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UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

AEHA

CONSERVARE SALUTEM

GEOHYDROLOGIC STUDY NO. 38-26-0313-88
SENECA ARMY DEPOT
ROMULUS, NEW YORK
13-21 OCTOBER 1987

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

HSHB-ME-SE

25 APR 1988

MEMORANDUM FOR: Commander, U.S. Army Materiel Command, ATTN: AMCSG, 5001 Eisenhower Ave., Alexandria, VA 22333-0001

SUBJECT: Geohydrologic Study No. 38-26-0313-88, Seneca Army Depot, Romulus, New York, 13-21 October 1987

Copies of report with Executive Summary are enclosed.

FOR THE COMMANDER:

Encl

PAUL R. THIES
LTC, MS
Chief, Waste Disposal Engineering Division

CF:
DA, USAEHSC, ATTN: CEHSC-E/CEHSC-F (w/encl)
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Cdr, SEAD, (w/encl)
Cdr, USATHAMA, ATTN: AMXTH-TE (w/encl)
Cdr, MEDDAC, Ft Devens, ATTN: PVNTMED Svc (2 cy) (w/encl)
Cdr, WRAMC, ATTN: PVNTMED Svc (w/encl)
Cdr, USAEHA Fld Spt Actv, Ft Meade (w/encl)

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
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EXECUTIVE SUMMARY
GEOHYDROLOGIC STUDY NO. 38-26-0313-88
SENECA ARMY DEPOT
ROMULUS, NEW YORK
13-21 OCTOBER 1987

The purpose, general summary and conclusions, and recommendations of the enclosed report follow:

a. Purpose. In June 1987, ground-water monitoring detected organic solvents near the closed incinerator at Seneca Army Depot. This site is near the post boundary, and approximately 1/2 mile off the post is a domestic drinking water well. Seneca Army Depot and the U.S. Army Materiel Command requested an investigation of the contamination to determine the direction, extent, and migration of the plume, and the risk to human health.

b. Summary and Conclusions.

(1) General. The study team completed 12 borings and installed nine monitoring wells across the site, from which samples were drawn. The site contains a number of possible sources of the ground-water contamination, the most probable being old burning pits, which were later used as part of the north landfill.

(2) Hydrogeology. The ground water appears to be in the fractured and weathered shale, confined to semiconfined between a glacial till and unweathered shale bedrock. The ground water flows evenly across the site toward the west-southwest.

(3) Ground-water Contamination. The contamination forms a definite plume, with two main constituents, trichloroethene and trans-1,2-dichloroethene. Chloroform, 1,2-dichloroethane, vinyl chloride, and a floating product that appeared to be diesel fuel were also detected.

No ground-water contamination has been detected offpost, either in the private wells, or in Well PT-26, installed in the northeast corner of the airstrip. However, based on the results from the wells onpost near the boundary, the contamination has probably migrated offpost at levels exceeding drinking water standards. Surface water sampling results show that the contamination may extend to surface water, and has moved offpost. The offpost surface water contamination is probably due to contaminated ground water seeping to the surface and not direct surface water flow.

c. Recommendations.

(1) We base the following recommendations on good environmental engineering practices: Keep the sites around the wells mowed; collect contaminated surface water before it flows offpost; investigate appropriate technologies for the collection and treatment of the contaminated ground water; excavate and clean contamination source areas; and properly dispose of contaminated materials.

(2) Based on 40 Code of Federal Regulations 264.101, negotiate corrective actions with the proper regulatory agencies; investigate the extent of the plume offpost.

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GEOHYDROLOGIC STUDY NO. 38-26-0313-88
SENECA ARMY DEPOT
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1. AUTHORITY. Memorandum, U.S. Army Materiel Command, AMCSG-S, 15 June 1987, subject: Fiscal Year 1988 Field Services Requirements.

2. PURPOSE. To investigate the ground-water contamination of the old incinerator at SEAD and determine the direction, extent, and nature of the plume, and the risk to human health (reference 8).

3. GENERAL.

a. Abbreviations and Definitions. Appendix A contains a list of abbreviations and definitions.

b. Project Personnel. William J. Bangsund, Environmental Engineer, as Project Officer, and William P. Smithson, Engineering Technician, from USAEHA conducted this study. Bill Pagano and Kevin Burchell from SEAD Roads and Grounds assisted with the field work.

c. Location.

(1) Seneca Army Depot is in Seneca County in the Finger Lakes Region of central New York (Figure 1). It is on the west side of the highlands separating Seneca Lake and Cayuga Lake.

(2) The study site is midway up the western edge of SEAD (Figure 2).

d. Background.

(1) History. Construction of Seneca Ordnance Depot (reference 12) began in July 1941. Later expansion included the airstrip from the former Sampson Air Force Base. Civilian employment peaked in 1943 at 2,500, and reached its low in 1946 at 600. Military employment is approximately 300 to 400. Present civilian employment is near 700. In August 1963, Seneca Ordnance Depot was transferred from the Chief of Ordnance to the U.S. Army Supply and Maintenance Command and renamed Seneca Army Depot. On 1 July 1966, SEAD was reassigned to the AMC. On 1 September 1976, DESCOM was activated with command and control over all AMC depots.

(2) Climate. The hottest month of the year in the area of SEAD (reference 18) is July, with an average daily high temperature of 80 °F. The coldest month is January, with an average low daily temperature of 4 °F. Prevailing winds are out of the west and northwest. The average yearly precipitation is 30 inches.

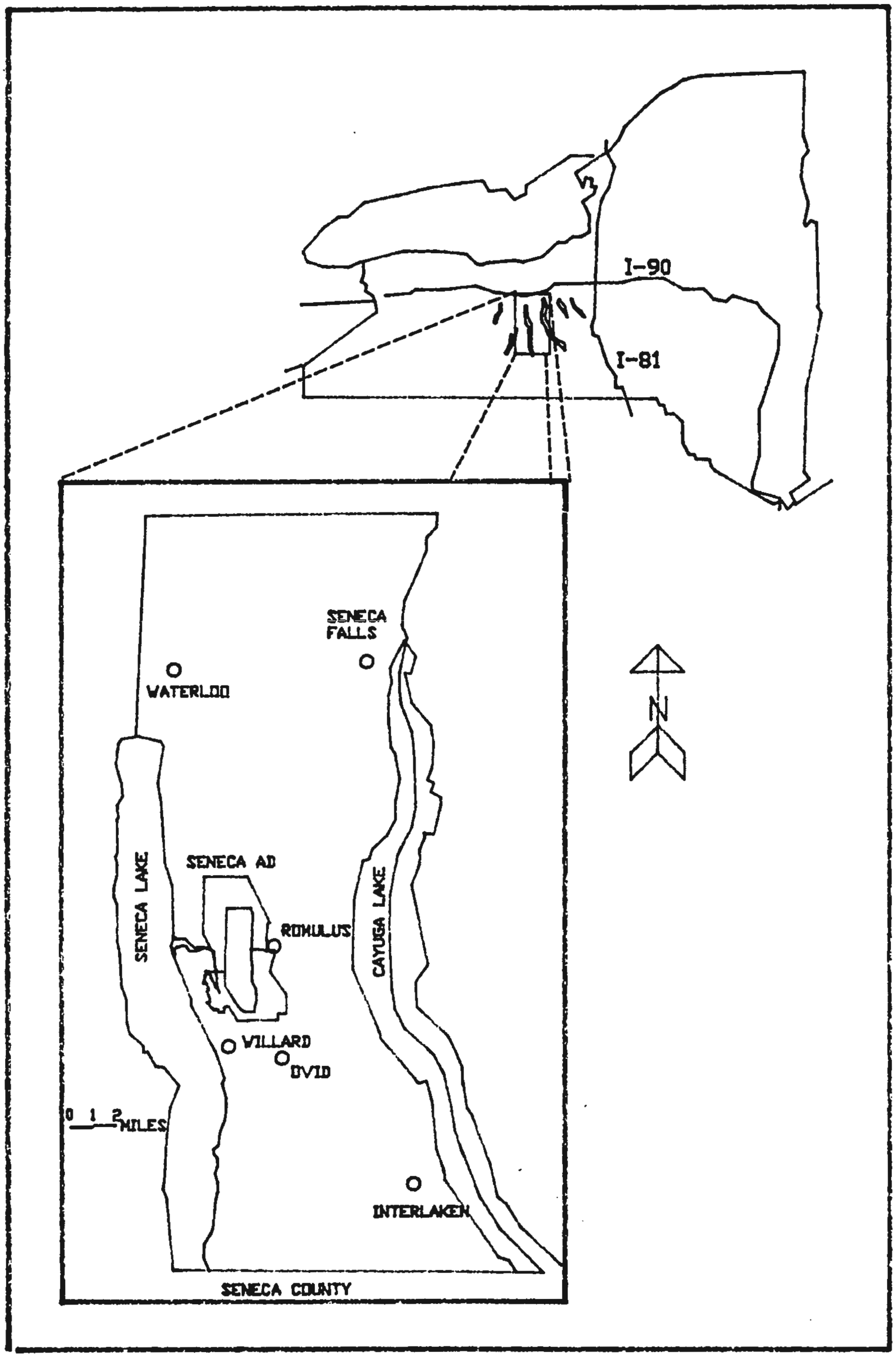

FIGURE 1. LOCATION OF SENECA ARMY DEPOT.

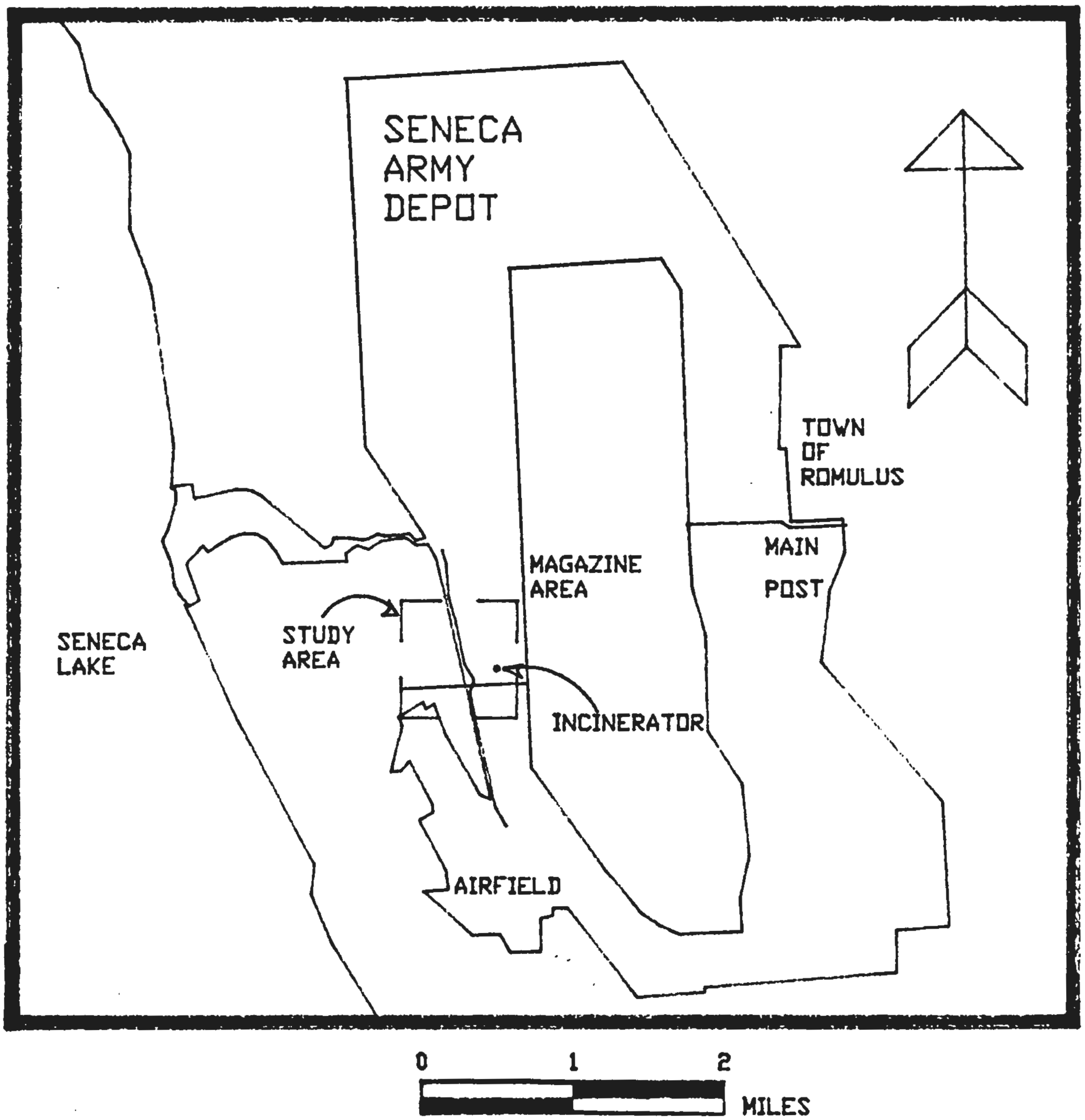

FIGURE 2. LOCATION OF THE STUDY AREA.

(3) Regional Hydrogeology. The SEAD is within the glacial till plain of the Central Lowlands physiographic province. Most surface drainage goes west to Seneca Lake. However, one stream in the northeast corner flows north into the Seneca-Cayuga Canal. Glacial deposits mantle most of Seneca County. North of SEAD is a glacial lake plain, and to the south is the north end of the Appalachian Plateau (Figure 3). Figure 4 is a map of the bedrock geology. The SEAD is underlain by a series of Middle Devonian shales that make up the Hamilton Group. The composite thickness of the units beneath the depot is approximately 500 feet. They dip evenly at a shallow angle to the south. Figure 5 shows cross sections of the SEAD area.

