1.2	1.2 UJ	1.2 UJ
Silver	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Thallium	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ
Vanadium	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	7.6
Zinc	14.3 U	27.8 U	12.9 U	40.1	6.1 U	24.3 U	7.8 U	2.5	8.1 U

Table 1-4. (Continued)

Analyte	B38W18D	B38W19D	B38W19S	B38W24D	B38W24S	B38W25D	B38W25S	B38W25S Dup	MISS01AA
Aluminum	178 U	21.7 U	74.5 U	27.1 U	61.8 U	48.6	74 U	102 U	38.2 U
Antimony	1.5	1.5	1.5	1.5	1.5	2.9	1.5	1.5	1.5
Arsenic	1.8	48.8 J	1.8	1.8	1.8	1.8	2.5	1.8	18.7
Barium	22.7	22.4	47.5	24.6	45.6	62.7	68.5	43.1	10.6
Beryllium	1.1	0.7	0.7	0.7	0.77	0.7	0.7	0.7	0.7
Boron	425	885	1240	92.1 U	132	236 J	171	227	222
Cadmium	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Calcium	154000	180000	657000	69700	57000	144000	199000	208000	714000
Chromium	29.9	4.2	4.2	4.2	4.2	36.5 J	14.6	12.7	4.2
Cobalt	18.5	3.3	3.3	3.3	6	4.4	3.6	3.3	3.3
Copper	3.1	3.1	4.8	3.1	3.1	3.1	3.1	3.1	3.1
Iron	14400	2630 J	1300	17500	46500	6760	14600	12000	360
Lead	1.5	1.5	1.5	1.5	1.8	1.5	1.5	1.5	2
Magnesium	14100	31200	69000	8290	8430	6940	7630	9110	22000
Manganese	4010	2030	301	3980	5420	1740 J	1410	1540	8.6
Molybdenum	7.1	7.1	20.4	7.1	7.1	7.1	7.1	7.1	10
Nickel	26.3	10.3	10.3	10.3	10.3	27.7	30	22.5	10.3
Potassium	6370	329000	40400	7530	7050	73900 J	88400	88800	1550
Selecnium	1.2 UJ	1.2	1.2 UJ	1.2 UJ	1.2 UJ	1.2 UJ	1.2 UJ	1.2 UJ	1.2 UJ
Silver	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Thallium	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ
Vanadium	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Zinc	152 J	2.5	6 UJ	17.2 UJ	7.6 UJ	11.3 U	12.4 UJ	13.1 UJ	7.6 UJ

Table 1-4. (Continued)

Analyte	MISS01B	MISS02A	MISS02B	MISS05A	MISS05B	MISS06A	MISS07B
Aluminum	31.8 U	896	89.9	77.2	66.4	31.8 U	49.3
Antimony	1.5	2.4	4.8 J	1.8	2.1 U	1.5	3.2 U
Arsenic	2.7 J	6000 J	1.8 UJ	3.8	10.9 J	1.8	53.4 J
Barium	66.9	12	18.1	37.8	128	122	32.9
Beryllium	0.7	0.7	1 U	0.7	0.7	0.7	0.7
Boron	93.1 U	1190	1220	588 J	665 J	2080	1210 J
Cadmium	3.9	3.5	3.5 UJ	3.5	3.5 UJ	3.5	3.5 UJ
Calcium	84500	54500	248000	683000	295000	292000	169000
Chromium	4.2	94.5	5.3	4.2 UJ	10.9	4.2	6.4
Cobalt	3.3	3.3	5.4	9.1	3.3	3.3	5.4
Copper	4.6	173	6	3.1	4.9	31.3	7.3
Iron	1030 J	892 J	8690	15800	3180 J	333	7270 J
Lead	1.5	3.6	1.5 UJ	1.5	1.5 UJ	1.5	1.5 UJ
Magnesium	17600	3410	33600	79200	52200 J	19200	60000 J
Manganese	271	50.6	4210	1330 J	2180	1540	2520
Molybdenum	7.1	7.1	7.1 UJ	7.1	7.1 UJ	16.4 U	7.1 UJ
Nickel	10.3	11.4	10.3	10.3	10.3	10.3	10.3
Potassium	6950	4340	40300	84600 J	231000	97000	20400
Selecnium	1.2	1.5	1.2 UJ	1.2 UJ	1.2 UJ	4.9	1.2 UJ
Silver	3.5	3.5	3.5 UJ	3.5	3.5	3.5	3.5
Thallium	2.3 UJ	2.3 UJ	2.3 UJ	2.3 UJ	2.3 R	2.3	2.3 R
Vanadium	6.7	10.1	6.8	6.7	6.7	6.7	28.7
Zinc	34.6	19.3	22	34.4	98 J	865	22.4 UJ

Notes:

- Lithium was not included as an analyte in the 1995 record of data. Lithium distribution in groundwater is shown in Figure 1-11.
- 1995 data only
- Values in µg/L
- U = The analyte was not detected. The detection limit is reported.
- J = Reported as an estimated value.
- UJ = Analyte was undetected; estimated value reported. The result is below the minimum detectable activity or less than the associated error term.
- *Source: BNI 1996b*

Table 1-5. Physical and Chemical Properties of Selected Organic Chemicals

Constituents	Mol. Wt.	Solubility[1] S_w (mg/L)	S_w @ Temp. C.	Vapor Pressure (tor @ °C)	Henry's Constant (K_h) atm.m^3/mol	K_h @ Temp. C.	Air Diff. Coeff.[2] cm^2/s	K_{OC} ml/g	BDR λ 1/day	Biodeg. half-life[3] (day)	Log (K_{OW})
1,1 Dichloroethane	99.0	5.50E+03	20	234 @ 25	5.45E-03	25	0.091	5.90E+01	1.13E-03	616	1.79
1,1 Dichloroethene	96.9	2.10E+02	25	591@ 25	1.49E-02	25	0.114 s	6.50E+01	3.85E-03	180	1.48
1,1,1 Trichloroethane	133.4	4.40E+03	20	100 @ 20	4.08E-03	25	0.019 s	1.10E+02	6.35E-04	1092	2.47
1,1,2 Trichloroethane	133.4	4.50E+03	20	25 @ 25	2.94E-05	25#	0.079 #	7.60E+01	4.75E-04	1458.33	2.17
1,1,2-Trichloro-1,2,2- -trifluoroethane	187.4	1.70E+02	25	273 @ 25	3.96E-01	25*	0.078	6.60E+02	4.81E-04	1440.00	3.02 *
1,2 Dichloroethane	99.0	8.69E+03	20	82 @ 25 e	1.10E-03	25	0.091	4.40E+01	9.63E-04	720	1.45
1,2 Dichloroethene	96.9	8.00E+02	#	200#	6.60E-03	ssc	0.114	7.75E+01	2.41E-04	2875	2.09 *
2-Butanone	72.1	2.75E+05		100 @ 25	6.61E-07	25#	0.092 s	1.15E+00	2.48E-02	28	0.26
4-Methyl-2-pentanone	100.2	1.91E+04		10 @ 30	1.03E-06	25#	0.078	3.31E+00	2.48E-02	672	0.72
Acetone	58.1	1.00E+06		270 @ 30	5.14E-07	25#	0.110 s	3.63E-01	2.48E-02	28	-0.24
Benzene	78.1	1.78E+03	20	95 @ 25	5.55E-03	25	0.093 s	6.20E+01	9.63E-04	720	2.13
Carbon disulfide	76.1	2.90E+03	20	298 @ 20	2.94E-04	25#	0.105 s	9.11E+01			2.16
Carbon Tetrachloride	153.8	8.00E+02	20	113 @ 25	2.93E-02	25	0.082 s	1.98E+02	1.93E-03	360	2.73
Chloroform	119.4	9.30E+03	25	160 @ 20	3.39E-03	25	0.091 s	6.00E+01	3.85E-04	1800	1.97
Chloroethane	64.5	5.74E+03	20	2660 @ 25	1.11E-02	24.8	0.107 s	1.70E+01	6.19E-03	112	1.43
Dimethylbenzene	106.2	2.00E+02		5 @ 20	5.25E-03	25	0.073 s	2.71E+02	1.93E-03	360	2.77
Methylene chloride	84.9	1.67E+04	25	429 @ 25	3.19E-03	25	0.104 s	2.20E+01	6.19E-03	112	1.25
Tetrachloroethene	165.8	1.50E+02	25	19 @ 25	2.87E-02	25	0.077 s	3.17E+02	4.19E-04	1653	2.53
Toluene	92.1	5.15E+02	20	28 @ 25	5.92E-03	25	0.087	1.39E+02	3.30E-03	210	2.69
Trichloroethene	131.4	1.10E+03	25	77 @ 25	1.17E-02	25	0.088 s	9.80E+01	4.19E-04	1653	2.53
Xylene	106.2	2.00E+02		5 @ 20	5.25E-03	25	0.073 s	2.71E+02	1.93E-03	360	2.77

[1] Solubilities, Henry's Constant and Log (Kow) have been taken from RREL Treatability Data Base (EPA 1994b)except otherwise indicated.

[2] Air diffusion coefficients are obtained from EPA 1987, except otherwise indicated.

[3] Biodegradation half-lives are taken from Hand Book of Environmental Degradation Rates (Howard et. al. 1991) except otherwise indicated.

[*] Represents calculated values, [#] indicates STF Data Base (EPA 1991b)as the source, and [s] indicates Shen et. al 1993 as the source

the Saddle River and it is likely that this PCE plume extends further downgradient than where current monitoring wells are located. The conceptual model also includes discharge of bedrock groundwater to surface water bodies. It is anticipated that the culvert for Westerly Brook will not be completely water tight and that groundwater is able to leak into the culbert. This provides a potential pathway for discharge of elevated concentrations in groundwater.

To conclude, groundwater containing PCE and its breakdown products exists in bedrock below MISS and Ballod. This plume may be contiguous beneath the former retention ponds. The extent of the VOC COCs in groundwater has not been defined and needs to be characterized. Based on the hydrogeological conceptual model in the RI the fate of PCE in groundwater is likely to be downgradient transport followed by discharge to Westerly Brook or the Saddle River.

Metals

Based on data from the RI (BNI 1992a) and subsequent groundwater monitoring, metals that have occurred above SDWA MCLs are as follows (see Figure 1-10) (BNI 1994a, BNI 1995a, and BNI 1996b): arsenic (2 to 6,000 μg/L), chromium (5 to 285 μg/L), iron (32 to 116,000 μg/L), lead (2 to 37 μg/L), manganese (9 to 63,100 μg/L), lithium (50 to 14,000 μg/L), and boron (56 to 2,080 μg/L) (see Table 1-6).

Non-mobile metals (aluminum, arsenic, chromium, iron, and lead) occur as COCs mainly in the overburden wells. In particular, MISS-2A (arsenic: 6,000 μg/L and chromium: 141 μg/L), MISS-1AA (chromium: 285 μg/L), MISS-7B (arsenic: 62 μg/L), and B38W17A (chromium: 56.6 μg/L) (Figure 1-10). With the exception of MISS-2A, these wells are associated with the former retention ponds. Concentrations of chromium in samples taken in 1994 and 1995 range from 5 to 285 μg/L. Use of low flow sampling in 1994 and 1995 has resulted in lower detected concentrations of these metals; the measured concentrations of chromium presented here are approximately half those from pre-1994 samples.

Lithium and boron are both elevated above background in bedrock and are attributed to migration from sources on MISS (Figures 1-11 and 1-12). These metals are not easily retarded and have migrated away from the retention ponds into the bedrock. There are no SDWA MCLs for either lithium or boron, and only lithium poses a potential hazard with an hazard quotient (HQ) greater than 1 (see SAIC 1993 and Table 1-6).

The background well (B38W02D) contains elevated concentrations of manganese, iron, and aluminum. These metals are common components of sandstones and the occurrence of these metals in elevated concentrations in the bedrock wells and in the overburden wells can be attributed in most cases to fine grained minerals entrained in the sample. Use of low flow sampling has reduced the concentrations of iron and aluminum in samples from the background well confirming that these elements are present in suspected material. However, concentrations of manganese remain high, suggesting that this metal is present in fine colloidal material or is dissolved. Bedrock wells have concentrations of manganese ranging from approximately 0.5 to 7.5 milligrams (mg)/L. The background well has a concentration range of 1.2 to 2.5 mg/L (NJGWQS = 50 μg/L).

Table 1-6. Preliminary Remediation Goals and Risk Levels for COCs in Groundwater and Surface Water

Chemical	Possible ARARs/Action Level (µg/L)	Detected Concentrations (µg/L)	Risk or Hazard[b]	Grey Region[c] (µg/L)	Proposed Detection Limits (µg/L)
arsenic	SDWA MCL = 50 NJGWQS = 8 NJSWQC = 0.017	2 to 6,000	Risk = $2.8x10^{-3}$ HQ = 15	6-8	<5
chromium	SDWA MCL = 100 NJSWQC = 160	5 to 285	HQ = 2.6	80-100	<60
iron	NJGWQS = 300	32 to 116,000		240-300	<100
lead	NJGWQS = 10 NJSWQC = 5	5 to 37		8-10	<5
manganese	NJGWQS = 50	9 to 63,100	HI = 10	40-50	<30
lithium	NA	50 to 14,000	HI = 2.6	80-100	<60
Tetrachloroethylene (PCE)	SDWA MCL = 5 NJGWQS = 0.4/1 NJ MCL = 1 NJSWQC = 0.388	20 to 1,500 [a]	Risk = $7x10^{-5}$	0.8 - 1	<1
Trichloroethylene (TCE)	SDWA MCL = 5 NJGWQS = 1 NJ MCL = 1 NJSWQC = 1.09	2 to 270 [a]	Risk = $2x10^{-4}$	0.8 - 1	<1
1,2-Dichloroethylene (1,2-DCE)	NJ MCL = 10 NJSWQC = 592 (trans isomer)	2 to 160 [a]		8-10	<6
1,1-Dichloroethylene (1,1-DCE)	SDWA MCL = 7 NJGWQS = 1/2 NJ MCL = 2 NJSWQC = 4.81	2 to 9 [a]	Risk = $1.5x10^{-5}$	1-7	<1
Vinyl Chloride	SDWA MCL = 2 NJGWQS = 0.8/5 NJ MCL = 2 NJSWQC = 0.083	2 to 5 [a]	Risk = $1.3x10^{-3}$	1-2	<1
Benzene	SDWA MCL = 5 NJGWQS = 5 NJ MCL = 1 NJSWQC = 0.15	1 to 89 [a]		0.8 - 1	<1

[a] data from 1995 sampling only
[b] SAIC 1993
[c] The gray region is a range of possible parameter values where the consequences of a false negative decision error are relatively minor.

SDWA MCL = Safe Drinking Water Act Maximum Contaminant Level
NJGWQS = New Jersey Ground Water Quality Standards
NJ MCL = New Jersey Maximum Contaminant Level
NJSWQS = New Jersey Surface Water Quality Standards

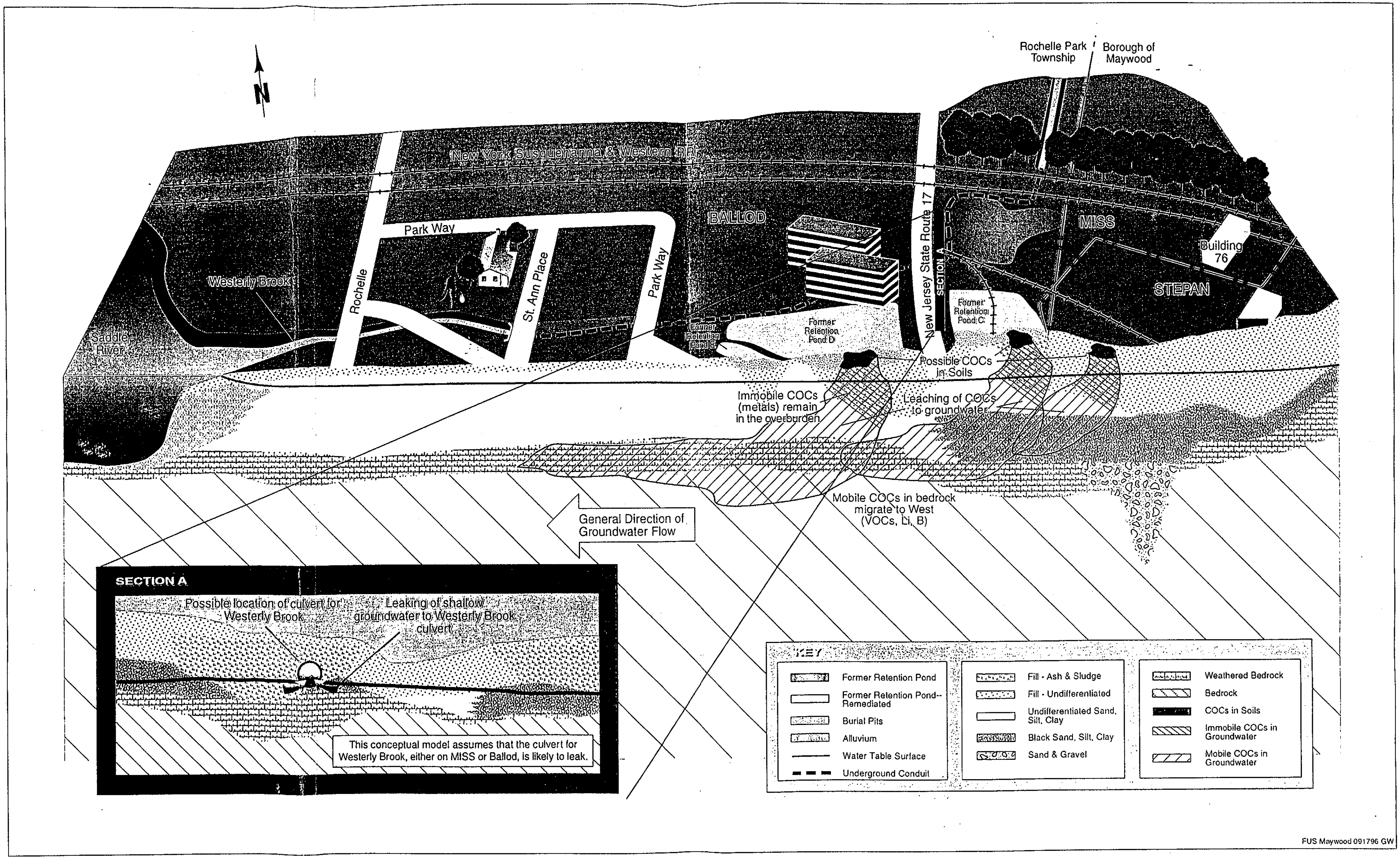


Figure 1-13. Site Conceptual Model for the Maywood Site

The general distributions of metals observed in annual monitoring are the same as reported in the RI and the conclusions have not changed. Arsenic and chromium exceed SDWA MCLs in the overburden, and may be due to leaching of metals from sources in the retention ponds and soils on MISS. Manganese exceeds MCLs in most bedrock wells but can be attributed to natural phenomena and not to MISS. Elevated concentrations of lithium are attributable to MISS.

