EPA REGION V ARCS PROGRAM

Donohue ENGINEERS ARCHITECTS SCIENTISTS

SITE STRATEGY/REMEDIAL ALTERNATIVES
MEMORANDUM
FOR
HIMCO DUMP SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STU
ELKHART, INDIANA

DRAFT

APRIL 1992

U.S. EPA Contract 68-W8-0093

Donohue & Associates, Inc.
in association with

Ebasco Services Inc.
STS Consultants Ltd.
John Mathes & Associates, Inc.
Life Systems, Inc.

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SITE STRATEGY/REMEDIAL ALTERNATIVES MEMORANDUM FOR HIMCO DUMP SUPERFUND SITE REMEDIAL INVESTIGATION/FEASIBILITY STUDY ELKHART, INDIANA

DRAFT

APRIL 1992

Prepared for:

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Region V
230 South Dearborn Street
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SITE STRATEGY/REMEDIAL ALTERNATIVES MEMORANDUM

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SITE STRATEGY/REMEDIAL ALTERNATIVES MEMORANDUM

Himco Dump Superfund Site
Elkhart, Indiana

1.0 INTRODUCTION

1.1 Purpose

This Site Strategy/Remedial Alternatives Memorandum has been prepared by SEC Donohue Inc. (SEC Donohue) for the Himco Dump Superfund Site (Himco site) in Elkhart, Indiana. This memorandum has been prepared as a substitute document in lieu of the Alternatives Array Document (AAD) for the Himco site.

A typical AAD addresses the identification, screening, and selection of possible remedial alternatives for a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site. Because municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. To take advantage of this aspect of municipal landfills, the United States Environmental Protection Agency (U.S. EPA) has developed some tools and methodologies to streamline the remedial investigations/feasibility study (RI/FS) process (U.S. EPA, 1991). In particular, the formulation and screening of remedial technologies, which is conducted as part of the AAD process, is limited to a few relevant technologies. These technologies are discussed in the guidance document, "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites", Final, February 1991 (U.S. EPA, 1991). Consequently, for CERCLA municipal landfill sites similar to the Himco site, the FS step of screening the universe of possible remedial alternatives is much more focused. It should be noted that the list of technologies described in the guidance document does not alleviate the responsibility of the SEC Donohue FS team to consider other appropriate technologies. The consideration of other appropriate technologies which are not included in the guidance document is ongoing. However, none have yet been identified by the FS team.

Section 1.0 of this memorandum presents the purpose of the memorandum, a description and history of the Himco site, a summarization of the RI for the site, a summarization of the baseline risk assessment for the site, and a description of the Himco site remediation approach. Section 2.0 presents a discussion of the remedial technologies and process options identified for the site. Section 3.0 presents a discussion of the remedial response alternatives which have been selected to be carried over for detailed evaluation in the FS

Report. Section 4.0 presents the Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) which have been identified for the Himco site. One of the objectives in preparing this memorandum it to present the preliminary listing of ARARs and to have both the U.S. EPA and the Indiana Department of Environmental Management (IDEM) personnel review and provide comments. Section 5.0 lists the references cited in this memorandum. Ten Technical Memoranda, A through J, are included as attachments. These technical memoranda present preliminary discussions and calculations regarding potential remedial actions for the Himco site.

1.2 Site Background

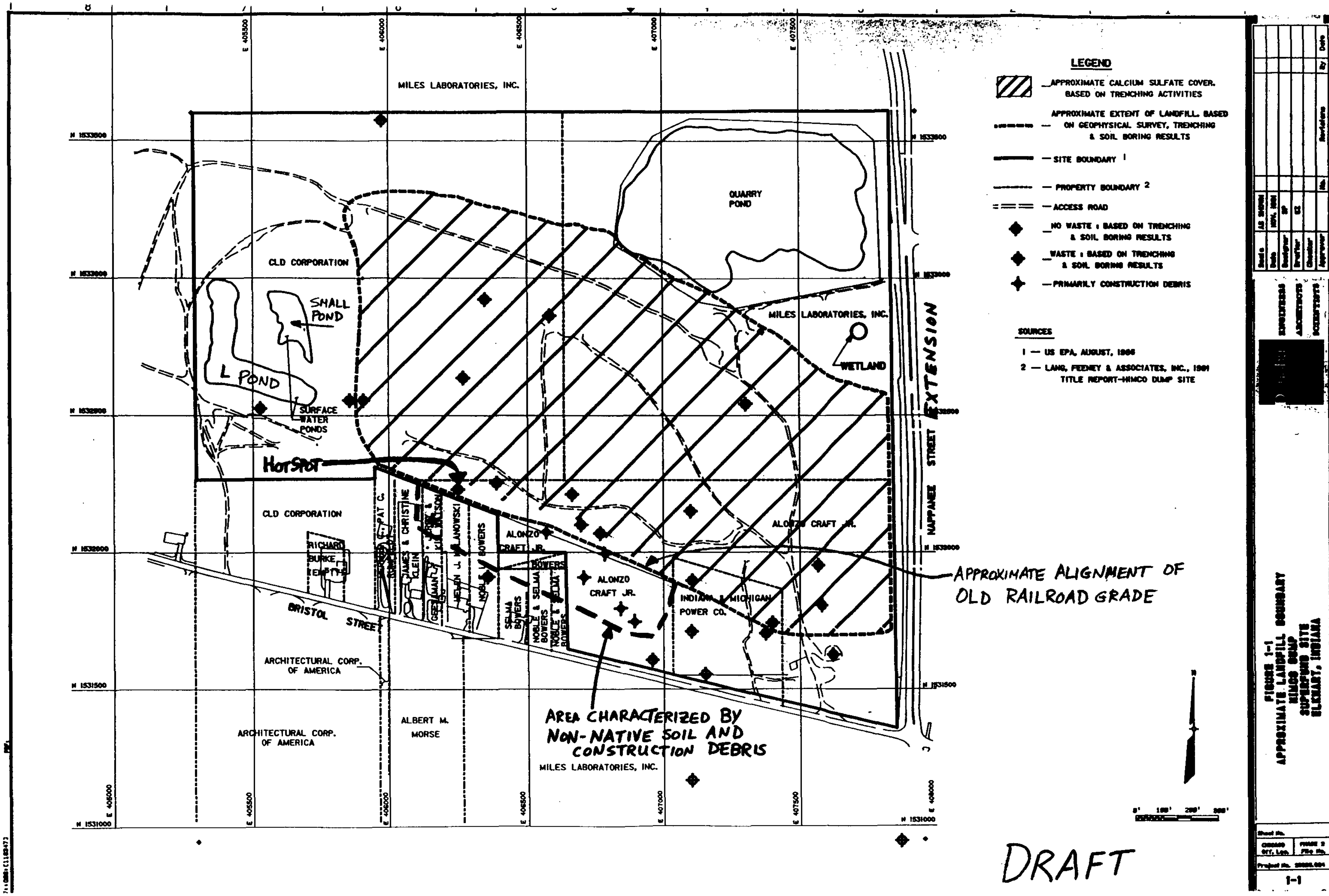
1.2.1 Site Description

The Himco site is a closed landfill located at County Road 10 and the Nappanee Street Extension in the town of Elkhart, located in Elkhart County, Indiana. The site covers approximately 50 acres in the Northeast quarter of Section 36, Township 38 North, Range 4 East, in Cleveland Township. The site is bounded on the north by a tree line and northernmost extent of the gravel pit pond; on the west by two ponds, the L pond and the small pond; on the south by County Road 10 and private residences; and on the east by Nappanee Street Extension (Figure 1-1). The site is not fenced. In the vicinity of the site are agricultural, residential, and light industrial land uses.

There is a sand access road into the southeast corner of the site near the intersection of County Road 10 and Nappanee Street Extension. A locked gate is present across this road, however, vehicles can easily drive around the gate and enter the site.

The highest elevation on the site is 774.5 feet above mean sea level (MSL). This high point is located on top of the mounded landfill area of the site. The typical ground surface elevation surrounding the mounded landfill area is approximately 762 feet above MSL. The landfill area of the site is covered with a layer of sand of varying thickness. Beneath the sand, a layer of white powdery calcium sulfate, also of varying thickness, is present. The western half of the existing landfill cover is vegetated with grasses. The eastern half of the existing landfill cover is vegetated with grasses, bushes, and young trees. Numerous piles of concrete and asphalt waste material are present across the eastern half of the landfill.

There is an abandoned gravel pit operation in the northeast corner of the site. An old truck scale and concrete structures are also present in this area. The gravel pit itself is filled with water which is approximately 30 feet deep. Two other smaller and shallower ponds, commonly referred to as the L pond and the small pond, exist on the west side of the site.


LEGEND
APPROXIMATE CALCIUM SULFATE COVER, BASED ON TRENCHING ACTIVITIES
APPROXIMATE EXTENT OF LANDFILL, BASED ON GEOPHYSICAL SURVEY, TRENCHING & SOIL BORING RESULTS
SITE BOUNDARY 1
PROPERTY BOUNDARY 2
ACCESS ROAD
NO WASTE : BASED ON TRENCHING & SOIL BORING RESULTS
WASTE : BASED ON TRENCHING & SOIL BORING RESULTS
PRIMARILY CONSTRUCTION DEBRIS
SOURCES
1 — US EPA, AUGUST, 1988
2 — LANG, FEENEY & ASSOCIATES, INC., 1991 TITLE REPORT-HIMCO DUMP SITE
MILES LABORATORIES, INC.
QUARRY POND
CLD CORPORATION
SMALL POND
L POND
SURFACE WATER PONDS
WETLAND
NAPPANEE STREET EXTENSION
HOT SPOT
ALONZO CRAFT JR.
INDIANA & MICHIGAN POWER CO.
BRISTOL STREET
ARCHITECTURAL CORP. OF AMERICA
ALBERT M. MORSE
RICHARD BURKE
APPROXIMATE ALIGNMENT OF OLD RAILROAD GRADE
AREA CHARACTERIZED BY NON-NATIVE SOIL AND CONSTRUCTION DEBRIS
DRAFT
FIGURE 1-1
APPROXIMATE LANDFILL BOUNDARY
HIMCO DUMP
SUPERFUND SITE
ELKHART, INDIANA
1-1

The area south of the landfill and north of County Road 10 is densely vegetated in places. Numerous small piles of rubble, concrete, asphalt and metal debris are scattered throughout the area. Calcium sulfate is not present in this area.

Eleven U.S. EPA monitoring wells and approximately 16 United States Geologic Survey (USGS) monitoring wells have been installed on or immediately adjacent to the Himco site.

1.2.2 Site History

The Himco site was privately operated by Himco Waste Away Service, Inc., and was in operation between 1960 and September 1976. As of January 1990, the parcels of land which comprise the landfill are owned by the following individuals or corporations:

1. Miles Laboratories
2. CLD Corporation
3. Alonzo Craft, Jr.
4. Indiana and Michigan Electric Company

A brief history of the Himco site was provided by Chuck Himes, principal landfill operator, during a SEC Donohue site visit on November 9, 1989. According to Mr. Himes, the area was initially a marsh and grassland. There was no liner, no leachate collection, or gas recovery system constructed as part of the landfill. Refuse was placed at ground surface across the site, with the exception of trench filling in the eastern area of the site. At that location, a total of five trenches 10-15 feet deep, the width of a truck and 30 feet long, were excavated. Paper refuse was reportedly dumped in the trenches and burned. The landfill had no borrow source but obtained sandy soil for daily cover from the gravel pit to the north, the L pond to the west, and essentially anywhere around the perimeter of the site where sand was available. Mr. Himes reported that essentially two-thirds of the waste in the landfill was calcium sulfate from Miles Laboratories. As much as 360 tons/day were dumped over an unknown time period. Other wastes accepted at the landfill included demolition/construction debris, household refuse, and industrial and hospital wastes. In 1976, the landfill was closed and covered. The cover consisted of approximately one foot of sand overlying a calcium sulfate layer.

In 1971, the Indiana State Board of Health (ISBH) first identified the Himco site as an open dump. In early 1974, residents along County Road 10 south of the Himco Dump complained to the ISBH about color, taste, and odor problems with their shallow wells. Analyses of six shallow wells along County Road 10 by the state showed high levels of manganese. These wells were finished at depths ranging from 20 to 30 feet. Mr. Himes, the principal landfill operator, was advised by ISBH to replace these six shallow residential wells. The new wells were finished at depths ranging from 152 to 172 feet below ground surface. Well logs indicate that these wells were finished below a clay confining layer.

In 1975, Mr. Himes signed a consent agreement with the ISBH Stream Pollution Control Board to close the dump by September of 1976.

In 1984, U.S. EPA field investigation team (FIT), as part of the Hazard Ranking System (HRS) scoring package, conducted a site inspection at the Himco Site. Laboratory analyses from a number of the existing USGS monitoring wells showed that the groundwater downgradient of the site was impacted by volatile organic compounds (VOCs), semivolatile organic compounds (semi-VOCs) and metals. At the time of the site inspection, leachate seeps were observed.

In June 1988, the Himco site was proposed for the National Priorities List (NPL) and in February 1990, the site was officially designated a NPL site.

In July 1989, under the Alternative Remedial Contract Strategy (ARCS) contract, the U.S. EPA issued a work assignment to SEC Donohue to conduct a RI/FS at the Himco site. From October 1990 through February 1991, SEC Donohue conducted a Phase I RI at the site. Activities completed included excavation of test pits, installation of monitoring wells, and collection of soil, landfill gas, surface water, sediment, and groundwater samples for chemical analysis. In September 1991, SEC Donohue conducted a Phase II RI at the site. Activities completed included excavation of test pits, installation of a monitoring well, and collection of soil, surface water, sediment, leachate and groundwater samples for chemical analysis.

1.2.3 Remedial Investigation Results

The RI at the Himco site was conducted to determine the nature, extent, and sources of contamination to support a human health risk assessment, ecological assessment, and to conduct a FS. Media sampled and analyzed during the RI included:

- surficial soil on the landfill cover
- surficial soil in areas adjacent to the landfill
- subsurface soils adjacent to the landfill

- waste mass gas under the landfill cover (3 feet deep)
- groundwater
- leachate collected from within the landfill
- Surface water and sediment from three surface water bodies (Quarry Pond, L Pond and Small Pond) at the site

Activities completed during the RI also included characterization of the waste in the landfill, geologic and hydrogeologic conditions, and an assessment of human and ecological impacts.

1.2.3.1 Landfill Characteristics

Figure 1-1 shows the landfill boundaries. The extent of the landfill was determined using a combination of geophysical surveys, test pit and soil boring observation, and examination of aerial photographs.

Test pit excavations in the landfill revealed the presence of mixed waste. In addition, leachate was present in the majority of trenches. Leachate was observed to be gray-black in color with "rainbow sheens", except at one location near the southwest corner of the landfill which was biphasic and red/brown in color. At this location the organic phase of the leachate contained approximately 48 percent toluene by weight. This location has been referenced as the hot spot in the landfill. The hot spot is indicated on Figure 1-1.

Three general layers were consistently observed in the landfill. The top layer can be characterized as a silty sand cover soil fill which ranged in thickness from a thin veneer to several feet. Underlying the sand cover, and in some cases at ground surface, calcium sulfate was found and varied in thickness from a few inches to as much as nine feet towards the southeast central and southern areas of the landfill. The areal extent of the calcium sulfate layer is shown in Figure 1-1. Beneath the calcium sulfate layer, an estimated 15 to 20 foot thick waste layer is present. Underlying the calcium sulfate, wastes were found to include paper, plastic, rubber, wood, glass, metal including an occasional drum, glass, and small amounts of hospital wastes (e.g., syringes, vials).

Non-native soil mixed with construction debris was observed in test pits outside the landfill along the south central and southwest edge of the landfill. This area is identified in Figure 1-1. No calcium sulfate was found in this area. Semi-VOC contamination was found to be most prominent in surface soil samples collected from this area.

1.2.3.2 Geology/Hydrogeology

The stratigraphy beneath the Himco site can be characterized as sand and gravel outwash deposits comprised of alternating beds, varying in thickness, of poorly to well graded sands and gravels, and gravel-sand-silt mixtures ranging from approximately 200 to 500 feet below ground surface. These outwash deposits constitute the primary groundwater aquifer at the site. Minor seams of silt and clay were also encountered, but there was no indication of a consistent confining layer beneath the site.

Groundwater occurs between approximately 5 and 20 feet below the ground surface at the site, at an elevation ranging from 752 to 756 feet (MSL). The elevation of the bottom of the waste mass is estimated to range from 755 to 760 feet (MSL). Three surface water bodies representing the surface expression of the water table exist at this site. Groundwater flow is generally to the south-southeast towards the St. Joseph River, which is a regional groundwater discharge for this area. Groundwater recharge is from under flow from the north and from surface water infiltration. The average horizontal flow gradient beneath the site is approximately 0.0016 ft/ft. Vertical gradients were predominantly upward and ranged from 0.00021 ft/ft to 0.0013 ft/ft. Calculated field hydraulic conductivities ranged from 0.12 cm/s to 0.00079 cm/s, with an average value of 0.0022 cm/s.

1.2.3.3 Site Contamination Condition

Groundwater

Two rounds of groundwater sampling revealed very limited groundwater contamination outside the boundaries of the waste. No pesticides or polychlorinated biphenyls (PCBs) were detected in groundwater samples, and only trace amounts of VOCs and semi-VOCS were detected. However, during RI Phase I sampling, trichloroethene exceeded its MCL of 5 ug/l in two USGS wells J1 and J2, which are located approximately 2000 feet off-site and side gradient of the Himco site. 1,1,1-trichlorethane (MCL of 200 ug/l) was detected in well J1 at 42 ug/l and in well J2 at 18 ug/l. Inorganic concentration ranges are presented in Table 1-1. Arsenic, beryllium, and antimony were primarily detected in wells near the southeast corner of the site. The highest concentrations of inorganics were consistently detected in shallow wells. Overall, inorganic analytes detected in filtered samples were similar in concentrations to unfiltered samples, expect for Phase I concentrations in USGS well E2, located near the southeast corner of the site. For USGS well E2, the majority of filtered metal concentrations were orders of magnitude lower than unfiltered samples. For example, lead and arsenic were detected in the unfiltered sample at 106 ug/l and 54.5 ug/l,

TABLE 1-1

SUMMARY OF DETECTED INORGANIC ANALYTES (TOTAL)
SHALLOW GROUNDWATER USEPA AND USGS WELLS

HIMCO DUMP RI/FS
1992

Analyte	MCL (ug/l)	Background Concentration Range (ug/l) Round 1	Round 2	Range of Concentrations in downgradient wells (ug/l) Round 1	Round 2
Aluminum	-	695-81.8	166(BJ)-6930	23.6(B)-113,000	77.1(BJ)-3130
Antimony	-	ND	ND (DJ)	31.2(B)-62.5	ND
Arsenic	-	ND	5.3(BJ)	1.0(B)-54.5	2.7(B)-24.2
Barium	2,000	22.5-65.5	56.5(B)-125(B)	6.4(B)-510	8.2(B)-218
Beryllium	-	3.1	ND	1.2(B)-5.4	1.3
Cadmium	5	ND	ND	ND	1.3-3.0(BJ)
Calcium	-	77,700-211,000	138,000-165,000	14,100-217,000	15,300-361,000
Chromium	100	6.5-20.9	2.8-24.6	4.3(BJ)-354	2.2-45.3
Cobalt	-	ND	25.4	5.7(B)-28.6(B)	3.1-11.4
Copper	-	8.7-16.7	31.0	3.7(B)-139	16.6-79.8
Iron	-	123-1,240	60.8(B)-17200	56.5(BJ)-39,300	29.4-78,500
Lead	15	2.2*	91.2*	1.1(BJ)-106(J)*	6.8-210*
Magnesium	-	11,200-25,100	20,300-32,900	2,650(B)-41,700	6,350-78,000
Manganese	-	38.1-99.9	9.2(B)-1,870	3.7(B)-2,070	9.2(Bb)-3590
Mercury	2	ND	ND	0.20(J)-1.0(J)	ND
Nickel	-	ND	47.5	79.4-111	7.10(B)-36.6(B)
Potassium	-	2,110	1,730(B)-2,120(B)	468(B)-12,900	1,090(B)-13,900
Selenium	50	2.4	ND	2.1(B)-33.0	ND
Silver	-	ND	ND	6.9(B)-18.4(J)	ND
Sodium	-	4,690-48,600	5,490-50,700(J)	1,850(B)-78,800	3380(BJ)-52,300(J)
Thallium	-	ND	ND	ND	ND
Vanadium	-	ND	26.8(B)	4.5(BJ)-106	3.8(B)-12.5(B)
Zinc	-	13.9-24.1	79	6.1(BJ)-390(J)	17(B)-13,600
Cyanide	-	ND	ND	ND	ND

Qualifiers

ND - Below detection limit
B - Analyte found in associated blank as well as in the sample
J - Indicates an estimated value
* - Filtered sample showed concentrators less than the corresponing MCLs.

respectively. In the filtered sample lead was detected at 2.1 ug/l, and arsenic was not detected. In addition, the total suspended solid concentration detected in well E2 was 378 mg/l. Therefore, contamination in well E2 appears to be associated with suspended solids. In addition, the majority of the highest concentrations of inorganic analytes were detected in well E2. Total lead was detected in seven wells above the MCL for lead. Concentrations ranged from 28.1 ug/l to 210 ug/l. However, filtered lead concentrations on these same wells were, non-detect or below MCLs.

Leachate

Leachate was sampled at four locations and analyzed for VOCs, semi-VOCs, pesticide/PCBs, metals/cyanide and water quality. A summary of contaminants detected in leachate is provided in Tables 1-2, 1-3, 1-4 and 1-5. Leachate from test pit TL5 separated into two phases. Each phase was analyzed separately for VOCs and semi-VOCs. All other analyses on TL5 were done with the two phases mixed. The other three leachate samples were single phase samples, and were described as gray-black water with some visible sheening.

Concentrations of VOC and inorganic contaminants detected in leachate were typically orders of magnitude higher than groundwater concentrations. In addition, some VOCs and semi-VOCs which were detected in the leachate were not detected in the groundwater. Three VOCs were detected in groundwater samples which were not detected in leachate samples include bromodichloromethane, chlorobenzene, and dibromochloromethane. None of these three compounds exceeded 2.0 ug/l in groundwater samples. The highest concentrations of VOCs were detected in leachate from TL5. Also, VOCs in TL5 were different between the two phases. Traces of pesticides were detected in leachate samples TL1 and TL2. Pesticides were not detected in any of the groundwater samples collected.

Soil

Contaminants were detected primarily in surficial soils. A summary of inorganic, VOC, and semi-VOC concentration ranges is presented in Tables 1-6, 1-7, and 1-8. Arsenic and beryllium were detected in surficial soil samples located across the western half of the site, around the quarry pond, and in the south-central area characterized by non-native soil and construction debris. The highest concentrations of arsenic were detected in soil samples from the south central area. Beryllium was detected at random locations at relatively consistent concentrations. VOCs were detected widespread across the site. In all cases, VOCs were found at low concentrations (less than 140 ug/kg). Semi-VOCs soil contamination was found to be most prominent in samples collected in the south-central area characterized by non-native soil and construction debris. Pesticides were detected in two soil samples collected from this area.