(4) Regulatory Status. The SEAD has applied for a RCRA permit for storing hazardous waste and for operating a deactivation furnace. The Hazardous and Solid Waste Amendments of 1984 to the RCRA requires that a Part B permit must include identification and corrective action at SWMU's with continuing releases of hazardous constituents (reference 3). Recently, USAEHA performed a review (reference 16) of SEAD's SWMU's. The SWMU's in the area of this study include the old incinerator with its cooling water pond, the ash and burn pits, and two closed landfills. Corrective action at a SWMU site must be coordinated with and approved by the appropriate regulatory agency.

4. FINDINGS AND DISCUSSION.

a. Methods.

(1) Well Siting. Prior to any well construction, the study team installed boreholes across the site (Figure 6). Ground-water samples were drawn from these boreholes and sent to USAEHA labs and analyzed for volatile organic compounds. The data from these samples and from the existing monitoring wells outlined the general extent of the plume. New monitoring wells and additional sampling boreholes were completed based on those samples (Figures 7 and 8). In addition, SEAD has already instituted a sampling program for the privately-owned offpost well (Figure 8).

(2) Drilling. The study team drilled the wells with a truck-mounted Acker AD-II drill rig. Boreholes were drilled with 6-inch hollow stem auger and 4-inch solid stem auger. Downhole equipment was cleaned with tap water between holes to minimize the possibility of cross contamination. The depth to the water table or the water bearing strata determined the depth of the holes. Appendix B contains the boring logs for the wells drilled. One well was constructed using a surface casing to seal off the upper saturated zone and screened in the bedrock. The surface deposits were drilled using 6-inch auger. Then a plug of concrete was poured into the hole, and a steel casing set. After the cement had set, drilling resumed. The hole plug and bedrock were drilled with NW drill steel driving a 3 1/4-inch tri-roller cone bit. Compressed air lifted the cuttings to the surface. The final construction of this well is shown in Figure 9.

PT 21?

