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COMPREHENSIVE GROUND WATER MONITORING EVALUATION OF FEED MATERIALS PRODUCTION CENTER HAMILTON COUNTY FERNALD, OHIO U.S. EPA OHD6890008976 OHIO

08/28/90

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ENCLOSURE

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1887

COMPREHENSIVE GROUND WATER MONITORING EVALUATION

OF

FEED MATERIALS PRODUCTION CENTER

HAMILTON COUNTY

FERNALD, OHIO

U.S.EPA OHD6890008976

OHIO ENVIRONMENTAL PROTECTION AGENCY

AUGUST 28, 1990

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GENERAL INFORMATION

Purpose

The purpose of this report is to document the results of a Comprehensive Ground Water Monitoring Evaluation (CME) conducted at the Fernald Feed Materials Production Center (FMPC), Fernald, Ohio. A CME is an in depth evaluation of the ground water monitoring program employed at a facility that manages hazardous waste in a surface impoundment, landfill or land treatment unit. A CME is designed to evaluate a facility's compliance with state hazardous waste ground water monitoring regulations contained in Ohio Administrative Code Rules 3745-65-90 through 3745-65-94.

Site Inspection

A site inspection of the facility was conducted on April 9, 1990 by Ohio Environmental Protection Agency (Ohio EPA) staff. Present from the Ohio EPA Southwest District Office was the author, Mike Proffitt, Division of Ground Water. The facility was represented by David Rast from the Department of Energy (DOE).

Information Sources

This report is based upon an extensive record review and the inspection of the facility conducted on April 9, 1990. In addition to correspondence contained in Ohio EPA files and information gathered during the inspection, the following documents provided information upon which this report is based:

DOE, 1987, RCRA Ground Water Monitoring Report, Volume 3-Round 3, Dames and Moore, March 1987

DOE, 1987, RCRA Ground Water Monitoring Report, Volume 4-Round 4, Dames and Moore, May 1987

DOE, 1987, Characterization Investigation Study, Roy F Weston, November 1987

DOE, 1988, RCRA Ground Water Monitoring Report, Volume 5-Round 5, Dames and Moore, November 1987

DOE, 1988, Remediation Investigation Feasibility Study Work Plan, Advanced Sciences Incorporated, March 1988

DOE, 1988, RI/FS Quality Assurance Project Plan, Volume V, Advanced Sciences Incorporated, March 1988

DOE, 1988, RCRA Ground Water Monitoring Report, Volume 6-Round 6, Westinghouse Materials Company of Ohio, March 1988

DOE, 1989, Ground Water Quality Assessment Program Plan Revision 1, Westinghouse Materials Company of Ohio, March 1989

DOE, 1989, RCRA Part B Permit Application, September 1989.

DOE, 1990, Feed Materials Production Center RCRA Annual Report (partial submittal), March 1990

Planing Research Corporation Environmental Management, Inc., June 26, 1989, Comprehensive Ground Water Monitoring Evaluation for U.S. DOE Feed Materials Production Center, Fernald, Ohio

Spieker, A., 1968. Ground Water Hydrology and Geology of the Lower Great Miami River, Ohio. USGS Professional Paper 605-A.

U.S. EPA 1989, Notice of Violations for FMPC Fernald, Ohio OH6890008976

Inspection Checklists

Attached to this report are the Resource Conservation and Recovery Act (RCRA) Inspection Checklists: Appendix A; Comprehensive Ground Water Monitoring Evaluation Worksheet, Appendix A-1; Facility Inspection Form for Compliance With Interim Status Standards Covering Ground Water Monitoring, and Appendix A-2; Inspection Compliance Form For A Facility Which Has Determined It May Be Affecting Ground Water Quality, all of which were filled out for The RCRA regulated unit Waste Pit 4.

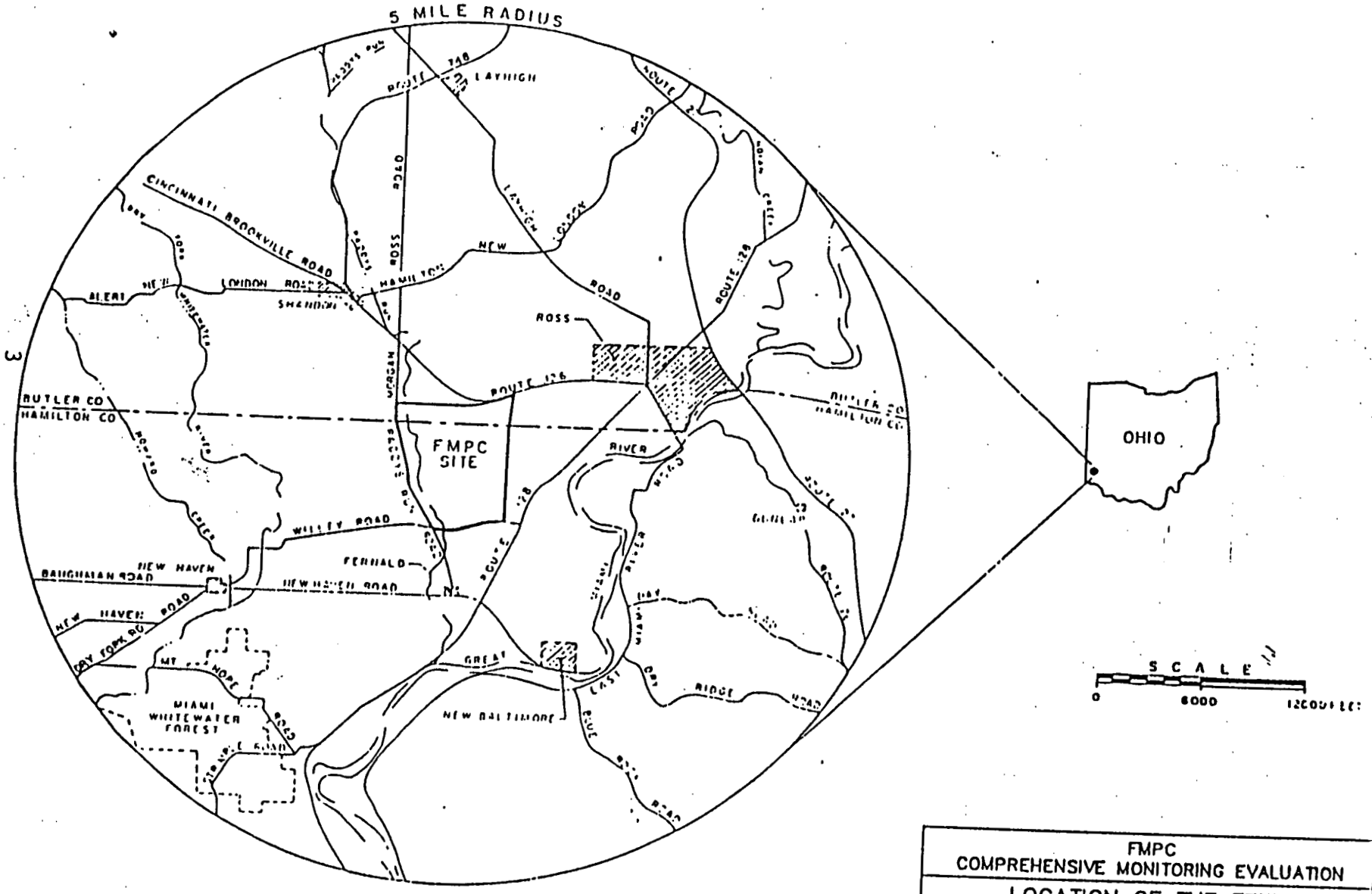
SITE HISTORY AND OPERATIONS

Facility Name: Fernald Feed Materials Production Center, Fernald, Ohio

EPA I.D. Number: OHD890008976

Facility Location

The FMPC facility is located 20 miles northwest of Cincinnati in the unincorporated town of Fernald, Ohio (Figure 1). The facility occupies approximately 1,050 acres in a rural and agricultural setting. There are two surface water bodies in the FMPC site area: Paddys Run, an intermittent stream which recharges the sand and gravel aquifer, and flows near the western boundary of the site; and the Great Miami River is approximately one (1) mile east of the site.



FMPC
COMPREHENSIVE MONITORING EVALUATION

LOCATION OF THE FEED MATERIALS PRODUCTION CENTER

CREATED: 7/26/89	REVISED: 7/26/89	FMPC.F1.DWG

PRC ENVIRONMENTAL MANAGEMENT, INC.

Figure 1 PRC 1989

The information presented below was presented in the 1989 CME prepared for the United States Environmental Protection Agency (US EPA) by Planning Research Corporation Environmental Management, Inc. (PRC). According to the CME, PRC obtained this information from the remediation investigation feasibility study (RI/FS) work plan (DOE, 1988), RI/FS Quality Assurance Project plan (QAPP)(DOE), 1988), and the Characterization Investigation Study (CIS) reports (DOE 1987).

Facility Description

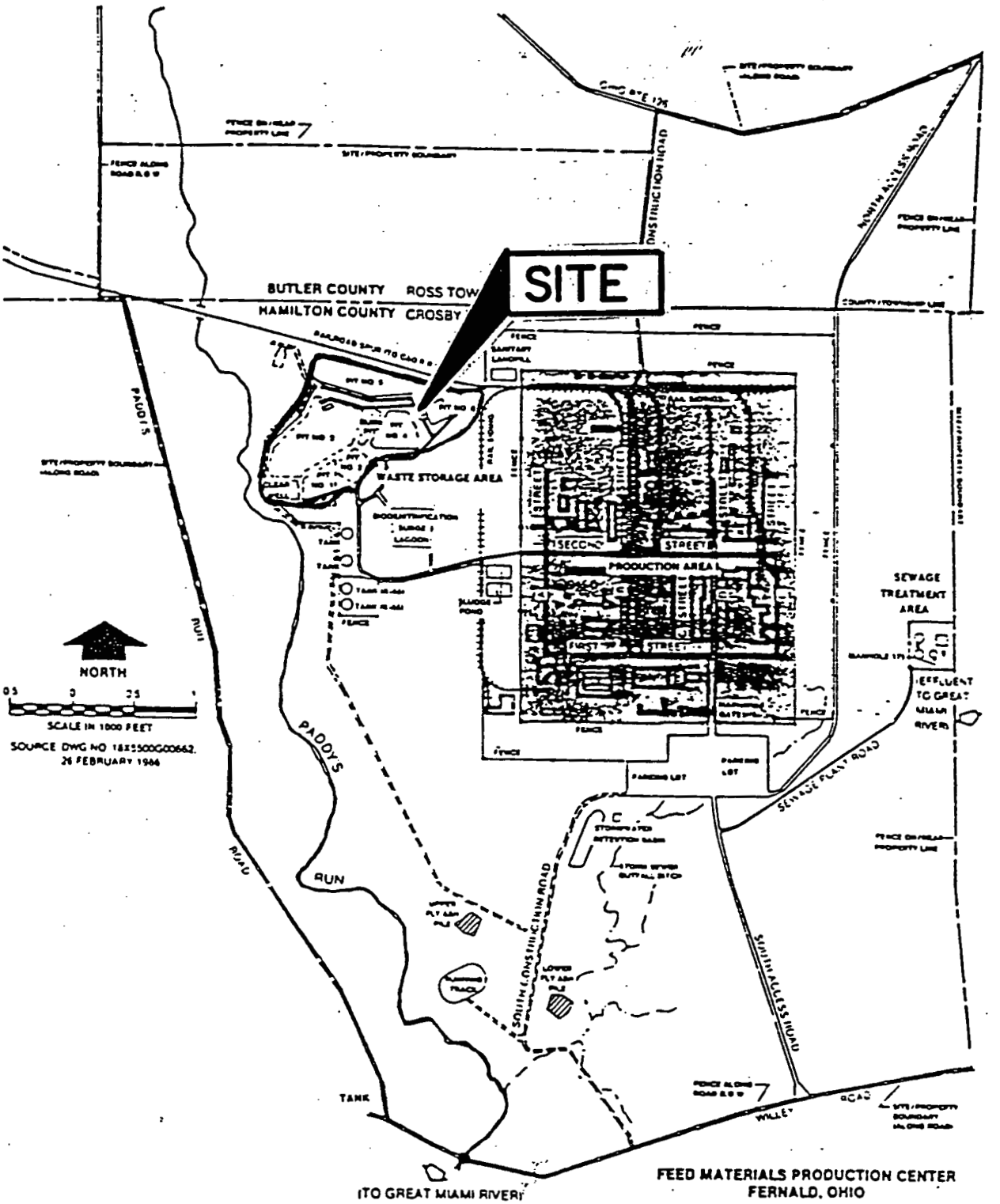
The FMPC manufactures metallic uranium fuel elements, target cores, and other uranium products for use in reactors for DOE. Past activities also included processing small amounts of thorium. In addition, thorium from other facilities is stored at the facility. The RI/FS QAPP gives a detailed discussion of plant operations.

The FMPC site (Figure 2) is divided into three general areas: the production area, the Waste Pit/K65 area, and the suspect areas. Waste Pit 4 (the hazardous disposal unit) is located in the Waste Pit/K65 area.

The waste storage area (Waste Pit/K65 Area) was the principal waste storage area at the FMPC facility. This area includes six waste storage pits and is located in the northwest portion of the facility (Figure 2). The other waste pits received various wastes, however, they are not the subject of this CME. At this time, only Waste Pit 4 is classified as a RCRA regulated unit, however, it has not been clearly determined if the other waste disposal units contain RCRA regulated hazardous wastes. Therefore, additional units may be added to the RCRA unit as more information is obtained.

A detailed listing of the types and volumes of waste disposed of in the waste pits is provided in Volume 2 of the Characterization Investigation Study (CIS) (DOE 1987). In addition, Volume 2 of the CIS presents analytical results of samples taken from each waste pit. Though other materials were disposed of in the waste pits, Barium Sulfate is the RCRA regulated waste disposed of in Pit 4. The presence of this waste characterizes Waste Pit 4 as a RCRA regulated unit.

Waste Pit No.4 was constructed in 1960 with a two (2) foot compacted clay liner on the walls and bottom of the waste pit; it received wastes until 1986. This pit received cakes, slurries, raffinate, graphite, noncombustible trash, and asbestos. Barium sulfate, a RCRA regulated material, was also a major (and unique) waste disposed in Waste Pit No.4. An estimated 3,000,000 Kg of uranium and 61,800 Kg of thorium were disposed of in this waste pit.



FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

MAP OF THE SITE

FMPC COMPREHENSIVE MONITORING EVALUATION		
MAP OF THE FEED MATERIALS PRODUCTION CENTER		
CREATED: 7/26/89	REVISED: 7/26/89	FMPC.F2.DWG
PRC ENVIRONMENTAL MANAGEMENT, INC		

Figure 2 PRC 1989

Facility Regulatory History

Operations for DOE began at the FMPC in early 1950 when National Lead of Ohio (NLO) entered into a contract to operate the facility. National Lead of Ohio operated the facility from 1951 to January 1, 1986. At that time, Westinghouse Materials Company of Ohio (WMCO) began managing the facility under contract to DOE. Currently, all production operations at the FMPC have ceased.

The FMPC is subject to RCRA regulations because (1) it stores hazardous waste in numerous tanks and containers and (2) disposed of hazardous waste in land based disposal units after November 1980. However, facility compliance with the RCRA regulations that apply to storage and handling of hazardous substances is outside the scope of the Division of Ground Water's review. As a result, the CME focused on the OAC 3745-65-90 through OAC 3745-65-94 regulations that apply to the land based disposal unit (Waste Pit No.4).

On December 2, 1988, DOE, U.S Department of Justice, and the Ohio Attorneys General's Office entered a Consent Decree. The ground water issue discussed in this document concern DOE's preparation of an acceptable Ground Water Quality Assessment Program Plan (GWQAPP). The first draft of this document had been reviewed by Ohio EPA, and DOE was given 45 days to incorporate Ohio EPA revisions in a final draft GWQAPP.

The FMPC's ground water detection monitoring program for Waste Pit No.4 began in August 1985. Initial background concentrations were established based on data from four sampling rounds from August 1985 through November 1986. DOE confirmed, based on statistical comparisons, that the FMPC facility could be affecting ground water quality and notified U.S.EPA of such on November 13, 1987. On November 25, 1987, DOE submitted a ground water quality assessment program plan (GWQAPP) to U.S.EPA stating that Waste Pit No.4 would be assessed as part of the site's ongoing RI/FS. However, U.S.EPA noted several inadequacies with the plan, and DOE submitted a revised GWQAPP on March 23, 1989.

In June 1989, PRC initiated a Comprehensive Ground Water Monitoring Evaluation of the FMPC program. The span of the CME begins in 1985 with the installation of monitoring wells for Waste Pit No. 4, and ends with the 1988 Round 6 RCRA Ground Water Quality Assessment Program Annual Report for FY-1988 for FMPC Waste Pit 4. The CME concluded with the following violations:

1) The initial background period continued over 16 months, not the 12 months specified (OAC 37-65-92(D)(1)).

2) The original detection monitoring wells completed in the till (TP- designated wells) were constructed in test pits but not cased in a manner that would maintain the integrity of the monitoring well (OAC 3745-65-91(C)).

