GROUNDWATER MONITORING PROGRAM FOR WASTE PIT # 4 LOCATED AT THE FEEDS MATERIAL PRODUCTION CENTER

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GROUNDWATER MONITORING PROGRAM

FOR

WASTE PIT #4

LOCATED AT THE

FEED MATERIALS PRODUCTION CENTER

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I. INTRODUCTION

In August, 1985, the Feed Materials Production Center (FMPC), a uranium metals processing facility operated by the Westinghouse Materials Company of Ohio (WMCO) as of January 1, 1986, for the U.S. Department of Energy (DOE), began an aquifer sampling and analysis program around Waste Pit #4. This program is designed to assist in bringing Pit 4, a RCRA regulated surface impoundment into compliance with the groundwater monitoring requirements of 40 CFR Part 265 Subpart F (265.90-265.94).

Recently, a Federal Facilities Compliance Agreement (FFCA) between U.S. EPA and U.S. DOE directed that certain procedural aspects of the Pit 4 aquifer sampling and analysis program be provided to U.S. EPA for review and approval. This report has been prepared responsive to Item B of the FFCA and provides information on:

- Geology and hydrology of the Waste Pit #4 area.
- Horizontal and vertical components of groundwater flow in the glacial till.
- Horizontal and vertical components of groundwater flow directions in the sand and gravel aquifer.
- Potentiometric maps showing groundwater flow directions in the sand and gravel aquifer.
- The location of RCRA monitoring wells.
- Subsurface geologic conditions underlying Pit #4 as illustrated through several cross sections.
- Design and construction specifications of the wells used in the monitoring of Pit 4.

- o Information on casing material, casing elevation, depth to water, groundwater table elevation, construction material.

II. WASTE PIT #4 - GEOLOGY AND HYDROLOGY

Waste Pit #4 was constructed by excavating into a layer of glacial till consisting mostly of silty clay. The bottom and walls of the pit then were lined with a minimum of 12 inches of compacted clay. Maximum depth of the pit is estimated at 24 feet. Between 1960 and the present, Pit 4 received about 50,000 cubic yards of low level radioactive waste containing slightly enriched uranium and thorium. Between May, 1981 and April, 1983, Pit 4 also received low-level radioactive waste containing barium chloride salt. Other materials disposed of in this pit have consisted of radioactivity contaminated construction rubble, asbestos, and graphite.