1.4 CONSTITUENTS OF CONCERN

The results of the RI investigation, routine monitoring of the MISS groundwater, and the human health risk assessment show chemical constituents in groundwater at MISS which are listed in Table 1-6. Each of these chemicals has either been detected in concentrations greater than a preliminary remediation goal (PRG) value or, where there is no PRG, occurs in significantly elevated concentrations. As discussed in Section 1.1, radiological constituents that occur in soils at Maywood are not in the scope of this study. Radiological constituents have not been observed in groundwater at Maywood.

1.5 PURPOSE AND SCOPE

The purpose of this document is to present an environmental sampling program that is designed to complete the characterization of groundwater and surface water at the Maywood Site. As a cost avoidance measure, DOE's SAFER approach and EPA's DQO process were used to assist in development of this SAP.

The scope of this investigation is to complete characterization of the nature and extent of COCs in groundwater and soils at MISS and Ballod, as well as in groundwater beneath properties offsite and downgradient of MISS and Ballod. Also included in this scope is characterization of hydrogeological, biological, and chemical parameters sufficient to allow (1) assessment of potential hazards that are posed to human health and the environment by COCs in groundwater derived from activities at this site, (2) evaluation of likely remedial technologies at this site, and (3) placement of groundwater wells for long-term monitoring purposes.

1.6 SAFER APPROACH

DOE's SAFER approach was used to develop a cost-effective and comprehensive environmental sampling program which meets all of the project objectives. As part of the SAFER approach, a detailed conceptual model for groundwater conditions was developed based on the current understanding of the Maywood site. The conceptual model developed for this site is presented in graphical form in Figure 1-13 and shows:

- potential sources of COCs and release mechanisms;
- pathways of migration; and
- exposure routes and potential receptors.

Inputs to the site model include the parameters that VOCs and some metals occur in groundwater at MISS, Ballod, and in residential areas downgradient of MISS that may be derived from past activities at Maywood (see Section 1.3) or adjacent facilities. Some COCs probably were transported to groundwater during operations at the Maywood Site. It is not known if the former retention ponds or soils on MISS or Ballod acted or currently act as sources for COC releases to groundwater onsite.

Identified potential sources for groundwater COCs are the former retention ponds that are located on the MISS and Ballod properties. The retention ponds may have (1) acted as sources during operations at the Maywood site by infiltration of water stored in the ponds, or (2) may be current sources of COCs as a result of leaching of chemicals from sludges that remain in the former ponds. An additional potential source for groundwater COCs at the Maywood site is an area around Building 76 once used for lithium production and disposal.

In addition to potential sources of COCs discussed above, there may be other point sources for groundwater VOC COCs where either (1) spills or other accidental releases occurred during operations at Maywood, or (2) small volumes of soil contain VOCs that are leaching to groundwater outside the MISS or Ballod properties.

Based on the Baseline Risk Assessment conducted for the Maywood site, hypothetical exposure routes where potential human or ecological receptors could be exposed to COCs in groundwater are as follows:

- contact with surface water containing COCs;
- ingestion of locally grown plants that have absorbed COCs from the groundwater.

The groundwater in the area of the Maywood site is not currently utilized for public water supply source. The Saddle River is also not used as a public drinking water source downstream of Westerly Brook or Lodi Brook. In addition, there is no known domestic well water usage between MISS and the Saddle River. Water ingestion is therefore not considered a pathway for current human exposure. However, groundwater consumption or other household uses are possible in future scenarios after the site has been cleaned up.

The SAFER approach assesses the site's "probable conditions" based on the available data. It is SAFER's intent that the "probable conditions" be understood to the extent necessary to meet the sampling objectives (i.e., evaluating site risk and selecting the preferred remedial alternative). It is understood in the SAFER process that some unknowns or deviations from the identified probable conditions can be left as uncertainties. These can be addressed during the Remedial Design/Remedial Action (RD/RA).

The SAFER approach uses "decision rules" (as does the DQO process) for the purpose of linking data collection to data needs and uses. Since the key decision is remedy selection, data collection must always be tied to remedial objectives. Decision rules are "if-then" statements which establish what decisions or actions will be taken depending upon the data evaluation. Development of decision rules forces a focus on the real need for a particular type of data and tends to reduce data collection to an essential minimum. Based on the decision rules, a level of uncertainty can be defined that is acceptable in making the characterization decision. The use of contingency plans and monitoring plans are designed more for RD/RA activities than characterization activities and therefore were not addressed in this plan. The decision rules for the Maywood groundwater investigation are described in the following DQO section.

1.7 DATA QUALITY OBJECTIVES

EPA's DQO process was used in conjunction with the SAFER process to develop this SAP (EPA 1994a). Task specific guidance to meet the DQOs is provided in Appendix A. The seven steps that comprise the DQO process are as follows:

Step 1: State the problem
Step 2: Identify the decision
Step 3: Identify inputs to the decision
Step 4: Develop a decision rule
Step 5: Define the study boundaries
Step 6: Specify limits on decision errors
Step 7: Optimize the design for obtaining data

During step 2 of this process, multiple questions are identified, each of which have corresponding decisions to be made (in this case, there are 4 questions).

1.7.1 Step 1: State the Problem

The objective of this step in the DQO process is to develop a concise description of the problem, identify the primary organizations involved in the study, provide a list of the planning team members, identify the primary decision maker(s), and provide relevant schedule milestones for the study (EPA 1994a). Information addressing these issues is summarized below.

Problem Statement

Past operations at the Maywood Chemical Works may have resulted in COCs in groundwater on the Maywood and Ballod properties, and under neighboring properties downgradient of Ballod. The nature of COCs in groundwater at MISS and Stepan has been characterized sufficiently by the DOE RI (BNI 1992a) and by the RI for the Stepan company property (CH2M Hill 1994); however, the extent is not adequately defined. From data presented in the RI, it is anticipated that groundwater containing elevated concentrations of COCs in the Westerly Brook catchment is likely to discharge into two surface water bodies — Westerly Brook and the Saddle River. In addition, groundwater flow in bedrock is dominated by fracture flow.

It is expected that characterization of the extent and fate and transport of COCs in the fractured bedrock will be complicated by fracture flow.

In support of the remedial action decision making process, it is necessary to (1) determine the source of COCs in groundwater at MISS and Ballod; (2) define the extent of COCs in groundwater; (3) evaluate the likely fate and transport of the COCs, (4) define the baseline risk that COCs in groundwater pose to the surrounding area; and (5) collect data to support the evaluation of remedial alternatives for groundwater.

The primary organizations involved in this study include DOE, EPA Region II, and the New Jersey Department of Environmental Protection. In addition, input from the Borough of Maywood and the Township of Rochelle Park and private landowners will be solicited for making decisions concerning sample locations in areas not owned by DOE.

The members selected for the Science Applications International Corporation/Bechtel National, Incorporated, (SAIC/BNI) planning team have backgrounds in the following disciplines: environmental geology, hydrogeology, geotechnical, risk assessment, data management, waste management, and health and safety. The technical expertise provided by this team is sufficient to ensure that all of the data needs for defining the nature and extent of COCs, evaluating ecological and human health risk, and evaluating remedial alternatives will be met. The SAIC field task leader has been identified as the primary decision maker for ensuring that the requirements of the SAP are met. The current project schedule proposes initial field operations to begin during November 1996, provided that site access to private properties can be obtained. If access is not available, work will begin in Spring 1997.

1.7.2 Steps 2, 3, and 4: Identify the Decisions, Identify Inputs to the Decisions, and Define Decision Rules

The goal of step 2 is to define the questions that the study will attempt to resolve. Then for each question, alternative actions are identified that may be implemented based on the outcome of the study. Each study question and corresponding alternative actions, are then joined to form a decision statement. In Step 3, inputs to the decision are identified, and in Step 4 decision rules for sampling were defined.

The following is a list of assumptions which have been made in the process of developing the decision statements:

- This SAP is focused on evaluating the extent of VOCs, lithium, and arsenic in groundwater at Maywood, and identifying the likely sources of groundwater COCs on the MISS and Ballod properties. The nature and extent of radiological and metal COCs (except lithium and arsenic) in groundwater at Maywood have been adequately defined in the RI. The nature and extent of radiological COCs in soils have also been adequately defined by the RI.

- A biased sampling approach will be used in this SAP where sample size and locations are determined using best technical judgment. There are two reasons for selecting this approach: (1) an extensive RI and groundwater monitoring effort precedes this SAP, thus the sampling strategy benefits from a large volume of existing data about this site, and (2) the extent of COCs in groundwater is considerably biased by hydrologic parameters that include groundwater flow direction and bedrock fracture locations. Thus, the media to be sampled are considerably heterogenous and the most efficient approach to sampling will be biased sampling based on existing data. Only one section of this SAP will use a systematic sampling approach and that is for selecting the passive soil gas sample locations. However, because the site-specific effectiveness of this method is not known and the potential uncertainty cannot be calculated, optimization of this sampling activity is based on reasonable cost and experience gained from similar sites.

- The sampling program has been designed to collect sufficient data to support an evaluation of risk, a focused feasibility study, and in selecting final remedial alternatives.

- Screening technologies will be used whenever possible to define the areal extent of the COCs and to define the presence and depth of fill areas.

- Sampling to ensure the safety of onsite remedial workers will be addressed in the site-specific Health and Safety Plan.

- In the absence of risk-based remedial goal options (RGOs) for groundwater and surface water, SDWA MCLs and New Jersey Ground Water Quality Standards (NJGWQS) will be used as reference guidelines for comparison purposes.

1.7.2.1 Question and Decision 1

Question

Is there an active source(s) of COCs on the MISS or Ballod properties or are COCs in groundwater derived from past sources/activities that have since been remediated or are located elsewhere?

- Are the possible sources of COCs on the MISS and Ballod properties (e.g., former retention ponds) currently acting as sources for groundwater COCs?
- Do point sources of soils containing VOCs exist, outside the known possible sources, that could be additional sources of COCs for groundwater?

Alternatives

Alternative actions for resolving Principal Study Question 1 are:

- No Action
- Contain the COCs at sources through capping (partial or complete), in situ solidification, or vertical barriers (groundwater)

- Onsite soil treatment (i.e., soil washing, bioremediation, soil venting)
- Removal and offsite disposal of soils (partial or complete removal)

Decision

Decision statement and proposed action for resolving Principal Study Question 1:

Decision. Determine whether COCs in groundwater at the Maywood site that pose or are likely to pose a risk to human health are derived from a currently active onsite source that will require remedial action in the form of containment, treatment, or removal.

Action for the SAP. Characterize the nature and extent of chemical COCs in soils on the MISS and Ballod Properties.

Inputs Required for Decision 1:

A. A passive soil gas survey will be conducted on the MISS and Ballod properties to delineate likely soil targets (Figure 1-14). The soil gas survey will be used as a screening survey with the goal of targeting soil sample locations for identification of potential onsite sources for VOCs.

Push probe soil samples will be taken from soils in and below the former retention ponds and the remediated former retention ponds on the Ballod property (Figure 1-15). Two borings will be driven into each pond. Soil samples will be analyzed for VOCs using an onsite laboratory. The push probe soil sampling will also be used in conjunction with the soil gas survey to identify additional potential targets.

C. Push probe soil samples will be taken at up to five likely additional targets. Two borings will be driven into each target. Soil samples will be analyzed for VOCs using an onsite laboratory.

D. Two monitoring well nests will be installed at locations where VOCs are detected either in soils or groundwater on the Ballod property (example locations: MW6 and MW7).

Decision Rules for Decision 1:

1. For location of push probe soil borings at additional targets the following decision rules will be used:

   - Up to five potential targets from the soil gas survey or based on results of preceding push probe sampling deemed likely to be indicative of VOCs in soils will be selected. Analysis of the soil gas results will take into account the subsurface geology, natural gas from vegetation decomposition, and moisture conditions that may bias sample results.

