FINAL

FEASIBILITY STUDY REPORT OF THE NEW CUMBERLAND ARMY DEPOT'S FORMER LANDFILL, MARSH RUN PARK, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Prepared for:

U.S. Army Corps of Engineers
Omaha District

Prepared by:

EA Mid-Atlantic Regional Operations
EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152

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EXECUTIVE SUMMARY

General

This feasibility study (FS) report presents the findings of a conceptual engineering analysis of possible remedial actions to address contamination at the former New Cumberland Army Depot Marsh Run Park landfill (Marsh Run Park site). This report was prepared by EA Engineering, Science, and Technology (Sparks, Maryland) under contract to the U.S. Army Corps of Engineers-Omaha District (Contract No. DACW 45-088-D-0009), and has been conducted in accordance with all requirements of the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). As such, all remedial investigation/feasibility study (RI/FS) activities have been conducted in accordance with the U.S. Environmental Protection Agency (EPA) requirements for hazardous waste investigation/cleanup actions under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), the Superfund Amendments and Reauthorization Act of 1984 (SARA), and the Revised National Contingency Plan (NCP) dated March 1990. This site is not currently listed or proposed for listing on the National Priority List (NPL).

Site History

The Marsh Run Park site was formerly owned by the U.S. Army as part of the New Cumberland Army Depot (NCAD). The site was located at the eastern limit of the depot and was used as a waste disposal site by the Army. The Army actively disposed of waste materials at the Marsh Run Park site between the early 1900s and the late 1950s. The Army stopped using the site as a landfill in the early 1960s and had provided final cover soil and closed the site by 1965.

In 1976, ownership of the property was transferred by the Army to the Bureau of Outdoor Recreation, who subsequently sold the property to Fairview Township. Fairview Township brought in offsite topsoil cover, graded the property, and used it as recreational fields until 1987.

The Army identified the Marsh Run Park site as a potential candidate for environmental investigation in a 1979 Installation Assessment of NCAD. A 1983 Installation Reassessment reaffirmed this recommendation. In 1987, the Department of Defense (DOD) initiated a Confirmation Study under DERP-FUDS. Subsequent to the Confirmation Study, in June 1988, the U.S. Army Corps of Engineers and the U.S. EPA collected soil samples from the surface soils of the site.

The DOD initiated an RI/FS at the site in October 1988. The final RI report was submitted in December 1989. A public meeting to discuss the RI findings and status to date on the FS was held in Fairview Township on 1 March 1990.

Summary of Findings of Environmental Investigations

Key findings of previous environmental investigations at the site concerning the contamination and risk characterizations include the following:

- Findings of the 1987 Confirmation Study indicated the presence of cyanide, semivolatile compounds, metals, and petroleum hydrocarbons in soil samples collected from test pits within the landfill at depths up to 5 ft below the surface. Trichloroethene (TCE) and trans-1,2-dichloroethene were found at concentrations exceeding maximum contaminant levels (MCLs) in ground-water samples from a monitoring well installed onsite. Heavy metals were also found in ground water from monitoring wells onsite.

- The June 1988 surface soil sampling event did not detect concentrations of contaminants at levels that would present unacceptable risks or health hazards to children who had been exposed to the soils.

- Using geophysical methods, during the RI, the approximate extent of former landfilled area was identified to be approximately 4.2 acres.

- Ground-water samples taken from monitoring wells installed during the RI indicated that the highest levels of volatile organic compound (VOC) contamination were in monitoring wells located north and northeast of the former landfill (MW-1, MW-4).

- Geologic characterization of the site indicated 1-2 ft of clean cover soil overlying 2-6 ft of waste fill. A thin layer (2-5 ft) of marsh clay underlies the waste fill and immediately overlies the bedrock aquifer. Shallow soils beyond the limits of the waste fill were found to be primarily low permeability silt and clay.

- Three-dimensional computer ground-water modeling was conducted using the U.S. Geological Survey (USGS) model MODFLOW 3.0. The ground-water model indicated that ground water is flowing primarily to the north-northeast within the bedrock aquifer and that about 98 percent of water that infiltrates the site migrates vertically into the bedrock aquifer flowing toward the Susquehanna River with only 2 percent migrating laterally and discharging to Marsh Run Creek.

- Surface-water samples from Marsh Run Creek indicated slightly elevated TCE and other VOC concentrations in water samples taken at the site and upgradient from the site. Surface water contamination was considered to be caused primarily from a source upgradient of the Marsh Run Park site.

- The risk assessment indicated that the only significant health risk associated with the site in its present condition is the potential for future ingestion of ground water from the bedrock aquifer at the site.

Remedial Action Objectives

Based upon the results of the RI, the baseline risk assessment (public health and environmental evaluations) and site Applicable or Relevant and Appropriate Requirements (ARARs), general, conceptual-level remedial action objectives for the Marsh Run Park site were developed. This preliminary listing of remedial action objectives has been submitted to Pennsylvania Department of Environmental Resources (PaDER) for review and comment. Remedial action alternatives are long-term permanent remedies that minimize or prevent hazardous substance releases from the site. Pursuant to SARA, remedial alternatives include a preference for permanent treatment and/or destruction of contaminants at the site. The specific remedial action objectives for the Marsh Run Park site are

1. Reduce or eliminate the chlorinated solvent contamination present in the bedrock aquifer to ground-water cleanup levels (MCLs). The cleanup standards to be achieved for volatile organic contaminants are as follows:

   trichloroethene - 5 µg/L
   cis-1,2-dichloroethene - 70 µg/L
   trans-1,2-dichloroethene - 100 µg/L
   vinyl chloride - 2 µg/L
   tetrachloroethene - 5 µg/L

2. Reduce or eliminate metals and volatile organic solvent contamination present in the shallow saturated zone to ground-water cleanup levels (MCLs). VOC cleanup levels are listed above. The cleanup standards to be achieved for inorganic contaminants are as follows:

   Arsenic - 30 µg/L
   Barium - 5,000 µg/L
   Beryllium - 0.5 µg/L
   Cadmium - 5 µg/L
   Chromium - 100 µg/L
   Copper - 1,300 µg/L
   Cyanide - 200 µg/L
   Lead - 5 µg/L
   Mercury - 2 µg/L

3. Reduce or eliminate the threat to future ground-water contamination by containment, treatment, or removal of the solvent contamination source area within the landfill, as identified based on the RI and the VOSS.

4. Reduce or eliminate future contaminant releases to Marsh Run Creek and the Susquehanna River through surface water or sediment pathways.

5. Reduce or eliminate future contaminant releases to Marsh Run and the Susquehanna River through ground-water pathways.

It was specified that cleanup of surface water at the site should address contamination emanating from Marsh Run Park only. It has been established that volatile organic solvent and metals contamination has been identified in surface water samples upstream of the Marsh Run site. This observation indicates that an upstream source is partly responsible for observed contamination identified in Marsh Run Creek. Furthermore, the

risk assessment indicates that the contamination levels identified in surface water and sediment samples, both at and upstream of the Marsh Run Park site, do not represent a public health risk. Therefore, remediation of surface water at the site will consist only of prevention (to the extent feasible) of future contaminant releases, via surface water or ground-water pathways, from the Marsh Run Park site. Restoration of surface water to ambient water quality criteria levels is not a component of this FS.

Screening of Remedial Technologies

Based upon the RI contamination assessment and risk assessment, the universe of potentially applicable remedial technologies was identified and screened as to their applicability to conditions at the Marsh Run Park site. Figure ES-1 shows the results of the preliminary technology screening.

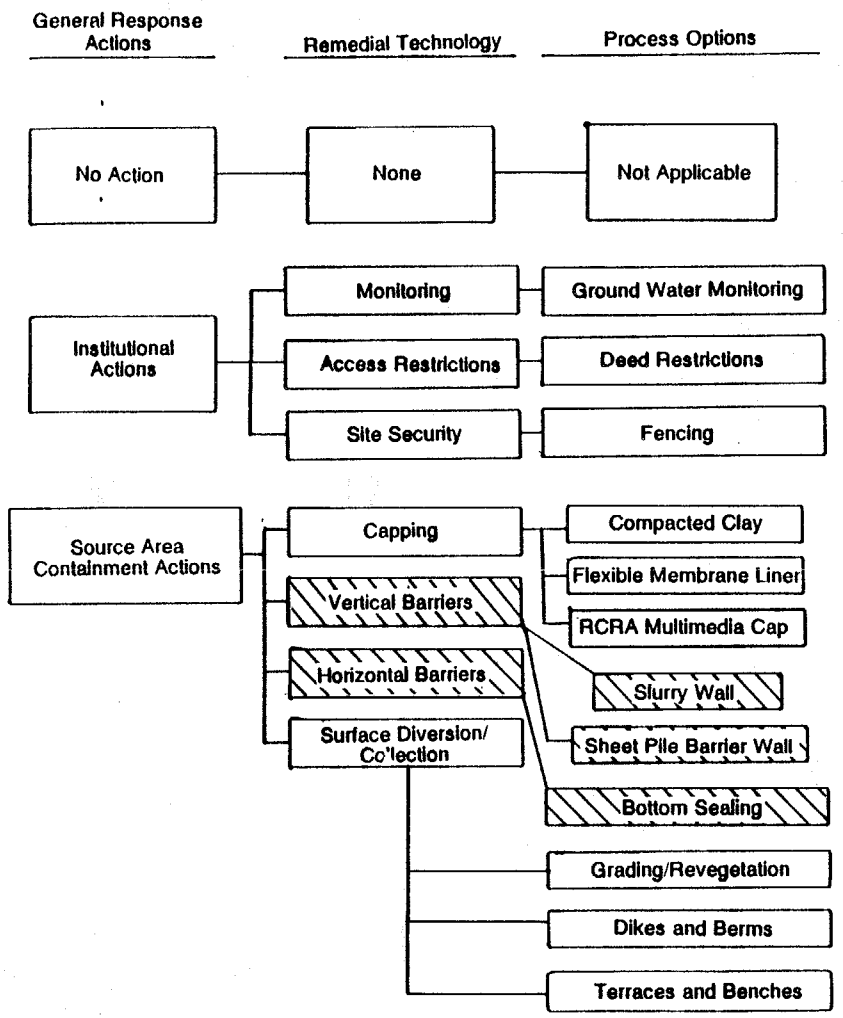
Development and Screening of Remedial Action Alternatives

Technologies retained for further consideration were then combined to develop a series of remedial action alternatives. The final remedial action will include an alternative to address source area contamination and an alternative to address ground-water contamination. A series of alternatives was developed and screened for both components of the remedial action. Screening criteria for this phase were effectiveness, implementability, and cost. Table ES-1 summarizes the remedial alternatives retained for detailed consideration.

Detailed Analysis of Alternatives

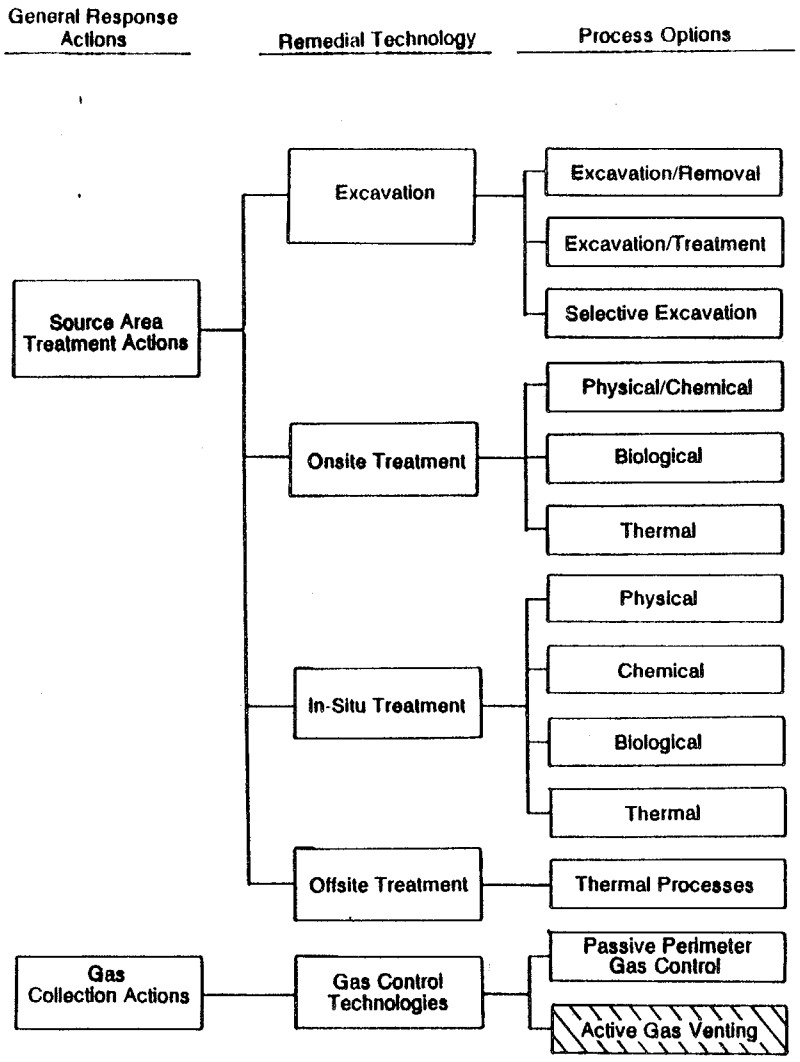
The alternatives retained after screening were then subjected to a detailed analysis. Pursuant to EPA's NCP, the alternatives were examined with respect to nine criteria. The evaluation criteria are as follows:

Figure ES-1. Summary of preliminary technology screening for Marsh Run Park Landfill, Fairview Township, Pennsylvania.



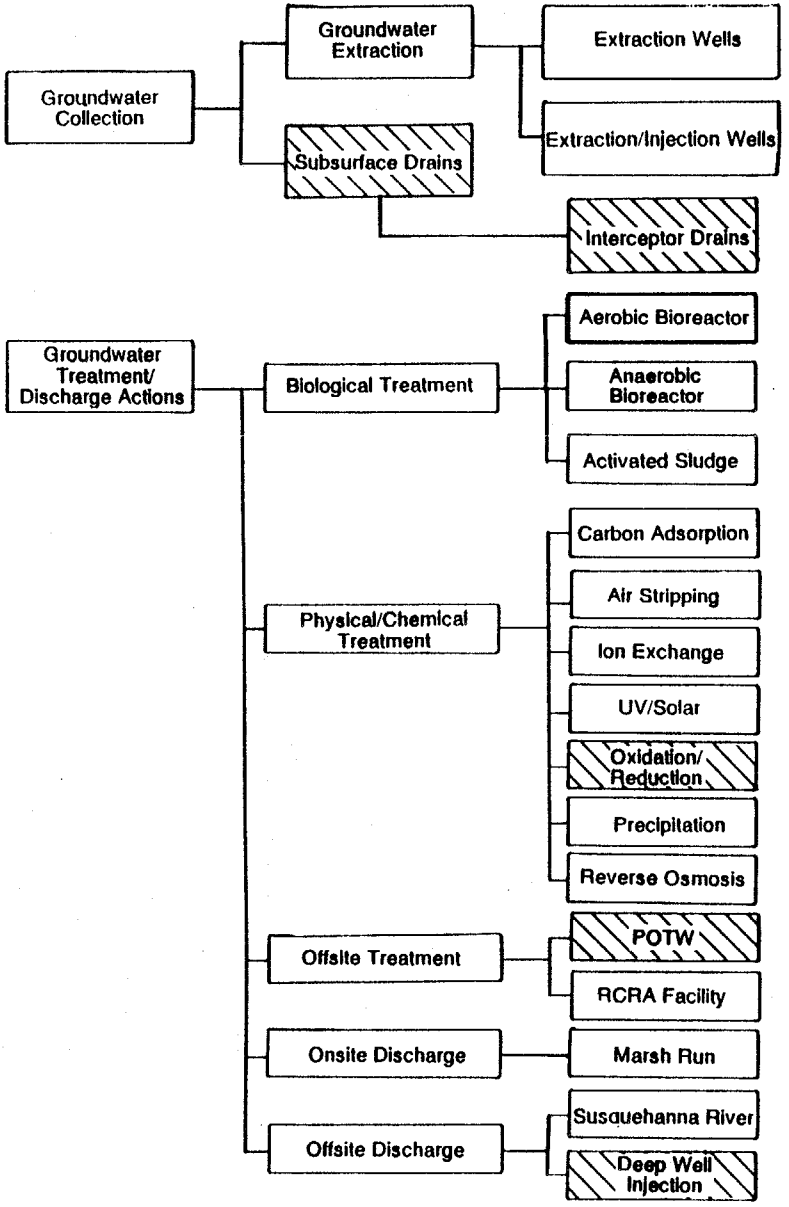
Description	Screening Comments
No Action	Required for consideration by NCP
Ongoing monitoring of wells	Potentially Applicable
Property deed to include development/ water use restrictions	Potentially Applicable
Perimeter fencing to be added	Potentially Applicable
Compacted clay with topsoil cover over identified fill area	Potentially Applicable
Flexible membrane liner with topsoil cover over identified fill area	Potentially Applicable
Compacted clay/flexible membrane liner with topsoil cover	Potentially Applicable
Perimeter trench filled with soil-bentonite slurry	Not feasible due to shallow depth to bedrock
Perimeter barrier wall built with interlocking Z-section sheet piles	Not feasible due to shallow depth to bedrock
Grout injection to create impervious barrier beneath the site.	Not feasible due to lack of proven use
Surface topopgraphy graded to promote drainage away from contamination source area	Potentially Applicable
Dikes/berms for erosion/sediment control and stormwater management	Potentially Applicable
Grading to create terraces or benches to control stormflows	Potentially Applicable

Figure ES-1. CON'T.



Description	Screening Comments
Excavation and offsite removal/ disposal of materials from within the defined "fill" area	Potentially Applicable
Excavation and onsite, offsite, or in-situ treatment of materials from within the defined "fill" area	Potentially Applicable
Selective excavation of defined ""hot-spot" area from within the define "fill" area	Potentially Applicable
Post excavation treatment methods for onsite soils including soil washing, stabilization/solidification, and chemical oxidation/reduction	Potentially Applicable
Post excavation soil treatment methods including aerobic and anaerobic bioreactors and land farming	Potentially Applicable
Post excavation soil treatment methods including low temperature thermal stripping, wet air oxidation, and rotary kiln incineration	Potentially Applicable
Removal of volatile contaminants through vapor phase extraction within the fill area	Potentially Applicable
Flushing of contaminants from fill area through injection of a soil flushing agent	Potentially Applicable
In-place enhanced biodegradation through enchanced oxygen supply	Potentially Applicable
Permanent destruction or immobilization of organic and inorganic soil contaminants	Potentially Applicable
Permanent destruction of organic and inorganic soil contaminants	Potentially Applicable
Installation of passive gas vents for landfill capping closure	Potentially Applicable
Addition of a pumping system to passive gas venting to vent large quantities of landfill gases	Not feasible due to minimal landfill gas generation

Figure ES-1. CON'T.



Process Options	Description	Screening Comments
Extraction Wells	Series of wells to extract contaminated groundwater	Potentially Applicable
Extraction/Injection Wells	Injection wells inject non-contaminated water to increase flow to extraction wells	Potentially Applicable
Interceptor Drains	Perforated pipe in trenches backfilled with perous media to collect contaminated water	Not feasible due to shallow depth of bedrock
Aerobic Bioreactor	Destruction of contaminants by anaerobic microorganisms in onsite treatment unit	Potentially Applicable
Anaerobic Bioreactor	Destruction of contaminants by anaerobic microorganisms in onsite treatment unit	Potentially Applicable
Activated Sludge	Destruction of contaminants using conventional biological waste treatment technology	Not feasible due to presence of high concentrations of inhibitory toxic organics
Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column	Potentially Applicable
Air Stripping	Mixing of large volumes of air with water in a packed column to promote transfer of VOCs to air	Potentially Applicable
Ion Exchange	Contaminated water passed through a resin bed where ions are exchanged between resin and water	Potentially Applicable
UV/Solar	Contaminanted water exposed to photocatalytic oxidation in the presence of an oxygen source such as hydrogen peroxide	Potentially Applicable
Oxidation/ Reduction	Addition of an oxidizing or reducing agent to treat contaminated liquid	Not feasible due to combination of organic and inorganic contaminants
Precipitation	Alteration of chemical equilibria to reduce solubility of the contaminants	Potentially Applicable
Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind	Potentially Applicable
POTW	Extracted groundwater discharged to local POTW for treatment	Not feasible due to concentrations of organic solvents
RCRA Facility	Extracted groundwater discharged to licensed RCRA facility for treatment and/or disposal	Potentially Applicable
Marsh Run	Extracted water discharged to Marsh Run onsite	Potentially Applicable
Susquehanna River	Extracted water discharged by pipeline to Susquehanna River	Potentially Applicable
Deep Well Injection	Extracted water discharged to deep well injection system	Deep aquifer not suitable for injection of contaminated water

TABLE ES-1 IDENTIFICATION OF FEASIBLE REMEDIAL ALTERNATIVES FOR THE FORMER MARSH RUN FIELD LANDFILL SITE, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Source-Area Alternatives

- No Action with Site Control
- Capping with Surface Water and Gas Venting Controls
- Excavation with Offsite Treatment
- Excavation with Onsite Thermal Treatment
- Selective Excavation with Offsite Treatment
- In Situ Soil Venting
- In Situ Soil Flushing/Bioremediation
- In Situ Vitrification

Ground-Water Alternatives

- Extraction/Carbon Adsorption/Discharge to Marsh Run Creek
- Extraction/Air Stripping/Discharge to Marsh Run Creek
- Extraction/Onsite Aerobic Bioreactor/Reinjection to Aquifer(a)
- Extraction/UV Oxidation/Discharge to Marsh Run Creek

(a) Aerobic biotreatment of ground water is only recommended in conjunction with in situ soil flushing/bioremediation.

1. Overall protection of human health and environment
2. Compliance with ARARs
3. Long-term effectiveness and performance
4. Reduction of toxicity, mobility, or volume of contamination
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

A total of seven source-area alternatives (including the "No Action" alternative) and four ground-water alternatives were subjected to detailed analysis. Table ES-2 summarizes key factors related to the final alternatives. A complete comparative assessment of the remedial alternatives is provided in Section 5 of this report. Table 5-3 of this report summarizes results of the comparative evaluation of alternatives.

Recommendations

This feasibility study has been developed to provide sufficient information so that the decision-makers can select the most appropriate remedial action for site conditions at the Marsh Run Park site. The selected remedial action should include one of the source-area alternatives in conjunction with one of the ground-water alternatives. Selection of the appropriate source area response is the most important decision that must be made. All of the ground-water alternatives (with the possible exception of biological treatment) would be expected to achieve approximately the same level of treatment at similar costs. Biological water treatment should only be selected in conjunction with *in situ* soil flushing/biodegradation, as biological water treatment is an integral component of the bioremediation system.

Pre-design activities should be conducted prior to the initiation of remedial design. Pre-design activities should include detailed aquifer characterization to be used to implement a ground-water extraction system, and treatability studies as recommended for source-area and/or ground-water alternatives.

Lance says: already pretty much documented

TABLE ES-2 COMPARISON OF FEASIBLE REMEDIAL ALTERNATIVES, MARSH RUN PARK, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Alternative No.		Type of Action	Performance Period	Innovative Technology	Subject to LDRs	Requires Offsite Transport/Disposal	Capital Cost ($ x 10^6)	Present Worth O&M Cost ($ x 10^6)	Total Cost ($ x 10^6)
SOURCE AREA - Soil									
1	No Action with Site Control	No Action	N/A	No	No	No	0.05	0.9	1.0
2	Capping	Containment	6 months	No	No	No	1.4	0.4	1.8
3A	Excavation/Offsite Incineration	Removal	6 months	No	No	Yes	115.0	0.4	115.4
3B	Excavation/Onsite Incineration	Onsite Treatment	5 years	Yes	Yes	Yes	47.0	0.4	47.4
4	Soil Venting	In Situ Treatment	9-12 months	Yes	No	No	3.9	0.4	4.3
5	Soil Flushing/ Bioremediation	In Situ Treatment	3-5 years	Yes	No	No	1.65	0.4	2.05
6	Vitrification	In Situ Treatment	6 months	Yes	No	No	50.65	0.4	51.05
7	Selective Excavation	Removal	6 months	No	Yes	Yes	43.1	0.4	43.5

Alternative No.		Type of Action	Performance Period	Innovative Technology	Air Discharge	NPDES Discharge	Capital Cost ($ x 10^6)	Present Worth O&M Cost ($ x 10^6)	Total Cost ($ x 10^6)
GROUND WATER									
1	Activated Carbon	Treatment/ Discharge	3-5 years[a] >10 years[b]	No	No	Yes	1.0	0.46 0.75	1.46 1.75
2	Air Stripping	Treatment/ Discharge	3-5 years[a] >10 years[b]	No	Yes	Yes	0.85	0.36 0.57	1.21 1.42
3	Aerobic Bioremediation	Treatment/ Recycle	3-5 years >10 years	Yes	Yes	Yes	0.77	0.32 0.48	1.09 1.25
4	UV Oxidation	Treatment/ Discharge	3-5 years >10 years	Yes	Yes	Yes	0.82	0.30 0.46	1.12 1.28

(a) Ground-water pump and treat is expected to achieve cleanup levels within 5 years for Source-Area Alternative Nos. 3A-7.
(b) Ground-water pump and treat is expected to require a minimum of 10 years to achieve cleanup levels for Source-Area Alternative Nos. 1 and 2.

1. INTRODUCTION

This feasibility study (FS) report summarizes findings of the FS conducted at the former New Cumberland Army Depot (NCAD) Marsh Run Park landfill. This FS was performed by EA Engineering, Science, and Technology (Sparks, Maryland) under contract to the U.S. Army Corps of Engineers-Omaha District (Contract No. DACW 45-088-D-0009), and has been conducted in accordance with all requirements of the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). As such, all remedial investigation/feasibility study (RI/FS) activities have been conducted in accordance with the U.S. Environmental Protection Agency (EPA) requirements for hazardous waste investigation/cleanup actions under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), the Superfund Amendments and Reauthorization Act of 1984 (SARA), and the Revised National Contingency Plan (NCP) dated March 1990. This site is not currently listed or proposed for listing on the National Priority List (NPL).

1.1 PURPOSE AND ORGANIZATION OF REPORT

Purpose

The purpose of this FS is to examine the findings of the final Remedial Investigation (RI) Report (December 1989) for the New Cumberland site and to develop and examine remedial action alternatives that address identified site contamination.

Remedial action alternatives were developed and screened based upon the applicable or relevant and appropriate Federal and State regulations and requirements (ARARs) and the findings of the contamination assessment and risk assessment from the RI. This document is prepared to analyze and present relevant information concerning potential remedial action alternatives for the Marsh Run Park site. In accordance with EPA protocols, this document does not recommend the final remedial action. The purpose of the FS is to provide sufficient information for the

decision-makers "to adequately compare alternatives, select an appropriate remedy for the site, and demonstrate satisfaction of the CERCLA remedy selection requirements in the Record of Decision (ROD)." Final remedy selection is recommended in the ROD document.

Organization

This FS report is divided into five sections:

- Section 1, Introduction: This section identifies the primary purpose of the FS and summarizes site background information, including the findings of the final RI report.

- Section 2, Identification and Screening of Technologies: This section provides an overview of the CERCLA FS evaluation process; identifies the action-specific and chemical-specific ARARs; defines the remedial action objectives for the project and identifies general response actions for the media of concern (source area, shallow saturated zone, bedrock aquifer). This section also includes the initial identification and screening of remedial action technologies and selection of representative process options.

- Section 3, Development and Screening of Alternatives: In this section, alternatives for remediation of the source area and ground-water contamination are developed from the technologies retained after technology screening. A preliminary screening of remedial alternatives with respect to effectiveness, implementability, and cost is conducted.

- Section 4, Detailed Analysis of Alternatives: The alternatives retained at the completion of Section 3 are examined in detail with respect to the nine evaluation criteria identified in the Revised National Contingency Plan (NCP) (dated March 1990).

- Section 5, Summary and Comparison of Remedial Action Alternatives: This section summarizes and compares the results of the detailed analysis of alternatives conducted in Section 4.

1.2 BACKGROUND INFORMATION

1.2.1 Site Description

The New Cumberland Army Depot's former landfill, Marsh Run Park, is located in Fairview Township, York County, Pennsylvania. It is situated adjacent to and east of NCAD. The site is bounded to the south and southeast by Marsh Run Creek and Marsh Run Road and to the north and northeast by Conrail (formerly Penn Central) railroad tracks. The Susquehanna River is immediately north of the railroad tracks. The site location is shown in Figures 1-1 and 1-2.

The site is approximately 14 acres in size and is situated in a relatively flat area, which was occupied by swampy wetlands prior to landfilling (see Figure 1-3). Approximately 4-5 acres of the site were formerly used as a landfill by the New Cumberland Army Depot. The surrounding area is semirural. Single-family dwellings are located to the south and southeast of the site along Marsh Run Creek.

Currently, the site exists as a filled wetland. Fill placed at the site averages 3-4 ft above the prefill surface. The present surface of the landfill is relatively flat with slight grading (performed by Fairview Township) to facilitate drainage. An NCAD access road borders the site to the east immediately outside of the Army Depot fence. Marsh Run Creek, which flows in a general west-to-east direction, bounds the southwest of the site (inside depot fence), passes beneath the depot access road, and borders the landfill immediately to the south and east (Figure 1-2).

Physical Characteristics of Study Area

The topography of Marsh Run Park is generally flat with topographic relief varying less than 10 ft across the site. The ground surface is covered with at least 6 in. of topsoil (silty loam) material brought in from an offsite location by Fairview Township. The topsoil material has promoted a good thick growth of fescue grass. Below the topsoil is a 1-2 ft thick cover of brown silty soils that were apparently excavated from the local area north of the site. Underlying the topsoil and cover fill in the central, south-central portion of the site is 2-6 ft of "waste fill" material. The "waste fill" material appears to be contained within the Marsh Run Park property boundaries. Based on boring and visual observations, the "waste fill" material appears to be primarily domestic-type debris, construction debris, and industrial debris derived from NCAD (USACE Confirmation Study Report 1988). Based on indirect geophysical methods, approximately 23,000-24,000 yd^3 of waste material are estimated to be buried at the site.

Outside of the "waste fill" proper, natural silt, clay, and sand up to 8 ft thick overly the Triassic shaley sandstone of the Gettysburg Formation. The Gettysburg Formation is typically a maroon silty or shaley fine sandstone. It forms the hills south of the site that rise abruptly several hundred feet in elevation.

The two distinct ground-water zones at the site are the shallow saturated zone (located in the fill and soils) and the underlying bedrock aquifer (Gettysburg Formation). Figure 1-4 is a schematic representation of subsurface conditions at the Marsh Run Park site in the vicinity of the "waste fill." In the vicinity of Marsh Run Park the saturated fill and soils are segregated from the bedrock aquifer by an apparently continuous clay layer (i.e., marsh and swamp sediments) 2 to 5 ft in thickness. Local residents obtain their water from wells installed in the Gettysburg Formation.

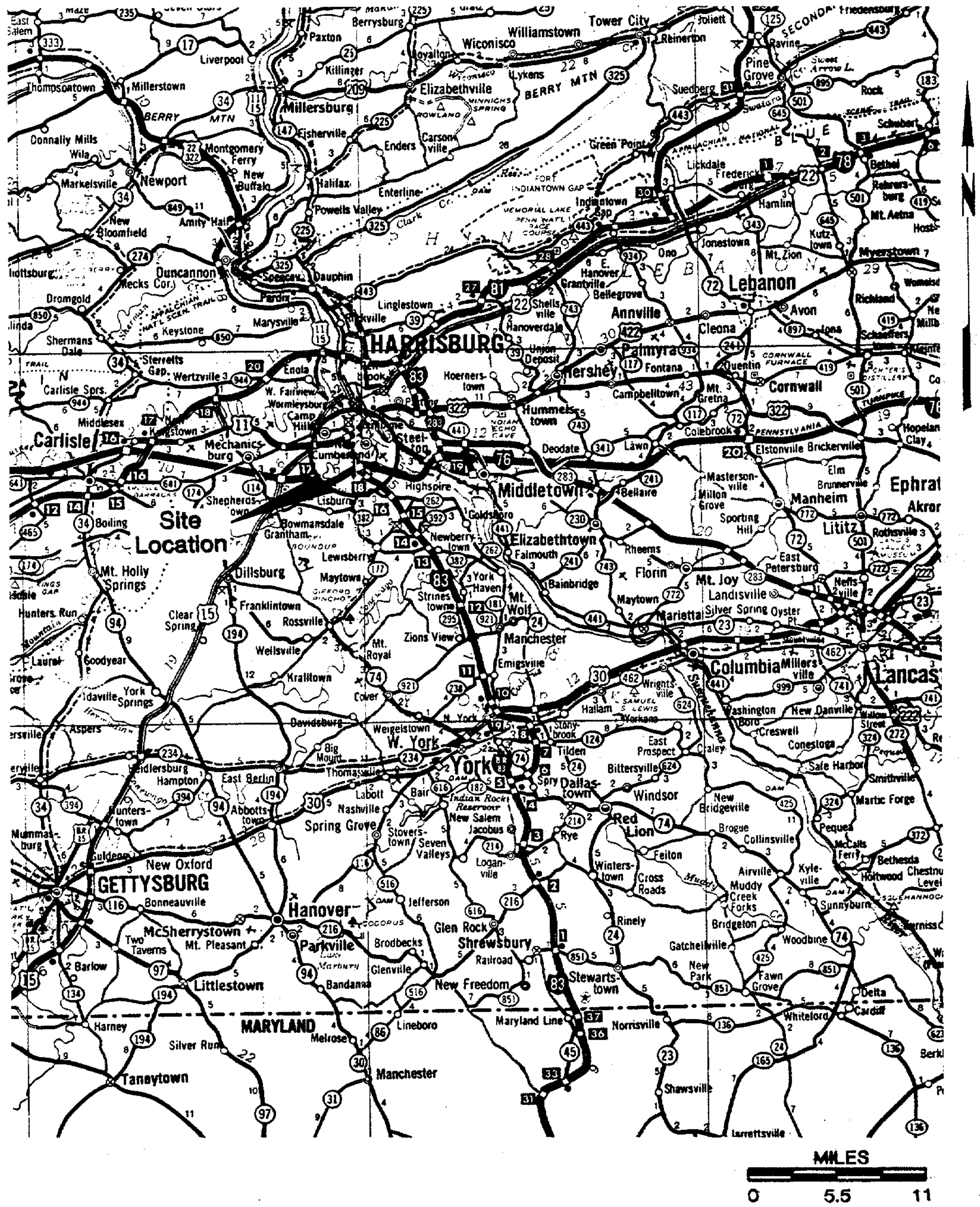


Figure 1-1. Vicinity map - Marsh Run Park site.