TABLE 1-2

SUMMARY OF DETECTED INORGANIC ANALYTES (TOTAL)
LEACHATE WATER

HIMCO DUMP RI/FS
1992

	MCL(ug/l)	Concentrations Detected (mg/l) by Trench Number TL-1	TL-2	TL-4	TL-5
Aluminum	-	78.1(B)	301	8.47(J)	356(N)
Antimony	-	ND	10.5	.0726(J)	ND
Arsenic	-	ND	ND	19 ug/l	ND
Barium	2,000	2.1(B)	3.7(B)	.53(B)	4.7(B)
Beryllium	-	1.6(BNJ*)	5.7(NJ*)	ND	1.5(BNJ*)
Cadmium	5	2,500(B) ug/L	ND	4.4(B) ug/l	ND
Calcium	-	1.66	2.14	288	.55
Chromium	100	4.5(BNJ)	4.5(BNJ)	32.9 ug/l	10,000(BNJ) ug/l
Cobalt	-	3,300(BJ) ug/l	ND	13.5 ug/l	ND
Copper	-	11,700(BJ) ug/l	8,800(BJ) ug/l	626 ug/l	3,000(BJ) ug/l
Iron	-	71.2	272	17.5	254
Lead	15	ND	28,300(NJ*) ug/l	505(J) ug/l	ND
Magnesium	-	89.4(J*)	205(J*)	60.3	108(J*)
Manganese	-	ND	9.6(B)	3.15	ND
Mercury	2	420(NJ) ug/l	420(NJ)	1.3(J) ug/l	ND
Nickel	-	ND	ND	55 ug/l	ND
Potassium	-	ND	ND	27.2	ND
Selenium	50	ND	ND	ND	ND
Silver	-	ND	ND	ND	ND
Sodium	-	ND	415	83.4	ND
Thallium	-	ND	ND	ND	ND
Vanadium	-	3,000(BNJ) ug/l	4,500(BNJ) ug/l	32.1(B) ug/l	ND
Zinc	-	6,700(B) ug/l	18,400 ug/l	713(J) ug/l	10,700(B) ug/l
Cyanide	-	ND	ND	108 ug/l	48,400 ug/l

Qualifiers

ND - Below detection limits
B - Analyte found in associated blank as well as in the sample
J - Indicates an estimated value
N - Spike sample recovery not within control limits. This value is usable.
*** - Duplicate analysis not within control limit. The values is usable.**

A/R/HIMCO/AO2

TABLE 1-3

SUMMARY OF DETECTED VOCS
LEACHATE WATER (ug/l)

HIMCO DUMP RI/FS
1992

Chemical	MCL(ug/l)	Concentrations Detected (ug/l) by Trench Number				
					TL-5	
		TL-1	TL-2	TL-4	Red Phase (mg/kg) (organic)	Yellow Phase (mg/kg) (aqueous)
Vinyl Chloride	-	47(J)	16	ND	ND	ND
Chloroethane	-	ND	3(CJ)	ND	ND	ND
Methylene Chloride	-	550	18	ND	ND	260(BJ)
Acetone	-	1,300	85	ND	ND	300(BJ)
Carbon Disulfide	-	130	4(J)	ND	ND	ND
1,1-Dichloroethane	-	220	64	5(J)	ND	ND
1,2-Dichloroethene (total)	100	410	66	ND	ND	ND
Chloroform	-	76(J)	ND	ND	ND	ND
2-Butanone	-	420	13	ND	ND	4,100(BJ)
1,1,1-Trichloroethane	200	520	ND	10	ND	ND
Trichloroethene	-	550(J)	11	180	ND	ND
Benzene	5	97(J)	32(J)	ND	ND	ND
4-Methyl 1-2-pentanone	-	110	9(J)	ND	17,000(J)	410(J)
2-Hexanone	5	ND	ND	ND	29,000(J)	570(J)
Tetrachloroethene	100	48(J)	ND	ND	ND	ND
Toluene	-	1,100	63	ND	480,000(J)	850(J)
Ethyl Benzene	-	640	150	ND	6,400(J)	ND
Styrene	-	ND	3(J)	ND	ND	ND
Xylenes (Total)	-	200	330	ND	44,000(J)	77(J)

Qualifiers

MD - Below detection limit
B - Analyte found in assoicated blank as well as in the sample.
J - Indicates an estimated value

A/R/HIMCO/AO2

TABLE 1-4

SUMMARY OF DETECTED SEMI-VOCS
LEACHATE WATER (ug/l)

HIMCO DUMP RI/FS
1992

Chemical	Concentrations Detected (ug/l) by Trench Number				
				TL-5	
	TL-1	TL-2	TL-4	Red Phase (mg/kg)	Yellow Phase (mg/kg)
Phenol	6,600	270	7.2	560 ug/l	ND
Benzyl alcohol	ND	ND	ND	ND	11
2-Methylphenol	440(J)	10(J)	ND	ND	ND
4-Methylphenol	4,200(J)	140(J)	ND	ND	ND
2,4-Dimethylphenol	84(J)	10(J)	ND	ND	ND
Benzoic Acid	ND	ND	ND	ND	9(J)
Naphthalene	ND	ND	4(J)	45(J)	ND
Acenaphthylene	ND	ND	1(J)	ND	ND
Diethylphthalate	ND	49(J)	ND	ND	ND
Phenanthrene	ND	ND	2(J)	ND	ND
Fluoranthene	ND	ND	7(J)	ND	ND
Pyrene	ND	ND	8(J)	ND	ND
Chrysene	ND	ND	5(J)	ND	ND
Bis(2-Ethylhexyl)phthalate	ND	22(J)	ND	180(J)	ND
Benzo(b)fluoranthene	ND	ND	6(J)	ND	ND
Benzo(k)fluoranthene	ND	ND	3(J)	ND	ND
Benzo(a)pyrene	ND	ND	5(J)	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	2(J)	ND	ND
Benzo(g,h,i)perylene	ND	ND	2(J)	ND	ND
Carcinogenic PAHs	ND	ND	21	ND	ND
Non-carcinogenic PAHs	ND	ND	19	ND	ND

Qualifiers

ND - Below detection limit.
J - Indicates an estimated value.

TABLE 1-5

SUMMARY OF DETECTED PESTICIDES/PCBs
LEACHATE WATER

HIMCO DUMP RI/FS
1992

Chemical Name	TL-01 (ug/l)	TL-02 (ug/l)
alpha-BHC	.017(DJ)	ND
beta-BHC	.097(DJP)	.068(DJP)
Heptachlor	0.12(DJP)	0.023(DJP)
Aldrin	0.13(DJP)	0.12(DJP)
Dieldrin	ND	0.073(DJP)
Endosulfan II	0.17(DJ)	0.048(DJP)
4,4-DDT	0.29(DJP)	ND
alpha-Chlordane	0.22(DJP)	ND
gamma-Chlordane	0.029(DJP)	0.028(DJP)

Qualifiers

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. This flag alerts data users that any discrepancies between the sample concentrations reported may be due to dilution of the sample or extract. The value is usable.

J - Indicates an estimated value.

P - This flag is used for a pesticide/aroclor target analyte when there is greater than 25% difference for detected concentrations between two GC columns.

A/R/HIMCO/AO2

TABLE 1-6

SUMMARY OF DETECTED INORGANIC ANALYTES
SURFICIAL SOIL

HIMCO DUMP RI/FS
1992

Analyte	Background (mg/kg)	Range of Concentrations Detected (mg/kg)
Aluminum	5,100	9.7(B) - 6,780(J)
Antimony	ND	3.1(BJ) - 46.8
Arsenic	1.5	0.47(B) - 5.8
Barium	62	1.3(BJ) - 101
Beryllium	0.69	0.20(BJ) - 0.91(BJ)
Cadmium	ND	1.1(B)
Calcium	386	360(B) - 321,000(J)
Chromium	6.5	1.1(B) - 13.2
Cobalt	3.7	1.5(B) - 5.3(B)
Copper	4.7	1.3(B) - 216
Iron	6,370	9.8(BJ) - 10100
Lead	7.8	0.5(BJ) - 245(J)
Magnesium	762	14.6(BJ) - 14000
Maganese	402	1.3(BJ) - 561(J)
Mercury	ND	0.13(J) - 0.54(J)
Nickel	6.5	2.4(B) - 12.0
Potassium	252	86.6(B) - 678(B)
Selenium	0.25	0.27(BJ) - 1.4(J)
Silver	ND	8.49(BJ) - 2.8(BJ)
Sodium	ND	20.8(B) - 90.6(B)
Thallium	ND	ND
Vanadium	11.8	1.6(BJ) - 19.1
Zinc	20.5	1.7(B) - 229
Cyanide	ND	1.3 - 24.3

Qualifiers

ND - Below detection limit
B - Analyte found in the associated blank as well as in the sample
J - Indicates an estimated value

TABLE 1-7

SUMMARY OF DETECTED VOLATILE ORGANIC COMPOUNDS
SURFICIAL SOILS

HIMCO DUMP - RI/FS
1992

Compound	Background (ug/kg)	Range of Concentrations Detected (ug/kg)
Methylene Chloride	ND	3(J) - 140
Acetone	ND	3(J) - 31
Carbon Disulfide	ND	0.8(J)
1,1 - Dichloroethene	ND	5(J)
2 - Butanone	ND	2(J) - 8
Tetrachloroethene	ND	6(J)
Trichloroethene	ND	0.9(J) - 4(J)
Toluene	ND	2(J) - 31
Ethyl Benzene	ND	0.7(J) - 2(J)
Styrene	ND	0.8(J)
Xylenes (total)	ND	0.7(J) - 6

Qualifiers

ND - Below detection limit
J - Indicates an estimated value

A/R/HIMCO/AK8

TABLE 1-8

SUMMARY OF DECTECTED SEMI-VOLATILE COMPOUNDS
SURFICIAL SOIL

HIMCO DUMP RI/FS
1992

Compound	Background (ug/kg)	Range of Concentrations Detected Above Background (ug/kg)
Naphthalene	ND	18(J)
2-Methylnaphthalene	ND	18(J)
Dimethylphathalene	ND	18(J)
1,4-Dichlorobenzene	80	120(J) - 210(J)
Benzoic Acid	ND	75(J)
Acenaphthene	ND	59(J) - 310(J)
Dibenzofuran	ND	23(J)
Fluorene	ND	43(J) - 120(J)
Phenanthrene	ND	42(J) - 1,500
Anthracene	ND	82(J) - 240(J)
Di-n-butylphthalate	ND	92(J) - 490(J)
Fluoranthene	ND	17(J) - 2,800
Pyrene	ND	34(J) - 2,000(J)
Butylbenzylpthalate	ND	300(J)
Benzo(a)anthracene	ND	25(J) - 1,300
Chrysene	ND	37(J) - 1,600
bis(2-Ethylhexyl)phthalate	93	18(J) - 7,800(J)
Benzo(b)fluoranthene	ND	67(J) - 3,200
Benzo(k)fluoranthene	ND	82(J) - 1,700
Benzo(a)pyrene	ND	430(J) - 2,200
Indeno(1,2,3-cd)pyrene	ND	230(J) - 3,700
Dibenzo(a,h)anthracene	ND	94(J) - 550(J)
Benzo(g,h,i)perylene	ND	250(J) - 3,500
Carbazole	ND	36(J)
Total Carcinogenic PAHs	ND	235(J) - 14,250(J)
Total Non-carcinogenic PAHs	ND	230(J) - 8,340(J)

Qualifiers

ND - Below detection limit
J - Indicates an estimated value

Surface Water and Sediment

Phase I data indicates minimal contamination in the surface water and sediment media. A complete analysis of Phase II data has not been completed for surface water and sediment. Therefore, this information is not included in this discussion.

Waste Mass Gas

VOCs were detected in all 14 waste mass gas samples collected from the landfill area. However, the concentration of total VOCs was less than 1 part per billion (ppb) in 12 of the 14 samples. VOCs at the other two locations totaled 9.8 ppb and 12.2 ppb.

1.2.4 Baseline Risk Assessment

The baseline risk assessment is an analysis of the potential adverse health effects (both current and future) resulting from exposures to contaminants at the site. By definition, a baseline risk assessment is limited to conditions under the no-action alternative, that is, in the absence of remedial actions. In general, the results of the baseline risk assessment are used to:

- Document both the causes and magnitude of the risk associated with the Himco Dump site.

- Assist in determining if remedial actions are necessary to mitigate unacceptable health risks.

A draft baseline risk assessment for the Himco site was completed based on the Phase I data as part of the RI (Life Systems, 1991). This draft baseline risk assessment is now being revised to incorporate RI Phase II data. The following section presents the results of the Phase I data baseline risk assessment.

1.2.4.1 Selection of Chemicals of Potential Concern

Table 1-9 presents the 73 chemicals of potential concern in soil or groundwater at the site, established during the Phase I baseline risk assessment. Chemicals were eliminated from consideration in the baseline risk assessment if they were not detected or if they were beneficial human nutrients and occurred at levels that did not exceed the beneficial level. Of these 73 chemicals, 27 chemicals (identified by an asterisk [*] in Table 1-9) were retained for evaluation in the risk characterization calculations.

TABLE 1-9

CHEMICALS OF POTENTIAL CONCERN

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

INORGANICS

Aluminum
Antimony*
Arsenic*
Barium*
Beryllium*
Cadmium*
Chromium*
Cobalt
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc
Cyanide

ORGANICS:

VOLATILES
1,1-Dichloroethane
1,1-Dichloroethene*
1,1,1-Trichloroethane
1,2-Dichloroethene
2-Butanone
2-Hexanone
4-methyl-2-pentanone
Acetone
Benzene*
Bromodichloreomethane*
Carbon disulfide
Chlorobenzene
Chloroethane
Chloroform
Ethylbenzene
Methylene chloride*
Styrene
Tetrachloroethene
Toulene
Trichloroethene
Xylenes

SEMIVOLATILES

1,4-Dichlorobenzene*
Acenaphtthene*
Anthracene*
Benzo(a)anthracene*
Benzo(a)pyrene*
Benzo(b)fluoranthene*
Benzo(k)fluoranthene*
Benzo(g,h,i)perylene*
Benzoic Acid
bis(2-Ethylhexyl)phthalate*
Butylbenzylphthalate
Chrysene*
Dibenz(a,h)anthracene*
Diethylphthalate
Dimethylphthalate
Di-n-butylphthalate
Di-n-octylphthalate
Fluoranthene*
Fluorene*
Indeno (1,2,3-cd)pyrene*
Phenanthrene*
Pyrene*

PESTICIDES/PCB's
4,4'-DDT
Arociar-1248

NON-CLP CHEMICALS:
Bromide, dissolved
Chloride
Nitrogen, ammonia
Nitrogen, nitrate & nitrite*
Phosphorus
Sulfate

TIC's:
1,1,2-Trifluoro-1,2,2-trifluoroethane
Phenobarbital

* Chemical contributing to risks greater than IE-06 for carcinogens or HI > 1.0 for non-carcinogens to current or hypothetical future populations.

1.2.4.2 Potentially Exposed Human Populations

An analysis of exposure pathways along with probable human activity patterns, current and future land uses, and site contamination was completed to determine complete exposure pathways and select exposure scenarios for quantification.

Current Populations

The current populations most likely to be exposed are:

- Residents south of the site
- Recreational dirt-bike riders
- Recreational visitors (waders, fisherman)

Future Populations

Hypothetical future use of the site could include agricultural use or commercial/residential development. The hypothetical future populations most likely to be exposed are:

- Residents on the waste mass
- Residents immediately adjacent to the waste mass
- Occupational workers on-site
- Agricultural workers on-site
- Downwind off-site residents

1.2.4.3 Exposure Scenarios

The exposure scenarios that were quantified in the baseline risk assessment are listed in Table 1-10. This table also includes the future on-site resident on the landfill exposure scenario which will be quantified as a part of the Phase II baseline risk assessment. Other exposure pathways may exist at this site, but they were judged to be relatively minor when compared to the pathways presented in Table 1-10.

1.2.4.4 Risk Summary

Cancer Risks

The risk of cancer from an exposure to a chemical is described in terms of the probability that an individual exposed for a lifetime will develop cancer. Cancer risk greater than one in a million (1E-06) may be a cause for concern.

TABLE 1-10
SUMMARY OF EXPOSURE PATHWAYS SELECTED FOR QUANTIFICATION

LAND USE	POTENTIALLY EXPOSURE POPULATION	EXPOSURE POINT	EXPOSURE MEDIUM	EXPOSURE ROUTE
Current	Residents (child and and adult) immediately south of the site	Each existing residence	Groundwater	Ingestion Inhalation-VOCs Dermal
	Dirt-bike rider	Site	Soil	Ingestion Dermal contact
			Air	Inhalation - Particulates - VOCs
	Wader	Surface water on-site	Surface water	Ingestion Dermal contact
			Sediment	Ingestion Dermal contact
	Residents (child and adult) northeast of site	Closest downwind resident northeast of site	Air	Inhalation - Particulates - VOCs
Hypothetical Future	Residents on Waste Mass (child and adult)	Residence on waste Mass	Soil	Ingestion Dermal contact
			Groundwater	Ingestion Inhalation-VOCs Dermal
	Residents (child and adult) immediately south of the waste mass.	Residence south of the waste mass	Soil	Ingestion Dermal contact
			Groundwater	Ingestion
	Occupational Workers	Plant or office facility on-site	Soil	Ingestion Dermal contact
			Groundwater	Ingestion
	Agricultural Workers	Site	Soil	Ingestion Dermal contact
			Air	Inhalation - Particulates - VOCs
			Groundwater	Ingestion
	Residents (child and adult) northeast of site	Closest downwind residence northeast of site	Air	Inhalation - Particulates - VOCs

Because of the relatively high concentrations of contaminants in the leachate, it is clear that risk for a future resident with a house on the waste mass is not acceptable. Based on Phase I residential well data, the total estimated cancer risk for current resident populations adjacent to the waste mass utilizing groundwater ranges from 4E-05 to 2E-04. Chemical contributing to this risk include arsenic, beryllium, benzene, 1,1-dichloroethene, bis(2-ethylhexyl)phthalate and methylene chloride. However, the Phase I residential well data driving these risks have been judged to be non-usable for risk assessment purposes due to the questionable integrity of these two wells (these wells were out of operation before being sampled). The cancer risk for current populations utilizing groundwater is being recalculated using data from monitoring wells E2 and M2 and will be included in the final baseline risk assessment. It is expected that this cancer risk will be at least as great, if not greater, than the cancer risk range calculated using the residential well (e.g., RW-02 and RW-05) data. The reason for this can be seen in Table 1-11 which compares arsenic concentrations for the two residential wells, RW-02 and RW-05, with the two monitoring wells, E2 and M2. From this table it can be seen that arsenic, which is a major contributor to the cancer risk, is at higher concentration in wells E2 and M2 than in RW-02 and RW-05.

Estimated cancer risks for other current populations range from 2E-08 (wader) to 1E-05 (downwind adult resident). Estimated cancer risks for future populations are highest for on-site resident adults (2E-03) (calculated from data from shallow wells E2 and M2). The majority of this risk is from the groundwater ingestion pathway.(Life Systems, 1991)

Non-cancer Risks

The potential for noncarcinogenic effects is evaluated on a Hazard Index (HI) approach which compares the intake over a specific exposure period to a reference dose derived for the same period. An HI greater than 1.0 indicates the possibility that adverse effects may occur. No HIs for current populations were found to exceed 1.0. The only HI that exceeds 1.0 for hypothetical future populations is one that involves the use of groundwater. Antimony, arsenic and nitrate/nitrite are the chemicals posing this risk.

1.3 Site Remediation Approach

Because many CERCLA municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. U.S. EPA has established a number of expectations as to the types of remedial alternatives that should be developed during the detailed analysis (U.S. EPA, 1991). This eliminates the need to conduct the initial screening of alternatives based on technical feasibility which is suggested under U.S. EPA's

TABLE 1-11

COMPARISON OF WELLS RW-02, RW-05, E2 AND M2

Himco Dump Superfund Site
Elkhart, Indiana

WELL	ARSENIC (ug/L)
RW-02	2.7
RW-05	ND
E2	54.5
M2	ND

ND - Not Detected

guidance (U.S. EPA, 1988) for a typical FS. Alternatives proposed in this technical memorandum will be screened for effectiveness, implementability and cost. The following sections discuss the strategy for the site remediation.

1.3.1 Groundwater

The results of the RI show that the landfill leachate is contaminated by VOCs, semi-VOCs, and inorganics. The RI results also show that the impact to groundwater outside the waste mass is currently limited to a few contaminants at low concentrations. However, the results of the Phase II baseline risk assessment is not available at this time to verify that groundwater outside the waste poses unacceptable risks. Additionally, because there is no liner or natural barrier to impede leachate migration to groundwater, the aquifer downgradient of the site may be unacceptably impacted in the future.

The FS will evaluate capping which might be sufficient to minimize leachate generation and therefore, reduce impacts to downgradient groundwater. To deal with the potential for current unacceptable risks or future releases in the event that capping does not fully mitigate leachate migration to groundwater, the FS will include an evaluation of groundwater remedies. The FS will also specify the conditions that would trigger the implementation of a groundwater remedy. We anticipate that one groundwater alternative will be selected and combined with the preferred remedy for the landfill content at the site for inclusion in the Record of Decision (ROD).

The FS will not develop groundwater cleanup objectives at this time. Instead, the ROD will state that a groundwater risk assessment will be conducted periodically (perhaps 5 year intervals) in the future. If the results indicate unacceptable risk, specific cleanup objectives will be determined prior to implementation of the groundwater remedy.

1.3.2 Hot Spot

One area of high contamination was identified in the landfill area (test pit TL5). U.S. EPA is considering an emergency removal action for this area. If this area is not remediated by U.S. EPA, SEC Donohue will include remediation of this area in the FS. Under this condition, the cleanup objectives for this hot spot will be based on the potential for groundwater contamination by residuals from the hot spot area. The residual threat by direct contact will be eliminated by capping following removal and treatment of the hot spot material. The hot spot material will be subject to land disposal restrictions and will probably be incinerated because of the high concentration of what appears to be organic solvent.

1.3.3 Site Soils and Waste

Capping the landfill and area south of the landfill will be considered for a detailed evaluation in the FS. Because capping in combination with institutional controls will eliminate the exposures to contaminated soils and wastes, the risk will be effectively eliminated. Therefore, no cleanup objectives will be developed for soils and wastes remediation.

2.0 IDENTIFICATION OF REMEDIAL TECHNOLOGIES

2.1 Introduction

In this section, remedial technologies and process options are identified and screened based on site-specific information. This process involves five steps:

- Develop remedial action objectives (RAOs) in accordance with U.S. EPA's expectations as to the types of remedial alternatives that should be developed for detailed analyses of municipal landfills as they are listed in the National Contingency Plan (40 CFR 300.430 (a)(1)).

- Develop general response actions (GRAs) for each medium of interest which could be taken to satisfy the site-specific RAOs.

- Identify volumes and areas of contamination for which GRAs may be required.

- Identify technologies and process options applicable to each GRA from the list of technologies most implemented at municipal landfills (U.S. EPA, 1991).

- Further screen the technologies and process options based on effectiveness, implementability, and cost to select a representative process option, where appropriate.

Technologies retained after the screening process are assembled into alternatives in Section 3.0.

2.2 Remedial Action Objectives

Remedial action objectives (RAOs) are site-specific remedial goals for protecting human health and the environment. RAOs for this site are developed in terms of eliminating exposure pathways. The RAOs may also be based on Federal and State ARARs. A list of Federal and State ARARs for the Himco site is presented in Section 4.0 of this memorandum. RAOs will not be developed in terms of reducing contaminant levels, since no chemical specific cleanup goals are being developed for the contents of the landfill or the groundwater at this site (refer to Section 1.3).

Based on the above discussion, RAOs identified for the Himco site include:

- Prevent direct contact with landfill contents.

- Reduce contaminant leaching to groundwater so that risk from groundwater use will not exceed 1E-04 or a HI of 1.0.

- Control surface water runoff and erosion to maintain cap integrity, to prevent direct contact, and to eliminate migration of contaminants to surface water and wetlands.

- Remediate the hot spot to reduce the potential of future groundwater contamination and direct contact.

- Collect and treat contaminated groundwater, leachate, or both if current conditions or future monitoring indicates groundwater risks cannot be controlled by source control (capping and hot spot removal).

- Control and treat landfill gas to reduce gas pressures. This will prevent damage to a cap and off-site migration of the landfill gases.

2.3 Identification of Areas and Volumes of the Impacted Media

The areal extent of the landfill was determined using a combination of geophysical survey, analysis of test pits and soil borings, and examination of the site aerial photos (refer to Section 1.2.3.2). Based on this investigation, the landfill boundaries were determined and are presented in Figure 1-1.

Leachate was encountered in nearly all test pits excavated at this site. Precipitation is the primary source of the leachate. The leachate volume may be estimated based on water balances using climatic (annual precipitation, evaporation) and surface drainage data. However, recognizing that most alternatives will include some form of cap, the volume of leachate will be estimated for the various cap types considered in the detailed evaluation. The HELP model will be used to estimate leachate volumes corresponding to each cap type. Refer to Attachments B and C for discussions regarding leachate volume.

As a result of the decomposition of wastes in the landfill, gas in generated. Gas generation rate is a function of landfill composition, age of material in the landfill, oxygen concentration, moisture content, and available nutrients. According to published information, the total production of landfill gas from a typical municipal refuses varies from less than 1 scf/lb to 7 scf/lb, (Wilkey, et.al., 1982). Landfill gas typically contains approximately 50% methane.

Hydrogen sulfide (H_2S) was encountered in all test pits. However, methane was not detected in these test pits. Because household wastes are present in the landfill, lack of detection of methane in the test pits is an anomaly. However, because construction demolition debris and industrial waste are also present in the landfill, gas generation rate is expected to be less than that of a typical household/municipal waste landfill.

2.4 Identification of General Response Actions

General Response Actions (GRAs) are defined as actions which will satisfy RAOs and which characterize the range of remedial responses appropriate to various media at a site (U.S. EPA, 1988). These may include institutional controls, containment, extraction, excavation, treatment (in-situ or above-ground), and disposal. Like RAOs, GRAs are medium-specific. Ultimately, combinations of GRAs will be incorporated as composite alternatives for detailed evaluation in the FS.

A list of preliminary remedial technologies for the Himco site is presented in Figure 2-1.

2.4.1 No Action

The No Action response action means that no site work other than periodic monitoring would be performed at the site. This response action is required for evaluation as designated by the National Contingency Plan (NCP).