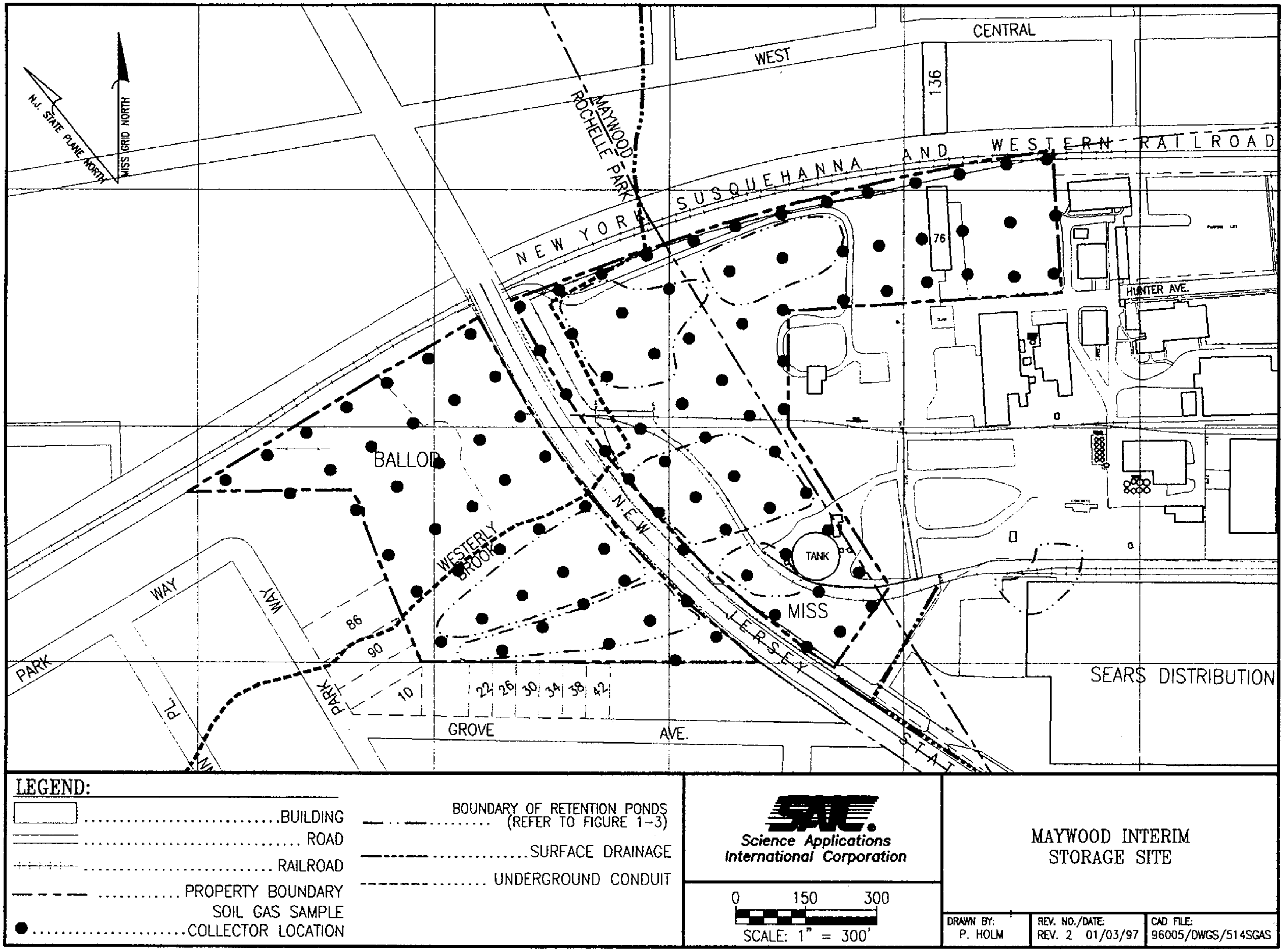


Figure 1-14. Soil Gas Sample Collector Locations

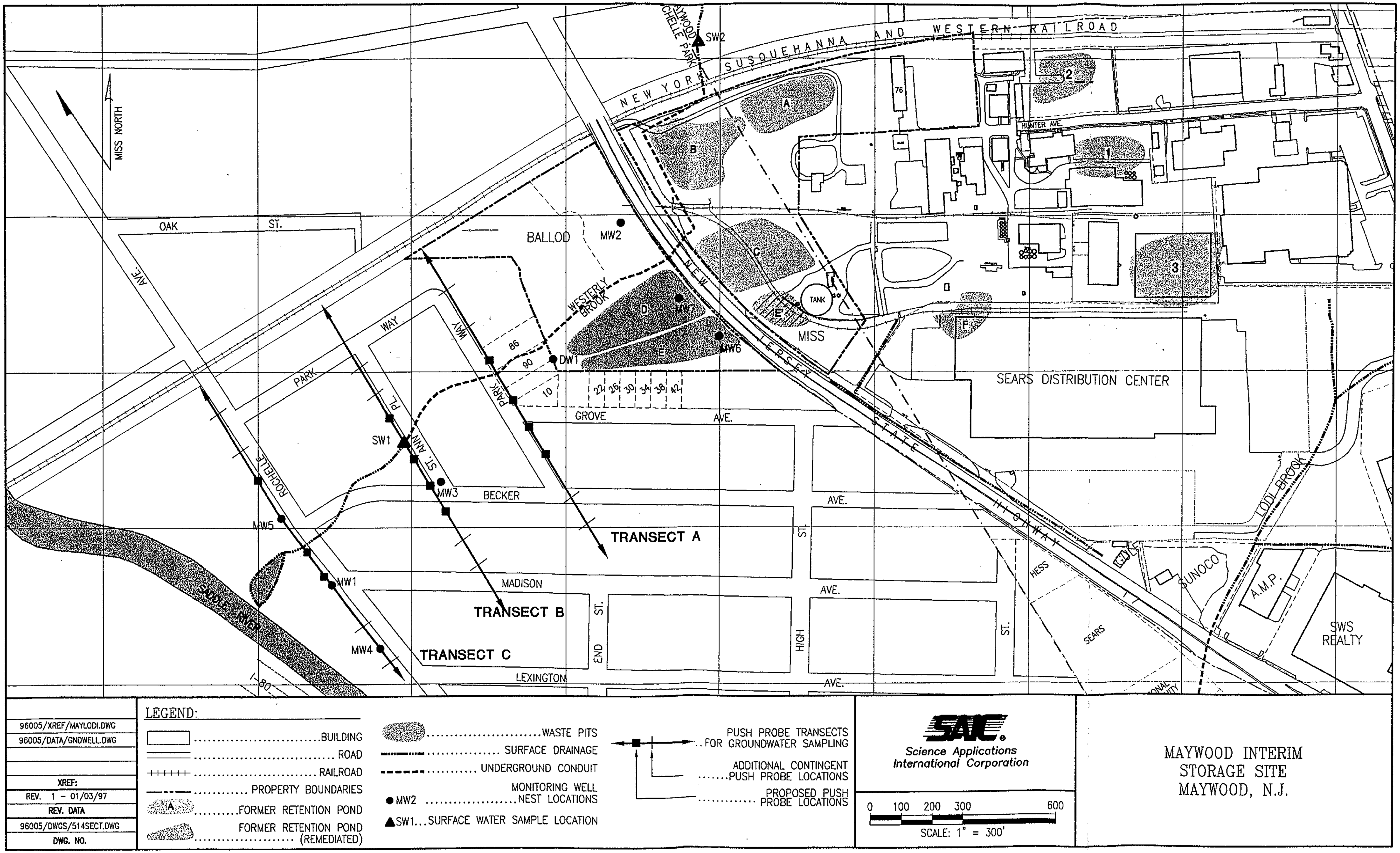


Figure 1-15. Location of Proposed Push Probe Transects, Monitoring Well Locations, and Surface Water Sample Sites

2. For selecting the intervals for soil sampling from the push probe borings the following decision rules will be used:

   - Soil samples will be taken from soil elevations with the two highest readings in each boring obtained from screening continuous soil samples with a photo ionization detector (PID) meter.

   - If elevated organic vapor readings occur at only one elevation then the second sample will be taken as close to the water table as practicable.

   - If elevated organic vapor readings do not occur in a boring then two additional well nests (2 wells) will be installed: one as close to the water table as practicable and a second from either the vadose zone or the bottom of the borehole. The decisions to select the second sample interval will be taken by the onsite geologist after careful review of the borehole log and information from adjacent wells. The interval selected will be the most likely to contain contamination.

1.7.2.2 Question and Decision 2

Question

Do COCs in groundwater or surface water, derived from the MISS and Ballod Properties, constitute an unacceptable potential risk to residents?

- Which COCs are derived from MISS and/or Ballod?
- Is there currently an unacceptable risk?
- Is it likely that there will be an unacceptable risk in the future?

Alternatives

Alternative actions for resolving Principal Study Question 2 are:

- No action
- Use institutional controls and/or onsite management techniques to control public access to groundwater
- In-Situ treatment of groundwater (reaction barriers, bioremediation, natural attenuation, passive collection/treatment trenches, air sparging)
- Ex-Situ treatment of groundwater (pump and treat, collection trenches)

Decision

Decision statement and proposed action for resolving Principle Study Question 2:

Decision. Determine whether COCs in groundwater at the Maywood site are derived from MISS or Ballod and currently pose or are likely to pose a risk to human health and require remedial action in the form of institutional controls, removal, containment, or treatment.

Action for the SAP. Characterize the nature and extent of VOCs, lithium, and arsenic in groundwater and characterize the hydrogeology of the site sufficient for fate and transport evaluation.

Inputs Required for Decision 2:

Since evaluation of existing RI data has determined that the nature and extent of metal (except lithium and arsenic) and radionuclide COCs in groundwater have been adequately characterized (Section 1.3) the focus of this SAP is to characterize the nature and extent of VOCs, lithium, and arsenic in groundwater. To characterize the nature and extent of VOCs, lithium, and arsenic in groundwater and to characterize the hydrogeology of the site sufficient for fate and transport evaluation, the following inputs are needed:

A. Determine if VOCs, lithium, and arsenic in groundwater are discharging into Westerly Brook and/or the Saddle River.

- Westerly Brook will be sampled at 1 location between the Ballod property and the Saddle River and one sample upstream of the MISS property (Figure 1-15).
- The Saddle River will not be sampled because (1) the potential of detecting COCs not from the Maywood site is high, and (2) the expected large flow volume in this river will dilute any groundwater discharge to the extent that COCs from the Maywood site are not likely to be detectable. The likelihood of discharge to the Saddle River will be determined from results of groundwater monitoring at a well nest located at MW1 (Figure 1-15).

B. Determine the extent of VOCs in groundwater in the overburden groundwater intervals. The sampling strategy for groundwater will involve screening level groundwater sampling using push probe technology accompanied by an in-field laboratory for VOC analysis to rapidly identify and delineate groundwater containing VOCs. Push probe sampling of groundwater will be followed by installation of permanent monitoring wells in the overburden at locations determined to be critical for monitoring the plume of VOCs in groundwater.

The strategy for sampling groundwater is to first delineate the leading edge of the VOC plume in the overburden formation using push probe technology. Identification of the leading edge of the VOC plume will be done by sampling transects across the anticipated direction for VOCs and moving sampling transects progressing west until groundwater without VOCs is detected. Once the leading edge of the overburden VOC plume is identified, the leading edge of the plume in bedrock groundwater will be identified by installing monitoring wells.

Because the number of sample points is dependent upon the results of the screening process, the exact number of sample points cannot be predicted. Rather, the goal for each sampling event is laid out with a reasonable maximum number of samples. The following sampling will be completed:

- Push probe samples of groundwater will be taken from soil borings on the MISS and Ballod properties (soil borings are discussed in decision 1). Groundwater samples will be taken from each soil boring at 3 ft intervals from the water table to the refusal depth and analyzed for VOCs and metals (including lithium and arsenic) in the field.
- Push probe sampling of groundwater will be conducted in up to three transects (A, B, and C) of borings situated west of the Ballod property (Figure 1-15). Each transect will consist of 4 planned sample locations and up to four additional locations contingent on the results of the initial 4 samples. Groundwater samples collected from each location will be analyzed for VOCs and metals in the field. Groundwater samples will also be analyzed for pH, temperature, specific conductance, and turbidity in the field shortly after sample collection.

- Permanent monitoring wells will be located at points deemed critical to monitoring the plume of VOCs, lithium and arsenic in overburden groundwater.

  Permanent monitoring wells will be used to obtain more reliable groundwater samples and additional groundwater parameters. Nests of monitoring wells will be installed at locations MW1 and MW2. Based on the anticipated extent of VOCs in groundwater as shown in the conceptual model (Figure 1-13) it is expected that up to three additional overburden monitoring wells will be installed (example locations are MW3 to MW5 on Figure 1-15). Groundwater samples collected from each well will be analyzed for VOCs, metals, (including lithium and arsenic) major anions, and radionuclides. Groundwater samples will also be analyzed for pH, temperature, specific conductance, and turbidity in the field at the time of sample collection.

C. Determine the extent of VOCs in groundwater in the bedrock groundwater interval. The sampling strategy will involve installation of permanent monitoring bedrock wells at locations determined from the overburden groundwater VOC results. In addition, one bedrock monitoring well will be installed to define the depth of VOCs in bedrock groundwater.

Because the number of sample points is dependent upon the results of the screening process, the exact number of sample points cannot be predicted. Rather, the goal for each sampling event is laid out with a reasonable maximum number of samples. The following sampling will be completed:

- Two bedrock monitoring wells will be installed, both with overburden wells as part of nested well pairs. These wells will be located close to the Saddle River at MW1 and on the Ballod property adjacent to NJ State Route 17, at location MW2 (Figure 1-15).

- Additional permanent bedrock monitoring wells will be located with overburden monitoring wells, as part of nested well pairs, at points deemed critical to monitoring concentrations of VOCs, lithium, and arsenic in groundwater. The strategy for additional wells will be: if the extent of VOCs in groundwater can be determined then position additional wells to monitor groundwater in front of the leading edge of the plume. Permanent monitoring wells will be used to obtain more reliable groundwater samples and additional groundwater parameters. Based on the anticipated extent of VOCs in groundwater, it is expected that 5 additional monitoring well nests will be installed (example locations are MW3, MW4, MW5, MW6, and MW7 on Figure 1-15). Groundwater samples collected from each well will be analyzed for VOCs, metals, major anions, and radionuclides. Groundwater samples will also be analyzed for pH, temperature, specific conductance, and turbidity in the field shortly after sample collection.

- The assumed conceptual model predicts that the extent of VOCs in bedrock groundwater will be reflected in the extent of contamination in the overburden deposits. Thus, the push probe technology is used to screen for the locations of monitoring wells. If results from the monitoring wells change the conceptual model, it may be necessary to complete additional bedrock monitoring wells to define the extent of VOCs in bedrock.

- One bedrock monitoring well will be installed at location B38W14D and sampled every 5 ft doing drilling (DW-1, Figure 1-15). The purpose of this well will be to identify the maximum depth of VOCs in bedrock. The well will be drilled until the maximum VOC concentrations have been observed (i.e., two consecutive samples with falling VOC concentrations). The well will be screened at the depth of highest concentrations unless that depth is between 46 and 51 ft (the depth of the screen in B38W14D) in which case the well will be plugged and abandoned.

D. To characterize the hydrology of the Maywood site and its vicinity the following will be carried out.

- Hydraulic head in all operating monitoring wells at the Maywood site (not just the ones installed by this SAP) will be measured over a 48-hour period in which there is no rainfall. This will allow construction of a hydraulic head map for the site and neighboring areas.

- Falling and/or rising head permeability tests will be performed at each bedrock and overburden monitoring well (MW1, MW2, MW3, MW4, MW5, MW6, and MW7 locations). Total of 14 tests maximum.

- Point dilution tests for each of the monitoring wells installed during this SAP (MW1, MW2, MW3, MW4, MW5, MW6, and MW7 locations). Total of 7 tests maximum.

- Continuous monitoring of hydraulic head and specific conductance will be performed for a one month period at 16 monitoring wells on MISS and Ballod.

These data will allow evaluation of the transient response of the flow system to storm events. In addition, flow in Westerly Brook will be monitored continuously for this 1-month period.

E. Resolve the data gap in the hydrologic conceptual model for the relationship between the bedrock and overburden aquifer down-gradient of the Maywood site. In particular, determine if upward hydraulic gradients occur between bedrock groundwater and shallow groundwater near the Saddle River.

- At each location where monitoring wells are installed (MW1, MW2, MW3, MW4, MW5, MW6, and MW7), well pairs will be constructed such that one well will be screened in the overburden and one in the shallow bedrock. Monitoring of hydraulic heads will be used to determine head gradients between the well screens.

Decision Rules for Decision 2:

Regarding push probe sampling of groundwater between the Ballod properties and the Saddle River (Figure 1-16):

- For each transect
  - If VOCs occur in groundwater in either of the outermost borings then additional borings will be drilled to sample groundwater stepping out along the direction of the transect line at 100 ft intervals (where feasible) until groundwater without VOCs occurs or a total of eight borings have been drilled in that transect. A maximum of 8 borings per transect will cover the likely migration paths for groundwater (total of 24 borings).
- Groundwater will be sampled and analyzed for VOCs using the following decision rules:
  - If VOCs do not occur in groundwater in transect A then this will indicate that the maximum extent of the plume has been determined and transect B will not be sampled.
  - If VOCs occur in transect A, but not in transect B, then transect C will not be sampled.
  - If VOCs occur in transects A and B then transect C will be sampled.

2. For location of additional paired well nests the following decision rules will be used (see Figure 1-16) (Note: example locations of the additional monitoring wells are shown in Figure 1-15; however, the final locations for these wells if they are installed will be dependent on water level measurements from the push probe borings and onsite access agreements):

- If VOCs do not occur in groundwater in Transect A then two additional monitoring well nests (4 wells) will be installed on transect A.