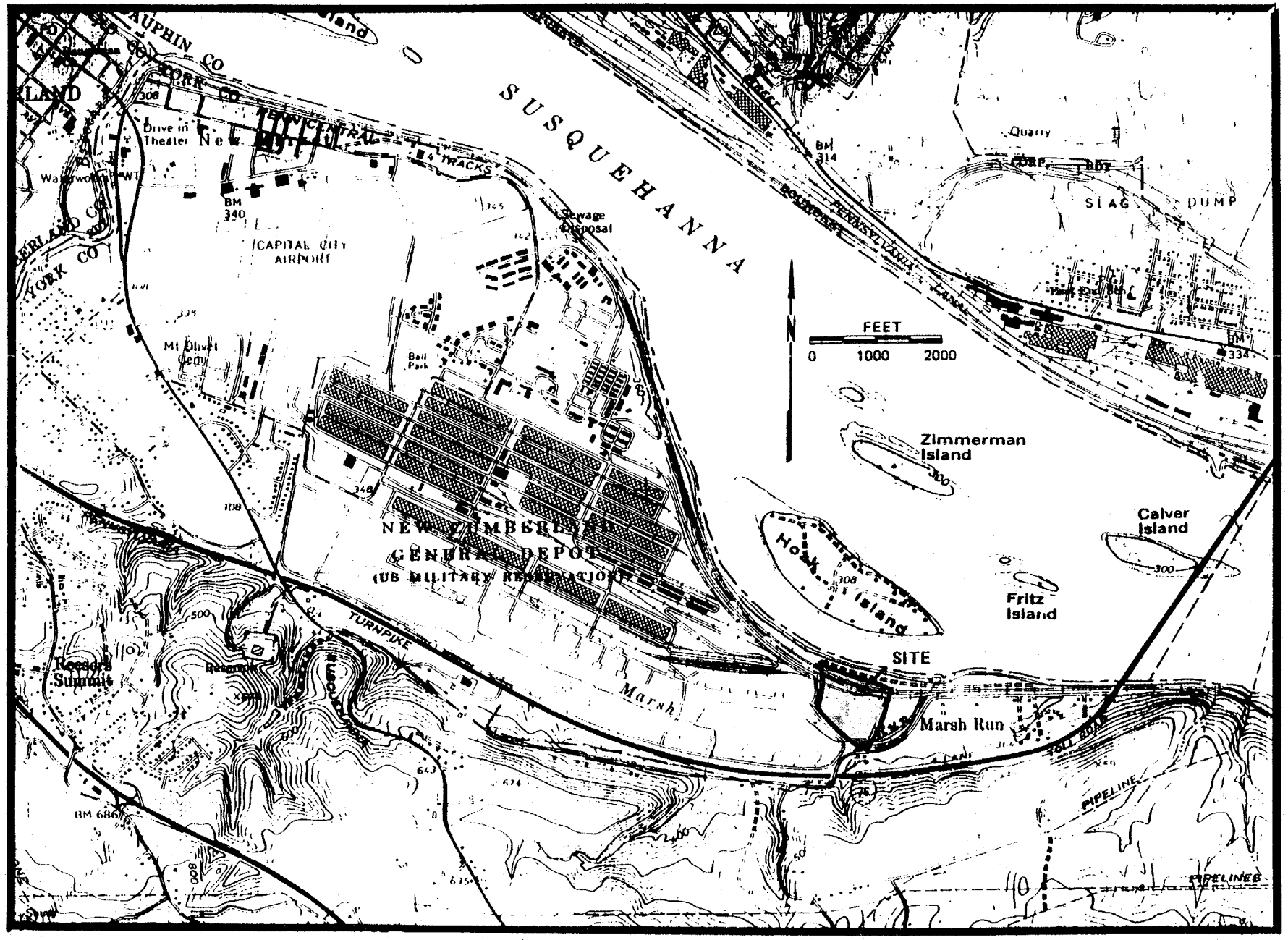


Figure 1–2. Marsh Run Field and vicinity.

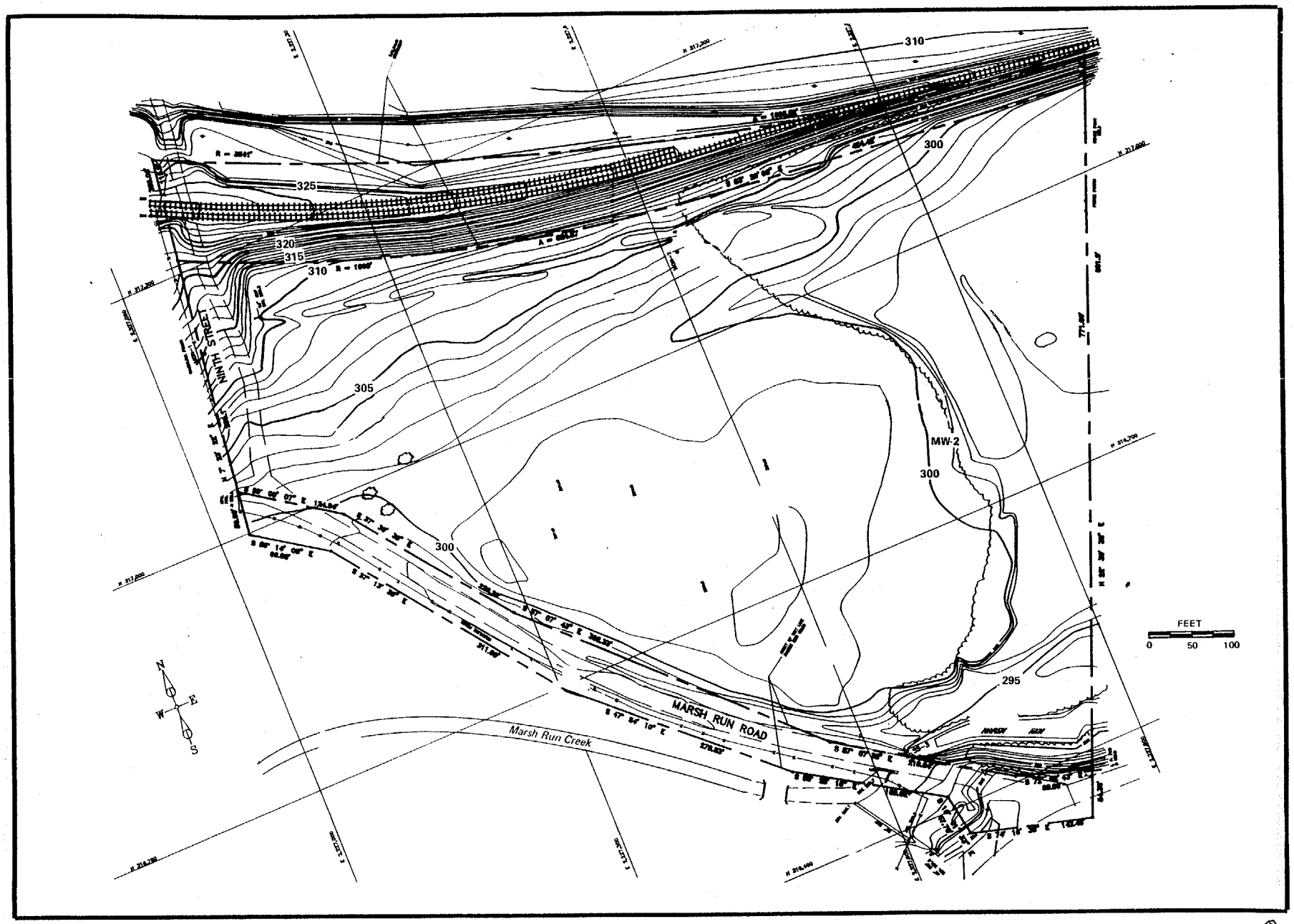


Figure 1-3. Existing site conditions - Marsh Run Park.

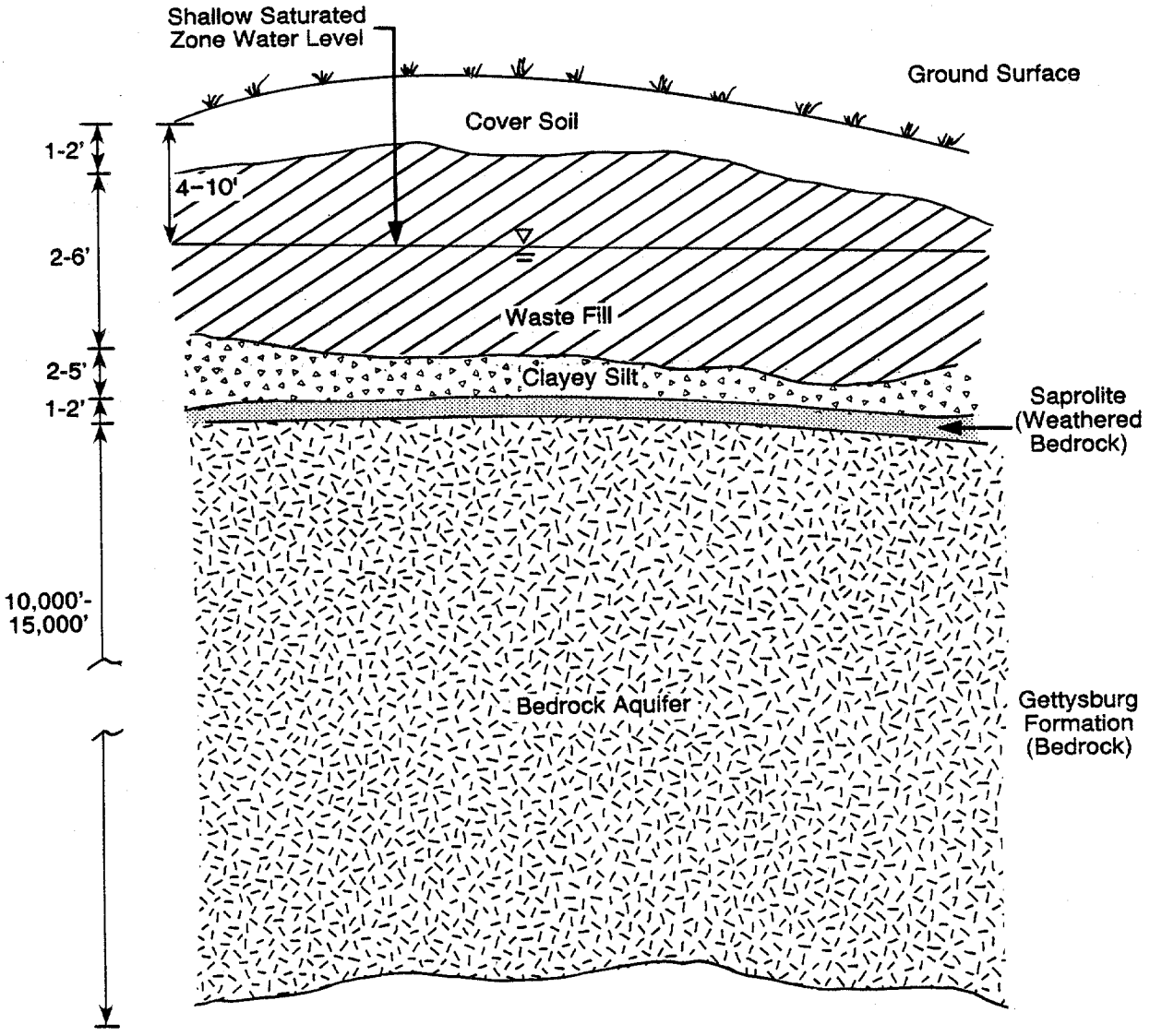


Figure 1-4. Schematic representation of subsurface conditions in the vicinity of the "waste fill" - Marsh Run Park.

The movement of ground water within and between the two distinct ground-water zones comprises the overall ground-water flow system at the site. It should be noted that although the two ground-water zones are distinct, there is significant hydraulic communication between zones.

1.2.2 Site History

Previously, the Marsh Run Park site was owned by NCAD, who used it as a landfill for disposal of installation-derived waste materials starting in the early 1900s. Landfilling of Depot-derived materials ceased in the late 1950s.

Ownership of the Marsh Run Park property was transferred in 1976 by the Army to the State Bureau of Outdoor Recreation, who sold the site to Fairview Township. Fairview Township brought in offsite topsoil cover, graded the property and used it as a recreational field. A 1979 NCAD installation assessment and a 1983 NCAD installation reassessment (CSL 1979, ESE 1983) identified Marsh Run Park as a potential candidate for an environmental investigation.

A Confirmation Study (CS) was conducted by the U.S. Army Corps of Engineers, Omaha District, under the Department of Defense (DOD), Defense Environmental Restoration Program (DERP). The results of the CS indicated the presence of ground-water and soil contamination at the site. The site use as a soccer field was discontinued in 1987 when the CS was initiated.

In summary, findings of the CS indicated the presence of semivolatile compounds, cyanide, and petroleum hydrocarbons in soil samples collected within the landfill confines in test pits at depths of up to 5 ft below the surface. Arsenic, barium, copper, mercury, zinc, cadmium, lead, and silver were also detected in several soil samples collected in the test pits excavated in the fill.

During the CS, ground-water samples from monitoring wells screened in the shallow saturated zone were analyzed for petroleum hydrocarbons, volatile organics, and dissolved metals. A ground-water sample collected from an onsite well was found to contain 26 ppb trans-1,2-dichloroethane and 5 ppb trichloroethene. Elevated levels of dissolved barium, manganese, copper, cobalt, magnesium, lead, and nickel were also detected in monitoring well samples collected onsite.

As a follow-up to the CS, 23 individual soil samples were collected from the landfill surface (down to 6 in.) by the U.S. Army Corps of Engineers and the EPA on 25 May and 22, 23 June 1988, respectively. These samples were collected for the purpose of evaluating human health risk associated with the surface soils on the field. Tables 1-1 and 1-2 summarize the compounds detected in these surficial samples. The risk evaluation addressed such exposure pathways as dust inhalation, dermal contact, and ingestion of soils. Results of the June 1988 U.S. Army Corps of Engineers document entitled "Public Health Evaluation of Marsh Run Park" indicated that the surface soil at Marsh Run Park did not present increased risks or health hazards to the children who had been playing at the field.

The RI of Marsh Run Park, which was conducted by EA, was initiated based on the data presented in the "Confirmation Study Report of the New Cumberland Army Depot, Fairview Township, Pennsylvania" (Woodward-Clyde Consultants, March 1988).

In October 1988 EA initiated field activities at the Marsh Run Park site. The objectives of the RI were to:

1. Evaluate the presence and extent of hazardous waste and associated contamination both vertically and horizontally at the landfill.

2. Assess the potential for contaminant migration in the surrounding environs.

TABLE 1-1 RESULTS OF CHEMICAL ANALYSIS OF SURFACE SOILS COLLECTED BY USACE AT MARSH RUN PARK, ON 25 MAY 1988
[all values in mg/kg (ppm)]

Analyte	CRDL[a]	SS1	SS2	SS2D	SS3	SS4	SS5	SS6	SS7	SS8	SS8D
Fluoranthene	0.33					0.16	0.85	0.78		8.10	4.84
Pyrene	0.33					0.14	1.16	0.64		6.86	4.10
Phenanthrene	0.33					0.16	0.51	0.45		7.15	3.63
Naphthalene	0.33						0.06			0.41	0.08
2-Methylnaphthalene	0.33						0.08			0.26	0.06
Anthracene	0.33					0.03	0.03			1.49	0.70
Chrysene	0.33						0.52	0.39		3.97	1.93
Benzo(a)anthracene	0.33						0.39	0.35		4.20	1.97
Indeno(1,2,3-c-d)pyrene	0.33							0.16		1.93	0.75
Benzo(g,h,i)perylene	0.33							0.18		2.05	0.80
Acenaphthene	0.33									0.96	0.38
Fluorene	0.33									0.98	0.42
Benzo(b)fluoranthene	0.33									2.04	0.90
Benzo(a)pyrene	0.33									3.33	1.41
Benzo(k)fluoranthene	0.33									1.77	0.89
Dibenzo(a,h)anthracene	0.33									0.78	
Dibenzofuran	0.33									0.58	0.22
Diethylphthalate	0.33	0.10	0.17	0.11	0.08	0.19	0.08			0.08	0.07
Di-n-butylphthalate	0.33	0.56	0.84	0.63	0.38	1.12	0.47	0.91	0.99	0.62	0.57
Bis(2-ethylhexyl)phthalate	0.33			0.61		0.69	1.27	1.60	1.89		0.94
Antimony	12.										
Arsenic	2.	4.23	6.93	6.79	6.36	2.77	6.81	3.93	4.19	6.22	5.63
Beryllium	1.										
Cadmium	1.										
Chromium	2.	9.03	8.88	9.28	3.33	14.60	4.23	13.40	14.80	8.36	16.60
Copper	5.	10.90	18.70	19.70	16.60	12.80	13.40	5.29	9.38	39.90	37.50
Lead	1.	10.80	12.50	14.10	130.00	25.10	73.70	21.90	15.30	44.00	32.70
Mercury	0.04	0.34	0.08	0.15	0.13	0.14	0.36	0.19	0.13	0.40	
Nickel	8.	10.30	14.00	15.10	4.82	12.40	4.74	10.60	10.80	8.87	11.70
Selenium	1.				0.18	0.12	0.17	0.08	0.16	0.10	0.11
Silver	2.										
Thallium	2.										
Zinc	4.	36.70	48.20	50.20	77.90	56.60	80.10	45.70	39.90	57.70	73.50
Cyanide	0.25[b]										

why list if BDL?

← BDL

only hits have been listed

(a) Contract Required Detection Limit
(b) Actual Detection Limit
Source: U.S. ACE 1988

TABLE 1-2 SUMMARY OF ANALYTICAL RESULTS FROM SURFICIAL SOIL SAMPLES COLLECTED BY EPA TAT AT MARSH RUN PARK ON 22, 23 JUNE 1988
[all values in mg/kg (ppm)]

Compound	Detection Limit	mg/kg (ppm)														
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S51	S52	S61	S62
1,2-Dichloroethene	0.5													9.4		
Trichloroethene	0.5												0.66	2.6		
Tetrachloroethene	0.5													2.6		
Toluene	0.5													0.20		
Xylenes, total	0.5													0.13		
2-Methylnaphthalene	0.33			0.22												
Naphthalene	0.33			0.40												
Acenaphthene	0.33			0.92												
Phenanthrene	0.33			1.9												
Fluoranthene	0.33			7.3			0.36	1.1								
Pyrene	0.33			6.6			0.32	0.79								
Chrysene	0.33			4.6												
Benzo(b)fluoranthene	0.33			8.3												
Benzo(k)fluoranthene	0.33			7.3												
[1,2-B] Pyridine 5H-Indeno	0.33			0.72												
Beryllium	2.5															
Cadmium	0.5	5.5	4.6	5.6	3.6	3.8	3.09	5.05	1.02	3.6	5.7	3.6	5.1	7.7	5.05	3.6
Chromium	1.0	3.5	4.1	33	3.06	1.5	5.7	7.6	2.6	5.7	7.4	8.7	9.7	49	5.05	5.7
Copper	1.0	17	15	797	11	26.6	5.15	29	1.5	8.8	16	12	98	185	11	8.8
Nickel	2.0	12	8.8	13	8.2	4.0	2.0	12	4.08	7.2	9.6	12	12	14	6.6	7.2
Lead	1.0	36	48	1,080	32	175	38	44	28	35	66	55	68	1,020	68	35
Zinc	0.5	49	48	1,510	35	116	29	55	19	32	46	75	209	399	28	32
Arsenic	0.5	1.5	0.67	2.4	0.83	1.3	0.70	1.3	0.58	1.0	1.5	0.57	1.2	2.6	0.56	0.95
Silver	0.5			5.6				1.5								
Antimony	10.0															
Selenium	0.5	2.3	0.81	3.8	0.60	1.4	0.95	1.2	0.63	2.4	1.9	0.81	1.5	1.9	1.7	1.5
Thallium	5.0	12		13		16						17		11	9.6	
Mercury	0.05		0.05	0.07						0.32	0.05	0.07		0.09	0.09	0.06
Cyanide	0.35			1.75								0.45		1.0		

Source: U.S. EPA 1988

3. Identify public health and environmental risks of contaminants relative to regulatory standards.

4. Define future investigations and/or actions required at the site.

During the performance of the RI it was recognized that six sites situated off of Marsh Run Park on the depot property (Figure 1-5) (within 3,500 ft) or along sensitive migration pathways (proximal to eastward-flowing Marsh Run Creek), have previously been investigated by others with regard to environmental problems on the depot. These sites may also have an indirect or direct environmental impact on the environs proximal to Marsh Run Park.

Based on the aforementioned previous investigations, indications are that the water quality of Marsh Run Creek is affected to some degree by the closed sanitary landfill upstream of Marsh Run Park (Site 4) (Figure 1-5) where leachate emanating from the landfill and discharging to Marsh Run Creek has been found to contain low-level PCBs, pesticides, and volatile organics (USAEHA 1978 and 1983). The USAEHA 1978 investigation sampled Marsh Run Creek upstream and adjacent to Marsh Run Park. Pesticides were detected in sediments adjacent to the Marsh Run Park site and further upstream as far as Marsh Run Pond. Both reports concluded that Marsh Run Creek was receiving low-level pesticides from the adjacent sanitary landfill on the depot (Site 4) and from previously spread sewage treatment sludge (Site 6).

Results of the USAEHA 1983 investigation indicated that pesticide was still being contributed to the stream sediments from adjacent sources upstream of Marsh Run Park. Several volatile organic compounds were also detected in surface water and leachate samples collected during this investigation. The closed sanitary landfill on the depot (Site 4) was identified as a potential source of volatile constituents.

The Firefighting Training Area (Site 5) was previously sampled in August 1988 in preparation for the Interim Final Report, Ground-Water Contamination Survey No. 38-26-0872-89 NCAD, 14-17 December 1987 and 4-5 August 1988. One soil sample revealed low levels of several semivolatile compounds, including phenanthrene, flouranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)flouranthene, and benzo(a)pyrene, as a consequence of other documented potential source areas upstream/upgradient of Marsh Run Park. One of the specific objectives of the RI was to determine whether or not these or other areas were potentially contributing contamination to the environs proximal to Marsh Run Park.

RI Investigation Task

The RI of the New Cumberland Army Depot's former landfill, Marsh Run Park, employed a variety of field investigative techniques in the performance of the site investigation. These techniques included geophysical surveying, monitoring well installation, monitoring well sampling, well point installation, in situ hydraulic conductivity analysis by slug test method, household supply well sampling of residences immediately adjacent to Marsh Run Park, and surface water and sediment sampling of Marsh Run Creek.

The site investigation was conducted in two phases. The first phase was initiated by the geophysical investigation and followed by subsequent installation of five new monitoring wells to supplement the existing three site wells installed during a 1987 Confirmation Study. In addition, stream surface water/sediment samples, and monitoring well soil and ground-water samples were collected and analyzed. The first phase was conducted between October 1988 and February 1989. Pursuant to the examination of the preliminary chemical analysis of ground water at the site and a review of previous investigations, a second phase of monitoring well installation and environmental sampling was conducted between July and August 1989.

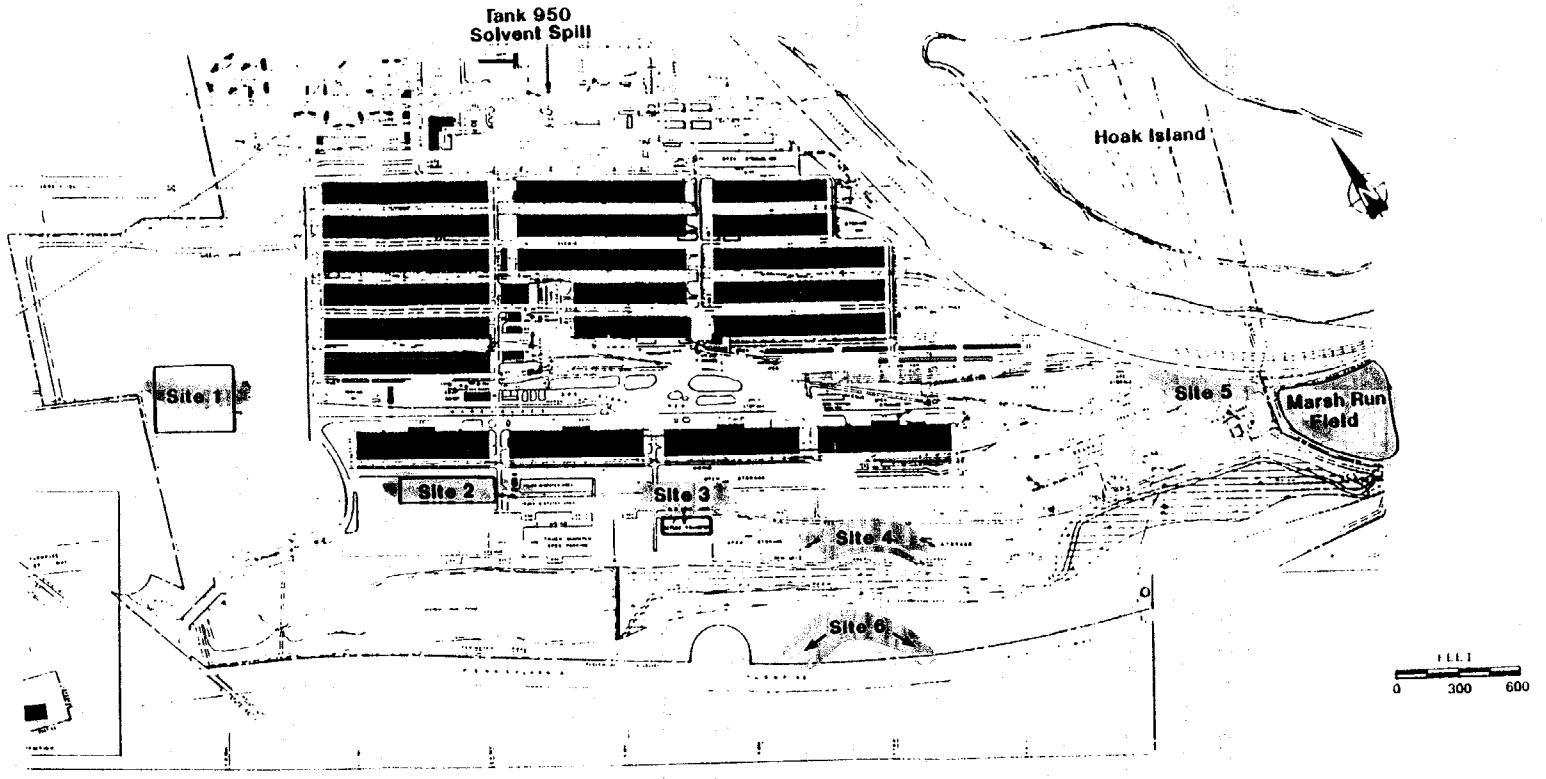


Figure 1-5. Location map of adjacent solid waste management units. (Source: Interim Final Report, Ground Water Contamination Survey No. 38-26-0872-89, 1988).

The second phase of the site investigation consisted of the installation of an additional five perimeter monitoring wells and three well points installed within the landfill waste material. A second sampling event included these five new monitoring wells, two of the three well points, four selected household supply wells adjacent to the site, the first phase monitoring wells, and three existing Confirmation Study wells. One additional sediment/surface water sample was collected further upstream of the site in Marsh Run Creek. The second phase of sampling was specifically targeted to identifying potential offsite sources of contamination and to further define site-related contamination.

1.2.3 Nature and Extent of Contamination

Results of Chemical Analysis of Samples Collected at Marsh Run Field

Results of chemical analysis have indicated that constituents (chemical compounds, trace metals, etc.) of potential concern have been detected at various RI sampling stations (i.e., soil, water, sediment). Figures 1-6 and 1-7 show the RI sampling stations. The distributions of constituents detected in soil, sediment, and water samples are discussed below.

Soil Samples

Although not directly sampled during the RI, the "waste fill" onsite can be characterized indirectly, based on peripheral analytical data of monitoring well boring soil samples and cover soil samples, as exhibiting elevated concentrations of semivolatile compounds, specifically PAHs. These compounds are ubiquitous and are common constituents of asphalt, coal tar, and creosote. They are fairly immobile in ground water. Analytical data for soils collected from MW-2 (eastern edge of fill) showed relatively high concentrations of several PAH compounds, particularly phenanthrene and fluoranthene, at levels exceeding 1,000 mg/kg. However, these levels were encountered at depths below the surface topsoil (i.e., greater than 1 ft below surface). PAH levels were approximately three orders of magnitude less (1,000 times lower) in the surficial topsoil

samples (Tables 1-1 and 1-2). Although the highest concentrations of PAHs were obviously detected onsite, much lower levels (i.e., approximately two to three orders of magnitude lower) were also found dispersed offsite in other fill material, which indicates that these semivolatile compounds are not unique to the site. Complete analytical results are discussed in Section 4 of the RI report.

Elevated concentrations of the trace metals barium, lead, copper, and silver, which were detected in soil samples collected onsite and below the surface cover, are apparently related to the "waste fill." Soil samples collected from MW-2 characteristically exhibited the highest concentrations of trace metals. Coincidentally, MW-2 is located closest to the "waste fill." Table 1-3 lists the constituents of potential concern that were detected in cover soil samples collected during the USACE and EPA sampling events. These constituents, since located at the surface, were carried through the risk assessment analysis.

Ground-Water Samples

Based on ground-water data from shallow overburden wells and the respective water level and saturated thickness of fill during each of the two sampling events, the fill placed on Marsh Run Park has been identified as a potential source of volatile organic compounds (VOCs). The detection of the volatile organic compounds including vinyl chloride and 1,2-dichloroethene (total) in shallow overburden wells during the second sampling event when water levels were higher and a greater portion of the "waste fill" was saturated indicates the fill as a potential temporal VOC source. Based on inferred ground-water flow patterns at the site, the presence of VOCs in the shallow ground water suggest the fill is a potential source of VOCs. It is unlikely that an offsite source would result in VOC contamination in the shallow overburden onsite based on inferred ground-water flow paths. Furthermore, with the exception of acetone, which is a common laboratory artifact (and which was detected in MW-5A), no VOC contamination was detected in the ground water anywhere offsite in either the overburden, bedrock, or residential wells.

This map should be more of a close up of the Marsh Run Park.

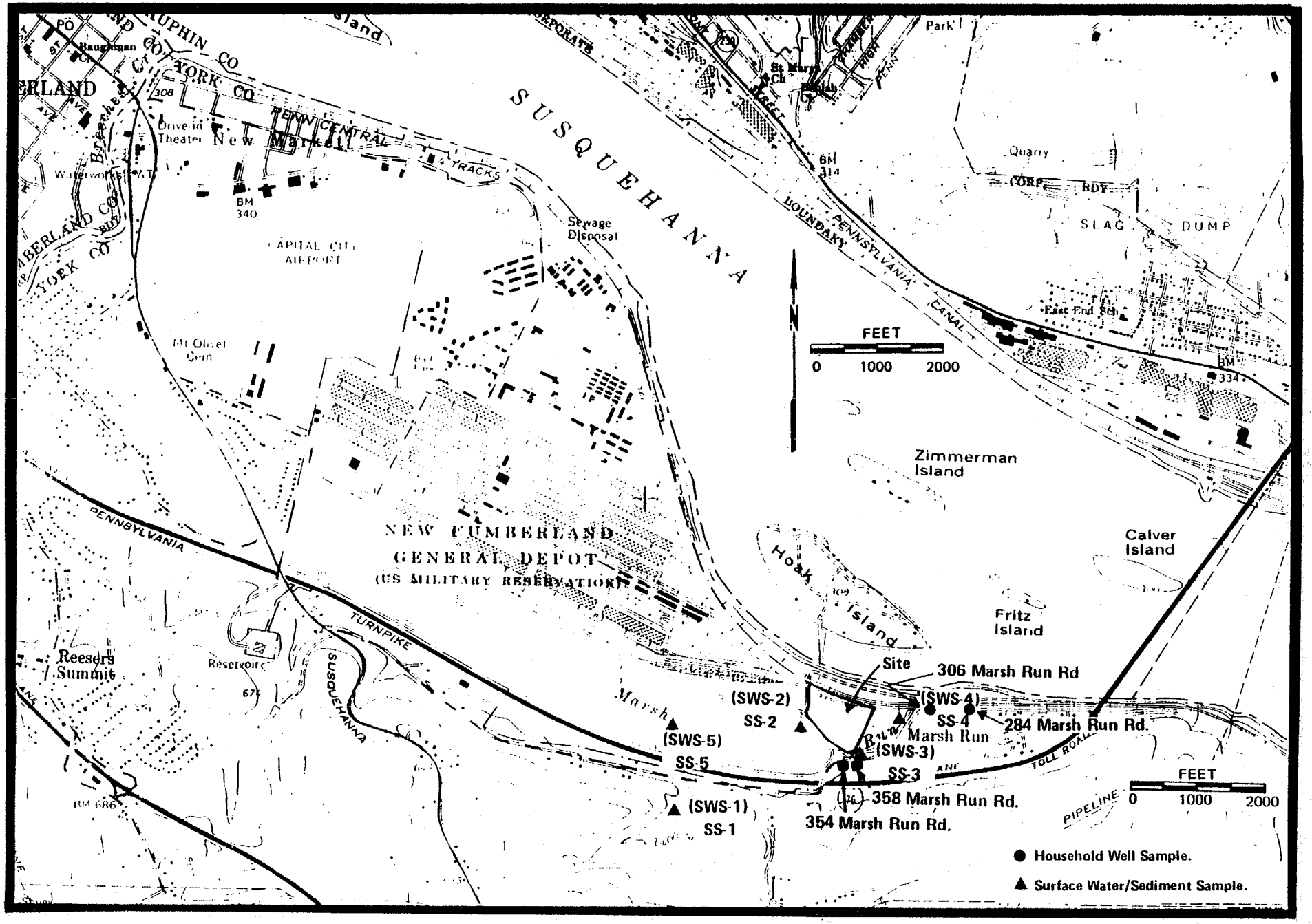


Figure 1-7. Location of storm surface water/sediment and household well samples.