3) During detection monitoring, water level measurements were not taken at each well for each sampling period (OAC 3745-65-92(E)).

4) DOE did not immediately resample the ground water after the first semiannual detection monitoring period (round 5), when statistically significant changes were detected in the water quality. The wells were resampled in round 6, but there is no indication that samples were split or that statistical determinations were made (OAC 3745-65-93(C)(2)).

5) The assessment monitoring wells selected to monitor the till aquifer are located at the perimeter of the waste pit area, but not adjacent to Waste Pit No. 4. These perimeter wells are not sufficient to determine the concentrations of hazardous constituents (including RCRA hazardous constituents or other hazardous constituents of concern i.e., uranium) in the ground water (OAC 3745-65-93 (D)(4)(b)) or characterize the contaminant plume (OAC 3745-70-14(C)(4)).

6) The locations of the assessment monitoring wells completed in the till aquifer do not define the extent of the contaminant plume; no additional plans are presented in the GWQAPP or annual report for investigating the outer boundary of the plume past the perimeter wells (OAC 3745-65-93(D)(4)(a)).

7) The GWQAPP does not specify sampling or analytical procedures for all constituents, specifically TOX and TOC (OAC 374565-93(D)(3)(b).

8) DOE failed to adequately implement portions of the assessment program by not conducting the required analyses in sampling rounds 1 and 2 as specified in the GWQAPP (OAC 3745-65-93(D)(4)).

9) The annual report for the assessment program did not include the analytical results for several wells listed in the GWQAPP (OAC 3745-65-94(B)(2)).

SITE AND REGIONAL GEOLOGY

The information concerning site and regional geology of the FMPC site has been obtained from the 1989 CME prepared by PRC. In the CME, PRC states that most of the available geologic information is synthesized in the Hydrogeologic Study of FMPC Discharge to the Great Miami River, DOE, 1988. In addition, DOE is in the process of conducting a site-wide RI/FS that includes the advancement of several hundred soil borings, installation of hundreds of monitoring wells, and ground water modeling. The general regional geologic setting is described by the topography, bedrock geology, and surficial geology. The site-specific geologic setting focuses on the two surficial geologic units: (1) surface till and (2) underlying outwash sand and gravel unit.

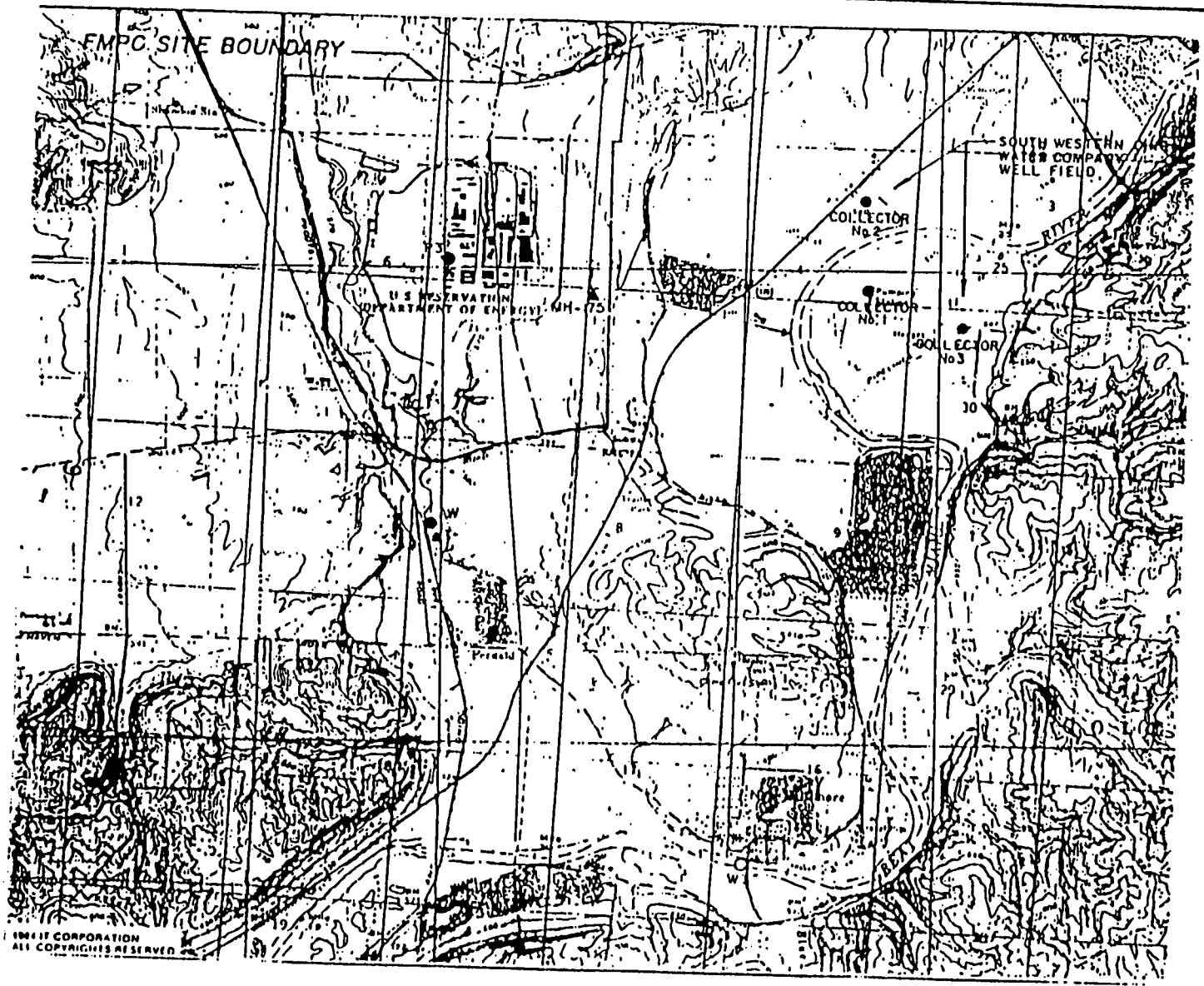
Regional Geology

The topography in the FMPC area consists of a relatively flat glacial till plain approximately 580 feet above mean sea level (MSL) between several bedrock outcrops that reach elevations of over 800 MSL. The FMPC is located on the glacial till plain. The surface elevation of the glacial deposits ranges from 600 feet west of the FMPC to 540 feet at the Great Miami River east of the site (Figure 3).

The geology of the FMPC site area generally consists of 150 to 200 feet of Pleistocene age glacial deposits overlying Ordovician shale bedrock (Figure 4). The bedrock consists of predominantly flat-lying Ordovician shale with thin, interbedded layers of limestone. This shale is part of the Cincinnatian Series and has a total thickness of approximately 800 feet. Prior to the glacial events of the Illinoisan and Wisconsin Periods, the ancestral Great Miami River eroded the bedrock surface and created an entrenched valley approximately 200 feet deep. This bedrock valley is 1/2 to 2 miles wide with a broad flat bottom and steep walls forming a "U" shape. During the subsequent Illinoisan and Wisconsinan (Pleistocene) glacial events, the valley was filled with glaciofluvial sand and gravel deposited by the melt waters of the retreating glaciers. Interbedded in the sand and gravel deposits are glacial till deposits of limited areal extent consisting of poorly sorted pebbles and cobbles in a clay matrix.

Site-Specific Geology

The geology of the FMPC site consists of a surficial glacial till unit overlying the regional glacial outwash deposit below. The glacial till is approximately 20 to 40 feet thick, with the base of the till generally at 540 feet MSL. The till composition varies both horizontally and vertically. In general, the till consists of low permeability silty clay with some sand and



LEGEND

- FMPC EFFLUENT LINE DISCHARGE POINT
- BACKGROUND SURFACE WATER SAMPLING POINT (ROSS BRIDGE)
- RIVER FLOW DIRECTION
- MANHOLE
- PRODUCTION WELLS
- SURFACE WATER SAMPLING POINT

REFERENCES

7.5 MINUTE USGS TOPOGRAPHIC MAPS OF HARRISON, OHIO - IND., SHANDON, OHIO GREENHILLS, OHIO, CINCINNATI WEST, OHIO, ADDYSTON, OHIO - KY, AND HOOVEN OHIO DATED 1955 (PR1981), 1965 (PR1981), 1965 (PR1981), 1961 (PR1981), 1962 AND 1961 SCALE 1" = 2000'

SCALE

0 2000 4000 FEET

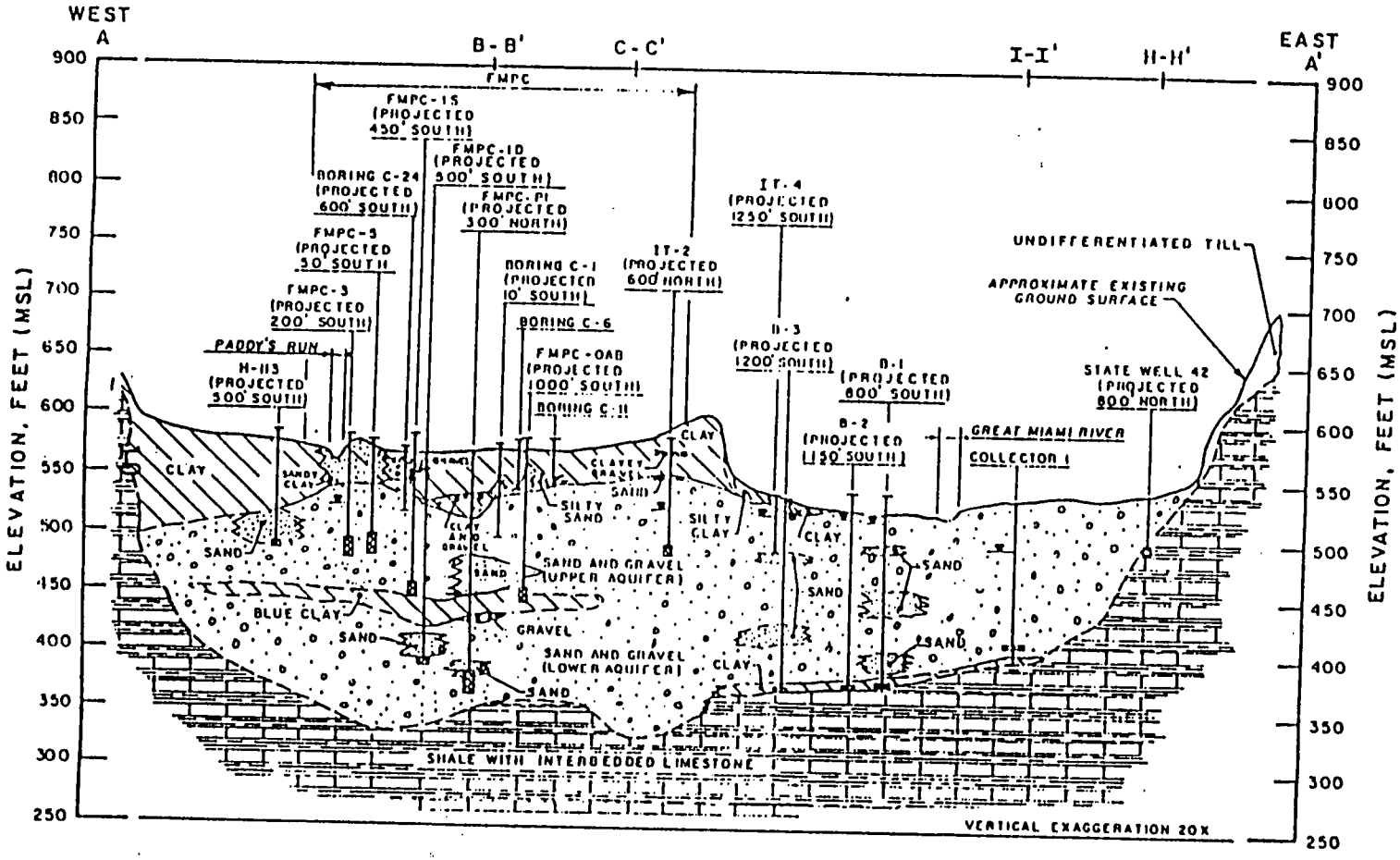
FMPC
COMPREHENSIVE MONITORING EVALUATION

TOPOGRAPHY
OF FMPC AREA

CREATED: 7/26/80	REVISED: 7/26/89	FMPC.F3.DWG

PRC ENVIRONMENTAL MANAGEMENT, INC.

Figure 3 PRC 1989



LEGEND:

OPEN INTERVAL

WATER LEVELS (MEASURED 3/27/86 THRU 4/11/86.)

REFERENCES:

MODIFIED FROM U.S.G.S. PROFESSIONAL PAPER No. 605-A USING AVALIABLE OHIO STATE WATER WELL RECORDS, SOWC WATER WELL DATA, DAMES AND MOORE DOE, FEED MATERIALS PRODUCTION CENTER GROUND WATER STUDY TASKS A AND C REPORTS AND IT BORING LOGS.

FIGURE ADAPTED FROM FERNALD LITIGATION DRAWING NO 303063-B16, PREPARED FOR U.S. DEPARTMENT OF ENERGY BY IT CORPORATION, NOVEMBER, 1986

CROSS SECTION A-A'

(LOOKING NORTH)

VERTICAL SCALE

0 100 200 FEET

HORIZONTAL SCALE

0 2000 4000 FEET

BORING LOGS AND RELATED INFORMATION PICT SUBSURFACE CONDITIONS ONLY AT E SPECIFIC LOCATIONS AND DATES INDICATED R CONDITIONS AND WATER LEVELS AT HER LOCATIONS MAY DIFFER FROM CONDITIONS CURRING AT THESE BORING LOCATIONS ALSO E PASSAGE OF TIME MAY RESULT IN A ANGE IN THE CONDITIONS AT THESE ING LOCATIONS

DEPTH AND THICKNESS OF THE SUBSURFACE STRATA CATED ON THE SECTIONS WERE GENERALIZED FROM INTERPOLATED BETWEEN THE TEST BORINGS ORMATION ON ACTUAL SUBSURFACE CONDITIONS STS ONLY AT THE LOCATION OF THE TEST BORINGS IT IS POSSIBLE THAT SUBSURFACE CONDITIONS WEEN THE TEST BORINGS MAY VARY FROM THOSE CATED

Figure 4 PRC 1989

FMPC
COMPREHENSIVE MONITORING EVALUATION

GENERALIZED WEST-EAST CROSS SECTION THROUGH FMPC STUDY AREA

CREATED: 7/26/89	REVISED: 7/26/89	FMPC.F4.DWG

PRC ENVIRONMENTAL MANAGEMENT, INC.

pebbles. Within the till are lenses of highly permeable sand and "flowing sands" (unconsolidated sand which tends to fill the interior of the hollow stem auger during drilling). To the east and south, the till grades into a silty sand deposit described as Pleistocene lake deposit. The till unit is extensive to the north and west to at least the limits of the boring program. However, Paddys Run has eroded the glacial till in the northwest and the glacial lake deposit in the southwest, exposing the underlying sand and gravel outwash deposit.

Underlying the glacial till and lake deposits is a sequence of highly permeable sand and gravel outwash deposits approximately 160 feet thick, with the base at about 380 feet MSL. In the vicinity of the waste pit and western production area, this sand and gravel unit is reported to be divided by a greenish-black silty clay approximately 10 to 20 feet thick and commonly referred to as the "blue clay". However, based on the boring logs generated from the RI/FS and a discussion with Bob Galbraith on 04/09/90, one the project geologist with ASI consultants, this unit may not be as contiguous as previously thought; instead it may represent several discontinuous clay units at approximately the same elevation and thus would not be considered an aquitard.