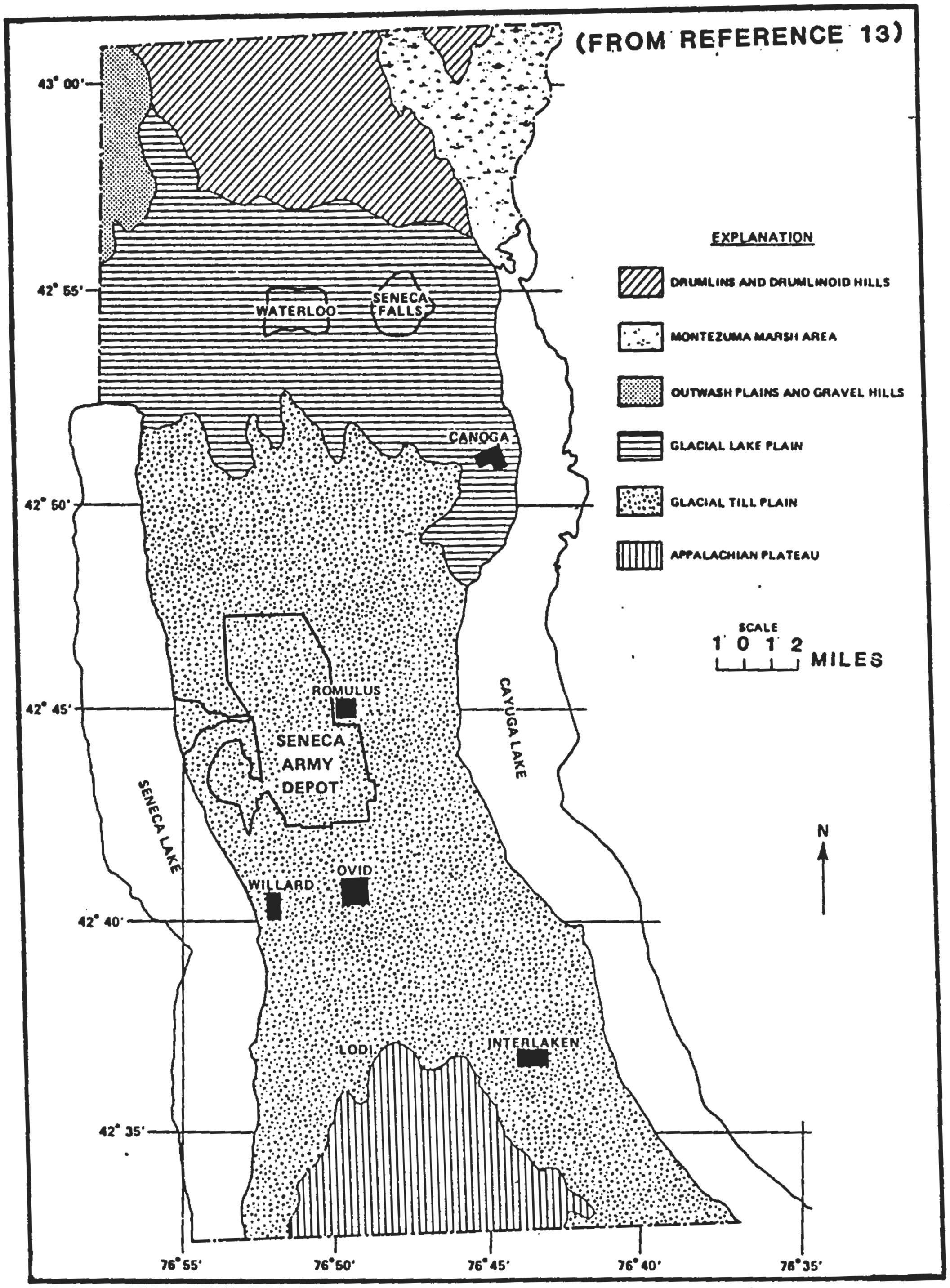

FIGURE 3 Physiographic Map of Seneca County, New York

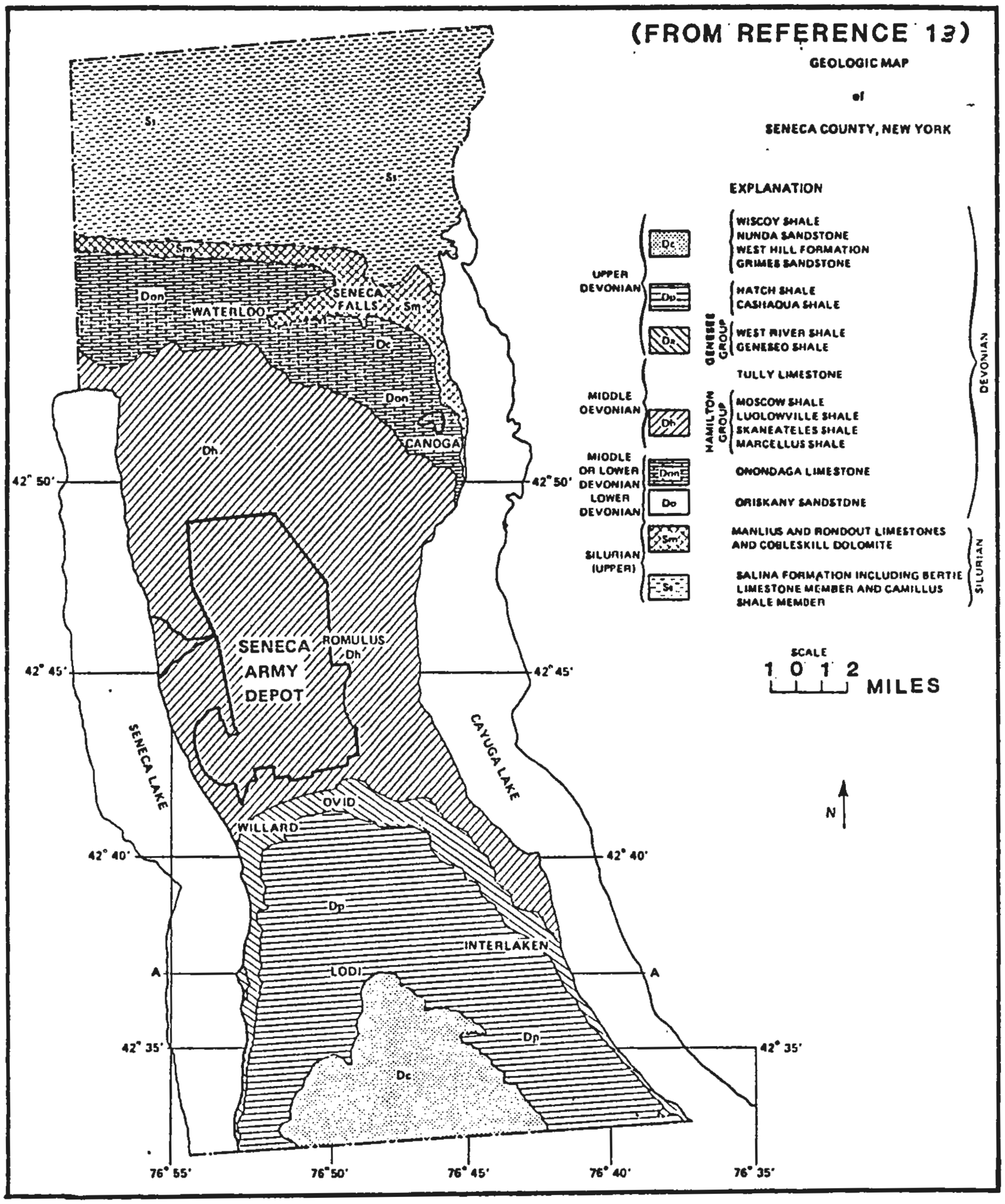

FIGURE 4 Geologic Map of Seneca County, New York

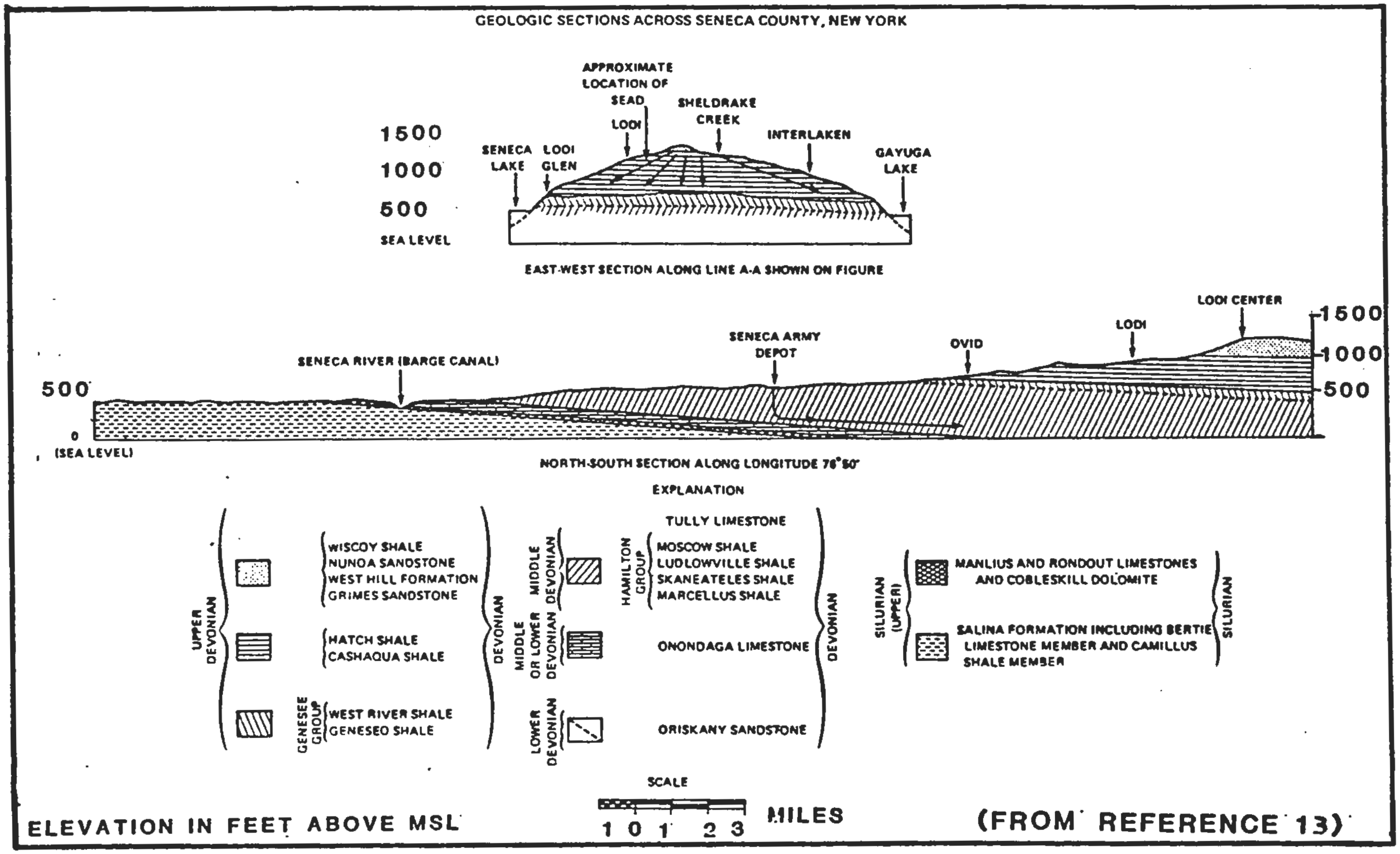

FIGURE 5 Geologic Cross Sections of Seneca County, New York

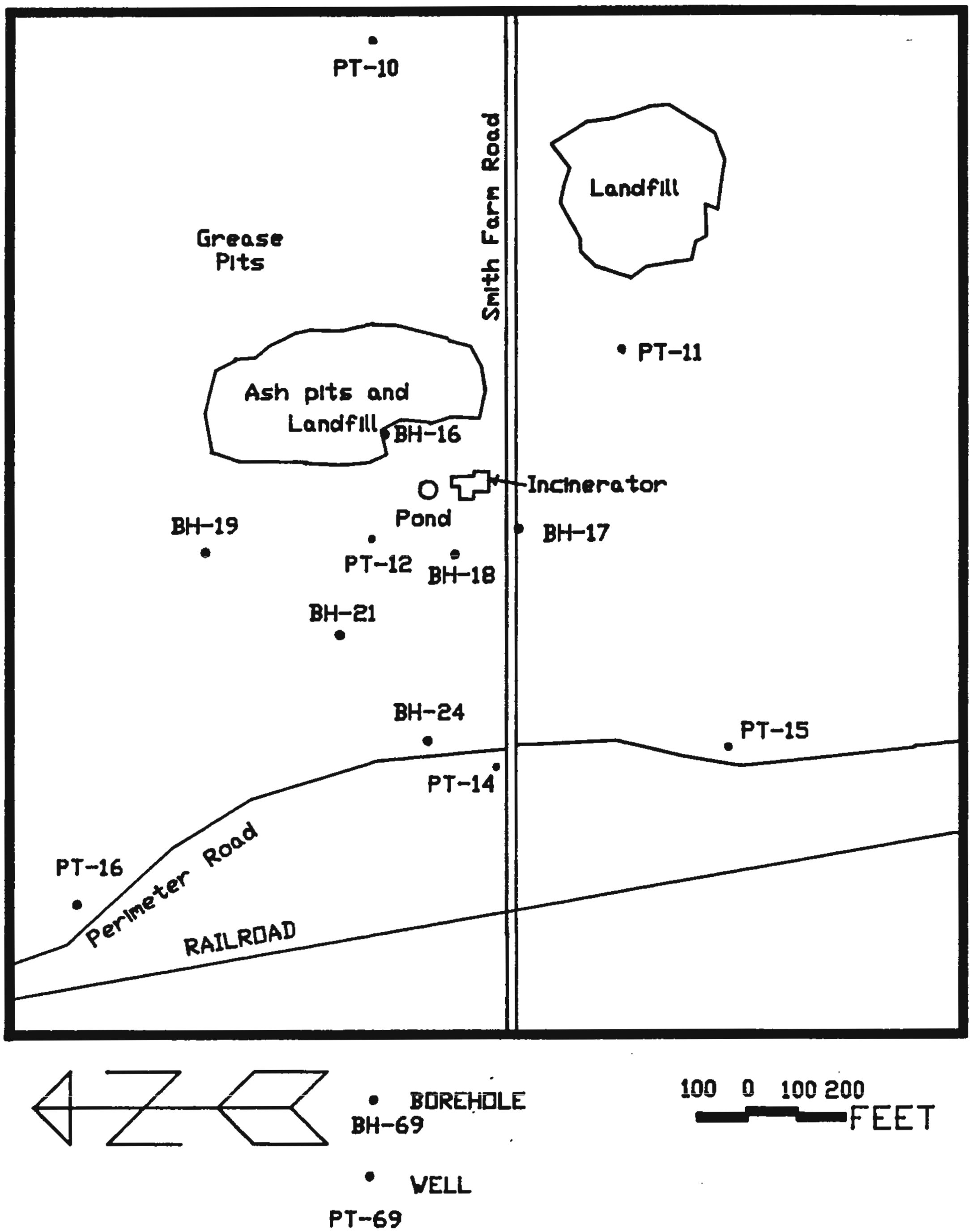

FIGURE 6. MAP SHOWING THE INITIAL SAMPLING POINTS.

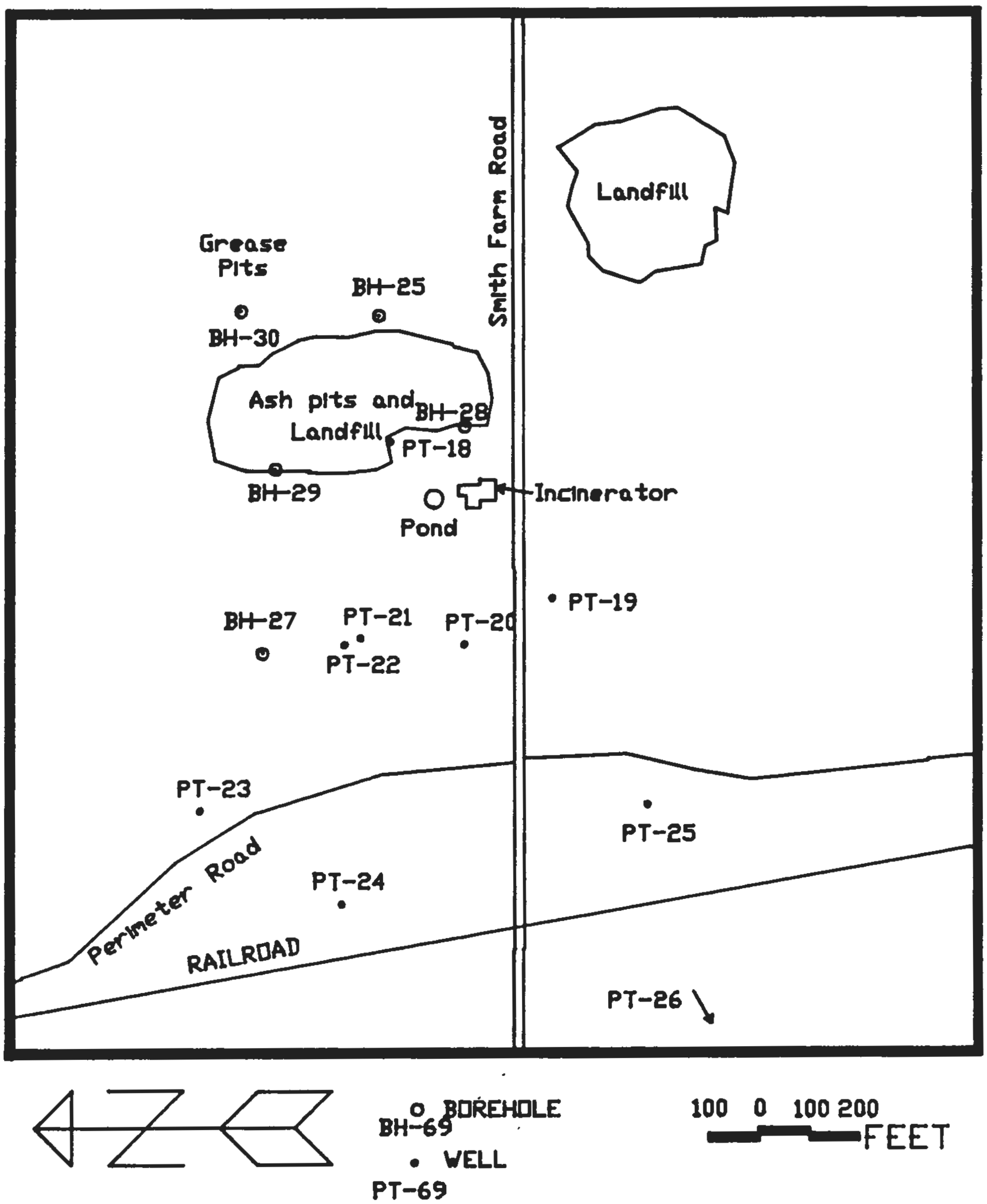

FIGURE 7. MAP SHOWING THE ADDITIONAL GROUND WATER SAMPLING POINTS.

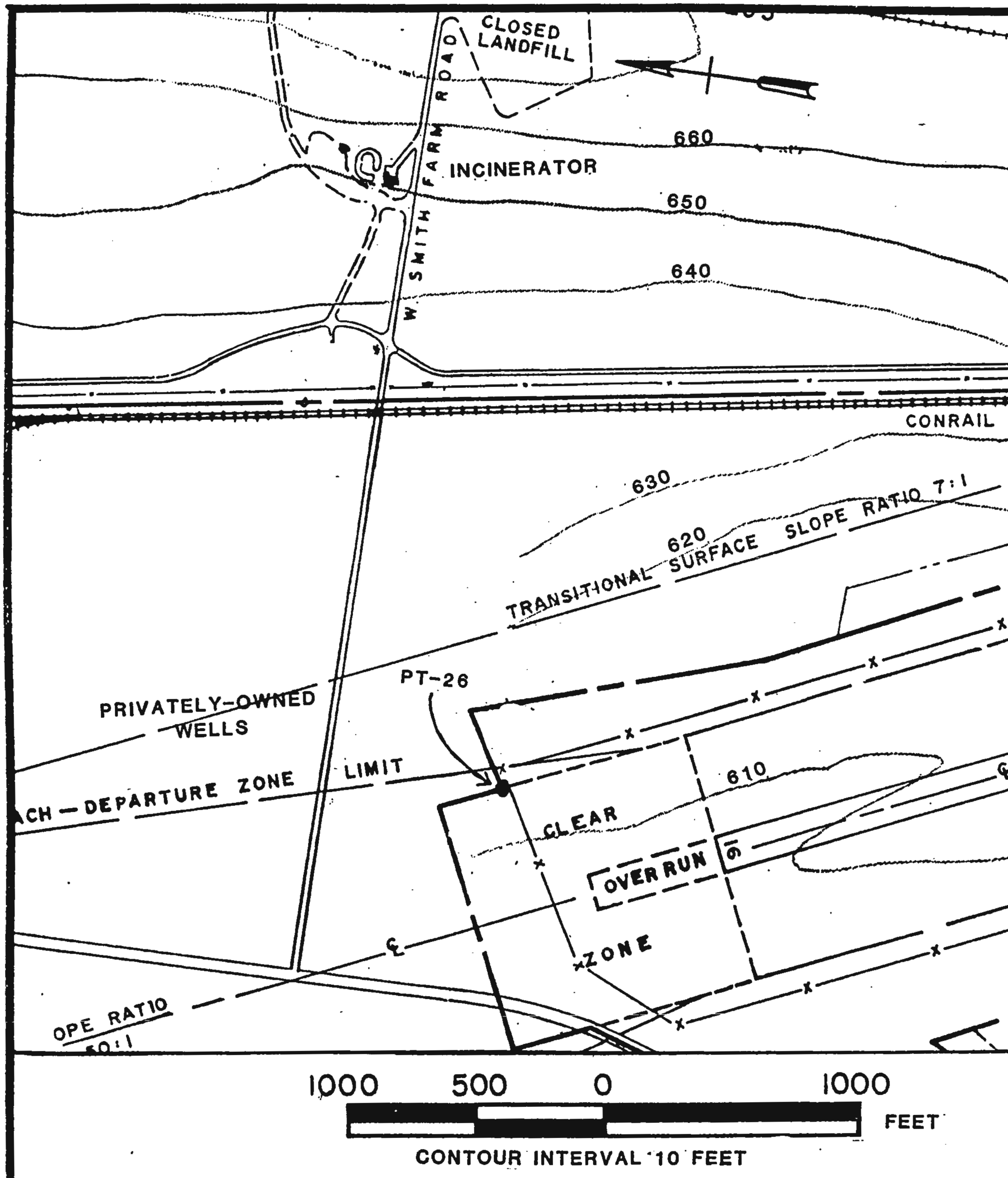

FIGURE 8 MAP SHOWING THE LOCATIONS OF THE WELL INSTALLED AT THE AIRPORT AND THE PRIVATELY-OWNED WELLS, OFF POST.

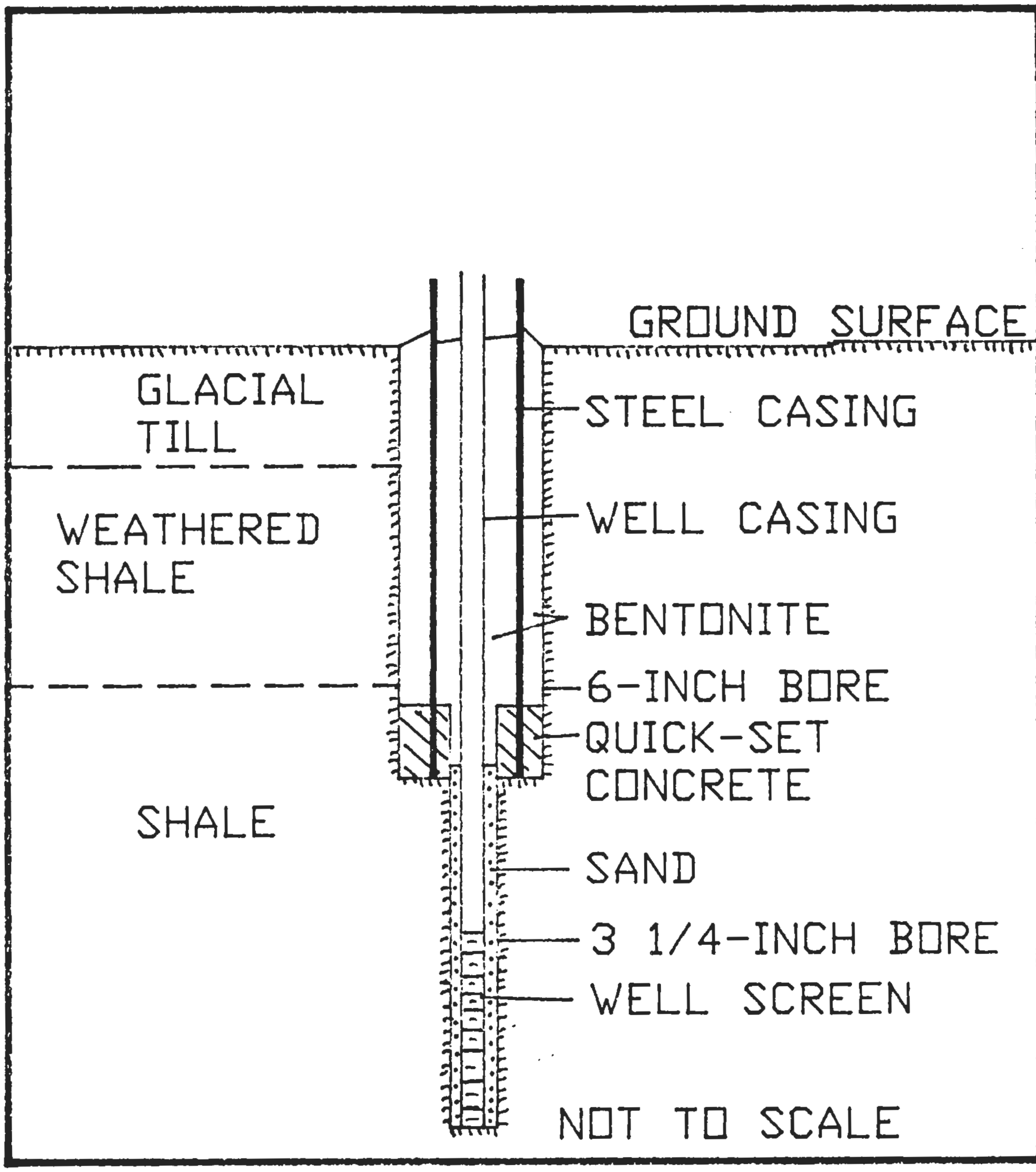

FIGURE 9. CONSTRUCTION DIAGRAM FOR THE DEEP WELL.