TABLE 1-3 CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL COVER SOILS AT THE MARSH RUN PARK SITE, NEW CUMBERLAND, PA(a)

Chemical	Average (mg/kg)	Reasonable Worst Case (mg/kg)	Frequency of Detection
ncPAHs (c)	3.63	21.7	7/17
cPAHs (d)	2.94	20.2	4/17
Diethylphthalate	0.15	0.19	6/17
Di-n-butylphthalate	0.8	1.12	7/17
bis(2-Ethylhexyl) phthalate	0.8	1.60	5/17
Cadmium	2.55	5.7	10/17
Copper	61.5	797	17/17
Lead	111	1,080	17/17
Mercury	0.19	0.36	11/17
Selenium	1.01	3.8	15/17
Silver	0.64	5.6	2/17
Thallium	4.5	16	3/17
Zinc	138	1,510	17/17
Cyanide (total)	0.25	1.75	1/17

(a) Values are based on results of sampling conducted by the COE and EPA TAT in June 1988.

(b) NR = not reported. Due to detection limit values, average values were calculated to be higher than the maximum detected value; therefore averages were not reported.

(c) Noncarcinogenic PAHs include acenaphthene, anthracene, bezo(g,h,i) perylene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene, and 2-methylnaphthalene.

(d) Carcinogenic PAHs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h) anthracene, and indeno(1,2,3-c-d)pyrene.

good

What was "reasonable worst case" based on? How derived.

Volatile organic contamination appears to be present in a localized area in the bedrock aquifer (Gettysburg Formation) beneath the site. The persistence of detected trichloroethene (TCE) and other chlorinated aliphatics at very similar concentrations during both sampling events suggests that a VOC contaminant source exists that has impacted the bedrock aquifer beneath the site. TCE was detected in site bedrock monitoring wells at concentration levels that exceeded the Maximum Contaminant Level (MCL) established by the EPA by 30 to 80 times. The VOC contamination is not present in upgradient monitoring wells to the west, to the southwest, or in residential wells to the east. Based on inferred ground-water flow patterns of the bedrock aquifer, the predominant contaminant migration direction of the VOC contamination localized beneath the site would be to the north toward the Susquehanna River.

The source of volatile organic compound contamination in both the bedrock and overburden ground water appears to be related to the fill material placed at Marsh Run Park. The varying ratios of TCE versus its probable biodegradation by-products 1,2-dichloroethene (total) and possibly vinyl chloride, in the saturated overburden and bedrock aquifer, respectively, may be related to the unique effects of each of the saturated matrix materials (fill clay and peat or bedrock) on the biotransformation capability of the microorganisms. Interactions between environmental conditions such as dissolved oxygen, redox potential, temperature, pH, and salinity, and the presence of particulate matter as well as the critical concentration range of the compound of interest, and the presence of adapted or adaptable organisms often control the occurrence, rate, and product of biodegradation (Parsons et al. 1982).

Trace metal contamination in the ground water appears to be partially site derived, but the presence of elevated trace metals in upgradient wells suggests that an offsite source of trace metals (possibly fill or the sewage sludge land treatment area, Site 6, Figure 1-5) is also contributing to the elevated trace metals in the shallow saturated zone

ground water. Comparison of "total" metals and "dissolved" metals concentrations in both the bedrock aquifer and the shallow saturated zone indicates that the dissolved fraction is not a significant percentage of the total metals concentration for water samples taken from the site (Table 1-4). This indicates that much of the observed trace metal concentrations must be undissovled, suspended, or adhered to sediment particles in the water.

Metal speciation is a function of the pH and eH of the soil and ground water environment. Sampling data indicate that pH of the shallow saturated zone ground water is approximately neutral (6-7.5), that there is no evidence of conditions at the site that might cause conditions to become more acidic, and that metals are likely to remain primarily in the undissolved or suspended state. Metals in this phase are not readily mobile in a subsurface ground-water environment. In addition, comparison of metal concentrations in the shallow saturated zone and the bedrock aquifer indicates that contamination levels in samples from the shallow saturated zone are considerably higher than levels observed in bedrock aquifer water samples (Table 1-4). This result is opposite from VOC concentration results which show that bedrock aquifer VOC contamination is considerably higher than shallow saturated zone VOC concentration. Consequently, these data indicate that VOCs are primarily migrating from the source area while metals remain primarily within the shallow saturated zone. Therefore, based upon dissolved metal concentrations, ground water pH, and comparison of shallow saturated zone and bedrock aquifer metal concentrations, trace metal mobility in the ground water is not considered a significant contaminant pathway.

A summary of constituents of potential concern detected in ground-water samples is presented in Table 1-5. Monitoring wells MW-1A, MW-2A, MW-3A, MW-4A, MW-5A, MW-6A, and MW-7A represent shallow saturated zone water conditions. Monitoring wells MW-1 through MW-7 represent bedrock aquifer conditions.

TABLE 1-4 SUMMARY OF GROUND WATER QUALITY DATA FOR METALS (FEB, AUG 1988 SAMPLING EVENTS)

units ?

	Shallow Saturated Zone Wells					mcl ppm	Bedrock Aquifer Wells				
	Total (Max)	Total (Avg)	Dissolved (Max)	Dissolved (Avg)	Percent Dissolved		Total (Max)	Total (Avg)	Dissolved (Max)	Dissolved (Avg)	Percent Dissolved
Arsenic	127	20.80	0	0	0	0.05	28.3	5.1	7.3	0.73	
Cadmium	33.6	7.8	0	0	0	0.010	0	0	0	0	0
Barium	2,360	598	668	179	30.0	1.	561	327	476	291	89.0
Copper	199	44.8	16.4	2.3	5.1	1.3 proposed	29.3	4.6	17.3	5.4	117.4
Mercury	1.0	0.29	0	0	0	0.002	0.7	0.24	0	0	0
Zinc	1,170	354	122	40	11.3	-	225	70.5	40.5	22.3	31.6
Chromium	372	63.3	0	0	0	0.05	48.2	7.4	0	0	0
Silver	0	0	0	0	0	0.05	0	0	0	0	0

compare to MCLs

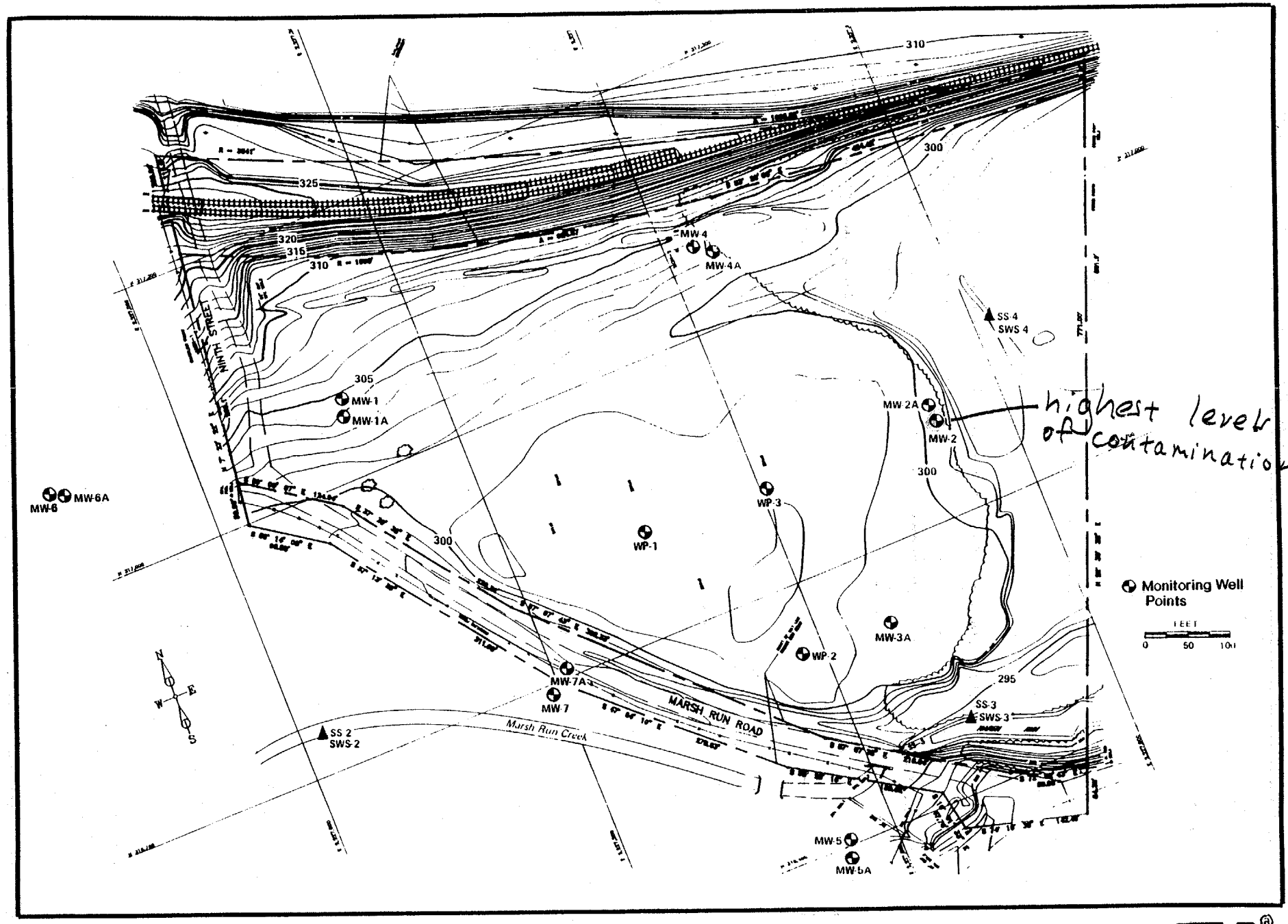


Figure 1-6. Site sampling plan.

TABLE 1-5 AVERAGE GROUND-WATER CONCENTRATIONS (μg/L) IN MONITORING WELLS AT MARSH RUN PARK FOR COMPOUNDS INCLUDED IN THE HUMAN HEALTH RISK ASSESSMENT

	MW-1	MW-1A	MW-2	MW-2A	MW-3A	MW-4	MW-4A
Volatiles							
Ethylbenzene	3.0	2.5 (d)	2.5 (d)	11.8 (b)	2.5 (d)	2.5 (d)	2.5 (d)
1,1-Dichloroethene	7.3 (b)	2.5 (d)	2.5 (d)	2.5 (d)	2.5 (d)	2.5 (d)	2.5 (d)
1,1,2,2-Tetrachloroethane	39.5 (b)	4.8	2.5 (d)	2.5 (d)	2.5 (d)	2.8	1.8
Trichloroethene	165.0	13.3	2.5 (d)	2.5 (d)	2.5 (d)	387.5 (b)	4.3
Acetone	5.0 (d)	5.0 (d)	5.0 (d)	5.0 (d)	5.0 (d)	10.5 (d)	5.0 (d)
Methylene Chloride	2.5 (d)	2.5 (d)	2.5 (d)	6.8 (b)	2.5 (d)	2.5 (d)	2.5
1,2-Dichloroethene (total)	23.8	42.3	2.5 (d)	12.6	2.5 (d)	67.3 (b)	3.8
1,1,2-Trichloroethane	3.8	2.5 (d)	2.5 (d)	2.5 (d)	2.5 (d)	6.3 (b)	2.5 (d)
Semivolatiles							
bis(2-ethylhexyl)phthalate	5.0	15.5 (b)	5.0	5.0	5.0	5.0	4.5
Metals							
Aluminum (c)	828	65,250	2,570	7,723	21,070	5,764	189,000 (b)
Arsenic (c)	5.0	44.4	5.0	10.0	8.0	9.6	77.6 (b)
Barium (c)	488	510	252	182	228	406	1,599 (b)
Beryllium (c)	1.7	3.0	2.5	2.5	2.3	1.7	7.2 (b)
Cadmium (c)	2.5	3.7	2.5	2.5	6.3 (b)	2.5	28.0 (b)
Calcium (c)	78,950	74,750	64,150	133,750	222,500	95,500	56,900
Chromium (c)	5.0	42.4	5.0	10.9	31.5	8.2	106.7 (b)
Cobalt (c)	25.0	31.2	25.0	33.7	25.0	19.9	81.8 (b)
Copper (c)	12.5	38.4	12.5	12.5	30.5	20.9	96.9 (b)
Iron (c)	637	97,100	1,950	20,775	30,790	7,723	374,500 (b)
Lead (c)	2.5	19.7	1.6	6.8	24.5	8.7	56.7 (b)
Magnesium (c)	13,550	22,900	16,450	51,375	45,100	23,775	57,800 (b)
Manganese (c)	63	4,125	44	4,943	872	642	10,800 (b)
Mercury (c)	0.29	0.32	0.10	0.29	0.31	0.32 (b)	0.32 (b)
Nickel (c)	20.0	95.5	20.0	29.8	38.8	20.0	102.3 (b)
Potassium (c)	2,130	10,000	1,525	3,873	10,485	3,070	15,400
Selenium (c)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Sodium (c)	8,505	9,365	8,240	19,300	14,100	11,150	8,295
Vanadium (c)	25.0	103.6	25.0	23.5	48.8	25.0	357.5 (b)
Zinc (c)	92	299	18	68	220	97	834
Boron (c)	47.2	54.5	15.0	88.2	499.5 (b)	36.0	24.0 (b)
Silicon (c)	13,450	43,450	16,000	29,100	50,500	23,350	119,500
Other Inorganics							
Fluoride	100	100	100	350 (b)	200	100	100

(a) Onsite wells are 1, 1A, 2, 2A, 3A, 4, 4A, 7, and 7A
(b) Maximum average of onsite wells
(c) Omitted from further consideration since maximum average concentration is within range of natural occurrence.
(d) Observed concentrations were less than detection limits. For risk assessment calculations, the value of ½ the analytical method detection limit is used.

TABLE 1-5 EXTENDED

	MW-5	MW-5A	MW-6	MW-6A	MW-7	MW-7A	Average[a] of Onsite Wells
Volatiles							
Ethylbenzene	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	3.6
1,1-Dichloroethene	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	3.0
1,1,2,2-Tetrachloroethane	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	6.8
Trichloroethene	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	64.7
Acetone	5.0[d]	23.0	5.0[d]	5.0[d]	5.0[d]	5.0[d]	5.6
Methylene Chloride	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	3.0
1,2-Dichloroethene (total)	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	17.7
1,1,2-Trichloroethane	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	2.5[d]	3.1
Semivolatiles							
bis(2-ethylhexyl)phthalate	5.0	5.0	5.0	5.0	5.0	5.0	6.1
Metals							
Aluminum	15,750	137,250	232	5,950	2,250	5,220	33,297
Arsenic	16.7	38.4	8.9	5.0	5.0	5.0	18.8
Barium	393	1,133	231	187	293	779	526
Beryllium	2.2	9.2	2.5	2.5	2.5	2.5	2.9
Cadmium	2.5	17.2	2.5	2.5	2.5	2.5	5.9
Calcium	111,650	84,250	49,300	144,000	119,000	173,000	113,167
Chromium	32.7	188.5	5.0	5.0	5.0	14.9	25.5
Cobalt	25.2	101.0	25.0	25.0	25.0	25.0	32.4
Copper	14.8	105.8	12.5	12.5	12.5	19.1	28.4
Iron	24,245	171,650	174	8,820	1,350	10,900	60,636
Lead	11.2	86.5	2.5	11.1	2.5	5.2	14.2
Magnesium	30,100	34,900	16,800	57,900	30,300	50,900	34,683
Manganese	962	10,130	17	1,760	148	2,120	2,640
Mercury	0.62	0.70	0.45	0.10	0.10	0.10	0.24
Nickel	40.9	145.0	20.0	20.0	20.0	23.5	41.1
Potassium	7,395	6,620	1,815	2,210	3,350	3,020	5,873
Selenium	1.9	2.5	2.2	1.5	2.5	2.5[b]	2.5
Sodium	63,850	68,650	10,250	234,000	16,900	48,200	16,006
Vanadium	39.7	274.0	25.0	14.5	25.0	25.0	73.1
Zinc	132	658	13	41	18	51	188
Boron	15.0	15.0	159.0	55.0	15.0	60.5	93.3
Silicon	37,550	95,250	11,250	15,700	16,800	28,500	37,850
Other							
Fluoride	100	100	100	100	100	200	150

Stream Surface Water and Sediments

Low-level volatile organic compounds are discharging to Marsh Run Creek upstream and possibly adjacent to Marsh Run Park. There are documented sources of low-level volatiles and semivolatiles upstream of Marsh Run Park. The primary sources of the VOCs in the stream are presently considered unrelated to Marsh Run Park.

Stream sediments detected upstream of Marsh Run Creek at SS-5 (Figure 1-7) were found to contain low-level PAHs and pesticides or pesticide metabolites indicative of an upstream source of these compounds with respect to Marsh Run Park. Metals detected in the surface water (measured as total metals) in some cases exceeded ambient surface water quality criteria for aquatic life. However, stream sediment transport and fugitive dust emissions were not identified as exposure pathways. Table 1-6 lists all potential chemicals of concern detected in surface water and sediment samples.

Ground-Water Modeling

Based on the data generated from the field investigation and a ground-water flow model utilizing the U.S. Geological Survey (USGS) three-dimensional MOD-FLOW numerical ground-water flow model, the assumption of ground-water flow mechanisms at the site are summarized as follows:

- Nearly all of the water (rain water) that infiltrates Marsh Run Park (i.e., 98 percent) will ultimately migrate vertically into the bedrock aquifer. A small portion (i.e., near the edge of the fill adjacent to Marsh Run Creek) will migrate laterally and discharge to Marsh Run Creek.

- The dominant flow pattern of ground water in the bedrock aquifer beneath the site is to the north toward the Susquehanna River. A minor component of bedrock aquifer ground water discharges to Marsh Run Creek.

- Marsh Run Creek, which flows south and east of the site, serves as a hydraulic barrier (because it is a ground-water discharge point). It prevents ground water beneath Marsh Run Park from underflowing Marsh Run Creek to the east or to the south where ground-water levels are higher than the stream elevation.

- The presence of the natural hydraulic barrier (Marsh Run Creek) and the topographically higher elevations to the southeast and east of the site further prevent potential migration of ground water from beneath the site to existing residences along Marsh Run Road. In order to induce ground-water flow from beneath the site toward the residences located southeast and east of the site, the ground-water elevation levels at the residences and extending toward Marsh Run Creek would have to be lowered in excess of the leakage capacity of Marsh Run Creek to the bedrock aquifer. Based on present or plausible future use, such a scenario is highly unlikely. Figure 1-8 illustrates the conceptualized ground-water flow model at Marsh Run Park.

Residential Wells

Water samples were collected and analyzed from private water supply wells at four residences in the vicinity of the site. The residences' private supply wells sampled during the RI showed no indication that site-derived contamination has impacted the wells. Analytical results indicate the residences' supply well water quality is within State and Federal drinking water quality standards.

TABLE 1-6 CONSTITUENTS OF POTENTIAL CONCERN IN SURFACE WATER/SEDIMENTS AT THE MARSH RUN PARK SITE, NEW CUMBERLAND, PA[a]

Chemical	Average	Reasonable Worst Case	Frequency of Detection
Surface Water (mg/liter):			
Trichloroethene	0.005	0.007	3/4
1,2-Dichloroethene (total)	NR[b]	0.001	1/4
Tetrachloroethane	NR[b]	0.002	1/4
ncPAHs (a)	0.0067	0.007	1/4
4,4'-DDE	0.000075	0.0001	1/4
4,4'-DDD	0.00013	0.00038	1/4
Aluminum	2.52	8.50	3/4
Barium	0.077	0.177	4/4
Chromium	0.0038	0.012	1/4
Copper	0.0082	0.013	1/4
Iron	4.82	16.4	4/4
Lead	0.011	0.038	1/4
Manganese	0.368	0.860	4/4
Vanadium	0.0078	0.016	1/4
Zinc	0.085	0.168	2/4
Sediments (mg/kg):			
ncPAHs (b)	1.51	5.53	1/4
cPAHs (c)	1.10	3.92	1/4
Diethylphthalate	NR[b]	0.15	1/4
Di-n-butylphthalate	0.182	0.24	1/4
bis(2-Ethylhexyl) phthalate	0.166	0.17	1/4
4,4'-DDE	0.151	0.580	1/4
4,4'-DDD	0.034	0.11	1/4
4,4'-DDT	0.068	0.245	1/4
Antimony	NR[b]	5	1/4
Arsenic	21.5	36.4	4/4
Cadmium	0.82	1.6	3/4
Lead	27.3	74.5	2/4
Manganese	350	726	4/4
Zinc	60.6	112	2/4
Cyanide (total)	0.28	0.34	3/4

(a) Values in table are based on sampling conducted during the RI.
(b) NR = not reported. Due to detection limit values, average values were calculated to be higher than the maximum detected value; therefore averages were not reported.

How was "Reasonable Worst Case" determined?

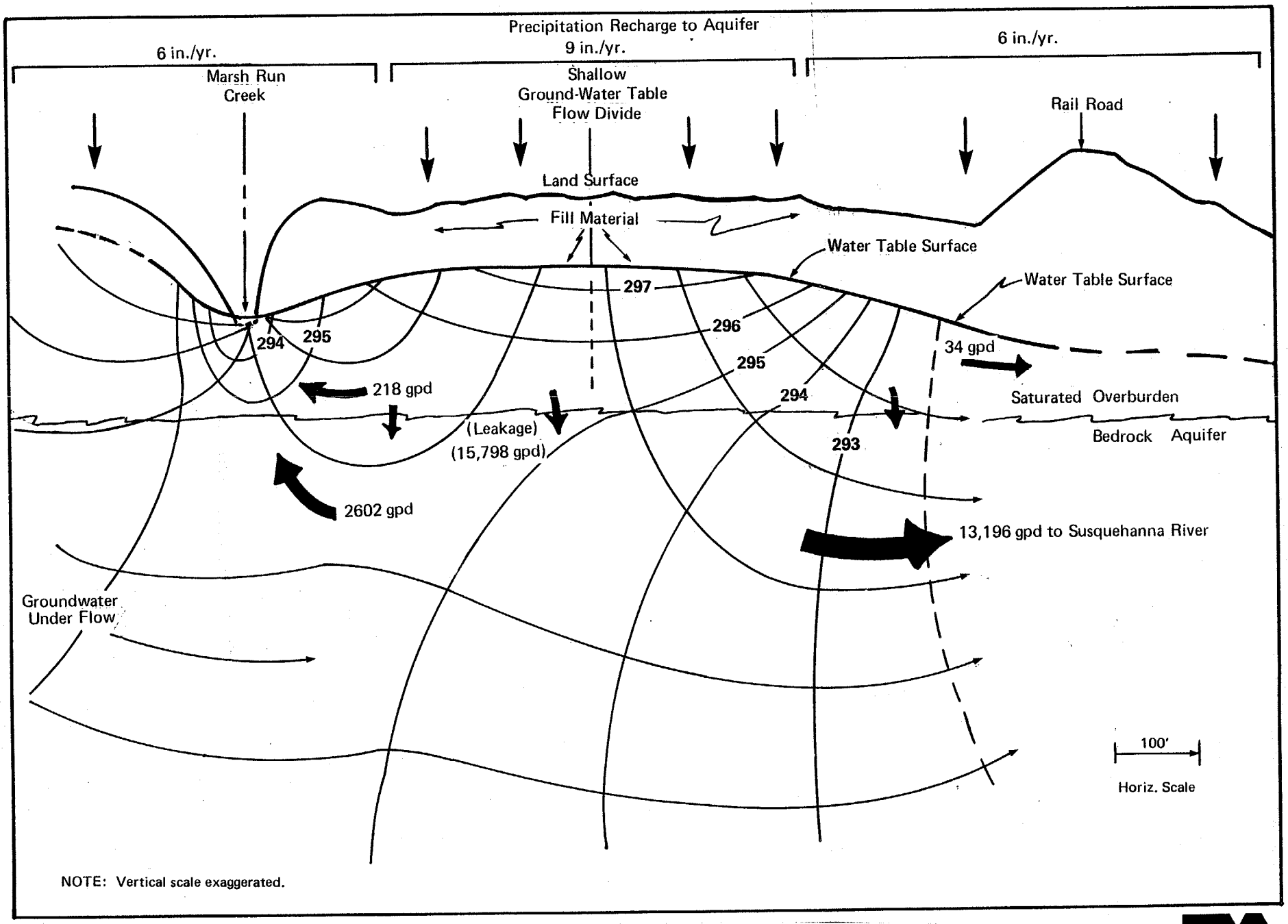


Figure 1-8. Idealized vertical cross section of ground water balance model.

1.2.4 Contaminant Fate and Transport

Fate and transport analysis of the constituents of concern was assessed by direct observation of sampling results and computer modeling of the ground-water contaminant transport mechanisms. Results of the fate and transport modeling are as follows:

- The potential source of volatile organic contamination detected in site monitoring wells is the fill placed at Marsh Run Park. Leaching of the buried waste materials (i.e., "waste fill") by percolating rain waters has carried these volatile compounds vertically to the bedrock aquifer.

- The primary transport mechanism of VOCs is most likely by the migration of these constituents under regional and intermediate ground-water flow conditions within the bedrock aquifer to ground-water discharge points at the Susquehanna River and possibly to Marsh Run Creek.

- Abiotic and microbial transformation of presumed parent volatile compounds trichloroethene, and possibly tetrachloroethene and 1,1,2,2-tetrachloroethane has resulted in the formation of daughter volatile compounds, specifically 1,2-dichloroethene (total) and possibly vinyl chloride. Vinyl chloride may itself also be a parent compound since it is a commonly used industrial solvent. These daughter compounds are more persistent (resistant to further degradation) than the parent compounds in the environment.

- Ground-water modeling of the Marsh Run Park hydrogeologic conditions indicate that the primary migration path of the VOC contamination appears to be within the bedrock northward toward the Susquehanna River. A southward bedrock aquifer component of flow is quasi-radial toward the intermediate ground-water discharge point, Marsh Run Creek.

- Marsh Run Creek's location with respect to the site, serves as a hydraulic barrier which intercepts all intermediate ground-water discharge from the site. Marsh Run Creek does not allow for ground-water in the bedrock aquifer or saturated overburden to migrate beyond its boundaries to residences to the south, southeast, and east. These residences are topographically higher in elevation than Marsh Run Park. The residences are uphill and upgradient of the site and exhibit no apparent site-derived contamination. Under current or realistic future ground-water pumping scenarios, site-derived contamination will not impact the nearby residences.

- Elevated trace metals detected in site monitoring wells appear to be both related to site-derived contamination and from an offsite source. An offsite source is indicated by the elevated trace metals in upgradient monitoring wells MW-5 and MW-5A. The offsite source is presumably west of Marsh Run Park where treated sewage sludge was disposed adjacent to Marsh Run Creek. Based on inferred ground-water paths to the depth investigated (i.e., 50 ft) interaction between an offsite source(s) and an onsite source is unlikely, due to Marsh Run Creek's role as a hydraulic barrier.

- Trace metal mobility in ground water is low based on the comparison of dissolved (filtered) and total (nonfiltered) trace metal concentrations in the ground water, ground-water pH, and the comparison of contaminant concentrations in the shallow saturated zone and the bedrock aquifer. Ground-water data show elevated metals to be primarily restricted to suspended and particulate phases or adhered to other particles solids (undissolved phase).

- The surface water of Marsh Run Creek has exhibited low levels of volatile organic concentrations adjacent to Marsh Run Park. However, surface water samples collected upstream have also shown similar compounds and concentrations. Although an upstream source of VOC contamination of Marsh Run Creek is evident, ground-water modeling indicates that ground-water base flow to Marsh Run Creek from the overburden and bedrock aquifer may also contribute to low-level surface water VOC contamination. This condition was not evident in MW-7, which is situated between Marsh Run Park and Marsh Run Creek.

- Both VOC solute mass flux via ground water to the Susquehanna and the resultant solute mass flux of Marsh Run Creek surface water discharge to the Susquehanna are greatly diluted by the Susquehanna River.

- Migration of contaminants via soil erosion or dust emissions is not a significant transport mechanism.

1.2.5 Baseline Risk Assessment

The overall objective of the risk assessment was to evaluate effects on humans and on the environment from releases from the site. The assessment considered releases from the former landfill site to ground water, to surface water and sediment, to soil, and to air.

The human health risk assessment considered the following topics: (1) contaminants detected during the remedial investigation at the site; (2) potential environmental pathways by which populations might be exposed to compounds released from the site; (3) estimated exposure point concentrations of the compounds of concern; (4) estimated intake levels of the compounds of concern; (5) toxicity values of the compounds of concern; (6) past, current, and future land-use conditions; and (7) uncertainties in the exposure and toxicity assessments. The level of risk

that the site posed to human health under past, current, and future use scenarios was then evaluated and discussed. The past assessment was based on past exposure scenarios (i.e., use of Marsh Run Park as a soccer field). All exposure assessments were based on the current physical conditions of the site.

Summary of Chemicals of Potential Concern

Tables 1-3, 1-4, and 1-5 list chemicals of potential concern for soil, surface water/sediments, and ground water, respectively. These are the compounds which were carried through the analysis to quantify the risk posed to humans by releases from the site.

Exposure Pathways

In light of the current physical conditions and past, present, and potential future uses of the site, the following human exposure pathways were quantitatively evaluated:

- Past exposure of local children to surface soils onsite via direct contact, incidental ingestion, and inhalation during activities involving use of the site as a playing field. Chemical data from surface soils collected by the EPA and USACE following the Confirmation Study (Woodward-Clyde 1988) were used to estimate exposure concentrations.

- Current exposure of local children to surface water/sediment contamination via direct contact (i.e., dermal contact) and incidental ingestion during wading and other recreational activities;

- Current exposure of local residents to contaminants in surface water via ingestion of fish from Marsh Run Creek;

- Future exposure of hypothetical onsite residents to ground-water contaminants via ingestion of ground water from onsite wells.

Evaluation of risks associated with the past use of Marsh Run Park as a soccer field (i.e., dermal exposure, incidental ingestion of cover soils and inhalation of dust) leads to the conclusions that this use resulted in little or no risk to the children using the field. The quantification of noncarcinogenic risks shows that hazard indexes for both average and worst case scenarios are both less than 1, indicating no expectation of noncarcinogenic effects. The lifetime excess cancer risk for both average and worst cases is orders of magnitude less than the risk level of 1 in a million, indicating that this risk could not be distinguished from background risk.

Evaluation of the current use scenario of children playing in Marsh Run Creek indicates that there is little cause for concern from contact with surface water or sediment. The current use scenario takes into account the current physical conditions of the site and the present limitations to its use as a recreational facility. Risk from exposure to both non-carcinogenic and carcinogenic compounds is within acceptable ranges even under the conservative assumptions of the reasonable worst case exposure scenarios.

Evaluation of risk from ingestion of fish from Marsh Run Creek indicates that there are no potential noncarcinogenic effects and that potential carcinogenic risk is at the lower end of the range of acceptable risks for remediation alternatives at Superfund sites (NCP, 300.430(e)(2)(i)(A), March 1990). In addition, field investigation during the RI suggests that there are no fish of edible size in Marsh Run Creek to make this a possible exposure pathway.

Evaluation of the risk from ingestion of onsite ground water (i.e., future use scenario) indicates that there would be potential risk associated with this exposure pathway. The hazard quotient associated

with arsenic indicates that ingestion of this element in drinking water would be at unacceptable levels regarding noncarcinogenic effects. In addition the carcinogenic risks (i.e., from volatile organic compounds) from drinking this ground water would not be acceptable. As stated previously, this is a highly unlikely exposure scenario since residential development is not likely to occur on the site. The site has very low growth potential. Development is unlikely to occur on a former landfill site. The site itself would be a wetlands/marsh area if it were not for the waste deposited on the site and the cap covering the fill. The area is in a floodplain and is bounded by railroad tracks. All of these factors combine to make any development on the site unlikely. In addition, development is not likely to occur in areas north of the site and adjacent to the Susquehanna since this area is also wetlands and is prone to flooding.

Evaluation of the offsite residential wells in the neighboring area showed that these wells did not contain contaminants and hence posed no risk from the ingestion of water from the residential wells. Groundwater monitoring described in Section 4 and modeling in Section 5 indicate that current residents are not downgradient of the site and that contaminants from the site are not likely to reach residential wells, indicating that there is no risk to current residents in the vicinity of Marsh Run Park.

Conclusions

Based on the above analysis, although there is apparent local site-related ground-water contamination, there are no risks identified with the site's existing conditions or past uses of the site as a recreational field. Potential risks may exist, however, if domestic water supply wells were to exist north of the site. It is highly unlikely that domestic wells will be installed in this proximity, since the area north of the site is wetlands, which are prone to flooding.

Offsite sources of contamination to the west of Marsh Run Park (i.e., upstream) of the site appear potentially to have contributed contamination to Marsh Run Creek.

1.2.6 Baseline Ecological Assessment

The vicinity of the Marsh Run site is largely grassland with boundary areas of upland forest and swamp. Terrestrial wildlife is expected to be limited to small mammals, birds, amphibians, reptiles, and assorted invertebrates. Larger wildlife are expected to be restricted from the site by a fence. The Marsh Run Creek borders the site for a small area before its confluence with the Susquehanna River. High sediment loads are expected to have adverse effects on the benthic invertebrate community of the stream. The sediment load appears to originate upstream from the Marsh Run site, as the thick vegetative cover on the landfill cap precludes the generation of excess sediments. The observed fish community is typical of streams classified as warmwater fisheries by the Pennsylvania Department of Environmental Resources (PaDER). The species observed and their sizes are not expected to be pursued as sport or food species by humans.