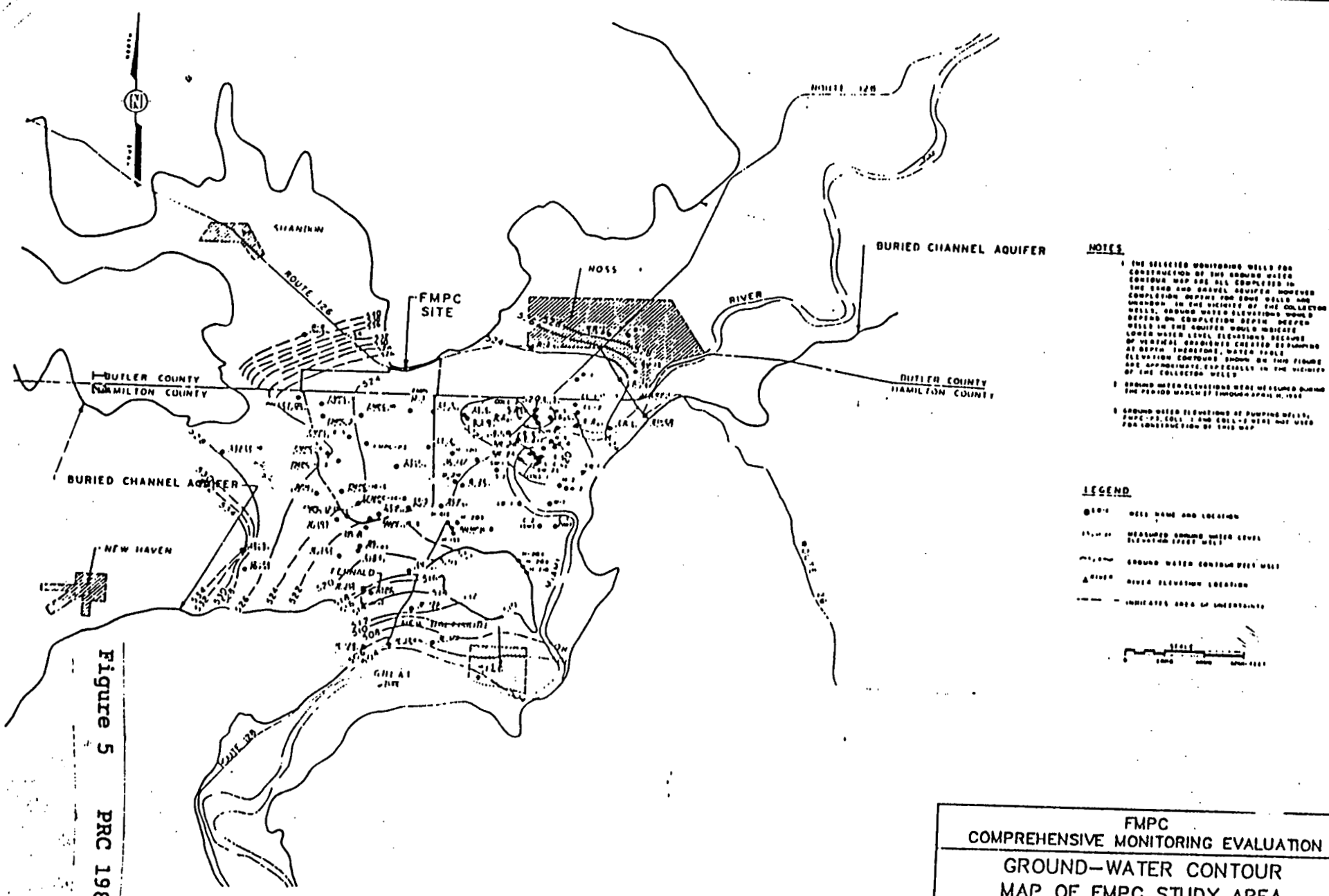
Hydrogeology

As with the geology described above, most of the available regional hydrogeology information is synthesized in the Hydrogeologic Study of the FMPC Discharge to the Great Miami River Study (DOE 1988). The hydrogeology of the sand and gravel unit has been reasonably well defined, however, the hydrogeology of the glacial till unit is very complex and has not been completely characterized. In addition, surface water bodies play a large role in the regional and site hydrogeology.

Regional Hydrogeology

The regional hydrogeology consists of a highly permeable glacial outwash sand and gravel aquifer within a bedrock valley. Portions of the sand and gravel aquifer are overlain by low permeability glacial till and lake plain aquifer. Since the glacial till aquifer is not regionally extensive, it is not discussed in this section.

Ground water in the sand and gravel buried valley aquifer flows from the west, north, and east toward the intersection of several buried bedrock valleys (Figure 5). Ground water exits in this area by flowing southwest through a branch of the buried valley aquifer near New Baltimore, Ohio. The Southern Ohio Water Company (SOWC) pumping wells produce a pronounced and persistent cone of depression and alters the natural ground water flow significantly.



FMPC
COMPREHENSIVE MONITORING EVALUATION

GROUND-WATER CONTOUR
MAP OF FMPC STUDY AREA

CREATED: 7/26/89	REVISED: 7/26/89	FMPC.F5.DWG

PRC ENVIRONMENTAL MANAGEMENT, INC.

Figure 5 PRC 1989

1887

The hydrogeologic characteristics of the sand and gravel buried valley aquifer have been reported by Spieker (1968). Transmissivity values range from 4,700 to 67,000 square feet per day (ft^2/day). Spieker estimated the storage coefficient to be about 0.2. Individual wells in the area are capable of pumping up to 3,000 gallons per minute (gpm).

Two surface water bodies are of concern in the FMPC site vicinity: Paddys Run and the Great Miami River. Paddys Run, an intermittent stream that extends along the entire western edge of the FMPC, receives surface water runoff and seep water from the waste pit area. When Paddys Run is filled with surface water, it flows south and eventually discharges to the Great Miami River. The northern stretch of Paddys Run is underlain by the glacial till deposit, which impedes (to some extent) surface water recharge to the underlying sand and gravel aquifer. The southern reach of Paddys Run has eroded through the glacial till, and surface water freely recharges the sand and gravel aquifer. The Great Miami River is a major surface water body approximately 4000 feet east of the FMPC. This river flows southwest and exhibits meandering patterns with sharp directional changes over short distances.

Site Hydrogeology

The site hydrogeology consists of 2 aquifers: a perched aquifer in the surficial glacial till unit, underlain by a highly permeable regional sand and gravel buried valley aquifer. Under an RI/FS study, the facility has completed several wells in each aquifer; "1000" series wells are completed in the glacial till aquifer, whereas "2000", "3000", and "4000" series wells are completed in the regional sand and gravel aquifer.

The hydrogeology of the surficial glacial till aquifer is very complex in regard to both the composition of the hydrogeologic unit (and sub-units within the till) and the ground water flow pattern. The till is a very complex glacial unit with numerous lenses of sand and gravel. Some of the sand lenses are very loose and under pressure; these areas are termed "flowing sands." Insufficient information is available to determine the lateral extent and interconnection between the sand lenses. In any event, these lenses can act as significant pathways of ground water (and contaminant) migration. During the RI/FS field activities, slug tests were performed of the till wells to define horizontal hydraulic conductivity. Results of the slug testing are presented in Table 1 and indicated that the hydraulic conductivity of the glacial till unit is variable. The hydraulic conductivities range from a relatively high value (1.6×10^{-3} cm/sec) to a relatively low value (2.5×10^{-6} cm/sec). The entire till aquifer is a perched aquifer because unsaturated sand and gravel occurs between the till and the underlying saturated buried valley sand and gravel aquifer. No information is available regarding the amount of recharge the till aquifer contributes to the underlying sand and gravel aquifer.

Table 1 PRC 1989

RESULTS OF SLUG TESTS: TILL WELLS

WELL	HYDRAULIC CONDUCTIVITY (CM/SEC)
1008	1.3×10^{-4}
1012	1.6×10^{-3}
1018	5.7×10^{-4}
1025	2.5×10^{-6}
1034	2.5×10^{-5}
1035	2.5×10^{-5}
1041	1.1×10^{-4}
1046	6.8×10^{-5}
1048	1.6×10^{-4}
1065	2.2×10^{-5}
1079	1.8×10^{-5}

The occurrence of ground water in the till is also very complex. Some wells are dry whereas other wells in the same area and of equal depth contain water. In addition, the water table elevations in some wells located in the waste pit area fluctuate greatly over time, while other wells in the same general area have relatively constant water table elevations.

PRC constructed a contour map of the water table elevations in the till wells for May 1988 (water table elevations were obtained from the RI/FS database). The contour shows a pronounce ground water mound centered around Waste Pit No.4. The water table map prepared by PRC is in general agreement with the water table map presented in the Ground Water Quality Assessment Program Annual Report for Round 6, 1988 (Figures 6a and 6b). PRC also used information from the database (DOE, 1989f) to contour water levels of subsequent months. These maps showed that the ground water mound dissipates in the fall and winter, but that a ground water high still remaining in the area of Waste Pit No.4.

The ground water in the sand and gravel aquifer basically is unconfined (the lower portion of this aquifer may be semiconfined depending on the characteristics and extent of the blue clay). Ground water flow in the sand and gravel aquifer is generally to the east (Figure 7) at an estimated rate of 70 feet/year. None of the site investigations have included pump tests to determine the hydrogeologic characteristics of this aquifer.

RCRA GROUND WATER MONITORING PROGRAM

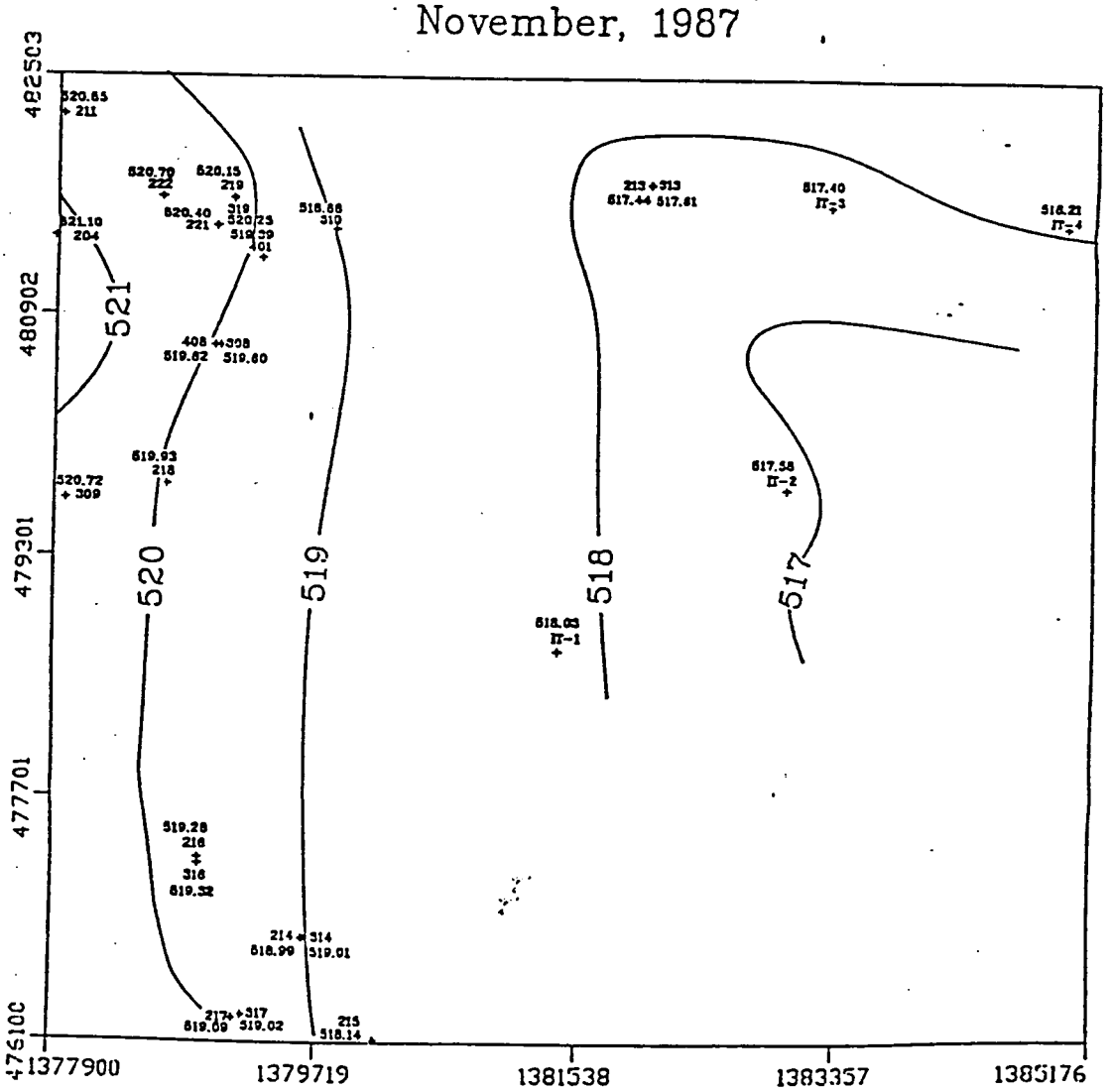
Information concerning the RCRA Hazardous Waste Ground Water Monitoring program is based upon all ground water data submitted to Ohio EPA through the Round 6 1988 sampling. The Ground Water Quality Assessment Program Plan (DOE 1989) submitted to Ohio EPA describes the installation of additional monitoring wells for the RCRA Hazardous Waste Ground Water Quality Assessment program. Though this plan has been implemented during the past year, the DOE has only submitted part of the annual report to the Ohio EPA. As a result, the author of this CME cannot thoroughly evaluate the most recent developments in ground water monitoring at the FMPC facility.

RCRA Detection Monitoring Well Locations

The RCRA detection monitoring system used in rounds one (1) through six (6) is made up of four groups of wells. The RCRA detection monitoring system is no longer used because the facility has been placed into assessment monitoring phase. The assessment monitoring well locations are discussed in the RCRA Ground Water Assessment Monitoring Program section.

The detection monitoring wells, identified on Figure 8 are as follows:

Department of Energy
FMPC
Pieziometric Surface Contour Map
RCRA Ground Water Monitoring Report
Round 6
November, 1987