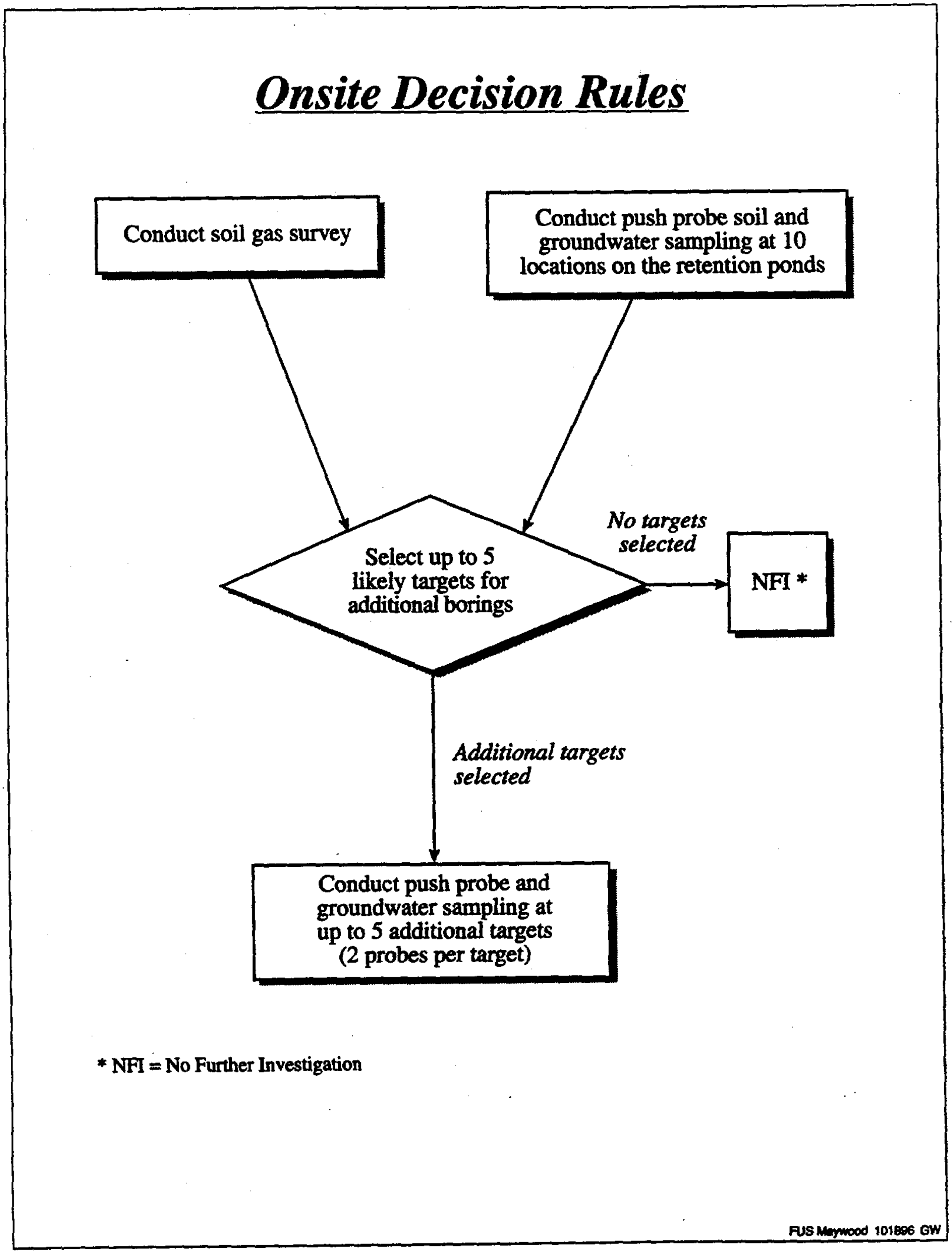


Figure 1-16. Onsite Decision Rules for Onsite and Offsite Field Activities

- If VOCs occur in Transect A but do not occur in groundwater in Transect B then two additional monitoring well nests (4 wells) will be installed on transect B.
- If VOCs occur in groundwater in transects A and B but not in C then two additional well nests (4 wells) will be installed, one on transect C and one on transect B.
- If VOCs occur in transects A, B, and C then three additional well nests (6 wells) will be installed, two on transect C and one on transect B.
- The location of the well screen for any overburden monitoring well will be at the depth of the highest VOC concentration in groundwater from that location. The screen for the bedrock monitoring well will be set at the interface between the vadose zoned bedrock and bedrock as defined by the onsite geologist.

In addition, if results from the monitoring wells change the conceptual model such that the extent of VOCs in overburden bedrock does not reflect the extent of VOCs in bedrock, it may be necessary to complete additional bedrock monitoring wells (Phase II) to define the extent of VOCs in bedrock (see Figure 1-17 for offsite decision rules).

1.7.2.3 Question and Decision 3

Question

What remedial action alternatives will cost effectively minimize or eliminate public and environmental exposure to COCs in groundwater?

- How effective will source remediation be in remediating groundwater COCs or will groundwater treatment be necessary?
- Is groundwater at the Maywood Site conducive to treatment options such as bioremediation or natural attenuation?

Alternatives

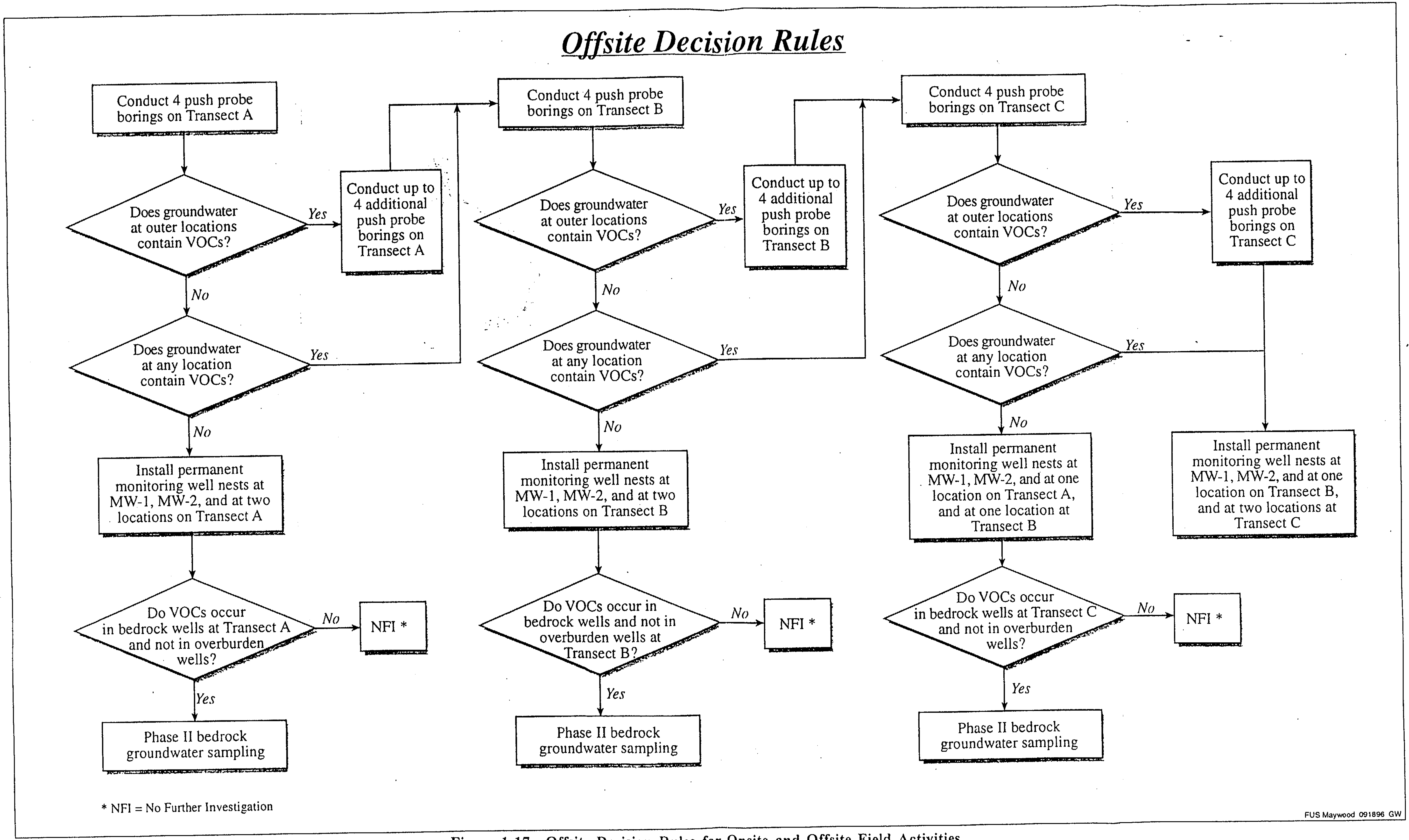
Alternative actions for resolving Principal Study Question 3 — *refer to alternatives for questions 1 and 2.*

Decision

Decision statement and proposed action for resolving Principle Study Question 3:

Decision. If the COCs in groundwater pose a potential risk to human health or the environment, then determine whether a cost-effective combination of institutional controls, containment, onsite/offsite disposal, and/or treatment can minimize or eliminate public exposure to COCs in groundwater.

Action for the SAP. Include sampling of soils and groundwater for engineering, hydrologic, and bioremediation parameters that may be needed to assess innovative technologies.



* NFI = No Further Investigation

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Figure 1-17. Offsite Decision Rules for Onsite and Offsite Field Activities

Inputs Required for Decision 3:

A. To determine the physical, chemical and biological properties of soils in this area, soil samples collected during installation of up to seven monitoring well nests (MW1, MW2, MW3, MW4, MW5, MW6, and MW7) will be analyzed for geotechnical (Table 1-7), hydrologic (Table 1-7), and bioremediation parameters (Table 1-8). In addition, soil samples may be taken from additional push probe borings specifically located outside the areas where VOCs have been detected in soils to obtain reasonable background parameters.

Table 1-7. Geotechnical Geochemical Parameters for Soil Analysis

Analytical parameter	Analytical Method
Geotechnical/Geochemical Parameters	
Permeability	SW 846, 9100
Hydraulic Conductivity	SW 846, 9100
Porosity	EM 1110-2-1906
Grain Size (sieve)	ASTM D422
Bulk Density	ASTM D4531-86
Cation Exchange Capacity	SW 846, 9081
pH	SW 846, 9045
Total Organic Carbon	SW 846, 9060[a]
Moisture Content	ASTM D4959-89
Atterburg Limits	
Shear Strength	
Distribution Coefficients (K_d) - Li, As, Cr	ASTM 4646
[a] As modified for solid media per laboratory-specific methodology.	

B. To determine additional geochemical and biological parameters of groundwater in and outside of the region in which VOCs have been identified in groundwater, samples from permanent monitoring wells will be analyzed for chemical and bioremediation parameters listed in Table 1-8. In addition, groundwater samples may be taken from additional push probe borings specifically located outside the area of where VOCs occur in groundwater to obtain background parameters.

1.7.2.4 Question and Decision 4

Can characterization of groundwater and the selection of a remedial alternative be conducted in a more cost-effective and less time-consuming manner by using innovative or alternative technologies?

Table 1-8. Biological Parameters for Soil and Groundwater Analysis

Analyte	Matrix	Interpretation
Conductivity	Water	Excessively high levels can inhibit bacterial activity.
Dissolved Oxygen	Water	Presence indicates oxidizing conditions. Any activity here would be aerobic.
Redox Potential	Water	Positive values suggest oxidizing conditions. Negative values suggest reducing conditions. Specific values may indicate which type of bacteria are active.
pH	Water	Extreme values can prohibit bacterial activity.
Phosphate	Water/Soil	Nutrient necessary for bacterial growth.
Total Kjeldahl Nitrogen	Soil	Nutrient necessary for bacterial growth. TKN provides an indication of long-term nitrogen supply.
Ammonia	Water/Soil	Indicates the amount of immediately available nitrogen.
Nitrate	Water	Under anaerobic conditions, this is used as an electron acceptor (similar to the way oxygen is used in aerobic conditions).
Manganese	Water/Soil	Alternate electron acceptor.
Sulfate	Water	Alternate electron acceptor.
Sulfide	Water	Indicates that sulfate reduction has occurred.
Methane	Water/Soil	Product of specific bacteria in an anaerobic environment. Also utilized as a food source for bacteria known to degrade chlorinated hydrocarbons.
Iron	Soil	Alternate electron acceptor.
Total Organic carbon	Water/Soil	Indicates the amount of long-term carbon available for metabolism.
Total Heterotrophic Bacteria	Water/Soil	Provides a general indication of the bacterial presence under aerobic conditions.
Solvent Mineralization Potential	Water/Soil	Samples are exposed to a radiolabelled compound representing contaminants. Productions of carbon dioxide and daughter products confirm biodegradation can occur when the contaminant is present.

- Can innovative technologies be used to overcome the problems presented by the heterogenous nature of COC occurrence that stem from the predominance of fracture flow in bedrock at this site?

Alternatives

Alternative actions for resolving Principal Study Question 4 are:

- Use push probe groundwater sampling techniques to perform groundwater characterization and to support the strategic positioning of long-term monitoring wells
- Use cost-effective screening technologies to focus the characterization activities (i.e., passive soil gas analysis)
- Use onsite analytical instrumentation to obtain real-time measurement and minimize data analysis time
- Collect data to allow evaluation of innovative remedial actions such as bioremediation or insitu groundwater treatment.

Decision

Decision statement and proposed action for resolving Principle Study Question 4:

Decision. Determine whether the characterization of VOCs, boron, and lithium in groundwater and onsite soils and the selection of a remedial alternative can be conducted in a cost-effective manner by using innovative/alternative technologies such as screening characterization technologies, onsite analytical instrumentation, and push probe groundwater sampling techniques.

Action for the SAP. Include screening analysis and innovative sampling technologies in the SAP if they are cost-effective and reliable.

Inputs Required for Decision 4:

A. Push probe groundwater sampling and soil gas analysis for identification of COCs in soil has been demonstrated at similar FUSRAP and other DOE sites. These technologies can be used effectively to characterize COCs in soil and groundwater and to support the field decision-making process. These methods will be used at the Maywood site to support on-site location of push probe borings and monitoring wells.

Decision Rules for Decision 4:

1. Background samples for biological parameters, soils, and groundwater chemistry will be taken using push probe technology at a suitable location. The suitable location of the background boring will be determined based on the results of sampling outlined in this SAP.

1.7.3 Step 5: Define the Study Boundaries

For purposes of site characterization, spatial boundaries of the study area have been defined as the zone of groundwater where COCs derived from the MISS or Ballod properties could be reasonably expected to occur as a result of migration in groundwater from these areas (Figure 1-18). Soils and groundwater from outside this study boundary may be taken to define background parameters. Due to the nature of this investigation, the study boundaries are flexible and may be modified based on results of groundwater analysis. However, COCs in groundwater that are detected outside of the current defined boundaries may not be derived from the Maywood site (and therefore would not be the responsibility of DOE). If results of sampling indicate COCs are present at the study boundaries, the boundaries will only be modified if hydraulic data from the borings indicate the location is potentially downgradient of the MISS or Ballod properties. (Note: In the case of VOCs, it is possible that COCs may occur at hydraulically upgradient locations as a result of migration in the vapor phase (Pankow and Cherry 1996); this will be taken into account.) Before a decision is made to alter the boundaries, all possible migration pathways for the COCs will be evaluated to determine if COCs are likely to have migrated from MISS outside the current study boundaries.

1.7.4 Step 6: Specify Limits on Decision Errors

The following section will (1) identify the possible range of the parameters of interest by estimating likely upper and lower bounds, (2) identify the type of decision errors, (3) define the null hypothesis, (4) define the "gray region" where the consequences of decision error are relatively minor, and (5) define the tolerable probability for the occurrence of decision error.

Range of the Parameters of Interest:

Based on the results from previous investigations, the range of concentration for COCs is presented in Table 1-6.

Decision Error and Null Hypothesis:

In the process of establishing acceptable limits for decision errors, the null hypothesis (H_0) is set to assume that the environmental media at the site contain COCs until they are shown not to contain COCs. With this being the case, a false positive decision error (Type I error) is made when it is concluded that the media do not contain COCs when they actually do. On the other hand, a false negative decision error (Type II error) is made when it is concluded that the media do contain COCs when they really do not.

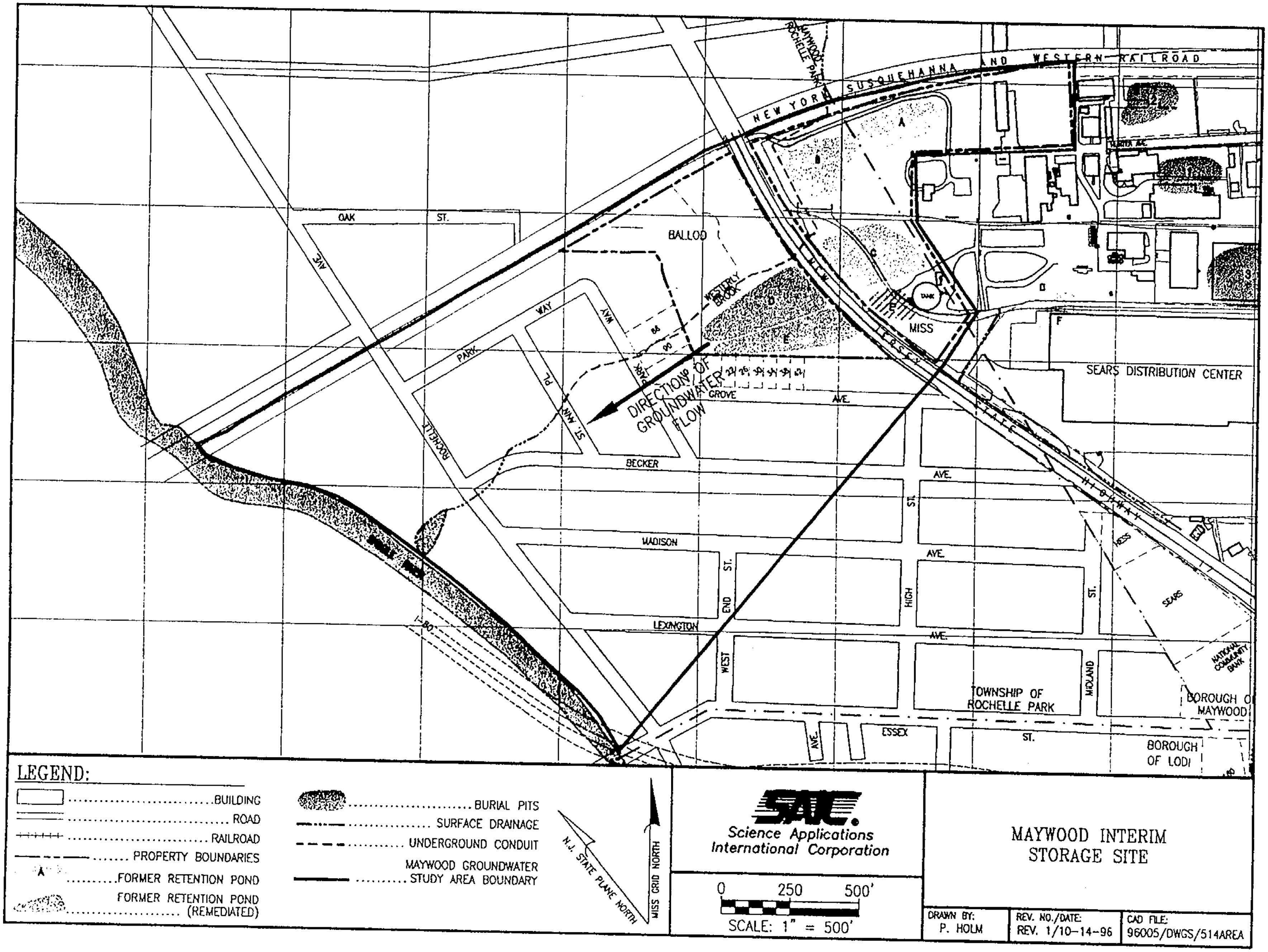


Figure 1-18. Boundary of the Maywood Groundwater Study Area

Potential Consequences of Decision Error and the "Grey Region":

Type I decision errors have the more serious consequences since they could result in COCs being left in place when they should have either been removed or covered to prevent public exposure. On the other hand, Type II decision errors will tend to increase remediation costs since clean soil is treated as containing COCs. The "gray region" is a range of possible parameter values where the consequences of a false negative decision error are relatively minor.