The site control present on the site (cover soil, fence separating NCAD, etc.) makes the potential for a terrestrial exposure route unlikely. The presence of contaminated ground water and the relationship between ground-water elevation, gradient, and stream base flow indicate a potential aquatic exposure route. The invertebrate and fish community present have the potential to be exposed to contaminants present in ground water.

Measured surface water contamination was observed to some extent at all stations, including those stations identified as background or upstream comparison stations. In several instances, background station concentrations were higher than those observed anywhere else.

1.2.7 Archeological/Historical Investigation

In October 1989, an archeological/historical investigation (Phase IA Cultural Resources Investigation) was conducted by MAAR Associates (Newark, Delaware) at the Marsh Run Park site. The purpose of the investigation was to evaluate the potential for prehistoric and/or historic cultural resources contained within the project area that would be affected by remedial action at the site.

This investigation, which consisted of extensive archaeological and historical background research, cartographic work, informant interviews, and a preliminary field reconnaissance, resulted in the identification of a 7-acre parcel contained within the larger 13.86-acre parcel which appears to have been extensively utilized as a landfill. Three auger tests, excavated to a maximum depth of 3 ft, could not penetrate to undisturbed natural strata. It was the considered opinion of MAAR Associates, Inc. that although the project area has the potential for containing undisturbed soils beneath and surrounding the landfill, the documented presence of hazardous wastes leaching into the soils and into the aquifer makes any requirements for further archaeological investigations neither prudent nor feasible. It is therefore being recommended that the proposed cleanup project be given a determination of "No Effect" with respect to archeological/historical considerations.

A copy of the Phase IA Cultural Resources Investigation prepared by MAAR Associates is provided in Appendix A. This report must be submitted to the Commonwealth of Pennsylvania for review and comment.

1.2.8 Volatile Organics Source Survey (VOSS)

During the process of screening remedial alternatives, it became apparent that additional characterization of the site in the vicinity of the "waste fill" would be needed to adequately assess source area remediation. Geophysical survey results from the RI had identified an area of approximately 4.3 acres of "waste fill" (see Figure 1-9). The RI

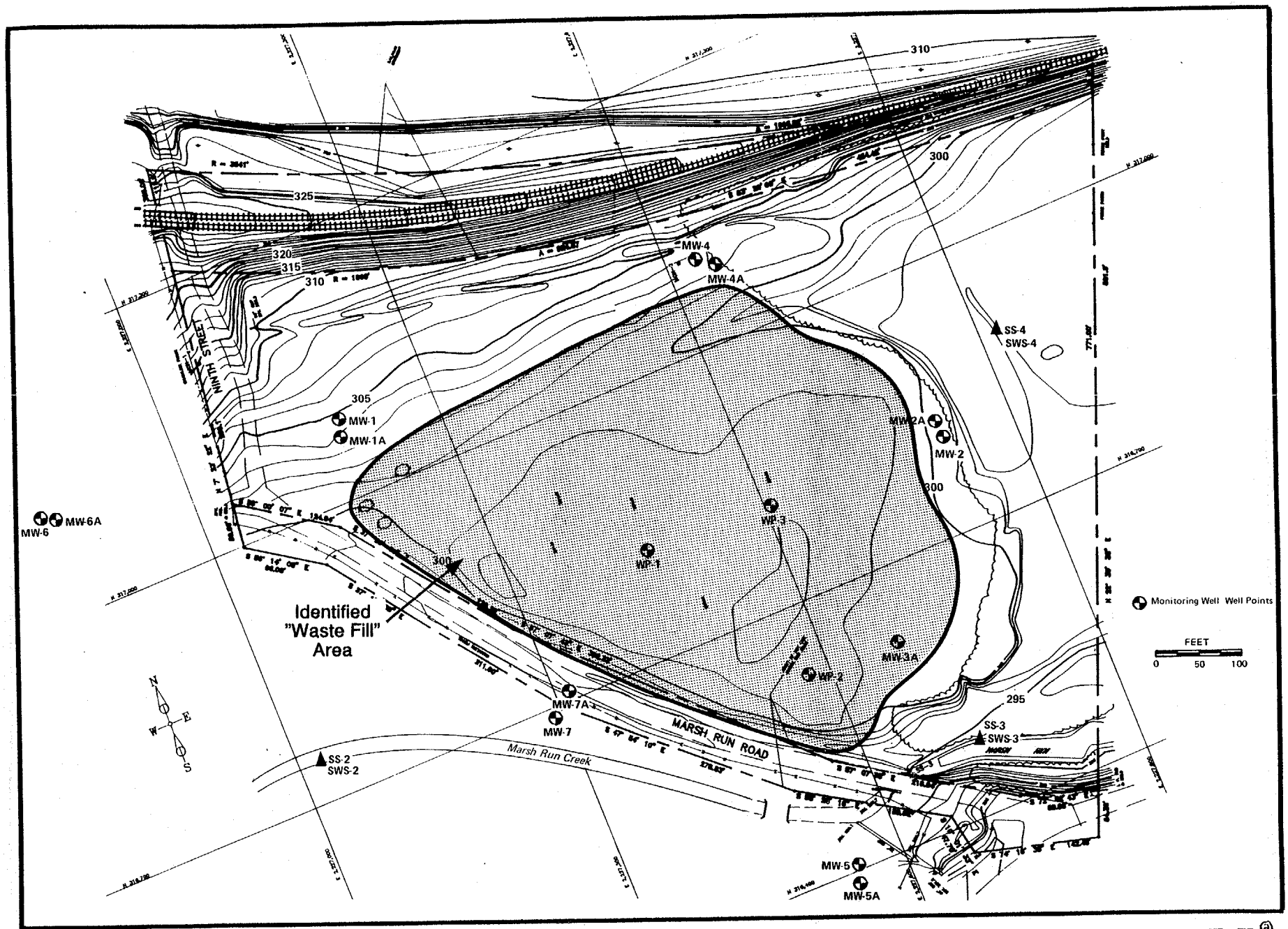


Figure 1-9. Approximate limits of "waste fill" area as identified by geophysical survey (1988).

concluded that this "waste fill" area was the source area for ground-water contamination in the shallow saturated zone and the bedrock aquifer. In order to more accurately assess the effectiveness of certain source area remedial actions, additional characterization of the identified source area was recommended. The objective of this characterization was to identify "hot spots" within the source area that most directly contribute to observed ground-water contamination.

The approach chosen for characterization of the source area was a volatile organics source survey (VOSS). The VOSS consisted of collecting ground-water samples from small diameter well points in the shallow saturated zone. The sampling depth was between 3 and 11 ft below ground surface. Actual sample depth was dependent upon depth to shallow saturated zone ground water, and sample depth was optimized to be representative of shallow saturated zone conditions beneath the waste fill. Water samples were collected and analyzed using field apparatus and procedures similar to those used for conducting soil vapor surveys.

The primary objective of the VOSS survey was to develop a characterization of water quality conditions within the shallow saturated zone. It was concluded that a direct assessment of shallow saturated zone ground water would be more useful for source area characterization than a soil vapor survey, because the VOSS approach provides a direct assessment of actual contaminant leaching from the source area to the shallow saturated zone, while a soil vapor survey can only show vadose zone contamination. Using the VOSS approach, it is possible to identify the types and concentrations of contaminants that have actually leached from the source area and to develop an assessment of water quality conditions in the immediate vicinity of the contaminant source area.

A grid pattern was established across the 4.3 acre "waste fill" area and extending north and northwest to encompass the area up to and including monitoring wells MW-1 and MW-4. This additional area was included since water samples from MW-1 and MW-4 had shown the highest TCE and other solvent concentration levels observed during the RI, and

since they are located hydrologically downgradient of the "waste fill" area. Figure 1-10 shows the locations where shallow saturated zone ground-water samples were collected during the VOSS.

Water samples were then analyzed for the presence of specific volatile organic contaminants using an onsite mobile gas chromatograph (GC) laboratory. Contamination data were plotted and contoured on a site map. Figures 1-11 through 1-13 show observed concentration levels for TCE, total 1,2-dichloroethylene (cis plus trans), and total organics in water samples from the shallow saturated zone.

Review of VOSS data indicates that it was only possible to collect shallow saturated zone water samples at approximately half of the proposed sample locations. Multiple attempts were made to collect water samples from each location, but samples could only be obtained at 48 locations. Probe refusal was encountered at only one location (7-2). All other unsuccessful sample points were due to inability to extract ground water at the sample location. There are several reasons why samples could not have been collected from all of the proposed sample locations. They include the heterogeneous nature of the "waste fill," depth to ground water in the northern portion of the site (9-11 ft) and technical limitations of sampling equipment.

It should be noted that although approximately half of the proposed sample locations did not yield water quality data, samples were obtained from 48 points within the fill area (Figure 1-14). These data provide thorough coverage of the source area. Furthermore, when examined in conjunction with the results of the EM survey and shallow and deep ground water monitoring results, the VOSS data provide an accurate assessment of localized contaminated areas ("hot spots") within the source area.

Assessment of the data indicated that volatile organic solvent contamination was observed throughout and north of the former landfilled area. Contaminant concentrations were found to be greatest in the northern

portion of the site. Contamination was not limited to the area identified as former landfill from the electromagnetic terrain conductivity survey (EM survey). Ground-water contamination in the shallow saturated zone was also observed immediately north of the landfilled area toward monitoring wells MW-1 and MW-4. This VOC-contaminated area exhibited some of the highest ground-water contamination concentrations at the site. The source area survey indicated that the VOC-contaminated area north of the landfill may be contributing a significant percentage of source area contribution to deep aquifer contamination. Figure 1-15 shows the approximate limits of the former landfill as estimated using EM survey (October 1988), and the additional VOC-contaminated area north of the landfill as estimated from the VOSS. It should be noted that the area of highest VOC contamination encompasses the northwestern portion of the former landfill and the south-central portion of the VOC-contaminated area. For the remainder of this report, the term source area will apply to the area encompassing both the "waste fill" and the VOC-contaminated area.

Areas of localized contamination within the source area ("hot spots") were identified based upon the results of the VOSS in conjunction with water quality data from the shallow saturated zone and bedrock aquifer monitoring wells and the EM survey. "Hot spots" are defined, at this time, as areas in which the shallow saturated zone VOC contaminant levels exceed health based risk levels (MCLs). The source area "hot spots" as defined at this time are shown in Figure 1-16. It should be noted that the delineation of "hot spots" shown at this time may be optimized during remedial action at the site, and is subject to change. The primary objective of defining "hot spots" is to be able to focus source area remediation to the areas within the source area which most directly contribute to bedrock aquifer contamination, and to avoid unnecessary source area activities in areas not detrimentally impacting bedrock aquifer quality.

The complete VOSS report, including all analytical and quality control data, and data assessment, is provided as Appendix B.

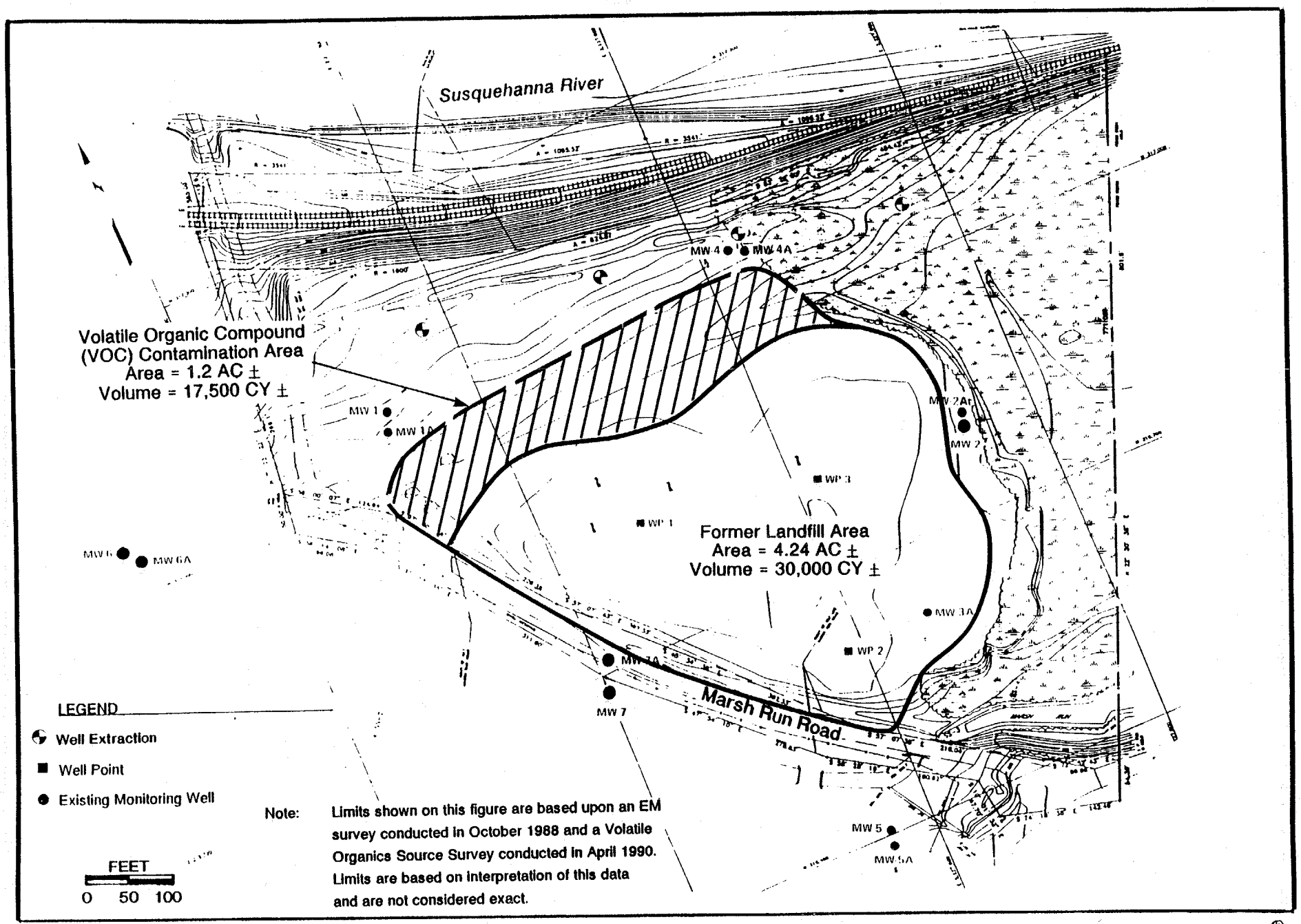


Figure 1-15. Approximate limits of ground water contamination source

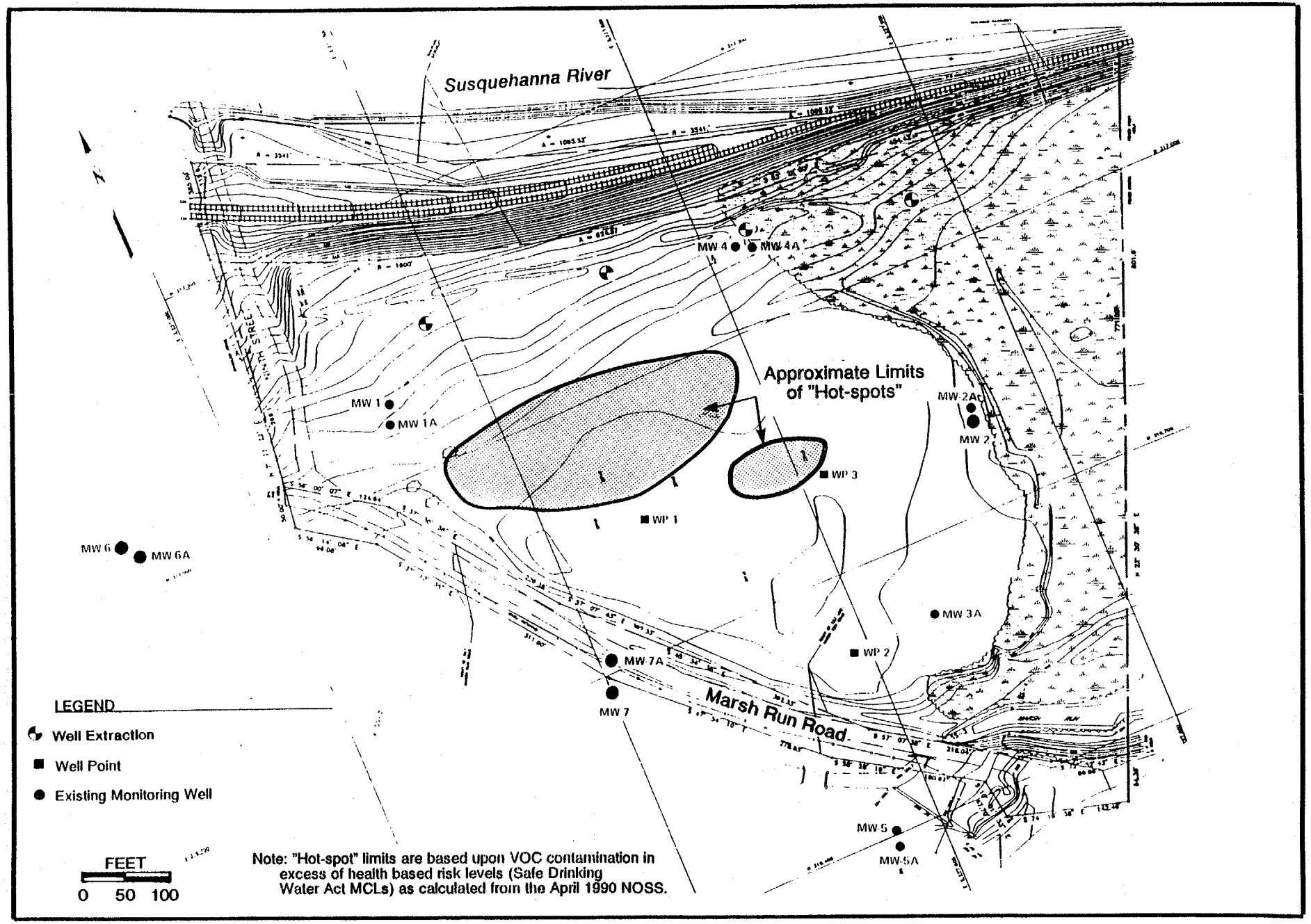


Figure 1-16. Approximate extent of "hot-spots" as identified from VOSS results (April 1990).

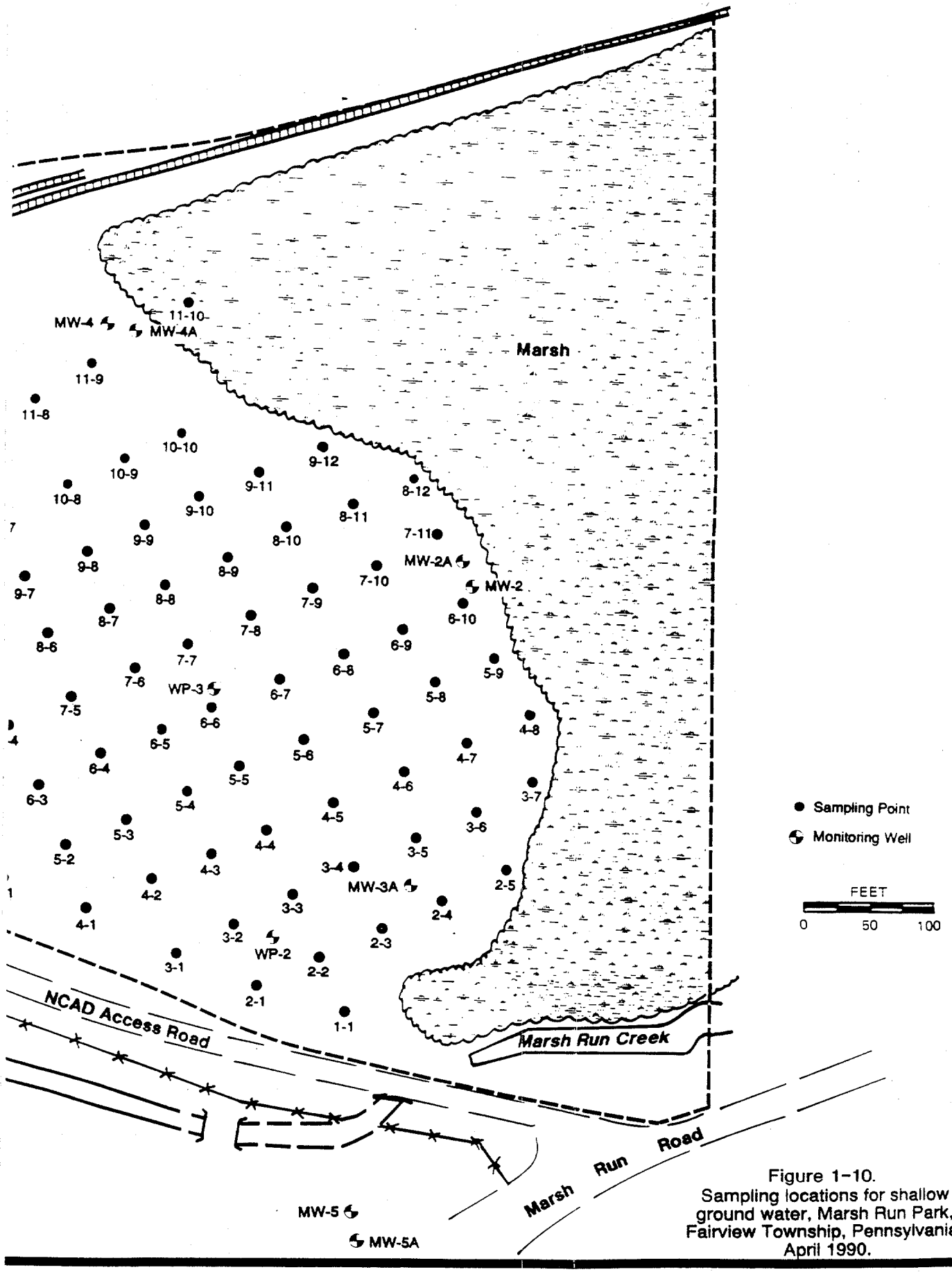
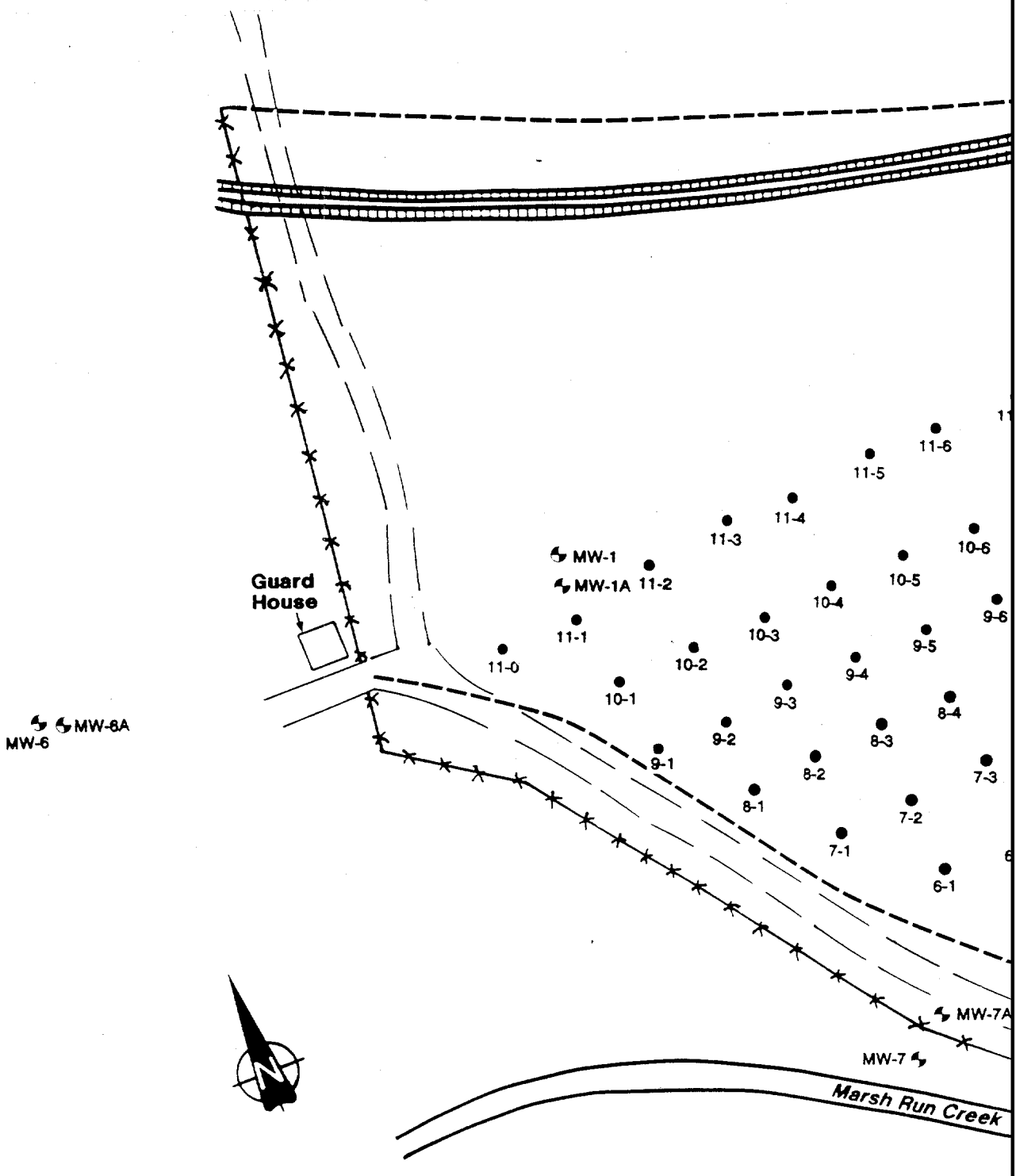


Figure 1-10.
Sampling locations for shallow ground water, Marsh Run Park, Fairview Township, Pennsylvania, April 1990.


Guard House
MW-1
MW-1A
MW-6
MW-6A
MW-7
MW-7A
11-0
11-1
11-2
11-3
11-4
11-5
11-6
10-1
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9-3
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7-1
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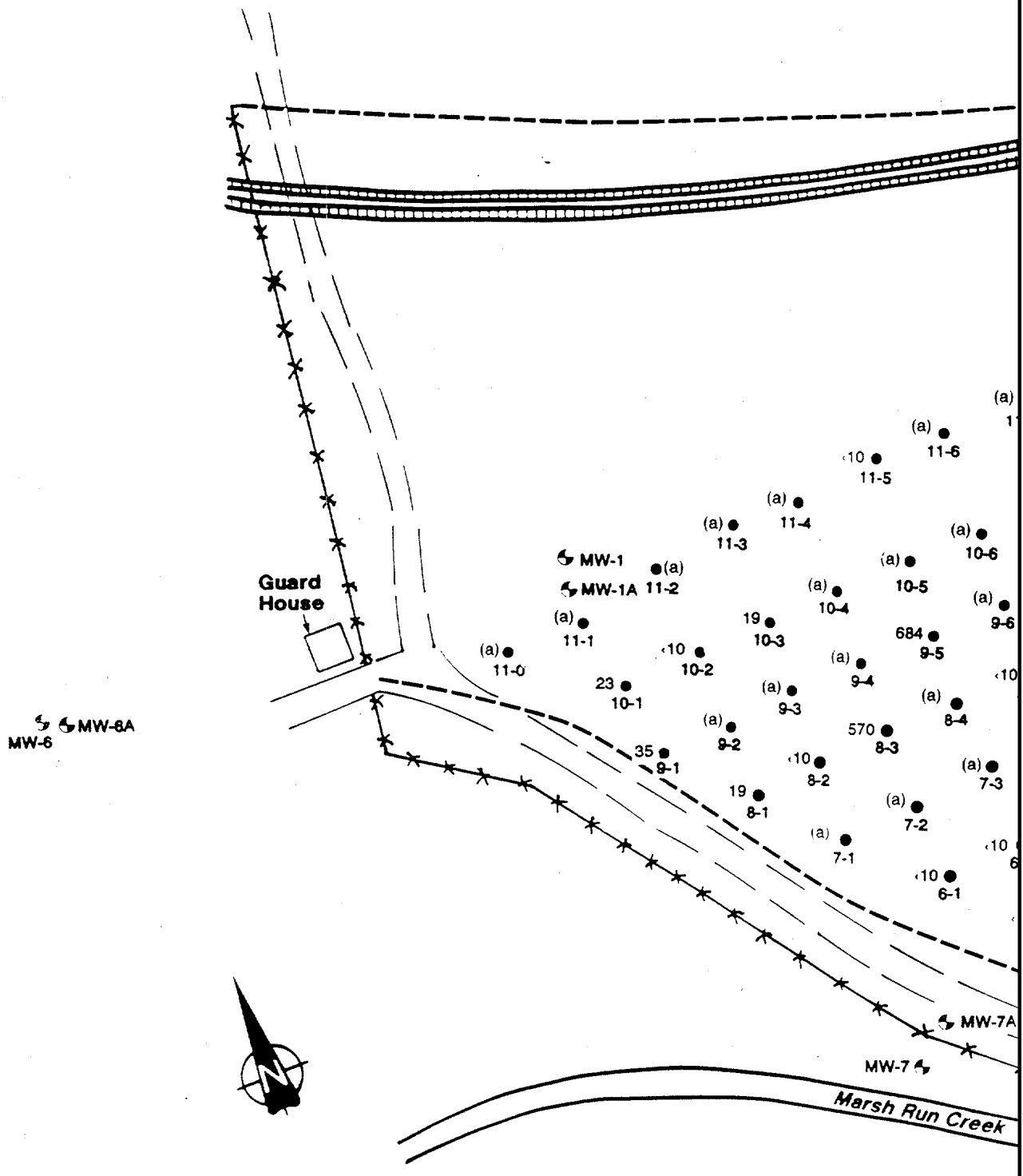
7-3
6-1
Marsh Run Creek


Guard House
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(a) 8-4
(a) 9-2
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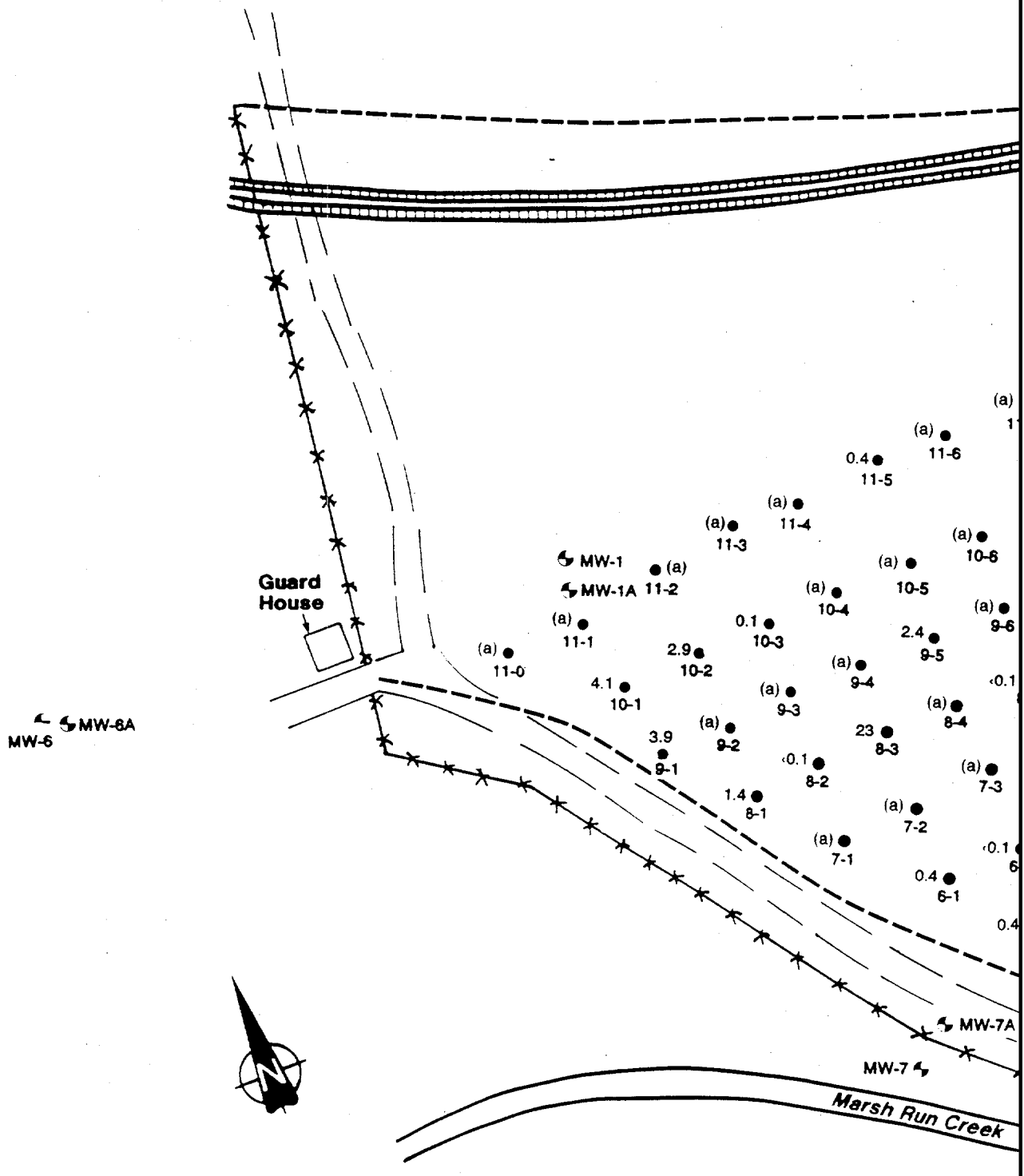
(a) 7-1
<10 6-1
N