Water Table Elevation – Upper Sand and Gravel

Contour interval = 1 foot

Figure 6a

DOE 1989

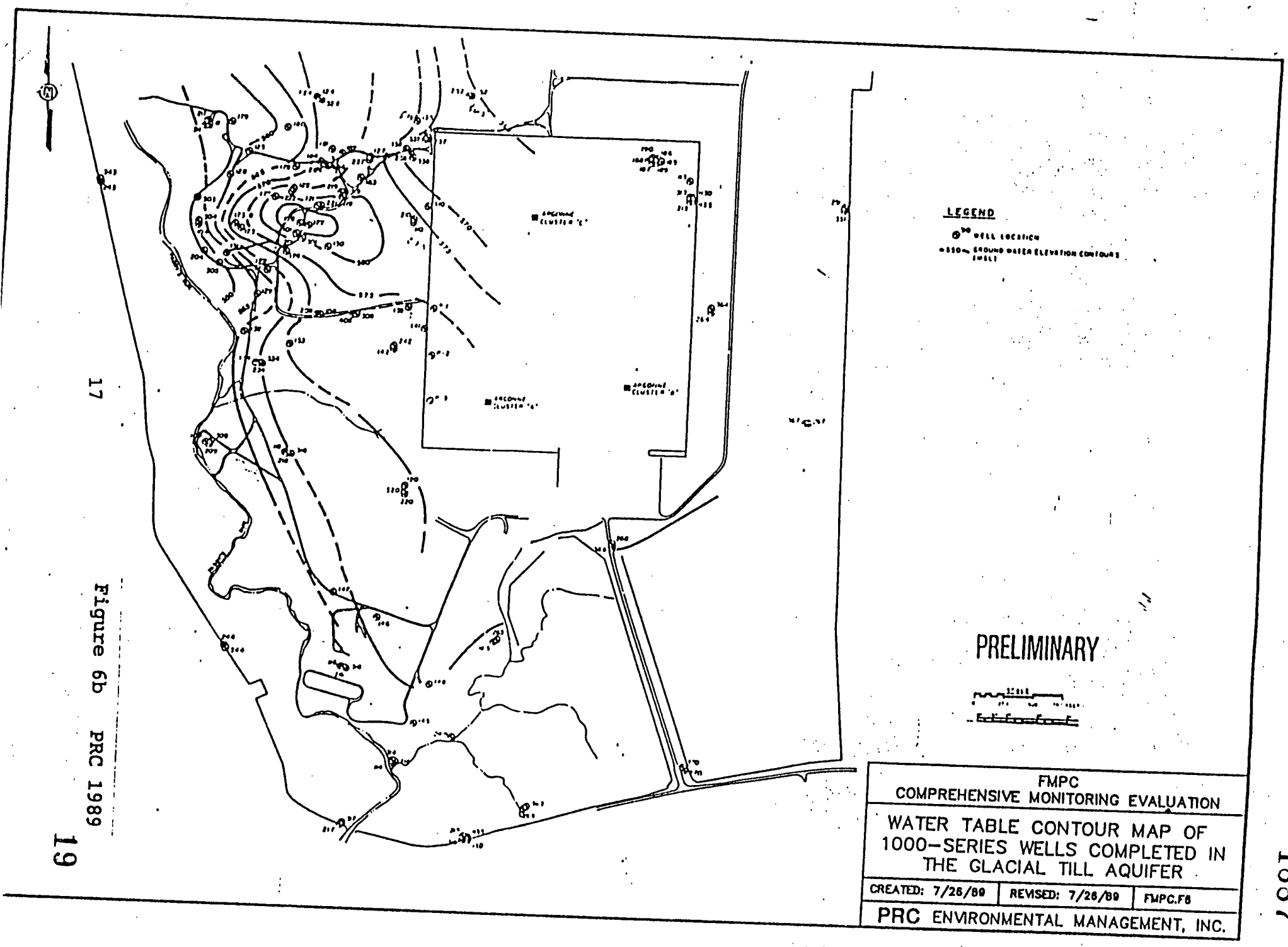


Figure 6b PRC 1989

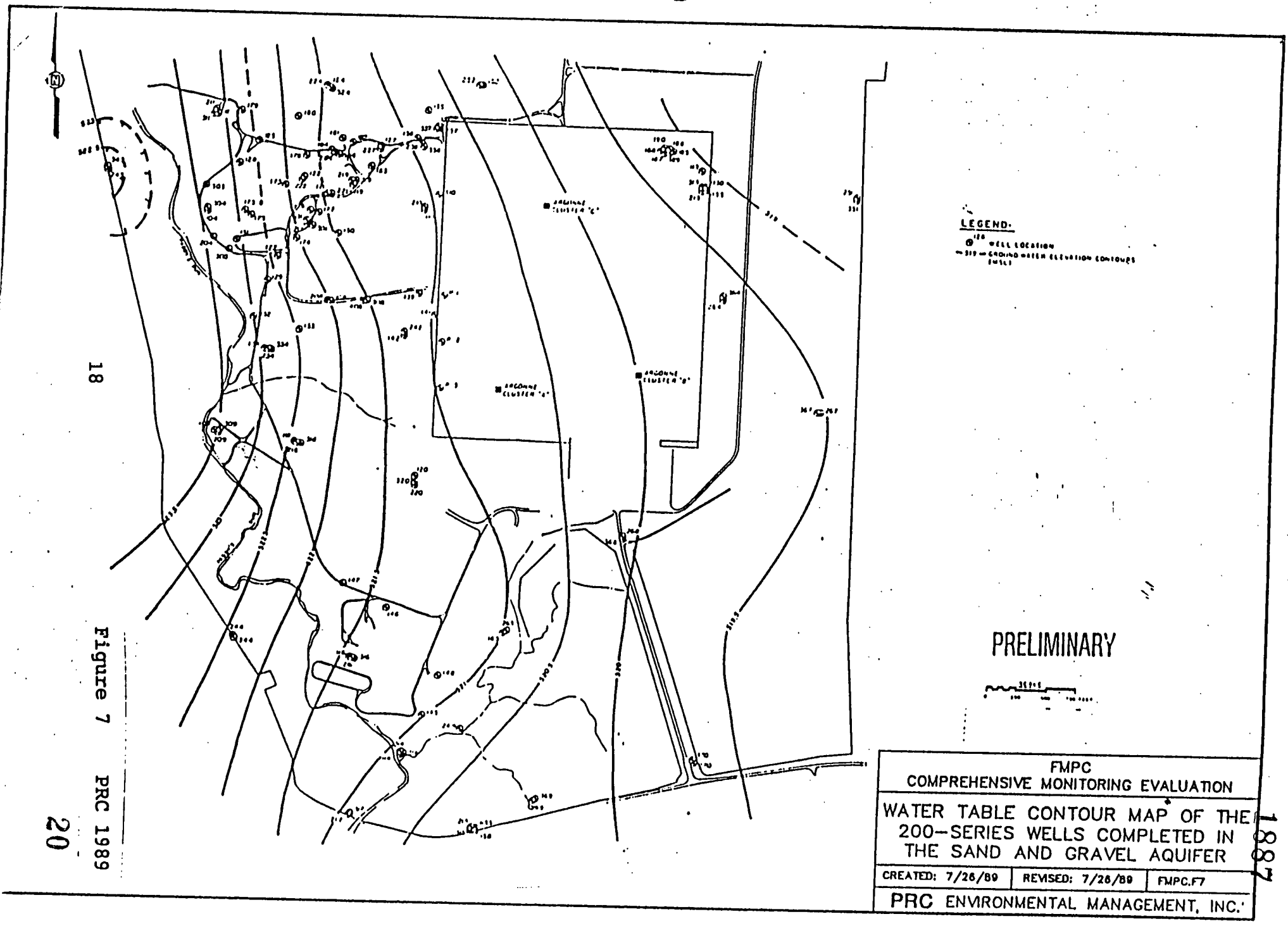
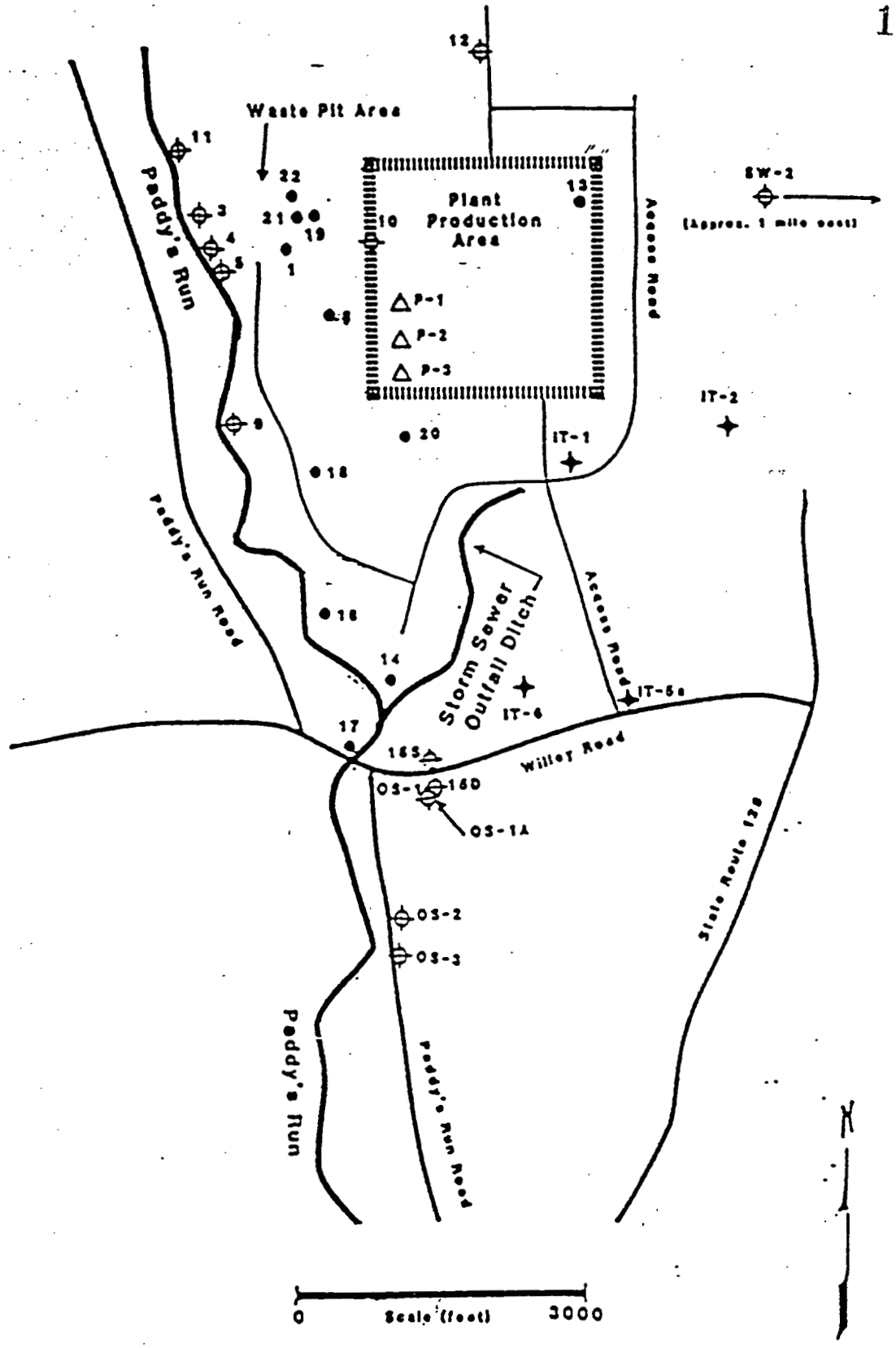


Figure 7 PRC 1989

Table 2
RCRA Detection Monitoring
Wells and Name Equivalents
1986-1989

1989 Well Identification	1987 Well Identification	1986 Well Identification
3001	301	1s
4001	401	1d
3003	303	3
2004	204	4
3005	305	5
3008	308	8s
4008	408	8d
3009	309	9
3010	310	10
2011	211	11
1012	112	12
2013	213	13s
3013	313	13d
2014	214	14s
3014	314	14d
2015	215	15s
4015	415	15d
2016	216	16s
3016	316	16d
2017	217	17s
3017	317	17d
2018	218	18s
3018	318	18d
1019	119	19TP
2019	219	19s
3019	319	19d
1020	120	20TP
2020	220	20s
3020	320	20d
1021	121	21TP
2021	221	21s
1022	122	22TP
2022	222	22s
2060	OS-1	OS-1
1060	OS-1A	OS-1A
2061	OS-2	OS-2
3062	OS-3	OS-3
SW-2	SW-2	SW-2
4101	P1	P1
4102	P2	P2
4103	P3	P3

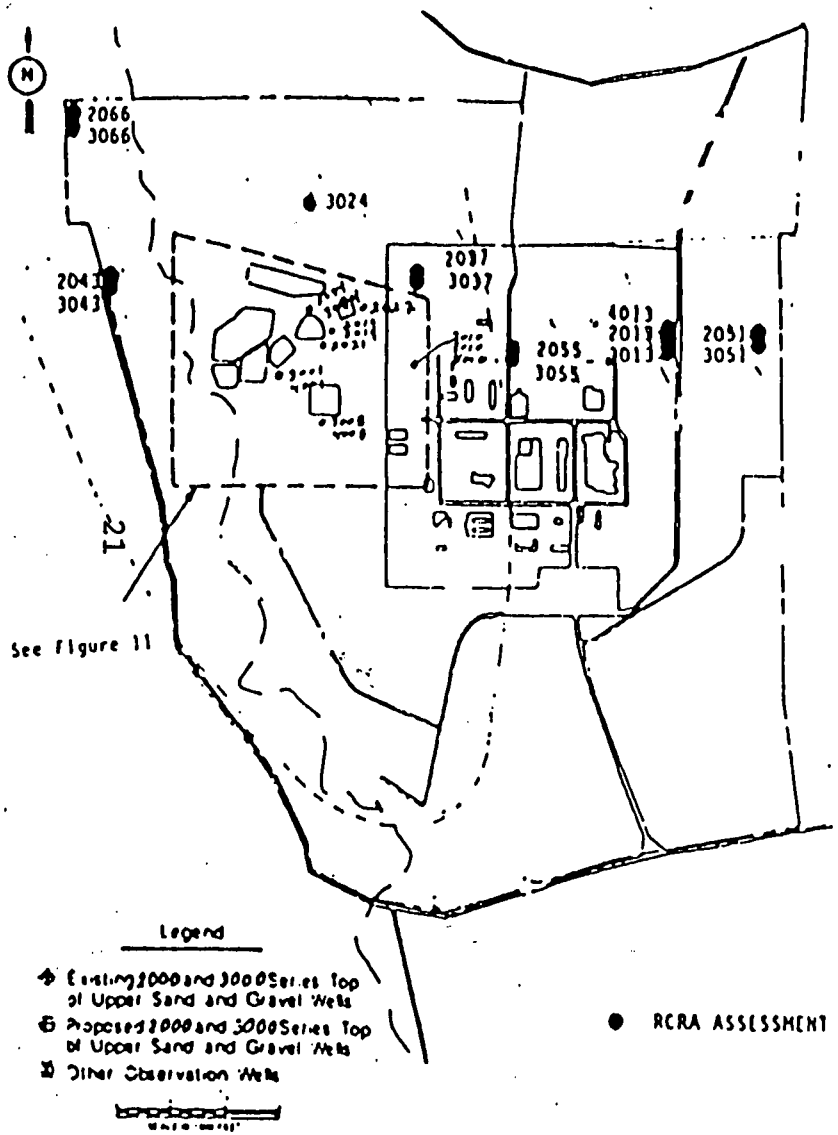


Explanation:

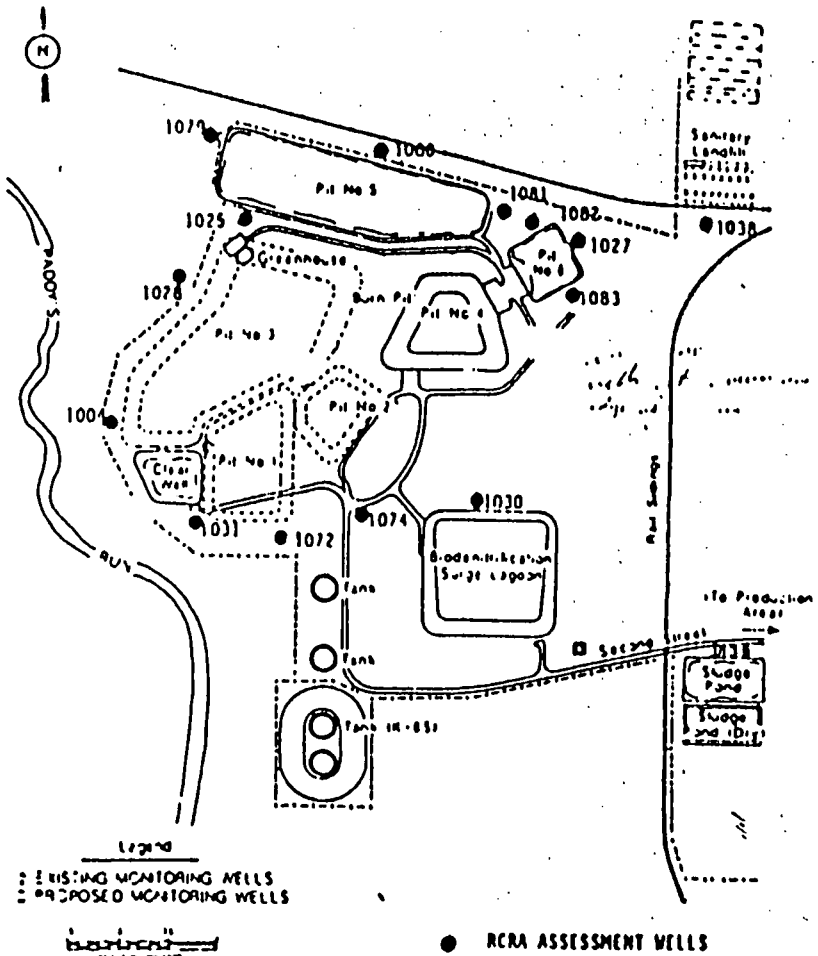
- Single Well Location
- Cluster Well Location
- Production Well Location
- IT Well Location

Figure 8 DOE 1989

Round 6 Well Locations



RI/FS 2000, 3000 and 4000 Series Wells - FMPC Site



RI/FS 1000 Series Wells - Waste Pit Area

Figure 9 PRC 1989

FMPC COMPREHENSIVE MONITORING EVALUATION		
RI/FS WELLS SELECTED FOR THE RCRA ASSESMENT PROGRAM		
CREATED: 7/26/89	REVISED: 7/26/89	FMPC.F9
PRC ENVIRONMENTAL MANAGEMENT, INC.		

Five shallow wells completed in the till in close proximity to Waste Pit No. 4 (well MW-12 (1012) is upgradient, and wells TP19 (1019), TP21 (1021), TP22 (1022), and OS-1A (1060) are down gradient).

Fourteen monitor wells completed in the sand and gravel aquifer and located within the FMPC boundaries. The majority of these wells are located in the waste pit area (wells MW-1s (3001), MW1d (4001), MW-3 (3003), MW-4 (2004), MW-5 (3005), MW-8s (3008), MW-8d (4008), MW-10 (3010), MW-13s (2013), MW-13d (3013), MW-19s (2019), MW-19d (3019), MW-21s (2021), and MW-22s (2022)).

Three plant production wells completed in the deeper portion of the sand and gravel aquifer (wells P-1 (4101), P-2 (4102), and P-3 (4103)).

Eighteen monitoring wells and four water supply wells completed in the sand and gravel aquifer outside the FMPC boundaries (wells SW-2 (upgradient), MW-9 (3009), MW-11 (2011), MW-14s (2014), MW-14d (3014), MW-15s (2015), MW-16s (2016), MW-16d (3016), MW-17d (3017), MW-18s (2018), MW-18d (3018), MW-20s (2020), MW-20d (3020), OS-1 (2060), HK-15d, OS-2 (2061), OS-3 (3062)) (PRC 1989).

(A table listing the old RCRA monitoring well numbers and their new RI/FS numbers is included as Table 2.)

Though the three (3) production wells and the four (4) supply wells are not acceptable as monitoring wells, they provided some of the only ground water data available prior to the installation of the RI/FS monitoring wells.

Only monitoring wells MW-22, MW-21, MW-19, and MW-1 are located directly in the waste pit areas. All other monitoring wells are placed throughout the site and could potentially be impacted by other sources. The RCRA ground water monitoring program detected a ground water impact originating from Waste Pit No. 4. This may indicate that the ground water was impacted prior to the installation of the monitoring wells, and not necessarily reflect the proper placement of the monitor wells so as to immediately detect a release from the regulated unit.

Monitoring Well Installation and Construction

Monitoring well diagrams and boring logs were included in the RCRA Part B Permit Application. Information concerning the specifications for the monitoring wells used as the RCRA monitoring wells in rounds one (1) through seven (7) and the RCRA monitoring wells used in the current monitoring program are included.

The following deficiencies were noted on the monitoring wells used in rounds one (1) through six (6):

MW-12 is set at a depth of 60 feet in a greenish gray shale. The annulus was backfilled with cuttings and a two (2) foot bentonite seal placed at the bottom of the boring. The screen set at the top of the bentonite seal, is 17 feet in length, and is surrounded by a gravel pack. The annular gravel pack continues to four (4) feet above the top of the screen. A four (4) foot bentonite seal was placed above the sand pack. The remaining annular space was backfilled with a clean sand and bentonite powder mix (DOE 1989).