For example, in the decision rule for locating groundwater sampling transects between Ballod and the Saddle River, a Type I decision (i.e., groundwater is considered not to contain VOCs when it does) could result in the extent of COCs in groundwater not being properly defined. Using the same example, a Type II decision (i.e., groundwater is considered to contain VOCs when it does not) may result in taking an additional transect of push probe borings when it is not needed. Using this example, the parameter is the concentration of a chemical that is considered as a COC which, in this case is the concentration of a chemical in groundwater that exceeds its PRG. The "grey region" for this parameter is a concentration range.

The "Grey region" is defined by decision makers. It is a measure of the range of parameter values where the decision making team finds large decision errors acceptable. For the null hypothesis used here, the "grey region" is the range of COC concentrations where the decision making team is likely to make a Type II decision (i.e., groundwater is considered to contain COCs when it does not). For concentration ranges that define a COC, the "gray region" is bounded on one side by the action level, where consequences of making a Type I decision (i.e., groundwater is considered not to contain COCs when it does) become critical, because above this value PRGs or risk based standards will be exceeded and may cause unacceptable risk. The "grey region" is bounded on the lower side by the concentration where the consequences of making a Type II decision error begin to result in significant increases in cost of remediation because the volume of medium that requires remediation increases significantly. The "grey region" concentration ranges for COCs in groundwater at the Maywood Site are listed in Table 1-6. The lower range of the "grey region" is difficult to determine before the FS is completed. Likely costs of remediation have not been estimated. Thus, for the purposes of this document it is assumed that the lower range of the grey region is 80 percent of the action level. Further refinement of remedial alternatives in the FS will result in better evaluation of the lower bound on the "grey region" after cost benefit analysis has been completed.

Detection Limit Requirements

The detection limits in Table 1-6 were calculated by setting the Practical Quantitation Limit (PQL) to 20 percent less than the concentration representing the low end of the "grey region." The PQL was assumed to represent the highest allowable detection limit.

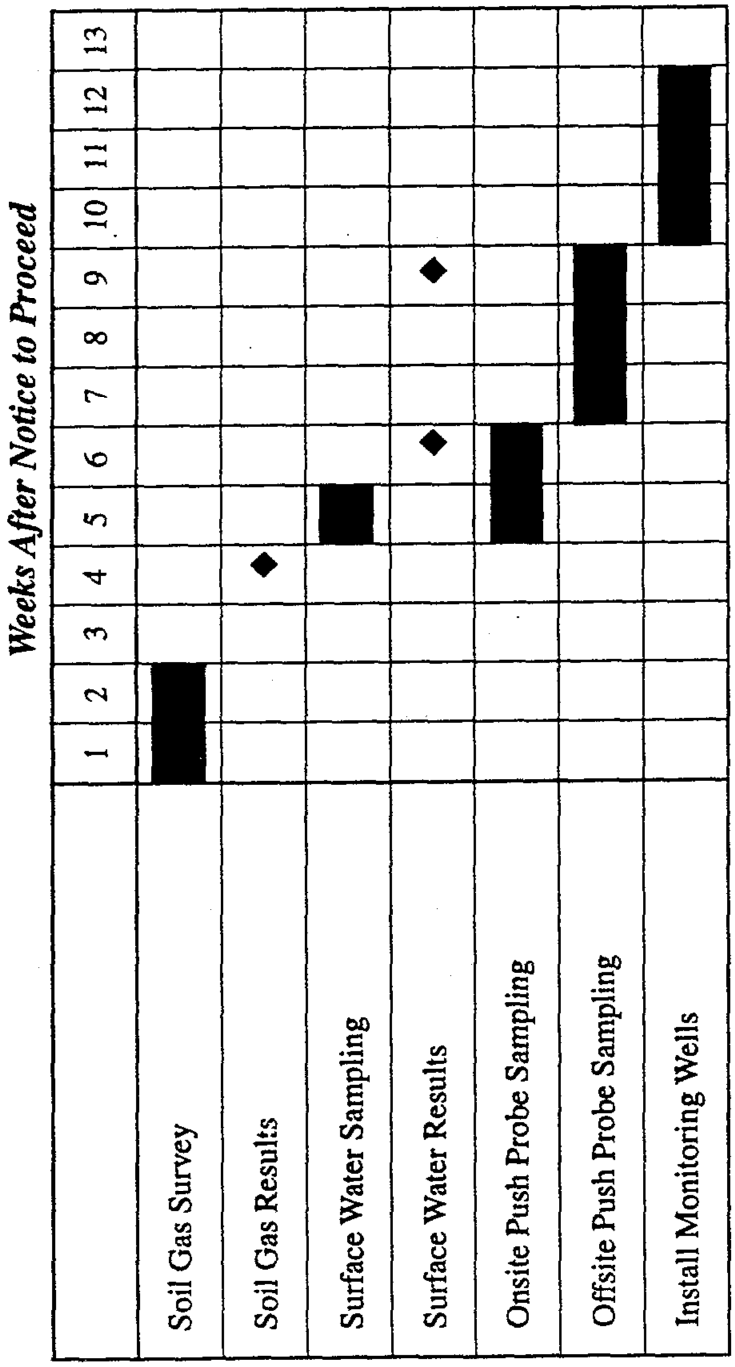
1.7.5 Step 7: Optimize the Design for Obtaining Data

As discussed in Section 1.7.2, a biased and systematic sampling approach will be used in this SAP where sample size and locations are determined using the best technical judgment. Sample locations and sample size have therefore been discussed in the preceding sections and have already been optimized to the site.

Optimization of the field sampling schedule is required to ensure the most efficient use of the resources available. Optimizing the schedule needs to take into account the following decisions in order to construct the critical path for sampling order:

- based on the decision rules certain sampling activities are naturally preceded by other screening activities. These are:
    - sampling of groundwater using push probe precedes installation of additional groundwater monitoring well nests; and
    - soil gas survey precedes sampling soils and groundwater onsite at additional targets.
- field team mobilization is an additional cost each time they are mobilized; thus, sampling should be conducted in a continuous field effort without significant stoppage for making decisions based on sample results.

Based on these inputs, the field activity schedule was optimized and is shown on Figure 1-19. It should be possible to complete sampling in two sampling phases. In the following section, Phase I sampling has been subdivided into the five sampling components shown on Figure 1-16. Phase II sampling will only be conducted if assumption about the conceptual model for groundwater are proven incorrect by sampling during Phase I.



	Weeks After Notice to Proceed												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Soil Gas Survey	■	■											
Soil Gas Results				◆									
Surface Water Sampling					■								
Surface Water Results						◆			◆				
Onsite Push Probe Sampling					■	■							
Offsite Push Probe Sampling							■	■	■				
Install Monitoring Wells										■	■	■	

Figure 1-19. Approximate Schedule for Field Activities

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2.0 FIELD INVESTIGATIVE APPROACH

This section outlines the field investigation proposed for characterization activities of VOCs and metals for the Maywood groundwater investigation. All activities will be conducted in accordance with Occupational Safety and Health Administration standards outlined in 29 CFR 1926 and 29 CFR 1910. All required access agreements will be obtained prior to the commencement of work.

2.1 PHASES I AND II

In Section 1.7 the rationale for sample types and locations and the approximate order of sampling were determined using the approaches laid out by DOE's SAFER and EPA's DQO processes. The optimized sampling design is described in the DQO section of this SAP (Section 1.7.5). Phases I and II are described below.

The sampling efforts for Phase I have been broken down into the following five components (the order in which the components are listed is not necessarily the order of implementing these activities):

Phase I

- **Component 1.** Review historical records; study area engineering drawings, figures, and maps; conduct walkover surveys and interviews.

- **Component 2.** Determine if Westerly Brook contains VOCs and elevated concentrations of boron, lithium, and arsenic. Up to 2 surface water samples will be taken in Westerly Brook.

- **Component 3.** Characterize nature and extent of VOCs in soil and groundwater on the MISS and Ballod properties. This will involve a soil gas survey covering MISS and Ballod followed by push probe sampling of soils and groundwater at up to 20 selected locations. Continuous soil sampling will be conducted during push probe boring operations. Two soil samples will be selected from each location for onsite laboratory analysis for VOCs and a proportion (approximately 10 percent) of the soil samples will be sent for offsite analysis of biological and chemical parameters. Groundwater will be sampled at 3 ft intervals in each push probe boring.

- **Component 4.** Characterize the extent of VOCs, lithium, and arsenic in shallow groundwater between Ballod and the Saddle River. This will involve sampling groundwater with push probe methods along up to 3 traverses of 4 to 8 push points. Groundwater will be sampled at 3 ft intervals in each boring.

- **Component 5**. Characterize the extent of VOCs, boron, lithium, and arsenic in bedrock groundwater and expand the monitoring network to include monitoring of the complete groundwater plume area. This will involve installing between 4 and 7 permanent monitoring well nests between MISS and the Saddle River (8 to 14 monitoring wells).

Phase II

In Phase II, the extent of groundwater COCs in bedrock will be further characterized if necessary. This will involve installing additional monitoring well nests between MISS and the Saddle River. This phase of sampling will only be conducted if sampling in Phase I indicates that the assumed conceptual model for groundwater hydrology, specifically upward gradients, is incorrect, and that there is a possibility of VOCs in bedrock groundwater not accounted for by the Phase I data. The number and location of borings in this phase cannot be predicted until Phase I data are analyzed.

2.1.1 Component 1: Records Search/Walkover Surveys/Interviews

Component 1 of the Maywood groundwater VOC investigation would involve record searches, walkover surveys, and interviews with appropriate parties in order to determine available sampling locations in the study area (Figure 1-18). Determining sampling locations and accessibility on the MISS property will be straightforward. A search of pertinent records and engineering drawings, figures, or maps of the residential neighborhood in the study area will be necessary. Since most of the area between the Ballod property and the Saddle River is comprised of private homes, a thorough review of available sampling locations must be undertaken. The current sampling strategy involves sampling locations in neighborhoods. A knowledge of storm sewers, drainage pipes, and underground utilities is necessary not only for determining drilling hazards but also for gaining insight to possible preferential pathways for groundwater and contaminant flow.

2.1.2 Component 2: Surface Water Sampling

Surface water samples will be collected from two locations as shown in Figure 1-15. The surface water samples will be analyzed for VOCs and metals (filtered and unfiltered). Temperature, pH, conductivity, redox potential (Eh), dissolved oxygen, and turbidity measurements will be made in the field shortly after sample collection. Analysis of the surface water samples will be performed by an onsite[1] laboratory utilizing a gas chromatograph/mass spectrometer (GC/MS) utilizing EPA Methods 8240 and 6010 for VOCs and metals, respectively. One complete sample set (VOCs and filtered and unfiltered metals) will be split

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[1] Due to the decision process for groundwater sampling, rapid turn-around of VOC and metal analysis is required (< 24 hours). To facilitate this, either an onsite laboratory, or an offsite laboratory with the ability to provide the necessary turn-around, will be used. The decision to use onsite or offsite laboratories will be made on the basis of cost.

for offsite laboratory analysis to confirm onsite[1] laboratory results. The analytical results provided by the offsite laboratory will be accompanied by a Confirmatory Level data package. Surface water will be analyzed in the field for temperature, pH, conductivity, Eh, dissolved oxygen, and turbidity shortly after sample collection using field screening instruments.

2.1.3 Component 3: Characterizing Nature and Extent of VOCs in Soil and Groundwater Onsite at MISS and Ballod

This component will involve push probe sampling of soil and groundwater at selected locations on MISS and Ballod and a soil gas survey covering MISS and Ballod properties.

Push probe Soil and Groundwater Sampling at MISS and Ballod

Soil and groundwater samples will be collected using a push probe system in order to characterize the extent of VOC contamination in soils and shallow groundwater on the MISS and Ballod properties. The purpose of this sampling is to determine the lateral and vertical extent of VOC's in the soil at MISS and Ballod properties to allow definition of likely sources. In addition, where potential sources are detected, the extent of contamination in groundwater at the source will be characterized.

Two sampling locations are planned in each former retention pond (retention ponds A, B, C, D, and E) as shown in Figure 1-15. In addition, up to 10 sampling locations will be added based on results of the first 10 push probes and/or the soil gas survey (depending on the sample schedule). If any of the five most likely targets are contiguous with a retention pond anomaly, then only one sample location will be selected for that target.

Soils

From each sampling location, soil samples will be collected continuously at 2-ft depth intervals using a push probe sampler such as the Geoprobe Large Bore Sampler, a 24-inch long by 1-3/8-inch diameter piston-type soil sampler. This sampler is capable of recovering a discrete sample that measures up to 320 milliliters (ml) in volume, in the form of a 22-inch by 1-1/16-inch core contained inside a removable liner. The liner is a 24-inch by 1-1/8-inch diameter removable/replaceable, thin-walled tube inserted into the Large Bore Sampler for the purpose of containing and storing soil samples. This liner will be stainless steel or teflon.

Soil sample lithologies will be described in a geological log. All samples will be screened in the field using a PID organic vapor meter. Up to three samples will be selected from each borehole for analysis after the probe hole is completed. Two samples will be selected from the sampling intervals showing the two highest organic vapor readings or soil discoloration above the water table. One sample will be selected from the first sample interval below the water table. If elevated organic vapor readings do not occur in the boring then only one sample will be taken from above the water table. This sample will be taken from either (1) any interval of potential contamination identified by the geologist, or (2) the sample interval directly above the water table. Up to 20 borings will be made and 60 soil samples taken.

In order to do this, samples will be taken and containerized from each soil core. On completion of the borehole, the samples from analysis will be selected and the remaining samples discarded.

Each soil sample will be analyzed at the onsite mobile laboratory for VOCs. Ten percent of the samples (6 samples) analyzed onsite[1] will be split and sent to an offsite laboratory for confirmation of onsite[1] analytical results and for analysis of metals. The analytical results provided by the offsite laboratory will be accompanied by a Confirmatory Level data package (Table 2-1).

Groundwater

When groundwater has been encountered during soil sampling, drilling and sampling activities will be suspended in order to take a static water level reading with an electronic water level indicator inside the push probe drive rods. Groundwater will be sampled at intervals of approximately 3 ft from this point to the end of the boring. Groundwater sampling will take place in accordance with the standard push probe system Standard Operating Procedures (SOPs) or a best available technology (BAT) sampler. Groundwater sampling can be accomplished utilizing either a peristaltic pump or using a stainless steel Mini-Bailer Assembly.

Groundwater samples will be collected at approximately 3 ft-intervals from where groundwater is first encountered to refusal from each push probe location. Each sample will be analyzed at an onsite[1] laboratory for VOCs and metals. Both filtered and unfiltered groundwater samples will be analyzed for metals. If insufficient volume of water for both filtered and unfiltered samples is available, then only an unfiltered sample will be analyzed. Samples will be filtered in the field before addition of preservative. Analysis of the samples will be performed by an onsite[1] laboratory utilizing a GC/MS utilizing EPA Methods 8240 and 6010 for VOCs and metals, respectively. Ten percent (2 samples) analyzed onsite[1] will be split for offsite laboratory analysis of VOCs to confirm onsite[1] laboratory results. The analytical results provided by the offsite laboratory will be accompanied by a Confirmatory Level data package (Table 2-1). Groundwater samples will be analyzed in the field for pH, temperature, conductivity, Eh, dissolved oxygen, and turbidity shortly after sample collection using field screening instruments.