Guard House
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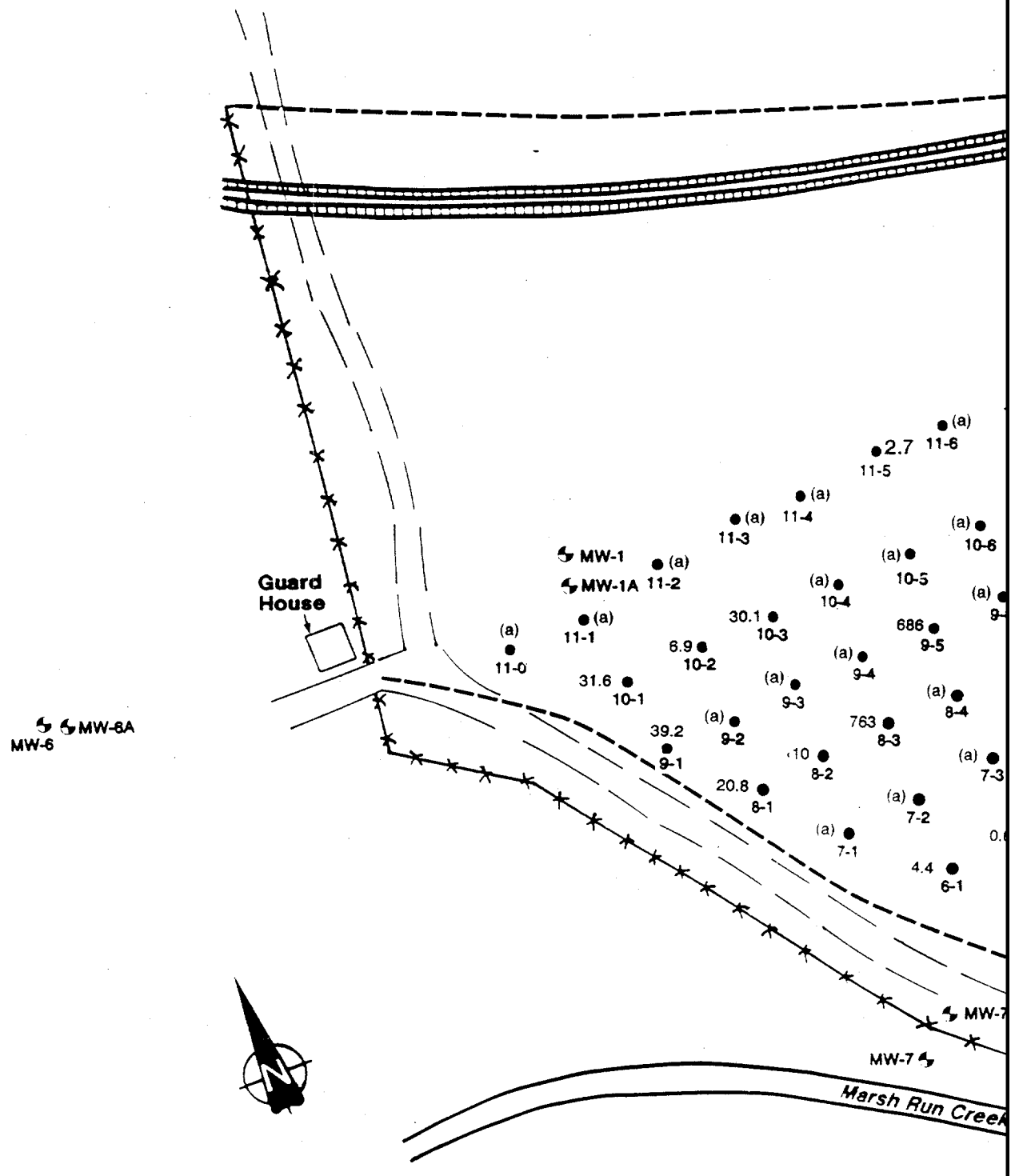
MW-7
Marsh Run Creek


Guard House
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Marsh Run Creek
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763
20.8
2.7
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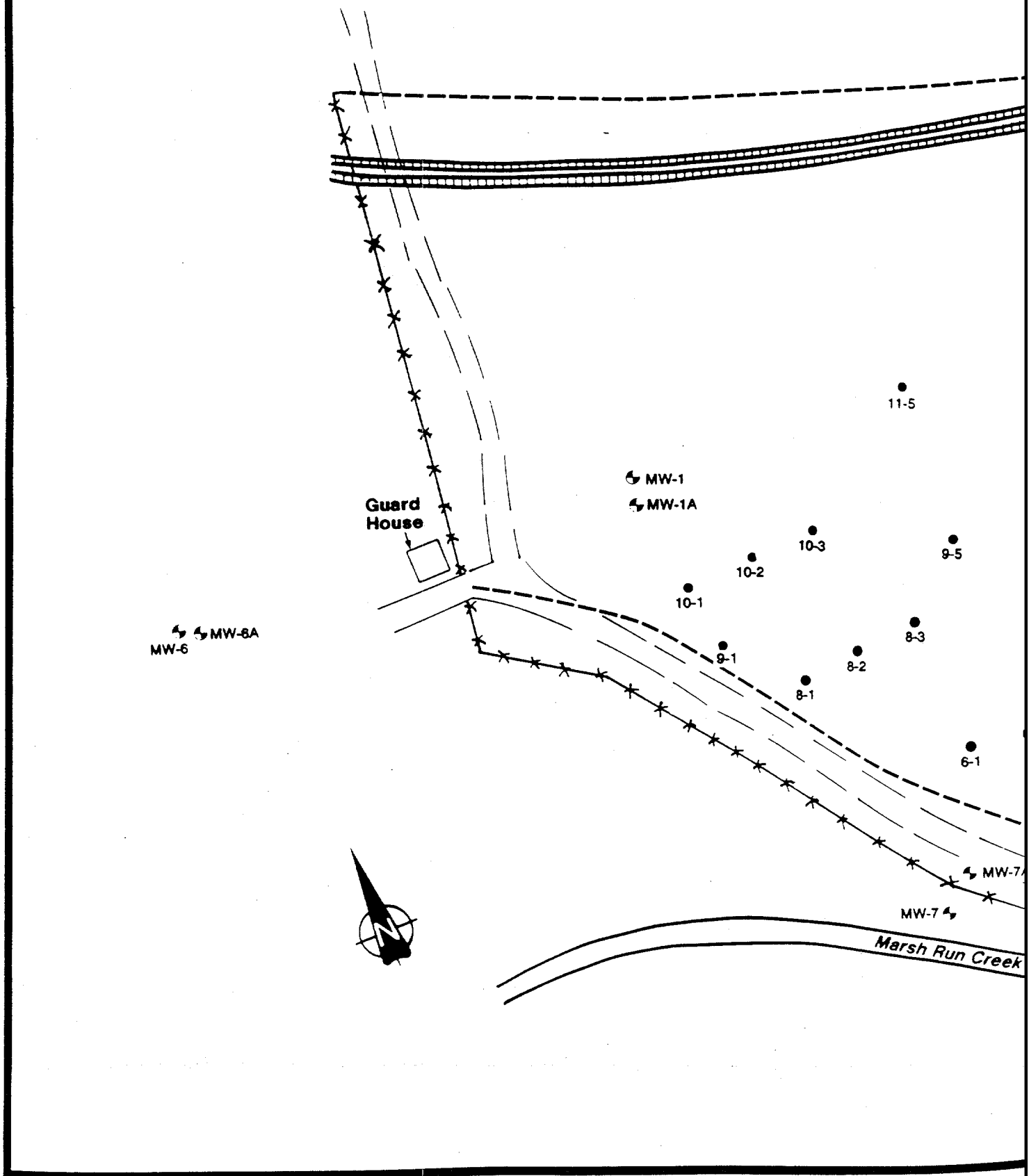
(a)
N


Guard
House
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9-1
8-1
6-1
MW-6
MW-6A
MW-7
MW-7
Marsh Run Creek
N

2.2.1 State Hazardous Waste Cleanup Laws

Remedial action at the former Marsh Run Park landfill will be performed in accordance with the Pennsylvania Hazardous Sites Cleanup Act (Pennsylvania Statues--Title 35--Health and Safety). The Pennsylvania Hazardous Sites Cleanup Act governs remediation of non-NPL hazardous waste sites in Pennsylvania. The legislation is administered by the PaDER Bureau of Waste Management. At this time, Pennsylvania has adopted the cleanup standards specified in Section 121 of CERCLA and the subsequent revisions to CERCLA contained in SARA.

2.2.2 Resource Conservation and Recovery Act Requirements

The Federal Resource Conservation and Recovery Act (RCRA) serves as the basis for development of technology-based requirements governing the identification and listing, storage, transportation, and disposal of hazardous wastes at active or proposed hazardous waste facilities (generators, transporters, storage or disposal facilities). RCRA requirements include ground-water protection, landfill permitting, design and performance standards, and standards for waste piles and surface impoundments. For this project, ARARs under RCRA relate to offsite disposal of waste materials from the site and to siting and closure permitting for onsite treatment actions. Specifically, 40 Code of Federal Regulations (CFR) 261 (Identification and Listing of Hazardous Waste), 40 CFR 263 (Standards Applicable to Transporters of Hazardous Waste), and 40 CFR 268 (Land Disposal Restrictions) will apply to removal and transportation of waste materials from the site. In addition, certain provisions of 40 CFR 264 (Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities), and 40 CFR 270 (EPA-administered permit programs: The Hazardous Waste Permit Program) will apply to any selected offsite hazardous waste disposal facilities as well as onsite treatment or disposal technologies and/or site closure by capping or other containment technology. All offsite hazardous waste disposal shall be at an RCRA-permitted treatment and disposal facility.

RCRA Land Ban Regulations

The requirements of 40 CFR 268 [the Land Disposal Regulations (LDR)] are of particular relevance to implementation of remedial alternatives at hazardous waste sites. The 8 November 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA serve as the basis for the LDRs. On 7 November 1986, the first of the LDRs went into place with the publication of treatment standards for spent solvent and dioxin-containing wastes. Shortly thereafter, EPA issued regulations pertaining to land disposal of "California List" wastes. Regulations for the "first third" wastes were issued on 17 August 1988. Regulations for the "second third" wastes were issued on 8 June 1989, and regulations for the "third third" wastes were proposed on 22 November 1989.

The Land Disposal Regulations (often referred to as the "Land Ban") prohibit land disposal of regulated wastes that have been classified as RCRA listed hazardous wastes (in accordance with 40 CFR 261) or as RCRA characteristic wastes. RCRA characteristic wastes are materials which are considered reactive, ignitable, corrosive, or toxic in accordance with specific testing methodology as identified in 40 CFR 261. The Toxicity Characteristic Leaching Procedure (TCLP) extraction procedure is used by EPA to define if a waste is a "toxic" characteristic waste. Based on what is known about waste materials at the Marsh Run Park site, it is possible that much of the "waste fill" materials will be classified as RCRA characteristic waste based on TCLP concentrations of solvents and heavy metals. TCLP testing has not been conducted on any soil samples from the site so it is not possible to determine at this time what percentage of "waste fill" material would be considered as RCRA characteristic waste. However, results of the VOSS survey show contaminant concentrations in the shallow saturated zone that are representative of contaminant leaching in that area. Actual TCLP analyses will be run of soil samples during the pre-design phase for any material considered for offsite disposal. TCLP extract limits for land disposal of wastes with contaminants as identified at the Marsh Run Park site are listed

in Table 2-1. Land Ban considerations will affect all offsite disposal options and may impact certain onsite remedial technologies.

EPA has issued guidance regarding the impact of land disposal regulations on Superfund response actions (EPA 1987). Four essential questions must be addressed in determining if the LDRs are ARARs:

1. Is the waste being placed?
2. Is the waste an RCRA hazardous waste?
3. Is the waste restricted?
4. Is the waste soil and debris?

The most significant question is that of "placement." EPA's proposed revisions to the National Contingency Plan (53 FR 51435) state that land disposal restrictions would only be triggered when hazardous wastes are "placed" in a land disposal unit. Placement is defined as

1. Depositing wastes in a land disposal unit for the first time.

2. Removing wastes from one unit and depositing them in another unit with or without intermediate treatment.

3. Consolidating wastes from several units into one unit.

4. Removing wastes from a land disposal unit, treating them, and redepositing them in the same unit.

Moving wastes entirely within a unit or treating wastes in situ would not be considered "placement." Therefore, LDRs would not impact remedial activities in which containment alone or containment with in situ treatment is proposed.

At present, EPA has also proposed two options to reduce the impact of land disposal regulations on Superfund cleanups:

1. Excavation, treatment, or redeposition in the same unit or area of contamination would not constitute land disposal and, therefore, would not trigger the LDRs.

2. Wastes that are excavated, treated, and redeposited elsewhere on the site, in a different, new or existing, unit would not trigger the LDRs, recognizing that a CERCLA site is essentially one large "unit" for the purpose of making remedial decisions.

These options have been proposed for public comment in the Federal Register.

The PaDER Bureau of Waste Management is responsible for implementation of RCRA in Pennsylvania. PaDER was granted primacy for implementation of RCRA in January 1986; however, EPA still retains authority for implementation of certain portions of the legislation, most notably many of the provisions of the 1985 HSWA.

2.2.3 Federal/State Drinking Water Standards

The Federal Safe Drinking Water Act (SDWA), passed by Congress in 1974 and amended by the Safe Drinking Water Act Amendments of 1986 (PL 99-339), establishes national interim primary drinking water standards. Primary drinking water standards are set as maximum contaminant levels (MCLs). MCLs represent the maximum allowable level of selected contaminants to which "...it is economically and technologically feasible to ascertain the level of such contaminant in water in public water systems." MCLs are developed by EPA based upon maximum contaminant level goals (MCLGs). MCLGs are nonenforceable health goals at which "...no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety." The SDWA tasks EPA with development of MCLs and MCLGs for drinking water contaminants. Pursuant to the SDWA, EPA sets MCL standards for drinking water contaminants "as close to the MCLGs as is feasible," where feasible means, "feasible with

TABLE 2-1 TCLP EXTRACT CONCENTRATIONS FOR RCRA CHARACTERISTIC WASTES

Constituent	Regulatory Level (mg/L)
Arsenic	5.0
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon Tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	200.0(a)
m-Cresol	200.0(a)
p-Cresol	200.0(a)
Cresol	200.0(a)
2,4-D	10.0
1,4-Dichlorobenzene	7.5
1,2-Dichlorobenzene	0.5
1,1-Dichloroethylene	0.7
2,4-Dinitrotoluene	0.13(b)
Endrin	0.02
Heptachlor (and its hydroxide)	0.008
Hexachlorobenzene	0.13(b)
Hexachloro-1,3-butadiene	3.0
Lead	5.0
Lindane	0.4
Mercury	0.2
Methoxychlor	10.0
Methyl ethyl ketone	200.0
Nitrobenzene	2.0
Pentachlorophenol	100.0
Pyridine	5.0(b)
Selenium	1.0
Silver	5.0
Tetrachloroethylene	0.7
Toxaphene	0.5
Trichloroethylene	0.5
2,4,5-Trichlorophenol	400.0
2,4,6-Trichlorophenol	2.0
2,4,5-TP (Silvex)	1.0
Vinyl chloride	0.2

Reference: 40 CFR Part 261 et al. EPA 29 March 1990/

(a) If o-, m-, and p-cresol concentrations cannot be differentiated, the total cresol (D026) concentration level is used. The regulatory level for total cresol is 200 mg/L.

(b) Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

the use of the best technology, treatment techniques, and other means, which the Administrator finds, after examination for efficacy under field conditions and not solely under laboratory conditions [to be] available (taking costs into consideration)."

The SDWA also calls for EPA to establish health advisories for contaminants found in drinking water. Various advisories including one day, ten day, longer term, and lifetime advisories have been developed for many drinking water contaminants. Appendix C includes a summary table identifying the MCLs, MCLGs, and drinking water health advisories for certain environmental contaminants that have been finalized or proposed as of October 1989. This list is continually updated by EPA as health assessments of other environmental contaminants are compiled. EPA is also directed under the SDWA to establish secondary maximum contaminant levels (SMCLs). SMCLs address aesthetic considerations such as odor, turbidity, and taste. SMCLs issued to date by EPA are also included in Appendix C.

Under Section 121 of CERCLA, remedial actions must require "...a level or standard of control that at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act...." EPA's revised NCP requires that a remedial action shall attain MCLGs for ground water or surface water when the MCLG is above zero. Where the MCLG has been set at zero, "...the MCL promulgated for that contaminant under the SDWA shall be attained..." (EPA 1990). Under certain circumstances, however, a waiver of the requirement to meet all ARARs, such as MCLGs, can be attained and a less stringent alternate concentration level (ACL) may be set and approved. Under new Section 121(d)(2)(B)(ii) of SARA, ACLs cannot be established

> "...if the process assumes a point of human exposure beyond the facility boundary. The only exception is in cases of a known or projected point of entry of groundwater to which such a standard would apply, into surface water which is a reasonable distance from the facility boundary. If at such points of entry, or at any point downstream where accumulations of constituents may occur, there will be no statistically significant increase of such constituents in the surface water from such groundwater,

and there are enforceable measures that preclude human exposure at any point between the facility boundary and points of entry into surface water, an alternate concentration level process may assume such points of entry into surface water as the point of human exposure."

EPA's "Interim Guidance on Compliance With Applicable or Relevant and Appropriate Requirements, July 1987" indicates that "for water that is or may be used for drinking, the Maximum Contaminant Levels (MCLs) set under the Safe Drinking Water Act are generally the applicable or relevant and appropriate standards." Section 300.430(e)(2)(B) of EPA's revised NCP clarifies and restates this guidance. Therefore, MCLs will be used as the cleanup standard for ground water at this site.

In Pennsylvania, the State has primacy for the Safe Drinking Water Act, and has adopted the Federal primary and secondary drinking water standards. Table 2-2 summarizes the water quality limits that will govern remedial actions at the Marsh Run Park site. The PaDER Bureau of Community Environmental Control is responsible for administration of the SDWA in Pennsylvania.

2.2.4 Federal Ambient Water Quality Criteria

The Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 and the Water Quality Act of 1987, commonly known as the Clean Water Act (CWA), was enacted to "...restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Section 303 of the CWA establishes levels of specified pollutants that ambient water can contain and still be suitable for certain uses (i.e., recreation, fish and wildlife, water supply, agricultural, and industrial use). Section 301 of the CWA identifies criteria for listing toxic pollutants and establishing effluent guidelines and pretreatment standards. Section 307 establishes effluent standards for pretreatment and toxic substances based upon Best Available Technology (BAT) for control.

TABLE 2-2 MAXIMUM CONTAMINANT LEVELS (MCLs) FOR SELECTED CONTAMINANTS IN WATER SUPPLY SYSTEMS IN PENNSYLVANIA

Compound	MCL (µg/L)[a]
Volatile Organics	
Trichloroethylene	5.0
cis-1,2-Dichloroethylene	70.0[b]
trans-1,2-Dichloroethylene	100.0[b]
1,1,1-Trichloroethane	200.0
1,1-Dichloroethylene	7.0
1,2-Dichloroethane	5.0
Vinyl Chloride	2.0
Carbon Tetrachloride	5.0
Tetrachloroethene	5.0[b]
Toluene	2,000.0[b]
Xylenes	10,000.0[b]
Benzene	5.0
Ethylbenzene	700.0[b]
1,1,2-Trichloroethane	3.0[c]
PAHs [Benzo(a)Pyrene]	0.2[c]
Inorganics	
Antimony	10.0/5.0[c]
Arsenic	50.0
Barium	1,000.0[a]/5,000.0[b]
Beryllium	1/2[c]
Cadmium	10[a]/5.0[b]
Chromium	50[a]/100.0[b]
Copper	1,300.0[b]
Cyanide	200.0[c]
Fluoride	4,000.0
Lead	5.0
Mercury	2.0
Nickel	100.0[c]
Selenium	10[a]/50.0[b]

(a) Final MCL, unless otherwise noted.
(b) Proposed MCL.
(c) Tentative MCL.
(d) This listing is not a complete listing of all compounds for which MCLs have been developed. It is meant to represent only compounds that have been previously detected in ground water or surface water sampling at Marsh Run Park.

Federal ambient water quality criteria documents currently have been published for pollutants listed as toxic under CWA. These criteria are unenforceable guidelines that may be used by states to set surface water quality standards. Under SARA, remedial actions must attain a level of standard of control equivalent to these criteria unless a waiver has been granted.

The water quality criteria are generally listed in categories representative of differing surface water use designations. Concentrations represent the maximum level of a contaminant that, if not exceeded, should protect most aquatic life against acute and chronic toxicity. Water quality criteria that have been published by EPA as of January 1990 are listed in Appendix D.

CWA authorizes establishment of the National Pollutant Discharge Elimination System (NPDES). NPDES regulates direct discharges into navigable waterways. All discharges are subject to NPDES permits which set limits on water quality of discharges based on the provisions of sections 301, 303, and 307 of the CWA.

For the Marsh Run Park project, the CWA will apply to discharge of effluent from onsite water treatment processes, if such processes are used. Regulations concerning effluent water quality are addressed in 40 CFR 122 and 123. The Commonwealth of Pennsylvania is authorized by EPA to administer the NPDES program (40 CFR 123) through Pennsylvania's Clean Streams Law. The Bureau of Water Quality Management in PaDER is responsible for administration of the NPDES program in Pennsylvania.

In addition to NPDES considerations, Sections 401 and 404 of the CWA address minimization of aquatic impacts associated with the discharge of fill material from wetlands. Federal Executive Orders 11988 and 11990 state procedures for floodplain management and wetland protection.

2.2.5 State Water Quality Standards

Pennsylvania's Water Quality Standards [Pennsylvania (Pa.) Code, Title 25--Environmental Resources, Chapter 16--Water Quality Toxics Management Strategy--Statement of Policy], Adopted 10 March 1989, and Chapters 91-95 and 97 of Title 25 govern Pennsylvania's administration of the Federal Clean Water Act. Pennsylvania, in its CWA implementation responsibility, has developed water quality criteria for toxic substances. Pennsylvania's water quality criteria are presented in Appendix D. These water quality criteria are used as the basis for development of effluent limits in NPDES permits in Pennsylvania and are addressed in Title 25, Chapter 93--Water Quality Standards. The procedures for NPDES applications, permitting, and monitoring are addressed in Pa. Code, Title 25--Environmental Resources, Chapter 92--National Pollutant Discharge Elimination System. Title 25, Chapter 95--Wastewater Treatment Requirements sets forth waste treatment requirements for all discharges and procedure for special circumstances including discharges to lakes, ponds, and impoundments. Chapter 97--Industrial Wastes applies to the discharge of industrial wastes to waters of the Commonwealth. Chapter 101--Special Water Pollution Regulations sets forth specific provisions concerning discharge of industrial wastes to Pennsylvania waters. Since Marsh Run Park is not currently listed on EPA's NPL, it will be necessary to apply for an NPDES permit for onsite waste treatment units that will discharge to waters of the Commonwealth.

2.2.6 State and National Air Quality Standards

In response to the Clean Air Act (CAA) of 1971 and subsequent amendments, EPA has established National Ambient Air Quality Standards (NAAQS). NAAQS are primary (health based) and secondary (welfare based) standards established for control of specific air emissions, as identified in Section 109 of the CAA. Table 2-3 identifies the NAAQS identified to date by EPA.

TABLE 2-3 EPA AMBIENT AIR QUALITY CRITERIA (NAAQS)

Chemical	Concentration[a] ($\mu g/m^3$)
Carbon Monoxide	40,000 (1 hour)[b] 10,000 (8 hours)[b]
Hydrocarbons (nonmethane)	160 (3 hours)[b][c][d] 20 ppd[e]
Lead	1.5 (90 days)
Nitrogen Dioxide	100 (1 year)[f]
Particulate Matter	260 (24 hours)[b] 75 (24 hours)[g]
Ozone	235[h]
Sulfur Dioxide	80 (1 year)[e]

(a) National Ambient Air Quality Standards.
(b) Annual maximum concentration is not to be exceeded more than once per year.
(c) As a guide in devising implementation plans for achieving oxidant standards.
(d) Not adopted by the Maryland Air Management Administration.
(e) Code of Maryland Regulations.
(f) Annual arithmetic mean concentration.
(g) Annual geometric mean concentration.
(h) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one.

In addition to the NAAQS, pursuant to Section 112 of the Federal Clean Air Act, EPA has identified pollutants "...for which no ambient air quality standard exists, but that cause or contribute to air pollution that may reasonably be anticipated to result in an increase in mortality, or in serious irreversible or incapacitating reversible illness." EPA has developed National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for eight air contaminants as of December 1989. A listing of contaminants for which NESHAPS have been promulgated is presented in Table 2-4. These standards will be applicable to remedial activities resulting in airborne discharges from the site.

EPA has also established New Source Performance Standards (NSPS) under Section 111 of the CAA. These standards apply to specific types and target one or more compounds discharged by the source type. The NSPS would apply to implementation of an onsite incinerator at the Marsh Run Park site.

PaDER has adopted in its entirety the Standards of Performance for New Stationary Sources, promulgated in 40 CFR Part 60 by the Administrator of EPA pursuant to Section 111(b) of the Federal Clean Air Act (U.S.C. Section 7411). PaDER has also adopted in its entirety the NAAQS (Section 109 of CAA) and the NESHAPs (Section 112 of CAA). Air pollutant discharges are regulated under Pa. Code, Title 25--Environmental Resources, Subpart C--Protection of Natural Resources, Article III--Air Resources, Chapter 121 (Pennsylvania Air Pollution Control Regulations) and Pa. Code, Title 35--Health and Safety, Chapter 23--Air Pollution (Pennsylvania Air Pollution Control Act).

Permits are required for any onsite stationary air pollution source as indicated in Section 4006.1 of the Pennsylvania Air Pollution Control Act. Permitting and approval of onsite hazardous air pollutant sources are addressed in Chapter 127 of the Pennsylvania Air Pollution Regulations. Chapter 128 of the Pennsylvania Air Pollution Regulations addresses other ARARs that require compliance during remedial alternative implementation, including standards for fugitive emissions [paragraph

(para.) 123.1], particulate matter emissions (para. 128.11), odor emissions (para. 123.31), and visible emissions (para. 123.41-123.43). In addition, emissions are subject to all other requirements of the CAA.

2.2.7 Other Action-Specific Federal ARARs

The following is a listing of other Federal regulations that may be action-specific ARARs, depending on the remedial action selected.

- Occupational Safety and Health Administration (OSHA) Health and Safety Requirements (29 CFR, Parts 1910, 1926, and 1904). Addresses requirements for worker safety during remedial investigation and remedial action activities at hazardous waste sites.

- Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR, Parts 107, 171.1-500). Addresses requirements for marking, manifesting, handling, and transport of hazardous materials; applicable if offsite treatment or disposal of wastes is required.

- Threshold Limit Values, American Conference of Governmental Industrial Hygienists (ACGIH). Provides standards for respiratory protection; applicable to air concentrations during remedial activities.

2.2.8 Other Action-Specific State ARARs

In addition to the Federal and State ARARs addressed previously, the following State regulations may be action-specific ARARs, depending on the remedial alternative selected.

- Pennsylvania Clean Streams Law - Chapter 102 (25 Pa. Code, Chapter 102). Provides requirements for erosion and sediment control provisions for earth-moving activities; jointly

TABLE 2-4. SUMMARY OF NESHAPS PROMULGATED BY EPA UNDER SECTION 112 OF THE CLEAN AIR ACT.

EPA'S TOXIC POLLUTANT EVALUATION AND CONTROL PROGRAM[1]

Preliminary Health and Source Screening	Detailed Assessment	Intent to List Section 112	Decision not to Regulate	Listed Under Section 112[4]	NESHAP Proposed	NESHAP Promulgated
Propylene Oxide[7]	Chlorine and HCl[8]	Chromium	Toluene	Asbestos	Benzene	Mercury
Ammonia[7]	Phosgene[6]	Carbon tectrachloride	POM	Beryllium	Coke-oven emmissions	Beryllium
Styrene[7]	Acetaldehyde[7]	Ethylene oxide	CFC-113	Vinyl chloride		Asbestos
Ethyl Chloride	Acrolein[9]	Chloroform	Methyl chloroform	Coke-oven emissions		Vinyl chloride
Methyl Methacrylate[7]	Hydrogen sulfide[7]	Ethylene dichloride	Manganese	Benzene		Benzene
Meleic Anhydride[7]	Beryllium[2]	Cadmium	Chlorobenzenes	Arsenic		Radionuclides
Phthalic Anhydride[7]	Dibenzofurans[6]	1-3-Butadiene	Vinylidene chloride	Radionuclides		Arsenic
Florides & Comps.	Asbestos2	Methylene chloride	Hexachlorocyclo-pentadiene	Mercury		
Phosphorus & Comps.	Dioxins[6]	Perchloroethylene	Chloroprene			
Hydrocyanic acid[7]	Formaldehyde	Trichloroethylene	Acrylonitrile3			
Selenium & Comps.[6]	Toluene disocyanate[6]		Nickel			
Mercuric Chloride[6]	Methyl isocyanate[6]		Phenol			
Bromine & Inorganic Compounds	Mineral fibers[6]		Copper			
Methanol[5]	Epichlorohydrin[5]		Zinc/zinc oxide			
Contaminant asbestos[6]			Epichlorohydrin			
			Naphthalene			
			Sodium Hydroxide			

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1 As of January 31, 1989 (received from U.S. Environmental Protection Agency, Research Triangle Park, NC).
2 Reassessment of original health effects information.
3 Referred to States for evaluation.
4 EPA is also regulating wood stove emissions and municipal waste combustor emissions under section 111 (New Source Peformance Standards) which will siginficantly reduce the toxic components of these emissions. Onboard controls for gasoline vapors from vehicle refueling are being developed under Title II of the CAA.
5 Reassessed based on noncancer health effects.
6 Ongoing
7 Incorporated into Source Category Ranking System. Pollutant specific determination will not be made.
8 Hold
9 Promoted initiatives underway in 2 States.

administered by PaDER Bureau of Soil and Water Conservation and York County Soil Conservation District.

- Pennsylvania Dam and Safety Encroachments Act of 1978 (25 Pa. Code, Chapter 105). Provides regulations related to encroachments in wetlands areas; administered by PaDER Bureau of Water Resources Management, Division of Rivers and Wetlands.

- Pennsylvania Flood Plain Management Act of 1978 (25 Pa. Code, Chapter 106). Provides regulation of obstructions constructed, owned, or maintained by a political subdivision of the Commonwealth located within the 100-year floodplain as delineated by FEMA Flood Hazard Boundary Maps; administered by PaDER Bureau of Dams and Waterway Management.

- Pennsylvania Water Well Drillers License Act of 1956 (25 Pa. Code, Chapter 107). Provides for licensing of well drillers, well construction records, well abandonment, and pollution prevention of underground waters; administered by PaDER Bureau of Topographic and Geologic Survey.

- Pennsylvania Historic Preservation Act of 1978 (71 Pa. Statutes, Section 1047.1 et. seq.).

- Pennsylvania Solid Waste Management Act of 1980 (25 Pa. Code, Chapter 75). Addresses requirements for identification, storage, collection, treatment, processing, and disposal of non-hazardous (Subchapter D) and hazardous (Subchapter C) wastes, and addresses State implementation of RCRA; administered by PaDER Bureau of Waste Management.

2.2.9 Circumstances In Which ARARs May Be Waived

Pursuant to Section 300.430(f)(3) of CERCLA and Section 504(e) of the Pennsylvania Hazardous Sites Cleanup Act (HSCA), several conditions presently exist under which all ARARs need not be attained. These waivers apply only to meeting ARARs with respect to remedial activities occurring onsite. A waiver must be invoked for each ARAR that will not be attained or exceeded. Other statutory requirements, such as that remedies must be cost-effective, cannot be waived.

The six criteria for waivers of ARARs provided for by CERCLA Section 121(d)(4) are as follows:

1. The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed.

2. Compliance with such requirement at the facility will result in greater risk to human health and the environment than alternative options.

3. Compliance with such requirement is technically impracticable from an engineering perspective.

4. The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation, through use of another method or approach.

5. With respect to a State standard, requirement, criteria, or limitation, the State has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions.

6. In the case of a remedial action to be undertaken solely under Section 104 using the Fund, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of amounts from the Fund to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats.

Criterion No. 6 is not applicable for this project since the Marsh Run Park site is not an NPL site and funding is not provided for by the Superfund. One additional criterion from Section 504 of the HSCA is applicable for this project. It states that PaDER may modify an ARAR if "the remedial action selected will not provide for cost-effective response."

2.3 REMEDIAL ACTION OBJECTIVES

Based upon the results of the RI and the baseline risk assessment (public health and environmental evaluations), general, conceptual-level remedial action objectives for the Marsh Run Park site have been developed. Remedial action alternatives are long-term permanent remedies that minimize or prevent hazardous substance releases from the site. Pursuant to SARA, remedial alternatives will include a preference for permanent treatment and/or destruction of contaminants at the site. The specific remedial action objectives for the Marsh Run Park site are

1. Reduce or eliminate the chlorinated solvent contamination present in the bedrock aquifer to ground-water cleanup levels (MCLs). The cleanup standards to be achieved for volatile organic contaminants are as follows:

   trichloroethene - 5 µg/L
   cis-1,2-dichloroethene - 70 µg/L
   trans-1,2-dichloroethene - 100 µg/L

vinyl chloride - 2 µg/L
tetrachloroethene - 5 µg/L

2. Reduce or eliminate metals and volatile organic solvent contamination present in the shallow saturated zone to ground-water cleanup levels (MCLs). VOC cleanup levels are listed above. The cleanup standards to be achieved for inorganic contaminants are as follows:

   Arsenic - 30 µg/L
   Barium - 5,000 µg/L
   Beryllium - 0.5 µg/L
   Cadmium - 5 µg/L
   Chromium - 100 µg/L
   Copper - 1,300 µg/L
   Cyanide - 200 µg/L
   Lead - 5 µg/L
   Mercury - 2 µg/L

3. Reduce or eliminate the threat to future ground-water contamination by containment, treatment, or removal of the solvent contamination source area within the landfill, as identified based on the RI and the VOSS.

4. Reduce or eliminate future contaminant releases to Marsh Run Creek and the Susquehanna River through surface water or sediment pathways.

5. Reduce or eliminate future contaminant releases to Marsh Run and the Susquehanna River through ground-water pathways.

It should be noted that cleanup of surface water at the site should address contamination emanating from Marsh Run Park only. It has been established that volatile organic solvent and metals contamination has been identified in surface water samples upstream of the Marsh Run site. This observation indicates that an upstream source is partly responsible

for observed contamination identified in Marsh Run Creek. Furthermore, the risk assessment indicates that the contamination levels identified in surface water and sediment samples, both at and upstream of the Marsh Run Park site, do not represent a public health risk. Therefore, remediation of surface water at the site will consist only of prevention of future contaminant releases, via surface water or ground-water pathways, from the Marsh Run Park site. Restoration of surface water to ambient water quality criteria levels will not be a component of this FS.