(3) General Monitoring Well Construction. Figure 10 shows general monitoring well construction. Monitoring wells were constructed in the boreholes using 2-inch ID Schedule 40 PVC pipe, in 10-foot sections, with flush-threaded, screw-type joints. The bottom 5-foot sections are 0.010-inch, factory-installed slotted screen. The filter pack around the well screen is clean, medium-grained sand, filled to a level, usually 1 foot, above the screen. The annular space above the sand is sealed with bentonite clay. A steel casing with a locking cap anchored in the bentonite protects the well. Concrete is not used in surface grouting because of the problem of frost heave. The problems this causes was evident on SEAD's existing wells. They generally had raised casings and broken concrete grouts which may have affected the integrity of the well casings. The study team attempted to repair the wells as much as possible. Appendix C contains the well construction data. Boreholes which were not completed as wells were backfilled with cuttings and dry cement as a seal.

(4) Bailing Sands and Silts. All wells were developed by bailing the sands and silts out of the casing until some degree of clarity was achieved. As a minimum, 10 well volumes of water were removed [see paragraph (6) below]. Teflon® bailers were used exclusively.

(5) Water Level Measurements. Immediately after drilling, the project officer measured the water level in the well. In addition, water levels were measured after allowing sufficient time for the water to rise to its static level. The measuring instrument was an electric water level indicator.

(6) Purging the Wells. Immediately prior to sampling, each of the wells was purged to assure that the samples were representative of the aquifer water. Generally, the volume purged was equal to 5 well volumes. The formula:

$$L \times 0.162 = n$$

where:
L = depth of water in the well (in feet)
n = number of gallons equal to one well volume

determines the volume of water standing in each 2-inch-diameter well. In most cases, the developing of the well was also considered the purging of the well.

® Teflon is a registered trademark of E.I. DuPont de Nemours and Company, Inc., Wilmington, Delaware. Use of trademarked names does not imply endorsement by the U.S. Army but is intended only to assist in identification of a specific product.

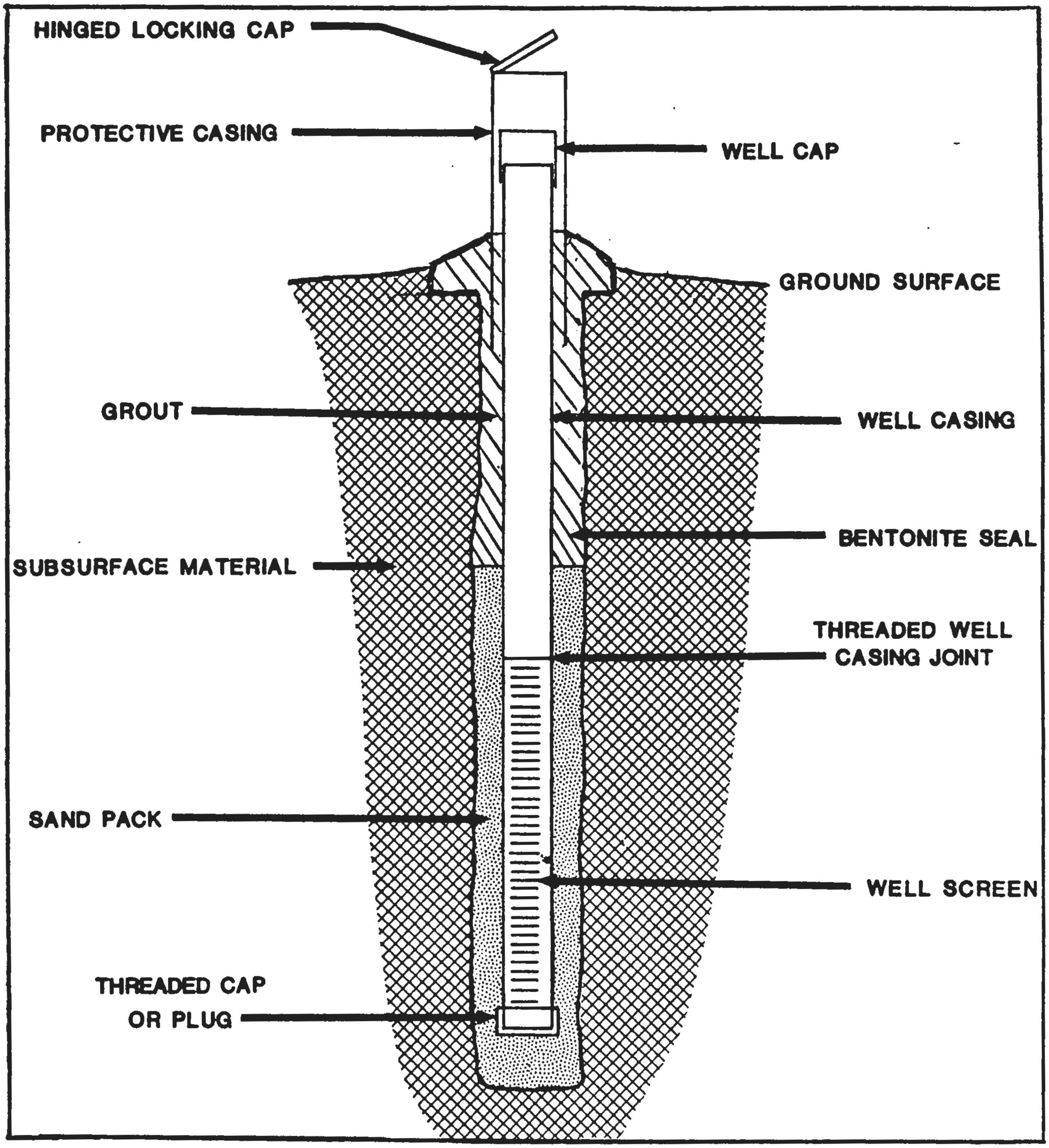

FIGURE 10
Generalized Monitoring Well Construction

(7) Sampling. All sample bottles were filled at the well, disturbing the sample as little as possible. All downhole equipment was thoroughly cleaned between wells using a triple rinse of distilled water. After sampling one well which contained obvious hydrocarbons, the bailer was carefully cleaned in the sewage treatment lab using a citrus-based degreaser and a tap water wash in addition to the distilled water rinses.

(8) Samples were stored at 4 °C at the wastewater treatment plant lab until sampling was complete. The samples were brought to USAEHA labs by the project officer. They were shipped in coolers with freezer packs.

b. Site Description. The site is a level field that gently slopes to the west. The site is grass covered, with a number of small drainage ditches running east-west across it. North of the site is a swampy area. The site contains a number of possible sources which are listed in Table 1. The most probable source is the burning pits, which later were used as part of the north landfill.

TABLE 1. POSSIBLE SOURCES OF CONTAMINATION IN THE STUDY AREA

SWMU Number (reference 16)	Description	Comments
SEAD-3	Incinerator cooling water pond	1974-79
SEAD-6	Landfill north	1941-60's and 74-79
SEAD-8	Landfill south	1974-79
SEAD-14	Burning pits	Oils and solvent sludges; 1941-74; 2 pits, 40x80 ft burned at least once per week
SEAD-15	Incinerator	1974-79
none	Grease pits	Unlined pits used for the disposal of kitchen grease

c. Results of Chemical Analyses.

(1) Initial Samples. On the first 2 days of the onsite work, the study team collected samples from the newly constructed well replacing well 13, and from a number of open boreholes. These samples were shipped back to the USAEHA lab for quick turn around. Table 2 contains the results of these samples. The regular monitoring wells had also been recently sampled. Table 3 contains the results from that work. These data were used to locate fully developed monitoring wells.

September is typically a time of low ground-water levels. Conversely, March is typically a time of high ground-water levels. These data show that the spring melt and rains may release more contamination from the source. Therefore, some of the results from this study may represent a seasonally low value.

TABLE 2. RESULTS OF FIRST SAMPLING (ALL VALUES IN PPB) 14-15 OCTOBER 1987

NUMBER	TCE	TRANS-1,2-DCE	OTHERS	
Well 13	BDL	BDL	BDL	
BH 16	1225	238	Vinyl chloride	7
			Methylene chloride	32
			Chloroform	390
BH 17	13	BDL	BDL	
BH 18	6	37	BDL	
BH 19	BDL (4)	BDL (3)	BDL	
BH 21	30	176	BDL	
BH 24	7	88	BDL	
Blank	BDL	BDL	BDL	

TABLE 3. MOST RECENT RESULTS FROM THE GROUND-WATER MONITORING PROGRAM

	September 1987		March 1987
PT-10		all BDL	all BDL
PT-11		all BDL	all BDL
PT-12	95	trans-1,2-dichloroethene	570
	94	Trichloroethene	540
	BDL	Vinyl chloride	11
PT-14	172	trans-1,2-dichloroethene	100
	192	Trichloroethene	160
	79	Vinyl chloride	BDL
PT-15	all BDL		all BDL
Blank	all BDL		all BDL

(2) Final Samples.

(a) Table 4 contains the remaining volatile organic analysis results. Well PT-18 has a high level of TCE, as well as DCE and chloroform. Borehole 29 (north of Well PT-18) has a high level of DCE, as well as TCE and vinyl chloride, and a floating product that appeared to be diesel fuel. Other wells contained TCE and/or DCE. The resampling of Well PT-18, along with the field blanks, indicate these results are acceptable.

(b) Sampling to date has been TOX, followed by volatile organics. Well PT-18 was also sampled for ABN extractable organic compounds, pesticides and PCBs, since these compounds would register in the TOX results. Wells PT-20, PT-22, and PT-24 were also sampled for ABN's. All these parameters were below detection limits in all these wells (see Appendix E for detection limits).

d. Discussion of results.

(1) Hydrogeology.

(a) Most of the area is covered by 1 to 5 feet of compact brown silty-sandy-gravelly till. This is a glacially-derived, unsorted, nonstratified deposit, typically with a very low permeability. Below the till is weathered and fractured shale, usually about 5-feet thick. The shale becomes increasingly harder and less fractured and weathered with depth. The shale is generally massive, displaying very few if any bedding features. The shale contains a small amount of naturally occurring oil. The ground water appears to be in the fractured and weathered shale, confined to semiconfined beneath the till. The saturated thickness is, therefore, effectively only 1 to 5 feet. Figure 11 is a cross section of a typical portion of the site. The shale below 10 feet is essentially dry, although some ground water undoubtedly flows through fractures. The amount of deep leakage through fractures from this site is unknown, but should be inconsequential, considering the thickness of the shale.

(b) At one location, two borings were drilled, one to 6 feet and the other to 10 feet. The top of the weathered shale was at a depth of 5 feet at this location. The water rose to the same level in both, approximately 4.5 feet, indicating the aquifer zone is at or above 5 feet.

(c) The hydraulic conductivity of the glacial till is less than 0.1 ft/day, based on laboratory measurements taken from a Shelby tube sample (see Appendix D). Roots and fractures would tend to increase this value, which is typical for a glacial till (reference 14). The hydraulic conductivity of the fractured shale is unknown. However, based on the project officer's experience in bailing the wells, the hydraulic conductivity must be quite high. This is due entirely to the secondary permeability created by the fractures. In one well, with at most a 5-foot saturated zone and only 6 feet of water in a 2-inch casing, there was no detectable drop in water level during rapid bailing.