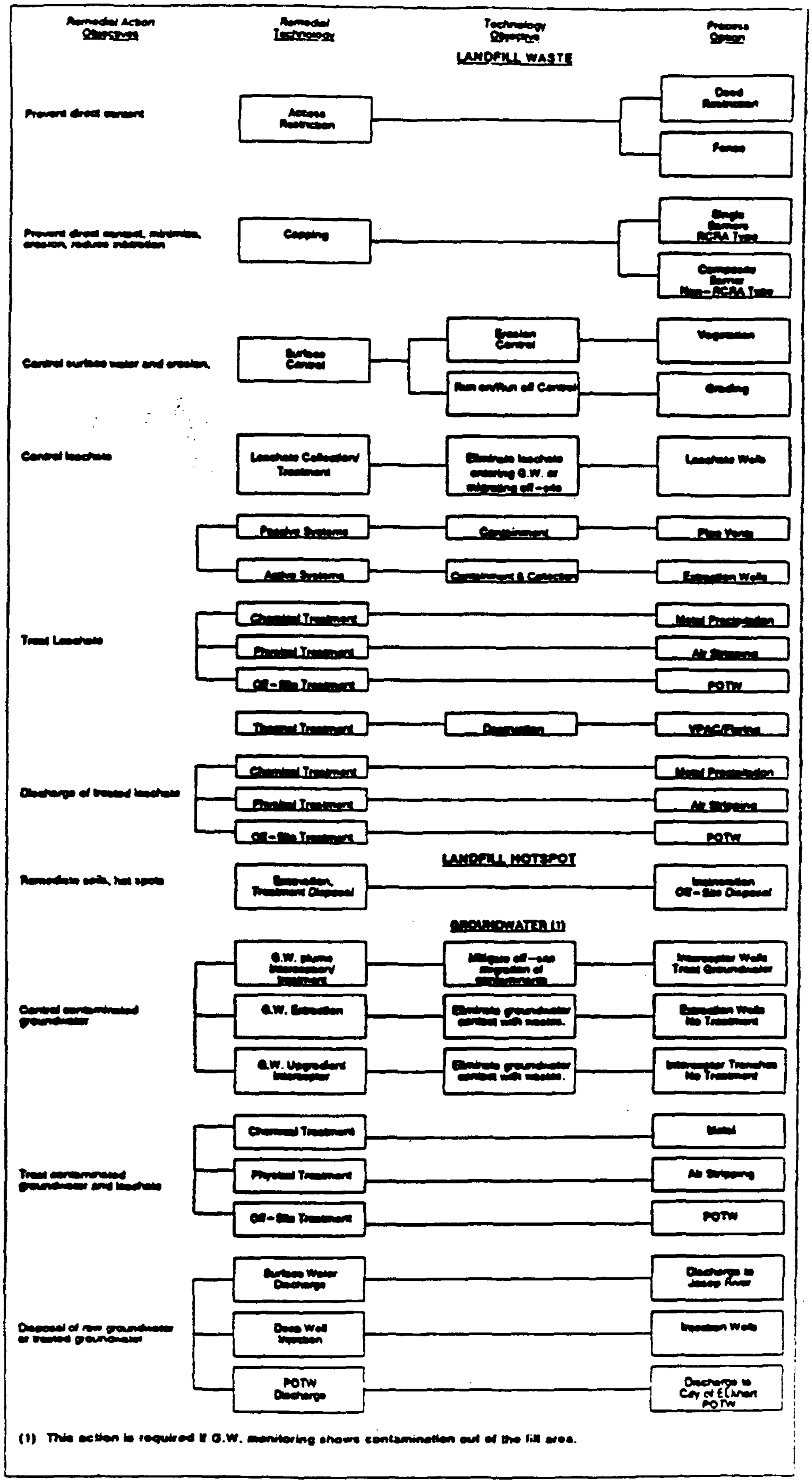
2.4.2 Institutional Controls

The Institutional Controls response action consists of legal restrictions on future use of the site (e.g., deed restrictions); physical restrictions (e.g., fencing) to prevent or reduce exposure to on-site contamination; and long-term site monitoring.

2.4.3 Landfill Closure

In the case of the Himco site, the SEC Donohue FS team defines "Landfill Closure" as a response action consisting of one or more of the following technologies: capping, leachate collection and treatment, and gas collection and treatment.

FIGURE 2-1
PRELIMINARY REMEDIAL TECHNOLOGIES
HIMCO DUMP SUPERFUND SITE
RI/FS



2.4.3.1 Capping

At the Himco site, this technology would consist of constructing a cap over the main landfill area at a minimum. The area to be potentially capped is presented in Attachment A. The cap could be extended into two areas of concern at the site, the hot spot and the area of the site south of the landfill which is characterized by non-native soil and construction debris. Refer to Attachment A for calculation of the are to be capped.

Capping technologies are designed to reduce surface water infiltration, to control emissions of gas and odors, to reduce erosion, and to improve aesthetics. They also provide a stable outside surface that prevents direct contact with wastes.

The FS will evaluate the following different types of capping technologies typically used at municipal landfills: (1) native soil cover capping; (2) single barrier (e.g., clay) capping; and (3) composite barrier (e.g., clay plus flexible membrane liner) capping.

2.4.3.2 Leachate Collection, Treatment and Disposal

During test pit activities at the Himco site, large quantities of leachate filled each of the test pits excavated in the main landfill area, and several of the trenches excavated south of the main landfill area. Leachate at the site is generated primarily due to rainfall infiltration. Groundwater migration through the waste and natural biodegradation of the waste contributes to the generation of leachate at the site also. The leachate at the site has been found to contain VOCs, semi-VOCs pesticides, and metals.

The function of a leachate collection system at the Himco site would be to minimize or eliminate the migration of leachate from the landfill area to groundwater or to nearby surface water systems. A discussion of leachate collection specific to the Himco site is presented in Attachment C.

Based on the chemical characteristics of the leachate, it is anticipated that the leachate will need to be treated either on or off-site. The technologies to be evaluated for leachate treatment are air-stripping for VOCs, carbon adsorption for semi-VOCs, and precipitation for inorganics.

Air Stripping

Air stripping is a mass transfer process in which VOCs are transferred from the aqueous to the vapor phase. Depending on the solubility and volatility of the contaminants, air strippers are capable of removing greater than 95 percent of the VOCs present in the influent to the unit process. Specific removal rates include the physical characteristics of contaminants, temperature, air-to-water ratio, and the physical characteristics of the air stripping equipment. For the Himco Dump Superfund site, due to the flow rate desired and VOCs present, a packed column or tower using counter-current flow of air and water is assumed. This configuration allows for high air-to-water contact time, required to achieve high removal efficiencies.

Air stripping should be effective for removing the VOCs present in the Himco leachate. Therefore, air stripping is retained for further evaluation.

Carbon Adsorption

The basic principle of operation for carbon adsorption is the mass transfer and adsorption of a molecule from a liquid or gas onto a solid surface. Activated carbon is manufactured in such a way as to produce extremely porous carbon particles whose internal surface area is very large (500 to 1,400 square meters per gram of carbon). This porous structure attracts and holds (adsorbs) organic molecules as well as certain metal and inorganic molecules.

Adsorption occurs because (1) the contamination has a low solubility in the waste, (2) the contaminant has a greater affinity for the carbon that for the water, or (3) a combination of the two. The amount of contaminants that can be absorbed by activated carbon ranges from 0.10 to 0.15 gram per gram of carbon (U.S. EPA, 1990).

Chemical Precipitation/pH Adjustment

Chemical precipitation is applicable for removing inorganic contaminants from leachate and groundwater. Precipitation is a process by which the chemical equilibrium of a waste stream is altered to reduce the solubility of heavy metals. The metals precipitate out as a solid material and are taken out of the solution by solids removal processes. Metals precipitation is not one unit operation, but a combination of coagulation, flocculation, sedimentation, and filtration processes.

The solubility of most heavy metals is reduced by raising the pH of a wastewater from 8 to 12. Some arsenic species are anionic and may not be removed by precipitation. However, these species may adsorb to the solids produced in the precipitation process.

Adjustment of pH alone, however, is usually insufficient for removal of the insoluble metal hydroxide solids. Coagulants, such as iron salts, alum, and polymers, must be added to neutralize charges and to cause the formation of metal precipitates. Chemical coagulants are added in a rapid mix tank and are followed by gentle mixing or "flocculation," which causes interlattice bridging and formation of flocs which settle rapidly. The settled solids can then be removed by a clarifier, a filter, or both.

Four options for disposal of treated leachate will be evaluated by the FS team for the Himco site. The four disposal options are discharge to Publicly Owned Treatment Works (POTW), National Pollutant Discharge Elimination System (NPDES) permitted discharge, infiltration, and injection.

Discharge to the POTW would consist of discharging treated leachate to the City of Elkhart wastewater system. A NPDES discharge is typically for discharges to surface water bodies. The feasibility of discharging treated site leachate to Christiana Creek, the St. Joseph River, or one of the three on-site ponds will be evaluated. Infiltration would consist of spray applicating the treated leachate over the ground surface at some point on or off site. Injection would consist of injecting the treated leachate to the aquifer system through injection wells.

2.4.3.3 Gas Collection and Treatment

The Himco site produces landfill gas (LFG) naturally due to the decomposition of organic material in the dump. The EPA guidance document states that LFG collection should be evaluated during the FS if the following situations exist at the site: (1) homes and buildings are within 1,000 feet of the landfill; (2) the final land use of the landfill involves use by the public; and (3) the landfill produces excessive odors (EPA, 1991). Situation 1 is definitely applicable to the Himco site. It can be argued that Situation 2 is applicable because the site is used for hunting, dirt bike riding, hiking, etc. It can also be argued that Situation 3 is applicable because nearby residents complained to the SEC Donohue RI field team about the "terrible" odors coming from the landfill, especially during the summer months. For these reasons, gas collection and treatment will be retained for detailed analysis. Both passive and active gas collection systems will be evaluated and are preliminarily discussed in Attachment D.

Passive LFG control systems alter subsurface gas flow paths without using mechanical components. The passive systems to be evaluated are pipe vents and trench vents. Pipe vents are used to vent LFG at points where it is collecting and building up pressure. They are often used with flares that burn the LFG at the point of release. Trench vents usually consist of gravel trenches surrounding the waste site. They form a path of least resistance through which gases migrate upward to the atmosphere.

Active LFG control systems use mechanical means to alter pressure gradients and redirect subsurface gas flows. The most logical active system to be evaluated is gas extraction wells equipped with gas collection headers and vacuum blowers or compressors. Gas extraction well systems typically consist of a series of extraction wells spaced throughout the landfill. Vacuum blowers are used to extract the gas from the wells and push the collected LFG to treatment or release point.

The technologies to be evaluated for LFG treatment are thermal treatment and direct release to the atmosphere. Thermal treatment of collected LFG is accomplished by flaring. Flaring systems typically consist of mixing LFG with an auxiliary fuel and feeding the mixture through a vertical, open ended pipe. Pilot burners next to the end of the pipe ignite the mixture. As the name suggests, direct release of LFG to the atmosphere consists of collecting and releasing LFG directly to the atmosphere without thermal treatment. This technology may be applicable at Himco if a cap is constructed over the dump.

2.4.4 Groundwater Collection, Treatment and Disposal

Collection and treatment of groundwater is a common component of the overall remediation of municipal landfill sites. The three groundwater control measures evaluated for the Himco site include: plume interception and treatment, water table drawdown, and an interceptor trenches. These measures are described below.

The plume interception alternative involves intercepting the plume down gradient of the site by means of a line of shallow extraction wells and treatment of the groundwater by air stripping, carbon adsorption, and metal precipitation (refer to Attachments F and J for site-specific discussion of plume interception).

The groundwater table drawdown alternative involves pumping groundwater from the deep portion of the aquifers to effectively drawdown groundwater to below the base of the wastes in the landfill. For this alternative, extraction wells screened in the the deep portion of the aquifer, will be installed within the landfill area. The extracted groundwater will be discharged to the St. Joseph River without treatment (refer to Attachments G and H for site-specific discussions of this alternative).

The interceptor trench alternative involves intercepting groundwater by means of interceptor trenches upgradient of the site. This measure will result in groundwater drawdown to below the base of landfill waste. The extracted groundwater will be discharged to the St. Joseph River without treatment (refer to Attachments E and I for site-specific discussions of this alternative).

2.5 Screening of Technologies

The technologies identified in the previous section are screened based on effectiveness, implementability, and cost.

Effectiveness of each technology is established by three criteria: the potential short-term and long-term effectiveness of the process options in controlling the contamination, the potential impacts to human health and the environment, and how proven and reliable the process is for remediating with regard to the matrix, contaminants, and the conditions at the Himco site.

Implementability of each technology is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-related requirements. Administrative feasibility refers to the availability of facilities, equipment, and personnel pertaining to a specific technology, and the ability to obtain the proper agency approval for the remedial action alternative.

Costs are developed by estimating the relative capital expenditures necessary to implement an alternative. These costs are based on vendor quotes, generic unit costs, and prior similar cost estimates.

Figure 2-2 presents the screening process for the identified process options.

FIGURE 2-2
EVALUATION OF POTENTIAL PROCESS OPTIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Response Actions	Remedial Technologies	Process Options	Description	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	None.	Does not achieve Remedial Action	Not acceptable to local, public or government.	None.
LANDFILL CONTENTS/HOT SPOTS						
Institutional Actions	Groundwater Monitoring	Groundwater Monitoring	Perform water quality analyses to monitor contaminant migration and assess future environmental impact.	Does not achieve RAOs. May be used in conjunction with other process options.	May be acceptable to local, public or government with additional process options.	Low
	Access Restrictions	Deed Restrictions	Institute deed restriction for contaminated properties.	Does not achieve RAOs. May be used in conjunction with other process options.	May be acceptable to local, public or government with additional process options.	Normal
		Fencing	Fence contaminatedproperties to isolate the site and minimize direct contact with contaminated landfill contents and soils.	Does not achieve RAOs. May be used in conjunction with other process options.	May be acceptable to local, public or government with additional process options.	Moderate
Removal (Hot Spots Only) *	Excavation	Excavation	Consists of soil removal using standard earth moving equipment, shoring, and common construction practices.	Effective in removal of contaminant source.	Readily implementable.	Low
Treatment (Hot Spots Only) *	Thermal Treatment	Rotary Kiln Extraction	A cylindrical, refractory-lined shell with a slightly inclined axis that rotates to provide mixing of wastes and combustion air while heating wastes to combustion temperatures.	Achieves complete destruction of organic contaminants.		High
Containment	Capping	Single Barrier Cap	A cap covering waste material to minimize infiltration of precipitation and reduce waste contact.	Effective in minimizing infiltration into the aquifer. Maintenance of cap integrity is required.	Readily implementable.	Low
		Composite Barrier Cap	A cap covering waste material to minimize infiltration of precipitation and reduce waste contact. This particular type of cap would also include a geomembrane for added protection against infiltration.	Effective in minimizing infiltration into the aquifer. Maintenance of cap integrity is required.	Readily implementable.	Low

(White box) Retained as representative process option.

(Shaded box) Eliminated from further consideration.

* Hot spot removal is not included in any of the selected alternatives for a detailed evaluation because EPA is considering remediation of the hot spot as a part of an emergency response.

FIGURE 2-2
EVALUATION OF POTENTIAL PROCESS OPTIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Response Actions	Remedial Technologies	Process Options	Description	Effectiveness	Implementability	Cost
LANDFILL/LEACHATE						
Collection	Leachate Collection	Leachate Extraction Wells	An effective method of removing leachate for treatment, that is generated by the landfill.	Effective in extracting leachate generated in the landfill.	Implementable	High
Leachate Treatment	On-Site Physical/ Chemical Treatment	Air Stripping	Effective and proven method for removal of VOCs.	Effective and reliable for metals removal. Process creates a sludge that requires disposal.	Readily implementable.	Low
		Chemical Precipitation /pH Adjustment	Effective and reliable for metals removal. Process creates a sludge that requires disposal.	Effective in eliminating contact of groundwater with wastes disposed of in landfill.	Implementable.	Low to Moderate
LANDFILL GAS						
Collection	Gas Collection	Passive Gas Collection	A high or low permeability system that is effective in controlling subsurface gas migration without mechanical components.	Effective in controlling subsurface gas migration.	Implementable	Low
		Active Gas Collection	A high or low permeability system that is effective in controlling subsurface gas by mechanical means such as a centrifugal blower, to alter pressure gradients and thus, extract gas for treatment, utilization or controlled venting.	Effective in controlling subsurface gas migration.	Implementable	Low to Moderate
Gas Treatment	Thermal Treatment	Enclosed Ground Flares	An effective means of burning waste gases and destroying organics that are heavier than methane. Steam or air are used to provide efficient mixing to complete the combustion process.	Effective in eliminating gases collected from landfill.	Implementable	Low
		Carbon Adsorption	Effective for obtaining good organic compound and low effluent contaminant levels. Requires periodic regeneration and/or proper disposal of spent carbon. It costs more than the flow flare process option and does not provide any added advantage.	Effective in eliminating gases collected from landfill.	Implementable	Moderate

(open box)	Retained as representative process option.
(shaded box)	Eliminated from further consideration.

FIGURE 2-2
EVALUATION OF POTENTIAL PROCESS OPTIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

GROUNDWATER

Response Actions	Remedial Technologies	Process Options	Description	Effectiveness	Implementability	Cost
Institutional Actions	Monitoring	Groundwater Monitoring	Perform water quality analyses to monitor contaminant migration and assess future environmental impact.	Does not achieve RAOs. May be used in conjunction with other process options.	Readily implementable.	Low.
	Groundwater Restrictions	Deed Restrictions	Institute deed restrictions for contaminated properties.	Does not achieve RAOs. May be used in conjunction with other process options.	May be acceptable to local, public or government with additional process options	Normal.
Plume Interception	Groundwater Extraction	Pumping from Wells	Remove contaminated groundwater by interceptor wells.	Effective in capturing the plume and preventing potential off-site migration.	Readily implementable.	Low
	Physical Treatment	Air Stripping	Reduce concentrations of VOCs through intimate contact of extracted groundwater with air.	Effective and proven method for removal of VOCs. Effluent air stream may have to be treated further before discharge.	Readily implementable.	Low
	Chemical Treatment	Chemical Precipitation /pH Adjustment	Process in which a dissolved contaminant is transformed into an insoluble solid and then removed by flocculation and sedimentation. The transformation to solids takes place at specific pH ranges for different contaminants and requires pH adjustment of the solutions.	Effective and reliable for metals removal. Process creates a sludge that requires disposal.	Readily implementable.	Low
Water table Drawdown	Groundwater Extraction	Pumping from Wells	Use extractor well to draw down water table.	Effective in eliminating contact of groundwater with wastes disposed of in landfill.	Implementable.	Low to Moderate
Diversion	Groundwater Diversion	Inceptor Trenches	Install interceptor trenches around the site to draw down water table.	Effective in eliminating contact of the groundwater with wastes disposed of in landfill. Requires more groundwater to be intercepted than the groundwater extraction alternative and does not provide any added advantage over the groundwater extraction process option.	Implementable with proper design.	Moderate

Retained as representative process option.

Eliminated from further consideration.

FIGURE 2-2
EVALUATION OF POTENTIAL PROCESS OPTIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

GROUNDWATER (Cont'd)

Response Actions	Remedial Technologies	Process Options	Description	Effectiveness	Implementability	Cost
Disposal of Groundwater	Discharge	Discharge to St. Joseph River	Discharge to St. Josef River.	Effective in discharge of treated groundwater.	Implementable.	Low
		Off-Site POTW	Discharge to the city of Elkhart POTW.	Effective in discharge of treated groundwater.	Not implementable. POTW will not accept groundwater from a CERCLA site.	Low
		Recharge to Groundwater	Discharge back to aquifer.	Is not effective in drawing down water table because no confining layer exists at this site.	Implementable.	Low to Moderate
	Sludge/Wastewater Disposal	Off-Site RCRA Disposal Facility	Effective in disposal of treatment wastestreams and sludges.	Effective in disposal of treatment waste streams and sludges and soils.	Implementable.	Moderate to High
Disposal of Leachate: Discharge	Off-Site POTW	Off-Site POTW	Discharge to the City of Elkhart POTW.	Effective in discharge of leachate.	May be implemented depending on the volume of the leachate.	Low
	TSDF	TSDF	Discharge to a permitted landfill for treatment and disposal.	Effective in discharge of leachate.	Implementable.	Moderate

Retained as representative process option.

Eliminated from further consideration.

3.0 DEVELOPMENT OF ALTERNATIVES

3.1 Introduction

In this Section, technologies and related process options which emerge from the identification and screening of technologies in Section 2.0 are combined into alternatives for the total site. The alternatives developed will eventually be evaluated in detail as part of the FS.

Because many municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. To take advantage of this aspect of landfills, the U.S. EPA has developed some tools and methodologies to streamline the RI/FS process for these sites. U.S. EPA has established a number of expectations related to remedial alternatives and listed them in the National Contingency Plan (NCP). These include:

- The principal threats posed by a site will be treated wherever practical, such as in the case of remediation of a hot spot area.

- Engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impractical.

- A combination of methods will be used as appropriate to achieve protection of human health and the environment. An example of combined methods for municipal landfill sites would be containment (capping) of the landfill contents with institutional controls.

- Institutional controls, such as deed restrictions, will be used to supplement engineering controls, as appropriate, to prevent exposure to hazardous wastes.

- Innovative technologies will be considered when such technologies offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

- Groundwater will be returned to beneficial uses whenever practical, within a reasonable time, given the particular circumstances of the site.

3.2 Development of Alternatives

In formulating site encompassing alternatives, an iterative process is used which systematically pairs applicable technologies to the defined waste matrices. Specific to the Himco site, matrices requiring analysis include groundwater, leachate, the contents of the landfill and landfill gas. Pollutants of concern include VOCs, semi-VOCs, and metals. To the extent possible, alternatives are developed to present an array of conventional and innovative treatment technologies, risk levels, and cleanup costs.

Section 2.0 of this report includes a discussion on the process for establishing RAOs. The alternatives formulated in this section are purposely developed to be flexible to accommodate a range of options from the least stringent to the most stringent treatment options.

It should be recognized that the groundwater, leachate, contents of the landfill, and landfill gas treatment operations discussed in Section 2.0 are separate processes, yet they are very interdependent. For instance, although source control alternatives are discernible activities unique from groundwater remediation, the extent of source control activities may have a direct impact on the need for groundwater treatment or on the duration and extent of groundwater treatment. Therefore, in developing total site alternatives, arrays of unit technologies for the contents of the landfill, leachate, landfill gas and groundwater matrices are prepared so that they can be matched to develop site alternatives to attain the desired preliminary remedial goals.

The development of site-wide alternatives is in part based on the following:

- The no action alternative is included as part of the detailed alternatives evaluation in the FS to provide a baseline against which other alternatives may be compared.

- Institutional controls are included within remedial alternatives in order to prevent exposure to hazardous wastes.

- Results of the RI show that the leachate in the landfill proper is contaminated by VOCs, semi-VOCs and metals. However, the impacts to the groundwater downgradient of the landfill is minimal and groundwater is currently contaminated with relatively low levels of inorganic compounds (e.g., arsenic at 54.5 ug/l in well E2). Results from the combined Phase I and Phase II data baseline risk assessment is not available at this time to determine whether there is a need to implement a groundwater remediation alternative. It is possible that the RAOs may be met by eliminating exposure routes, without inclusion of a

3.2.2 Alternative 2 - Containment by Means of a Clay Cap, Passive Gas Collection, Groundwater Monitoring and Institutional Controls

Alternatives for the Landfill Contents

This alternative includes containment of the landfill by means of a clay cap, collection of landfill gas via a passive gas piping network, and monitoring and institutional controls including controls in the form of deed restrictions, fencing and use of the groundwater. If the results from the combined Phase I and Phase II sampling program and baseline risk assessment indicate that the groundwater is posing unacceptable risks (accumulated excess cancer risk greater than IE-04 or hazard index of greater than 1), then one of the two groundwater remedial controls recommended in Section 2.0 will be implemented. Similarly, if subsequent groundwater monitoring identifies the migration of contaminants to the groundwater, and that one of the following criteria applies:

- The accumulated excess cancer risks due to exposures to groundwater down gradient of the site exceeds 1E-04;
- The accumulated excess non-carcinogenic risk due to exposures to groundwater down gradient of the site exceeds a HI of 1; or
- MCLs are exceeded;

then, groundwater remedial controls may be instituted. The FS will identify the wells to be included for groundwater monitoring and will present a statistical mechanism to determine whether the criteria described above are exceeded and a groundwater control measure is needed.

The cap would include a six-inch vegetated soil layer underlain by two-foot low permeability (permeability of less than 1E-07 cm/sec) clay cover. A passive landfill gas collection system would be included as part of the cap. The gas well nests will be equipped with a flare system to treat the gases. Leachate from the landfill is assumed to not be a concern due to the implementation of the clay cap which will drastically reduce the amount of infiltration to the landfill, and thus minimize the generation of any leachate.

groundwater remediation alternative. However, as a contingent measure, system alternatives formulated on the following pages have been considered to include provisions for groundwater remedial control measures to ensure the protection of human health and the environment. The selected groundwater remedial alternatives include options for mitigating potential future contaminated groundwater transport away from the landfill area and preventing contact between the groundwater and the waste within the landfill.

- Contaminated leachate from the landfill is best addressed via collection in leachate wells. Options for treating the contaminated leachate include transport to an off-site POTW or TSDF, and construction of an on-site treatment system. The selection of which treatment option to incorporate will be dependent upon the volume of leachate requiring treatment.