2.4 GENERAL RESPONSE ACTIONS

Based upon the information obtained through the RI and previous investigations and the remedial action objectives, an inventory of general response actions for the Marsh Run Park site has been developed. The response actions have been developed to identify the universe of technologies that have demonstrated promise in remediation of site problem areas similar to that identified at the Marsh Run Park site. Evolving technologies, such as those being demonstrated under EPA's Superfund Innovative Technology Evaluation (SITE) program and technologies under investigation and development through the DOD Installation Restoration Program, were examined in addition to traditionally accepted remedial action technologies. A summary of general response actions is presented in Table 2-5. The identified response actions and technologies include source-control measures and ground-water control measures. The "No Action" alternative will be used as a baseline to evaluate comparative advantages/disadvantages of other alternatives.

Remediation of the Marsh Run Park site addresses two potential problem areas: (1) source area remediation, and (2) ground-water contamination. Surface water and sediment contamination are not addressed, pursuant to the results of the baseline risk assessment. Contamination of surface soil was not identified as a problem area, since surface soil in the former landfilled area was uncontaminated clean fill deposited on the site by the current owner. Chemical analysis of surface soil samples initiated by both the Army and PaDER did not identify contaminant levels

of concern in the surficial soils at the Marsh Run Park site. Furthermore, the RI risk assessment concluded that the surface soils did not represent a public health risk in accordance with current EPA risk assessment guidance.

2.4.1 Source Area

The suspected contamination source area is a former waste disposal landfill associated with NCAD. An approximate "waste fill" area of 4.2 acres was estimated based upon an EM survey conducted during the RI. The EM survey identified anomalies in the subsurface that may be indicative of buried man-made materials. The EM survey does not provide information from which to make estimates of contaminant locations within the fill.

A volatile organics source survey (VOSS) conducted during the FS indicated additional contamination of shallow saturated zone ground water with volatile organic compound contamination (including TCE) over an area of approximately 1.2 acres. This VOC-contaminated area is also considered to be part of the source area contributing to deep aquifer contamination. Therefore, the total identified source area (consisting of the "waste fill" area and the is VOC area) encompasses approximately 5.4 acres (see Figure 1-14).

Information presently available indicates that the primary contamination associated with the source area is elevated volatile organics and metals concentrations (see Table 1-3 and Appendix B). Volatile organic solvent contamination was not observed in soil samples collected during investigation activities, with the exception of samples collected from drilling of MW-2. The evidence of carbon disulfide and 1,2-dichlorethene in soil samples from MW-2, and the evidence of TCE and other volatile solvent contamination in the ground water downgradient of the source area, indicate that volatile organic contamination could be expected to be

TABLE 2-5 GENERAL REPSPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES FOR MARSH RUN PARK LANDFILL, FAIRVIEW TOWNSHIP, PENNSYLVANIA

General Response Actions	Remedial Technology Types and Process Options	Site Problems Primarily Addressed by Technologies
No Action	None	None
Institution Actions	Monitoring Access Restrictions Site Security . Fencing	Human/Wildlife Contact with site contaminants
Source Area Containment Actions	Capping Techniques . Compacted Clay . Flexible Membrane Liner . RCRA Multimedia Cap Vertical Barriers . Slurry Wall . Sheet Pile Barrier Horizontal Barriers . Bottom Sealing Surface Diversion/Collection . Grading/Revegetation . Dikes and Berms . Terraces and Benches	Surficial Infiltration: Subsurface Soils, Bedrock Aquifer, Surface Water, Sediments
Ground-Water Collection/Treatment Actions	Ground-Water Extraction . Extraction Wells . Extraction/Injection Wells Subsurface Drains . Interceptor Trenches	Bedrock Aquifer, Shallow Saturated Zone

TABLE 2-5 (Cont.)

General Response Actions	Remedial Technology Types and Process Options	Site Problems Primarily Addressed by Technologies
Ground-Water Collection/Treatment Actions (Cont.)	Physical/Chemical Treatment . Activated Carbon Adsorption . Air Stripping . UV Oxidation . Physical/Chemical Precipitation	
	Biological Treatment . Aerobic Bioreactor . Anaerobic Bioreactor	
	Offsite Treatment . Publicly Owned Treatment Works (POTW) . RCRA Disposal Facility	
	In Situ Treatment . Bioremediation . Aeration	
	Onsite Discharge . Marsh Run Creek	
	Offsite Discharge . Susquehanna River . POTW . Deep Well Injection	
Source Area Treatment Actions	Excavation . Excavation/Removal . Excavation/Treatment . Selective Excavation	

TABLE 2-5 (Cont.)

General Response Actions	Remedial Technology Types and Process Options	Site Problems Primarily Addressed by Technologies
Source Area Treatment Actions (Cont.)	Onsite Treatment Physical/Chemical Processes . Soil Washing/Extraction . Stabilization/Solidification . Chemical Oxidation/Reduction Biological Processes . Aerobic Bioreactor . Anaerobic Bioreactor . Landfarming Thermal Processes . Low-Temp. Thermal Stripping . Wet Air Oxidation . Rotary Kiln Incineration . Infrared Incineration	Source Area Contribution to Bedrock Aquifer Contamination
	In Situ Treatment Physical Processes . Soil Venting	Surface Soils, Subsurface Soils
	Chemical Processes . Soil Flushing	Ground Water
	Biological Processes . In Situ Bioremediation	
	Thermal Processes . In Situ Vitrification . RF Heating	
Collection Actions	Gas Control Technologies . Passive Perimeter Gas Control . Active Gas Venting	Subsurface Soils, Shallow Saturated Zone Water

encountered within the waste fill soils. Results of the VOSS conducted during the FS also indicate that VOC contamination will be encountered within the waste fill soils.

An estimated waste fill volume of approximately 30,000 yd^3 was calculated based upon RI site characterization information (EM survey and soil borings). The estimated fill thickness ranges from 2 to 6 ft with an average thickness of 4 ft. Subsequent to the VOSS, an additional volume of approximately 17,500 yd^3 of VOC-contaminated soil was identified immediately north of the "waste fill" area. Therefore, the total source area volume is estimated to be approximately 47,500 yd^3.

From the results of the VOSS, it was possible to locate "hot spots" within the identified source area (Figure 1-16). "Hot spots" were identified as regions within the source area where the concentrations of specific volatile organic contaminants in water samples collected from the shallow saturated zone exceeded Safe Drinking Water Act MCLs. This criterion was used because it identifies areas within the source area where contamination in the soil has resulted in shallow saturated zone ground-water contamination in excess of regulatory levels. These "hot spots" are the primary cause of the continuing source area contribution to ground-water contamination in the bedrock aquifer. The areal extent of identified "hot spots" is approximately 2 acres with an estimated waste volume of about 18,000 yd^3 (4,000 yd^3 waste and 14,000 yd^3 contaminated soil).

The primary objective of source area remediation is reduction or elimination of the contribution from the source-area to bedrock aquifer contamination. Source-area remediation is to be considered at this site primarily in support of ground-water remediation activities. No specific soil cleanup levels are proposed, since risk assessment does not indicate that soil contamination pathways exceed EPA's acceptable risk limits for existing site conditions.

2.4.2 Shallow Saturated Zone

The shallow saturated zone consists of ground water associated with clean fill and waste fill materials located above a clay/silt layer and the shale/siltstone bedrock aquifer. The water table in the shallow saturated zone is located between 4 and 10 ft below the ground surface. Modeling data using the USGS MODFLOW model indicate that the primary ground-water flow path for shallow saturated-zone ground water is downward toward the bedrock aquifer (98 percent of total flow). Therefore, remediation of shallow saturated-zone ground-water contamination will be addressed primarily through bedrock aquifer remediation and source area remediation. Specific remedial responses for shallow saturated-zone contamination only will not be addressed.

2.4.3 Bedrock Aquifer

The upper 30 ft of the bedrock aquifer at Marsh Run Park consists primarily of fractured shale and siltstone. Depth to bedrock is between 12 and 15 ft over most of the site. A thin (1-2 ft thick) layer of highly weathered rock (saprolite) overlies the bedrock. A total of 13 wells were drilled into the bedrock aquifer during site investigation activities. Chemical analysis data from ground-water samples indicate that ground water in the site vicinity is contaminated with TCE and other volatile organic contaminants, as well as various heavy metal contaminants. Slug testing during monitoring well installation indicates that the approximate aquifer transmissivity is 4,327 gpd/ft with a hydraulic conductivity of 7.3×10^{-4} cm/sec. For purposes of the FS, the available aquifer characteristics information will be used in conjunction with the MODFLOW ground-water modeling package to assess ground-water pumping conditions. It is essential that more refined aquifer testing (i.e. long-term, pump testing, geophysical well logging, fracture studies, etc.) be conducted during pre-design activities to optimize location and pumping rate for extraction wells.

Alternatives for remediation of the bedrock aquifer will be evaluated for their ability to achieve the ground-water cleanup standards presented in Section 2.3. Ground-water treatment technologies will be expected to address both metals and volatile organics contamination remediation.

2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

2.5.1 Screening Process

After the initial listing of potential remedial technology types and process options has been compiled, it is necessary to conduct screening to develop remedial action alternatives for detailed examination. A two-stage screening process has been used for this site. In the first stage, the universe of potential remedial technology types and process options is screened with respect to technical implementability for the given site conditions. The preliminary technology screening is presented in the following sections. Table 2-6 summarizes the first-stage screening results.

The second-stage screening is an examination of potential remedial alternatives that were developed using technologies retained from the preliminary technology screening. The second-stage screening is addressed in Section 3.

2.5.2 No Action Options

Pursuant to Section 300.430 (e)(6) of the revised National Contingency Plan (8 March 1990) and EPA's current guidance for conducting RI/FS investigations, the "No Action" option must be developed and examined as a potential remedial action for all sites. The No Action option is examined as a baseline by which other remedial actions are compared.

2.5.2.1 No Action

Under this alternative, no further remedial action would be taken. The existing 1-2 ft soil cap would be used to minimize rainfall infiltration through the landfill and to prevent surface exposure of contaminated soil. A long-term ground-water monitoring program would be established at the site to identify and assess potential adverse environmental or public health impacts. The existing monitoring well network would be used as a component of the ground-water monitoring program. It would also be necessary that additional ground-water monitoring wells be installed downgradient of the observed contamination (both in the shallow saturated zone and in the deep aquifer) to assess contamination migration trends and document contamination levels at the site boundaries.

This alternative would require long-term sampling and analysis of ground water to document water quality and contaminant migration. By sampling existing and new wells, this alternative would establish a mechanism for identifying changes in ground-water flow patterns, contaminant levels, and contaminant plume migration. A monitoring program would also provide an early warning of increases in contaminant levels.

In the absence of remedial action, this technology would not mitigate the contamination currently at the site, nor prevent contaminant levels from increasing. This option is not retained for further consideration.

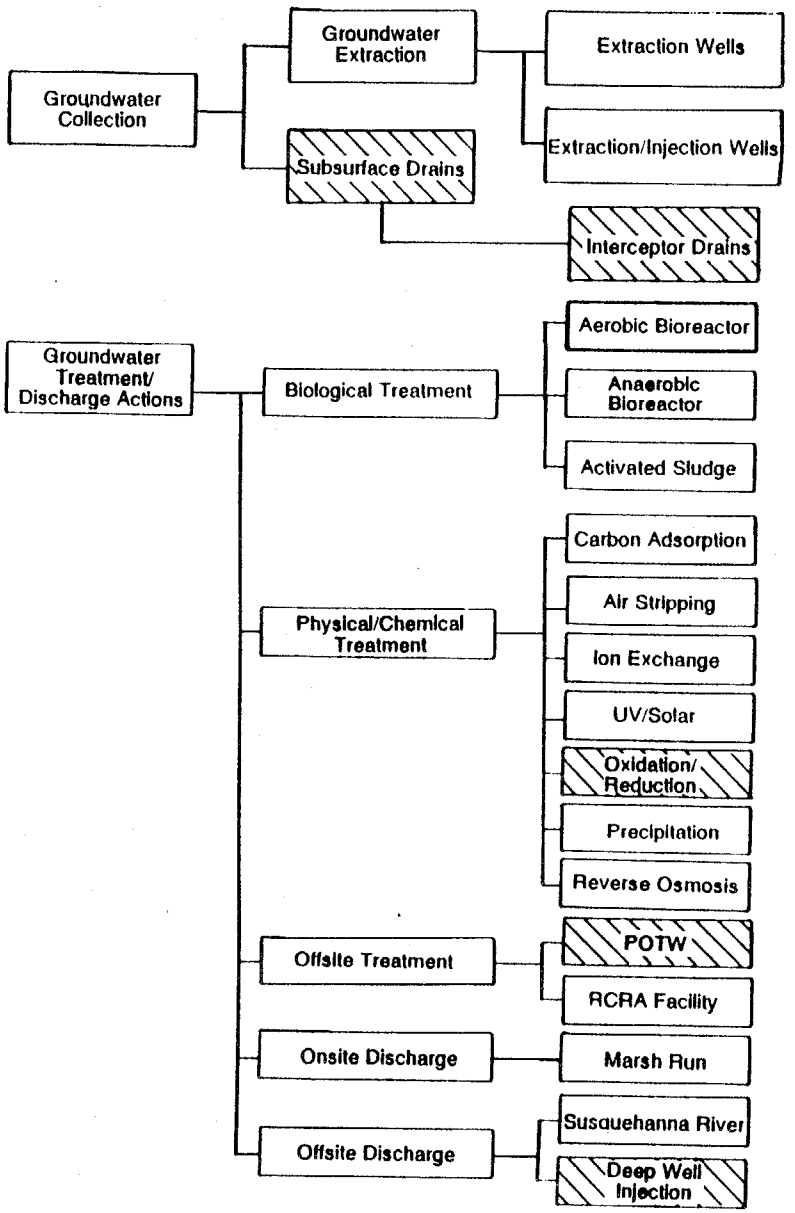
2.5.2.2 No Action with Site Control

This action contains all of the elements previously described in the No Action option. In addition, this action includes several site control measures. Specifically, deed restrictions would be placed on the property, limiting future uses and prohibiting use of onsite ground water as a drinking water source. In addition, a perimeter fence would be installed and maintained around the site perimeter. It is possible that deed restrictions would not be a permanent remedial action since such

Table 2-6. Summary of preliminary technology screening for Marsh Run Park Landfill, Fairview Township, Pennsylvania.

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No Action	Required for consideration by NCP
Institutional Actions	Monitoring	Ground Water Monitoring	Ongoing monitoring of wells	Potentially Applicable
	Access Restrictions	Deed Restrictions	Property deed to include development/ water use restrictions	Potentially Applicable
	Site Security	Fencing	Perimeter fencing to be added	Potentially Applicable
Source Area Containment Actions	Capping	Compacted Clay	Compacted clay with topsoil cover over identified fill area	Potentially Applicable
		Flexible Membrane Liner	Flexible membrane liner with topsoil cover over identified fill area	Potentially Applicable
		RCRA Multimedia Cap	Compacted clay/flexible membrane liner with topsoil cover	Potentially Applicable
	Vertical Barriers	Slurry Wall	Perimeter trench filled with soil-bentonite slurry	Not feasible due to shallow depth to bedrock
		Sheet Pile Barrier Wall	Perimeter barrier wall built with interlocking Z-section sheet piles	Not feasible due to shallow depth to bedrock
	Horizontal Barriers	Bottom Sealing	Grout injection to create impervious barrier beneath the site.	Not feasible due to lack of proven use
	Surface Diversion/ Collection	Grading/Revegetation	Surface topopgraphy graded to promote drainage away from contamination source area	Potentially Applicable
		Dikes and Berms	Dikes/berms for erosion/sediment control and stormwater management	Potentially Applicable
		Terraces and Benches	Grading to create terraces or benches to control stormflows	Potentially Applicable

Table 2-6. CON'T.



Description	Screening Comments
Series of wells to extract contaminated groundwater	Potentially Applicable
Injection wells inject non-contaminated water to increase flow to extraction wells	Potentially Applicable
Perforated pipe in trenches backfilled with perous media to collect contaminated water	Not feasible due to shallow depth of bedrock
Destruction of contaminants by anaerobic microorganisms in onsite treatment unit	Potentially Applicable
Destruction of contaminants by anaerobic microorganisms in onsite treatment unit	Potentially Applicable
Destruction of contaminants using conventional biological waste treatment technology	Not feasible due to presence of high concentrations of inhibitory toxic organics
Adsorption of contaminants onto activated carbon by passing water through carbon column	Potentially Applicable
Mixing of large volumes of air with water in a packed column to promote transfer of VOCs to air	Potentially Applicable
Contaminated water passed through a resin bed where ions are exchanged between resin and water	Potentially Applicable
Contaminanted water exposed to photocatalytic oxidation in the presence of an oxygen source such as hydrogen peroxide	Potentially Applicable
Addition of an oxidizing or reducing agent to treat contaminated liquid	Not feasible due to combination of organic and inorganic contaminants
Alteration of chemical equilibria to reduce solubility of the contaminants	Potentially Applicable
Use of high pressure to force water through a membrane leaving contaminants behind	Potentially Applicable
Extracted groundwater discharged to local POTW for treatment	Not feasible due to concentrations of organic solvents
Extracted groundwater discharged to licensed RCRA facility for treatment and/or disposal	Potentially Applicable
Extracted water discharged to Marsh Run onsite	Potentially Applicable
Extracted water discharged by pipeline to Susquehanna River	Potentially Applicable
Extracted water discharged to deep well injection system	Deep aquifer not suitable for injection of contaminated water

Table 2-6. CON'T.

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Source Area Treatment Actions	Excavation	Excavation/Removal	Excavation and offsite removal/ disposal of materials from within the defined "fill" area	Potentially Applicable
		Excavation/Treatment	Excavation and onsite, offsite, or in-situ treatment of materials from within the defined "fill" area	Potentially Applicable
		Selective Excavation	Selective excavation of defined "hot-spot" area from within the define "fill" area	Potentially Applicable
	Onsite Treatment	Physical/Chemical	Post excavation treatment methods for onsite soils including soil washing, stabilization/solidification, and chemical oxidation/reduction	Potentially Applicable
		Biological	Post excavation soil treatment methods including aerobic and anaerobic bioreactors and land farming	Potentially Applicable
		Thermal	Post excavation soil treatment methods including low temperature thermal stripping, wet air oxidation, and rotary kiln incineration	Potentially Applicable
	In-Situ Treatment	Physical	Removal of volatile contaminants through vapor phase extraction within the fill area	Potentially Applicable
		Chemical	Flushing of contaminants from fill area through injection of a soil flushing agent	Potentially Applicable
		Biological	In place enhanced biodegradation through enchanced oxygen supply	Potentially Applicable
		Thermal	Permanent destruction or immobilization of organic and inorganic soil contaminants	Potentially Applicable
	Offsite Treatment	Thermal Processes	Permanent destruction of organic and inorganic soil contaminants	Potentially Applicable
Gas Collection Actions	Gas Control Technologies	Passive Perimeter Gas Control	Installation of passive gas vents for landfill capping closure	Potentially Applicable
		Active Gas Venting	Addition of a pumping system to passive gas venting to vent large quantities of landfill gases	Not feasible due to minimal landfill gas generation

restrictions may be difficult to enforce for subsequent property transactions. This issue should be assessed by EPA and PaDER for legal implications.

This "no action" option would also require the sampling and analysis of onsite monitoring wells, periodic inspection and maintenance of the surface soil and vegetation, and periodic inspection and maintenance of the perimeter fence. As indicated above, the existing monitoring well network would probably not be sufficient to assess contaminant migration trends and to document contamination levels at the site limits. Consequently, additional monitoring wells would need to be installed downgradient of the site to monitor conditions in the shallow saturated zone and in the deep aquifer. Samples from existing monitoring wells would also be analyzed for comprehensive water quality monitoring.

This action would establish a mechanism for identifying changes in ground-water flow patterns, contaminant levels, and contaminant plume migration. It would also restrict site access and would restrict use of the contaminated ground water at the site if deed restrictions are enforceable. It would not restrict use of ground water outside of the site boundaries. This action is retained for further consideration, since section 300.430(e)(6) of the NCP requires consideration of a "no action" alternative during the feasibility study process.

2.5.3 Source Area Containment Actions

Source area containment technologies at the Marsh Run Park site consist of low-permeability barriers to prevent the further migration of source-area contaminants into the surrounding environment.

2.5.3.1 Capping

Capping would be designed to minimize contact and infiltration of rainwater, thereby reducing the potential for leachate generation from buried wastes. It would also help to eliminate erosion and stormwater transport of wastes.

The capping process requires a relatively impermeable barrier overlying the contents of the disposal area and a suitable cover soil to protect the barrier and support the growth of vegetation.

Several capping materials may be considered, including:

- Clay
- Synthetic membranes
- Asphalt or concrete
- Soil mixtures

Clay has historically been the most extensively used capping material. It can be highly effective in a compatible climate and chemical environment. A clay cap of sufficient thickness and adequate impermeability should provide an effective cap construction material for the Marsh Run Park site.

Synthetic membranes may also be used as cap construction material. The factors influencing the use of synthetic membranes include chemical compatibility, prevention of tears and punctures, and proper overlapping of seams.

Both asphalt and concrete caps are more susceptible than clay to shrinkage and/or cracking, thus increasing the risk of infiltration and necessitating periodic maintenance (EPA 1985). Therefore, asphalt and concrete will be eliminated from further consideration as cap construction material.

Current environmental regulations require that the designs of most hazardous waste landfill caps conform to the performance standards in 40 CFR Part 264.310, which addresses RCRA landfill closure requirements. Most cap designs are multilayered to conform to these standards. A typical multilayered design, shown in Figure 2-1, includes an upper vegetative layer, underlain by a drainage layer and two low-permeability layers. The vegetation is supported by the loam layer; the drainage layer is composed of sand or a geosynthetic drainage net; and the low-permeability layer is formed by the combined synthetic liner and clay system. An additional layer of stone and gravel is often placed immediately above the waste materials as structural backfill to support the cap. Prior to capping, the fill must be graded and compacted in order to enhance the stability of the cap and reduce settlement. A gas collection system is typically included as a component of the cap.

The use of capping technology would necessitate compliance with RCRA and State requirements for the capping of hazardous waste disposal areas. Closure considerations deal primarily with cover material and design, while post-closure concerns involve site maintenance and monitoring. In addition, SARA encourages technologies that reduce the mobility and toxicity of contaminants. Capping by itself fails to meet this requirement.

Capping provides a barrier between the surface environment and buried wastes. A properly installed cap prevents or minimizes infiltration of rainwater and erosion of wastes, thereby reducing the potential for the migration of contaminants.

The effectiveness of a cap in reducing the potential for leachate generation is dependent on ground-water levels. Ground water coming in contact with buried wastes, which is more likely when the local water table is elevated, may produce leachate despite the existence of a well-designed cap.

Capping may be combined with ground-water extraction or other containment technologies to prevent or reduce the movement of a contaminated plume. Therefore, capping will be retained for further consideration, for use in conjunction with other technologies.

2.5.3.2 Vertical Barriers

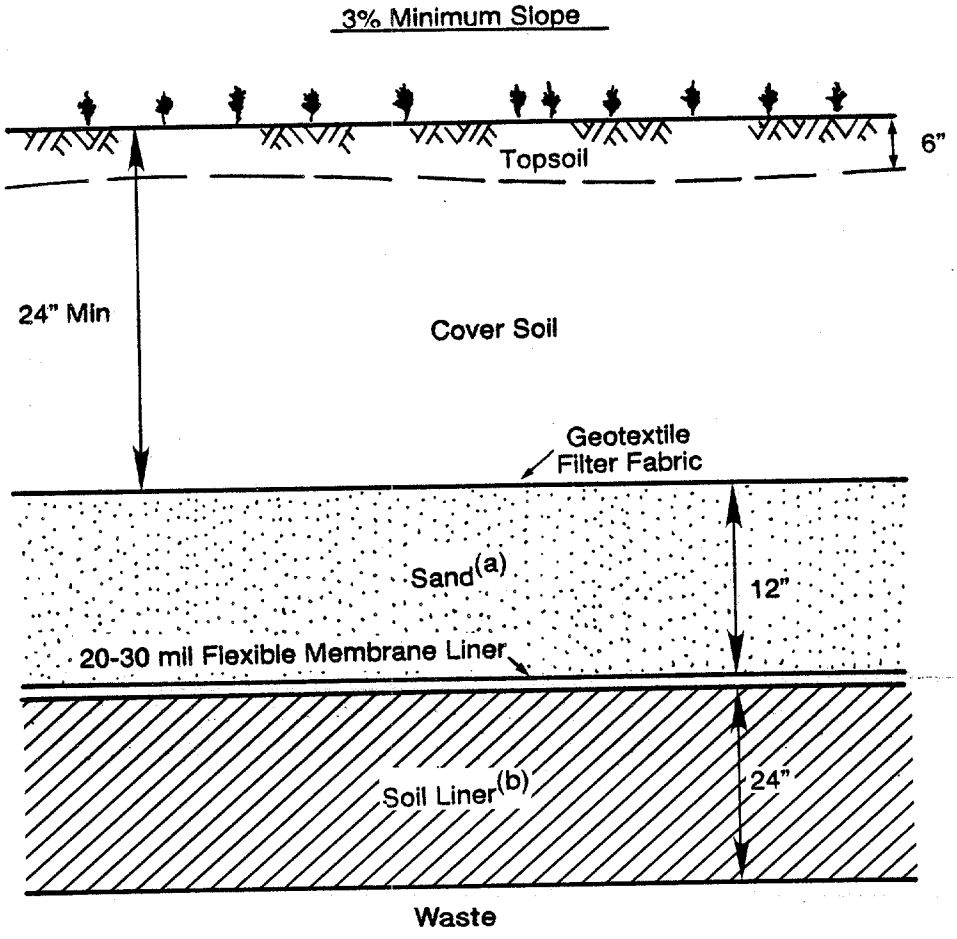
Vertical ground-water barriers are installed to prevent the lateral migration of contaminants from disposal areas or to divert ground water to prevent contact with waste materials.

Various technologies and materials can be employed in constructing ground-water barriers, including

- Slurry walls:
  - Soil/Bentonite
  - Cement/Bentonite
- Sheet piling
- Grout curtains
- Vibrating beam
- Gel injection

Of the methods listed above, slurry walls and sheet pile barrier walls have proven to be most reliable and effective for hazardous waste applications.

A vertical barrier wall option would require a thorough hydrogeologic and geotechnical evaluation prior to design. Variables at the Marsh Run Park site affecting the long-term effectiveness of these technologies include the following:



(a) The drainage layer may be 12" of sand or a geosynthetic drainage net.

(b) The soil liner may be structural backfill or, where permeability considerations warrant, may be a compacted clay liner.

Figure 2-1. Typical RCRA multimedia cap.

- Depth to bedrock
- Hydraulic gradient
- Compatibility with contaminants
- Permeability and uniformity of confining layer

A slurry wall is generally constructed by excavating a narrow trench while simultaneously pumping in the slurry material. Most commonly, the slurry material consists of bentonite clay and water. The mixture stabilizes the trench and at the same time creates a relatively impermeable coating along the inside of the trench walls. In some cases, a slurry of Portland cement, bentonite, and water is used. Cement-bentonite slurry walls, however, are limited in their use by a higher permeability and their narrower range of chemical compatibilities as compared to soil-bentonite slurry walls. Once the trench is excavated to the desired depth, a blended soil and bentonite or Portland cement mix is backfilled into the trench to the ground surface. A slurry wall must be keyed into a confining stratum (low-permeability clay or rock) to effectively cut off ground-water flow. In addition to slurry wall and grouted cutoffs, steel sheet piling can be used to form a ground-water barrier.

Sheet steel piling can be employed as a ground-water barrier much like the slurry wall previously discussed. Because of costs and unpredictable wall integrity, however, it is not often used except for temporary dewatering for other construction, as erosion protection where some other barrier, such as a slurry wall, intersects flowing surface water, or where structural integrity of the wall is required for subsequent excavation activities.

One of the largest drawbacks of sheet piling, or any other barrier technology requiring pile driving, is the problem caused by rocky soils. Damage to or deflection of the piles is likely to render any such wall ineffective as a ground-water barrier. Because bedrock is encountered at depths of 11-15 ft over much of the site, the use of steel sheet piles would be severely restricted.

Any type of containment technology would necessitate compliance with RCRA and State requirements for the closure and postclosure of hazardous waste landfills.

Vertical ground-water barriers can reduce lateral ground-water flow through unconsolidated deposits. Vertical ground-water barriers are not effective at reducing flow through consolidated deposits due to constructability issues. The placement of a vertical barrier wall would reduce the continual lateral migration of contaminants through the shallow saturated zone. Limitations to the use of vertical barriers at this site include depth to the bedrock aquifer and the lack of a competent confining layer with which to "key" in the vertical barrier. Site characterization during the RI indicated that bedrock is encountered at depths of 11-15 ft below the surface over much of the site. Consequently, it may be possible to construct a low permeability vertical barrier to divert ground-water flow within the shallow saturated zone, but the shallow depth to bedrock would limit the implementability of vertical barriers for the deeper (bedrock) aquifer. Since the majority of flow in the shallow saturated zone ultimately flows downward into the bedrock aquifer (98 percent by RI ground-water modeling), this technology could not effectively control contaminant migration at the site. Therefore, this technology will not be retained for further consideration.

2.5.3.3 Horizontal Barriers

Horizontal ground-water barriers can be categorized as bottom-sealing methods. The purpose of bottom sealing is to place an impermeable barrier beneath waste disposal areas to prevent vertical movement of contaminants.

Bottom sealing is accomplished through grout injection. A series of holes is drilled through the waste disposal area and grout is injected at the base of the hole. The grout forms a horizontal barrier underlying

the waste. At present, though potentially promising, no detailed analysis as to its effectiveness and cost is available, and no known application to hazardous waste sites in the U.S. has been completed. Therefore, horizontal barriers are eliminated from further consideration.

2.5.3.4 Surface Diversion/Collection

Surface water diversion technologies for the Marsh Run Park site would be required to control the erosional effects of localized stormwater runoff and to prevent damage during flooding. The following technology discussions are presented as they apply to meeting these objectives. Table 2-7 provides a screening summary of surface water diversion technologies.

Grading and Revegetation

Grading and revegetation as a means of surface water control is considered in conjunction with capping. Grading is used to reshape the surface of landfills in order to manage surface water runoff while reducing erosion. Typical slopes are 3 to 5 percent (EPA 1985). Grading is often performed in conjunction with surface sealing practices and revegetation because of its inherent aesthetic and soil transport control aspects. Revegetation involves preparing the soil surface, seeding, fertilizing, and mulching to establish a good growth of vegetation. Revegetation decreases erosion by wind and water and contributes to the development of a naturally fertile and stable surface environment.

The equipment and methods used in grading and revegetation involve standard construction procedures. Revegetation may be used to upgrade the appearance of the landfill; however, substantial quantities of local soil may be required to modify the existing soil. Also, periodic regrading and future site maintenance may be necessary to repair depressions that have formed because of differential settlement and/or to repair slopes that have slumped. Guidelines for grading and revegetation are specified in PaDER Title 25, Section 273, and 40 CFR Part 264 (RCRA).

Regrading and revegetation decrease erosion by wind and water and contribute to the development of a naturally fertile and stable surface environment. Regrading and revegetation also help to minimize infiltration of surface water, thereby reducing or eliminating leachate generation. This technology will be retained for further consideration, in conjunction with other remedial technologies.

Dikes and Berms

Dikes and berms both are diversion systems designed to prevent erosion from surface runoff. The two terms, dikes and berms, are used interchangeably. Dikes and berms are well-compacted earthen ridges or ledges constructed immediately upslope from or along the perimeter of disposal sites. These structures are generally designed to provide short-term protection of critical areas by intercepting storm runoff and diverting the flow to natural or man-made drainage ways, stabilized outlets, or sediment traps.

Dikes and berms may be used to prevent excessive erosion of newly constructed slopes until more permanent drainage structures are installed or until the slope is stabilized with vegetation. They also have widespread use during excavation and removal operations. These structures are designed to handle relatively small amounts of runoff; they are not recommended for drainage areas larger than 5 acres (EPA 1985).

Dikes and berms are technologies that could be used in combination with a containment option. Therefore, these technologies must comply with RCRA and State regulations for closure and postclosure of hazardous waste landfills. Dikes and berms are retained for further consideration, in conjunction with other remedial action technologies.

TABLE 2-7 TECHNOLOGY SCREENING SUMMARY SURFACE WATER DIVERSION TECHNOLOGIES

Technology	Retained for Further Evaluation	Comments
Grading and Revegetation	Yes	Ancillary technology for capped area
Dikes and Berms	Yes	Provide temporary protection to excavated areas or newly constructed slopes
Terraces and Benches	Yes	Control erosion, mitigate contaminant transport during storm event
Levees and Floodwalls	Yes	Site is located within major floodplain

Terraces and Benches

Terraces and benches are relatively flat areas constructed along the contour of very long or very steep slopes to slow runoff and divert it into ditches for transport at nonerosive velocities. These structures are also known as bench terraces or drainage benches.

Although terraces and benches are slope reduction devices, they are generally constructed with reverse fall or natural fall to divert water to stabilized drainageways. Terraces and benches may be used to break up steeply graded slopes of covered disposal sites into less erodible segments. Upslope of disposal sites, they act to slow and divert storm runoff around the site. Downslope of landfill areas, they act to intercept and divert sediment-laden runoff to traps or basins. Hence, they may function to hydrologically isolate active disposal sites, to control erosion of cover materials on completed fills, or to collect contaminated sediments eroded from disposal areas. For disposal sites undergoing final grading (after capping and prior to revegetation), construction of terraces and benches may be included as part of the integrated site closure plan. Use of terraces and benches is an effective means of controlling surface water flow and mitigating movement of contaminants during storm events. This technology will be retained for further consideration, in conjunction with other remedial action technologies.