MW-12 has been regarded as representative of upgradient water quality for the RCRA monitoring wells set in the till aquifer, however, since the monitoring well construction diagram indicates that the well is set in shale, it is doubtful that the well can yield water quality data which would be applicable to the other monitoring well locations. Additionally, the placement of cuttings into the bottom of the boring could potentially introduce contaminants to the ground water.

Monitoring well SW-2 has been used as the upgradient well for the sand and gravel aquifer. This well is a supply well located approximately one (1) mile east of the FMPC facility. The distance between this well and the waste pit area make the location inappropriate as an upgradient well. Elevated levels of nitrate, sulfate, and gross beta activity indicate that this well is probably not representative of background ground water quality.

TP-19, TP-21, and TP-22 were constructed by digging test pits with a backhoe. PVC riser with five (5) feet of number 10 screen at the bottom was placed in the pit. Gravel was backfilled into the pit, followed by bentonite, then the entire pit was backfilled with a washed gravel and bentonite powder mix.

Though the construction of these test pit wells was done in an unconventional manner, they have supplied the only ground water information available for the waste pit area.

Monitoring wells P-1, P-2, P-3, MW-1s, MW-3, MW-5, SW-2, OS-2, and OS-3 were constructed in a manner which makes it impossible to take water levels (DOE 1988). This characteristic makes the monitoring wells unsuitable for the RCRA ground water monitoring program.

Monitoring wells 14d, 15d, 16d, 17s, 17d, 12, TP-19, TP-21, and TP-22 were all constructed by first placing cuttings in the bottom of the boring. This practice can introduce contaminants from the upper zones into the ground water,

producing unreliable monitoring wells. Monitoring wells 15d and 16d do not have a bentonite plug separating the cuttings from the bottom of the screen, making the likelihood of contamination even greater.

Boring logs and monitoring well completion diagrams for monitoring wells 1s, 1d, 3, 4, 5, 8s, 8d, 9, 10, and 11 were not sufficient to determine monitoring well construction.

No boring logs or monitoring well completion diagrams were submitted for monitoring wells OS1, OS1A, OS2, OS3, or SW-2.

The following deficiency was noted for the monitoring wells used for the 1989 RCRA ground water quality assessment:

Monitoring Well 2066 is classified as an upgradient sand and gravel well, however, the boring logs indicate that the monitoring well is screened in till.

Ground Water Monitoring History

The Fernald FMPC began its RCRA ground water monitoring program in August 1985. Round one sampling , which included sampling 43 monitoring wells, began in August 1985 and was completed in January 1986.

The second round of sampling was completed in May 1986. This phase, as well as all following phases to date, occurred over a shorter period of time than that of round 1. This round included sampling 42 monitoring wells. Round 3 was completed in August 1986 and included sampling 42 monitoring wells. Round 4 was completed in November 1986. This round included sampling 40 monitoring wells on and off site. Round 5 was completed in May

1987 and included 41 monitoring wells. Round 6 was completed in December 1987 and included sampling 40 monitoring wells. Monitoring wells used for the individual sampling rounds are listed in Table 3.

During the first year, DOE was to sample the RCRA monitoring wells quarterly in order to establish background concentrations as described in 40 CFR 265.92 b 3 c1 (OAC 37-65-92 (D)(1)). The first sampling round was extended over a 5 month period, and the next three sampling rounds occurred at 3 month intervals. The total period of time used to establish background concentrations was 16 months.

Table 3

RCRA Monitoring Wells Sampled for RCRA Program

Monitoring Wells	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6
HK-15d		X	X	X		
MW-10	X	X	X	X	X	X
MW-11	X	X	X	X	X	X
MW-12	X	X	X	X	X	X
MW-13d	X	X	X	X	X	X
MW-13s	X	X	X	X	X	X
MW-14d	X	X	X	X	X	X
MW-14s	X	X	X	X	X	
MW-15d	X	X			X	X
MW-15s	X	X	X	X	X	X
MW-16d	X	X	X	X	X	X
MW-16s	X	X	X	X	X	X
MW-17d	X	X	X	X	X	X
MW-17s	X	X	X	X	X	X
MW-19d	X	X	X	X	X	X
MW-18s	X	X	X	X	X	X
MW-19d	X	X	X	X	X	X
MW-19s	X	X	X	X	X	X
MW-1d	X	X	X	X	X	X
MW-1s	X	X	X	X	X	X
MW-20d	X	X	X	X	X	X
MW-20s			X	X	X	X
MW-21s	X	X	X	X	X	X
MW-22s	X	X	X	X	X	X
MW-3	X	X	X	X	X	X
MW-4	X	X	X	X	X	X
MW-5	X	X	X	X	X	X
MW-8d	X	X	X	X	X	X
MW-8s	X	X	X	X	X	X
MW-9	X	X	X	X	X	X
OS-1	X	X	X	X	X	X
OS-1a	X	X	X	X	X	X
OS-2	X	X	X	X	X	X
OS-3	X	X	X	X	X	X
P1	X	X	X	X	X	X
P2	X	X	X	X	X	X
P3	X	X			X	X
SW-1	X					
SW-2	X	X	X	X	X	X
TP-19	X	X	X	X	X	X
TP-20	X	X	X	X	X	X
TP-21	X	X	X	X	X	X
TP-22	X	X	X	X	X	X

A statistical analysis was completed following Round 5 on the ground water indicator parameters comparing upgradient and downgradient monitoring wells at Waste Pit No. 4. These analyses were done in accordance with procedures defined within Appendix IV of 40 CFR 264, the Technical Enforcement Guidance Document, and as required by 40 CFR 265.93 and OAC 3745-65-93. Consistent with these requirements, the Cochran's Approximation to the Behrens-Fisher Student's T-Test was employed to compare background and downgradient monitoring data for select Detection Program wells. Statistical analysis was completed comparing background till well 1012 to downgradient wells 1019, 1021, and 1022. Similarly, statistical analysis was completed comparing background well SW-2 to downgradient wells 2019, 3019, 2021, and 2022. These downgradient wells were selected for comparison because of their close proximity to Waste Pit No. 4 (DOE, 1989)

The results of the statistical analysis completed on the first four rounds of RCRA Detection Monitoring appear in Appendix E-II of the RCRA Part B Permit Application, 1989. In general, the statistical evaluation indicated the following for the glacial till unit:

> Total Organic Carbon (TOC) concentrations significantly increased in all downgradient wells.
>
> In all downgradient wells pH significantly decreased in comparison to the upgradient well.
>
> Specific conductance significantly increased in two of the three downgradient wells (Wells 1019 and 1022) as compared to the upgradient well. (DOE, 1989)

The statistical evaluation of the data collected from the background and downgradient wells in the sand and gravel aquifer indicated to following:

> Specific conductance significantly increased in all downgradient wells as compared to the background well.
>
> pH significantly decreased in one downgradient well (Well 3019) as compared to the background well. (DOE, 1989)

Once DOE established that a significant change in ground water quality had occurred, additional ground water samples from those downgradient wells where a significant difference was detected should have been resampled as described in 40 CFR 265.93(c)(2) (OAC 3745-65-93 (c)(2)). DOE did not resample the monitoring wells until round 6.

Ground Water Quality

Round 6 sampling confirmed ground water impact by Pit 4. Elevated levels of sodium, sulfate, total dissolved solids, conductivity, gross alpha, gross beta, radium, uranium, phenolics, chloride, nitrate, potassium, strontium, and 1,1,1 trichloroethane were noted by Ohio EPA when compared to background (Tables 4a, 4b, 4c, 4d). Though not all of these parameters are RCRA hazardous waste constituents, all solid waste originating from a RCRA regulated unit which has RCRA hazardous waste disposed of in it are hazardous wastes subject to assessment monitoring 40 CFR 261.3(c)(2)(i) (PRC 1989).

RCRA Ground Water Assessment Monitoring Program

The Fernald FMPC was placed into assessment phase monitoring on November 13, 1987, when DOE notified U.S. EPA that a release from Waste Pit No. 4 had been confirmed.

DOE designed a Ground Water Assessment Program Plan (GWAPP) to fulfill requirements in 40 CFR 265 Subpart F (OAC 3745-65-90). After several revisions, a GWAPP was agreed upon by Ohio EPA, U.S. EPA, and DOE in March 1989.

Monitoring Well Locations

DOE was required to submit the 1989 RCRA Ground Water Quality Assessment Report to Ohio EPA by March 1, 1990. DOE failed to submit this report on time; however, they did submit a partial report to Ohio EPA Division of Solid and Hazardous Waste Management on March 5, 1990. The report does not include any technical information and only includes raw, unverified data. A revised report was received by this office on May 23, 1990. This report is a partial submittal of technical information, and is currently under review by Ohio EPA. As a result, it is impossible to thoroughly evaluate the current RCRA Assessment Monitoring Program monitoring well placement.

Table 4a

Impacted monitoring wells (plant production wells)
All results in parts per million

Contaminants	P-1
Chloride	
Sodium	
Sulfate	140
Phelolics	
Nitrate	
Potassium	
TDS	
Conductivity	1020
1,1,2,2-Tetrachloroehene	
Cloroethene	
Bromoform	
cis-1,2-Dichloroethene	
1,1 Dichloroethane	
1,2-Dichlorobenzene	
Gross Alpha	
Gross Beta	6
Radium 226	
Radium 228	
Uranium	
Strontium 90	

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Table 4b

Concentrations in parts per million

Contaminant	TP-19	TP-21	TP-22
Sodium	418		
Sulfate	280	220	410
TDS	2490		1840
Conductivity	5310		2240
1,1,2,2-Tetrachloroethene	1.54		
Chloroethene	0.87		
Bromoform	0.91		
cis-1,2-Dichloroethene	29.5		
1,1 Dichloroethane	15		
1,2-Dichlorobenzene	0.63		
Gross Alpha		954	149
Gross Beta		3310	938
Radium 228		23	4
Uranium		6440	4200

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Table 4c All results in parts per million

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Contaminants	MW-9	MW-14d	MW-15s	MW-20s	OS-1	OS-2	OS-3
Chloride							
Sodium							
Sulfate							
Phelolics	0.006						
Nitrate	1.54	1.46	1.98	2.84	2.04	2.21	
Potassium							
TDS							
Conductivity							
1,1,2,2-Tetrachloroehene							
Cloroethene							
Bromoform							
cis-1,2-Dichloroethene							
1,1,1 Trichloroethane			5.13				
1,1 Dichloroethane							
1,2-Dichlorobenzene							
Gross Alpha			35		59	59	
Gross Beta	18	17	95	21	104	99	23
Radium 226						1	
Radium 228							
Uranium		13	267		396	319	204
Strontium 90							

Table 4a

All results in parts per million

Contaminants

Contaminant	MW-3	MW-4	MW-10	MW-13s	MW-13d	MW-19s	MW-19d	MW-21s	MW-22s
Chloride			85		64				
Sodium			132						
Sulfate	92		780	116	300	92	400	89	105
Phelolics		0.006							
Nitrate			71						
Potassium			14.3						
TDS			2000		860		900	980	864
Conductivity							1180	1200	1220
1,1,2,2-Tetrachloroehene									
Cloroethene									
Bromoform									
cis-1,2-Dichloroethene									
1,1 Dichloroethane									
1,2-Dichlorobenzene									
Gross Alpha	2960					9		31	3
Gross Beta	14100		62			1270		2770	1220
Radium 226	16								
Radium 228	294							12	
Uranium	11700					7		9	
Strontium 90								22	

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The revised GWQAPP states that 43 monitoring wells will be used in the assessment program. These wells are listed in Table 5 and shown on Figure 9. As shown on Figure 9, the till aquifer is being monitored by 14 downgradient wells and two upgradient wells. The downgradient wells monitor the circumference of the waste pit area. Although not shown in Figure 9, there are a number of wells inside and outside the waste pit area not being used in the assessment monitoring program (PRC 1989). These 43 monitoring well locations include nine (9) monitoring wells used in the first six (6) rounds of sampling (3001 (1s), 4001 (1d), 3008 (8s), 3010 (10), 2013 (13s), 3013 (13d), 2019 (19s), 3019 (19d), 2021 (21s); other than the nine (9) monitoring wells used in the detection monitoring program, the assessment wells have been recently installed.

Monitoring well locations for the RCRA ground water assessment program are illustrated in Figures 8 and 9. The location of these monitoring wells cannot be assessed at this time due to a lack of technical information. Ohio EPA will be able to evaluate monitoring well locations once the 1989 Ground Water Quality Assessment Report for 1989 is submitted by DOE.

DOE states in the GWQAPP that since similar materials were disposed of in the various waste pits, it is impossible to attribute any contaminants to a specific waste pit. Based on this condition, DOE has placed monitoring wells around the perimeter of the entire waste pit area and has not attempted to delineate any of the waste pits.

A persistent ground water high centered around Waste Pit 4 has been identified, indicating that Waste Pit 4 is a source of recharge. Additionally, consistent occurrence of VOC's in TP-19 in rounds 2 through 6 of the detection monitoring program have been documented, and the highest total uranium and total thorium concentrations are from monitoring wells adjacent to Waste Pit 4 (TP-19, TP-21, and TP-22) (PRC 1989).

Monitoring wells TP-19, TP-21, and TP-22 were eliminated from the ground water monitoring program. Though these wells were improperly constructed, the locations of these wells provided important ground water elevation data. This data is critical to monitor the effects of mounding in this area. As a result, Ohio EPA feels that the test pit wells should be replaced with 1000 series monitoring wells. These wells should be screened at the same interval as the corresponding test pit wells. This would provide a good source of ground water data to be used to document contaminant movement and hydrogeologic activity in this sensitive area. Once the additional monitoring wells have been installed, the test pit wells should be closed in an approvable manner.

Table 5

SELECTED RI/FS WELLS AND SITE-SPECIFIC PARAMETERS FOR THE RCRA ASSESSMENT PROGRAM

Parameters	Rationale	Upgradient Till Wells
Cobalt	A	1024
Beryllium	A	1052
Zinc	A	
Vanadium	A	Downgradient Till Wells
Nickel	A	
Copper	A	1027
Magnesium	A	1080
Calcium	A	1079
Aluminum	A	1004
Barium	A	1074
Chromium	A	1031
Lead	A	1028
Silver	A	1072
Iron	A	1030
Fluoride	A	1038
Nitrate	A,B	1081
Chloride	A,B	1083
Sulfate	A,B	1082
pH	I	1025
Conductivity	I	
TOC	I	Upgradient Sand & Gravel Wells
TOX	I	
Tetrachloroethene	A	2066/3066
Methylene Chloride	B	2043/3043
Dichloroethane	B	
Acetone	B	Downgradient Sand & Gravel Wells
Trichloroethene	C	
Toluene	B	3001/4001
Total Uranium	A	2084/3084
Uranium-234	A	2021
Uranium-235	A	2019/3019
Uranium-238	A	2027
Thorium-228	A	2010/3010/4010
Thorium-230	A	2013/3013/4012
Technetium-99	A	2051/3051
		2055/3055
Organic Phosphate	A	3008/4008
PCB	A	3024
		2037/3037

A Major constituent of Waste Pit No. 4.
B Constituent found in waste pit area ground water.
C Consistent of Waste Pit No. 4.
I Ground Water Indicator Parameter.

Based upon the results from the Round 6 sampling event (the most recent data available at the time of the inspection), the location of the RCRA ground water monitoring wells is not adequate to determine the rate and extent of ground water contamination and contaminant migration. Ground water impact has been documented in the southern most monitoring wells (OS-2 and OS-3), the western most monitoring wells (MW-3, MW-4, MW-5), and the eastern most monitoring well (MW-13). Additional monitoring wells are needed to define the extent of the contaminant plumes and to determine contaminant concentrations within the plumes.

SITE INSPECTION

A site inspection was conducted on 04/09/90 by Mike Proffitt Ohio EPA-DGW in order to determine the structural integrity of the 41 RCRA monitoring wells used in Round 6 sampling. Emergency repairs were underway on the K65 silos and, as a result, access to many of the monitoring wells was not possible. The monitoring wells which were inspected were: MW-19s (2019), MW-19d (3019), MW-21s (2021), MW-10 (3010), MW-16s (2016), MW-16d (3016), MW-14s (2014), MW-14d (3014), MW-4 (2004), MW-11 (2011), MW-17s (2017), and MW-17d (3017). Additionally, several off site wells could not be inspected. These wells were on private property and prior permission was needed for their access.

All monitoring wells inspected were in a similar condition. Monitoring wells were protected with a locking metal casing. Each casing was set in a concrete pad. All casings were locked and in good condition. None of the monitoring wells were protected by posts to prevent damage resulting from collision with equipment and vehicles. Though this may not be critical in the waste pit area, monitoring wells in the production area are very susceptible to damage.

A sampling pump was found lying on the ground next to MW-10. It was evident that the pump had been exposed at this location for a long time, based upon the amount of material that had built up on the pump and the hose. I informed Dave Rast that the pump should be retrieved and decontaminated before it is accidentally introduced into the well.

No ground water sampling was being conducted during the site inspection, therefore sampling procedures were not observed; however, the sampling and analysis plan included in the GWQAPP was reviewed. As discussed earlier, this document was approved by Ohio EPA in March, 1989.