- One area of high organic contamination within the contents of the landfill was identified as part of the RI. U.S. EPA is considering remediation of this area as part of an emergency response action. No additional hot spots or areas of significant contamination have been identified or defined to require treatment. Therefore, no provisions are included within a number of the alternatives for contaminated soils or waste in the unsaturated zone of the landfill.

- The heterogeneous nature of the Himco site precludes the use of ISVE, in-situ biological treatment, stabilization or thermal treatment processes for addressing the contents of the landfill. Preference is given to containment options such as capping that will reduce the "diffuse" contribution of contaminants from the municipal waste.

A total of four alternatives, including no action, evolved for remediating the landfill contents, and two alternatives evolved for groundwater control measures from the development of alternatives.

3.2.1 Alternative 1 - No Action

As noted above, the no-action alternative is required as part of the NCP and provides a baseline against which other alternatives can be compared.

3.2.3 Alternative 3 - Containment by Means of a Clay Cap, Passive Gas Collection, Leachate Collection and On-Site Treatment, Groundwater Monitoring and Institutional Controls

Alternative 3 is similar to Alternative 2 as it includes similar elements for remediating the landfill contents and provisions to implement the groundwater remediation controls. Alternative 3 also includes collection and treatment of the contaminated leachate in an on-site treatment plant or a discharge to public owned treatment works (POTW) or to an off-site treatment, storage and disposal facility (TSDF).

Leachate from the landfill would be collected via a series of shallow perimeter wells. On-site treatment of the leachate is assumed to include air stripping in conjunction with vapor phase granular activated carbon for treatment of the off-gas for the VOCs present, aqueous carbon adsorption for removal of the Semi-VOCs present and chemical precipitation for control of the metals.

3.2.4 Alternative 4 - Containment by Means of a Multi-Layer RCRA Cap, Active Landfill Gas Collection and On-site Treatment, Leachate Collection and On-Site Treatment, Groundwater Monitoring and Institutional Controls

Alternative 4 is similar to Alternative 3 except a multi-barrier (RCRA-type) cap would be constructed instead of a clay cap and the landfill gas collection system would be equipped with blowers in lieu of a passive collection system. The provisions for implementing groundwater alternatives is similar to Alternatives 2 and 3.

This alternative is the most extensive remedial action being considered. First, the multi-barrier cap is more protective in controlling water migration through the landfill area and at preventing the diffuse dispersion of landfill gases. Second, the active landfill gas collection system will accelerate the removal of gas from the landfill and provide a defined means for collecting and controlling the gas. Third, the landfill leachate will be collected via leachate wells and treated on-site or discharged to POTW or an off-site TSDF (similar to Alternative 3). Fourth, the groundwater monitoring and remedial action contingency plan will be similar as that presented in Alternatives 2 and 3. A RCRA cap would include a 24-inch soil cap, 12-inch sand drainage layer, flexible membrane layers and 12-inch cover soil.

<u>Groundwater Alternatives</u>

The provisions to implement a groundwater control measure were presented in Section 3.2.2. Based on the screening of technologies in Section 2.0 of this memorandum, the following groundwater remediation alternatives will be considered for a detailed evaluation in the FS.

Alternative 1 - Plume Interception and Groundwater Treatment

Alternative 1 includes installation of the plume interceptor wells downgradient of the site and groundwater remediation via air stripping, carbon adsorption and metal precipitation. This alternative may be coupled with any of the soil alternatives in order to meet the site-wide preliminary remediation goals. However, this alternative is most viable for Alternative 2 of the landfill content in which no leachate collection measure is considered.

The groundwater Alternative 1 may be implemented at a portion of the landfill down gradient side (one-third or two-thirds), depending on the nature of the contaminant releases from the landfill.

Alternative 2 - Groundwater Drawdown. No Treatment.

Alternative 2 includes groundwater extraction wells to drawdown the water table in the landfill to eliminate mixing between the groundwater and landfill contents. This alternative is most effective with the landfill contents alternatives, which include a leachate collection system. Additionally, this alternative is effective if evaluation of the monitoring data suggests that groundwater mixing with the wastes at the landfill is the primary mechanism for contaminants release from the landfill.

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

ARARs are any local, state, and federal promulgated standards or regulations that pertain to contaminants, actions, and locations. A preliminary summary of potential ARARs for the Himco site is presented in Table 4-1. This summary of potential ARARs is presented in this memorandum to allow U.S. EPA and IDEM personnel to comment on and to modify the ARARs.

5.0 REFERENCES

Life Systems, Inc., September 13, 1991, "Draft Baseline Risk Assessment - Human Health Evaluation, RI/FS Support for the Himco Dump Site."

U.S. EPA, October 1988, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," EPA/540/G-89/004.

U.S. EPA, August, 1990, "Treatment Technologies," Published by Government Institutes, Inc., Rockville, Maryland.

U.S. EPA, February 1991. "Conducting Remedial Investigation/Feasibility Studies for CERCLA Municipal Landfill Sites," EPA/540/P-91/001.

Wilkey, Michael, L., et al., 1982, "Methane from Landfills," Argonne National Laboratory, Argonne, Illinois.

Walton, William C., 1988, Groundwater Pumping Tests, Lewis Publishers, Inc., Chelsea, Michigan.

R/HIMCO/AP1

TABLE 4-1

SUMMARY OF POTENTIAL ARARS

MIDCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
FEDERAL					
40 CFR 6, Appendix A Protection of Wetlands	Executive Order 11990	Remediation of municipal landfill sites located next to wetland. Areas will have to be implemented in a manner which minimizes the destruction loss or degradation of wetlands.	Location	Applicable	Affects any alternative selected
40 CFR 52 Approval and Promulgation of Implementation Plans	52.770 - 52.797	File an Air Pollution Emission Notice (APEN) with the State to include estimation of emission rules for each pollutant expected. Include with filed APEN the following: • Modeled impact analysis of source emissions • Provide a Best Available Control Technology (BACT) review for the source operation. Predict total emissions of volatile organic compounds (VOCs) to demonstrate emissions do not exceed 450 lbs/hr, 3,000 lbs/day, 10 gal/day, or allowable emission levels from similar sources using Reasonably Available Control Technology (RACT).	Action	Applicable	Air stripping of waste piles Consolidation Excavation Gas collection Land Treatment Process Technologies
40 CFR 61 National Emission Standards for Hazardous Air Pollutants	61.01-.06 61.10-.14 61.16-.19	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm. Verify that emissions of mercury, vinyl chloride, and benzene do not exceed levels expected from sources in compliance with hazardous air pollution regulations.	Action	Applicable	Air stripping Consolidation of waste piles Excavation Gas Collection Treatment options

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

SINCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
CLEAN WATER ACT (CWA) OF 1977 AS AMENDED (33 U.S.C. 1251)					
40 CFR 122 EPA Administered Permit Programs: The National Pollutant Discharge Elimination System (NPDES)	122.44	Applicable federally approved state water quality standards must be complied with. These standards may be in addition to or more stringent than other federal standards under the CWA.	Action	Applicable	Groundwater Discharge
Water Quality Standards	131				
	122.4	Use of best available technology (BAT) economically achievable is required to control toxic and non-conventional pollutants. Use of best conventional pollutant technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.	Action	Applicable	Groundwater Discharge
	122.44(d)(4)	The discharge must conform to applicable water quality requirements when the discharge affects a state other than the certifying state.	Action	Applicable	Groundwater Discharge
	122.44(e)	Discharge limitations must be established for all trade pollutants that are or may be discharged at levels greater than those that can be achieved by technology-based standards.	Action	Applicable	Groundwater Discharge
	122.44(i) 122.21	Discharger must be monitored to ensure compliance Discharge will monitor: • The mass of each pollutant discharged. • The volume of effluent discharged. • Frequency of discharge and other measurements as appropriate. Approved test methods for waste constituents to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided.	Action	Applicable	Groundwater Discharge

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

SINCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
CLEAN WATER ACT (CWA) OF 1977 AS AMENDED [33 U.S.C. 1251] (CONTINUED)					
	122	Permit application information must be submitted, including a description of activities, listing of environmental permits, etc. Monitor and report results as required by permit (at least annually). Comply with additional permit conditions such as: • Duty to mitigate any adverse effects on any discharge. • Proper operation and maintenance of treatment systems.			
40 CFR 125 Criteria and Standards for the National Pollutant Discharge Elimination System	125.1-3 125.100 125.104	Establish criteria and standards for technology-based requirements in permits under Sections 301(b) and 402 of the CWA. Develop and implement the Best Management Practices (BMP) program and incorporate in the NPDES permit to prevent the release of toxic constituents to surface waters. The BMP program must: • Establish specific procedures for the control of toxic and hazardous pollutant spills. • Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure. • Assure proper management of solid and hazardous waste in accordance with regulations promulgated under RCRA.	Action	Applicable	Groundwater Discharge

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
CLEAN WATER ACT OF 1977 AS AMENDED [33 U.S.C. 1251] (CONTINUED)					
40 CFR 136 Guidelines Establishing Test Procedures for the Analysis of Pollutants	136.1-136.4	Sample preservation procedures, container materials, and maximum allowable holding times are prescribed.	Action	Applicable	Groundwater Discharge
	208(b)	The discharge must be consistent with the requirement of a Water Quality Management plan approved by EPA under Section 208(b) of the Clean Water Act.	Action	Applicable	Groundwater Discharge
40 CFR 144 Underground Injection of Wastes and Treated Groundwater	144.12 144.13 144.14	UIC program prohibits: • Injection activities that allow movement of contaminants into underground sources of drinking water (USDW) and result in violations of MCLs or adversely affect health. • Construction of new Class IV wells, and operation and maintenance of existing wells. Wells used to inject contaminated groundwater that has been treated and is being reinjected into the same formation from which it was withdrawn are not prohibited if activity is part of CERCLA or RCRA actions.	Action	Applicable	Groundwater Discharge
	144.16	All hazardous waste injection wells must also comply with he RCRA requirements.			
40 CFR 403 General Pretreatment Regulations for Existing and New Sources of Pollution					
Discharge to POTW	403.5	Specific prohibitions preclude the discharge of pollutants to POTW that: • Create a fire or explosion hazard in the POTW.	Action	R&A	Groundwater Discharge

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
CLEAN WATER ACT (CWA) OF 1977 AS AMENDED [33 U.S.C. 1251] (CONTINUED)		• Are corrosive (pH <3.0). • Obstruct flow resulting in interference. • Are discharged at a flow rate and/or concentration that will result in interference. • Increase the temperature of wastewater entering the treatment plant that would result in interference, but in no case raise the POTW influent temperature above 104°F (40°C).			
CLEAN AIR ACT of 1963, AS AMENDED [42 U.S.C. 7401]	Section 101	Design system to operate odor free.	Action	Applicable	Air Stripping Excavation Gas Collection Land Treatment Options
		Devise fugitive and odor emission control plan for this section.			
50 FR 30784 July 29, 1985	NA	Applicable federal waste quality criteria for the protection of aquatic life must be complied with when environmental factors are being considered.	Action	Applicable	Groundwater Discharge
52 FR 3748 February 5, 1987	NA	Proposed standards for control of emissions of volatile organics (CAA requirements to be provided).	Action	Applicable	Gas Collection
20 CFR 1910 Worker Protection	All Parts	Rules are administered by IOSHA and do not exceed federal requirements.	Action	Applicable	Any portion of alternative involving treatment, consolidation, excavation or discharge.

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
SOLID WASTE DISPOSAL ACT (SWDA) AS AMENDED BY RESOURCE & RECOVERY ACT (RCRA) OF 1976 (42 U.S.C. 6901)					
40 CFR 264 Standards for Owners and Operation of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities					
Disposal and Closure Requirements	264	Area from which materials are excavated may require cleanup to levels established by closure requirements.	Action	Applicable	Excavation
Subpart G	264.18	Post-closure care to ensure that site is maintained and monitored.	Applicable	Action	O&M
	264.71 and 264.72	RCRA permit-by-rule requirements must be complied with for discharges of RCRA hazardous wastes to POTW's by truck, rail, or dedicated pipe.	Action	R&A	Groundwater Discharge
	264.111	General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.		R&A	Removal/Disposal
		Disposal or decontamination of equipment, structures, and soils.			
		Meet health-based levels of unit.			
	264.220	Use two liners below the waste, a top liner that prevents waste migration into the liner, and a bottom liner that prevents waste migration through the liner throughout the post-closure period.	Action	Applicable	Containment
	264.221(c)	Prevent overtopping of surface impoundment.	Action	R&A	Surface Impoundments

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
SOLID WASTE DISPOSAL ACT (SWDA) AS AMENDED BY RESOURCE & RECOVERY ACT (RCRA) OF 1976 [42 U.S.C. 6901] (CONTINUED)					
Subpart X		Standards for miscellaneous units (long-term retrievable storage, thermal treatment other than incinerators, open burning, open detonation, chemical, physical, and biological treatment units using other than tanks, surface impoundments, or land treatment units) require new miscellaneous units to satisfy environmental performance standards by protection of groundwater, surface water, and air quality, and by limiting surface and subsurface migration.	Action	R&A	Treatment Options
Subpart D		Treatment of wastes subject to ban on land disposal must attain levels achievable by best demonstrated available treatment technologies (BDAT) for each hazardous constituent in each listed waste.	Action	R&A	Treatment Options
	264.228(a)(1) and 264.258	Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes) contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.	Action	Applicable	Removal/Disposal
	264.228(a)and(b) 264.258(b) 264.310(a)and(b) 264.117(c) 264.111	Placement of a cap over hazardous waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed for: • Provide long-term minimization of migration of liquids through the capped area. • Function with minimum maintenance.	Applicable	Action	Capping

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

NINCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
SOLID WASTE DISPOSAL ACT (SWDA) AS AMENDED BY RESOURCE & RECOVERY ACT (RCRA) OF 1976 [42 U.S.C. 6901] (CONTINUED)					
		• Promote drainage and minimum erosion or abrasion of the cover.			
		• Accommodate settling and subsidence so that the cover's integrity is maintained.			
		• Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.			
		Eliminate free liquids, stabilize wastes before capping (surface impoundments).			
		Restrict post-closure use of property as necessary to prevent damage to the cover.			
		Prevent run-on and runoff from damaging cover.			
		Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles).			
		Disposal or decontamination of equipment, structures, and soils.			
	264.251	Use liner and leachate collection and removal system.	Action	R&A	Waste Piles
Surface Water Control	264.251(c)(d) 264.273(c)(d) 264.301(c)(d)	Prevent run-on and control and collect runoff from a 24-hour, 25-year storm (wastes piles, land treatment facilities, landfills).	Action	R&A	Land Treatment Process Technologies

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
SOLID WASTE DISPOSAL ACT (SWDA) AS AMENDED BY RESOURCE & RECOVERY ACT (RCRA) OF 1976 (42 U.S.C. 6901) (CONTINUED)					
	264.271 264.272 264.273 264.276 264.278 264.281 264.282 264.283	Ensure that hazardous constituents are degraded, transformed, or immobilized within the treatment zone. Maximum depth of treatment zone must be no more than 1.5 meters (5 feet) from the initial soil surface, and more than 1 meter (3 feet) above the seasonal high water table. Demonstrate that hazardous constituents for each waste can be completely degraded, transformed, or immobilized in the treatment zone. Minimize runoff of hazardous constituents. Maintain run-on/runoff control and management system. Special application conditions if food-chain crops are grown in or on treatment zone. Unsaturated zone monitoring. Special requirements for ignitible or reactive waste. Special requirements for incompatible wastes. Special requirements for RCRA hazardous waste.	Action	R&A	Land Treatment Process Technologies
40 CFR 268 Land Disposal Restrictions	268	Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions.	Action	R&A	Consolidation
		Movement of excavated to a previously uncontaminated, on-site location, and placement in or on land may trigger land disposal restrictions.	Action	Applicable	Excavation

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
SOLID WASTE DISPOSAL ACT (SWDA) AS AMENDED BY RESOURCE & RECOVERY ACT (RCRA) OF 1976 [42 U.S.C. 6901] (CONTINUED)					
		RCRA hazardous wastes are subject to land disposal restrictions. Land disposal restrictions set performance requirements on treatment of the wastes before land disposal. The effective date for final group of RCRA wastes is May 8, 1990. Extensions to the effective dates have been granted for specific RCRA wastes that are contained in soil and/or debris.	Action	Applicable	Removal/Disposal
		All noted and characteristic hazardous wastes or soils and debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by Land Ban. If alternative treatment technologies can achieve treatment similar to that required by Land Ban, and if this achievement can be documented, then a variance may not be required.	Applicable	Action	Closure
STATE					
326 INDIANA ADMINISTRATIVE CODE (IAC)					
Ambient Air Quality Standards	1-3	Particulate matter emissions must be controlled according to 326 IAC 6-4, which requires that there be no release of visible emissions off-site.	Action	Applicable	Air Stripping Consolidation of waste piles Excavation Gas Collection Treatment Options
Facility Construction	2	Requires permits for construction of a facility depending upon its potential to emit VOCs.	Action		Air Stripping Consolidation of waste piles Excavation Gas Collection Treatment Options

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

SIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
326 INDIANA ADMINISTRATIVE CODE (IAC) (CONTINUED)		**Permit Review Thresholds** VOC - 15 lbs/day, 3 lbs/hour, 25 tons/year TSP - 25 lbs/day, 5 lbs/year, 25 tons/year SO_2 - 20 lbs/day, 10 lbs/hour, 25 tons/year NO_2 - 25 lbs/day, 5 lbs/hour, 25 tons/year CO - 125 lbs/day, 25 lbs/year, 25 tons/year Lead - 1 ton/year - 5 source types 5 tons/year - other lead source permit levels Facilities with lower emission must be registered.			
VOC Emissions	8-1-6	This rule establishes limits for VOC emissions from new sources. Best Available Control Technology (BACT) is required for new sources with potential emission of 25 tons per year or greater.			
Particulate Matter Emissions	6-4	This rule establishes primary and secondary ambient air quality standards necessary to protect public health and welfare for total suspended particulates (TSP), particulate matter with a nominal diameter less than 10 microns (PM_{10}), lead, ozone, nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and carbon monoxide (CO). These standards are shown below.			

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
327 INDIANA ADMINISTRATIVE CODE (IAC)					
Disposal of Wastewater Water Management	2-1	Surface Water Quality Standards are in 327 IAC 2. The rule applies to all waters of the state. "Waters of the state: means such accumulations of water, surface and underground, natural and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this state, but the term does not include any private pond, or any off-stream pond, reservoir or facility built for reduction or control of pollution or cooling of water prior to discharge unless the discharge therefrom causes or threatens to cause water pollution. Although not specifically mentioned, wetlands are included in this definition.	Action	Applicable	Groundwater Discharge
	2-6	Requires the person responsible for a spill that threatens to enter and damage waters of the state to immediately report the spill to IDEM, immediately notify downstream water users, immediately contain and cleanup the spill, and to file reports as required by IDEM.			
	3	327 IAC 3 requires a permit to construct wastewater treatment facility and also for sewer extensions serving a population equivalent of 25 or more, 2,500 gpd or more, or over 300 feet in length and contains standards for these facilities. Effluent limits must be obtained prior to applying for the construction permit.			

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
327 INDIANA ADMINISTRATIVE CODE (IAC) (CONTINUED)					
Direct Discharge of Treatment System Effluent	5-2-8 5-2-13 5-2-14 5-2-15	Off-site discharges must obtain a permit pursuant to 327 IAC 5 (NPDES Permit). Effluent limits are obtained from IDEM for either on-site or off-site discharges regardless of the requirement for a permit. Effluent limits are determined on a case-by-case basis. Limits can be requested by a letter containing information including the contaminants and the expected concentrations, volume of treated effluent, name of receiving stream, and proposed POTW are regulated by the pretreatment sections of 327 IAC 5. Permit may be obtained directly from the POTW if it is <u>delegated</u>. Most large municipal POTWs are delegated. IDEM should be consulted to verify the pretreatment standards of the POTW.	Action	Applicable	Groundwater Discharge
Public Water Supply	8-1 thru 8-2	Provides public water supply standards for any water which is supplied to the public or is used or available for drinking in any school, resort, camp, hotel, apartment house building, place of employment or place frequented by the public. Also provides drinking water standards for community water supply serving 25 or more people or 15 service connection. Outlines minimum sampling frequency for groundwater and surface water sources.	Chemical	RLA	Groundwater Discharge
Public Water Supply Construction	8-3	Requires a permit to construct water main extensions larger than 2,500 feet or 5% increase in customers, public water supplies that serve at least 25 persons or 15 connections, supplies serving restaurants, transient housing or multiple customers through a plumbing system.	Action	Applicable	Groundwater Discharge

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
327 INDIANA ADMINISTRATIVE CODE (IAC) (CONTINUED)		Facility must comply with sanitary or health regulations and conform to design criteria in "Recommended Standards for Water Works" established by the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, the American Water Works Association Standards or acceptable to the Commissioner.			
329 INDIANA STATE ADMINISTRATIVE CODE (IAC) SOIL AND DEBRIS REMOVAL					
Final Cover of Solid Waste Landfill Disposal Facility	2-6 2-14 2-44 3-33-3(a)	Placement of a cap over a landfill requires a cover designed and constructed to: • Provide long-term minimization of infiltration of liquids through the capped area. • Function with minimum maintenance. • Promote drainage and minimize erosion or abrasion of the cover. • Accommodate settling and subsidence so that the cover's integrity is maintained. • Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Action	Applicable	Capping
Solid and Hazardous Waste Management	2-21	Cleanup waste that is not hazardous is regulated as Special Waste. Waste must be characterized and certified by the State as special waste, then it can be sent to a sanitary landfill approved to accept special waste. Methods of sampling and analysis are the same as for hazardous waste. EPTox method is required until Indiana adopts the TCLP.	Action	Applicable	Treatment Options Disposal Excavation

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
329 INDIANA STATE ADMINISTRATIVE CODE (IAC) SOIL AND DEBRIS REMOVAL					
	3	Indiana rules for disposal of hazardous waste only exceed federal rules in administrative and financial assurance requirements. Indiana has not yet adopted the TCLP for determining characteristic hazardous waste, therefore, EPTOX will be required. Indiana also has its own manifest.			Excavation
Security	3-16-5	Sites should be secured in accordance with this rule which: 1. Requires prevention of unknowing and unauthorized entry of persons or livestock if physical contact with the waste, etc., could cause injury or, if disturbance of the waste, etc., would cause a violation. 2. The facility must have either: A 24-hour surveillance system which continuously monitors and controls entry <u>or</u> an artificial or natural barrier which completely surrounds the active portion <u>and</u> a means to control entry (i.e., a lock), at all times, through the gates or other entrances to the active portion. 3. "Danger - Unauthorized Personnel Keep Out" signs are required at each entrance and at other locations sufficient to be seen from any approach, legible from a distance of at least 25 feet.	Action	Applicable	Affects any alternative selected
Contingency Plan	3-18	Existing Hazardous Waste Facility Standards - Contingency Plan and Emergency Procedures, requires that facilities have a contingency plan which minimizes hazards from fire, explosion, or any unplanned sudden or non-sudden release. Emergency coordinator must notify State and local officials specified in the plan. Include:	Action	Applicable	Affects any alternative selected

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

MIDCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
329 INDIANA STATE ADMINISTRATIVE CODE (IAC) SOIL AND DEBRIS REMOVAL (CONTINUED)					
		1. Name and telephone number of reporter 2. Name and address of facility 3. time and type of incident 4. Name and quantity of materials involved 5. Extent of injuries 6. Possible hazards to human health/environment outside facility.			
	3-46-2	General performance standard requires minimization of need for further maintenance; control; minimization, or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.	Action	R&A	Clean Closure (Removal)
	3-46-5	Disposal or decontamination of equipment, structures and soils must meet both state and federal requirements.	Action	R&A Applicable	Clean Closure (Removal) Capping
	3-46-8(d)	Restrict post-closure use of property as necessary to prevent damage to cover.	Action	Applicable	Capping Closure
	3-51-6	Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.	Action	R&A	Clean Closure (Removal)
	3-53-5	Installation of final cover to provide long-term minimization of infiltration.	Action	Applicable	Capping Closure
	3-53-5(b)	Prevent run-on and runoff from damaging cover.	Action	Applicable	Capping Closure
		Protect and maintain surveyed benchmarks used to locate waste cells.			

TABLE 4-1

SUMMARY OF POTENTIAL ARARS (CONTINUED)

SIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Laws/Regulations	Applicable Rules	Applicability	Classification	Type	Affected Portion of Alternative
329 INDIANA STATE ADMINISTRATIVE CODE (IAC) SOIL AND DEBRIS REMOVAL (CONTINUED)					
Surface Water Control	3-33-2(f)(g)(h)	Prevent run-on and control and collect runoff from a 24-hour 25-year storm during closure and post-closure status.	Action	Applicable	Closure
Excavation	3-40 through 3-34.9	Area from which materials are excavated may require cleanup to levels established by closure requirements.	Action	Applicable	Closure Excavation
INDIANA CODE (IC) DEPARTMENT OF NATURAL RESOURCE					
Construction of Water Treatment Facility	13-2-22	Requires the prior approval of DNR. Project may not 1) restrict the waterway, 2) adversely affect the fish, wildlife or botanical resources, or 3) be unsafe to life and property.	Action	R&A	Groundwater Discharge
Construction in a Floodway		Permit is required to 1) place, fill, or erect a permanent structure in, 2) remove water from; or 3) remove material from a navigable waterway.	Action	R&A	Groundwater Discharge
Extraction Well	13-2-6.1	Extraction wells with 100,000 gpd capacity requires registration with DNR.			Groundwater Pump and Treat

R&A - Relevant and Applicable
NA - Not Applicable

A/R/SIMCO/AN9

ATTACHMENT A

AREA OF THE CAP

TECHNICAL MEMORANDUM - Area of the Cap

DATE: March 31, 1991

TO: Mehdi Geraminegad

FROM: Karen Roberts

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Surface Area to be Capped as Part of Remedial Action

The purpose of this memorandum is to summarize the calculations used to estimate surface area to be capped as a part of the potential remedial action for this site and to provide a description of the methods used to estimate this area.