If for some reason the groundwater sampler is not successful in retrieving a sufficient volume of water for analysis, then temporary groundwater wells will be installed and sampled at the proposed sampling locations after the boring is complete, according to push probe System SOPs; otherwise, the groundwater sampler will be used to perform all of the push probe groundwater sampling.

Table 2-1. Characterization Activities

Medium	Method	Location	Contingent Locations	Number of Samples (plus QA samples)	Number of Contingent Samples (plus QA samples)	On-site Analysis	Number of Offsite Confirmatory samples / Offsite Analysis
Soil	Hollow Stem Auger - Shelby Tube	MW1 and MW2	MW3 and MW7	4(0)	10(0)	None	Geotechnical (Table 1-7)
Soil	Hollow Stem Auger - Shelby Tube	MW1 and MW2	MW3 and MW5	2(0)	5(0)	None	Bioremediation Parameters (Table 1-8)
Surface Water Sampling	Grab/scoop	Westerly Brook (Figure 1-15)	None	2(1)	0(0)	VOCs, metals (filtered and unfiltered), field parameters[a]	2 Full chemistry (Table 2-2)
Surface Water	Continuous monitoring	West of brook	None	NA	NA	Flow	NA
Soil	Geoprobe soil samples	10 Borings at retention Ponds on MISS and Ballod (Figure 1-15)	10 Borings at additional targets on MISS and Ballod	30(3)	30(3)	Metals, VOCs, SVOCs,	3 + 3 contingent samples full chemistry (Table 2-2)
Soil	Geoprobe soil samples	10 Borings at retention Ponds on MISS and Ballod (Figure 1-15)	10 Borings at soil gas targets on MISS and Ballod	5[b](0)	5[b](0)	None	Bioremediation Parameters (Table 1-8)
Groundwater	Geoprobe groundwater samples / temporary monitoring well	10 Borings at retention Ponds on MISS and Ballod (Figure 1-15) Sampling 3 ft intervals	10 Borings at soil gas targets on MISS and Ballod Sampling 3 ft intervals	30(3)	30(3)	VOCs, metals (filtered and unfiltered), field parameters[a]	1 + 1 contingent sample full chemistry (Table 2-2)
Groundwater	Geoprobe groundwater samples / temporary monitoring well	10 Borings at retention Ponds on MISS and Ballod (Figure 1-15)	10 Borings at soil gas targets on MISS and Ballod	5[b](0)	5[b](0)	None	Bioremediation Parameters (Table 1-8)
Groundwater	Geoprobe groundwater samples / temporary monitoring well	4 borings on Transect A Sampling 3 ft intervals	4 on transect A and 16 on transects A and B Sampling 3 ft intervals	12(2)	60(6)	VOCs, metals (filtered and unfiltered), field parameters[a]	1 + 2 contingent samples full chemistry (Table 2-2)

Table 2-1. (Continued)

Medium	Method	Location	Contingent Locations	Number of Samples (plus QA samples)	Number of Contingent Samples (plus QA samples)	On-site Analysis	Number of Offsite Confirmatory samples / Offsite Analysis
Groundwater	Geoprobe groundwater samples / temporary monitoring well	4 borings on Transect A	4 on transect A and 16 on transects A and B	2(0)	4(0)	None	Bioremediation Parameters (Table 1-8)
Groundwater	Monitoring Well groundwater sampling	MW1 and MW7 - overburden and bedrock wells at each location	MW3 and MW5 - overburden and bedrock wells at each location	4(1)	8(1)	None	Full chemistry (Table 2-2)
Groundwater	Monitoring Well groundwater sampling	MW1 and MW2 - overburden and bedrock wells at each location	MW3 and MW5 - overburden and bedrock wells at each location	4(0)	8(0)	None	Bioremediation Parameters (Table 1-8)
Groundwater	Screening Sampling during installation	DW1	None	6(0)	0	VOCs	None
Groundwater	Deep Monitoring well sampling	DW1	None	1(0)	0	None	Full Chemistry (Table 2-2)
Groundwater	Monitoring Well groundwater sampling	MW1 and MW2 - overburden and bedrock wells at each location	MW3 and MW7 - overburden and bedrock wells at each location	4(NA)	8(NA)	Falling and/or rising head permeability test, point dilution test	NA
Groundwater	Monitoring Well pressure measurments	MW-1, -2, and up to 23 existing wells TBD	MW3 and MW7	25(NA)	3(NA)	Measure water level by dipping	NA
Groundwater	Monitoring Well pressure measurments	MW-1, -2, and up to 6 existing wells TBD	MW3 and MW7	10(NA)	7(NA)	Continuous (30 min intervals) electronic monitoring of pressure, specific conductance, and temperature for 30 days.	NA
Soil Gas	Passive Collectors	MISS and Ballod	None	135(14)	None	VOCs	NA

[a] Field parameters are temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox potential.

[b] One sample from each retention pond/soil gas target.

Once soil and groundwater sampling are completed, boreholes will be grouted following the push probe system's standard SOPs. The grout will be Portland Type I/II cement mixed with approximately 4 to 5 percent bentonite powder.

Soil Gas Survey

A passive, time-integrative soil gas survey will be conducted to locate and identify the VOCs in the soil and groundwater onsite at MISS. Installation and retrieval of the soil gas collectors will follow the standard SOPs and quality assurance/quality control (QA/QC) of the specific technique used. The soil gas collectors can easily be deployed in shallow holes [6 inches to 1 foot (ft)] or on the surface. If the sampling location is in an area covered with asphalt or concrete, a hole will be drilled through the cap to the soil beneath for placement of the collector. The collectors are then covered with local soils for uncapped locations, or, for capped locations, aluminum foil and a concrete patch. The soil gas collector's location, date and time of emplacement, and other relevant information will be recorded on the Soil Gas Survey Field Deployment Form. Soil gas collectors will be retrieved after the amount of time determined by the specific technique, usually three days to several weeks.

After following the specific techniques, SOPs for retrieval, the samples will be sent to an offsite laboratory for analysis by mass spectrometry or GC/MS, using modified EPA Method 8240. These analytical methods enhance specific compound identification and minimize compound masking. The emphasis of this investigation will be on detection of halogenated organic compounds (PCE, TCE, 1,2-DCE, 1,1-DCE, vinyl chloride, and benzene are the primary COCs). Analytical results are reported as semiquantitative emission flux rates and detections will be mapped using isopleth contours.

Approximately 135 soil gas sample collectors will be placed in a grid with approximately 100 ft spacing for most of the survey (Figure 1-14). This survey grid is focused on delineating possible VOCs on MISS and Ballod, particularly potential sources in the vicinity of Building 76 and the retention ponds. Sample points in this grid include areas of known groundwater contamination and areas of uncontaminated soil and groundwater.

2.1.4 Component 4: Characterize the Extent of VOCs in Shallow Groundwater Between Ballod and the Saddle River

For this component, soil and groundwater samples will be collected using a push probe system in order to characterize the extent of VOCs in shallow groundwater downgradient of MISS and to obtain data necessary to evaluate possible remediation technologies. The purpose of this sampling is to determine the nature and extent of VOCs in shallow groundwater downgradient of MISS and Ballod.

Up to 24 push probe borings will be driven to refusal to a depth of approximately 20 ft in order to collect groundwater samples. If refusal occurs at a shallow depth (5 to 15 ft) and it is suspected that weathered bedrock has not been encountered, then up to 2 additional attempts will be made at the same location (1 to 2 ft either side) to achieve top of weathered bedrock. In the repeated attempts, soil sampling will not be conducted until the depth of refusal from prior attempts is achieved. Soil samples will be taken only for bioremediation parameters at selected intervals in each boring. Soil and groundwater sampling will follow the same SOPs for the push probe sampling system described in Component 3. Analytes for groundwater will be the same as those for Component 3. Soil will be analyzed only for biological parameters (Table 1-8).

Up to three transects (A, B, and C) of four borings each, plus four additional contingent borings are proposed. The locations of the transect take advantage of the layout of residential streets downgradient of MISS (Figure 1-15), however; depending on property access requirements the borehole locations could be located on residential properties or municipal right-of-ways. However, the final locations of transect borings will depend on the location of underground utilities and access. If the locations of borings shown on Figure 1-15 is not feasible, then nearby locations will be selected.

Transect C would be situated just to the west of the street bordering the Saddle River. As outlined in the decision rule (see Figure 1-17), if VOCs occur in groundwater in either of the outermost borings along each transect, then additional contingent borings will be driven to sample groundwater stepping out along the direction of the transect line at 100-ft intervals (where feasible) until VOC-free groundwater is encountered or a total of eight borings has been driven in a transect. A maximum of eight borings per transect or a total of twenty-four borings is planned for the area downgradient of MISS. For planning purposes it is assumed that each transect will be sampled; however, under the following scenarios, using the SAFER and DQO approaches, the extent of sampling will be reduced:

- If there is no indication of VOCs in groundwater in transect A, then transects B and C will not be sampled.
- If there is no indication of VOCs in transect B (after VOC detection in groundwater in transect A) then transect C will not be sampled.

Borings at these locations, if completed in paved areas, will be driven following the push probe system's SOPs for sampling underneath asphalt and concrete by initially driving a pilot hole or pre-probing.

2.1.5 Component 5: Monitoring Well Installation/Sampling

Between 4 and 7 nests of two monitoring wells (one screened in bedrock and one in the overburden) will be installed at locations downgradient of MISS. Of these locations one will be adjacent to Highway 17 on the Ballod property and a second will be near the Saddle River

(Figure 1-15). In addition, one deep well will be drilled at the location of existing wells B38W14S and B38W14D. The remaining locations will be selected based on push probe sampling in component 3 using the following decision rules:

- If VOCs do not occur in groundwater in Transect A then two additional monitoring well nests (4 wells) will be installed on transect A.
- If VOCs occur in Transect A, but do not occur in groundwater in Transect B, then two additional monitoring well nests (4 wells) will be installed on transect B.
- If VOCs occur in groundwater in transects A and B but not in C then two additional well nests (4 wells) will be installed, one on transect C and one on transect B.
- If VOCs occur in transects A, B, and C then three additional well nests (6 wells) will be installed, two on transect C and one on transect B.
- If VOCs occur in groundwater or soil on the Ballod property, two well nests (4 wells) will be installed or Ballod adjacent to Highway 17 (Figure 1-15).

In each nest, one monitoring well will be screened in the shallow unconsolidated aquifer and one in the bedrock aquifer, respectively. Each bedrock aquifer monitoring well will be installed first in order to determine the interval where the shallow unconsolidated aquifer well should be installed. Borings in the overburden will be drilled using a hollow stem auger or other suitable equipment capable of retrieving split spoon samples of soil.

The deep monitoring well boring will be sampled at 5-ft intervals during drilling. The boring will be installed after two consecutive samples with falling VOC concentrations. The well screen will be located at the elevation with maximum VOC concentrations, unless the depth coincides with the depth of the well screen in well B38W14D (46 to 51 ft) in which case the boring will be plugged and abandoned.

Soil Sampling During Monitoring Wells Installation

Up to two soil samples will be collected from each monitoring well nest location by a hollow stem auger using a Shelby-Tube sampler. These samples will be analyzed for geotechnical parameters (Tables 1-7 and 2-1). In addition a soil sample will be taken and analyzed for bioremediation parameters (Tables 1-8 and 2-1). This sample will be one split-spoon sample or a third Shelby-Tube sample taken in the overburden from below the water table.

For geotechnical analysis, one Shelby-Tube sample will be collected from the upper two feet of the soil column. The second Shelby-Tube sample will be collected from the upper two feet of the first encountered saturated interval. For bioremediation parameters, a split-spoon or third Shelby-Tube sample will be collected from the next two feet of saturated zone. To ensure that the soil is not artificially compacted during the sample collection process, the Shelby-Tube sampler will be hydraulically pushed into the ground as opposed to being beaten into the ground using a hammer.

Monitoring Well Construction

Monitoring wells will be comprised of a 4-in.-diameter PVC and riser pipe. The screen will be 5-ft in length and the slot size will be 0.01 inches (Figure 2-1). Wells installed in the overburden will be an 8 inch-diameter borehole drilled approximately 12 ft below the first encountered saturated interval in each aquifer. The well will be constructed so that the screen is positioned across the zone with the highest VOC concentrations observed while sampling using the push probe. This construction will assure that fluctuating water levels remain within the screened interval.

Wells installed in bedrock will be an 8 inch-diameter borehole drilled to approximately 10 ft below the zone of weathered bedrock or to a maximum depth of 60 ft whichever is shallowest. Bedrock wells will be screened across the bedrock/weathered bedrock interface.

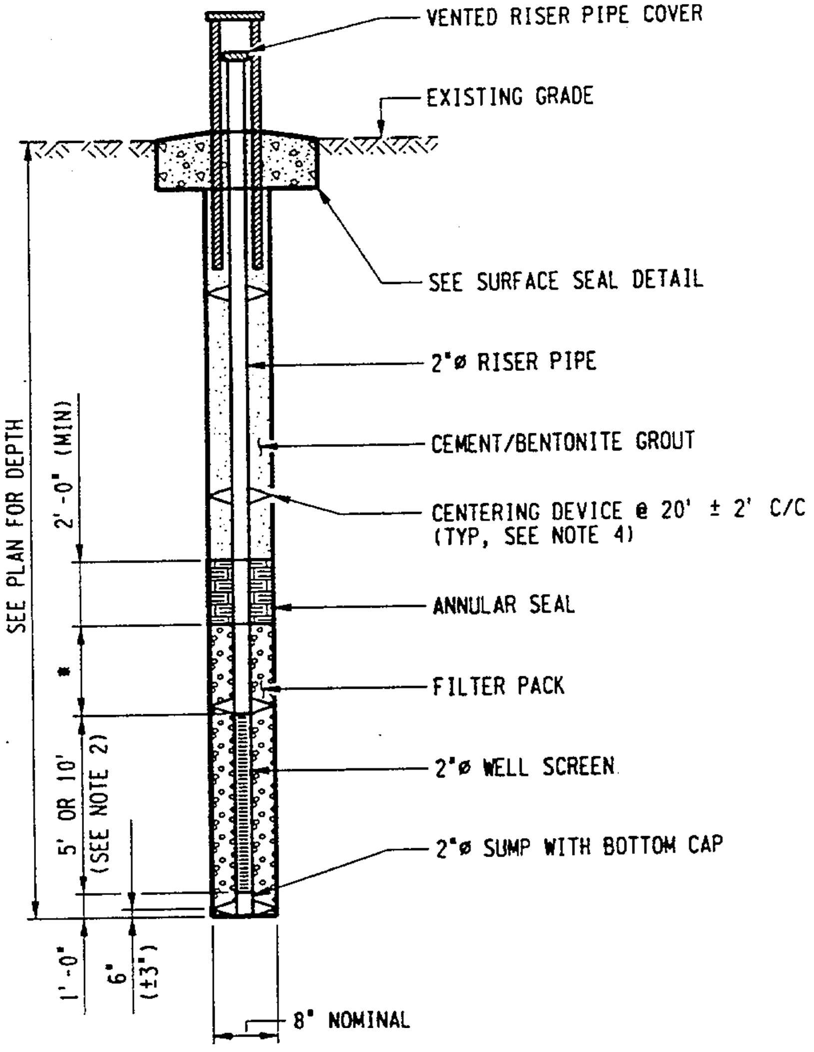
A sand pack will be built around the well screen to a depth of 2 ft above the top of the screened interval, and will be of a grain size compatible with the selected well screen (see Driscoll 1986). A 2-ft bentonite seal will then be placed over top of the sand pack, followed by grouting to the ground surface. Since the Maywood site receives a relatively high annual precipitation (rain and snow) rate, above-ground well completions are desirable (Figure 2-1) unless the location will interfere with site operations or are in public locations where below ground completion is more desirable (Figure 2-2).

Sampling Monitoring Wells

Prior to sampling, each well will be developed to attempt to remove fine grained materials from the formation, remove any clay material that may be smeared along the walls of the borehole, and develop the sand pack so the well reflects true aquifer conditions. The well will be developed until a minimum of three well volumes of water have been removed. During development, water quality parameters will be monitored: pH, specific conductance, dissolved oxygen, and turbidity. Development will be considered complete when turbidity has been minimized (± 10 percent variation over three successive samples) and water quality parameters have stabilized (pH ± 0.1 and conductivity ± 10 percent).

Micro-Purge techniques will be used just prior to well sampling to remove stagnant well water just prior to sampling. Similar to development, purging shall be performed until the pH (± 0.1), conductivity (± 3 percent), Eh (± 10 mV), dissolved oxygen (± 10 percent), and turbidity (± 10 percent) have stabilized.