TABLE 4. VOLATILE ORGANIC ANALYSIS RESULTS

Wells	Trans-1,2-dichloroethene	Trichloroethene	Chloroform	Vinyl chloride	1,2-dichloroethane
PT-10	BDL	BDL	BDL	BDL	BDL
PT-11	BDL	BDL	BDL	BDL	BDL
PT-12	95	94	BDL	BDL	BDL
PT-15	BDL	BDL	BDL	BDL	BDL
PT-16	BDL	BDL	BDL	BDL	BDL
PT-17	172	192	BDL	BDL	BDL
PT-18	160	8800	390	BDL	BDL
PT-19	BDL	BDL	BDL	BDL	BDL
PT-20	39	14	BDL	BDL	BDL
PT-21	6	BDL	BDL	BDL	BDL
PT-22	220	110	BDL	BDL	9
PT-23	BDL	BDL	BDL	BDL	BDL
PT-24	66	BDL	BDL	BDL	BDL
PT-25	BDL	BDL	BDL	BDL	BDL
PT-26	BDL	BDL	BDL	BDL	BDL
Boreholes					
BH-16	Replaced by Well PT-18				
BH-17	13	BDL	BDL	BDL	BDL
BH-18	6	37	BDL	BDL	BDL
BH-19	3	4	BDL	BDL	BDL
BH-23	BDL	BDL	BDL	BDL	BDL
BH-24	7	88	BDL	BDL	BDL
BH-25	BDL	BDL	BDL	BDL	BDL
BH-26	Replaced by Well PT-20				
BH-27	76	51	BDL	BDL	BDL
BH-28	BDL	BDL	BDL	BDL	BDL
BH-29	8600	660	BDL	1700	BDL
BH-30	BDL	BDL	BDL	BDL	BDL
Surface Water					
31	4	23	BDL	BDL	BDL
32	110	50	BDL	BDL	BDL
33	BDL	BDL	BDL	BDL	BDL

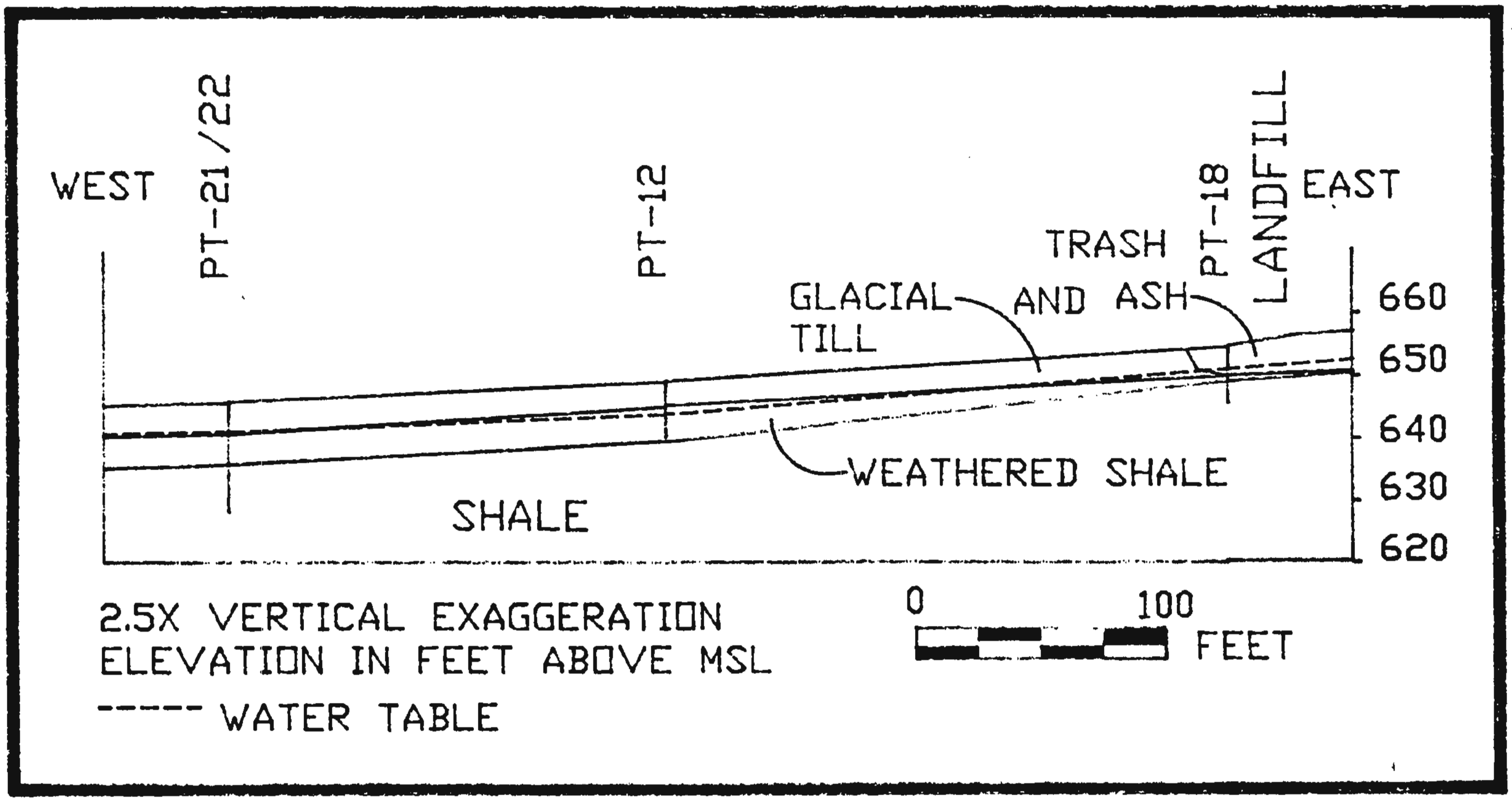

FIGURE 11. CROSS SECTION OF THE STUDY AREA.

(d) Figure 12 is a ground-water surface map of the site. The ground water flows evenly across the site toward the west-southwest. North of the landfill is a swampy area. This area does not appear to affect the flow of the ground water. Surface water in the study area is probably due to the discharge of contaminated ground water.

(e) Based on 5 years of records, it appears that late winter to early summer is the time of highest ground-water levels. Ground-water levels appear to be lowest in late summer to early winter.

(2) Extent of the Contaminant Plume.

(a) Figure 13 is a map showing the concentrations of TCE in the wells and boreholes. Figure 14 shows the concentrations of total DCE in the wells. Figure 15 shows the total affected area. Based on these results, and the distribution of the chemicals, it appears there may be two different source areas. One, in the vicinity of Well PT-18, is a source of TCE and chloroform. The other, in the vicinity of borehole 29 (north of Well PT-18), is a source of DCE and vinyl chloride, and a floating product that appeared to be diesel fuel. It should also be noted that many of these compounds have a parent/daughter product relationship by biodegradation, as shown in Table 5.

(b) The vinyl chloride detected in borehole 29 and the chloroform found in Well PT-18 have not migrated. The plume appears to be moving west-southwest, crossing Smith Farm Road at the intersection of the perimeter security road.

TABLE 5. RELATIONSHIP OF THE COMPOUNDS DUE TO BIODEGRADATION (from reference 10)

Carbon tetrachloride → chloroform → methylene chloride

Tetrachloroethylene → trichloroethylene → { *cis* 1,2-dichloroethene / *trans* 1,2-dichloroethene / 1,1-dichloroethene } → vinyl chloride

1,1,1-trichloroethane → 1,1-dichloroethane → chloroethane

(c) Figure 16 is a map showing the results of the surface water sampling. These results show that the contamination may extend to surface water, and has moved offpost. These results should be confirmed. At the time of the study, the surface water was generally small intermittent streams, which were the result of ground-water discharge. The offpost surface water contamination is probably due to ground water seeping to the surface and not direct surface water flow. The middle surface water sample had all parameters below detection limits. This is despite being downstream of contaminated surface water, and in an area where the ground water is contaminated. This may be an indication that the surface water will degas.

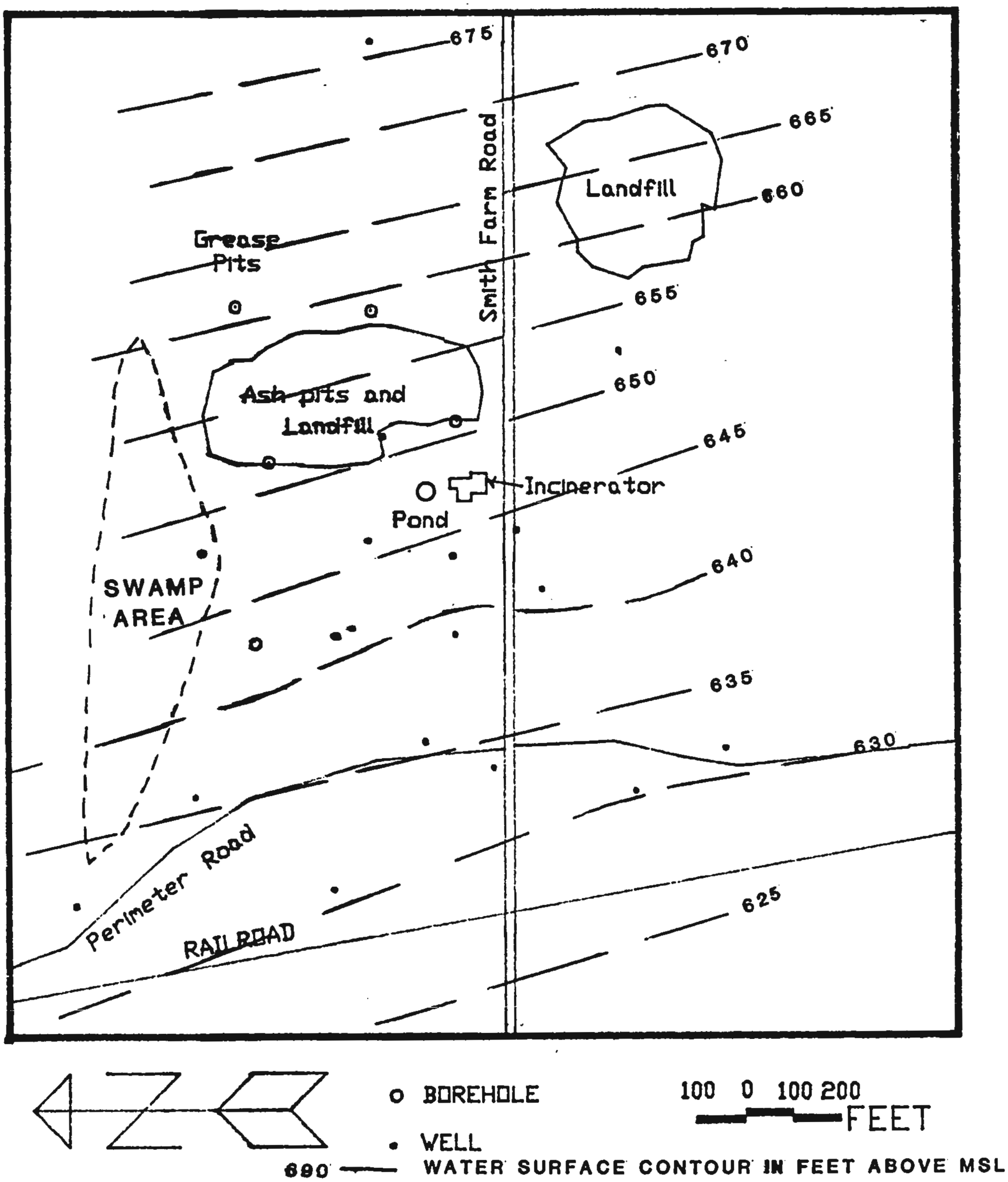

FIGURE 12. MAP OF THE GROUND-WATER SURFACE.

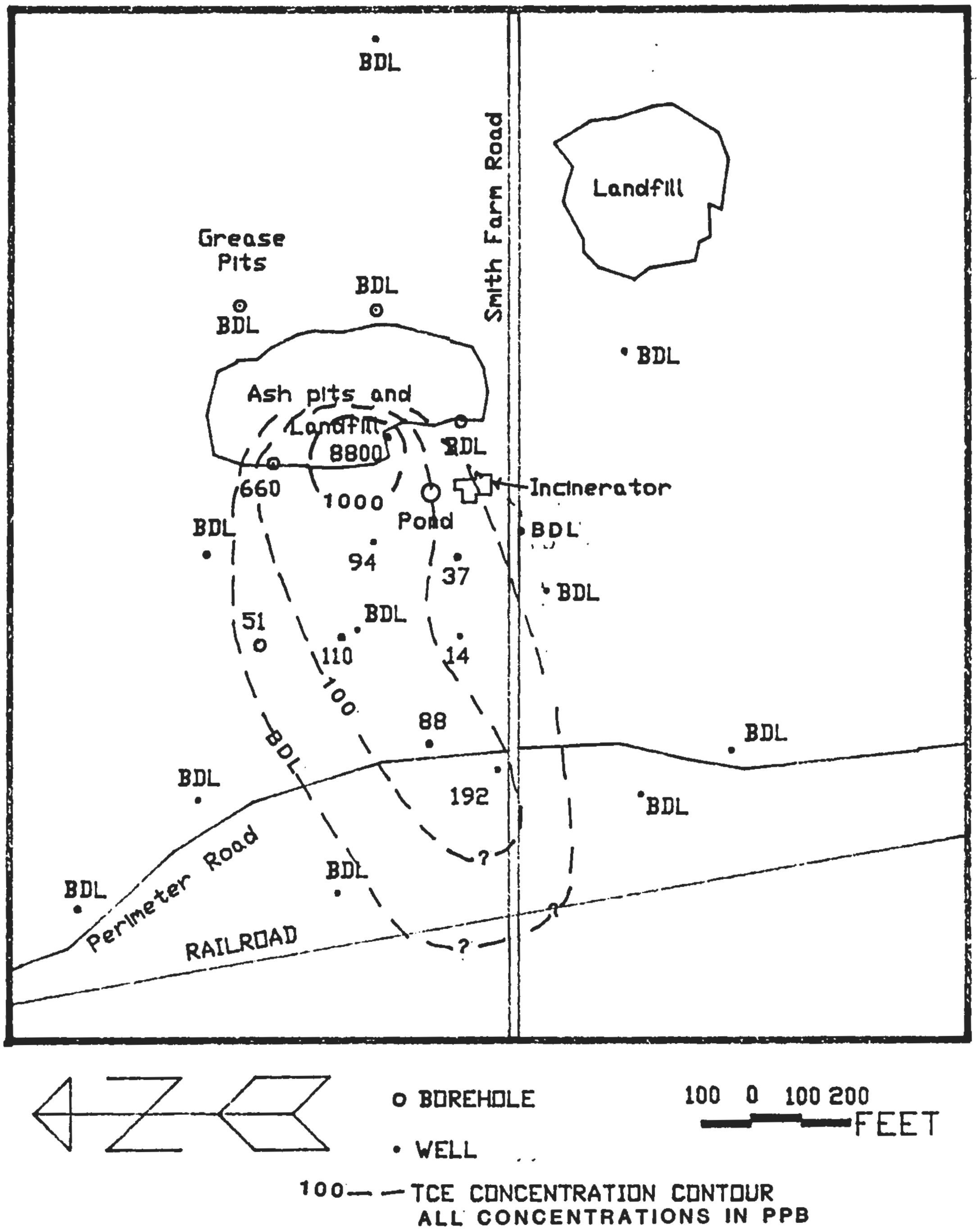

FIGURE 13. MAP SHOWING THE CONCENTRATION OF TCE DETECTED IN THE SAMPLES.