The extent of the landfill was determined by use of geophysical testing, test pits, and aerial photographs. The cap will cover the extent of the landfill as well as a parcel of land southeast of the site. The additional parcel is bordered on the south by County Road 10, on the east by Nappanee Road Extension, and on the west by residential property.

A Himco Dump site map with existing 500 x 500 foot grid was used to estimate the area to be capped.

The following area to be capped was determined from the map:

(9.75 grid blocks) x (250,00 square feet) = 2,437,500 square feet

R/HIMCO/AO4

ATTACHMENT B

INFILTRATION/MIXING RATIO

TECHNICAL MEMORANDUM - Infiltration/Mixing Ratio

DATE: March 31, 1991

TO: Himco File

FROM: Mehdi Geraminegad

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

<u>Evaluate Effectiveness of Capping</u>

Capping would prevent direct contact with contaminated wastes at the site and would reduce infiltration to groundwater and thereby reduce adverse impacts to the aquifer. The effectiveness of the cap to minimize impacts on groundwater is evaluated by estimating a mixing ratio which is dependent on the infiltration rate and groundwater flow rate underneath the landfill (see Eq. 1 in the attachment). The mixing ratio was calculated for three cases: no cap, non-RCRA cap, and RCRA cap. A higher mixing ratio means a less effective cap and a lower mixing ratio means a more effective cap. The infiltration rate will be estimated using the HELP model which has a built-in routine for climatic information and for simulating infiltration rates for various cap and surface drainage conditions. The calculations for mixing ratios will be presented in the FS report.

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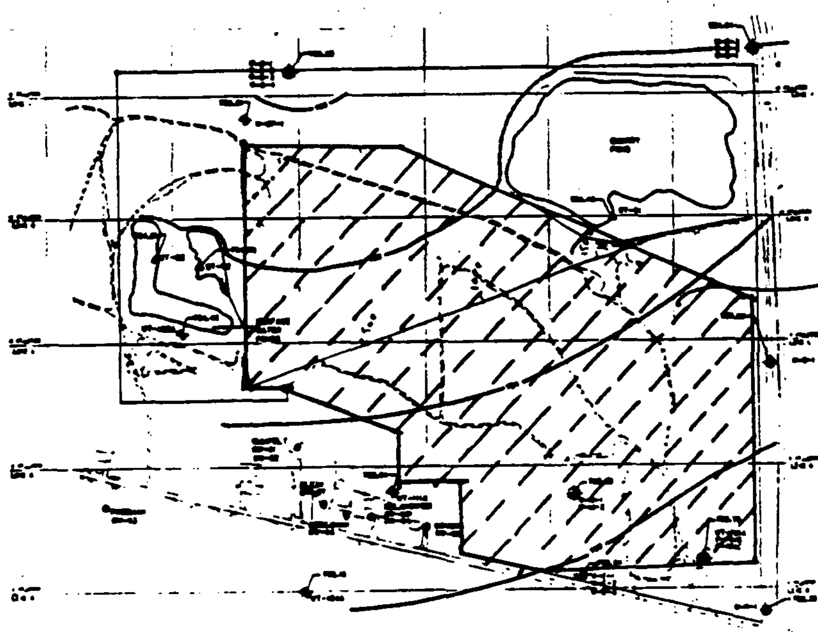
CONSULTING ENGINEERS

CLIENT EPA DATE 3-27-92

PROJECT Him Co Dump BY [illegible] G CHKD

PROJECT NO. 20026 PAGE NO. 1/4

Estimate mixing ratio between leachate and groundwater for various cap condition.



Area to be Capped = 2437500 ft2

mixing ratio can be found by

$$\frac{Q_{inf} + F(Q_{G.W.})}{Q_{G.W.} + E_{inf}} \quad (Eq. 1)$$

where

Q_{inf} = Infiltration flow rate, it depends on precipitation and evaporation rate, cap type (cover soil type and thickness, Liner, Top soil, etc.), and surface drainage condition.

Q_{inf} = (precipitation − evaporation − Surface run off −) × Area

(precipitation − evaporation − surface runoff = infiltration)

1. Under no cover condition
   To be calculated using HELP model

2- Under a non-RCRA type cap
   To be calculated using HELP model

3- under a RCRA-type cap (cap with a liner)
   To be calculated using HELP model

Q_{GW} : Groundwater Transversing the fill area

$Q_{GW} = V_{GW} * W * H$

W = largest width of landfill transverse to groundwater flow direction.
w = 1650 feet

H = Depth of the aquifer in the nearby residential well (RW02) being impacted by leachate

H is taken at 10 feet. this is based on the depth of residential well RW-02 which is estimated to be 22 feet at the residential well and water level depth of approximately 12' (22 - 12 = 10)

V_{GW} = groundwater flux = $K i_{avg}$ = $2.3 * 10^{-2} cm/sec * \frac{2}{1400}$ = 1.076 E-6 ft^3/ft^2 sec

Q_{GW} = 4.24 m. gallon/years (8.07 gpm)

F = fraction of Q_{GW} passing through the wastes at Himco site.

According to USGS (USGS, 1981), groundwater in the Elkhart area fluctuates 2-4 feet with highest water table in late march and april. It is assumed that in the dump area water table rose to one foot above the waste 2 months each year.

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CLIENT EPA DATE

PROJECT Himco Dump BY CHKD

PROJECT NO. 20026 PAGE NO. 4/4

Based on this assumption F is calculated at

$$F = 2 \text{ month} * \frac{1}{12 \text{ month}} * 1 \text{ ft} * \frac{1}{10 \text{ ft}} = .0167$$

ATTACHMENT C

LEACHATE COLLECTION SYSTEM

TECHNICAL MEMORANDUM - Leachate Collection System

DATE: March 27, 1992

TO: Himco File

FROM: Mehdi Geraminegad

SUBJECT: EPA ARCS V
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

<u>Leachate Collection Systems</u>

Eliminating leachate infiltration to groundwater was considered or response actions to mitigate groundwater contamination at this site. Because the bottom of the waste in the Himco site is in direct contact with the site groundwater, a leachate collection system was considered to cover the entire area of the landfill. The attached calculation sheets present assumptions and analytical procedures to estimate the optimal leachate well spacing. Based on this calculation, the optimal spacing between leachate wells was calculated to be 200 feet and the total required number of leachate wells were estimated to be 60 wells.

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CLIENT EPA DATE 6-3-92

PROJECT Himco Dump FS BY mohdiC CHKD

PROJECT NO. 20026 PAGE NO. 1/4

preliminary Design for the leachate Collection system

objective: Find spacing between leachate wells

Assumptions: leachate wells will extend to 2' above the site Natural water level

In most landfills, leachate wells are installed along the perimeter of the landfill to minimize off-site migration (leachate break through) through the sides of the landfills. In these landfills, a perimeter lateral barrier and a horizontal barrier (bottom of the waste) isolate the landfill. However, these Conditions do not exist in the Himco Dump site.

In the Himco site, there is not a lateral or a horizontal barrier to isolate the waste from the aquifer and the waste is hydraulically connected to the aquifer. Under this Condition, the design objective was to collect leachate anywhere within the landfill in order to minimize vertical migration of the leachate to the groundwater.

Based on the above discussion, it is assumed that leachate

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CLIENT EPA DATE 4-3-92

PROJECT Himco BY mehd G CHKD 2/4

PROJECT NO. 20026 PAGE NO. 4

wells will be distributed throughout the whole landfill site. In order to estimate optimal spacing between well, radius of influence (R) was calculated for each well using an emperical equation (see Eq. 1). The well spacing was calculated to be 200 feet (see calculations on pages 3 and 4). This spacing is typically used in landfills. Using this spacing the number of wells within the landfill was estimated to be:

$$\text{Number of leachate well} = \frac{\text{Landfill Area}}{200 * 200} = \frac{2{,}237{,}500}{40000} = 60$$

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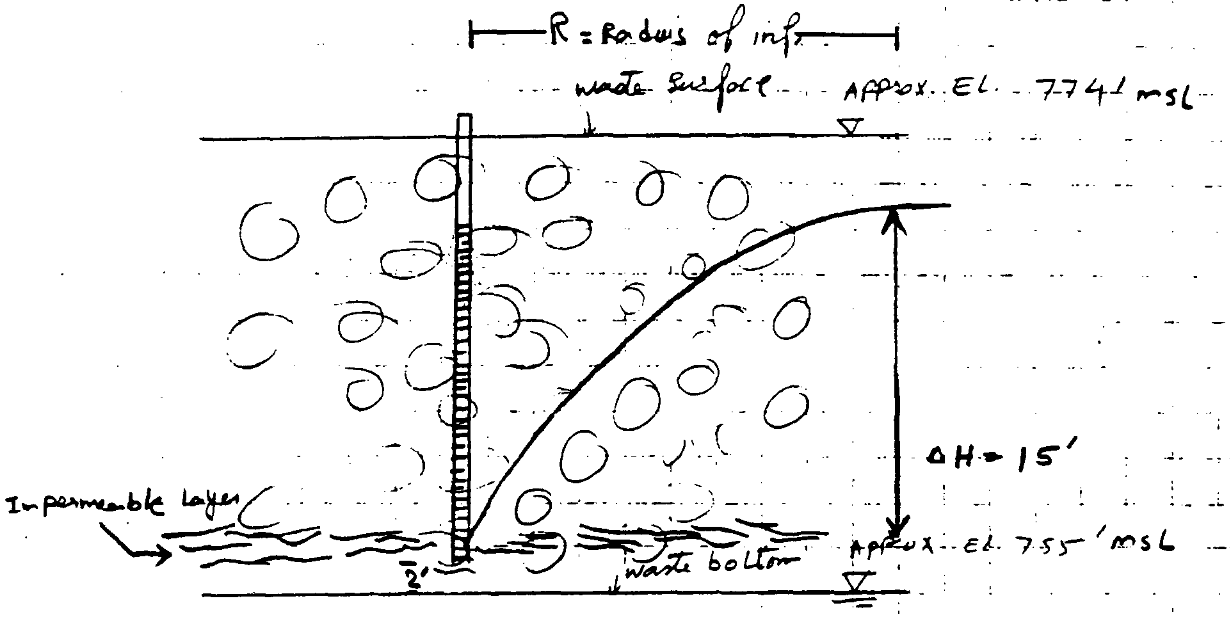
CLIENT EPA DATE 4-7-9?

PROJECT Hir Co BY mehd CHKD

PROJECT NO. 20026 PAGE NO. 3/4



Based on Test pit results leachate was encountered at 3' to 5' below surface. Assuming that the initial leachate head would be approximately 15', then $\Delta H \approx 15'$

The radius of influence may be calculated using

$R = C \Delta H \sqrt{K}$ (Eq. 1) (Foundation Eng. Haynes Davis 1962 McGraw Hill Series in Soil Engineering and Foundation)

Assume K ranges from 10^{-4} cm/sec to 10^{-3} cm/sec

$C = 3$

$R = 45'$ to $140'$

say $R \approx 100'$

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CLIENT EPA DATE 9-3-92

PROJECT Himco BY ______ CHKD ______

PROJECT NO. ~~80022~~ 6 PAGE NO. 41/61

Base on the above Calculation well spacing of 200 feet (2 * R) was selcted as the optimal spacing between wells.

ATTACHMENT D

GAS COLLECTION SYSTEM

TECHNICAL MEMORANDUM - Gas Collection System

DATE: March 31, 1992

TO: Mehdi Geraminegad

FROM: Walter Tremel

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Gas Collection System

Passive Gas Collection and Flare

This option provides for the passive collection and removal of the gases generated in the landfill. The system includes an array of gas wells spaced approximately one gas extraction well for every 1.6 acre (approximate 260 ft x 260 ft) of cap area. The gas wells are connected to a header which in turn is connected to an array of VPAC and flare units.

Equipment required:

32 gas extraction wells.

10,000 ft. 3 inch schedule 40 PVC pipe and fittings

10,000 ft. long, six foot deep trench with pipe supports/protection

8 VPAC units

8 Flame units

Active Gas Collection and Flare

This option provides for a vacuum induced collection to removal the gases generated in the landfill. The system includes an array of gas extraction wells approximately spaced one well per 1.6 acre of cap area (approximate 260 ft x 260 ft). The extraction wells are connected to a header, which is connected to a blower which induces a slight vacuum on the extraction wells, and a flare stack where the organic contaminants are destroyed by thermal destruction.

Equipment required:

32 Gas extraction wells.

10,000 ft., 3 inch sch 40 PVC pipe and fittings

10,000 ft. 4 inch sch 40 PVC pipe and fittings

10,000 ft. 6 inch sch 40 PVC pipe and fittings

10,000 ft. Six foot deep trench with pipe supports/protection

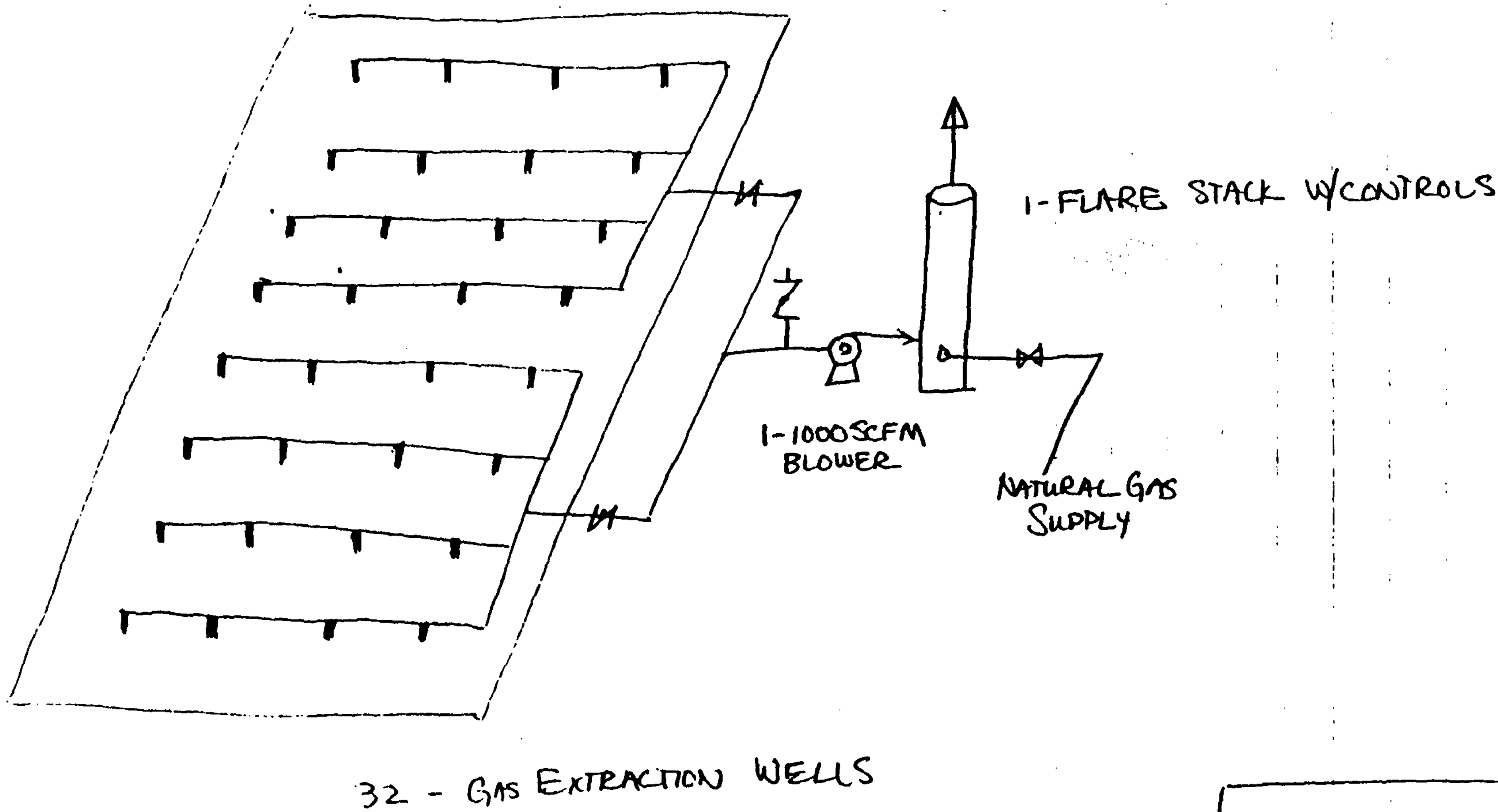
One Vacuum/blower 1,000 scfm capacity

One Natural gas fired flare stack

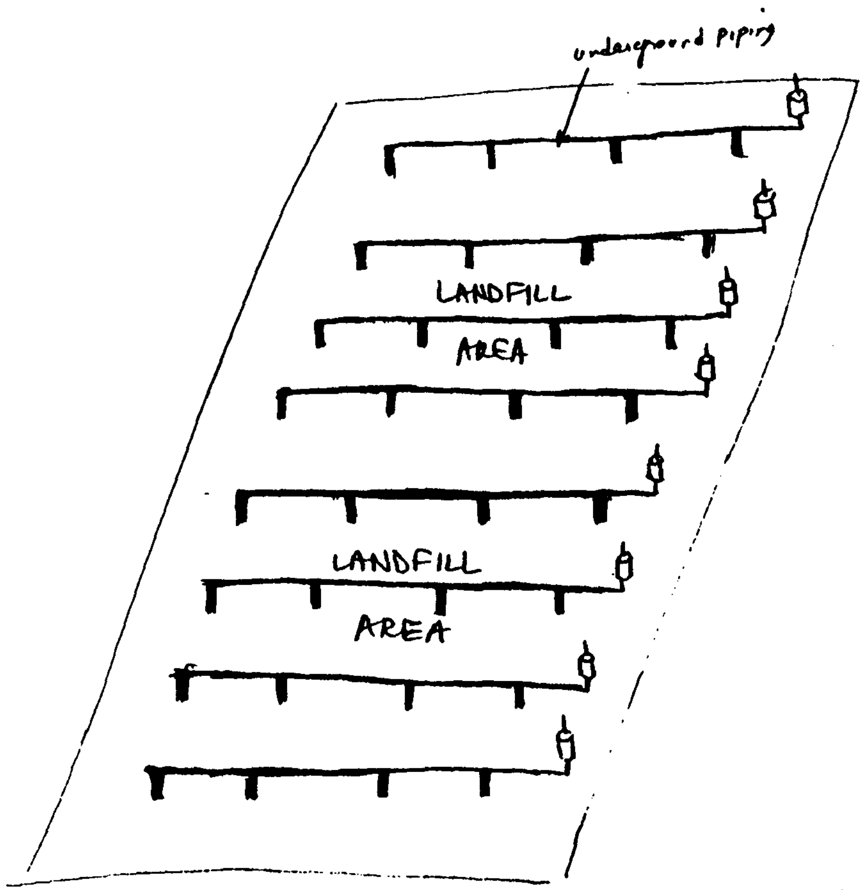
One Size 2 - 480/3-phase VAC motor starter/breaker unit with NEMA 4 enclosures

500 ft. 1§ conduit with 3 - 10 AWG wires and 3 - 14 AWG wires

1,000 ft. 2 inch Natural Gas supply line with meter and pressure controls.



HIMCO DUMP SITE
Active GAS COLLECTION & FLARE
PFD



32 - GAS EXTRACTION WELLS
8 - VPAC UNITS
8 - FLARE UNITS

HIMCO DUMP SITE
PASSIVE GAS COLLECTION
PFD

ATTACHMENT E

INTERCEPTOR TRENCH

TECHNICAL MEMORANDUM - Interceptor Trench

DATE: March 27, 1991

TO: Himco File

FROM: Mehdi Geraminegad

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Volume Estimate of Groundwater to be
Intercepted Using Interceptor Trenches

Eliminating groundwater contact with the waste in the Himco Dump area was considered as a response action to mitigate groundwater contamination at this site. Interceptor trenches are considered a process option to draw water table down 1 to 2 feet below the anticipated bottom of wastes in the landfill. This corresponds to an approximate water table elevation of 753.00, a water table draw down of 1 to 2.5 feet in the landfill area. For this purpose, interceptor trenches are considered along the east, north, and south boundaries of the Himco Dump (See Figure in the attachment).

The table in the attachment provides length of each trench sector, water table drawdown, and estimated flow from each trench sector. Flow in each sector has been estimated using the flow equation (Eq. 3) to a slot from one side source (Refer to the reference). Based on this calculation, the total flow which requires pumping and discharge to St. Joseph River is estimated at 2120 gpm.

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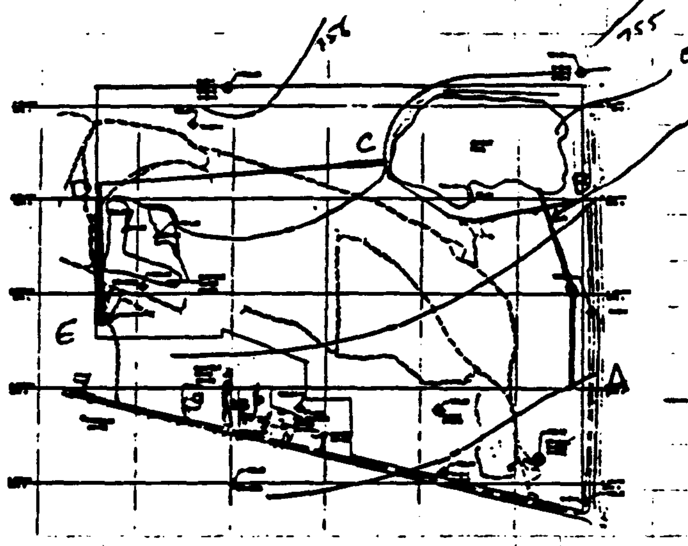
CLIENT EPA DATE 3-27-92

PROJECT Himco Dump BY [illegible] CHKD

PROJECT NO. 20026. PAGE NO. 1/3

Estimate volume of groundwater to be captured using interceptor trenches up gradient of the site.

objective: Drop water table in Himco site to EL. 753.00 ft (msl)



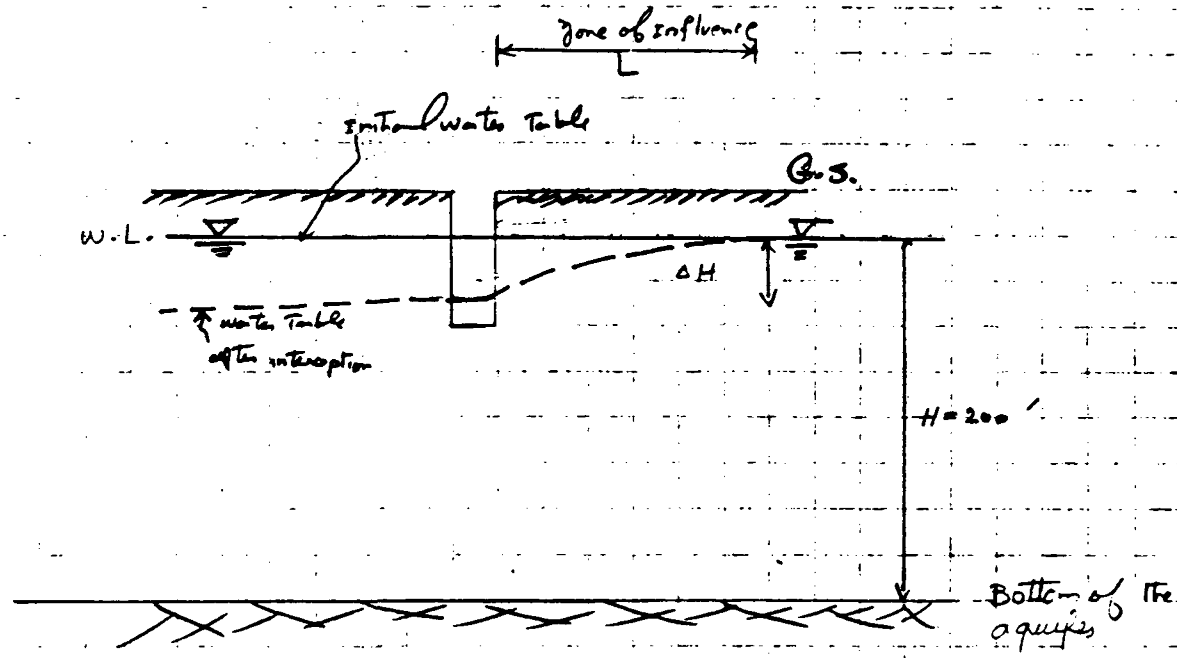
Trench Sector	Length x (ft)	Avg water table ΔH (ft)	L[(1)] (ft)	M[(3)] (ft)	Q[(2)] (gpm)
AB	1100	1	30	4.78	332
CD	1500	2.5	76	13.56	942
DE	750	1.5	46	4.57	317
Quarry side	1000	2	60	7.69	533
				TOTAL	2120

(1) See Eq. 1

(2) See Eq. 3

(3) See Eq. 4

Flow To a partially penetrating Trench



Flow to a partially penetrating slot can be estimated through the following equation

$$Q_p = \frac{K\,H\,x\,\Delta H}{L + EA} \quad \text{(Eq. 1)}$$

(Source: Foundation Engineering, Haynes Davis 1962, McGraw Hill Civil Engineering Series)

EA is a factor for partial penetration and for a very small penetration depth it is equal to H

K permeability of the aquifer

x Trench section length

ΔH Head change

DONOHUE & ASSOCIATES, INC.