One groundwater sample will be collected from each of these wells and will be analyzed for VOCs, metals (filtered and unfiltered), radionuclides (filtered and unfiltered), major anions, and biological parameters (Tables 2-1 and 2-2) at an offsite laboratory. All sampling will follow



* = 2' TO 10' (AS DETERMINED
IN THE FIELD BY BECHTEL)

TYPE I WELL INSTALLATION

NTS

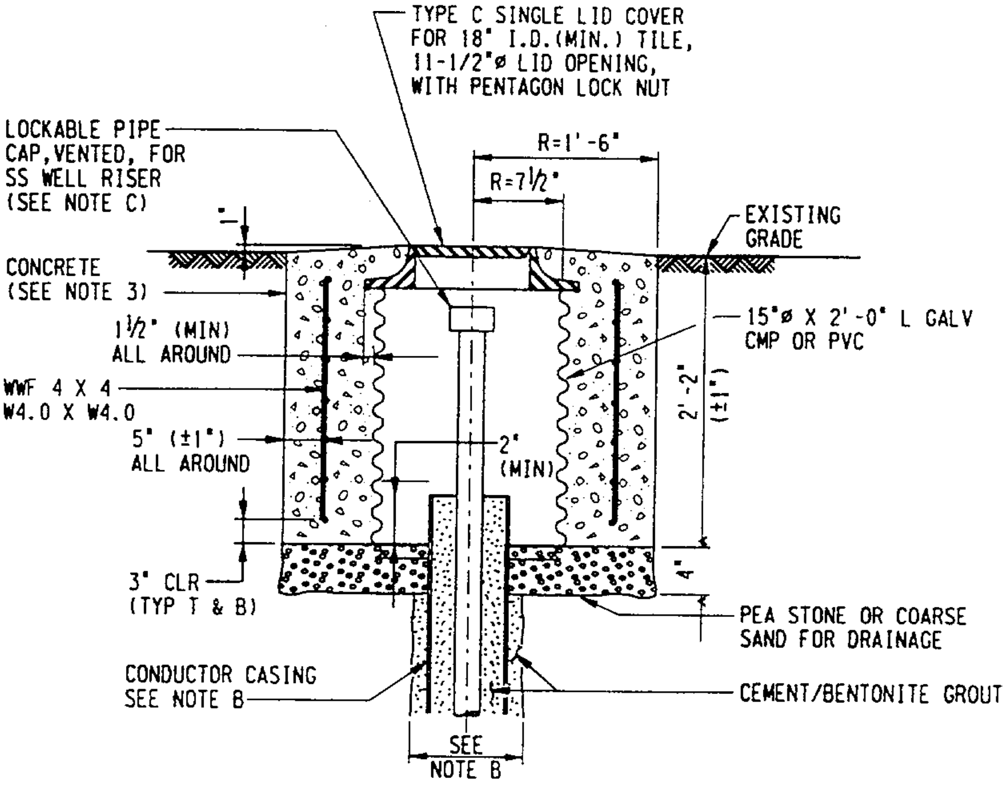
NOTES:

A. TYPE I WELL INSTALLATION IS FOR OUTDOOR LOCATIONS WHERE MONITORING WELL IS TO BE INSTALLED ENTIRELY ABOVE BEDROCK.

SOURCE: BECHTEL DESIGN DRAWING 191-DD00-C-03, REV 8.

112F005.DGN

Figure 2-1. Above Ground Well Completion



FLUSH MOUNT SURFACE SEAL FOR MONITORING WELL

NOTES:

A. THIS DETAIL IS INTENDED TO DEPICT ONLY THE FLUSH MOUNT SURFACE SEAL. THE MONITORING WELL SHALL BE COMPLETED PER THE APPROPRIATE WELL INSTALLATION DETAIL.

B. NO CONDUCTOR CASING REQUIRED FOR TYPES I AND II INSTALLATIONS.

C. TOP OF PIPE CAP TO BE SET 3" TO 6" BELOW EXISTING GRADE.

SOURCE: BECHTEL DESIGN DRAWING 191-DD00-C-03,REV 8.

112F006.DGN

Figure 2-2. Below Ground Well Completion

Table 2-2. Preservatives, Containers, and Holding Times

Analyte/Test	Container (provided by all sources)	Quantity	Preservative	Holding Time	Sample Extraction	Sample Analysis Method
Soil/Sediment						
VOCs (including methane)	125 ml clear glass jar	20 g	Cool 4°C	14 d	NA	SW846, 8260A
SVOCs	250 ml amber glass jar	100 g	Cool 4°C	14 d ext 40 d	3550	SW 846, 8270B
Metals (including Li, B, and As)	250 ml glass jar	20 g	Cool 4°C	18 d	3050	SW 846, 6010/7000
Phosphate	250 ml glass jar	20 g	Cool 4°C	28 d	NA	EPA 365.4 Mod
total Kjeldahl nitrogen	250 ml amber glass jar	20 g	Cool 4°C	28 d	NA	EPA 351.2 Mod
ammonia	250 ml glass jar	20 g	Cool 4°C	28 d	NA	EPA 350.2 Mod
total organic carbon	250 ml amber glass jar	50 g	Cool 4°C	28 d	NA	SW 846, 9060
Total Hetrotrophic Bacteria	250 ml glass jar	50 g	Cool 4°C	a.s.a.p.	NA	SM[a]-9215-C
Solvent Mineralization potential	250 ml glass jar	100g	Cool 4°C	a.s.a.p.	NA	Specialty Lab SOPs
Geotechnical Parameters (Table 1-5)	Shelby Tube	Shelby Tube	None	NA	NA	
Surface Water/Groundwater						
VOCs (including methane)	2-40 ml VOC vials	80 ml	HCl to pH<2, Cool 4°C	14 d	NA	SW 846, 8260A
SVOCs	950 ml amber glass	1000 ml	Cool 4°C	7 d ext	3520	SW 846, 8270B
Metals (including Li, B, and As)	1000 ml poly. bottle	1000 ml	HNO_3 to pH<2, Cool 4°C	180 d	3005	SW 846, 6010/7000
Total organic carbon	125 ml glass spectrum	50 ml	H_2SO_4 to pH<2, Cool 4°C	28 d	NA	SW 846, 9060
anions (Cl, F, PO_4, SO_4)	250 ml poly. bottle	100 ml	Cool 4°C	28 d	NA	SW 846, 9056
NO_3/NO_2	250 ml poly. bottle	100 ml	H_2SO_4 to pH<2, Cool 4°C	28 d	NA	EPA 353.2
phosphate (Total)	1 L poly. bottle	500 ml	H_2SO_4 to pH<2, Cool 4°C	28 d	NA	EPA 365.4
sulfide	1 L poly. bottle	500 ml	2 ml zinc acetate + NaOH to pH>9	7 d	NA	EPA 376.2
total Kjeldahl nitrogen	1 L poly. bottle	500 ml	H_2SO_4 to pH<2, Cool 4°C	28 d	NA	EPA 351.2
ammonia	1 L poly. bottle	400 ml	H_2SO_4 to pH<2, Cool 4°C	28 d	NA	EPA 350.2
pH	NA	NA	NA	NA	NA	EPA 150.1
temperature	NA	NA	NA	NA	NA	EPA 170.1
conductivity	NA	NA	NA	NA	NA	EPA 120.1
turbidity	NA	NA	NA	NA	NA	EPA 170.1
dissolved oxygen	NA	NA	NA	NA	NA	EPA 360.1
redox potential	NA	NA	NA	NA	NA	Electrometric

[a] SM = Standard Methods

Instruction Guide EP-018, "Procedures for Sample Containers, Preservatives, and Holding Times" (BNI 1994b). Measurements of pH, temperature, conductivity, and turbidity will be made in the field shortly after sample collection.

Hydraulic Testing of Monitoring Wells

One falling and/or rising head permeability test will be performed in up to 14 groundwater monitoring wells to provide additional data on aquifer characteristics.

Hydraulic head will be measured in all operating monitoring wells (this study and existing DOE wells) over a 48-hour period in which there is no rainfall. This will allow for a hydraulic head map to be constructed for MISS and neighboring properties. Continuous monitoring of hydraulic head and specific conductance will be performed for a one month period at up to 14 monitoring wells. Continuous monitoring will be conducted with downhole pressure transducers (10 psi) and specific conductance probes. Readings will be taken every 15 minutes. Over the same period, water level in Westerly Brook will be monitored continuously every 10 minutes.

3.0 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Sample handling, packaging, and shipping practices will be conducted in accordance with FUSRAP procedures. Samples shall be handled using the sample custody and labeling methodology described in the instruction guide (IG) 191-1G-028, "Instruction Guide for Surface Water and Sediment Sampling Activities" (BNI 1993a) and the sample surveying, packaging, and shipping methodology in Project Instruction (PI) C7.7 "How to Ship Samples from a FUSRAP Site" (BNI 1996a).

Samples for offsite analysis will be shipped to the following laboratories:

Chemical: Roy F. Weston, Inc.
208 Welsh Pool Road
Lionville, PA 19341
Attn: Sample Log-in

Geotechnical: Applied Geotechnical Engineering Consultants (AGEC)
c/o Mountain States Analytical
1645 West 2200 South
Salt Lake City, Utah 84119
Attn: Scott Frazier

Radiological: ThermoNutech (TN)
Attn: Sample Log-In
601 Scarboro Road
Oak Ridge, TN 37830

Procedures for dealing with the various laboratories are described in PI E2.7, "Interaction with the Geotechnical Analysis Subcontractor," and PI E2.4, "Interaction with the Chemical Analysis Subcontractor." Samples will be marked and labeled according to PI C7.3, "Marking Requirements for the Transportation of Hazardous Materials," and Instruction Guide PI C7.4, "Labeling Requirements for the Transportation of Hazardous Material" (BNI 1995a, BNI 1996c, BNI 1996e and BNI 1996f).

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4.0 DECONTAMINATION

Decontamination will be conducted in accordance with the "Instruction Guide for Decontamination of Field Sampling Equipment at FUSRAP Sites" (BNI 1992b) and "Radioactive Decontamination and Waste Control" (BNI 1996e). Decontamination procedures vary depending upon parameters for which samples will be analyzed and the expected COCs present in the media being sampled. Decontamination of drilling equipment by the drilling subcontractor will be conducted onsite or as specified by the Site Superintendent.

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5.0 HANDLING OF INVESTIGATION-DERIVED WASTE

All waste generated during field activities will be handled in accordance with BNI waste disposal procedures (BNI 1993b). Investigation derived waste from drilling and sampling will be returned to the borehole from which it was derived in accordance with EPA and New Jersey requirements. Efforts throughout the field program will be made to minimize the volume of soil and water wastes derived from drilling, sampling, and decontamination procedures, as well as the volume of personal protective equipment (PPE) waste. Prior to disposal, PPE will be scanned onsite using hand-held alpha and beta/gamma screening instruments to segregate radiological waste from clean waste.

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6.0 QUALITY ASSURANCE PROJECT PLAN

To address the work scope outlined in this document, the QA objectives established for this project are listed below. Generally, the total error in the results derived from the data will be controlled to achieve an acceptable level of confidence in the decisions that are made from the data. The methods and procedures used to implement and accomplish the following objectives are described throughout the plan.

- Implement standard operating procedures (SOPs) for field sampling, sample custody, equipment operation and calibration, sample analysis, data reduction, and data reporting that will ensure the consistency and thoroughness in data generated.

- Assess the quality of data generated to ensure that all data are scientifically valid, and of known and documented quality and legally defendable, where appropriate. This is largely accomplished by establishing DQOs using EPA's seven step DQO process (EPA 1994a; see Section 1.7 of this SAP).

- Achieve an acceptable level of confidence in the decisions that are made from data by controlling the degree of total error permitted in the data using QC checks. Data that fail the QC checks, or do not fall within the acceptance criteria established, will be rejected from further use or qualified for limited use.

- Ensuring that the quality assurance procedures outlined in this plan are properly implemented by conducting compliance inspections and audits. In addition, verify that corrective actions are executed for any nonconformances identified.

6.1 SAMPLING PROCEDURES

SOPs will be carefully followed during the field sampling activities to ensure that the samples collected are an accurate reflection of current site conditions. The advantage to following SOPs is that all samples are collected in a consistent manner, which supports the comparability of the analytical results. All field activities will adhere to requirements outlined in the *Quality Action Plan* (BNI 1996h). Sampling procedures will follow Instruction Guides 191-IG-028 (BNI 1993a) and 191-IG-041 (BNI 1996d). Any deviation from SOPs or the SAP during field activities will follow the procedure for field change requests (FCRs), M4.6 "Preparation of FCR" Rev. 1 (BNI 1996j).

6.2 QUALITY ASSURANCE/QUALTIY CONTROL

QC samples will be collected at the same time and handled in the same manner as the regular sample. Environmental duplicate samples or survey measurements (e.g., organic vapor surveys) should be collected at a frequency of at least five percent (one for every 20 samples/measurements taken), or one per radiological or chemical sample set/batch (whichever is smaller). Do not collect duplicates for geotechnical analyses. Rinsate blanks should be collected from the sampling equipment for each day of sampling and analyzed for those parameters being sampled on that day. Matrix spikes should be collected from at least one sampling location for every 20 locations sampled, or one per batch (whichever is smaller). Trip blanks should be collected at locations where samples will be analyzed for VOCs. Additional requirements for QA/QC samples should be consulted in 191-IG-041, "Instruction Guide for Soil Sampling Activities" (BNI 1996d); 191-IG-028, "Instruction Guide for Surface Water and Sediment Sampling Activities" (BNI 1993a).

6.3 SAMPLE CUSTODY

To ensure the court defensibility of analytical results, sample chain-of-custody will be maintained at all times, from the time the sample is collected to the time the analytical results are returned from the onsite or offsite laboratory. Sample custody will be maintained through the utilization of chain-of-custody forms, chain-of-custody labels, assigning sample ownership, and locking samples in an area known to be free of COCs when not in the custody of the sample custodian.

6.4 FIELD NOTEBOOKS AND DOCUMENTATION

All field activity records will be kept in accordance with PI E2.9, "Control of Field Log Books" (BNI 1996a).

All sampling personnel will keep indelible black ink records of daily field activities in bound field notebooks. Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during projects and to refresh the memory of the field personnel if called upon to give testimony during legal proceedings. In a legal proceeding, logbooks are admissible as evidence, and consequently must be factual, detailed, and objective.

Field logbooks must be permanently bound, the pages must be numbered, and all entries must be written with permanent ink, signed, and dated. If an error is made in a notebook, corrections can be made by the person who made the entry. A correction is made by crossing out the error with a single line, so as not to obliterate the original entry, and then entering the correct information. All corrections must be initialed and dated. The first page of the logbook should be used as a "Table of Contents" to facilitate the location of pertinent data. The first daily event entry should always be the date, followed by a detailed description of the weather conditions. All entries should always begin with the time of the entry.

To expedite sampling activities and to reduce the number of documentation errors made in the field, pre-printed sample collection logbooks are proposed to be used for this sampling program.

Examples of the pre-printed information that will be contained within the sample logbooks include the:

- Site name
- Sampling location
- Sampling interval
- Sample number
- Sample media (soil, water, sediment, etc.)
- Type of sample (grab, composite, integrated)
- Analyses to be performed

Whenever possible, field sampling forms should be used to reduce documentation requirements and to remind field personnel of the type of information they need to collect. Examples of sampling forms are as follows:

- Borehole log forms
- Well completion forms
- Well development forms
- Well purging and sampling forms
- Water level measurement forms

At the completion of field activities, all field documentation, analytical data, and reports generated from this data will be assigned a document control number and submitted to Project Document Control Center as a permanent record.

6.5 EQUIPMENT OPERATION AND CALIBRATION

All sampling, field-screening, and analytical equipment used to support this effort will be calibrated to operate within the specifications provided by the manufacturer. Calibration will be performed as stipulated by the manufacturer's calibration procedure or as specified by the analytical method. Continuing calibration of all field instruments will be conducted periodically throughout the work day. For radiological screening instruments source/response checks will be performed. Instruments such as organic vapor analyses, pH meters, etc. will be calibrated using standard solutions.

6.6 SAMPLE ANALYSIS

The analyses that will be run on the various types of samples and their corresponding precision and accuracy requirements are discussed in Section 1.7.5 and included in Tables 1-6 and 2-2. The analyses performed in the field will be modified versions of these methods.

All of the data resulting from this field effort will be loaded into the Bechtel Integrated Environmental Data Management System. This system will assist the user in evaluating the data and will control changes made to the database.