2.5.4 Source Area Treatment Actions

Various source area treatment actions are presented. Source area treatment is proposed to reduce or eliminate the continuing contribution of contamination to the deep aquifer from the source area. Onsite, *in situ*, and offsite treatment methods are presented.

2.5.4.1 Excavation

The excavation and removal of buried wastes and contaminated subsurface soils are considered for the site. After excavation, the area must be backfilled, regraded, and revegetated.

Excavation involves the physical removal of buried wastes from a source area using standard excavation practices and technology. Excavation is performed extensively in hazardous waste site remediation and would satisfy the objective of preventing any future release of contaminants to the ground water. Typical equipment used includes backhoes, draglines, clamshells, vacuum trucks, and front-end loaders.

Concern exists for contaminants being released to the ground water as a result of agitating the wastes during excavation. Vehicle-mounted, high-strength vacuums can collect liquids, solid, and any other material that can fit through an 8-in. hose. These vacuums are equipped with a boom and up to 500 ft of hose, which increase their reach over large areas.

Materials handling is another major concern which affects the implementability of excavation. Staging areas would be necessary. These areas would be used to prepare wastes for disposal or treatment and should be graded to prevent puddling, lined with clay to prevent ground-water contamination, and bermed to prevent runoff.

Backfilling, grading, and revegetation after excavation are necessary to prevent large open areas that would trap rainwater and run-on. Confirmatory sampling of remaining soils would confirm the removal of all contaminants. The excavated area would be backfilled with clean soil obtained from offsite. Grading and revegetation have been previously discussed in Section 2.5.3.4.

Transporting of wastes resulting from excavation must meet Federal and State shipping and manifesting regulations.

Excavation and removal of buried wastes eliminates the environmental and health concerns associated with leachate production and subsequent ground-water contamination. However, consideration must be given to the health and safety of remedial workers. Buried wastes at the site contain volatile organic compounds, and workers would be subject to exposure to these vapors. Onsite air monitoring and dust, vapor, and odor control provisions will be necessary during all excavation operations.

Excavation activities can result in the release of fugitive dusts and runoff from disturbed soils. Dust controls could include water sprays or application of chemical dust suppressants. Surface water controls may also be required.

Transportation of waste offsite without treatment is the least favorable remedy under SARA. In addition, the Land Ban restrictions may preclude the disposal of Marsh Run Park wastes at an offsite landfill. Samples of waste for offsite disposal will be subjected to TCLP testing to determine if provisions of the LDRs apply for that waste. VOSS survey results indicate that material from areas identified as "hot spots" will be subject to the provisions of the LDRs. Therefore, excavation and removal are retained for further consideration only in conjunction with onsite source area treatment methods (Sections 2.5.4.2, 2.5.4.3, and 2.5.4.4) and offsite incineration (2.5.4.9).

2.5.4.2 Onsite Physical/Chemical Treatment

Onsite physical/chemical treatment technologies would be used in conjunction with source area excavation. The most commonly used onsite physical/chemical treatment technologies for hazardous waste sites are

1. Soil washing
2. Stabilization/solidification
3. APEG (alkaline polyethylene glycolate) process
4. B.E.S.T. solvent extraction

Most of these technologies have limited effectiveness for treating heterogeneous waste mixtures because they have been developed for treatment of relatively homogeneous soils. Extensive soil/waste separation would be necessary to break down the excavated wastes to process the soils in the soil washing, APEG, or B.E.S.T. treatment units. If selective hot spot excavation is conducted, however, soil washing may still be a viable alternative. Therefore, only soil washing and stabilization/solidification are discussed in this section.

Soil Washing

Soil washing is the extraction of contaminants from excavated soil by mixing the soil with water, solvents, surfactants, and chelating agents. The contaminated water is then treated for removal of contaminants. Heavily contaminated soils are commonly treated several times in a multi-stage countercurrent treatment system. Soil washing technology has been developed independently by EPA and by ECOVA Corporation. Soil washing is most effective on soils with less than 35 percent fine-grained material. Soil washing is not particularly effective for remediation of waste fill due to the heterogeneous mixture of materials and particle sizes. Soil washing has been proven effective in removing heavy metals, volatile organic contaminants, polycyclic aromatic hydrocarbons (PAHs), phenols, and polychlorinated biphenyls (PCBs) from silty and sandy soils. Soil washing is accomplished in a transportable, self-contained waste treatment unit. Extracted contaminants are concentrated and disposed of by offsite incineration.

Soil washing has been demonstrated to be effective in removing various gasoline components, solvents, pesticides, phenols, and heavy metals to State mandated treatment levels. EPA's demonstration unit has concentrated on remediation of gasoline-contaminated soils, and ECOVA's unit has demonstrated successful treatment of pesticides, phenols, and heavy metals.

ECOVA currently operates a mobile soils washing unit which it transports to sites across the country. The unit is capable of processing 10 yd^3 of soil per day. Treatability testing would be required in advance to determine the appropriate solvents, surfactants, or acid washes that would be required. In addition, permitting and regulatory acceptance would need to be addressed prior to implementation of remedial activities. Soils washing will be retained for consideration for remediation of "hot spots" identified outside the limits of the waste fill area.

Solidification/Stabilization

Solidification is a process by which waste is mixed with a solidifying agent such as cement, lime, thermoplastics, or organic polymers in order to obtain an inert solid form. The goal of solidification is to produce a waste that is easily handled and less subject to leaching due to stabilization or containment of the waste in a solid matrix. Several solidifying agents are available; the most common agents used are cement-based. Most cement processes use Portland cement and proprietary agents to aid in solidifying the waste of concern to an inert solid form such as a block or friable, clay-like unit. Wastes can be mixed in situ, in conventional cement-mixing equipment, prior to landfilling, or in drums which are subsequently landfilled. Each successive mixing method offers a more consistent mix and uniform product, but at an added cost. The advantages of cement use are a high pH end product, which limits metal leaching from wastes, and the relatively inexpensive cost of cement.

Disadvantages of cement processes include the formation of a much greater bulk to be landfilled (20 to 100 percent greater) and incompatibility with various salts and organic matters (Pojasek 1980). However, various proprietary additives on the market can limit the bulk and aid in the solidification of organic wastes such as wastewater sludge. Nonetheless, treatability studies should be performed prior to extensive landfill design in order to confirm the compatibility and effectiveness of solidification on this waste and the ratio of solidifying reagents.

Additional techniques used to achieve solidification involve the use of silicate additives, polypropylene, synthetic resins, or molten glass.

Solidification may offer distinct advantages over direct landfilling in light of the new Land Ban laws currently in effect. Wastes that may not be landfilled under Land Ban may become acceptable for such disposal if they are stabilized by solidification; however, treatability studies would be needed to confirm this. Possible concerns in the solidification process are exposure to contaminants within the waste and the release of volatiles during the solidification process. Furthermore, solidification/stabilization has not sufficiently demonstrated effectiveness or longevity in containment of volatile organic solvents. This technology will not be retained for further consideration.

2.5.4.3 Onsite Thermal Treatment

Onsite thermal treatment processes would be conducted in conjunction with excavation to address source area contamination. Onsite thermal treatment processes include

1. Low-temperature thermal stripping
2. Rotary kiln incineration
3. Wet air oxidation
4. Infrared incineration
5. Fluidized bed incineration
6. Circulating bed incineration
7. Pyrolysis

All of these processes may be potentially applicable. Different vendors provide different treatment processes. A treatability study/test burn would need to be conducted to select an appropriate treatment process for wastes at the Marsh Run Park site.

Onsite Incineration

Incineration involves the thermal destruction of organic compounds to a nonhazardous product. This process can be completed using either an incinerator erected onsite or a commercial facility located offsite. In general, the major technical considerations for effective incineration are an ability to handle the physical properties of the waste involved, adequate size to allow for a reasonable waste throughput rate, and an ability to effectively destroy the waste based on the chemical properties of the feed.

In terms of waste throughput, only incinerators capable of handling large volumes should be considered. Most large incinerators can handle maximum loads of 2-4 tons an hour (EPA 1986). Incinerators that can handle large volumes of solid wastes are outlined in Table 2-8. Another requirement of the incineration process is cleanup of off-gases in order to meet pertinent air quality standards. Gas cleanup technologies currently used include bag houses for particulate removal, various designs of scrubbers for particulate sulfur and chloride removal, and precipitators for particulate removal. Gas treatment, in turn, requires treatment of the resulting aqueous and solid waste streams by filtration, physical/chemical treatment, and land disposal.

Construction of a new onsite incineration facility would require compliance with all Federal and State regulations including RCRA and the Clean Air Act. RCRA design and permitting standards are listed under Subpart C, 40 CFR Part 264. Use of an onsite mobile incinerator involves leasing a unit and transporting the unit on and off the site. Use of an offsite incineration facility would require that transportation of the hazardous waste meet all DOT regulations. It would also require approval from the incinerator's owner/operator. Such approval would depend on the facility's available capacity and ability to effectively destroy the waste from the former Marsh Run Park landfill.

New incinerator construction typically meets with strong public opposition, creating time-consuming siting problems. The entire process of siting, permitting, design, and construction could take about 3-5 years. The capital cost for such a project is relatively high compared with other alternatives. For the above reasons, construction of an onsite incinerator is eliminated from further consideration.

Incineration technologies are capable of thermally destroying organic hazardous materials. Incineration processes would not destroy contaminants, such as heavy metals, and would not reduce the volume of noncombustible materials, such as scrap metal, within the fill. The volumes of buried wastes at the site could be greatly reduced to substances that include carbon dioxide, water, sulfur dioxide, NO, HCl, and ash. Public health and environmental threats from the buried wastes would be significantly reduced. Incineration does not remove inorganics, of which heavy metals are of particular concern. In addition, ash and sludge remaining from the incineration process must be disposed of using a secondary technology such as landfilling. Concentrations of metals in incineration ash may impact disposal. Disposal of incineration ash must be in conformance with all requirements of RCRA, most notably the LDRs.

Incineration would effectively destroy the source area volatile contaminants that are contributing to ground-water contamination. Use of an onsite, mobile incinerator is retained for further consideration.

2.5.4.4 Onsite Biological Treatment

Onsite biological source area treatment methods consist of handling and treating excavated waste materials using biological processes. Biological treatment processes that could be used include

1. Aerobic bioreactor
2. Anaerobic bioreactor
3. Landfarming

TABLE 2-8 INCINERATION TECHNOLOGIES

Incinerator	Temperatures	Advantages	Disadvantages
Rotary Kiln	1,500-3,000 F	Proven technology in the area of hazardous waste incineration. High incineration efficiency and versatility.	High capital costs due to the need for extensive off-gas treatment. High operating costs due to low thermal efficiency.
Fluidized Bed	1,400-1,800 F	More efficient than Rotary Kiln.	Certain physical properties of the waste handled may result in residuals being trapped in incinerator bed. As a result, additional disposal problems may occur.
Circulating Bed	1,450-1,600 F	Efficient combustion allows for minimal capital investment in off-gas treatment systems and low auxiliary fuel costs.	Not as well-proven a technology as Rotary Kiln or Fluidized Bed. Mores sensitive to physical condition of waste handled than Fluidized Bed.
Multiple-Hearth	1,400-1,800 F	Well-proven technology in the incineration of sludge. High residence time and an ability to handle water-saturated sludge.	Difficulty in regulating combustion can result in "Cold Spots" which would lead to insufficient combustion, especially of thermally resistant wastes.

Sources: EPA September 1986
Randolph, Breyer & Associates 1987

TABLE 2-8 (Cont.)

Incinerator	Temperatures	Advantages	Disadvantages
Wet-Air Oxidation	300-500 F (500-1,500 psig)	Efficient in the treatment of nonbiodegradable substances with a high Chemical Oxygen Demand (COD). Effective destruction of thermally resistant organics.	Requires extensive waste pretreatment and treatment of oxidation product streams including gas, water, and solid treatment. Possible problems with treatment of halogenated organics.
Pyrolysis	900-1,600 F	Thermal decomposition in the absence of air allows for lower temperatures of combustion.	Not a well-proven technology and requires extensive pretreatment prior to thermal treatment.
Infrared	1,500-1,800 F	Pilot units currently available have successfully treated thermally resistant wastes.	Potentially high operating cost due to use of electricity for combustion. Problems with feed system failure.
Low Temperature Thermal Treatment	400-450 F 1,800 F (After-burner)	Very efficient, cost-effective approach to removal of volatile organic solvents from soil. Available as mobile unit. Significantly less power requirements than more traditional processes.	This is a media transfer technique rather than a destructive technique. Treatment of gaseous effluent in afterburner required prior to discharge. Metal contaminants are not removed. Lower explosive limits must be considered when treating soils contaminated with flammable solvents.

Use of a bioreactor is not examined due to the heterogeneous nature of the waste and materials handling/treatment considerations associated with bioreactors.

Landfarming

Landfarming involves the incorporation of waste fill materials into or on the surface of soil for microbial decomposition of contaminants to nonhazardous products. Landfarming is generally not applicable to the Marsh Run Park site for the following reasons:

- The waste has significant concentrations of metals, which would likely make the material unsuitable for land application.
- The "waste fill" is extremely heterogeneous and contains a significant non-soil fraction.
- Emission of volatile organic contaminants, both during excavation and subsequent treatment, would be extremely difficult to control.
- Long-term treatability studies would be required to determine the suitability of the material for land application.

Due to the above considerations, onsite biological source area treatment technologies are eliminated from further consideration.

2.5.4.5 In Situ Physical Treatment

In situ physical treatment methods do not require excavation of the source area. In situ treatment methods are proposed to provide treatment/removal of the volatile contamination from the source area to prevent future contribution to ground-water contamination. For this

feasibility study, in situ soil venting is the most promising in situ physical treatment technology.

In Situ Soil Venting

In situ soil venting is a vacuum extraction procedure that removes VOC contamination from the soil matrix via vapor phase and/or liquid phase pathways. In soil venting, VOCs are removed from the ground and can be further treated to either completely degrade the compound or transfer it to another medium. Complete degradation may be accomplished through biological, chemical, or physical means. The transfer to another medium does not destroy the pollutant, but removes it from the site. The use of granular activated carbon (GAC) to filter the air is a common media transfer method. In addition to extracting contaminants directly, the pumping action draws a continuous supply of air through the soil, which enhances in situ biodegradation of the pollutant by naturally occurring aerobic bacteria. Oxygen is an important limiting factor in aerobic biodegradation, and venting has been shown to contribute satisfactory quantities of this element for the respiration of microorganisms. A soil venting system consists of the installation of wells and trenches into the soil and a pump to draw air out of the wells. In turn, air is moved through the soil and into the wells, providing a continuously renewing source of oxygen. At the Marsh Run Park site, the fill is porous enough (hydraulic conductivity = 7×10^{-4} to $>1 \times 10^{-2}$ cm/sec) to permit sufficient air flow.

This method has been shown to be effective for the aerobic biodegradation of volatile organic compound-saturated soils. In addition, the subsequent treatment of the vented gas (using activated carbon or catalytic oxidation) can further reduce the contamination without any discharge to the surrounding environment. Potential impacts to human health and the environment during construction would be minimal because well points could be pushed into the fill, as was done previously for the remedial investigation. Treatability studies would be necessary to determine

if the pollutants could be biodegraded and to isolate or identify the microorganisms.

This technology is retained for further consideration.

2.5.4.6 In Situ Chemical Treatment

In situ chemical treatment consists of flushing of contaminants from the source area through injection of a soil flushing agent.

Soil Flushing

Organic and inorganic contaminants can be washed from contaminated soils by an extraction process called "soil flushing," "solvent flushing," "ground leaching," or "solution mining." Water or an aqueous solution is injected into or sprayed onto the area of contamination, and the contaminated elutriate is collected and pumped to the surface for removal, recirculation, or onsite treatment and reinjection. During elutriation, the flushing solution mobilizes the sorbed contaminants by dissolution or emulsification.

Soil flushing technology is currently in the laboratory stage. Studies have been conducted to determine the appropriate solvents for mobilizing various classes and types of chemical constituents. The technology may be easy or difficult to apply, depending on the ability to flood the soil with the flushing solution and to install collection wells or subsurface drains to recover all the applied liquids. Provisions also must be made for ultimate disposal of the elutriate. The achievable level of treatment varies and depends on the contact of the flushing solution with the contaminants, the appropriateness of solutions for the contaminants, and the hydraulic conductivity of the soil. The technology is more applicable to highly permeable soils.

Test results to date indicate the low molecular weight halogenated hydrocarbons such as TCE and tetrachloroethylene (PCE) can be effectively removed from soils by water flushing. Soluble salts of certain heavy metals, including nickel, zinc, and copper, have also been shown to be effectively flushed. Adjustment of pH may be needed to enhance removal of some metals.

Soil flushing will be retained for further consideration in conjunction with enhanced bioremediation.

2.5.4.7 In Situ Biological Treatment

In situ biological treatment (enhanced bioremediation) consists of providing nutrients and oxygen to enhance the rate of microbial biodegradation of volatile organic contamination in the source area.

Enhanced Bioremediation

Biological remediation consists of the use of microbiological organisms to degrade the organic pollutant compounds to carbon dioxide and water. Treatment systems can be either in situ or in bioreactors located on the surface. Basically, the system consists of supplying nutrients and oxygen to the indigenous bacteria and fungi to stimulate their growth and reproduction, enabling them to use the pollutants as a substrate. As the compounds are broken down, they are incorporated into the microorganisms' biochemical cycles and are effectively transformed from toxic to nontoxic substances.

While this technology is relatively new, there have been established cases where in situ biotreatment systems have successfully degraded TCE and other solvents to nontoxic end products. Treatment systems are available from commercial vendors, including stock bioreactors--both slurry and liquid-solid contact. Well-established technologies such as well installation and pumping systems are also a component of bioremediation. Nutrient and oxygen sources are plentiful.

Bioremediation has proven to be effective in the degradation of certain types of pollutant wastes; however, certain conditions must be provided for the microorganisms to achieve this. These conditions pertain mainly to providing a suitable environment based on temperature, nutrient availability, oxygen availability, and sufficient surface area contact. This is most easily accomplished in an on-surface bioreactor which treats either soil or water. It is more difficult to produce the proper environment in situ, and this difficulty increases with depth.

Threats to health for this option would be most prevalent during excavation of the soil and the handling of the slurry mixture prior to placement in the bioreactor.

It has been observed that there are difficulties in using this method to degrade some chlorinated hydrocarbons, and that more complex techniques are necessary to produce the desired results. Additional compounds (such as methane) need to be added to the mixture, to assist the microbes' metabolic processes. Treatability studies are required prior to any bioremediation process design.

This technology is retained for further consideration.

2.5.4.8 In Situ Thermal Treatment

In situ thermal treatment methods apply thermal processes to volatilize or destroy organic solvent contaminants in the source area. Two proven thermal technologies are radio frequency (RF) heating and in situ vitrification (ISV). RF heating uses electromagnetic energy to vaporize hydrocarbons. The high ground-water table at the Marsh Run Park site will result in excessive power requirements to heat the soil. Furthermore, the technology should not be applied in areas where large, buried metal objects are in the treatment zone. Therefore, this technology will not be retained for further consideration.

In Situ Vitrification

ISV is an innovative technology that utilizes a thermal treatment process to convert contaminated soil, sludge, or buried materials into a chemically inert crystalline product.

The process is accomplished in place through the insertion of molybdenum electrodes in square array to a desired depth. Because soil is not electrically conductive, a mixture of graphite and glass frit is placed around the electrodes to form a conductive path. As electrical power is applied, the graphite heats the soil to 3,600 F, well above the melting point of the soil. Over time, the melt increases in depth and the soil becomes conductive. As the vitrified zone grows, it incorporates non-volatile elements and destroys organic components by pyrolysis. The pyrolized products migrate to the surface where they may oxidize in the presence of oxygen. A hood encloses the melt zone to capture the off-gas for treatment prior to discharge.

Currently there are several laboratory-scale and pilot-scale units and one full-scale unit available. The full scale unit consists of three trailers connected in series.

Once treatment of an area is completed, backfilling above the vitrified mass with clean soil is necessary due to subsidence. Because of the density increase during melting, volume reduction is typically 25-30 percent.

ISV appears to satisfy the SARA preference for a permanent solution and a technology which significantly reduces the mobility of hazardous substances.

Existing public health and environmental hazards will be eliminated upon completion of the ISV treatment process, as organic contaminants will be destroyed and metals and inorganics will either be dissolved in the glass or incorporated into the vitreous matrix.

The ISV process does not pose unusual health or environmental problems if it is used within the prescribed capabilities of the equipment. Concern does exist for the control of gases generated during the melting process. Because of the high temperature of the melt (1,600-2,000 C), the great majority of the gases have been pyrolyzed into very small molecules or diatomic gases that do not pose significant hazards to remedial workers or the environment. However, the possibility does exist for a small amount of hazardous material to result from the process. These gases must be processed by the off-gas treatment system to prevent uncontrolled release to the environment.

Although the technology has the advantage of not requiring excavation, there is a concern for the release of organic vapors during the electrode placement process. Continuous air monitoring and proper respiratory protection will be required. Other disadvantages of ISV are that the technology has not been applied at many sites; the long-term effectiveness of the technology has not been established with certainty; and the inhomogeneity of and presence of water and inclusions within the waste mass will significantly increase electrical requirements. The primary advantage of this option is that it provides for permanent destruction of organic contaminants and stabilization of inorganic contaminants. In situ vitrification is retained for further consideration.

2.5.4.9 Offsite Treatment

Offsite treatment processes would be used in conjunction with source area excavation and with certain onsite source area treatment processes. Offsite waste treatment would consist of either incineration or landfilling. The selection of incineration or landfilling is a function of the waste classification. Pursuant to the Land Disposal Regulations under RCRA, effective 8 November 1990, all wastes classified as "hazardous" under RCRA are subject to the LDRs. The LDRs effectively limit the use of landfilling as a disposal practice for many classes of wastes. The LDRs also identify Best Demonstrated Available Technology (BDAT) requirements

for the wastes covered under the LDRs. Consequently, offsite treatment and disposal of source area wastes may require different disposal practices for different areas within the source area.

Incineration

A discussion of incineration has been presented in Section 2.5.4.3 of this document. That discussion was primarily geared toward onsite incineration, but the technological considerations for offsite incineration are very similar. One major difference between onsite and offsite incineration is that disposal to an offsite incinerator does not require the extensive siting and permitting requirements that apply to many onsite incinerators. Test burns of the waste material, however, are still required. Other permitting requirements include manifesting and transportation permits and disposal permits. The offsite incinerator must meet all RCRA permit requirements for the site wastes. There are presently no RCRA-permitted hazardous waste incinerators in the State of Pennsylvania.

Landfill Disposal

At the Marsh Run Park site, any excavated material that is not treated or incinerated will require offsite landfilling. In addition, solidified waste or waste ash may be landfilled to further reduce the potential for contaminant migration.

Offsite landfill disposal involves the transportation of contaminated soils to the nearest EPA-approved hazardous waste disposal facility. The technical considerations relevant to this approach involve the method of transportation, the selection of a transporter, and the location of the offsite facility chosen, based on the characteristics of the disposed waste.

Offsite landfill disposal would involve compliance with all Pennsylvania DOT (PennDOT) and other DOT regulations and would necessitate transporting the waste under RCRA manifesting requirements. The transporter should be able to provide evidence of adequate liability insurance, contingency plans in case of accidents, and permits necessary to move hazardous waste across state lines if necessary. In addition, the use of an offsite commercial disposal facility would necessitate extensive analysis of the waste.

Offsite transport and disposal of wastes without treatment is designated as the least favorable remedy under SARA. In addition, landfilling of wastes is subject to the land disposal restrictions of the 1984 Hazardous and Solid Waste Amendments which became effective 8 May 1990. Due to the above, landfill disposal is considered only in conjunction with other offsite disposal actions, and only for wastes that are not subject to provisions of the LDRs.

2.5.5 Gas Collection Actions

Gas collection actions would be used in conjunction with remedial actions that require capping of the site. Gas collection is provided to collect and vent landfill breakdown gases (such as methane) that would be trapped within the landfill if an impermeable cap were constructed. Gas venting can be accomplished using passive or active gas collection approaches.

2.5.5.1 Passive Gas Venting Controls

Passive gas venting controls may be utilized to prevent accumulation of landfill decomposition gases in conjunction with remedial capping at the Marsh Run Park site. These controls have been applied at many municipal landfills and RCRA landfill closures, and are demonstrated to be effective when properly designed.

Gases move through the subsurface by two primary mechanisms: convective (pressure) flow and diffusive flow. Convective flow can be controlled by providing a high-permeability (low-pressure) pathway for gas flow. Gases will flow in the direction of least resistance. Diffusive flow, however, cannot be controlled by high-permeability vents. Gas moving under diffusive flow tends to move randomly in all directions from the source. Diffusive gas flow is not considered to be a concern since gas venting controls are provided only as a method of preventing landfill breakdown gases from being trapped within an impermeable cap.

Gas venting at this site would consist of providing individual plastic pipe gas vents across the surface of the landfill. Gas venting would only be provided in conjunction with capping of the site since gas migration is not anticipated to be of concern with any other remedial actions.

Passive perimeter gas control is retained for consideration in conjunction only with surface capping technologies.

2.5.5.2 Active Gas Extraction

Gas emissions from the surface of the site and landfill breakdown gas migration in the subsurface could be mitigated by the installation of an active gas venting system around the perimeter of the site. Active gas venting systems are in operation at many landfills and waste sites and are demonstrated to be effective and reliable. Active systems differ from passive systems in that active systems use mechanical equipment such as compressors, vacuum blowers, and valves, and involve construction of extraction wells. A typical extraction well is shown in Figure 2-2.

At the Marsh Run Park site, buried gas collection piping and a blower system with a vent stack could be constructed onsite. Subsurface gases would be extracted from the site and discharged through the stack to the atmosphere. No treatment of the gases is planned under this alternative.

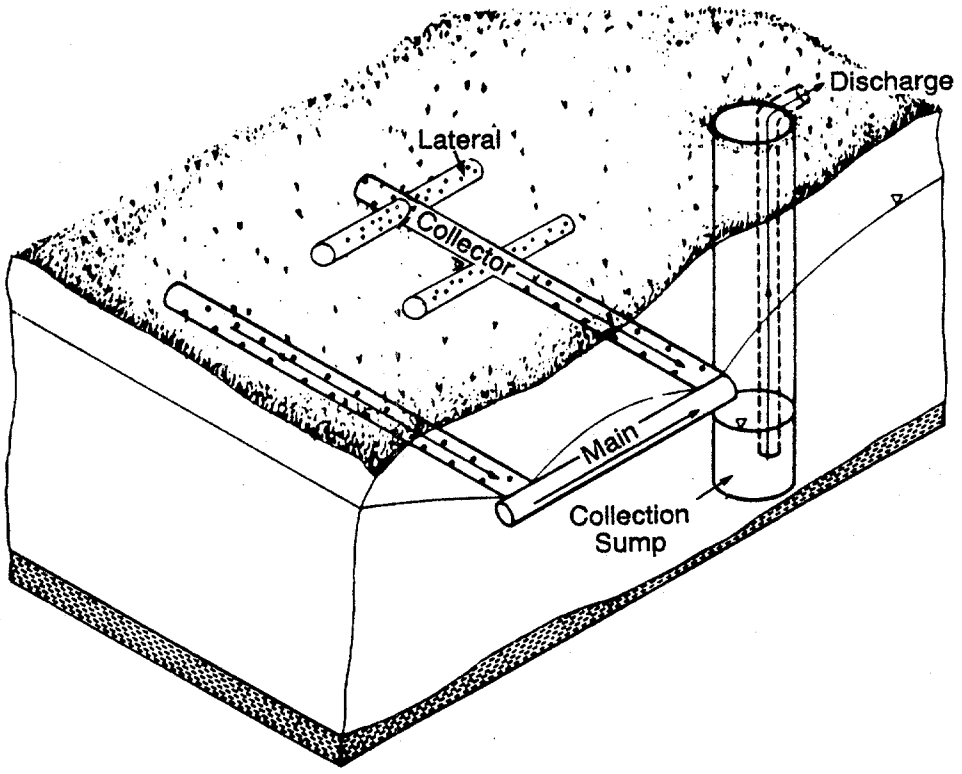


Figure 2-2. Subsurface drainage system components.

Because the former Marsh Run Field landfill has not been in operation in the past 20 years, it is expected that methane gas generation has dissipated significantly. Consequently, because minimal future gas generation is anticipated, active gas venting is not considered as an appropriate remedial technology for this site.

2.5.6 Ground-Water Collection Actions

Ground-water collection actions that are proposed will extract contaminated ground water from the bedrock aquifer to contain the aquifer contamination within the site boundaries. Extracted ground water will be treated and the treated effluent discharged. Ground-water treatment and discharge are addressed in Section 2.5.7. Ground-water extraction is necessary to prevent migration of contamination through the aquifer into offsite surface waterbodies (Marsh Run and the Susquehanna River). Two approaches to ground-water collection are presented--ground-water pumping and subsurface drains.

2.5.6.1 Ground-Water Pumping

Ground-water pumping systems can be an effective means of controlling and reducing contaminant plumes. The former Marsh Run Field landfill ground-water contamination problem could be remediated through ground-water extraction and treatment, depending on aquifer and contaminant characteristics. The contaminant plume in the water-table aquifer existing onsite could be efficiently and predictively managed and controlled by pumping.

Pumping techniques involve the pumping of ground water through a series of strategically placed wells to capture the contaminated ground water. The extraction of ground water induces a flow toward the pumping wells. This flow directs the contaminated ground-water plume to wells for removal.

Implementing a ground-water pumping system requires installation of extraction wells, pumping equipment, and a suitable means of treating and disposing of the liquid. Treatment and discharge are discussed later in this chapter.

The effectiveness of ground-water pumping is related to site hydrology, aquifer yield, and other hydrogeologic factors. A series of long-term pump tests would be necessary to establish aquifer characteristics for pump design and final well placement.

The withdrawal of contaminated water from the existing plume beneath the Marsh Run Park site will decrease the potential for contaminant release from ground-water sources and discharge of contaminants to nearby surface waterbodies. The action of ground-water pumping may also result in other environmental effects such as inducing flushing of the aquifer.

This alternative is retained for further consideration.

2.5.6.2 Subsurface Drains

Subsurface drains include any type of buried conduit used to convey and collect aqueous discharges by gravity flow. Subsurface drains essentially function like an infinite line of extraction wells. They create a continuous zone of influence in which ground water within this zone flows toward the drain. Subsurface drainage components are illustrated in Figure 2-2.

Because drains essentially function like an infinite line of extraction wells, they can perform many of the same functions as wells. They can be used to contain or remove a plume, or to lower the ground-water table to prevent contact of water with the waste material.

For shallow contamination problems, drains can be more cost-effective than pumping, particularly in strata with low or variable hydraulic conductivity. Under these conditions, it would be difficult to design

and it would be cost-prohibitive to operate a pumping system to maintain a continuous hydraulic boundary. Subsurface drains may also be preferred over pumping where ground-water removal is required over a period of several years, because the operation and maintenance costs associated with pumping are substantially higher.

One of the biggest drawbacks to the use of subsurface drains is that they are generally limited to shallow depths. Although it is technically feasible to excavate a trench to almost any depth, the costs of shoring, dewatering, and hard rock excavation can make drains cost-prohibitive at depths of greater than 40 ft.

Subsurface drains could be effective for control of surficial aquifer ground water at this site. Subsurface drains would be of questionable value in controlling ground water from the deep aquifer at Marsh Run Park since the deep aquifer is a bedrock aquifer which would likely require significant blasting to construct the drains. This technology is not retained for further consideration.

2.5.7 Ground-Water Treatment/Discharge Actions

Ground-water treatment and discharge actions will be conducted in conjunction with ground-water collection actions. Ground-water treatment and discharge will provide for the remediation of contaminated ground water and return of the treated water to the environment. Onsite biological, chemical, and physical ground-water treatment processes and offsite water treatment methods are addressed. Onsite and offsite discharge of treated ground water is also addressed.

2.5.7.1 Treatment of Liquid Wastes

Liquid waste would be generated from two sources:

- ground-water pumping
- leachate

Contaminants found in the ground water at the Marsh Run Park site include trace metals and volatile organics. The trace metals found during the RI to exist in significant concentrations above background levels are arsenic, cadmium, chromium, lead, and manganese. Volatile organics (several concentrations up to 300 µg/L; high iron concentrations were also observed) were found to exist in the bedrock aquifer. These include trichloroethene (TCE), 1,1-dichloroethane, 1,2-dichloroethane, trans-1,2-dichloroethane, vinyl chloride, and 1,1,2,2-tetrachloroethane.

Liquid waste treatment can be broken down into three basic categories: biological treatment, chemical treatment, and physical treatment. These are summarized in Table 2-9.

The treatment approach for the ground water at Marsh Run Park will probably be a two-phase approach, subsequent to the results of treatability testing. A pretreatment phase will probably be required to precipitate or filter metals from the water prior to treatment for removal of VOCs.

Pretreatment would be needed to reduce iron concentrations that could cause scaling in the VOC treatment units. Pretreatment may also be needed to reduce concentrations of biologically inhibitory compounds such as cadmium and lead, if aerobic biodegradation is used for VOC removal. Pretreatment is also needed to minimize the potential for clogging caused by suspended solids.

VOC removal would be conducted subsequent to pretreatment. VOC removal could be performed using biological, chemical, or physical methods.

Biological, chemical, and physical treatment technologies are abundant and diverse. These processes could be used separately or in combination to effectively treat the liquid wastes pumped out of the ground and to reduce to acceptable levels the potential threats to human health and the environment.