CONSULTING ENGINEERS

CLIENT EPA DATE 3-27-92

PROJECT Himco Dump BY [illegible] CHKD

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L = zone of influence = C' (ΔH) $\sqrt{K}$ Dewatering

K is in cm/sec and ΔH is in feet. C' is 2 for gravity flow.

$L = 2 * \Delta H \sqrt{K}$ (Eq. 2) ← in 10^{-4} cm/sec

$K = 2.33 * 10^{-2}$ cm/sec (Average value

or = $K = 233 * 10^{-4}$ cm/sec

$$Q_p = \frac{K H x \Delta H}{(L+H)} \quad (Eq. 3)$$

$$Q_p = 2.33 * 10^{-2} \text{ cm/sec} * \frac{1 \text{ ft}}{30.54 \text{ cm}} * 200 * \left(\frac{x \Delta H}{L+H} \right) \quad Eq. 4$$ ← M

Total groundwater To be Capture = 2120 gpm

ATTACHMENT F

PLUME INTERCEPTION

TECHNICAL MEMORANDUM - Plume Interception

DATE: March 30, 1992

TO: Mehdi Geraminegad

FROM: Steve Padovani

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Review of Groundwater Model for Interceptor Well
in the Contaminant Plume at the Himco Dump Site

Introduction

This memorandum presents the methodology and results of the numerical procedure used to simulate the groundwater table for the plume interception alternative which is considered for a detailed evaluation in the FS. The plume interception alternative was considered to migrate any potential off-site migration of the contaminants through the shallow part of the aquifer. The numerical simulation was performed to develop the well setting which would effectively capture contaminants potentially migrating off-site.

Assumptions and Methods of Calculation

After a series of trial and error calculations, a cluster of well spacing at 230 feet was selected and the drawdown associated with various pumping rates were simulated using the "Pumping Test Design Model" program (Walton, 1988). Based on this simulation 35 gpm was found to be the optimal pumping rate from each extraction well (see attached figure). Drawdown quantities were first calculated for the fully penetrating model using the Walton program. Drawdown values versus distance from the fully penetrating model were then used to run the Walton program for a partially penetrating model. The partial penetration values are attached and the associated groundwater elevation contours are plotted on the attached figure.

The following assumptions were made for the fully and partially penetrating models:

- pumping wells fully penetrate the aquifer (fully penetrating model only);

- pumping wells are screened from the water table to ten feet below the water table (partially penetrating model only);
- well storage capacity is deemed negligible;
- the aquifer is assumed to be homogeneous, isotropic, infinite in areal extent, and constant in thickness throughout;
- the outwash sands comprise the primary aquifer beneath the site;
- there are no boundaries or discontinuities;
- horizontal and vertical hydraulic conductivities are the same; and
- the aquifer is unconfined, therefore, the top of the aquifer equals the initial water level depth.

The following aquifer parameters were assumed for the fully penetrating model based on the results of the remedial investigation:

Aquifer Horizontal Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Vertical Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Thickness (ft.)	200
Artesian Aquifer Storativity	5.0×10^{-7}
Water Table Storativity (dimensionless)	0.16
Extraction Well Effective Radius (ft.)	0.33
Top of Aquifer Depth (ft.)	9.0
Base of Aquifer Depth (ft.)	200
Initial Water Level Depth (ft.)	9.0
Production Well Discharge Rate (gpm)	35
Time after pumping started (min) (steady state)	12,000

The following aquifer parameters were assumed for the partially penetrating model based on the results of the remedial investigations:

Production Well Discharge Rate (gpm)	35
Aquifer Storativity	0.16
Time after pumping started (min)	12,000
Drawdown with full penetration (ft.) (value from fully penetrating model based on distance from discharge well)	See Attachment
Aquifer Horizontal Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Vertical Hydraulic Conductivity (gpd/sq.ft.)	466.2

Radial Distance to Well (ft.) (value associated with drawdown from fully penetrating model)	See Attachment
Aquifer Thickness (ft.)	200
Distance from aquifer top to bottom of production well (ft.)	19
Distance from aquifer top to production well screen top (ft.)	9
Distance from aquifer top to bottom of observation well (ft.)	19
Distance from aquifer top to top of observation well screen (ft.)	9

The values from aquifer top and base depth, thickness, and initial water level depth were determined from borehole and monitoring well water levels along the southern end of the landfill as listed in the RI report. The top of the aquifer (or initial water level depth) was determined by averaging the depth from ground surface to the water table in monitoring wells on and surrounding the site. Aquifer thickness was determined by subtracting the initial water level depth from the most common aquifer depth. Aquifer depths ranged from approximately 200 feet to 480 feet below ground surface. However, aquifer depths exceeding 200 feet appeared to be primarily along the western end of the site.

Drawdown values were subtracted from natural groundwater level elevations on-site to produce new water table elevation contours.

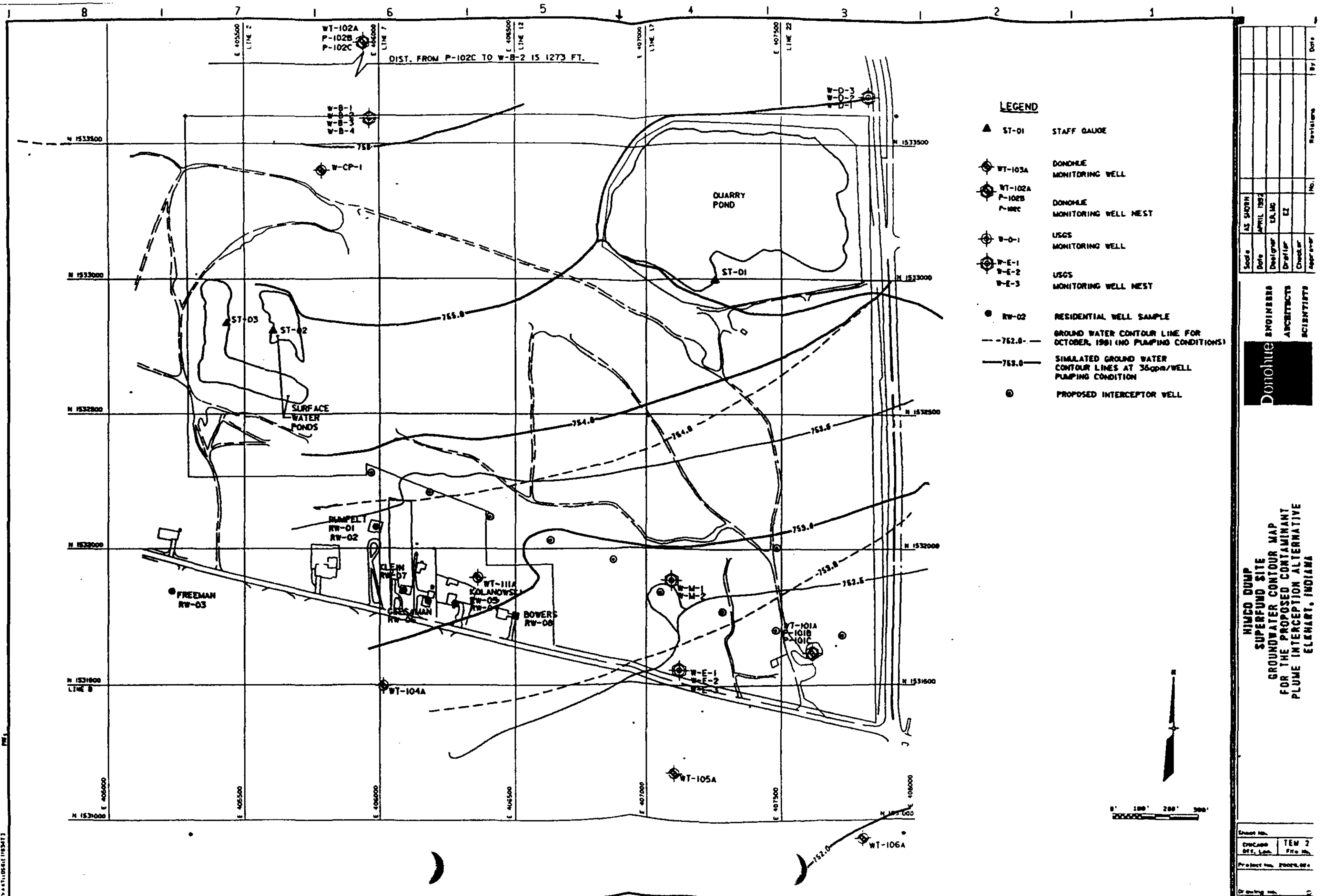
Results

The attachment provides the computer simulation print out for the above simulation. The attached figure presents the simulated groundwater contours resulting from the steady state pumping of nine wells at 35 gpm.

The extraction system appears to effectively intercept groundwater along the southern boundary of the landfill. The top portion of the groundwater aquifer is successfully captured according to this model.

Conclusions

A pumping rate of 35 gpm would effectively alter the natural groundwater flow direction in order to capture any contaminants in the groundwater with little affect on the surrounding area.



DIST. FROM P-102C TO W-B-2 IS 1273 FT.
QUARRY POND
SURFACE WATER PONDS
ST-01
ST-02
ST-03
WT-102A
P-102B
P-102C
W-B-1
W-B-4
W-CP-1
W-D-1
W-D-3
PUMPELT
RW-01
RW-02
KLEIN
FREEMAN
RW-03
WT-111A
BOWERS
RW-08
W-M-1
W-M-2
WT-101A
W-E-1
W-E-2
WT-104A
WT-105A
WT-106A
LEGEND
ST-01 STAFF GAUGE
WT-103A DONOHUE MONITORING WELL
WT-102A P-102B P-102C DONOHUE MONITORING WELL NEST
W-D-1 USGS MONITORING WELL
W-E-1 W-E-2 W-E-3 USGS MONITORING WELL NEST
RW-02 RESIDENTIAL WELL SAMPLE
GROUND WATER CONTOUR LINE FOR OCTOBER, 1981 (NO PUMPING CONDITIONS)
SIMULATED GROUND WATER CONTOUR LINES AT 35gpm/WELL PUMPING CONDITION
PROPOSED INTERCEPTOR WELL
Donohue ENGINEERS ARCHITECTS SCIENTISTS
HIMCO DUMP
SUPERFUND SITE
GROUNDWATER CONTOUR MAP
FOR THE PROPOSED CONTAMINANT
PLUME INTERCEPTION ALTERNATIVE
ELKHART, INDIANA
Scale AS SHOWN
Date APRIL 1992
TEM 2

FULLY PENETRATING MODEL
(35 gpm)

DATA BASE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT): 466.20
AQUIFER VERT. HYDR. COND. (GPD/SQ FT): 466.200
AQUIFER THICKNESS (FT): 200.00
ARTESIAN AQUIFER STORATIVITY (DIM): 5.00000-07
WATER TABLE STORATIVITY (DIM): 0.1600
PRODUCT. WELL EFFECTIVE RADIUS (FT): 0.330
TOP OF AQUIFER DEPTH (FT): 9.00
BASE OF AQUIFER DEPTH (FT): 200.00
INITIAL WATER LEVEL DEPTH (FT): 9.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

SELECTED DISTANCES (FT)

TIME(MIN)	0.33	52.30	131.38	330.00	828.92	2082.16
0.10	9.51	9.13	9.06	9.02	9.00	9.00
0.16	9.57	9.15	9.08	9.02	9.00	9.00
0.26	9.61	9.17	9.09	9.03	9.00	9.00
0.41	9.63	9.18	9.10	9.03	9.00	9.00
0.66	9.64	9.19	9.11	9.04	9.00	9.00
1.04	9.65	9.19	9.11	9.04	9.00	9.00
1.65	9.66	9.20	9.12	9.05	9.00	9.00
2.61	9.66	9.21	9.12	9.05	9.01	9.00
4.14	9.67	9.21	9.13	9.05	9.01	9.00
6.56	9.67	9.22	9.13	9.06	9.01	9.00
10.39	9.68	9.22	9.14	9.06	9.01	9.00
16.47	9.68	9.22	9.14	9.06	9.01	9.00
26.10	9.68	9.23	9.14	9.07	9.01	9.00
41.36	9.69	9.23	9.15	9.07	9.01	9.00
65.55	9.69	9.23	9.15	9.07	9.01	9.00
103.90	9.69	9.24	9.15	9.07	9.02	9.00
164.66	9.70	9.24	9.16	9.08	9.02	9.00
260.97	9.70	9.24	9.16	9.08	9.02	9.00
413.62	9.70	9.24	9.16	9.08	9.02	9.00
655.54	9.70	9.25	9.16	9.09	9.02	9.00
1038.95	9.71	9.25	9.17	9.09	9.02	9.00
1646.63	9.71	9.26	9.17	9.09	9.03	9.00
2609.74	9.72	9.26	9.18	9.10	9.03	9.00
4136.15	9.73	9.27	9.19	9.11	9.03	9.00
6555.36	9.74	9.28	9.20	9.12	9.04	9.00
10389.54	9.75	9.29	9.21	9.13	9.05	9.01
12000.00	9.75	9.30	9.21	9.13	9.06	9.01

TIME AFTER PUMPING STARTED(MIN):12000.00

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.33	9.75
3	0.52	9.71
4	0.83	9.67
5	1.31	9.63
6	2.08	9.59
7	3.30	9.55
8	5.23	9.50
9	8.29	9.46
10	13.14	9.42
11	20.82	9.38
12	33.00	9.34
13	52.30	9.30
14	82.89	9.25
15	131.38	9.21
16	208.22	9.17
17	330.00	9.13
18	523.01	9.09
19	828.92	9.06
20	1313.75	9.03
21	2082.16	9.01

PARTIALLY PENETRATING MODEL
(35 gpm)

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.75
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.1511E+02
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 4.95
DRAWDOWN WITH PART. PENETR. (FT): 5.70

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.71
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 7.1000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 5.2000E-01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 1.9000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 9.0000E+00
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 1.9000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 6.0870E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 2.62
DRAWDOWN WITH PART. PENETR. (FT): 3.33

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.67
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 8.3000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 8.4016E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 3.61
DRAWDOWN WITH PART. PENETR. (FT): 4.28

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.63
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3100E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 6.9118E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 2.97
DRAWDOWN WITH PART. PENETR. (FT): 3.60

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.59
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0800E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 5.4735E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 2.35
DRAWDOWN WITH PART. PENETR. (FT): 2.94

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.55
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 4.1568E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 1.79
DRAWDOWN WITH PART. PENETR. (FT): 2.34

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.23
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2300E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 3.0193E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 1.30
DRAWDOWN WITH PART. PENETR. (FT): 1.53

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.50
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2300E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 3.0193E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 1.30
DRAWDOWN WITH PART. PENETR. (FT): 1.80

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.46
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 8.2900E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 2.1017E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.90
DRAWDOWN WITH PART. PENETR. (FT): 1.36

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.42
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3140E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.4114E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.61
DRAWDOWN WITH PART. PENETR. (FT): 1.03

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.38
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0820E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 9.0660E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.39
DRAWDOWN WITH PART. PENETR. (FT): 0.77

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.34
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 5.4286E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.23
DRAWDOWN WITH PART. PENETR. (FT): 0.57

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.30
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2300E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 2.8746E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.12
DRAWDOWN WITH PART. PENETR. (FT): 0.42

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.25
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 8.2890E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.2782E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.05
DRAWDOWN WITH PART. PENETR. (FT): 0.30

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.21
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3138E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 4.5620E-01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.02
DRAWDOWN WITH PART. PENETR. (FT): 0.23

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.17
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0822E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.0241E-01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.17

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 3.00
AQUIFER STORATIVITY (DIM): 0.0000E+00
TIME AFTER PUMPING STARTED (MIN): 0.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.00
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 0.0000E+00
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 0.0000E+00
RADIAL DISTANCE TO WELL (FT): 0.0000E+00
AQUIFER THICKNESS (FT): 0.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 0.0000E+00
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 0.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 0.0000E+00
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 0.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.7014E+38
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT)=% 1.701412E+38
DRAWDOWN WITH PART. PENETR. (FT)=% 1.701412E+38

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.13
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 1.1776E-02
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.13

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.09
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 5.2301E+02
AQUIFER THICKNESS (FT)= 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT)= 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT)= 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT)= 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION= 4.4966E-04
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT)= 0.00
DRAWDOWN WITH PART. PENETR. (FT)= 0.09

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.06
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 8.2892E+02
AQUIFER THICKNESS (FT)= 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT)= 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT)= 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT)= 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION= 2.9237E-06
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT)= 0.00
DRAWDOWN WITH PART. PENETR. (FT)= 0.06

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.03
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3138E+03
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

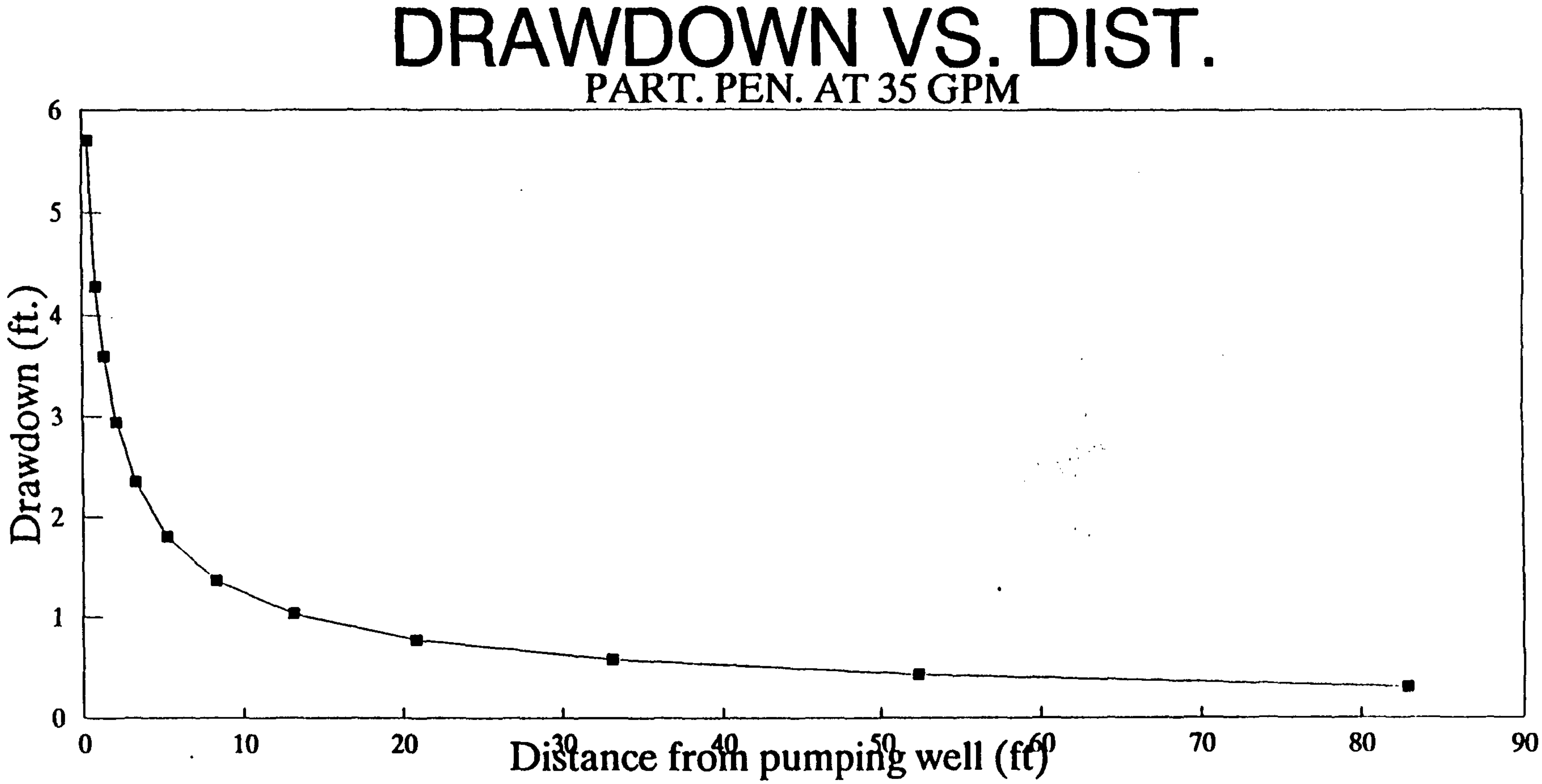
WELL FUNCTION: 1.1441E-09
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.03

DATA BASE:

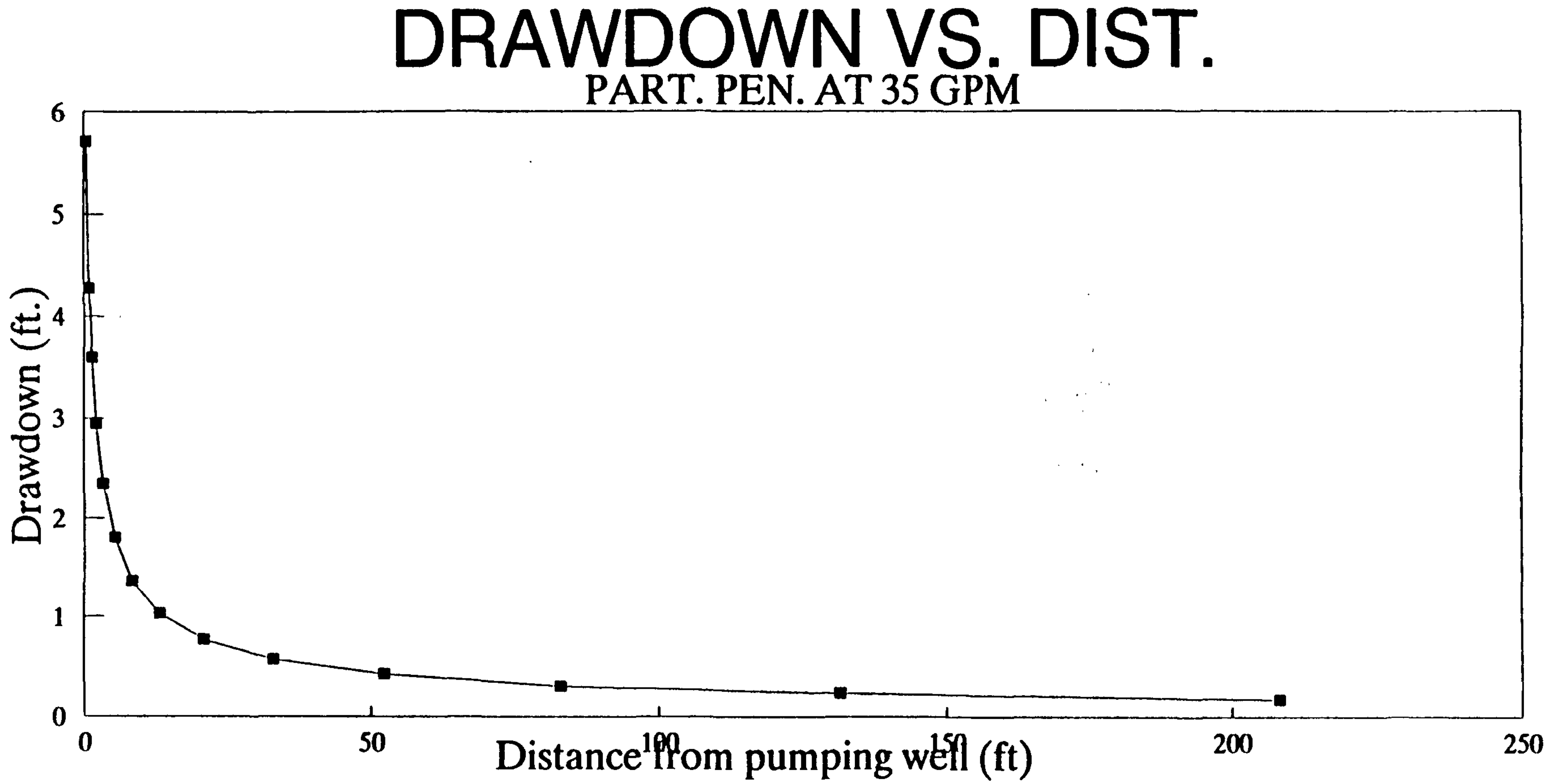
PRODUCTION WELL DISCHARGE RATE (GPM): 35.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):12000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.01
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0822E+03
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 9.0000E+00
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.9000E+01
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 9.0000E+00