COMPLIANCE STATUS SUMMARY

This section of the Comprehensive Ground Water Monitoring Evaluation evaluates the Fernald FMPC's compliance in conjunction with Ohio hazardous waste regulations and the following violations were noted. For additional information, the attached RCRA checklists should be consulted. All citations are based on state rules.

OAC 3745-65-93(D)(4)(a)

The FMPC has not defined the extent of the contaminant plume. Perimeter wells used in the detection monitoring program have shown contamination, however, FMPC has not submitted any data to show that the Ground Water Assessment Program has been able to define the extent of the contaminant plume.

OAC 3745-65-93(D)(4)(b)

The FMPC has not determined the concentrations of the hazardous waste constituents in the ground water. The FMPC has not submitted any data concerning the concentrations of these constituents to Ohio EPA, and therefore has not complied with this regulation.

OAC 3745-65-75(F)

Annual Ground Water Monitoring Reports should be submitted to Ohio EPA by March first of each year. Because FMPC has not submitted any annual Ground Water Monitoring Reports, they have not complied with this rule.

OAC 3745-65-94(B)(2)

FMPC has failed to submit the RCRA Ground Water Assessment Program annual report on March 1, 1990. FMPC's violation of this rule was included in charges of contempt of court filed by the state of Ohio, as described in State of Ohio VS United States Department of Energy, and Westinghouse Materials Company of Ohio, Inc., Feed Materials Production Center; Civil Action No. C-1-86-0217. Because of this violation, Ohio EPA has not been able to evaluate the RCRA Assessment Monitoring Program in this CME.

FMPC has not calculated the rate of migration of hazardous waste or hazardous waste constituents in the ground water during the reporting period. FMPC was to include this information in the 1989 Annual Ground Water Assessment Monitoring Program Report, which was to be submitted to Ohio EPA by March 1, 1990. Because FMPC has not submitted this information to Ohio EPA, FMPC is in violation of this rule.

APPENDIX A

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COMPREHENSIVE GROUND-WATER MONITORING EVALUATION WORKSHEET

The following worksheets have been designed to assist the enforcement officer/ technical reviewer in evaluating theground-water monitoring system an owner/operator uses to collect and analyze samples of ground water. The focus of the worksheets is technical adequacy as it relates to obtaining and analyzing representative samples of ground water. The basis of the worksheets is the final RCRA Ground Water Monitoring Technical Enforcement Guidance Document which describes in detail the aspects of ground-water monitoring which EPA deems essential to meet the goals of RCRA. Appendix A is not a regulatory checklist. Specific technical deficiencies in the monitoring system can, however, be related to the regulations as illustrated in Figure 4.3 taken from the RCRA Ground-Water Monitoring Compliance Order Guide (COG) (included at the end of the appendix). The enforcement officer, in developing an enforcement order, should relate the technical assessment from the worksheets to the regulations using Figure 4.3 from the COG as a guide.

Comprehensive Ground-Water Monitoring Evaluation	Y/N
I. Office Evaluation Technical Evaluation of the Design of the Ground-Water Monitoring System	
A. Review of Relevant Documents	
1. What documents were obtained prior to conducting the inspection:	
a. RCRA Part A permit application?	Y
b. RCRA Part B permit application?	Y
c. Correspondence between the owner/operator and appropriate agencies or citizen's groups?	Y
d. Previously conducted facility inspection reports?	Y
e. Facility's contractor reports?	Y
f. Regional hydrogeologic, geologic, or soil reports?	Y
g. The facility's Sampling and Analysis Plan?	Y
h. Ground-water Assessment Program Outline (or Plan, if thefacility is in assessment monitoring)?	Y
i. Other (specify) _____	

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B. Evaluation of the Owner/Operator's Hydrogeologic Assessment	1887
1. Did the owner/operator use the following direct techniques in the hydrogeologic assessment:	
a. Logs of the soil borings/rock corings (documented by a professional geologist, soil scientist, or geotechnical engineer)?	Y
b. Materials tests (e.g., grain size analyses, standard penetration tests, etc.)?	N
c. Piezometer installation for water level measurments at different depths?d. Slug tests?	N
e. Pump tests?	N
f. Geochemical analyses of soil samples?	N
g. Other (specify) (e.g., hydrochemical diagrams and wash analysis)	
2. Did the owner/operator use the following indirect technique to supplement direct techniques data:	
a. Geophysical well logs?	N
b. Tracer studies?	N
c. Resistivity and/or electromagnetic conductance?	N
d. Seismic Survey?	N
e. Hydraulic conductivity measurements of cores?	N
f. Aerial photography?	Y
g. Ground penetrating radar?	N
h. Other (specify)	
3. Did the owner/operator document and present the raw data from the site hydrogeologic assessment?	Y
4. Did the owner/operator document methods (criteria) used to correlate and analyze the information?	Y
5. The owner/operator prepare the following:	
a. Narrative description of geology?	Y
b. Geologic cross sections?	Y
c. Geologic and soil maps?	N
d. Boring/coring logs?	Y
e. Structure contour maps of the differing water bearing zones and confining layer?	Y
f. Narrative description and calculation of ground-water flows?	N

	Y/N
g. Water table/potentiometric map?	Y
h. Hydrologic cross sections?	Y
6. Did the owner/operator obtain a regional map of the area and delineate the facility?	Y
If yes, does this map illustrate: a. Surficial geology features?	Y
b. Streams, rivers, lakes, or wetlands near the facility?	Y
c. Discharging or recharging wells near the facility?	Y
7. Did the owner/operator obtain a regional hydrogeologic map?	Y
If yes, does this hydrogeologic map indicate: a. Major areas of recharge/discharge?	Y
b. Regional ground-water flow direction?	Y
c. Potentiometric contours which are consistent with observed water level elevations?	Y
8. Did the owner/operator prepare a facility site map?	Y
If yes, does the site map show: a. Regulated units of the facility (e.g., landfill areas,impoundments)?	Y
b. Any seeps, springs, streams, ponds, or wetlands? No seeps indicated on maps	N
c. Location of monitoring wells, soil borings, or test pits?	Y
d. How many regulated units does the facility have? _____	NOT YET DETERMINED
If more than one regulated unit then, • Does the waste management area encompass all regulated units?	UNDETERMINED
• Is a waste management area delineated for each regulated unit?	N
C. Characterization of Subsurface Geology of Site	
1. Soil boring/test pit program:	
a. Were the soil borings/test pits performed under thesupervision of a qualified professional?	Y
b. Did the owner/operator provide documentation for selecting the spacing for borings?	N
c. Were the borings drilled to the depth of the first confining unit below the uppermost zone of saturation or ten feet into bedrock?	Y
d. Indicate the method(s) of drilling:	Y

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	Y/N
Auger (hollow or solid stem) X Mud rotary ____ Reverse rotary ____ Cable tool X Jetting ____ Other (specify) ____	1887
e. Were continuous sample corings taken?	N
f. How were the samples obtained (checked method[s]) • Split spoon X • Shelby tube, or similar ____ • Rock coring ____ • Ditch sampling ____ • Other (explain) ____	
g. Were the continuous sample corings logged by a qualified professional in geology?	Y
h. Does the field boring log include the following information: • Hole name/number?	Y
• Date started and finished?	Y
• Driller's name?	Y
• Hole location (i.e., map and elevation)?	Y
• Drill rig type and bit/auger size?	Y
• Gross petrography (e.g., rock type) of each geologic unit?	Y
• Gross mineralogy of each geologic unit?	Y
• Gross structural interpretation of each geologic unit and structural features (e.g., fractures, gouge material, solution channels, buried streams or valleys, identification of depositional material)?	Y
• Development of soil zones and vertical extent and description of soil type?	Y
• Depth of water bearing unit(s) and vertical extent of each?	Y
• Depth and reason for termination of borehole?	Y
• Depth and location of any contaminant encountered in borehole?	Y
• Sample location/number?	Y
• Percent sample recovery?	Y
• Narrative descriptions of: —Geologic observations?	Y
—Drilling observations?	
i. Were the following analytical tests performedon the core samples: • Mineralogy (e.g., microscopic tests and X-ray diffraction)?	N
• Petrographic analysis: —degree of crystallinity and cementation of matrix?	N
—degree of sorting, size fraction (i.e., sieving), textural variations?	N
—rock type(s)?	N

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	Y/N
—soil type?	Y
—approximate bulk geochemistry?	N
—existence of microstructures that may effect or indicate fluid flow?	N
• Falling head tests?	Y
• Static head tests?	U
• Settling measurements?	U
• Centrifuge tests?	U
• Column drawings?	U
D. Verification of Subsurface Geological Data 1. Has the owner/operator used indirect geophysical methods to supplement geological conditions between borehole locations?	N
2. Do the number of borings and analytical data indicate that the confining layer displays a low enough permeability to impede the migration of contaminants to any stratigraphically low water-bearing units?	N
3. Is the confining layer laterally continuous across the entire site?	N
4. Did the owner/operator consider the chemical compatibility of the site-specific waste types and the geologic materials of the confining layer?	Y
5. Did the geologic assessment address or provide means for resolution of any information gaps of geologic data?	N
6. Do the laboratory data corroborate the field data for petrography?	NA
7. Do the laboratory data corroborate the field data for mineralogy and subsurface geochemistry?	NA
E. Presentation of Geologic Data 1. Did the owner/operator present geologic cross sections of the site?	Y
2. Do cross sections: a. identify the types and characteristics of the geologic materials present?	Y
b. define the contact zones between different geologic materials?	Y
c. note the zones of high permeability or fracture?	Y
d. give detailed borehole information including:	

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• location of borehole?	Y
• depth of termination?	Y
• location of screen (if applicable)?	N
• depth of zone(s) of saturation?	Y
• backfill procedure?	N
3. Did the owner/operator provide a topographic map which was constructed by a licensed surveyor?	
4. Does the topographic map provide:	
a. contours at a maximum interval of two-feet?	Y
b. locations and illustrations of man-made features (e.g., parking lots, factory buildings, drainage ditches, storm drain, pipelines, etc.)?	Y
c. descriptions of nearby water bodies?	Y
d. descriptions of off-site wells?	Y
e. site boundaries?	Y
f. individual RCRA units?	N
g. delineation of the waste management area(s)?	Y
h. well and boring locations?	Y
5. Did the owner/operator provide an aerial photograph depicting the site and adjacent off-site features?	Y
6. Does the photograph clearly show surface water bodies, adjacent municipalities, and residences and are these clearly labelled?	Y
F. Identification of Ground-Water Flowpaths	
1. Ground-water flow direction	
a. Was the well casing height measured by a licensed surveyor to the nearest 0.01 feet?	Y
b. Were the well water level measurements taken within a 24 hour period?	N
c. Were the well water level measurements taken to the nearest 0.01 feet?	N
d. Were the well water levels allowed to stabilize after construction and development for a minimum of 24 hours prior to measurements?	N
e. Was the water level information obtained from (check appropriate one):	
• multiple piezometers placed in single borehole? ____	
• vertically nested piezometers in closely spaced separate ____	
• boreholes? ____	
• monitoring wells? X	

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	Y/N
f. Did the owner/operator provide construction details for the piezometers?	N
g. How were the static water levels measured (check method[s]). • Electric water sounder X • Wetted tape X • Air line ____ • Other (explain) ____	1887
h. Was the well water level measured in wells with equivalent screened intervals at an equivalent depth below the saturated zone?	Y
i. Has the owner/operator provided a site water table (potentiometric) contour map?	Y
If yes, • Do the potentiometric contours appear logical and accurate based on topography and presented data? (Consult water level data)	Y
• Are ground-water flow-lines indicated?	N
• Are static water levels shown?	Y
• Can hydraulic gradients be estimated?	Y
j. Did the owner/operator develop hydrologic cross sections of the vertical flow component across the site using measurements from all wells?	N
k. Do the owner/operator's flow nets include: • piezometer locations?	N/A
• depth of screening?	N/A
• width of screening?	N/A
• measurements of water levels from all wells and piezometers?	N/A
2. Seasonal and temporal fluctuations in ground-water a. Do fluctuations in static water levels occur? If yes, are the fluctuations caused by any of the following:	Y
—Off-site well pumping	N
—Tidal processes or other intermittent natural variations (e.g., river stage, etc.)	N
—On-site well pumping	N
—Off-site, on-site construction or changing land use patterns	N
—Deep well injection	N
—Seasonal variations	Y
—Other (specify) ____	
b. Has the owner/operator documented sources and patterns that contribute to or affect the ground-water patterns below the waste management?	Y
c. Do water level fluctuations alter the general ground-water gradients and flow directions?	Y
d. Based on water level data, do any head differentials occur that may indicate a vertical flow component in the saturated zone?	U

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	Y/N
e. Did the owner/operator implement means for gauging long term effects on water movement that may result from on-site or off-site construction or changes in land-use patterns?	1887 N
3. Hydraulic conductivity	
a. How were hydraulic conductivities of the subsurface materials determined?	
• Single-well tests (slug tests)?	N
• Multiple-well tests (pump tests)	N
• Other (specify) _____	
b. If single-well tests were conducted, was it done by:	
• Adding or removing a known volume of water?	N/A
• Pressurizing well casing?	N/A
c. If single well tests were conducted in a highly permeable formation, were pressure transducers and high-speed recording equipment used to record the rapidly changing water levels?	N/A
d. Since single well tests only measure hydraulic conductivity in a limited area, were enough tests run to ensure a representative measure of conductivity in each hydrogeologic unit?	N/A
e. Is the owner/operator's slug test data (if applicable) consistent with existing geologic information (e.g., boring logs)?	N/A
f. Were other hydraulic conductivity properties determined?	N
g. If yes, provide any of the following data, if available:	
• Transmissivity _____	
• Storage coefficient _____	
• Leakage _____	
• Permeability _____	
• Porosity _____	
• Specific capacity _____	
• Other (specify) _____	
4. Identification of the uppermost aquifer	
a. Has the extent of the uppermost saturated zone (aquifer) in the facility area been defined? If yes,	Y
• Are soil boring/test pit logs included?	Y
• Are geologic cross-sections included?	Y
b. Is there evidence of confining (competent, unfractured, continuous, and low permeability) layers beneath the site? If yes,	Y
• how was continuity demonstrated? explanation of boring logs	
c. What is hydraulic conductivity of the confining unit (if present)? CM/Sec How was it determined?	Not Determined

	Y/N
d. Does potential for other hydraulic communication exist (e.g., lateral incontinuity between geologic units, facies changes, fracture zones, cross cutting structures, or chemical corrosion/alteration of geologic units by leachage? If yes or no, what is the rationale? Yes, confining layer is of lower permeability. It is not low enough to stop infiltrtion.	1887
G. Office Evaluation of the Facility's Ground-Water Monitoring System—Monitoring Well Design and Construction: These questions should be answered for each different well design present at the facility. 1. Drilling Methods a. What drilling method was used for the well? • Hollow-stem auger ☒ • Solid-stem auger ☐ • Mud rotary ☐ • Air rotary ☐ • Reverse rotary ☐ • Cable tool ☒ • Jetting ☐ • Air drill w/ casing hammer ☐ • Other (specify) _____	
b. Were any cutting fluids (including water) or additives used during drilling? If yes, specify: • Type of drilling fluid _____ • Source of water used _____ • Foam _____ • Polymers _____ • Other _____	N
c. Was the cutting fluid, or additive, identified?	N/A
d. Was the drilling equipment steam-cleaned prior to drilling the well? • Other methods _____	Y
e. Was compressed air used during drilling? If yes, • was the air filtered to remove oil?	N
f. Did the owner/operator document procedure for establishing the potentiometric surface? If yes, • how was the location established?	Y
g. Formation samples	46

	Y/N 1387
• Were formation samples collected initially during drilling?	Y
• Were any cores taken continuous?	N
• If not, at what interval were samples taken?	N/A
• How were the samples obtained? X Split spoon X Shelby tube — Core drill — Other (specify)	
• Identify if any physical and/or chemical tests were performed on the formation samples (specify) ASTM standard penetration test RAD 2 organic vapor screening	
2. Monitoring Well Construction Materials	
a. Identify construction materials (by number) and diameters (ID/OD)	

	Material	Diameter
• Primary Casing	PVC	4 in
• Secondary or outside casing (doubleconstruction)		
• Screen	PVC	4 in

b. How are the sections of casing and screen connected?	
• Pipe sections threaded	X
• Couplings (friction) with adhesive or solvent	
• Couplings (friction) with retainer screws	
• Other (specify)	
c. Were the materials steam-cleaned prior to installation?	
• If no, how were the materials cleaned?	Y
3. Well Intake Design and Well Development	
a. Was a well intake screen installed?	Y
• What is the length of the screen for the well? 5%15 feet	
• Is the screen manufactured?	Y
b. Was a filter pack installed?	Y
• What kind of filter pack was employed? sand pack	
• Is the filter pack compatible with formationmaterials?	Y
• How was the filter pack installed? direct placement in annulus	47