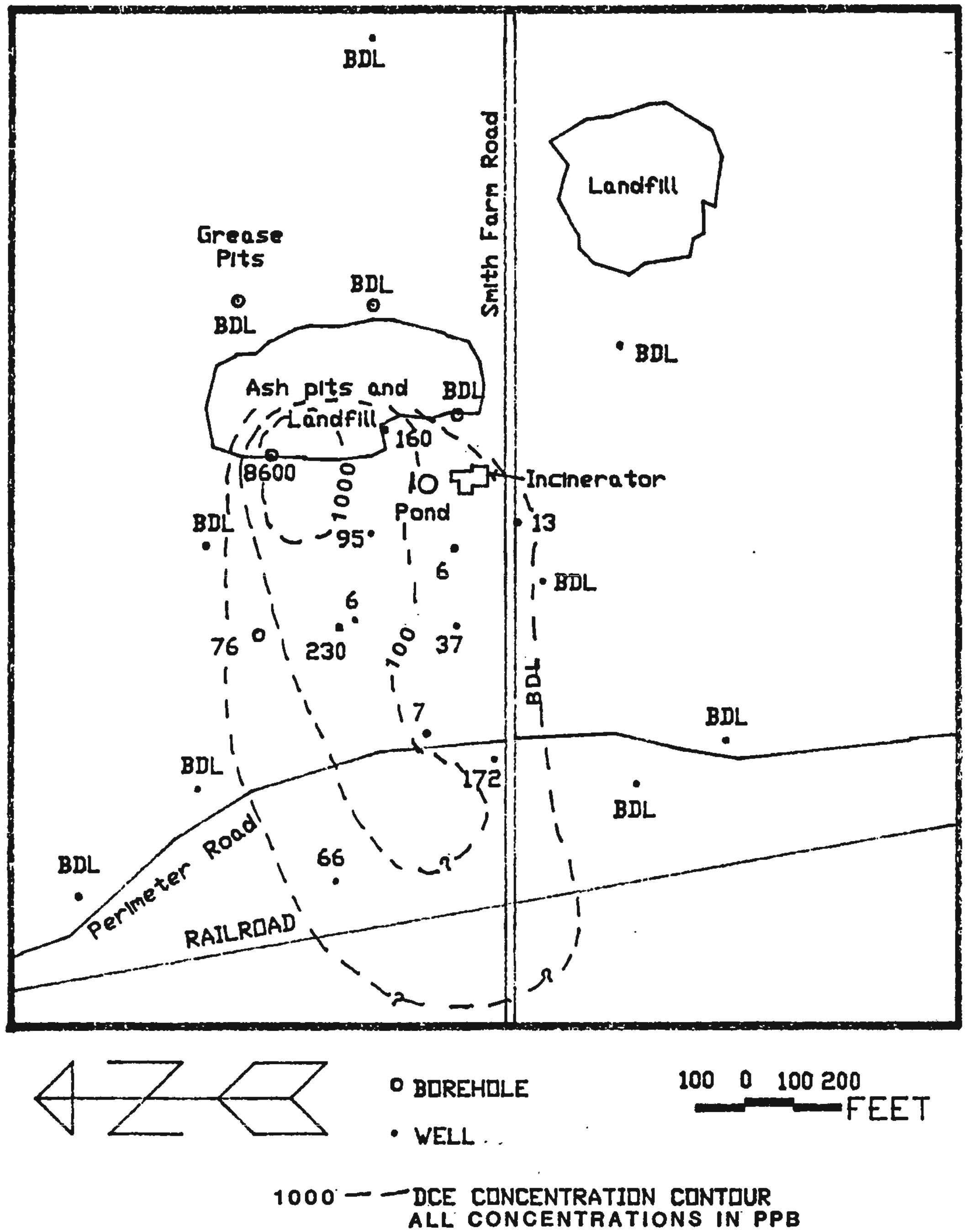

FIGURE 14. MAP SHOWING THE CONCENTRATIONS OF DCE DETECTED IN THE SAMPLES.

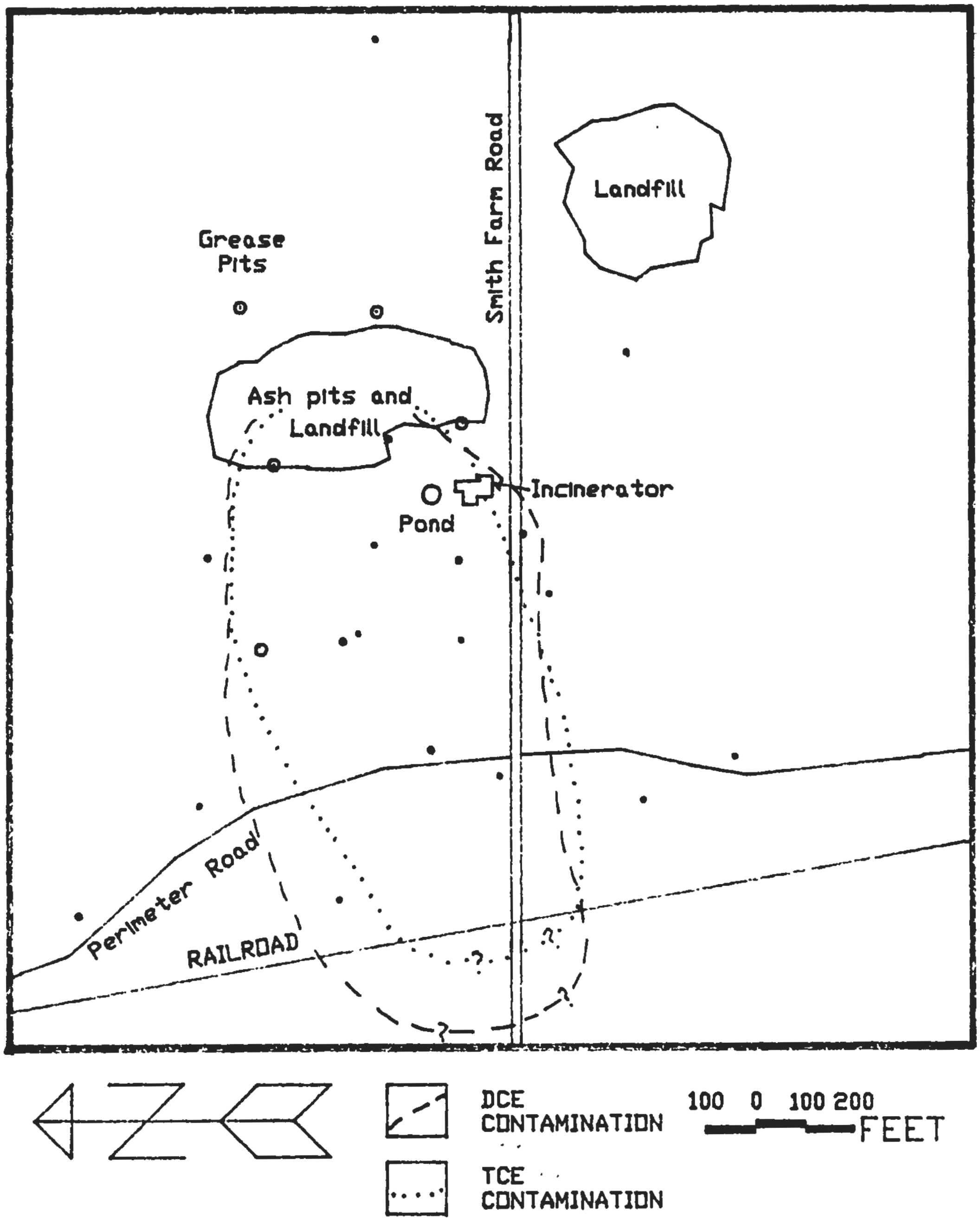

FIGURE 15. MAP SHOWING THE TOTAL AREA OF AFFECTED GROUND WATER.

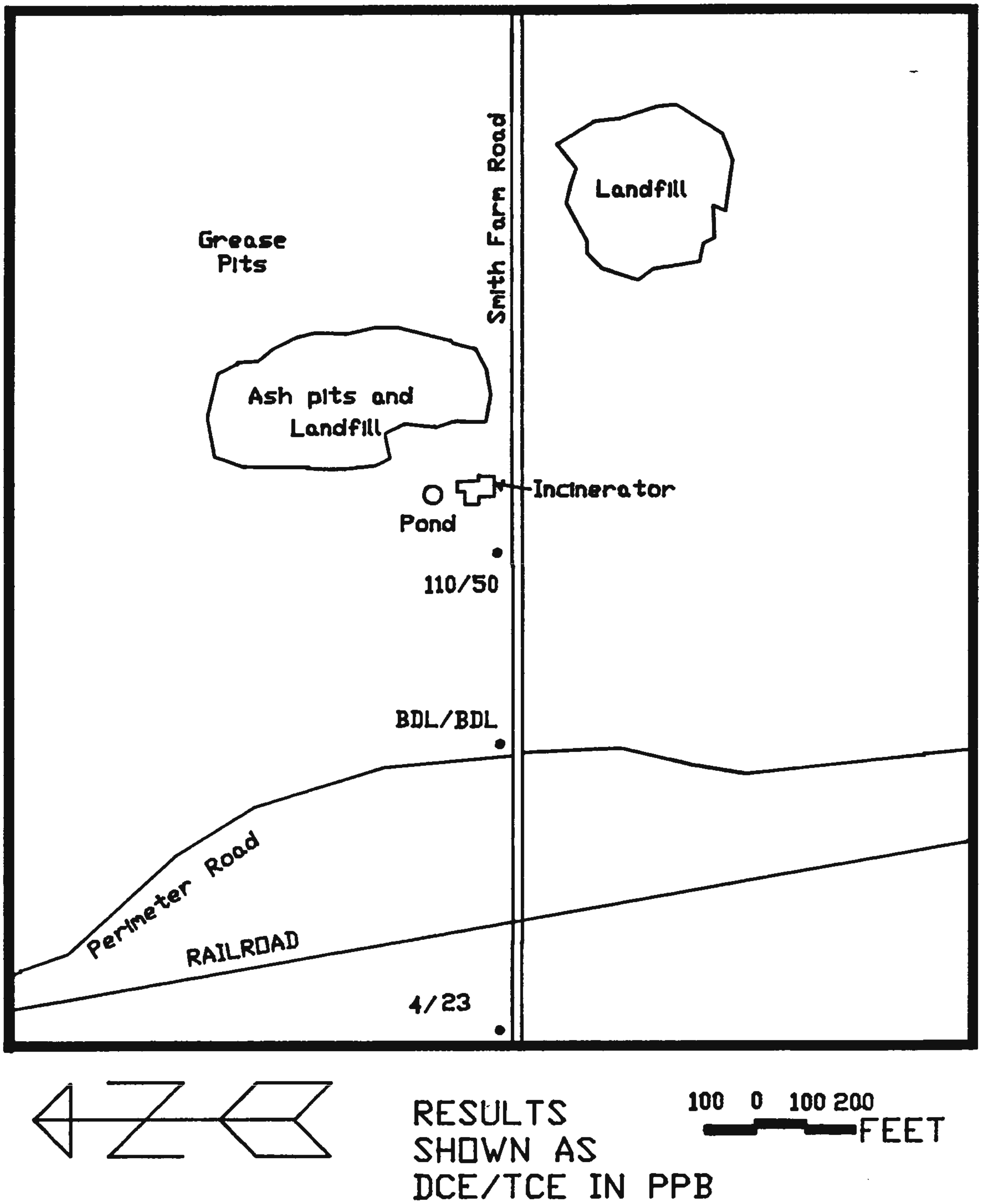

FIGURE 16 MAP SHOWING THE SURFACE WATER SAMPLING RESULTS.

No contamination has been detected in the private wells offpost. These wells are approximately 1/2 mile from the post boundary. Well PT-26 was installed in the northeast corner of the airstrip. This well is also approximately 1/2 mile from the site. No contamination was detected in this well. This indicates that the plume has not extended this far. No wells could be placed offpost during this study. However, based on the results from the wells onpost near the boundary, as well as the surface water sampling, the contamination has probably migrated offpost at levels exceeding drinking water standards.

(3) Appendix F contains information on the volatile organic chemicals detected at this site.

(4) Table 6 lists the MCL's and RMCL's for the compounds detected. These values are based on potential carcinogenic effects of these chemicals.

TABLE 6. MCL's AND RMCL's FOR THE COMPOUNDS DETECTED (ALL VALUES IN PPB) (FROM REFERENCE 1)

	RMCL	MCL
Trichloroethene	0	5
trans-1,2-dichloroethene	70 (proposed)	--
Chloroform	--	100
Vinyl chloride		1
1,2-dichloroethane	0	5 (proposed)

e. Possible responses.