COMPUTATION RESULTS:

WELL FUNCTION: 5.2054E-15
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.01

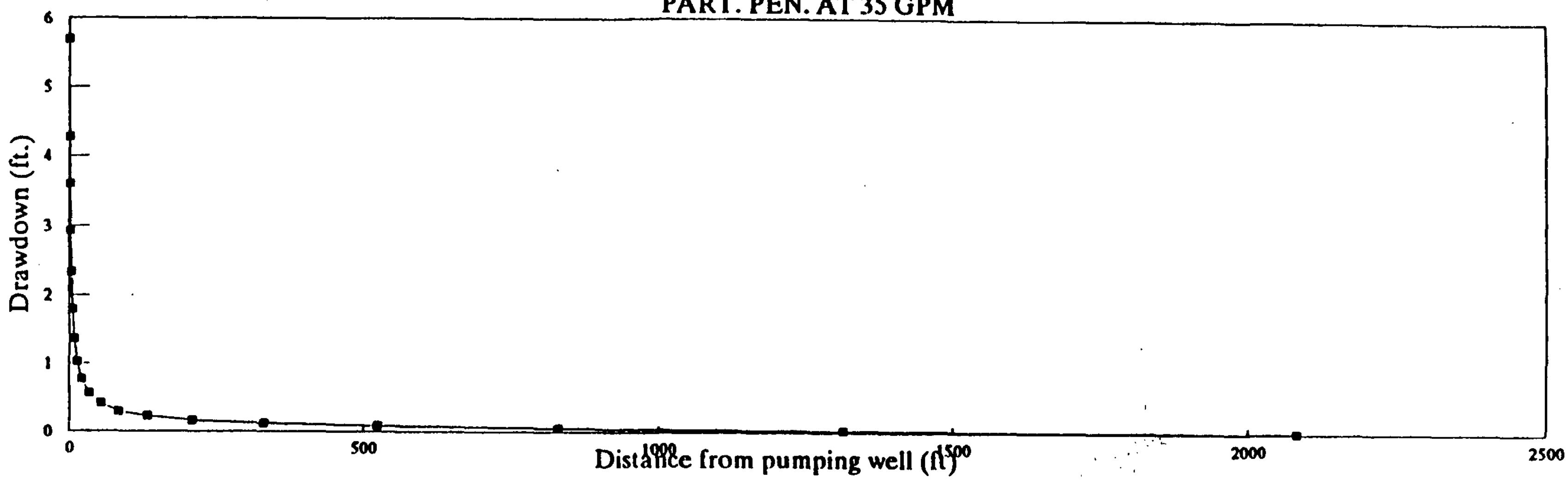


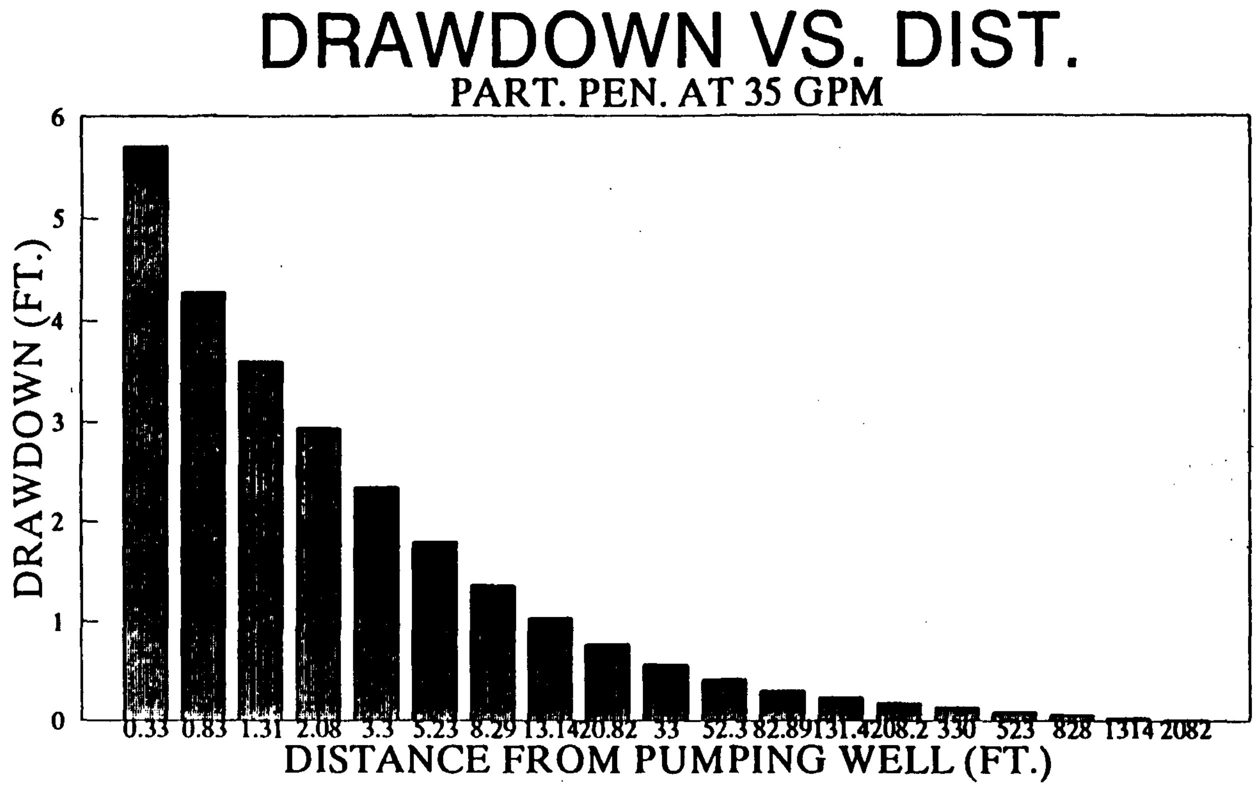
Assumptions: Horiz. Hydr. Cond = Vertical Hydr. Cond. = 466.2 GPD/SQ FT
Aquifer = 200 ft thick
Storativity = .16
Well Screened = 9 to 19 feet below ground surface
Initial water level = 9.00 feet


DRAWDOWN VS. DIST.
PART. PEN. AT 35 GPM
Drawdown (ft.)
6
5
4
3
2
1
0
0
50
100
150
200
250
Distance from pumping well (ft)

DRAWDOWN VS. DIST.

PART. PEN. AT 35 GPM




DRAWDOWN VS. DIST.
PART. PEN. AT 35 GPM
DRAWDOWN (FT.)
6
5
4
3
2
1
0
0.33 0.83 1.31 2.08 3.3 5.23 8.29 13.14 20.82 33 52.3 82.89 131.4 208.2 330 523 828 1314 2082
DISTANCE FROM PUMPING WELL (FT.)

)   )

ATTACHMENT G

WATER TABLE DRAWDOWN

TECHNICAL MEMORANDUM - Water Table Drawdown

DATE: March 30, 1992

TO: Mehdi Geraminegad

FROM: Steve Padovani

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Review of Groundwater Model for a Water Table
Drawdown Well System at the Himco Dump Site

Introduction

This memorandum presents the methodology and results of the numerical procedure used to simulate the groundwater table beneath the Himco Dump site for the groundwater drawdown alternative which is considered for a detailed evaluation in the FS. The objective of this alternative is to ensure that the groundwater beneath the site would not be in contact with the waste in the landfill. This response action would reduce the potential for groundwater contamination. Under this alternative, non-contaminated water will be extracted from the deep portion of the aquifer (150-200 feet) and will be discharged to St. Joseph River.

The numerical simulation was performed to develop the well setting which would effectively draw down the water table at least two feet under the entire landfill area.

ASSUMPTIONS AND METHODS OF CALCULATION

A cluster of six extraction wells evenly spaced within the landfill was selected and drawdowns associated with various pumping rate were simulated using the "Pumping Test Design Model" program (Walton, 1988). Based on this simulation, 200 gpm was found to be the optimal pumping rate from each extraction well. The Walton program was first run assuming a fully penetrating model. Drawdown values from the fully penetrating model were then used to run the Walton program for a partially penetrating model. The simulated drawdowns for partially penetrating wells are provided in the attachment and the associated groundwater elevation contours are plotted in the attached figure.

The following assumptions were made for the fully penetrating and partially penetrating models:

- pumping wells fully penetrate the aquifer (fully penetrating model only);
- pumping wells are screened from 50 feet to 100 feet below the water table (partially penetrating model only);
- well storage capacity is deemed negligible;
- the aquifer is assumed to be homogeneous, isotropic, infinite in areal extent, and constant in thickness throughout;
- the outwash sands comprise the primary aquifer beneath the site;
- there are no boundaries or discontinuities;
- horizontal and vertical hydraulic conductivities are the same; and
- the aquifer is unconfined, therefore, the top of the aquifer equals the initial water level depth.

The following aquifer parameters were assumed for the fully penetrating scenario based on the results of the remedial investigations:

Aquifer Horizontal Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Vertical Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Thickness (ft.)	200
Artesian Aquifer Storativity	5.0×10^{-7}
Water Table Storativity (dimensionless)	0.16
Extraction Well Effective Radius (ft.)	0.33
Top of Aquifer Depth (ft.)	9.0
Base of Aquifer Depth (ft.)	200
Initial Water Level Depth (ft.)	9.0
Production Well Discharge Rate (gpm)	200
Time after pumping started (min) (steady state)	30,000

The following aquifer parameters were assumed for the partial penetration scenario based on the results of the remedial investigation:

Production Well Discharge Rate (gpm)	200
Aquifer Storativity	0.16
Time after pumping started (min)	30,000

Drawdown with full penetration (ft.) (value from fully penetrating model based on distance from discharge well)	See Attachment
Aquifer Horizontal Hydraulic Conductivity (gpd/sq.ft.)	466.2
Aquifer Vertical Hydraulic Conductivity (gpd/sq.ft.)	466.2
Radial distance to well (ft.) (value associated with drawdown from fully penetrating model)	See Attachment
Aquifer Thickness (ft.)	200
Distance from aquifer top to bottom of production well (ft.)	100
Distance from aquifer top to production well screen top (ft.)	50
Distance from aquifer top to bottom of observation well (ft.)	100
Distance from aquifer top to top of observation well screen (ft.)	50

The values from aquifer top and base depth, thickness, and initial water level depth were determined from borehole and monitoring well water levels along the southern end of the landfill as listed in the RI report. The top of the aquifer (or initial water level depth) was determined by averaging the depth from ground surface to the water table in monitoring wells on and surrounding the site. Aquifer thickness was determined by subtracting the initial water level depth from the most common aquifer depth. Aquifer depths ranged from approximately 200 feet to 480 feet below ground surface. However, aquifer depths exceeding 200 feet appeared to be primarily along the western end of the site.

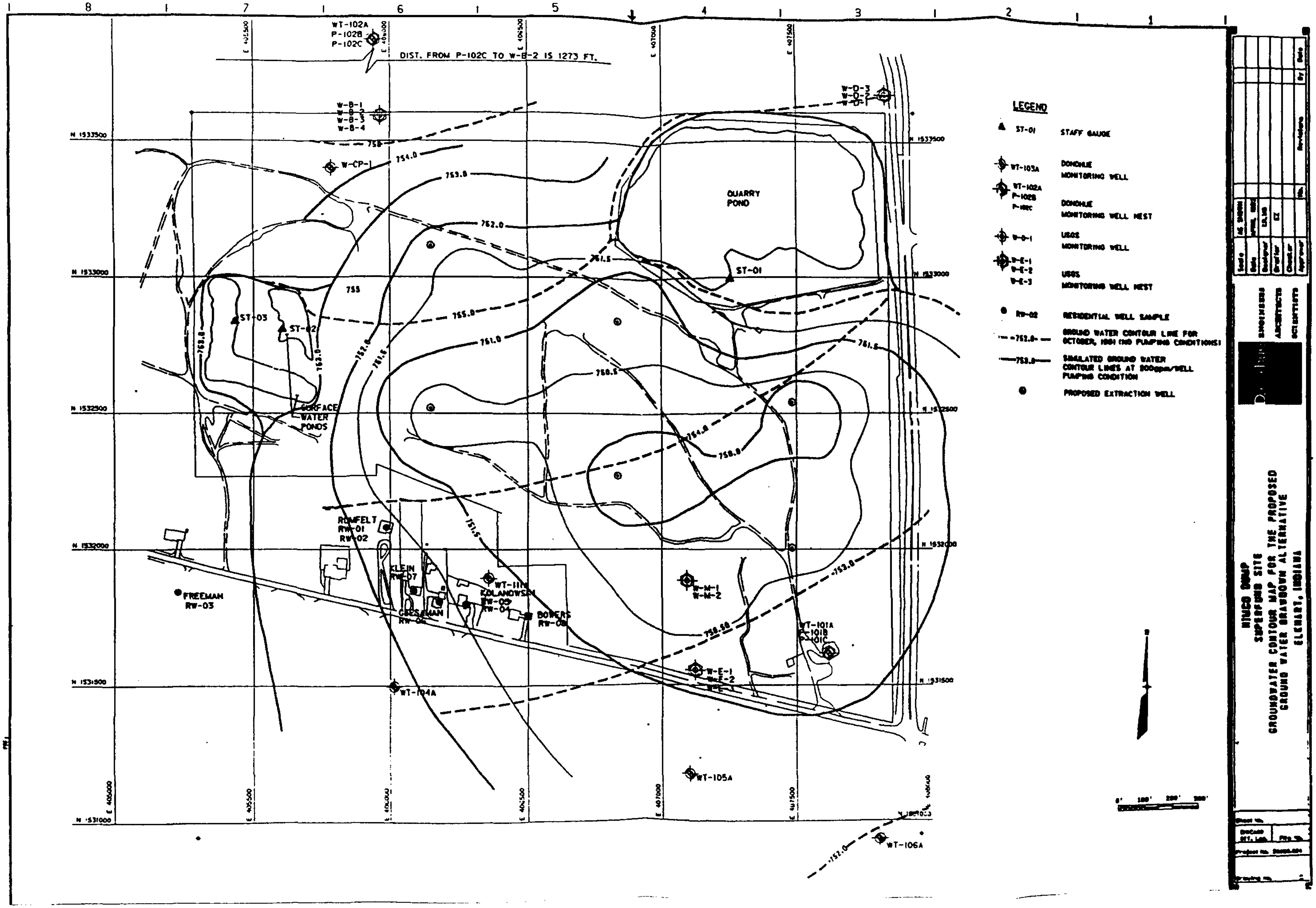
Results

The attachment provides the computer printout for the above simulation. The attached figure presents simulated groundwater contours resulting from the steady state pumping of six wells at 200 gpm.

This extraction system appears to effectively lower the water table approximately three feet under the extent of the landfilled area.

Conclusion

A pumping rate of 200 gpm effectively draws down the water table under the landfilled area of the site far enough to ensure that the water table is not in contact with the waste in the landfill.



LEGEND
ST-01 STAFF GAUGE
WT-103A DONOHUE MONITORING WELL
WT-102A P-102B P-102C DONOHUE MONITORING WELL NEST
W-D-1 USGS MONITORING WELL
W-E-1 W-E-2 W-E-3 USGS MONITORING WELL NEST
RW-02 RESIDENTIAL WELL SAMPLE
GROUND WATER CONTOUR LINE FOR OCTOBER, 1991 (NO PUMPING CONDITIONS)
SIMULATED GROUND WATER CONTOUR LINES AT 300gpm/WELL PUMPING CONDITION
PROPOSED EXTRACTION WELL
DIST. FROM P-102C TO W-B-2 IS 1273 FT.
QUARRY POND
SURFACE WATER PONDS
ROMFELT RW-01 RW-02
FREEMAN RW-03
KLEIN RW-07
KOLANOWSKI RW-05 RW-04
BOWERS RW-08
WT-104A
WT-105A
WT-106A
WT-101A
W-M-1 W-M-2
W-CP-1
HIMCO DUMP
SUPERFUND SITE
GROUNDWATER CONTOUR MAP FOR THE PROPOSED
GROUND WATER DRAWDOWN ALTERNATIVE
ELKHART, INDIANA

FULLY PENETRATING MODEL
(200 gpm)

DATA BASE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT): 466.20
AQUIFER VERT. HYDR. COND. (GPD/SQ FT): 466.200
AQUIFER THICKNESS (FT): 200.00
ARTESIAN AQUIFER STORATIVITY (DIM): 5.0000D-07
WATER TABLE STORATIVITY (DIM): 0.1600
PRODUCT. WELL EFFECTIVE RADIUS (FT): 0.330
TOP OF AQUIFER DEPTH (FT): 9.00
BASE OF AQUIFER DEPTH (FT): 200.00
INITIAL WATER LEVEL DEPTH (FT): 9.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

SELECTED DISTANCES (FT)

TIME(MIN)	0.33	52.30	131.38	330.00	828.92	2062.16
0.10	11.94	9.73	9.36	9.10	9.00	9.00
0.16	12.29	9.85	9.44	9.12	9.01	9.00
0.26	12.50	9.94	9.51	9.16	9.01	9.00
0.41	12.62	10.02	9.56	9.19	9.01	9.00
0.66	12.70	10.07	9.61	9.21	9.02	9.00
1.04	12.75	10.11	9.65	9.24	9.02	9.00
1.65	12.79	10.15	9.68	9.27	9.03	9.00
2.61	12.82	10.18	9.71	9.29	9.03	9.00
4.14	12.85	10.21	9.74	9.31	9.04	9.00
6.56	12.88	10.23	9.76	9.33	9.05	9.00
10.39	12.90	10.26	9.79	9.35	9.05	9.00
16.47	12.92	10.28	9.81	9.36	9.06	9.00
26.10	12.94	10.30	9.83	9.38	9.07	9.00
41.36	12.96	10.32	9.84	9.40	9.07	9.00
65.55	12.98	10.33	9.86	9.41	9.08	9.00
103.90	12.99	10.35	9.88	9.43	9.09	9.00
164.66	13.01	10.37	9.89	9.44	9.09	9.00
260.97	13.03	10.38	9.91	9.45	9.10	9.00
413.62	13.04	10.40	9.93	9.47	9.11	9.00
655.54	13.06	10.42	9.94	9.49	9.12	9.00
1038.95	13.08	10.44	9.96	9.51	9.13	9.00
1646.63	13.11	10.46	9.99	9.53	9.15	9.00
2609.74	13.15	10.50	10.02	9.56	9.17	9.01
4136.15	13.19	10.54	10.07	9.60	9.20	9.01
6555.36	13.25	10.60	10.12	9.66	9.24	9.02
10389.54	13.32	10.67	10.19	9.73	9.29	9.03
16466.32	13.40	10.75	10.28	9.80	9.36	9.06
26097.35	13.50	10.84	10.37	9.89	9.44	9.10
30000.00	13.53	10.88	10.40	9.93	9.47	9.11

TIME AFTER PUMPING STARTED(MIN):30000.00

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)	Drawdown
2	0.33	13.53	-4.53
[illegible]	[illegible]	[illegible]	-4.29
4	0.83	13.04	-4.04
5	1.31	12.80	-3.8
6	2.08	12.56	-3.56
7	3.30	12.32	-3.32
8	5.23	12.08	-3.08
9	8.29	11.84	-2.84
10	13.14	11.60	-2.60
11	20.82	11.36	-2.36
12	33.00	11.12	-2.12
13	52.30	10.88	-1.88
14	82.89	10.64	-1.64
15	131.38	10.40	-1.40
16	208.22	10.16	-1.16
17	330.00	9.93	-.93
18	523.01	9.69	-.69
19	828.92	9.47	-.47
20	1313.75	9.27	-.27
21	2082.16	9.11	-.11
22	3300.00	9.03	-.03
23	5230.15	9.00	

PARTIALLY PENETRATING MODEL
(200 gpm)

AQUIFER STORATIVITY ...

TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 4.53
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 2.4784E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 6.09
DRAWDOWN WITH PART. PENETR. (FT): 10.62

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 4.29
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 2.2124E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 5.44
DRAWDOWN WITH PART. PENETR. (FT): 9.73

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 4.04
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 8.3000E-01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.9398E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 4.77
DRAWDOWN WITH PART. PENETR. (FT): 8.81

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 3.80
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 1.3100E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.6757E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 4.12
DRAWDOWN WITH PART. PENETR. (FT): 7.92

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 3.56
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0800E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.4116E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 3.47
DRAWDOWN WITH PART. PENETR. (FT): 7.03

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 3.32
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+00
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.1542E+01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 2.84
DRAWDOWN WITH PART. PENETR. (FT): 6.16

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM)= 200.00
AQUIFER STORATIVITY (DIM)= 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT)= 3.08
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT)= 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT)= 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 5.2300E+00
AQUIFER THICKNESS (FT)= 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT)= 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT)= 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT)= 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION= 9.0756E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT)= 2.23
DRAWDOWN WITH PART. PENETR. (FT)= 5.31

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM)= 200.00
AQUIFER STORATIVITY (DIM)= 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT)= 2.84
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT)= 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT)= 4.6620E+02
RADIAL DISTANCE TO WELL (FT)= 8.2900E+00
AQUIFER THICKNESS (FT)= 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT)= 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT)= 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT)= 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION= 6.7668E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT)= 1.66
DRAWDOWN WITH PART. PENETR. (FT)= 4.50

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 2.60
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3140E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

ELL FUNCTION: 4.6932E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 1.15
DRAWDOWN WITH PART. PENETR. (FT): 3.75

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 2.36
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0820E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 2.9452E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.72
DRAWDOWN WITH PART. PENETR. (FT): 3.08

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 2.12
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.6141E+00
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.40
DRAWDOWN WITH PART. PENETR. (FT): 2.52

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 1.88
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2300E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 7.4380E-01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.18
DRAWDOWN WITH PART. PENETR. (FT): 2.06

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 1.64
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 8.2890E+01
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 2.7487E-01
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.07
DRAWDOWN WITH PART. PENETR. (FT): 1.71

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 1.40
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3138E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 7.9928E-02
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.02
DRAWDOWN WITH PART. PENETR. (FT): 1.42

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 1.16
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0822E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.5833E-02
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 1.16

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN)=30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.93
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.7371E-03
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.93

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.69
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 5.2301E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 6.5820E-05
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.69

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
~~AQUIFER STORATIVITY (DIM): 1.6000E-01~~
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.47
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 8.2892E+02
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 4.2779E-07
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.47

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.27
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 1.3138E+03
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 1.6740E-10
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.27

DATA BASE:

PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.11
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 2.0822E+03
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

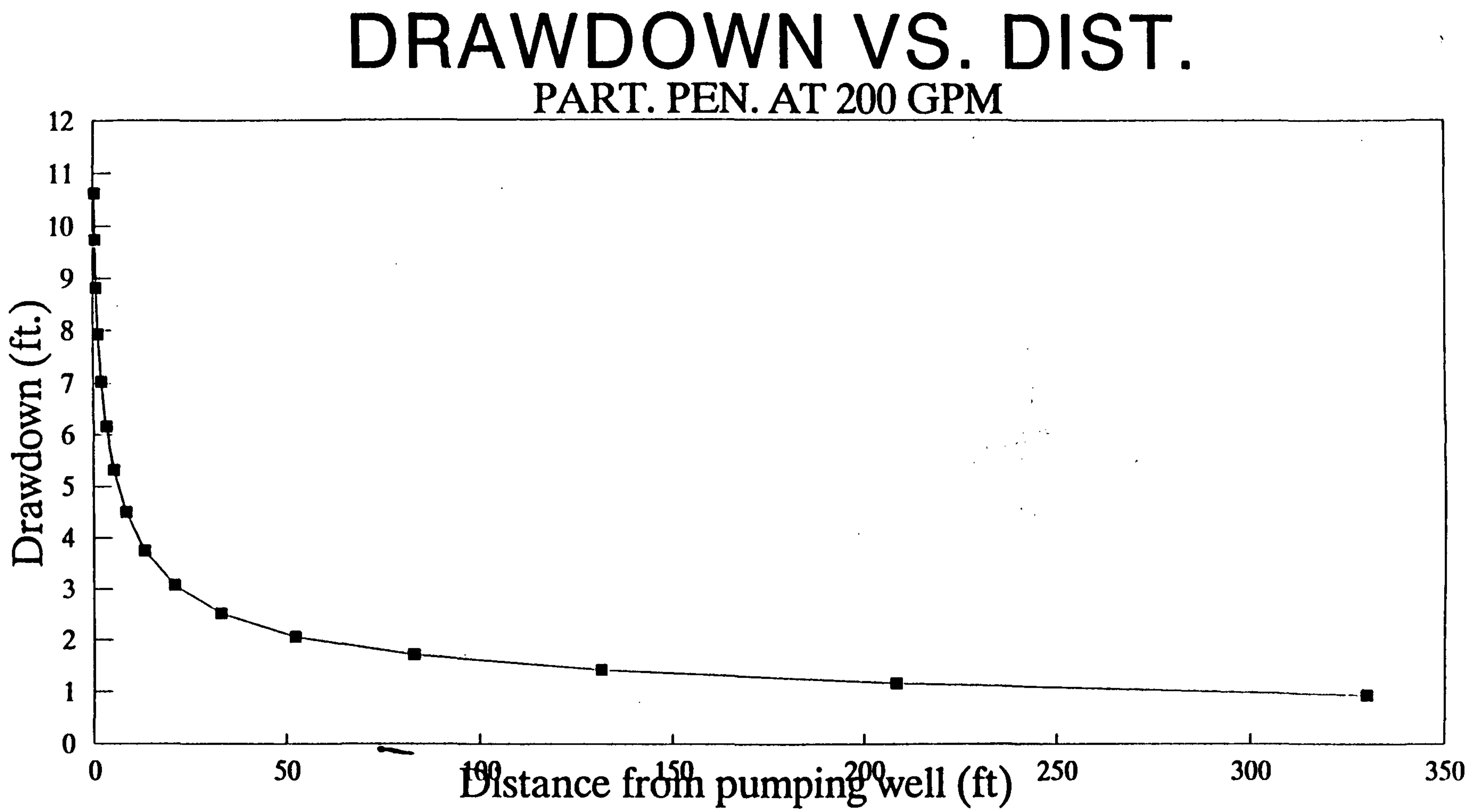
WELL FUNCTION: 7.6165E-16
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.11