	Y/N
• What are the dimensions of the filter pack? 10" 2-4 feet above screen in 1 & 2000 series	1887
• Has a turbidity measurement of the well water ever been made?	N
• Have the filter pack and screen been designed for the insitu materials? _____	Y
c. Well development • Was the well developed?	Y
• What technique was used for well development? X Surge block 2 —Bailer —Air surging X Water pumping —Other (specify) _____	
4. Annular Space Seals a. What is the annular space in the saturated zone directlyabove the filter pack filled with: X Sodium bentonite (specify type and grit) pellets —Cement (specify neat or concrete) —Other (specify)	
b. Was the seal installed by: —Dropping material down the hole and tamping —Dropping material down the inside of hollow-stem auger —Tremie pipe method X Other (specify) direct placement in anullus	
c. Was a different seal used in the unsaturated zone? If yes,	Y
• Was this seal made with? X Sodium bentonite (specify type and grit) volclay grout —Cement (specify neat or concrete)- Other (specify)	
• Was this seal installed by? —Dropping material down the hole and tamping —Dropping material down the inside of hollow stem auger X Other (specify) pressure grouting with tremie pipe	
d. Is the upper portion of the borehole sealed with a concrete cap to prevent infiltration from the surface?	Y
e. Is the well fitted with an above-ground protectivedevice and bumper guards?	Y
f. Has the protective cover been installed with locks to prevent tampering?	48 Y

	Y/N
H. Evaluation of the Facility's Detection Monitoring Program	
1. Placement of Downgradient Detection Monitoring Wells	1887
a. Are the ground-water monitoring wells or clusters located immediately adjacent to the waste management area?	
b. How far apart are the detection monitoring wells?	RIES
c. Does the owner/operator provide a rationale for thelocation of each monitoring well or cluster?	Y
d. Does the owner/operator identified the well screenlengths of each monitoring well or clusters?	Y
e. Does the owner/operator provide an explanation for the well screen lengths of each monitoring well orcluster?	Y
f. Do the actual locations of monitoring wells orclusters correspond to those identified by the owner/operator?	Y
2. Placement of Upgradient Monitoring Wells	
a. Has the owner/operator documented the location ofeach upgradient monitoring well or cluster?	Y
b. Does the owner/operator provide an explanation forthe location(s) of the upgradient monitoring wells?	Y
c. What length screen has the owner/operator employed inthe background monitoring well(s)?	5-15 ft
d. Does the owner/operator provide an explanation for the screen length(s) chosen?	Y
e. Does the actual location of each background monitoring well or cluster correspond to that identified by the owner/operator?	Y
I. Office Evaluation of the Facility's Assessment Monitoring Program	
1. Does the assessment plan specify:	
a. The number, location, and depth of wells?	Y
b. The rationale for their placement and identify the basis that will be used to select subsequent sampling locations and depths in later assessment phases?	N
2. Does the list of monitoring parameters include all hazardous waste constituents from the facility?	Y

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	Y/N
a. Does the water quality parameter list include other important indicators not classified as hazardous waste constituents?	Y
b. Does the owner/operator provide documentation for he listed wastes which are not included?	N
3. Does the owner/operator's assessment plan specify the procedures to be used to determine the rate of constituent migration in the ground-water?	Y
4. Has the owner/operator specified a schedule of implementation in the assessment plan?	Y
5. Have the assessment monitoring objectives been clearly defined in the assessment plan?	N
a. Does the plan include analysis and/or re-evaluation to determine if significant contamination has occurredin any of the detection monitoring wells?	N
b. Does the plan provide for a comprehensive program of investigation to fully characterize the rate and extent of contaminant migration from the facility?	N
c. Does the plan call for determining the concentrations of hazardous wastes and hazardous waste constituentsin the ground water?	Y
d. Does the plan employ a quarterly monitoring program?	Y
6. Does the assessment plan identify the investigatory methods that will be used in the assessment phase?	
a. Is the role of each method in the evaluation fully described?	Y
b. Does the plan provide sufficient descriptions of the direct methods to be used?	Y
c. Does the plan provide sufficient descriptions of the indirect methods to be used?	N/A
d. Will the method contribute to the further characterization of the contaminant movement?	N
7. Are the investigatory techniques utilized in the assessment program based on direct methods?	Y
a. Does the assessment approach incorporate indirect methods to further support direct methods?	N/A
b. Will the planned methods called for in the assessment approach ultimately meet performance standards for assessment monitoring?	N/A
c. Are the procedures well defined?	Y
d. Does the approach provide for monitoring wells similar in design and construction as the detectionmonitoring wells?	Y

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	Y/N
e. Does the approach employ taking samples during drilling or collecting core samples for further analysis?	Y
8. Are the indirect methods to be used based on reliable and accepted geophysical techniques?	1887 N/A
a. Are they capable of detecting subsurface changesresulting from contaminant migration at the site?	
b. Is the measurement at an appropriate level of sensitivity to detect ground-water quality changes at the site?	
c. Is the method appropriate considering the nature of the subsurface materials?	
d. Does the approach consider the limitations of these methods?	
e. Will the extent of contamination and constituent concentration be based on direct methods and sound engineering judgment? (Using indirect methods tofurther substantiate the findings.)	
9. Does the assessment approach incorporate any mathe-matical modeling to predict contaminant movement?	Y
a. Will site specific measurements be utilized toaccurately portray the subsurface?	Y
b. Will the derived data be reliable?	Y
c. Have the assumptions been identified?	N
d. Have the physical and chemical properties of the site-specific wastes and hazardous waste constituentsbeen identified?	Y
J. Conclusions	
1. Subsurface geology	
a. Has sufficient data been collected to adequately define petrography and petrographic variation?	Y
b. Has the subsurface geochemistry been adequately defined?	N
c. Was the boring/coring program adequate to definesubsurface geologic variation?	Y
d. Was the owner/operator's narrative description complete and accurate in its interpretation of the data?	Y
e. Does the geologic assessment address or provide means to resolve any information gaps?	N
2. Ground-water flowpaths	N
a. Did the owner/operator adequately establish the hori-zontal and vertical components of ground-water flow?	

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	Y/N
b. Were appropriate methods used to establish ground-water flowpaths?	Y
c. Did the owner/operator provide accurate documentation?	N
d. Are the potentiometric surface measurements valid?	Y
e. Did the owner/operator adequately consider the seasonal and temporal effects on the ground-water?	N
f. Were sufficient hydraulic conductivity tests performed to document lateral and vertical variationin hydraulic conductivity in the entire hydrogeologic subsurface below the site?	N
3. Uppermost Aquifer a. Did the owner/operator adequately define the upper-most aquifer?	Y
4. Monitoring Well Construction and Design a. Do the design and construction of the owner/operator's ground-water monitoring wells permit depth discrete ground-water samples to be taken?	Y
b. Are the samples representative of ground-water quality?	Y
c. Are the ground-water monitoring wells structurally stable?	Y
d. Does the ground-water monitoring well's design and construction permit an accurate assessment of aquifer characteristics?	Y
5. Detection Monitoring a. Downgradient Wells • Do the location, and screen lengths of the ground-water monitoring wells or clusters in the detection monitoring system allow the immediate detection of a release of hazardous waste or constituents from the hazardous waste management area to the uppermost aquifer?	N
b. Upgradient Wells • Do the location and screen lengths of the upgradient (background) ground-water monitoring wells ensure the capability of collecting ground-water samples representative of upgradient (background) ground-water quality including any ambient heterogenous chemical characteristics?	N
6. Assessment Monitoring a. Has the owner/operator adequately characterized site hydrogeology to determine contaminant migration?	N
b. Is the detection monitoring system adequately designed and constructed to immediately detect any contaminant release?	Y

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	Y/N
c. Are the procedures used to make a first determinationof contamination adequate?	Y
d. Is the assessment plan adequate to detect, characterize, and track contaminant migration?	N
e. Will the assessment monitoring wells, given site hydrogeologic conditions, define the extent and concentration of contamination in the horizontal and vertical planes?	
f. Are the assessment monitoring wells adequately designed and constructed?	
g. Are the sampling and analysis procedures adequate to provide true measures of contamination?	Y
h. Do the procedures used for evaluation of assessment monitoring data result in determinations of the rate of migration, extent of migration, and hazardous constituent composition of the contaminant plume?	N
i. Are the data collected at sufficient frequency and duration to adequately determine the rate of migration?	Y
j. Is the schedule of implementation adequate?	U
k. Is the owner/operator's assessment monitoring plan adequate?	Y
• If the owner/operator had to implement hisassessment monitoring plan, was it implemented satisfactorily?	U
II. Field Evaluation	
A. Ground-Water Monitoring System	
1. Are the numbers, depths, and locations of monitoring wells in agreement with those reported in the facility's monitoring plan? (See Section 3.2.3.)	Y
B. Monitoring Well Construction	
1. Identify construction material material diameter a. Primary Casing Stanless steel 4" ID b. Secondary or outside casing _____	
2. Is the upper portion of the borehole sealed with conrete to prevent infiltration from the surface?	Y
3. Is the well fitted with an above-ground protective device?	Y
4. Is the protective cover fitted with locks to prevent tampering? If a facility utilizes more than a single well design, answer the above questions for each well design?	Y

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	Y/N
III. Review of Sample Collection Procedures	1887
A. Measurement of Well Depths /Elevation	
1. Are measurements of both depth to standing water and depth to the bottom of the well made?	Y
2. Are measurements taken to the 0.01 feet?	Y
3. What device is used? ELECTRONIC WATER LEVEL INDICATOR	
4. Is there a reference point established by a licensed surveyor?	Y
5. Is the measuring equipment properly cleaned betweenwll locations to prevent cross contamination?	Y
B. Detection of Immiscible Layers	
1. Are procedures used which will detect light phase immiscible layers?	Y
2. Are procedures used which will detect heavy phase immiscible layers?	N
C. Sampling of Immiscible Layers	
1. Are the immiscible layers sampled separately prior to well evacuation?	N/A
2. Do the procedures used minimize mixing with watersoluble phases?	N/A
D. Well Evacuation	
1. Are low yielding wells evacuated to dryness?	Y
2. Are high yielding wells evacuated so that at least three casing volumes are removed?	Y
3. What device is used to evacuate the wells? Immersible pump	
4. If any problems are encountered (e.g., equipmentmalfunction) are they noted in a field logbook?	54 Y

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	Y/N
E. Sample Withdrawal	
1. For low yielding wells, are samples for volatiles, pH, and oxidation/reduction potential drawn first after the well recovers?	Y
2. Are samples withdrawn with either flurocarbon/resins or stainless steel (316, 304 or 2205) sampling devices?	Y
3. Are sampling devices either bottom valve bailers or positive gas displacement bladder pumps?	Both
4. If bailers are used, is fluorocarbon/resin coated wire, single strand stainless steel wire, or monofilament used to raise and lower the bailer?	nylon rope
5. If bladder pumps are used, are they operated in acontinuous manner to prevent aeration of the sample?	N/A
6. If bailers are used, are they lowered slowly to prevent degassing of the water?	N
7. If bailers are used, are the contents transferred to the sample container in a way that minimizes agitation and aeration?	Y
8. Is care taken to avoid placing clean sampling equipment on the ground or other contaminated surfaces prior to insertion into the well?	Y
9. If dedicated sampling equipment is not used, is equipment disassembled and thoroughly cleaned between samples?	NA
10. If samples are for inorganic analysis, does the cleaning procedure include the following sequential steps: a. Dilute acid rinse (HNO_3 or HC1)?11. If samples are for organic analysis, does the cleaning procedure include the following sequential steps:	N
11. If samples are for inorganic analysis, does the cleaning procedure include the following sequential steps: a. Nonphosphate detergent wash?	Y
b. Tap water rinse?	N
c. Distilled/deionized water rinse?	Y
d. Acetone rinse?	Y
e. Pesticide-grade hexane rinse?	N

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	Y/N
12. Is sampling equipment thoroughly dry before use?	1887 N
13. Are equipment blanks taken to ensure that sample cross-contamination has not occurred?	Y
14. If volatile samples are taken with a positive gas displacement bladder pump, are pumping rates below 100 ml/min?	N/A
F. In-situ or Field Analyses	
1. Are the following labile (chemically unstable) parameters determined in the field:	
a. pH?	Y
b. Temperature?	Y
c. Specific conductivity?	Y
d. Redox potential?	N
e. Chlorine?	N
f. Dissolved oxygen?	Y
g. Turbidity?	N
h. Other (specify) _____	
2. For in-situ determinations, are they made after well evacuation and sample removal?	Y
3. If sample is withdrawn from the well, is parameter measured from a split portion?	N/A
4. Is monitoring equipment calibrated according to mannufacturers' specifications and consistent with SW-846?	Y
5. Is the date, procedure, and maintenance for equipment calibration documented in the field logbook?	Y
IV. Review of Sample Preservation and Handling Procedures	
A. Sample Containers	Y
1. Are samples transferred from the sampling device directly to their compatible containers?	56

	Y/N 1887
2. Are sample containers for metals (inorganics) analyses polyethylene with polypropylene caps?	Y
3. Are sample containers for organics analysis glass bottles with fluorocarbonresin-lined caps?	Y
4. If glass bottles are used for metals samples are the caps fluorocarbonresin-lined?	N/A
5. Are the sample containers for metal analyses cleanedusing these sequential steps:	
a. Nonphosphate detergent wash?	
b. 1:1 nitric acid rinse?	
c. Tap water rinse?	
d. 1:1 hydrochloric acid rinse?	
e. Tap water rinse?	
f. Distilled/deionized water rinse?	
6. Are the sample containers for organic analyses cleaned using these sequential steps:	
a. Nonphosphate detergent/hot water wash?	
b. Tap water rinse?	
c. Distilled/deionized water rinse?	
d. Acetone rinse?	
e. Pesticide-grade hexane rinse?	
7. Are trip blanks used for each sample container type to verify cleanliness?	
B. Sample Preservation Procedures	
1. Are samples for the following analyses cooled to 4°C:	
a. TOC?	Not Collected
b. TOX?	Y
c. Chloride?	N/A
d. Phenols?	N/A
e. Sulfate?	Y
f. Nitrate?	Y
g. Coliform bacteria?	N/A
h. Cyanide?	N/A
i. Oil and grease?	N/A
j. Hazardous constituents (}261, Appendix VIII)?	Y

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	Y/N
2. Are samples for the following analyses field acidified to pH <2 with HNO_3:	1887
a. Iron?	Y
b. Manganese?	Y
c. Sodium?	Y
d. Total metals?	N/A
e. Dissolved metals?	Y
f. Fluoride?	N
g. Endrin?	N/A
h. Lindane?	N/A
i. Methoxychlor?	N/A
j. Toxaphene?	N/A
k. 2,4, D?	N/A
l. 2,4,5 TP Silvex?	N/A
m. Radium?	Y
n. Gross alpha?	Y
o. Gross beta?	Y
3. Are samples for the following analyses field acidfied to pH <2 with H_2SO_4:	
a. Phenols?	N/A
b. Oil and grease?	N/A
4. Is the sample for TOC analyses field acified to pH <2 with HCl?	Not Collected
5. Is the sample for TOX analysis preserved with 1 ml of 1.1 M sodium sulfite?	N
6. Is the sample for cyanide analysis preserved with NaOH to pH >12?	N/A
C. Special Handling Considerations	
1. Are organic samples handled without filtering?	Y
2. Are samples for volatile organics transfered to the appropriate vials to eliminate headspace over the sample?	Y
3. Are samples for metal analysis split into two portions?	N
4. Is the sample for dissolved metals filtered through a 0.45 micron filter?	Y
5. Is the second portion not filtered and analyzed for total metals?	58 N
6. Is one equipment blank prepared each day of ground-water sampling?	N

	Y/N
Review of Chain-of-Custody Procedures	1887
A. Sample Labels	
1. Are sample labels used?	Y
2. Do they provide the following information:	
a. Sample identification number?	
b. Name of collector?	Y
c. Date and time of collection?	Y
d. Place of collection?	Y
e. Parameter(s) requested and preservitives used?	Y
3. Do they remain legible even if wet?	Y
B. Sample Seals	
1. Are sample seals placed on those containers to ensure samples are not altered?	Y
C. Field Logbook	
1. Is a field logbook maintained?	Y
2. Does it document the following: Did not review field logbook	
a. Purpose of sampling (e.g., detection or assesment)?	
b. Location of well(s)?	
c. Total depth of each well?	
d. Static water level depth and measurement technique?	
e. Presence of immiscible layers and detection method?	
f. Collection method for immiscible layers and sample identification numbers?	
g. Well evacuation procedures?	
h. Sample withdrawal procedure?	
i. Date and time of collection?	
j. Well sampling sequence?	
k. Types of sample containers and sample identification number(s)?	
l. Preservative(s) used?	
m. Parameters requested?	
n. Field analysis data and method(s)?	
o. Sample distribution and transporter?	
p. Field observations?	59

	Y/N
—Unusual well recharge rates?	1887
—Equipment malfunction(s)?	
—Possible sample contamination?	
—Sampling rate?	
D. Chain-of-Custody Record	
1. Is a chain-of-custody record included with each sample?	Y
2. Does it document the following:	
a. Sample number?	Y
b. Signiture of collector?	Y
c. Date and time of collection?	Y
d. Sample type?	Y
e. Station location?	Y
f. Number of containers?	Y
g. Parameters requested?	Y
h. Signatures of persons involved in chain-of-custody?	Y
i. Inclusive dates of custody?	Y
E. Sample Analysis Request Sheet	
1. Does a sample analysis request sheet accompany each sample?	Y
2. Does the request sheet document the following:	
a. Name of person receiving the sample?	Y
b. Date of sample receipt?	Y
c. Duplicates?	–
d. Analysis to be performed?	Y
IV. Review of Quality Assurance/Quality Control	
A. Is the validity and reliability of the laboratory and field generated data ensured by a QA/QC program?	Y
B. Does the QA/QC program include:	
1. Documentation of any deviation from approved procedures?	Y

	Y/N
2. Documentation of analytical results for:	
a. Blanks?	Y
b. Standards?	
c. Duplicates?	Y
d. Spiked samples?	
e. Detectable limits for each parameter being analyzed?	
C. Are approved statistical methods used?	Y
D. Are QC samples used to correct data?	Y
E. Are all data critically examined to ensure it has been properly calculated and reported?	Y
VII. Surficial Well Inspection and Field Observation	
A. Are the wells adequately maintained?	Y
B. Are the monitoring wells protected and secure?	Y
C. Do the wells have surveyed casing elevations?	Y
D. Are the ground-water samples turbid?	N
E. Have all physical characteristics of the site been noted in the inspector's field notes (i.e., surface waters, topography, surface features)?	Y
F. Has a site sketch been prepared by the field inspector with scale, north arrow, location(s) of buildings, location(s) of regulated units, locations of monitoring wells, and a rough depiction of the site drainage pattern?	N

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	Y/N
VIII. Conclusions	
A. Is the facilitycurrently operating under the correct monitoring progaram according to the statistical analyses performed by the current operator?	Y
B. Does the ground-water monitoring system, as designed and operated, allow for detection or assessment of any possible ground-water contamination caused by the facility?	U
C. Does the sampling and analysis procedures permit the owner/operator to detect and, where possible, assess the nature and extent of a release of hazardous constituents to ground water from the monitored hazardous waste management facility?	U
Ohio EPA has not received the technical data to support questions B and C.	