(1) Corrective action alternatives.

(a) Do nothing. This is probably an unacceptable option.

(b) Withdrawal Wells and Water Treatment. The thickness (approximately 2 feet) of the semiconfined aquifer may make this approach impractical.

(c) Recovery trenches with water treatment. Because the aquifer is so shallow and so thin, an alternative method to recover the ground water for treatment would be a series of dewatering trenches used in conjunction with wells or sumps. These could be constructed quickly and inexpensively by SEAD.

(d) Removal of the Source. If the source is a leaking container, it may be found by electromagnetic survey and removed. However, if the source is disseminated throughout the soil, it may be more difficult to recover. Even so, recovery may still be possible because of the geology of the site. Below 10 feet, the bedrock is relatively impermeable, so there is a shallow limit of vertical migration. Removal of soils would probably generate a large quantity of hazardous waste.

(e) Enhanced biodegradation of the contamination is another possibility. This process is made more promising, again, by the hydrogeology.

(f) Cut-off walls and capping the source area will lessen, and maybe stop the migration from the source. However, this does not eliminate the source, and requires maintenance in perpetuity.

(2) Further study of the plume could include wells offpost, and further surface water sampling. Figure 17 is a map showing the recommended approximate locations of future wells. The extent of plume migration offpost may also be somewhat determined by sampling surface water.

(3) The SEAD should ensure contaminated surface water does not flow offpost. However, this will not prevent offpost surface water contamination, since much of that water comes directly from ground-water seeps.

5. SUMMARY AND CONCLUSIONS.

a. General. The study team completed a number of borings and installed nine new monitoring wells across the site, from which samples were drawn. The site contains a number of possible sources, the most probable being the burning pits, which later were used as part of the north landfill.

b. Hydrogeology.

(1) Most of the area is covered by 1 to 5 feet of compact brown silty-sandy-gravely till. This is a glacially-derived unsorted, nonstratified deposit, typically with a very low permeability. Below the till is weathered and fractured shale, usually about 5 feet thick. The shale becomes increasingly harder and less fractured and weathered with depth. The ground water appears to be in the fractured and weathered shale, confined to semiconfined beneath the till. The shale beneath is essentially dry, although some ground water undoubtedly flows through some deep fractures. The amount of leakage from this site is unknown but should be inconsequential, considering the thickness of the shale. The ground water flows evenly across the site toward the west-southwest.

(2) The hydraulic conductivity of the fractured shale is much higher than either the overlying glacial till or the underlying unweathered shale. Late winter to early summer is the time of highest ground-water levels. Ground-water levels appear to be lowest in late summer to early winter.

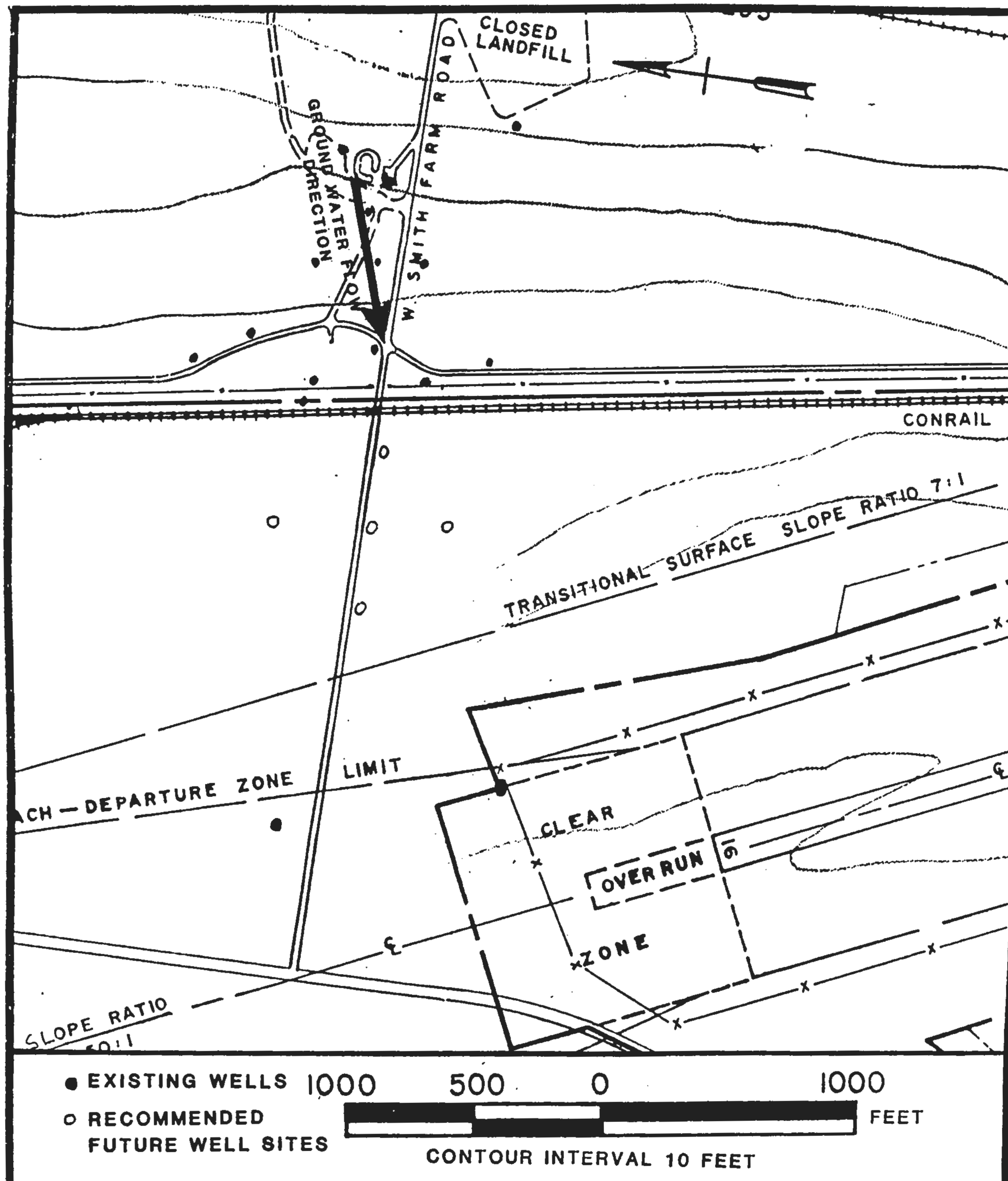

FIGURE 17. MAP SHOWING THE RECOMMENDED LOCATIONS FOR FUTURE WELLS.

c. Ground-Water Contamination.

(1) The contamination forms a definite plume, with two main constituents, trichloroethene and trans-1,2-dichloroethene. Chloroform, 1,2-dichloroethane, vinyl chloride, and a floating product that appeared to be diesel fuel were also detected.

(2) No ground-water contamination has been detected offpost, either in the private wells, or in Well PT-26, installed in the northeast corner of the airstrip. However, based on the results from the wells onpost near the boundary, the contamination has probably migrated offpost at levels exceeding drinking water standards.

(3) The vinyl chloride detected in borehole 29 and the chloroform found in Well PT-18 have not migrated. The plume of trichloroethene and trans-1,2-dichloroethene appears to be moving west-southwest, crossing Smith Farm Road at the intersection of the perimeter security road.

(4) Surface water sampling results show that the contamination may extend to surface water, and has moved offpost. These results should be confirmed. The offpost surface water contamination is probably due to contaminated ground water seeping to the surface and not direct surface water flow. One sample collected onpost indicates that the surface water may degas the solvents.

d. Corrective Measures.

(1) A number of remedial methods have been developed to deal with this type of problem. In this instance, the best method of ground-water recovery would probably be a system with intercept trenches.

(2) Federal regulations (reference 3) require that Seneca AD, as a facility applying for RCRA hazardous waste storage and treatment permit, must institute corrective action at this site.

(3) Although the contamination has extended off the installation, the source and most of the contamination is still on post. The offpost extent of the contamination must be determined, and may require corrective action, as directed by Federal regulation (reference 21). However, that work should not hinder corrective measures directed toward the onpost contamination. The onpost work should be relatively easy to implement, and will quickly reduce the total contamination and the offpost migration. It may be done as interim corrective measures in accordance with USEPA draft strategy for SWMU work (reference 22).

(4) Army regulation (reference 23) requires that any offpost construction required for contamination abatement, including monitoring wells, must be approved by: HQDA(DAEN-MPO-U), Washington, DC 20314.

6. RECOMMENDATIONS.

a. We base the following recommendations on good environmental engineering practice.

(1) Keep the sites around the wells mowed.

(2) Collect contaminated surface water before it flows offpost.

(3) Investigate appropriate technologies for the collection and treatment of the contaminated ground water.

(4) Excavate and clean contamination source areas, and properly dispose of contaminated materials (see paragraph 6b).

b. Based on 40 CFR 264.101 the following recommendations are made:

(1) Negotiate corrective actions with the proper regulatory agencies.

(2) Investigate the extent of the plume offpost, upon approval of HQDA.

7. TECHNICAL ASSISTANCE. Direct requests for services through appropriate command channels of the requesting activity. Send them to the Commander, U.S. Army Environmental Hygiene Agency, ATTN: HSHB-ME-SG, Aberdeen Proving Ground, MD 21010-5422, with an information copy furnished to the Commander, U.S. Army Health Services Command, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000.

8. REFERENCES. See Appendix G for the list of references.

WILLIAM J. BANGSUND
Environmental Engineer
Waste Disposal Engineering Division

APPROVED:

JOHN W. BAUER
Program Manager
Ground Water and Solid Waste

APPENDIX A

ABBREVIATIONS AND DEFINITIONS

ABN	Acid-Base-Neutrals
alluvium	All deposits of gravel, sand, silt and clay resulting from the actions of modern rivers and streams
AMC	U.S. Army Materiel Command
aquifer	Any formation, portion of a formation, or group of formations capable of yielding a usable quantity of water at atmospheric pressure
BDL	Below detectable limit
DCE	Trans-1,2-dichloroethene, or trans-1,2-Dichloroethylene
DEH	Directorate of Engineering and Housing
DESCOM	U.S. Army Depot System Command
ground water	Water occurring below the earth's surface in pore spaces and fractures
hydraulic conductivity	The measure of how well water may move through an aquifer; comparable to permeability
MCL	Maximum contaminant level
mg/L	Milligrams per liter, roughly equivalent to ppm
MSL	Mean sea level
PCB	Polychlorinated biphenyl
Pleistocene	A geologic time period, the earlier of two epochs in the Quaternary period, beginning approximately 1 million years before present and ending approximately 15,000 years before present
ppb	Parts per billion, roughly equivalent to μg/L
ppm	Parts per million, roughly equivalent to mg/L
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act

RMCL	Recommended Maximum Contaminant Level
SEAD	Seneca Army Depot
SWMU	Solid waste management unit, pronounced shmoo
TCE	Trichloroethylene, trichloroethene
TOX	Total Organic Halides
µg/L	Micrograms per liter, roughly equivalent to ppb
USAEHA	U.S. Army Environmental Hygiene Agency
water table	The surface defined by the level to which ground water from an unconfined aquifer will rise to in a well

APPENDIX B

DRILLING LOGS

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 Seneca AD DATE 18 Oct 87

LOCATION South of Smith Farm Road DRILLERS William P. Smithson

DRILL RIG Acker AD-II BORE HOLE Well PT-19

DEPTH (feet)	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0–5		Moist brown silty-gravely-clay	
5–5.5			
5.5–10		Gray shale, fractured ▽	
		Cuttings very dry	
10–14		Very hard shale Some fracture zones	
14		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 Seneca AD DATE 10 Oct 87

LOCATION West of incinerator DRILLERS William P. Smithson

approximately 200 feet

DRILL RIG Acker AD-II BORE HOLE Well PT-20

DEPTH (feet)	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0 – 2.5		Brown silty-gravely-clay	
2.5 – 10		Weathered shale	
6.67		▽ 3	
10 – 14		Hard shale	
14		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 Seneca AD

DATE 16 Oct 87

LOCATION Between incinerator and perimeter security road

DRILLERS William P. Smithson

DRILL RIG Acker AD-II

BORE HOLE Well PT-22

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
(feet)		Brown silty-pebbly-clay	
3.7			
5		Weathered shale	
10		Hard shale	
12		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 DATE 18 Oct 87

LOCATION Between wells PT-16 and PT-17 DRILLERS William P. Smithson

DRILL RIG Acker AD-II BORE HOLE Well PT-23

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
(feet)		Brown silty, gravely-clay; dry	
4.5		Gray shale dry cuttings	
5.5		Light brown, dry cuttings	Very quiet, easy drilling Slower drilling
8		Hard shale	
10		Dry cuttings	
10.5		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 39-26-0313-88 Seneca AD   DATE 18 Oct 87

LOCATION Corner of fence offset   DRILLERS William P. Smithson

DRILL RIG Acker AD-II   BORE HOLE Well PT-24

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
(feet)		Brown silty gravely clay and ash	
	3		
3	Shelby	Ash, weathered shale	
4.75		▽ 3	
5	Tubes		
5.5		Hard shale	Oil slick on mud
10		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 DATE 18 Oct 87

LOCATION North end of airstrip out side of perimeter fence (NE corner) DRILLERS William P. Smithson

DRILL RIG Acker AD-II BORE HOLE Well PT-26

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
(feet)		Red-brown clay, some sand and silt	
2		Very weathered shale?	
3.5		Gray-brown weathered shale	
5			
5.2		∇ 3	
10		Gray chips at shale	
11		Hard shale	
15		Very hard 17' BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

(The proponent of this form is HSHB-ES)

PROJECT 38-26-0313-88 DATE 17 Oct 87

LOCATION On fenceline, between wells 17 and 15 DRILLERS

DRILL RIG Acker AD-II BORE HOLE Well Pt-25

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
(feet)		Brown silty=pebbly clay film	
2		Weathered gray shale	
5			
5.67		▽	
9		Hard shale	
10			
		Very hard, some fractures	Oil slicks on and coming from hole
14		BOH	

AEHA Form 130, 1 Nov 82

Replaces HSHB Form 78, 1 Jun 80, which will be used.