TABLE 2-9 LIQUID WASTE TREATMENT TECHNOLOGIES

Technology	Comments
Biological:	
Aerobic Biodegradation	Removal of biodegradable compounds
Activated Sludge	Removal of biodegradable compounds
Fixed Film	Removal of biodegradable compounds
Algal Cell Absorption	Removal of heavy metals
Anaerobic Biodegradation	Removal of biodegradable compounds
Chemical:	
Oxidation/Reduction	Removal of metals
Precipitation	Removal of metals
Neutralization	pH Adjustment
Physical:	
Flocculation	Promotes the removal of a large percentage of metals
Sedimentation	Removal of metals and inorganics
Activated Carbon	Removal of dilute concentrations of organics
Air Stripping	Removal of volatile organics
UV/Oxidation	Removal of volatile organics
Ion Exchange	Removal of ions including metals
Reverse Osmosis	Removal of most ions prior to ion exchange
Filtration	Removal of suspended solids
Equalization Basin	Produces uniform waste stream for subsequent processing units
Dissolved Air Flotation	Removal of inorganics and oils
Steam Stripping	Removal of volatile organics
Sludge Dewatering	Removal of inorganics

Ground-water treatment technologies are both proven and reliable. In addition, innovative technologies are becoming available which could be more effective in eliminating the pollutant through degradation. A treatability study would be required for the design of any system.

All three classes of (biological, chemical, physical) water treatment are potentially applicable. Certain processes, such as activated sludge, are inhibited by toxic contaminants and may not be applicable. Table 2-10 summarizes the water treatment processes retained for further consideration.

2.5.7.2 Discharge Technologies

The degree of wastewater treatment performed on the extracted ground water, as summarized in Section 2.5.7.1, is determined by the quality of effluent allowed in the receiving waters or any other source designated for extracted ground-water acceptance. Sources being considered for receiving treated water are as follows:

- Discharge to surface water
- Discharge to local publicly owned treatment works (POTW)
- Discharge to ground water (injection wells)
- Discharge to infiltration trenches

Discharge of the treated ground water to nearby surface water requires onsite treatment. The degree of treatment required depends upon the stream's classification and applicable water quality standards under PaDER regulations. Discharge to the local POTW requires proximity of a municipal sewer line to the site and approvals from the local sewerage authority and the PaDER. Impacts of the contaminated ground water on the plant sludge must be considered. Discharge to ground water through injection wells or through infiltration trenches would be considered as part of a bioremediation treatment process. The type of treatment of the water would depend on the design of the bioremediation system. The availability of permits should be considered.

For the Marsh Run Park site, the most likely discharge technologies will be:

- Discharge to Marsh Run and/or associated wetlands
- Discharge to ground water through in situ bioremediation

Discharge to a POTW would require coordination with the POTW, an NPDES permit, and construction of a discharge line from the site to the nearest collection lateral of the public system. This activity might also require acquisition of property rights for construction of the discharge line. Discharge to the Susquehanna River would require construction of a discharge pipe beneath the two railroad embankments north of the site. This activity would require an NPDES permit and would require acquisition of property rights from site owners north of the Marsh Run Park site.

Discharge to Marsh Run would require an NPDES permit but would be relatively easy to implement at the site. This activity would not require the acquisition of property rights from other owners. Discharge to the ground water through bioremediation would also require permitting but appears to be feasible for conditions at the Marsh Run Park site. All of these discharge technologies could be appropriate for site conditions at the Marsh Run Park site.

For purposes of development of remedial alternatives, discharge to Marsh Run will be used for all alternatives with the exception of in situ bioremediation alternatives. This approach was selected based upon technical implementability and constructability considerations. For bioremediation, ground water will be reinjected into the aquifer to enhance the bioremediation process.

TABLE 2-10 POTENTIALLY APPLICABLE GROUND-WATER TREATMENT TECHNOLOGIES FOR MARSH RUN PARK LANDFILL, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Pretreatment Technologies

Precipitation
Flocculation
Sedimentation
Equalization Basins

VOC Treatment Technologies

Aerobic Biodegradation
Anaerobic Biodegradation
Activated Carbon
Air Stripping
UV/Oxidation
Reverse Osmosis
Ion Exchange

Advanced Waste Treatment and Sludge Handling Technologies

Activated Carbon
Reverse Osmosis
Neutralization
Sludge Dewatering

2.6 SUMMARY OF TECHNOLOGY SCREENING

Based on the preliminary screening of remedial technologies, certain technologies have been eliminated from further consideration. The remaining technologies will be used to develop remedial alternatives. Table 2-11 summarizes the general response actions and remedial technologies that have been retained at the conclusion of the preliminary technology screening.

TABLE 2-11 REMEDIAL TECHNOLOGIES RETAINED AT THE CONCLUSION OF PRELIMINARY TECHNOLOGY SCREENING

General Response Action	Remedial Technology	Access Options
No Action/Institutional Actions	No Action with Site Control	. Ground-Water Monitoring . Deed Restrictions . Perimeter Fencing
Source Area Containment Actions	Capping	. RCRA Multimedia Cap
	Surface Diversion/Collection	. Grading/Revegeation . Dikes and Berms . Terraces and Benches
Source Area Treatment Actions	Excavation	. Excavation/Removal . Excavation/Treatment . Selective Excavation
	Onsite Treatment	. Soils Washing . Mobile Incinerator
	In Situ Treatment	. Soil Venting . Soil Flushing/Bioremediation . Vitrification
	Offsite Treatment	. Incineration . Landfilling
Gas Collection Actions	Gas Control	. Passive Perimeter Gas Control
Ground-Water Collection Actions	Ground-Water Extraction	. Extraction Wells . Extraction/Injection Wells

TABLE 2-11 (Cont.)

General Response Action	Remedial Technology	Access Options
Ground-Water Treatment/Discharge Actions	Biological Treatment	. Aerobic Bioreactor . Anaerobic Bioreactor
	Physical/Chemical Treatment	. Carbon Adsorption . Air Stripping . Ion Exchange . UV/Oxidation . Precipitation/Sedimentation . Reverse Osmosis . Oxidation/Reduction
	Offsite Treatment	. RCRA Facility
	Onsite Discharge	. Marsh Run Creek

3. DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 DEVELOPMENT OF ALTERNATIVES

The purpose of developing remedial action alternatives is to provide a range of potential techniques that comply with the general response actions for the Marsh Run Park site.

Pursuant to review of the ARARs for this project, it is apparent that any remedial action selected (with the exception of the "No Action" alternative) would need to consider ground-water treatment. Consequently, the alternatives shown here are divided into source-area alternatives and ground-water alternatives. It is recognized that all remedial actions (except the No Action alternative) would need to select one source-area alternative and one ground-water alternative so that the final alternative would address both source-area and ground-water considerations.

The development and screening of alternatives presented in this section has been conducted in accordance with EPA's "Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA" (EPA 1988).

Table 3-1 summarizes the alternatives that were developed for screening. The following sections briefly outline the alternatives identified in Table 3-1.

3.1.1 Source Area Alternative No. 1: No Action with Site Control

This alternative is presented as a baseline for comparison of other remedial alternatives. Major components are as follows:

- Install perimeter fence around site.
- Monitor ground water from downgradient wells (MW-1, MW-2, MW-4, MW-1A, MW-2A, MW-4A) and from new monitoring wells

installed downgradient of the source area for the next 30 years.

- Include in the property deed restrictions related to future site uses or use of ground water from the site as a source of drinking water.

3.1.2 Source Area No. 2: Capping with Surface Water and Gas Controls

This alternative is a source area containment action. Major components are as follows:

- Install perimeter fence.

- Construct multimedia cap in accordance with PaDER requirements over former landfill area and areas of volatile organic contamination immediately north of the landfill (±5.5 acres).

- Provide surface management for erosion and sediment control.

- Provide surface water controls through grading, dikes, berms, etc., to divert runon/runoff from the capped area.

- Provide passive gas vents in the capped area as required. (Off-gas treatment may be required, subsequent to analysis of gas composition and generation rate.)

- Revegetate all disturbed areas.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

TABLE 3-1 IDENTIFICATION OF REMEDIAL ALTERNATIVES FOR THE FORMER MARSH RUN FIELD LANDFILL SITE, FAIRVIEW TOWNSHIP, PENNSYLVANIA

No Action Alternative

- No Action with Site Control

Source-Area Alternatives

- Capping with Surface Water and Gas Controls
- Excavation with Offsite Treatment
- Excavation with Onsite Thermal Treatment
- Excavation with Onsite Soils Washing
- Selective Excavation with Offsite Treatment
- In Situ Soil Venting
- In Situ Soil Flushing/Bioremediation
- In Situ Vitrification

Ground-Water Alternatives

- Extraction/Onsite Aerobic Bioreactor/Discharge to Marsh Run Creek
- Extraction/Onsite Aerobic Bioreactor/Reinjection to Aquifer
- Extraction/Carbon Adsorption/Discharge to Marsh Run Creek
- Extraction/Air Stripping/Discharge to Marsh Run Creek
- Extraction/UV Oxidation/Discharge to Marsh Run Creek
- Extraction/Reverse Osmosis/Discharge to Marsh Run Creek

- Conduct monitoring of ground water from upper aquifer monitoring wells for the next 30 years.

3.1.3 Source-Area Alternative No. 3: Excavation with Offsite Treatment

This alternative is a source area removal action. Major components are as follows:

- Install perimeter fence.
- Install erosion and sediment control and stormwater management provisions.
- Excavate complete former "waste fill" area and VOC-contaminated area north of the landfill (47,500 yd^3).
- Transport excavated material offsite for disposal at a RCRA treatment, storage, and disposal facility (TSDF) in accordance with EPA, DOT, and other Federal/State regulations.
- Backfill excavated areas with clean fill, regrade, and revegetate.
- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal requirements.
- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

3.1.4 Source-Area Alternative No. 4: Excavation with Onsite Thermal Treatment

This alternative is a source area removal/treatment action. Major components are as follows:

- Install perimeter fence.

- Install erosion and sediment control and stormwater management provisions.

- Excavate complete former landfilled area and VOC-contaminated area north of the landfill (47,500 yd^3).

- Construct low-temperature thermal stripping facility onsite.

- Treat contaminated materials with onsite thermal treatment system. Replace treated materials onsite. Provide for off-site disposal of all materials that cannot be replaced onsite.

- Backfill excavated areas with clean fill.

- Provide for adequate site closure per RCRA requirements.

- Revegetate disturbed area.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.5 Source-Area Alternative No. 5: Excavation with Onsite Soils Washing

This alternative is a source area removal/treatment action. Major components are as follows:

- Install perimeter fence.

- Install erosion and sediment control and stormwater management provisions.

- Excavate complete former landfilled area and VOC-contaminated area north of the landfill (47,500 yd^3).

- Provide materials separation equipment to separate bulky waste materials, debris, and garbage from soil fraction.

- Treat landfill area soil fraction and VOC area soil north of landfill using onsite soils washing.

- Provide for transport and offsite disposal at an RCRA TSDF for all excavated materials except treated soils.

- Replace treated soils onsite.

- Backfill excavated areas with clean fill, regrade, and revegetate.

- Conduct all activities in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.6 Source-Area Alternative No. 6: Selective Excavation with Offsite Treatment

This alternative is a source area removal action. Major components are as follows:

- Install perimeter fence.
- Install erosion and sediment control and stormwater management provisions.
- Excavate soil from the VOC-contaminated "hot spot" northwest of WP-1 (±16,000 yd^3).
- Excavate "hot spot" northwest of WP-3 from the former landfill (±1,500 yd^3).
- Provide for transportation and offsite disposal at a RCRA TSDF in accordance with EPA, DOT, and other Federal/State regulations.
- Backfill excavated areas with clean fill, regrade, and revegetate.
- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.
- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.
- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.7 Source-Area Alternative No. 7: In Situ Soil Venting

This alternative is an in situ source area treatment action. Major components are as follows:

- Install perimeter fence.
- Install stormwater management and erosion and sediment control provisions.
- Conduct limited soil venting pilot test onsite.
- Install in situ soil vapor vacuum extraction system consisting of shallow gas collection wells and laterals, vacuum extraction pumps, and off-gas treatment system (activated carbon or catalytic oxidation).
- Provide surface water controls for stormwater runon/runoff and erosion/sediment control.
- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.
- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.
- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.8 Source-Area Alternative No. 8: In Situ Soil Flushing/ Bioremediation

This alternative is an in situ source area treatment action. Major components are as follows:

- Install perimeter fence.

- Install erosion and sediment control and stormwater management provisions.

- Conduct treatability testing to optimize treatment parameters.

- Provide onsite aerobic bioreactor for water treatment.

- Regrade site to construct biological infiltration basin.

- Provide surface water controls for stormwater runon/runoff and erosion/sediment control.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.9 Source-Area Alternative No. 9: In Situ Vitrification

This alternative is an in situ treatment action. Major components are as follows:

- Install perimeter fence.

- Install erosion and sediment control and stormwater management provisions.

- Conduct in situ vitrification treatment over the "hot spot" areas (±2.0 acres).

- Provide surface water controls for stormwater runon/runoff and erosion/sediment control.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of surface water and sediments in Marsh Run Creek and the Susquehanna River.

- Conduct post-action monitoring of ground water from existing, upper-aquifer monitoring wells.

3.1.10 Ground-Water Alternative No. 1: Onsite Aerobic Bioreactor/ Discharge to Marsh Run Creek

This alternative is a ground-water treatment action. Major components are as follows:

- Conduct aquifer characterization studies.

- Install ground-water extraction wells and associated piping.

- Conduct biodegradation treatability study on ground water from the site.

- Provide pretreatment unit(s) for metals removal (pursuant to treatability test results).

- Provide aerobic bioreactor for organics treatment. Aerobic bioreactor should be supplied with microbes, nutrients, and oxygen based upon treatability test results.

- Provide process piping for discharge of treated effluent to Marsh Run Creek.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of ground water from deep-aquifer, downgradient monitoring wells.

3.1.11 Ground-Water Alternative No. 2: Onsite Aerobic Bioreactor/ Reinjection

This alternative is a ground-water treatment action. This alternative is identical to Ground-Water Alternative No. 1, except that treated effluent will be re-introduced into the aquifer through onsite infiltration and shallow (upper water-bearing zone) injection wells.

3.1.12 Ground-Water Alternative No. 3: Carbon Adsorption

This alternative is a ground-water treatment action. Major components are as follows:

- Conduct aquifer characterization studies.

- Conduct activated carbon pilot test with ground water from the site to optimize operating parameters and determine pretreatment requirements.

- Install ground-water extraction wells and associated piping.

- Provide precipitation/sedimentation or filtration process unit(s) for metals removal (pursuant to treatability test results.

- Provide granular activated carbon (GAC) treatment unit(s) for organics treatment.

- Provide process piping for discharge of treated effluent to Marsh Run Creek.

- Conduct all actions in a manner that mitigates impact on wetlands in accordance with PaDER and Federal regulations.

- Conduct post-action monitoring of ground water from deep-aquifer, downgradient monitoring wells.

3.1.13 Ground-Water Alternative No. 4: Air Stripping

This alternative is a ground-water treatment action. This alternative contains all of the same major components as Ground-Water Alternative No. 3, except that an air stripping pilot test is conducted and a countercurrent air stripping system is provided in place of the activated carbon unit(s).

3.1.14 Ground-Water Alternative No. 5: UV Oxidation

This alternative is a ground-water treatment action. This alternative contains all of the same major components as Ground-Water Alternative No. 3, except that a UV oxidation pilot test is conducted and a UV oxidation treatment system is provided in place of the activated carbon unit(s).

3.1.15 Ground-Water Alternative No. 6: Reverse Osmosis

This alternative is a ground-water treatment action. This alternative contains all of the same major components as Ground-Water Alternative No. 3, except that a reverse osmosis pilot test is conducted, and a reverse osmosis treatment system is provided in place of the activated carbon system.

3.2 SCREENING OF ALTERNATIVES

The alternatives developed to attain the general response actions are evaluated with respect to effectiveness, implementability, and cost in accordance with EPA's March 1990 NCP. The evaluation for effectiveness includes short-term and long-term effectiveness and reduction of toxicity, mobility, or volume of contamination. The evaluation for implementability addresses technical concerns (e.g., ability to construct, operate, and maintain the treatment system), and administrative concerns (e.g., ability to obtain permits, offsite or onsite disposal considerations, and need for specialists). The cost evaluation includes capital costs and operation and maintenance (O&M) costs. Present worth costs are based on a 30-year period, an 8 percent discount rate, and 1990 dollars. Costs presented are preliminary. Detailed costing is provided for alternatives examined in detail in Section 4.

Source-area alternatives are addressed separately from ground-water alternatives. It should be noted that all source-area alternatives (except the No Action alternative) will be conducted in conjunction with a ground-water alternative. Consequently, the evaluation for effectiveness, implementability, and cost for source area actions will address containment or treatment of the source area only. Ground-water remediation is addressed independently.

3.2.1 Source-Area Alternative No. 1: No Action with Site Control

Effectiveness

Construction of a perimeter fence would assist in preventing unauthorized personnel from potential contamination. Deed restrictions, if enforceable, would limit allowable future site uses and could legally restrict use of onsite water as a drinking water source. Ground-water and surface-water monitoring could provide indications of whether contamination from the site is or may be impacting offsite ground water

or surface water. This alternative does not reduce the toxicity, volume, or mobility of existing ground-water contamination.

Implementability

This alternative would be easily implemented. Effective ground-water monitoring would probably require additional wells to be installed downgradient of the site at or beyond the site boundaries. Other existing downgradient wells could be used in the monitoring program. Ground-water monitoring and monitoring of surface water and sediments from Marsh Run Creek and the Susquehanna River would be conducted over the next 30 years. Deed restrictions would be required to control use of the site.

Costs

Capital Cost = $50,000-100,000
O&M Cost = $40,000-50,000/yr
Present Worth = $450,000-750,000 (1990)

Conclusion

This alternative would not be effective in achieving the remedial action objectives, but will be carried on for detailed analysis to establish a baseline for comparison of alternatives, pursuant to Section 300.430(e)(3)(ii)(6) of the revised NCP.

3.2.2 Source-Area Alternative No. 2: Capping with Surface Water and Source Controls

Construction of a perimeter fence would assist in preventing unauthorized personnel from potential contamination. Construction of a multimedia cap would further prevent exposure to contaminated soils beneath the existing soil cover. An impermeable cap in conjunction with surface water controls would minimize surface water infiltration through the

landfill, thus limiting leachate production. Capping does not, however, address ground water in the shallow saturated zone, although the depth to ground water is expected to increase due to prevention of surface water infiltration through the cap. This alternative reduces the mobility of ground-water contamination, and, in conjunction with ground-water extraction and treatment, provides for reduction of toxicity and volume of contamination. Ground-water monitoring provides for assessment of effectiveness and identification of contamination that would require further action.

Implementability

Construction of a multimedia cap and site regrading necessary to establish surface water controls is a relatively standard procedure and could be readily implemented for the site conditions at the Marsh Run Park site. The proximity to wetlands areas east of the landfill will require coordination with PaDER and may require permitting. This alternative will require monitoring and periodic inspections to ensure that the cap integrity is maintained.

Costs

Capital Cost = $\$1\text{-}2 \times 10^6$
O&M Cost = \$30,000-40,000/yr
Present Worth = $\$1.5\text{-}2.5 \times 10^6$ (1990)

Conclusion

This alternative will provide reduction of source area contaminant migration and will be reliable as a long-term remedial action. This alternative should be retained for detailed analysis.

3.2.3 Source-Area Alternative No. 3: Excavation with Offsite Treatment

Effectiveness

This alternative will provide for complete removal and destruction of contaminants in the soils and waste in the source area. This alternative provides for permanent removal of contamination sources from designated areas and should eliminate the need for future surficial aquifer monitoring. Ash disposal resulting from incineration would be handled at the RCRA disposal facility.

Implementability

Offsite incineration would consist of excavation of designated areas and transport and disposal of contaminated material to an offsite RCRA facility. Excavation of a former landfill may present some technical difficulties and potential health hazards. The proximity to wetlands areas east of the landfill will require coordination with PaDER and may require permitting. Packaging of waste debris will be a time-consuming, potentially hazardous activity.

Available treatment capacity is not expected to be a concern. Offsite incineration is technically proven and is a reliable option.

Costs

Capital Cost = \$100-150 x 10^6
O&M Cost = \$30,000/yr
Present Worth = 100.5-150.5 x 10^6 (1990)

Conclusion

Offsite incineration is technically feasible. This alternative will reduce the toxicity, mobility, and volume of source area contamination. This alternative will be retained for detailed analysis.

3.2.4 Source-Area Alternative No. 4: Excavation with Onsite Treatment

Effectiveness

This alternative will provide for removal and destruction of volatile organic contamination of soils and wastes within the designated source area. This alternative will not address metals contamination of source area materials. The removal of volatile contamination source shall eliminate need for future shallow ground-water monitoring. Onsite ash disposal may be complicated due to RCRA land disposal regulations.

Implementability

Onsite incineration would consist of excavation of designated areas, construction of a mobile incineration system onsite, and incineration of waste materials. Onsite incineration would require a test burn and would have to comply with the Federal Clean Air Act and State air regulations for stack emissions. The onsite incinerator should be technically reliable. Public acceptance and perception may be of concern.

Excavation considerations and wetlands considerations for this alternative would be the same as described for Source-Area Alternative No. 3. Replacement of incinerator ash onsite may be affected by RCRA Land Disposal regulations.

Costs

Capital Cost = \$40-60 x 10^6
O&M Cost = \$30,000/yr
Present Worth = \$40.5-60.5 x 10^6 (1990)

Conclusions

Onsite incineration is technically reliable and implementible. This alternative will reduce the toxicity, mobility, and volume of source area contamination. This alternative will be retained for detailed analysis.

3.2.5 Source-Area Alternative No. 5: Excavation with Onsite Soils Washing

Soils washing would provide an effective approach to separation of heavy metals and volatile organics contamination from the soil component of buried wastes at the Marsh Run Park site. Soils washing is not feasible for treatment of non-soil materials and is limited in effectiveness for fine-grained soils. Extracted contaminants would require offsite disposal. This alternative would reduce the volume of contamination, particularly in the VOC-contaminated area immediately north of the landfill. This alternative would not offer any advantages over excavation/offsite disposal in the landfill portion of the site.

Implementability

Portable soils washing treatment systems are available through several vendors. Soils washing should be technically reliable for non-landfill material. Handling of extracted contaminants would require transport and disposal to a RCRA-permitted TSDF. Soils washing has not been demonstrated to be usable for treatment of non-soil material. Extensive pretreatment separation would be required.

Excavation and wetlands considerations for this alternative would be the same as described for Source-Area Alternative No. 3.

Costs

Capital Cost = $\$75\text{-}90 \times 10^6$
O&M Cost = \$30,000/yr
Present Worth = $\$75.5\text{-}90.5 \times 10^6$ (1990)

Conclusion

Excavation with onsite soils washing presents limited effectiveness and implementability for treatment of non-soil wastes. Extensive separation and handling requirements prior to treatment present elevated public health and environmental risks. This alternative does not offer substantially more benefit than other excavation alternatives. Consequently, this alternative will not be retained for further consideration.

3.2.6 Source-Area Alternative No. 6: Selective Excavation with Offsite Treatment

Effectiveness

Selective excavation would be used to remove and dispose of VOC-contaminated soil north of the landfilled area and to remove/dispose of identified "hot spot" areas within the fill area. Selective excavation would be effective in removing identified contamination sources contributing to ground-water contamination at the site. This alternative reduces the toxicity, mobility, and volume of source area contamination and would be effective both in short-term and long-term considerations. Post-action ground-water and surface-water monitoring would be conducted to assess the impact of remedial actions on site conditions.

Implementability

Selective evaluation involves excavation of VOC-contaminated soil north of the landfill and excavation of designated contaminated areas within the former landfill. Excavation within the landfill may present some difficulties but is not an uncommon procedure. The proximity of wetlands areas east of the landfill will require coordination with PaDER and may require permitting. Transport and disposal of excavated materials would be in accordance with EPA, DOT, and State regulations, and would required disposal at an RCRA-permitted TSDF.

Costs

Capital Cost = \$25-55 x 10^6
O&M Cost = \$30,000/yr
Present Worth = \$25.5-55.5/yr (1990)

Conclusion

This alternative would provide for permanent reduction of toxicity, mobility, and volume of source area contamination and would minimize future contribution to ground-water contamination. It will be retained for detailed analysis.

3.2.7 Source-Area Alternative No. 7: In Situ Soil Venting

Effectiveness

In situ soil venting would be effective for remediation of VOC contamination above the water table in the source area at the Marsh Run Park site. Soil venting may have limited effectiveness for treatment of contamination below the water table unless the system is designed with an air/water separator. A pilot test should be conducted in a limited portion of the site to determine if the ground-water level at the site will impact performance. Soil venting is a demonstrated reliable technique for remediation of volatile organic solvent contamination.

Implementability

In situ soil venting would not require extensive disturbance of site conditions. Some grading would be required, and clean offsite soil would be required as a cap for the soil venting system. A treatment system for extracted gas (catalytic oxidation or vapor phase activated carbon) would be required to meet air discharge regulations. Treatment and air discharge permits would be needed. Construction activities would need to be accompanied by erosion/sediment controls to minimize

disturbance to adjacent wetlands. Offsite disposal would be required only for spent carbon.

Costs

Capital Cost = $3.5-5.0 x 10^6
O&M Cost = $30,000/yr
Present Worth = $4.0-5.5 x 10^6 (1990)

Conclusion

This alternative should provide effective reduction of toxicity, mobility, and volume of source area contamination. It should also permanently minimize future source area contribution to ground-water contamination. It will be retained for detailed analysis.

3.2.8 Source-Area Alternative No. 8: In Situ Soil Flushing/ Bioremediation

Effectiveness

Bioremediation of chlorinated organic solvents in the source area may be effective in reducing contaminant levels below action levels. Recent research indicates that, with addition of a proper co-metabolite (alternate substrate), aerobic microbes have demonstrated effectiveness in degrading TCE, cis- and trans-dichloroethylene (DCE), and other chlorinated solvents (Ecova 1989). A treatability study would be required to determine optimum operating conditions (microbe, nutrient, oxygen supplies).

Implementability

Minimal disturbance of existing landfill would be effected. Clean offsite fill materials would be required to construct perimeter berms for the biological infiltration basin. A liquid contact bioreactor and process piping would be needed to recycle microbes and nutrients through

the system. An onsite treatment permit and treatability testing would be required. Provisions for handling and treating storm flows from the infiltration basin would be needed. Provisions for erosion/sediment controls would be necessary to minimize disturbance to adjacent wetlands.

Costs

Capital Cost = $\$1.4\text{-}2.0 \times 10^6$
O&M Cost = $\$30,000$/yr
Present Worth = $\$1.9\text{-}2.5 \times 10^6$ (1990)

Conclusion

This alternative may be effective in reducing toxicity and volume of organic solvent contamination in the source area. This alternative should be retained for detailed analysis.

3.2.9 Source-Area Alternative No. 9: In Situ Vitrification

Effectiveness

This alternative would be effective in providing for immobilization of source area contamination. Volatile organic contamination would be volatilized, contained, and treated during the vitrification process. The resultant glass block would effectively contain other contaminants. ISV has been shown to be effective to depths up to 30 ft. Factors that may limit effectiveness of ISV include depth to ground water and inclusions within the waste soil matrix (i.e., metal, rubble, combustibles, etc.).

Implementability

ISV has been effectively applied for remediation of source areas contaminated with organics and metals. The fill material at the Marsh Run Park site may adversely affect treatment effectiveness. A treatability study

should be conducted. An onsite treatment permit would be required. This alternative would not require regrading of the site, but would require that clean borrow material be imported to backfill the vitrified area since vitrification results in a net reduction in volume of treated material.

Costs

Capital Cost = $48-64 x 10^6
O&M Cost = $30,000/yr
Present Worth = $48.5-64.5 x 10^6 (1990)

Conclusion

Although site conditions may adversely affect use of this technology, this alternative will be retained for further consideration since it will provide for permanent long-term reduction of the volume, mobility, and toxicity of source area contamination.

3.2.10 Ground-Water Alternative No. 1: Onsite Bioreactor/Discharge to Marsh Run Creek

Effectiveness

Ground-water extraction will provide an effective approach to restricting contaminant migration beyond the site boundaries. The final design depth, location, and number of extraction and/or injection wells should be determined based upon aquifer characterization studies conducted during the predesign phase of the remedial design/remedial action (RD/RA) (see Section 6.2). Additional downgradient monitoring wells may also be required to monitor system effectiveness. Pretreatment of extracted ground water by precipitation/sedimentation or filtration would be effective in removal of metals and suspended solids prior to organic contaminant treatment. Pretreatment may be required for removal of iron, which

could result in encrusting conditions on VOC treatment units. Pretreatment may also reduce concentrations of contaminants that may be inhibiting to biological VOC treatment (i.e., cadmium, lead).

Biological treatment in a liquid contact bioreactor may be effective in degrading TCE and other organic solvents found in the ground water at Marsh Run. Pre-design pilot testing with ground water from the site will be required. Biological water treatment may not be successful in reducing VOC concentrations to below cleanup levels, unless it is combined with in situ soil flushing/bioremediation as a source area action. Discharge to Marsh Run would negatively impact performance of biological treatment since recycle of treated ground water through the source area enhances microbial activity within the source area.

Implementability

Pre-design treatability testing will be required. At least one 72-hour pump test should be performed on the deep aquifer to determine design depth, location, and number of extraction wells. A treatability test should also be conducted to examine the effectiveness of onsite aerobic biodegradation.

Implementation of components of this alternative should not be difficult, although a limited number of suppliers can provide an onsite aerobic bioreactor to effectively treat chlorinated solvents.

Costs

Capital Cost = \$750,000-1.0 x 10^6
O&M Cost = \$80,000-100,000/yr
Present Worth = \$1.5-1.75 x 10^6 (1990)

Conclusion

Although this alternative appears to present a viable approach to reducing the toxicity, mobility, and volume of ground-water contamination, it would be of limited effectiveness if not applied in conjunction with Source-Area Alternative No. 8: In Situ Soil Flushing/Bioremediation. Since it is preferable that biologically treated liquids be recycled through the source area instead of discharged from the site, this alternative will not be retained for further consideration. (See Ground-Water Alternative No. 2: Onsite Bioreactor/Reinjection.)

3.2.11 Ground-Water Alternative No. 2: Onsite Bioreactor/Reinjection

Effectiveness

Ground-water extraction, pretreatment, and biological treatment considerations are identical to those for Ground-Water Alternative No. 1. The only difference for this alternative is that biologically treated effluent is recirculated through the source area. This alternative appears to represent an effective long-term approach to remediation of ground-water contamination.

Implementability

Implementability considerations are identical to those for Ground-Water Alternative No 1.

Costs

Capital Cost = $750,000-1,000,000
O&M Cost = $80,000-100,000/yr
Present Worth = $1.5-1.75 \times 10^6$ (1990)

Conclusion

This alternative appears to present a viable approach to reducing the toxicity, mobility, and volume of ground-water contamination when conducted in conjunction with Source-Area Alternative No. 8: In Situ Soil Flushing/Bioremediation. This alternative will be retained for detailed analysis.

3.2.12 Ground-Water Alternative No. 3: Carbon Adsorption

Effectiveness

Ground-water extraction and pretreatment considerations are as previously described for Ground-Water Alternative No. 1.

Organics treatment by granular activated carbon is a proven effective treatment practice for chlorinated solvent contamination.

Implementability

Pre-design treatability testing will be required. At least one long-term pump test should be performed on the deep aquifer to determine design depth, location, and number of extraction wells (see Section 6.2). A bench scale treatability test should be conducted to optimize design parameters for the activated carbon treatment unit.

Implementation of components of this alternative should not be difficult. Availability of activated carbon treatment units should not be a problem. Permitting, including an NPDES discharge permit for the treated effluent, will be required.

Costs

Capital Cost = $750,000-800,000
O&M Cost = $120,000/yr
Present Worth = $2.1-2.2 x 10^6 (1990)

Conclusion

This alternative should provide an effective approach to reducing the toxicity, mobility, and volume of ground-water contamination. It will be retained for detailed consideration.

3.2.13 Ground-Water Alternative No. 4: Air Stripping

Effectiveness

Ground-water extraction and pretreatment considerations are as previously described for Ground-Water Alternative No. 1.

Organics treatment by countercurrent air stripping is a proven effective treatment practice for chlorinated solvent contamination.

Implementability

Implementability considerations are as previously described for Ground-Water Alternative No. 3, except that air stripping is used instead of activated carbon for organics treatment.

Costs

Capital Cost = $750,000-1.5 x 10^6
O&M Cost = $85,000/yr
Present Worth = 1.5-2.0 x 10^6 (1990)

Conclusion

This alternative should provide an effective approach to reducing the toxicity, mobility, and volume of ground-water contamination. It will be retained for detailed consideration.

3.2.14 Ground-Water Alternative No. 5: UV Oxidation

Effectiveness

Ground-water extraction and pretreatment considerations are as previously described for Ground-Water Alternative No. 1.

Organics treatment by UV oxidation has recently been demonstrated effective under EPA's SITE program for treatment of volatile organic contamination, including TCE and DCE.

Implementability

Implementability considerations are as previously described for Ground-Water Alternative No. 3, except that UV oxidation is used instead of activated carbon for organics treatment.

Costs

Capital Cost = \$750,000-1.5 x 10^6
O&M Cost = \$70,000/yr
Present Worth = \$1.4-1.9 x 10^6 (1990)

Conclusion

This alternative is an innovative technology that has proven effective for remediation of similar contaminants in ground water at a Superfund site in California. This alternative will be retained for detailed consideration.

3.2.15 Ground-Water Alternative No. 6: Reverse Osmosis

Effectiveness

Ground-water extraction and pretreatment considerations are as previously described for Ground-Water Alternative No. 1.

Reverse osmosis is an effective treatment technology for removal of dissolved solids, but is limited in effectiveness for treatment of high-volume, highly contaminated waste streams. Reverse osmosis (RO) will not reliably treat wastes with a high organic content since the membrane may be dissolved by the wastes. RO treatment is also highly dependent upon pretreatment and is highly susceptible to plugging and fouling.

Implementability

Implementability considerations are similar to those for Ground-Water Alternative No. 3. Additional pretreatment units would probably be required. Availability of equipment should not be a problem. Permitting, including NPDES discharge permits, would be required.

Costs

Capital Cost = $\$1.7\text{-}2.3 \times 10^6$
O&M Cost = \$300,000-400,000/yr
Present Worth = $\$3\text{-}5 \times 10^6$ (1990)

Conclusion

This alternative would be effective only as a polish unit in conjunction with other ground-water treatment technologies. Since other technologies

(i.e., activated carbon, air stripping) that are more effective, cost efficient, and proven for long-term reliability. This alternative will not be retained for detailed consideration.