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Figure 4.3
Relationship of Technical Inadequacies to Ground-Water Performance Standards

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Examples of Basic Elements Required by Performance Standards	Examples of Technical Inadequacies that may Constitute Violations	Regulatory Citations
1. Uppermost Aquifer must be correctly identified.	• failure to consider aquifers hydraulically interconnected to the uppermost aquifer.	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• incorrect identification of certain formations as confining layers or aquitards.	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• failure to use test drilling and/or soil borings to characterize subsurface hydrogeology.	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
2. Ground-water flow directions and rates must be properly determined.	• failure to use piezometers or wells to determine ground-water flow rates and directions (or failure to use a sufficient number of them).	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• failure to consider temporal variations in water levels when establishing flow directions (e.g., seasonal variations, short-term fluctuations due to pumping).	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• failure to assess significance of vertical gradients when evaluating flow rates and directions.	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• failure to use standard/consistent benchmarks when establishing water level elevations.	§265.90(a) §265.91(a)(1, 2) §270.14(c)(2)
	• failure of the owner/operator (o/o) to consider the effect of local withdrawal wells on ground-water flow direction.	§265.90(a) §265.91(a)(1)
	• failure of the o/o to obtain sufficient water level measurements.	§265.90(a) §265.91(a)(1)

Examples of Basic Elements Required by Performance Standards	Examples of Technical Inadequacies that may Constitute Violations	Regulatory Citations
3. Background wells must be located so as to yield samples that are not affected by the facility.	• failure of the o/o to consider the effect of local withdrawal wells on ground-water flow direction.	§265.90(a) §265.91(a)(1)
	• failure of the o/o to obtain sufficient water level measurements.	§265.90(a) §265.91(a)(1)
	• failure of the o/o to consider flow path of dense immiscibles in establishing upgradient well locations.	§265.90(a) §265.91(a)(1)
	• failure of the o/o to consider seasonal fluctuations in ground-water flow direction.	§265.90(a) §265.91(a)(1)
	• failure to install wells hydraulically upgradient, except in cases where upgradient water quality is affected by the facility (e.g., migration of dense immiscibles in the upgradient direction, mounding water beneath the facility).	§265.90(a) §265.91(a)(1)
	• failure of the o/o to adequately characterize subsurface hydrogeology.	§265.90(a) §265.91(a)(1)
	• wells intersect only ground water that flows around facility.	§265.90(a) §265.91(a)(1)
4. Background wells must be constructed so as to yield samples that are representative of in-situ ground-water quality.	• wells constructed of materials that may release or absorb constituents of concern	§265.90(a) §265.91(a)
	• wells improperly sealed—contamination of sample is a concern.	§265.90(a) §265.91(a), (c)
	• nested or multiple screen wells are used and it cannot be demonstrated that there has been no movement of ground water between strata.	§265.90(a) §265.91(a)(1, 2)

Elements Required by Performance Standards	Examples of Technical Inadequacies that may Constitute Violations	Regulatory Citations
4. Background wells must be constructed so as to yield samples that are representative of in-situ ground-water quality. (Continued)	• improper drilling methods were used, possibly contaminating the formation.	§265.90(a) §265.91(a)
	• well intake packed with materials that may contaminate sample.	§265.90(a) §265.91(a), (c)
	• well screens used are of an inappropriate length.	§265.90(a) §265.91(a)(1, 2)
	• wells developed using water other than formation water.	§265.90(a) §265.91(a)
	• improper well development yielding samples with suspended sediments that may bias chemical analysis.	§265.90(a) §265.91(a)
	• use of drilling muds or nonformation water during well construction that can bias results of samples collected from wells.	§265.90(a) §265.91(a)
5. Downgradient monitoring wells must be located so as to ensure the immediate detection of any contamination migrating from the facility.	• wells not placed immediately adjacent to waste management area.	§265.90(a) §265.91(a)(2)
	• failure of o/o to consider potential pathways for dense immiscibles.	§265.90(a) §265.91(a)(2)
	• inadequate vertical distribution of wells in thick or heavily stratified aquifer.	§265.90(a) §265.91(a)(2)
	• inadequate horizontal distribution of wells in aquifers of varying hydraulic conductivity.	§265.90(a) §265.91(a)(2)
	• likely pathways of contamination (e.g., buried streams channels, fractures, areas of high permeability) are not intersected by wells.	§265.90(a) §265.91(a)(2)
	• well network covers uppermost but not interconnected aquifers.	§265.90(a) §265.91(a)(2)

Examples of Basic Elements Required by Performance Standards	Examples of Technical Inadequacies that may Constitute Violations	Regulatory Citations
6. Downgradient monitoring wells must be constructed so as to yield samples that are representative of in-situ ground-water quality.	See No. 4 above.	
7. Samples from background and downgradient wells must be properly collected and analyzed.	• failure to evacuate stagnant water from the well before sampling.	§265.90(a), §265.92(a) §265.93(d)(4) §2705.14(c)(4)
	• failure to sample wells within a reasonable amount of time after well evacuation.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• improper decisions regarding filtering or non-filtering of samples prior to analysis (e.g., use of filtration on samples to be analyzed for volatile organics).	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• use of an inappropriate sampling device.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• use of improper sample preservation techniques.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)

Performance Standards	that may Constitute Violations	Regulatory Citations
7. Samples from background and downgradient wells must be properly collected and analyzed. (Continued)	• samples collected with a device that is constructed of materials that interfere with sample integrity.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• samples collected with a non-dedicated sampling device that is not cleaned between sampling events.	§265.90(a) §265.92(a) §265.93(d §270.14(c
	• improper use of a sampling device such that sample quality is affected (e.g., degassing of sample caused by agitation of bailer).	§265.90 §265.92 §265.93(d)(4) §270.14(c)(4)
	• improper handling of samples (e.g., failure to eliminate headspace from containers of samples to be analyzed for volatiles).	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure of the sampling plan to establish procedures for sampling immiscibles (i.e., "floaters" and "sinkers").	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure to follow appropriate QA/QC procedures.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure to ensure sample integrity through the use of proper chain-of-custody procedures.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure to demonstrate suitability of methods used for sample analysis (other than those specified in SW-846).	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure to perform analysis in the field on unstable parameters or constituents (e.g., pH, Eh, specific conductance, alkalinity, dissolved oxygen).	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)

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Examples of Basic Elements Required by Performance Standards	Examples of Technical Inadequacies that may Constitute Violations	Regulatory Citations
7. Samples from background and downgradient wells must be properly collected and analyzed. (Continued)	• use of sample containers that may interfere with sample quality (e.g., synthetic containers used with volatile samples).	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)
	• failure to make proper use of sample blanks.	§265.90(a) §265.92(a) §265.93(d)(4) §270.14(c)(4)

APPENDIX A-1

FACILITY INSPECTION FORM FOR COMPLIANCE WITH INTERIM STATUS STANDARDS COVERING GROUND-WATER MONITORING

Company Name: Fernald FMPC ; EPA I.D. Number: OH6890008976

Company Address: _____ ; Inspector's Name: Mike Proffitt

Company Contact/Official: Dave Rast ; Branch/Organization: DOE

Title: RCRA Coordinator ; Date of Inspection: 4/9/90

	Yes	No	Unknown
Type of facility: (check appropriately)			
a) surface impoundment			
b) landfill	X		
c) land treatment facility			
d) storage facility			
Ground-Water Monitoring Plan			
1. Has a ground-water monitoring plan been submitted to the Regional Administrator for facilities containing a surface impoundment, landfill, land treatment process, or storage facility?	X		
2. Was the ground-water monitoring plan reviewed prior to site visit? If "No",	X		
a) Was the ground-water plan reviewed at the facility prior to actual site inspection? If "No", explain.	X		

	Yes	No	Unknown	
3. Has a ground-water monitoring program (capable of determining the facility's impact on the quality of groundwater in the uppermost aquifer underlying the facility) been implemented? 265.90(a)	X			
4. Has at least one monitoring well been installed in the uppermost aquifer hydraulically upgradient from the limit of the waste management area? 265.91(aX1)	X			
a) Are sufficient ground-water samples from the uppermost aquifer, representative of background ground-water quality and not affected by the facility, ensured by proper well				
1) Number(s)?	X			
2) Location?	X			
3) Depth?	X			MW-12 screens 2 aquifer
5. Have at least three monitoring wells been installed hydraulically downgradient at the limit of the waste handling or management area? 265.91(a)	X			
6. Have the locations of the waste handling, storage, or disposal areas been verified to conform with information in the ground-water plan?	X			
7. Do the numbers, locations, and depths of the ground-water monitoring wells agree with the data in the ground-water monitoring system program? If "No", explain discrepancies.	X			

	Yes	No	Unknown
8. Has a ground-water sampling and analysis plan been developed? 265.92(a)	X		
a) Has it been followed?	X		
b) Is the plan kept at the facility?	X		
c) Does the plan include procedures and techniques for:			
1) Sample collection?	X		
2) Sample preservation?	X		
3) Sample shipment?	X		
4) Analytical procedures?	X		
5) Chain of custody control?	X		
9. Are the required parameters in ground-water samples planned to be tested quarterly for the first year? 265.92(b) and 265.92 (cX1)	X		
a) Are the ground-water samples analyzed for the following:			
1) Parameters characterizing the suitability of the ground-water as a drinking supply? 265.92(bX1)	X		
2) Parameters establishing ground-water qaulity? 265.92(bX2)	X		
3) Parameters used as indicators of ground-water contamination? 265.92(bX2)	X		
(i) Are at least four replicate measurements obtained for each sample? 265.92(cX2)	X		
(ii) Are provisions made to calculate the initial background arithmetic mean and variance of the respective parameter concentrations or values obtained from well(s) during the first year? 265.92(cX2)	X		
b) For facilities which have complied with first year ground-water sampling and analysis requirements:			
1) Have samples been obtained and analyzed for the ground-water qaulity parameters at least annually? 265.92(dX1)	X		
2) Have samples been obtained and analyzed for the indicators of ground-water contamination at least semi-annually? 265.92(dX2)	X		

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	Yes	No	Unknown
c) Were ground-water surface elevations determined at each monitoring well each time a sample was taken? 265.92(e)		X	
d) Were the ground-water surface elevations evaluated to determine whether the monitoring wells are properly placed? 265.93(f)		X	
e) If it was determined that modification of the number, location or depth of monitoring wells was necessary, was the system brought into compliance with 265.91(a)? 265.93(f)		X	
10. Has an outline of a ground-water quality assessment program been prepared? 265.93(a)	X		
a) Does it describe a program capable of determining:			
1) Whether hazardous waste or hazardous waste constituents have entered the ground water?	X		
2) The rate and extent of migration of hazardous waste or hazardous waste constituents?	X		
3) Concentrations of hazardous waste or hazardous waste constituents in in ground water?	X		
b) Have at least four replicate measurements of each indicator parameter been obtained for samples taken for each well? 265.93(b)		X	
1) Were the results compared with the initial background mean?		X	
(i) Was each well considered individually?		X	
(ii) Was the Student's t-test used (at the 0.01 level of significance)?		X	
2) Was a significant increase (or pH decrease) found in the:			
(i) Upgradient wells		X	
(ii) Downgradient wells	X		
If "Yes", Compliance Checklist A-2 must also be completed.			

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	Yes	No	Unknown
11. Have records been kept of analyses for parameters establishing ground-water quality and indicators of ground-water contamination? 265.94(aX1)	X		
12. Have records been kept of ground-water surface elevations taken at the time of sampling for each well? 265.94(aX1)	X		
13. Have the following been submitted to the Regional Administrator 265.94(aX2) :			
a) Initial background concentrations of parameters listed in 265.92(b) within 15 days after completing each quarterly analysis required during the first year?	X		
b) For each well, any parameters whose concentrations or values have exceeded the maximum contaminant levels allowed in drinking water supplies?	X		
c) Annual reports including: No annual reports submitted.			
1) Concentrations or values of parameters used as indicators of ground-water contamination for each well?			
2) Results of the evaluation of ground-water surface elevations?			

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APPENDIX A-2

INSPECTION COMPLIANCE FORM FOR A FACILITY WHICH HAS DETERMINED IT MAY BE AFFECTING GROUND-WATER QUALITY

Company Name: Fernald FMPC ; EPA I.D. Number: OH6890008976

Company Address: _____ ; Inspector's Name: Mike Proff[illegible]t

Company Contact/Official: Dave Rast ; Branch/Organization: DOE

Title: RCRA Coordinator ; Date of Inspection: 4/9/90

	Yes	No	Unknown
Type of facility: (Check appropriately)			
a) surface impoundment			
b) landfill	X		
c) land treatment facility			
d) storage facility			
Ground-Water Monitoring Plan			
1. Has(Have) comparison(s) of ground-water contamination indicator parameters for the upgradient well(s) 265.93(b) shown a significant increase (or pH decrease) over initial background?		X	
a) If "Yes", has(have) the increases(s) been submitted to the Regional Administrator as part of the annual report? 265.94(a)(2)(ii)			
2. Have comparisons of indicator parameters for the downgradient wells 265.93(b) shown a significant increase (or decrease) over initial background?	X		
a) If "Yes", were additional ground-water samples taken for those downgradient wells where the significant difference was determined? 265.93(c)(2)		X	
1) Were samples split in two?		X	
2) Was the significant difference due to laboratory error? (If "Yes", do not continue.)		X	

	Yes	No	Unknown
3. If significant differences were not due to laboratory error, was a written notice sent to the Regional Administrator within 7 days of (laboratory) confirmation?		X	
4. Within 15 days of notification of the Regional Administrator was a ground-water quality assessment program submitted? 265.93(dX2)	X		
a) Does the plan specify 265.93(dX3) :			
1) Well information (specifics)	X		
(a) number?	X		
(b) locations?	X		
(c) depths?	X		
2) Sampling methods?	X		
3) analytical methods?	X		
4) evaluation methods?	X		
5) schedule of implementation?	X		
b) Does the plan allow for determination of 265.93(dX4) :			
1) Rate and extent of migration of hazardous waste or hazardous waste constituents?	X		
2) Concentrations of the hazardous waste or hazardous waste constituents?	X		
c) Is it indicated that the 1st determination was made as soon as technically feasible? 265.93(dX5)		X	
1) Within 15 days after determination was a written report containing the assessment of ground-water quality submitted to the Regional Administrator?		X	
d) Was it determined that hazardous waste or hazardous waste constituents from the facility has entered the ground water?	X		
1) If "No", was the original indication evaluation program, required by 265.92, reinstated?			
(a) Was the Regional Administrator notified of the reinstatement of program within 15 days of the determination? 265.93(dX7)			

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	Yes	No	Unknown
e) If it was determined that hazardous waste or hazardous waste constituents have entered the ground water 265.93(dX7) :			
1) For facilities where program was implemented prior to final closure, are determinations of hazardous waste or hazardous waste constituents continued on a quarterly basis? (If program was implemented during the post-closure care period, determinations made in accordance with the ground-water quality assessment plan may cease.)	X		
(a) Were ground-water quality reports submitted to the Regional Administrator within 15 days of determination?		X	
2) Were(are) records kept of the analyses and evaluations, specified in the ground-water qaulity assessment (throughout the active life of the facility)? 265.94(bX1)	No report submitted		
(a) If a disposal facility, were(are) records dept throughout the post-closure period as well?			
f) Are annual reports submitted to the Regional Administrator containing the results of the ground-water quality assessment program? 265.94(bX2)		X	
1) Do the reports include the calculated or measured rate of migration of hazardous waste or hazardous waste constituents?	N/A		