APPENDIX C

WELL CONSTRUCTION DATA

U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
GROUND-WATER MONITORING WELL SUMMARY

PROJECT 38-26-0313 88 DATE 13-21 Oct 87

WELL NUMBER	MW-18	MW-19	MW-20	MW-22	MW-21
1. Height of Monitoring Well Casing above ground level	30"	30"	30"	30"	30"
2. Total Depth of Well below ground level	9	9	8' 10"	9	17' 5"
3. Depth to Top of Well Screen below ground level	4	4	3' 10"	4	12' 5"
4. Well Screen Length	5	5	5	5	5
5. Well Screen Slot Size	0.010	0.010	0.010	0.010	0.010
6. Well Diameter	2 in ID	2 in ID	2 in ID	2 in ID	2 in ID
7. Monitoring Well Casing Material	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC
8. Monitoring Well Screen Material	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC
9. Grout Thickness below ground level	3' 10"	4	3	3' 11'	10' 6"
10. Depth to Top of Bentonite Seal below ground level	All wells grouted to surface with bentonite				
11. Bentonite Seal Thickness	3' 10"	4	3	3' 11"	10' 6"
12. Depth to Top of Sand Pack	3' 10"	4	3	3' 11"	10' 6"
13. Depth to Static Water Level from top of monitoring well casing	5' 11"	5' 5½"	6' 8"	6' 6"	18' 8½"
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87
14. Depth to Static Water from ground level	654.6	644.0	644.1	645.1	645.8
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87
15. Elevation at ground level	654.6	644.0	644.1	645.1	645.8
16. Elevation - Top of monitoring well casing					
17. Ground-water elevation	651.1	641.0	637.4	641.1	629.2
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87
Comments					

U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
GROUND-WATER MONITORING WELL SUMMARY

PROJECT 38-26-0313-88 DATE 13-21 Oct 87

WELL NUMBER	MW-23	MW-24	MW-25	MW-26	
1. Height of Monitoring Well Casing above ground level	30"	30"	30"	30"	
2. Total Depth of Well below ground level	9'	9'	9'	9'	
3. Depth to Top of Well Screen below ground level	4'	4'	4'	6'	
4. Well Screen Length	5'	5'	5'	5'	
5. Well Screen Slot Size	0.010"	0.010"	0.010"	0.010"	
6. Well Diameter	2 in ID	2 in ID	2 in ID	2 in ID	
7. Monitoring Well Casing Material	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	
8. Monitoring Well Screen Material	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	Schd 40 PVC	
9. Grout Thickness below ground level	4	3	4	4' 10"	
10. Depth to Top of Bentonite Seal below ground level	All wells grouted to surface with bentonite				
11. Bentonite Seal Thickness	4	3	4	4' 10"	
12. Depth to Top of Sand Pack	4	3	4	4' 10"	
13. Depth to Static Water Level from top of monitoring well casing	5' 5"	4' 9½"	5' 8"	5' 2"	
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	
14. Depth to Static Water from ground level	2' 11"	2' 3½"	3' 2"	2' 8"	
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	
15. Elevation at ground level	638.6	633.3	634.0	617.5	
16. Elevation - Top of monitoring well casing					
17. Ground-water elevation	635.7	631	630.8	615	
Date Measured	19 Oct 87	19 Oct 87	19 Oct 87	19 Oct 87	
Comments					

APPENDIX D

RESULTS OF PHYSICAL ANALYSES OF THE SOILS

SOIL ANALYSIS FOR SENECA (GP) (B. BANGSUND) 12/08/87

SOILS ANALYSIS			
PROJECT NO.	38-26-0313-87	38-26-0313-87	38-26-0313-87
LOCATION	SENECA	SENECA	SENECA
BORE HOLE NO.	FENCE	FENCE2-4	FENCE2-4
DEPTH OF SAMPLE (FT)	0-2	2-4	2-4
SAMPLE TYPE	SHELBY TUBE	SHELBY TUBE	SHELBY TUBE
GRAIN SIZE ANALYSIS			
% PASSING 1.5"	100.0%	100.0%	
% PASSING 1.0"	100.0%	100.0%	
% PASSING 0.5"	100.0%	100.0%	
% PASSING NO. 4	93.7%	95.4%	
% PASSING NO. 10	79.1%	77.5%	
% PASSING NO. 20	66.2%	70.1%	
% PASSING NO. 40	57.9%	66.5%	
% PASSING NO. 100	48.0%	61.3%	
% PASSING NO. 200	42.5%	56.9%	
PERMEABILITY cm/sc			
IN SITU		5.07E-07	1.52E-05
PD-COMPACTION MOLD		NA	NA
PD-HAND REMOLDED		NA	NA
3-VOID		NA	NA
VOID RATIO (K)		0.62	0.96
% SATURATION (K)		119.82	104.32
% POROSITY (K)		38.16	49.01
DRY DENSITY (K)		1.67	1.38
% MOISTURE CONTENT (K)		27.15	37.14
SPECIFIC GRAVITY		2.70	2.70

COMPLETED BY Mark E. Farr CHECKED BY Holdsmith APPROVED BY

WNS = WILL NOT STICK

SPECIFIC GRAVITY IS ESTIMATED AS 2.7

APPENDIX E

CHEMICAL PARAMETERS, ANALYTICAL METHODS, AND DETECTION LIMITS

CHEMICAL PARAMETERS, ANALYTICAL METHODS, AND DETECTION LIMITS

Volatile Organic Compounds, Method No. 624 (reference 5)

	BH 29 Limit of Detection		All Others Limit of Detection
Chloromethane	60.	µg/L	3.
Bromomethane	60.	µg/L	3.
Vinyl chloride	60.	µg/L	3.
Chloroethane	60.	µg/L	3.
Methylene chloride	60.	µg/L	3.
Trichlorofluoromethane	60.	µg/L	3.
1,1-Dichloroethene	60.	µg/L	3.
1,1-Dichloroethane	60.	µg/L	3.
trans-1,2-Dichloroethene	60.	µg/L	3.
Chloroform	60.	µg/L	3.
1,2-Dichloroethane	60.	µg/L	3.
1,1,1-Trichloroethane	60.	µg/L	3.
Carbon tetrachloride	60.	µg/L	3.
Bromodichloromethane	60.	µg/L	3.
1,1,2,2-Tetrachloroethane	60.	µg/L	3.
1,2-Dichloropropane	60.	µg/L	3.
trans-1,3-Dichloropropene	60.	µg/L	3.
Trichloroethene	60.	µg/L	3.
Dibromochloromethane	60.	µg/L	3.
1,1,2-Trichloroethane	60.	µg/L	3.
Benzene	60.	µg/L	3.
cis-1,3-Dichloropropene	60.	µg/L	3.
2-Chloroethylvinyl ether	60.	µg/L	3.
Bromoform	60.	µg/L	3.
Tetrachloroethene	60.	µg/L	3.
Toluene	60.	µg/L	3.
Chlorobenzene	60.	µg/L	3.
Ethylbenzene	60.	µg/L	3.

Geohydrologic Study No. 38-26-0313-88, 13-21 Oct 87

CHEMICAL PARAMETERS, ANALYTICAL METHODS, AND DETECTION LIMITS

Acid Extractable Organics, Method 625 (reference 5)

	Field No. BH 26 Limit of Detection		All Others Limit of Detection
2-chlorophenol	20.	µg/L	10.
phenol	20.	µg/L	10.
2-nitrophenol	20.	µg/L	10.
2,4-dimethylphenol	20.	µg/L	10.
2,4-dichlorophenol	20.	µg/L	10.
4-chloro-3-methylphenol	20.	µg/L	10.
2,4,6-trichloropheno	20.	µg/L	10.
2,4-dinitrophenol	50.	µg/L	25.
4-nitrophenol	50.	µg/L	25.
2-methyl-4,6-dinitrophenol	50.	µg/L	25.
pentachlorophenol	50.	µg/L	25.

CHEMICAL PARAMETERS, ANALYTICAL METHODS,
AND DETECTION LIMITS

Base/Neutral Extractable Organic Compounds Method 625 (reference 5)

	Limit of Detection	
N-nitrosodimethylamine	10.	µg/L
bis (2-chloroethyl) ether	10.	µg/L
1,3-dichlorobenzene	10.	µg/L
1,4-dichlorobenzene	10.	µg/L
1,2-dichlorobenzene	10.	µg/L
bis (2-chloroisopropyl) ether	10.	µg/L
hexachloroethane	10.	µg/L
N-nitrosodi-n-propylamine	10.	µg/L
nitrobenzene	10.	µg/L
isophorone	10.	µg/L
bis (2-chloroethoxy) methane	10.	µg/L
1,2,4-trichlorobenzene	10.	µg/L
naphthalene	10.	µg/L
hexachlorobutadiene	10.	µg/L
hexachlorocyclopentadiene	10.	µg/L
2-chloronaphthalene	10.	µg/L
acenaphthylene	10.	µg/L
dimethyl phthalate	10.	µg/L
2,6-dinitrotoluene	10.	µg/L
acenaphthene	10.	µg/L
2,4-dinitrotoluene	10.	µg/L
fluorene	10.	µg/L
4-chlorophenyl phenyl ether	10.	µg/L
dithyl phthalate	10.	µg/L
1,2-diphenylhydrazine	10.	µg/L
N-nitrosodiphenylamine	10.	µg/L
4-bromophenyl phenyl ether	10.	µg/L
hexachlorobenzene	10.	µg/L
phenanthrene	10.	µg/L
anthracene	10.	µg/L
di-n-butyl phthalate	10.	µg/L
fluoranthene	10.	µg/L
pyrene	10.	µg/L
benzidine	25.	µg/L
butyl benzyl phthalate	10.	µg/L
benzo (a) anthracene	10.	µg/L
chrysene	10.	µg/L
3,3-dichlorobenzidine	25.	µg/L
bis (2-ethylhexyl) phthalate	10.	µg/L
di-n-octyl phthalate	10.	µg/L
benzo (b) fluoranthene	10.	µg/L
benzo (K) fluoranthene	10.	µg/L
benzo (a) pyrene	10.	µg/L
indeno (1,2,3-cd) pyrene	10.	µg/L
dibenzo (a,h) anthracene	10.	µg/L
benzo (ghi) perylene	10.	µg/L

CHEMICAL PARAMETERS, ANALYTICAL METHODS,
AND DETECTION LIMITS

Pesticides, PCBs, and Herbicides (references 5 and 6)

	Limit of Detection	
Alpha BHC	0.05	µg/L
Beta BHC	0.05	µg/L
Gamma BHC - Lindane	0.05	µg/L
Delta BHC	0.05	µg/L
Heptachlor	0.05	µg/L
Aldrin	0.05	µg/L
Heptachlor Epoxide	0.05	µg/L
DDE	0.05	µg/L
DDD	0.05	µg/L
DDT	0.05	µg/L
Dieldrin	0.05	µg/L
Endrin	0.05	µg/L
Chlordane	0.5	µg/L
oxaphene	5.	µg/L
Endosulfan I	0.05	µg/L
Endosulfan II	0.05	µg/L
Endosulfan Sulfate	0.2	µg/L
Endrin Aldehyde	0.5	µg/L
PCB-1016	5.	µg/L
PCB-1221	5.	µg/L
PCB-1232	5.	µg/L
PCB-1242	5.	µg/L
PCB-1248	5.	µg/L
PCB-1254	5.	µg/L
PCB-1260	5.	µg/L
Methoxychlor	0.5	µg/L

APPENDIX F

INFORMATION ON THE CHEMICALS DETECTED

1. The following descriptions were taken from reference 20.

a. Trans-1,2-dichloroethene (also known as Trans-1,2-dichloroethylene) is a general solvent for organic compounds, also known as acetylene dichloride. It is a colorless liquid with a pleasant odor. It decomposes slowly in water, and is slightly soluble.

b. 1,2-dichloroethane is a colorless, oily liquid with a chloroform-like odor. It is stable and slightly soluble in water. It is a solvent used as a paint remover and metal degreaser, in soaps and scouring compounds, and in wetting and penetrating compounds.

c. Chloroform is a clear, colorless liquid that is slightly soluble in water. It is used as a solvent, with propellents and refrigerants, and as a fumigant.

d. Vinyl chloride is a gas, slightly soluble in water. It is used in organic synthesis of plastics, and in plastic adhesives.

2. The following is from reference 17. Trichloroethylene is a powerful industrial solvent of both natural and synthetic organic compounds. It is used mainly for degreasing and in dry cleaning. The liquid form is about 1.5 times heavier than water, and the vapor form is about 4.5 times heavier than air. The solubility of TCE in water is 1100 mg/L (slightly soluble). Trichloroethylene appears to be chemically and physically stable in ground-water aquifers but is susceptible to biodegradation. For humans, TCE is specifically damaging to the liver and kidneys and has been classified a B2 carcinogen.

APPENDIX G

REFERENCES

1. Title 40, CFR, 1987 rev, Part 141, National Primary Drinking Water Regulations.

2. Title 40, CFR, 1987 rev, Part 143, National Secondary Drinking Water Regulations.

3. Title 40, CFR, 1987 rev, Section 264.101, Corrective Action for Solid Waste Management Units.

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