DATA BASE:

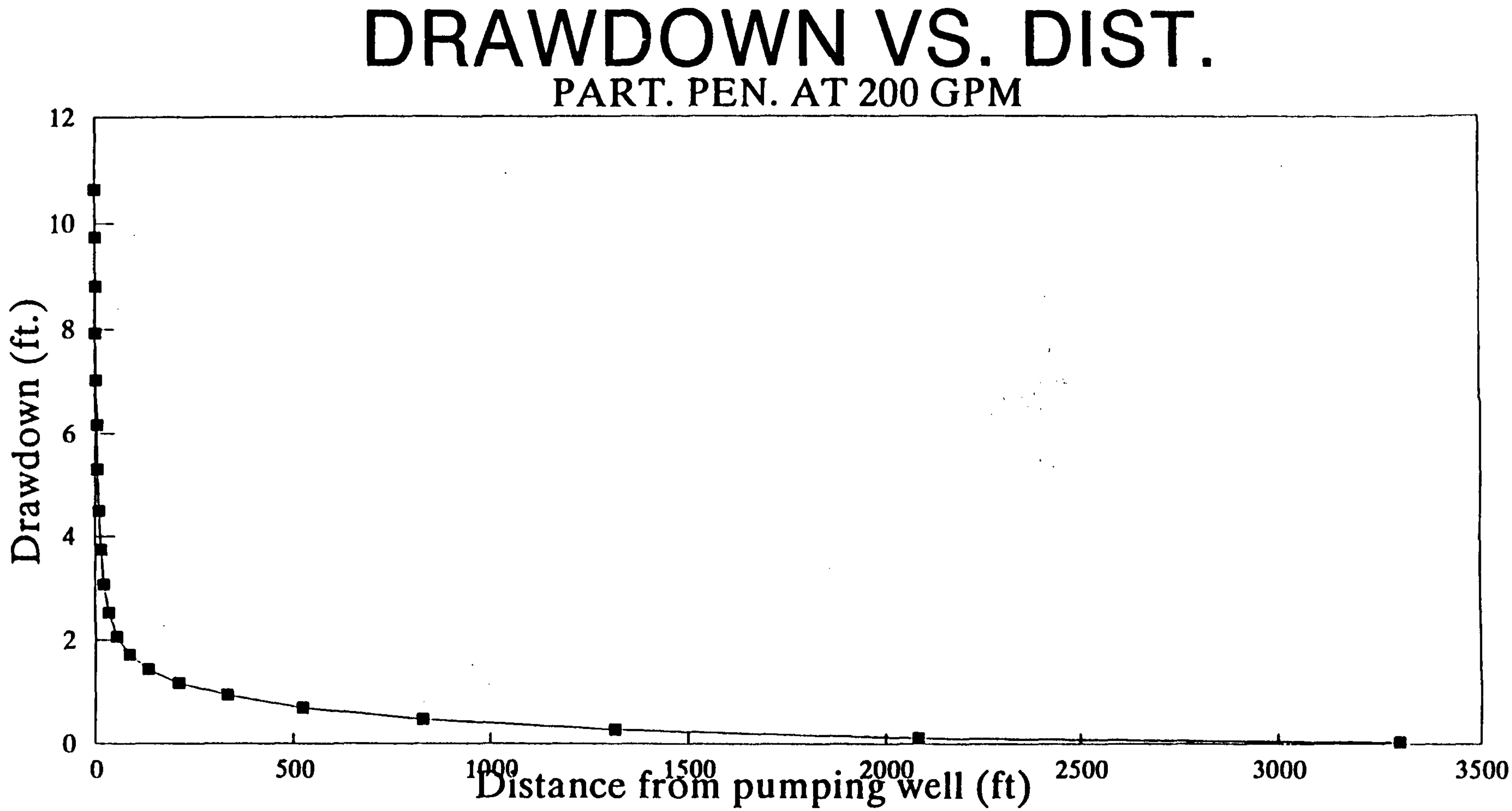
PRODUCTION WELL DISCHARGE RATE (GPM): 200.00
AQUIFER STORATIVITY (DIM): 1.6000E-01
TIME AFTER PUMPING STARTED (MIN):30000.00
DRAWDOWN WITH FULL PENETRATION (FT): 0.03
AQUIFER HORIZ. HYDR. CONDUCTIVITY GPD/SQ FT): 4.6620E+02
AQUIFER VERT. HYDR. CONDUCTIVITY (GPD/SQ FT): 4.6620E+02
RADIAL DISTANCE TO WELL (FT): 3.3000E+03
AQUIFER THICKNESS (FT): 2.0000E+02
DIST. FROM AQUIFER TOP TO BOTTOM OF PROD. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO PROD. WELL SCREEN TOP (FT) 5.0000E+01
DIST. FROM AQUIFER TOP TO BOTTOM OF OBS. WELL (FT): 1.0000E+02
DIST. FROM AQUIFER TOP TO TOP OF OBS. WELL SCREEN(FT): 5.0000E+01

COMPUTATION RESULTS:

WELL FUNCTION: 2.9770E-24
DRAWDOWN DUE TO PART. PENETR. IMPACTS (FT): 0.00
DRAWDOWN WITH PART. PENETR. (FT): 0.03



*Assumptions: Horiz Hydr. Cond = Vertical Hydr. Cond = 466.2 GPD/SQ FT
Aquifer = 200ft thick
Storativity = .16
Well screened = 50 to 100 feet below ground surface
Initial water level = 9.00 ft


DRAWDOWN VS. DIST.
PART. PEN. AT 200 GPM
Drawdown (ft.)
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
Distance from pumping well (ft)

ATTACHMENT H

EXTRACTION WELLS TO ST. JOSEPH RIVER

TECHNICAL MEMORANDUM - Extraction Wells to the St. Joseph River

DATE: March 31, 1992

TO: Mehdi Geraminegad

FROM: Walter Tremel

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Collect and Transfer Groundwater from
the Extraction Wells to the St. Joseph River

This groundwater process option involves extraction of groundwater from beneath the landfill dump site to drop the aquifer water table below the fill in the dump area. Groundwater extracted form the wells will be conveyed to the St. Joseph River approximately 5,000 feet to the south of the landfill for discharge.

The system includes an array of six extraction wells located within the landfill with a total groundwater extraction pumping rate of 1,200 gpm (see attached figure). Each extraction well will be screened at 150 ft. to 200 ft. and will be regulated to pump approximately 200 gpm. The groundwater from these extraction wells will be directed through a pipe header to a central point where an inline centrifugal pump will pump the extracted groundwater through a 8 inch x 5,000 foot pipeline to its discharge point in the St. Joseph River.

Equipment required:

6 Groundwater extraction wells screened between 150 to 200 ft.

6 Submersible pump capable of pumping 200 gpm.

6 Motor starter/breaker units.

3,400 ft. - 1-inch conduit with power and control wires.

2,800 ft. - 4-inch PVC pipe and fittings

600 ft. - 6-inch PVC pipe and fittings

5,200 ft. - 8-inch PVC pipe and fittings

1 - 1,200 gpm inline centrifugal pump.

1 - Pump/motor foundation.

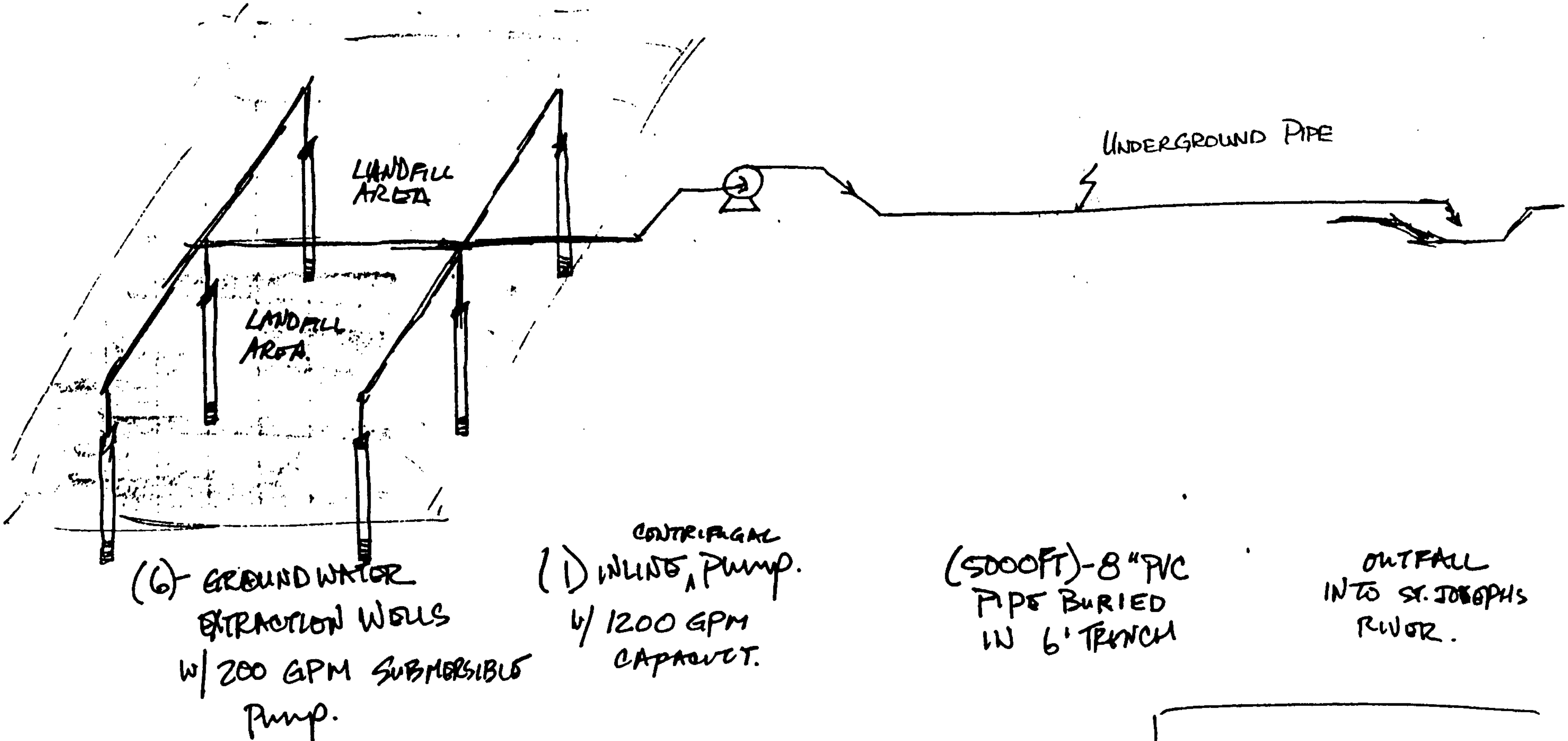
1 - Motor starter/breaker unit with NEMA 4 enclosures 100 ft. - 1-inch conduit with power and control wires.

8,600 ft. - 4-foot deep trench for pipe protection.

10 wooden electric poles.

1000 ft - Electric utility supply lines.

1 - Pole mounted transformer.



HIMCO DUMP SITE
GROUNDWATER DRAWDOWN
PFD.-

ATTACHMENT I

INTERCEPTOR TRENCHES TO ST. JOSEPH RIVER

TECHNICAL MEMORANDUM - Interceptor Trenches to St. Joseph River

DATE: March 31, 1992

TO: Mehdi Geraminegad

FROM: Walter Tremel

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Collect and Transfer Water from
Interceptor Trenches to St. Joseph River

This interceptor trench process option provides for intercepting groundwater in interceptor trenches upgradient of the landfill site and thereby lowering the water table in the aquifer below the dump area. An estimated 2,120 gpm of groundwater will be collected and directed to sumps within the trenches, and pumped to the St. Joseph River.

The system includes a series of interceptor trenches placed along the perimeter of the site interconnected with the quarry pond located north east of the site. The groundwater intercepted by these trenches will be directed to the quarry pond and later pumped with a centrifugal pump through a 10 inch x 5,000 foot pipeline to its discharge point in the St. Joseph's river.

Equipment Required:

1,100 ft - Groundwater diversion trench extending from the east side of quarry.

1,500 ft - Groundwater diversion trench extending from the north side of quarry.

750 ft - Groundwater diversion trench along the west side of the site.

6,500 ft. - 10 inch PVC pipe and fittings

1 - 2120 gpm Centifugal pump.

1 - Pump/motor support structure.

1 - Starter/breaker unit.

500 ft. - 2-inch conduit with power and control wires.

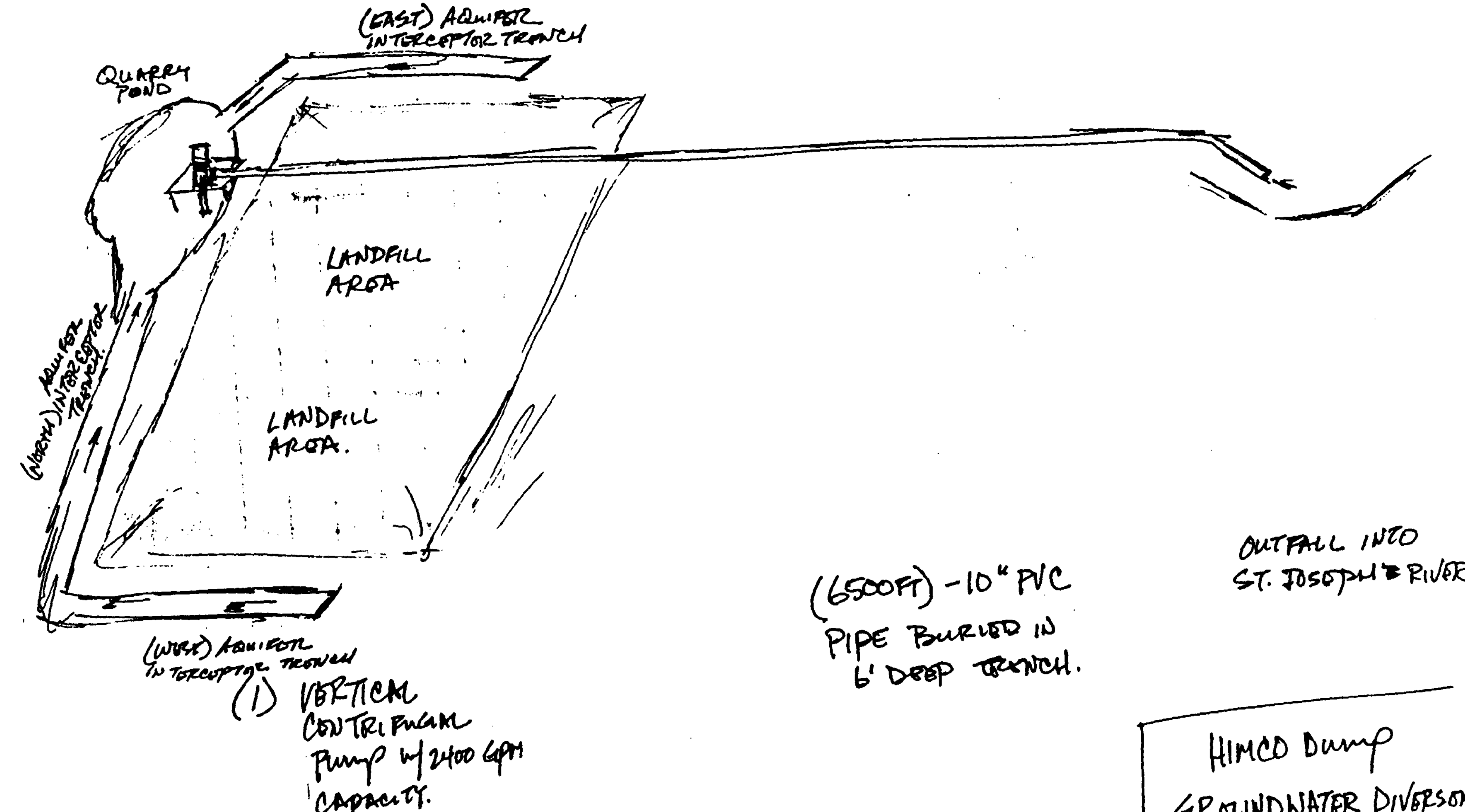
6,500 ft. - 4 ft. deep trench for pipe protection.

10 - Wooden Electric poles.

1000 ft - Electric utility supply lines.

1 - Pole mounted transformer.

HIMCO Dump Groundwater Diverson PFD -



ATTACHMENT J

PLUME INTERCEPTION SYSTEM TO ST. JOSEPH RIVER

TECHNICAL MEMORANDUM - Plume Interception System to St. Joseph River

DATE: March 31, 1992

TO: Mehdi Geraminegad

FROM: Walter Tremel

SUBJECT: EPA ARCS V Program
Himco Dump Superfund Site, Elkhart, Indiana
SEC Donohue Project No. 20026

Collect and Transfer of Groundwater from the
Plume Interceptor System to St. Joseph River

The plume interceptor process option provides for the capturing of contaminant plume down gradient of the site to eliminate off-site migration of contaminants. It includes an array of extraction wells placed down gradient of the dump area. Because the extent of groundwater contamination is not known at this site, the plume interception system is designed to cover 1/3 downgradient face of the site. However, the same plume interceptor system can be considered for the remaining down gradient face of the site. An estimated 105 gpm of groundwater will be intercepted and extracted by the extraction wells, treated by a combination of air stripping, liquid phase active carbon adsorption, and precipitation prior to being pumped to the St. Joseph River or being discharged to the POTW.

The system includes an array of three extraction wells located downgradient of the landfill with a total groundwater extraction pumping rate of 105 gpm. Each extraction wells will be placed at a spacing of approximately 220 ft. and will be regulated to pump approximately 35 gpm (see attached Figure). The groundwater from these extraction wells will be directed through a pipe header to a central point where it will be treated with air stripping to remove VOC contaminants, LPAC to remove semi-volatile contaminants, and precipitation to remove inorganic contaminants. A centrifugal pump will pump the treated extracted groundwater through a 4 inch x 5,000 foot pipeline to its discharge point in the St. Joseph's river or to the POTW.

Equipment required:

3 - Groundwater extraction wells with a submersible pump capable of pumping 35 gpm.

3 Motor starter/breaker units.

1,000 ft. - 1-inch conduit with power and control wires.

1,000 ft. - 3-inch PVC pipe and fittings.

5,000 ft. - 4-inch PVC pipe and fittings.

5,000 ft. - 4-foot deep trench for pipe protection.

1 - packed air stripping tower with 105 gpm and 1,000 scfm capacity.

2 - Vapor Phase activated carbon units.

2 - Liquid Phase activated carbon units.

1 - 5,000 gal fiberglass reinforced plastic (FRP) rectangular reagent mixing tank with agitators.

3 - 2,500 gal FRP reagent holding tanks with feed pump systems.

2 - 2,500 gal Acid/Base feed tanks with pump systems.

1 - 10,000 gal FRP vertical insulated collection/storage tank, with high and low level alarms.

2 - 105 gpm Centifugal pumps.

1 - 1,000 scfm air blower.

1 - 60 ft. x 120 ft. equipment foundation/containment area.

3 - Motor starter/breaker units.

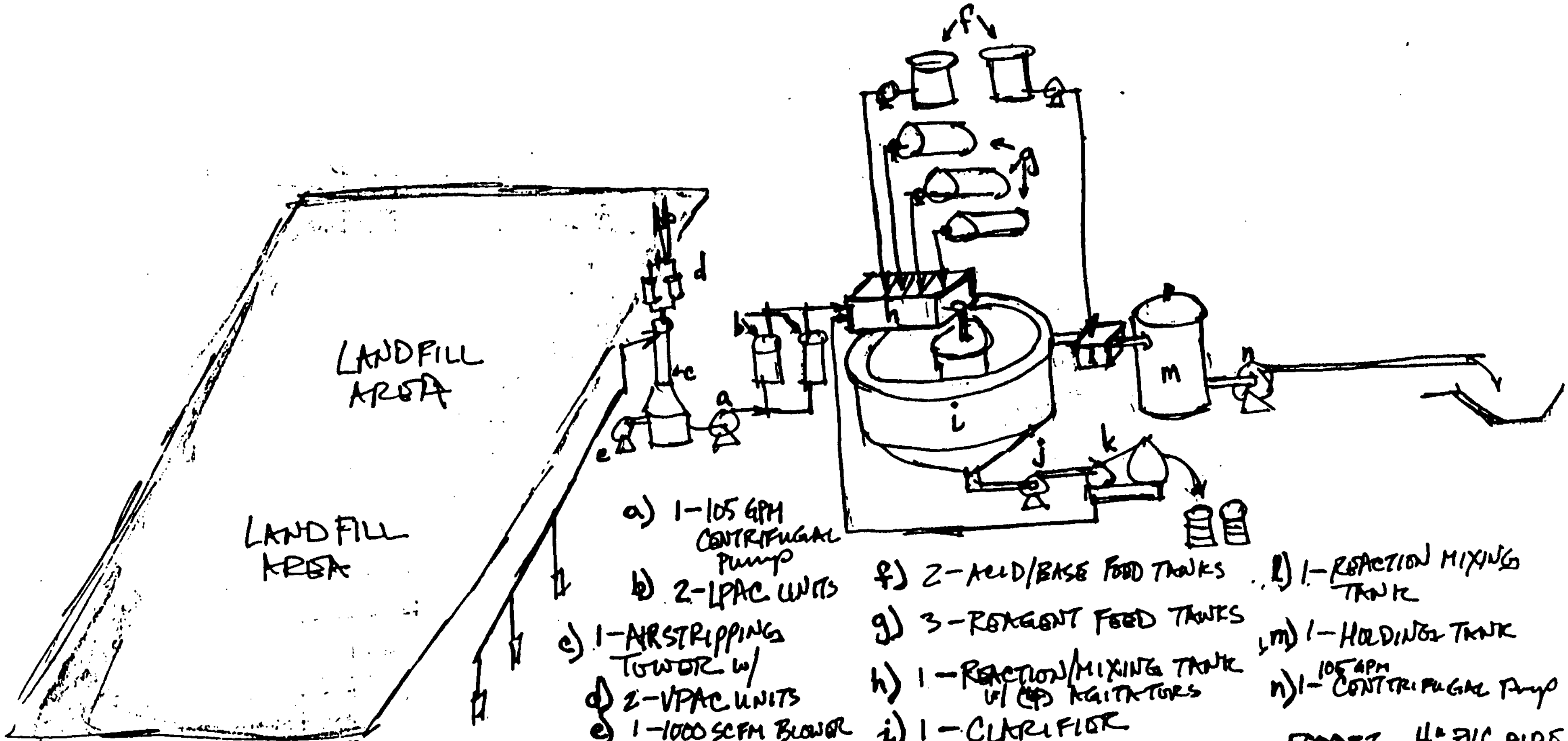
500 ft. - 1-inch conduit with power and control wires.

10 - Wooden Electric poles.

1000 ft E- lectric utility supply lines.

1 - pole mounted transformer.

R/HIMCO/A04



a) 1-105 GPM CENTRIFUGAL PUMP
b) 2-LPAC UNITS
c) 1-AIRSTRIPPING TOWER w/
d) 2-VPAC UNITS
e) 1-1000 SCFM BLOWER

3-GROUNDWATER EXTRACTION WELLS W/35 GPM SUBMERSIBLE PUMPS

f) 2-ACID/BASE FEED TANKS
g) 3-REAGENT FEED TANKS
h) 1-REACTION/MIXING TANK W/ (5) AGITATORS
i) 1-CLARIFIER
j) 1-UNDERFLOW PUMP
k) 1-FILTER

l) 1-REACTION MIXING TANK
m) 1-HOLDING TANK
n) 1-105 GPM CENTRIFUGAL PUMP

5000 FT - 4" PVC PIPE IN 6' DEEP TRENCH

OUTFALL TO ST. JOSEPH RIVER

HIMCO DUMP SITE
GROUNDWATER INTERCEPTION
PFD