6.7 DATA REPORTING

While there will be insufficient time to develop data reports in the field during onsite operations, streamlined data reports will be prepared for this data upon returning from the field. Additionally a World Wide Web (WWW) Homepage will be established for this site. As data is obtained, it will be posted on the WWW to enable stakeholders to access this information. These reports shall include the following information:

- Sample number
- Sampling and analysis times and dates
- Data results
- Holding time results
- Instrument calibration data
- Copy of chain-of-custody record

The reporting requirements for analytical methods performed at an offsite laboratory will be more extensive, and will include:

- Sample number
- Sampling and analysis time and dates
- Data results
- Holding time results
- Instrument calibration data
- Summary of quality control check data
- Documentation of any nonconformances that may have affected the analytical results

6.8 DATA QUALITY AND LEGAL DEFENSIBILITY

In order for analytical data to be defensible in a court of law, documentation must exist to substantiate that:

- sample custody was not broken between the time the sample was collected and the time it was analyzed;
- samples were analyzed within maximum holding times;
- instruments were properly calibrated at the time analyses were performed; and
- analytical precision and accuracy requirements were met.

For this reason, chain-of-custody seals and forms will be used for samples being analyzed onsite or offsite. Sample logbooks will be used to record the sample collection date and time. Samples will be transported to the onsite laboratory at the end of each day of sampling. The custody of samples requiring offsite analysis will be transferred to the overnight shipping company within 24 hours of sample collection. The onsite and offsite laboratory will be provided a sampling schedule prior to the commencement of field operations to support the planning process. The frequency of instrument calibration will be consistent with the requirements of the specified analytical methods, and the precision and accuracy requirements will be consistent with those specified in Tables 1-6 and 2-2.

6.9 FIELD QUALITY CONTROL CHECKS

Field quality control samples such as duplicates, rinsate blanks, field blanks, and when appropriate trip blanks, will be collected as appropriate throughout the field effort as required by the Quality Action Plan (BNI 1996h). Data resulting from these blanks will be used to evaluate the precision of analytical methods, test the effectiveness of equipment decontamination procedures, test the quality of water used to support the sampling effort (decontamination water), and to confirm that TCLP-VOC samples are not contaminated in transport to the laboratory.

6.10 QUALITY CONTROL CHECKS

Quality control checks such as running blank, spike, and duplicate samples will be performed routinely during sample analysis to assure that onsite and offsite analytical instruments are providing reliable data. These control checks will be performed at the frequency consistent with that specified by the analytical method.

6.11 AUDITS AND CORRECTIVE ACTIONS

A minimum of one surveillance will be performed during field operations to confirm that field operations are being performed in accordance with this SAP and FUSRAP SOP. The surveillance will pay particularly close attention to onsite analytical methods, and the management of field data. Corrective actions shall be implemented immediately in the field to resolve any nonconformances identified by the surveillance.

7.0 HEALTH AND SAFETY

All field operations will be performed under the guidance and direction of the onsite Health and Safety Representative who will ensure the implementation of the health and safety requirements outlined in the site-specific Health and Safety Plan. Hazards of particular concern at the Maywood site include:

- Heat stress
- Inhalation of radiologically contaminated dust particles
- Ingestion of radiologically contaminated dust particles
- External radiological exposure
- Inhalation of VOCs (i.e., PCE and vinyl chloride)
- Explosivity of VOCs
- Hazards associated with working in the vicinity of heavy machinery
- Encountering buried electrical lines while drilling and sampling

The Health and Safety Plan will be submitted to all contractors onsite prior to the initiation of work on the site.

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8.0 REFERENCES AND BIBLIOGRAPHY

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APPENDIX A

GENERAL FIELD SAMPLING GUIDANCE

GENERAL FIELD SAMPLING GUIDANCE

Sampling Guidelines

These guidelines provide task-specific guidance to meet the data quality objectives stated in Section 1.7 of the Maywood Groundwater Sampling Analysis Plan (SAP). The Formerly Utilized Sites Remedial Action Program (FUSRAP) has instituted a series of work-controlling documents which standardize sampling activities for the program. The work-controlling documents include a Project Instruction (PI), an Instruction Guide (IG), a Health Physics Operational Procedure and a Work Instruction (WI). Applicable documents will be identified and carefully followed so that all samples are collected in a consistent manner, which supports the comparability of the analytical results.

General Sampling Responsibilities

1. The Site Superintendent (SS) or designee will be responsible for general oversight of the activities onsite. The SS and Project Management Contractor (PMC) [Bechtel National Inc. (BNI)] Environmental Technology (ET) team lead/designee will interface with the Chemical Services Subcontractor (CSS), the Geotechnical Services Subcontractor (GTSS), and the Environmental Studies Contractor (ESC) [Science Applications International Corporation (SAIC)] to direct completion of specific tasks.

2. The PMC ET (BNI) team lead/designee and CSS and GTSS supervisors will be responsible for ensuring that appropriate samples and survey measurements are collected, ensuring that appropriate methods are used and documented, that samples are shipped in a timely and correct fashion, and that optimum locations are identified for sample collection.

3. The ESC (SAIC) is responsible for assuring that all aspects of the SAP are met (including concurrence with optimum sample collection).

4. The PMC (BNI) Site Safety and Health Representative (SSHR) will provide safety oversight.

5. The BNI Field Engineer (FE) will be responsible for supervising the handling, packaging, labeling, storing, and disposing of investigation derived waste (IDW).

6. During sampling, each sample crew should have in their possession a copy of the most recent PI or IG pertinent to the sampling method which they are performing, a copy of the final Maywood Groundwater SAP, and applicable changes such as Field Change Notices (FCN) or Field Change Requests (FCR).

7. All stages of sampling should be performed in a manner that minimizes the time and cost of sampling, analysis, and disposal.

Identify Utilities Prior to Sampling

Prior to sampling, the SS/FE will evaluate each sample location for possible underground utility lines. The SS/FE will also coordinate sampling locations with property owners prior to commencing operations. The SS or designee will initiate One-Call to identify the locations of all underground utilities prior to sampling.

Health and Safety

All personnel must have current OSHA hazardous worker training and a current medical exam approved by Bechtel. The personnel must also have received Radworker II training. The guidelines stated in the Health and Safety Plan for the Maywood Site will be followed. The Site Safety and Health Representative (SSHR) will determine if continuous air monitoring is required. The PMC health physics technician will be responsible for monitoring worker exposure, the worker's breathing zone, work practices and for determining when work practices require modification to protect the workers. A Hazardous Work Permit (HWP) will be completed, listing the PPE requirements for the work and any hazards associated with the work. Workers will be briefed on HWP contents prior to starting work. Underground utility locations will be verified by the Site Superintendent or Field Engineer prior to the collection of intrusive samples, as applicable.

Decontamination

(See Section 4.0 of the Sampling and Analysis Plan)

Coordination with Analytical Laboratories

For offsite chemical analyses, coordinate with BOA laboratories according to PI E2.4, Rev. 7 "Interaction with the Analytical Laboratory Subcontractor" (BNI 1996d).

For geotechnical physical analyses, coordinate with AGEC according to PI E2.7, "Interaction with the Geotechnical Analysis Subcontractor" (BNI 1995a).

Sample Identification

Sample identification (ID) shall conform to the general format: 38-*####*. All samples from a single borehole will be assigned the same sample ID with a different letter depth identifier (AB for the interval 0 to 1 ft, CD for the second 1 to 2 ft interval, etc.). All samples shall be labeled in sequential order, regardless of the matrix. Each QA/QC sample will be identified according to the applicable sample ID followed by an additional two- or three-letter identifier: -DP for field duplicate, -MS for matrix spike, -MSD for matrix spike duplicate. Rinse blanks shall be labeled 38-RB-Month/day of collection.

Quality Control Samples/Survey Measurements

(See Section 6.2 of the Sampling and Analysis Plan)

Background Samples/Measurements

Background samples and measurements will be collected in accordance with TN Procedure 3C.2, "Determination of Background" (TN 1992). Background sample locations and depths will be representative of soil horizons (texture, structure, and color) found onsite. Samples will be collected at locations which are remote from the site to ensure no onsite contamination contributes to background levels.

Field Screening of Samples/Increments/Boreholes

Screen samples/increments/boreholes by using portable survey instruments (organic vapor analyzers including photo- or flame ionization detectors to verify where organic concentrations *occur* in each borehole. Record the highest reading of the field screening and any observations for every 1 ft interval in a field logbook. Samples may be sent for chemical analysis when field screening or analytical results indicate the presence of organic contamination in the interval/sample.

Sample Analyses

To eliminate the need to handle acids in the field, water samples collected for radioanalyses shall be preserved in the laboratory.

Additional offsite analytical and geotechnical parameters which may be requested for waste classification or characterization are listed on Table 2-1.

An on-site gas chromatograph/mass spectrometer (GS/MS) will be used to identify volatile or semi-volatile chemical constituents. A minimum of 10 percent of samples should be sent to an off-site laboratory for confirmatory analysis.

Identification of Soil Sample or Borehole Locations

Document sampling locations by measuring from two permanent structures or features with the goal of obtaining measurements that are reproducible horizontally within 1.5 m. The vertical position of soil sample boreholes should be reproducible to within 0.15 m. The leaching of all boreholes, groundwater wells, and soil gas sample locations should be surveyed, by a surveyor licensed in the State of New Jersey, so that their horizontal and vertical coordinates can be reproduced to 0.001 m. Record sampling locations so that the points can be relocated on figures by CADD. Elevations of deep boreholes used for groundwater sampling will be determined in the field using a level in conjunction with existing benchmarks. Alternatively, a global positioning instrument may be used to locate sample points.

Logbook Maintenance, Sample Packaging, Archiving, and Shipping

(See Sections 3.0 and 6.4 of the Sampling and Analysis Plan)

Waste Management

This section describes the work required to properly manage investigation derived waste (IDW) resulting from the groundwater characterization effort at the Maywood site. IDW will consist of drill spoils, excess sample material, PPE, decontamination water and solutions, and coring water.

Waste minimization methods will be utilized throughout the characterization effort. However, any generated IDW will be segregated by soils, water/liquids, and miscellaneous materials (solids) such as PPE at the point of generation. Field surveying techniques, historical data, and analytical results will be used to determine whether the IDW is radiologically clean or contaminated. Based on currently available data, no IDW is expected to be considered a hazardous waste. However, if unique or unusual site conditions are encountered (either from visual observations or field instrumentation reading) additional sampling and analysis will be performed as necessary to determine if the material should be classified as a hazardous waste. Any IDW that is containerized will be labeled and stored in accordance with established program procedures and instructions and other applicable regulatory requirements. All IDW dispositions shall be conducted in a manner that is protective of human health and the environment.

Soils

Radiologically clean IDW will be returned to the location on the property from which it was obtained to the extent possible; residual material will be returned to the DOE-owned Maywood Interim Storage Site (MISS) for other uses. To the maximum extent possible, IDW that is determined to be radiologically impacted will also be replaced in the location and from the property from which it was generated. Any remaining IDW that is radiologically impacted will be containerized, labelled, and returned to MISS for temporary storage. This material will be shipped for offsite disposal during other shipments of waste resulting from ongoing removal actions at vicinity properties.

Water/Liquids

For water and liquid IDW that is determined to be radiologically clean, it will be spread on the property of origin and allowed to infiltrate back into the soils as appropriate and to the extent possible. Excess volumes will be containerized, taken to MISS, and used as dust control and/or spread for infiltration into the soils. Radiologically impacted liquid IDW will be handled in the same fashion except that spreading and infiltration must occur within an area of existing radiological impacted soil. Under no circumstances shall spread-water or -liquids be allowed to create surface water runoff.

Miscellaneous Materials

Miscellaneous solid materials will be surveyed for elevated radiological concentrations. Any material that is deemed radiologically clean will be segregated and either taken to MISS for reuse (equipment) or to a solid waste disposal (consumables). For materials that are radiologically impacted, an attempt will be made to decontaminate them to meet radiological release criteria. If successful, these materials will then be handled as clean IDW. Materials that cannot be decontaminated to release-criteria will be managed appropriately by containerizing, labelling, and returning to MISS for eventual offsite disposal.

Soil Gas Survey

Installation and retrieval of the passive, time-integrative soil gas sample collectors will follow the field procedures of the specific technique selected. A predictive time model for determining the optimum time of collector deployment must be used. The field procedures must include instructions for deployment of system components in locations covered with soil or vegetation and those locations covered with concrete or asphalt as shown in Figure A-1. Installation and retrieval of soil gas collectors must also follow the specific techniques of the QA/QC program. After retrieval, the soil gas samples must be sent to an offsite analytical laboratory.

Soil Sampling Guidelines

(See Section 2.1.8 and 2.2.1 of this Sampling and Analysis Plan)

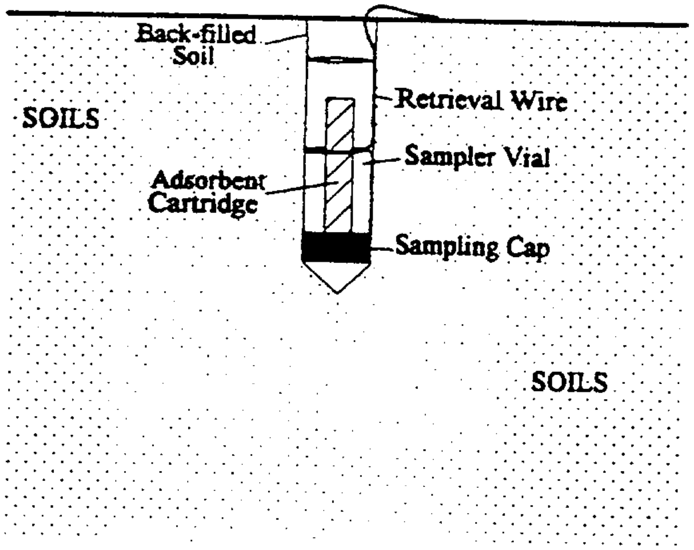
All soil samples will be collected in accordance with “Instruction Guide for Soil Sampling Activities” (191-IG-041) (BNI 1996e). Geotechnical samples will be coordinated with the laboratory according to PI E2.7, “Interaction with the Geotechnical Subcontractor” (BNI 1995b).

Retrieval of soil samples by push probe methods must follow the SOPs of the specific system used. The SOPs must outline how the specific system’s equipment will be used to collect discrete soil samples at depth. A specific soil sampler that is attachable to the specific system’s equipment must be used, such as the Geoprobe Large Bore Soil Sampler. The dimensions of the soil sampler must be large enough to provide an adequate volume for chemical analysis. The soil sampler and any associated liners must be comprised of materials conducive for sampling VOCs.

Groundwater Sampling Guidelines

The collection of groundwater samples by "direct push" methods must follow the SOPs of the specific system used. The SOPs must outline how the specific system’s equipment will

DEPLOYMENT THROUGH SOILS



DEPLOYMENT THROUGH AN ASPHALT/CONCRETE CAP

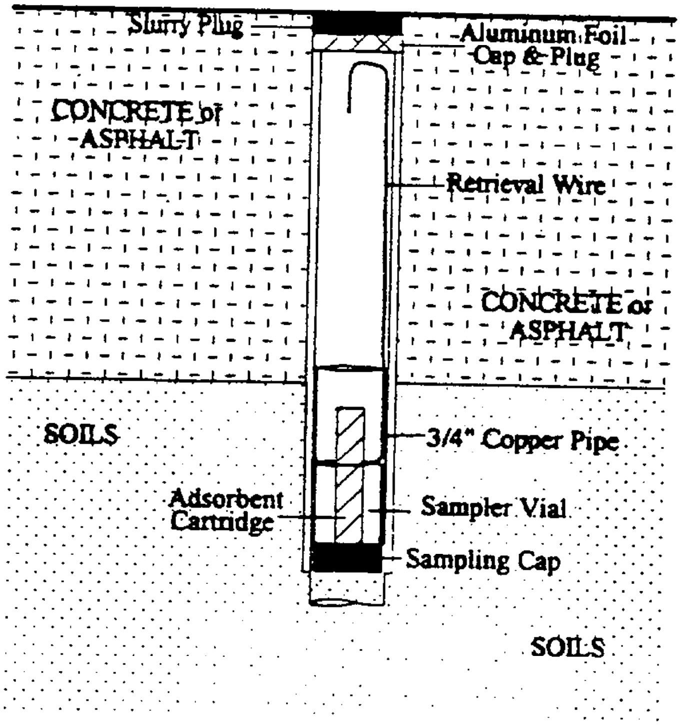


Fig. A-1. Example of Soil Gas Collection System be used to collect discrete groundwater samples. Options for groundwater sampling are using a discrete groundwater sampler incorporating either a mini-bailer or peristaltic pump, such as the Geoprobe Screen Point 15 Groundwater Sampler or a BAT Sampler. The specific system used must be able to provide an adequate volume of groundwater for chemical analysis. The specific system used must be comprised of materials conducive for sampling VOCs and metals.

Continuous Measurement and Recording of Hydrostatic Pressure, Groundwater Electrical Conductivity, and Groundwater Temperature simultaneously in a Well using a Data Logger

After monitoring well installation, the simultaneous measurement of hydrostatic pressure, groundwater conductivity, and groundwater temperature in a well must be collected following the SOPs of the specific data logger used. The SOPs must outline how the specific data logger is properly installed, how the probes and pressure transducers are calibrated, and how data is collected. The SOPs must outline the use of computer software to communicate with the data loggers.

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