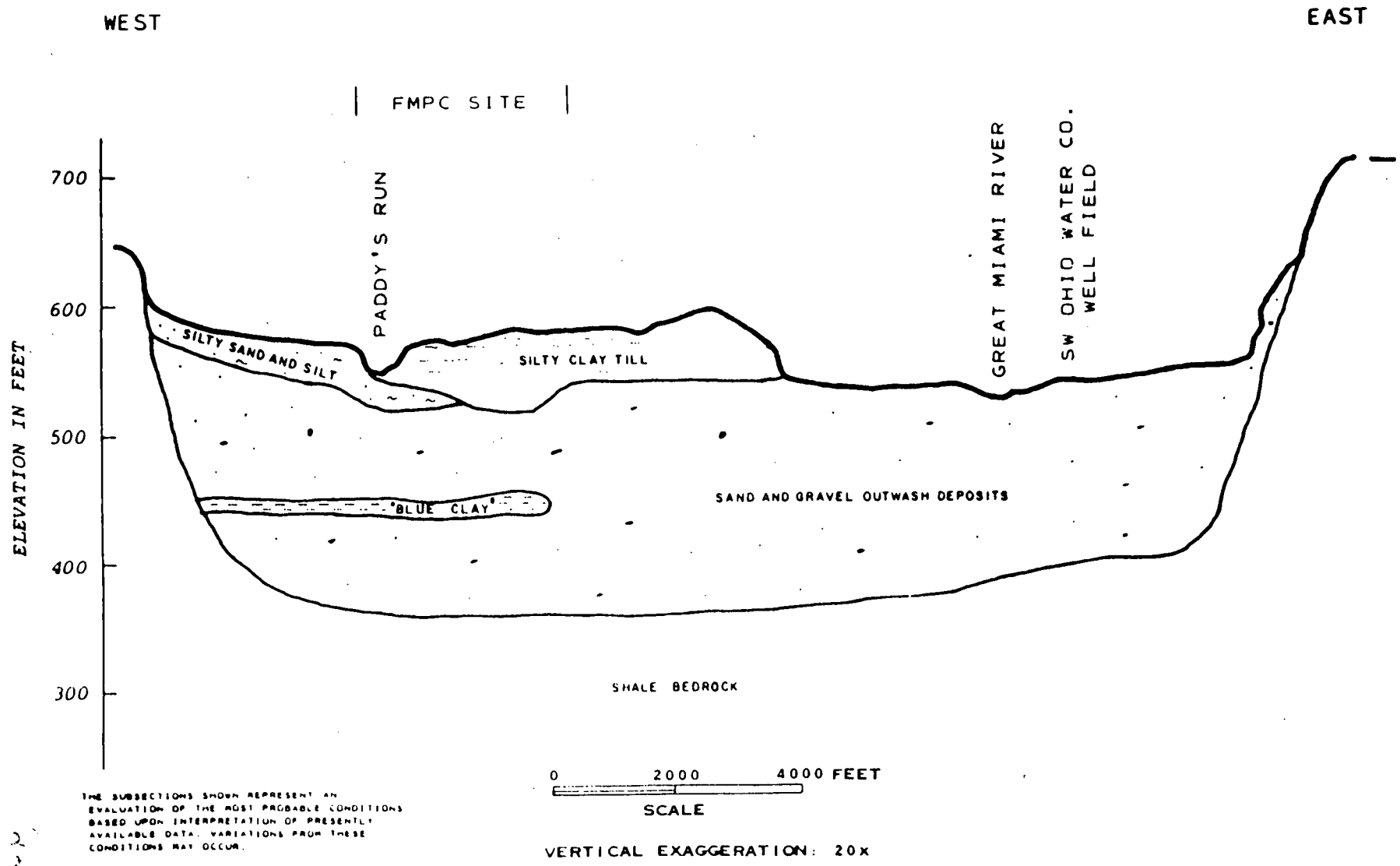
FMPC GEOLOGY AND HYDROLOGY

The FMPC is located in a two-mile wide valley filled with glacial deposits. This valley parallels the Great Miami River between the towns of Ross and Hooven, Ohio. A generalized geologic cross-section for the FMPC site area is presented in Figure 1.

- In Late Ordovician time (approximately 450 million years ago) sediments which would become a predominantly flat-lying shale with thin interbedded limestone were deposited in a shallow sea. This shale (a part of the Cincinnatian Series) is the relatively impermeable bedrock which now underlies the FMPC site area.

- Sometime prior to, or perhaps contemporaneous with, Pleistocene glaciation, a large watercourse (larger than the present-day Great Miami River) cut its channel into this shale bedrock to a level of more than 200 feet below that of the present-day Great Miami River. This approximately two-mile wide channel (informally called the New Haven Trough) may be an abandoned course of the ancestral Ohio River.

- During subsequent Pleistocene glacial advances and retreats across the site area (Illinoisan-approximately 300,000 years to 400,000 years ago and Wisconsinan-approximately 100,000 years ago) the New Haven Trough was filled with about 200 feet of glacial sediments. These sediments were deposited by water running from the margins of the glaciers and consisted mainly of well sorted sand and gravel. Deposited on top of these sediments was a blanket of clay-rich, relatively impermeable glacial till from a more recent event.



THE SUBSECTIONS SHOWN REPRESENT AN EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. VARIATIONS FROM THESE CONDITIONS MAY OCCUR.

GENERALIZED GEOLOGIC CROSS SECTION OF NEW HAVEN TROUGH

DAMES & MOORE

FIGURE 1

- Erosion by the Great Miami River and its tributaries then removed significant portions of the glacial till and left terrace remnants which stand topographically higher than surrounding bottom lands. The FMPC site lies on top of one of these terrace remnants.

SAND AND GRAVEL AQUIFER

Unconformably overlying the shale bedrock is a sequence of highly permeable sand and gravel glacial outwash deposits laid down by the meltwaters of receding continental ice sheets. These outwash deposits generally consists of an unconsolidated medium to coarse grained, olive brown 200 foot thick layer of sand and gravel. The sand and gravel layer is arranged in irregularly alternating layers of silty sand, medium to coarse sand, and medium to coarse gravel.

In the vicinity of the Waste Pit Storage Area, this layer is separated into two units by 10 to 20 foot thick layer of greenish-black silty clay. The FMPC production wells are completed below this "blue clay" layer. This blue clay layer underlies about 360 acres of the site and apparently occurs only in the vicinity of the Waste Pit Storage Area and the production wells. It was probably deposited in an ice marginal lake or as a backwater deposit of a glacial stream. The top of this "blue clay" layer lies about 125 feet below the land surface.

Hydrologically, the sand and gravel above and below the "blue clay" layer acts as a single unit. The "blue clay" layer is not sufficiently extensive to act as an aquitard and no significant head differences exist between wells completed above and below this layer.

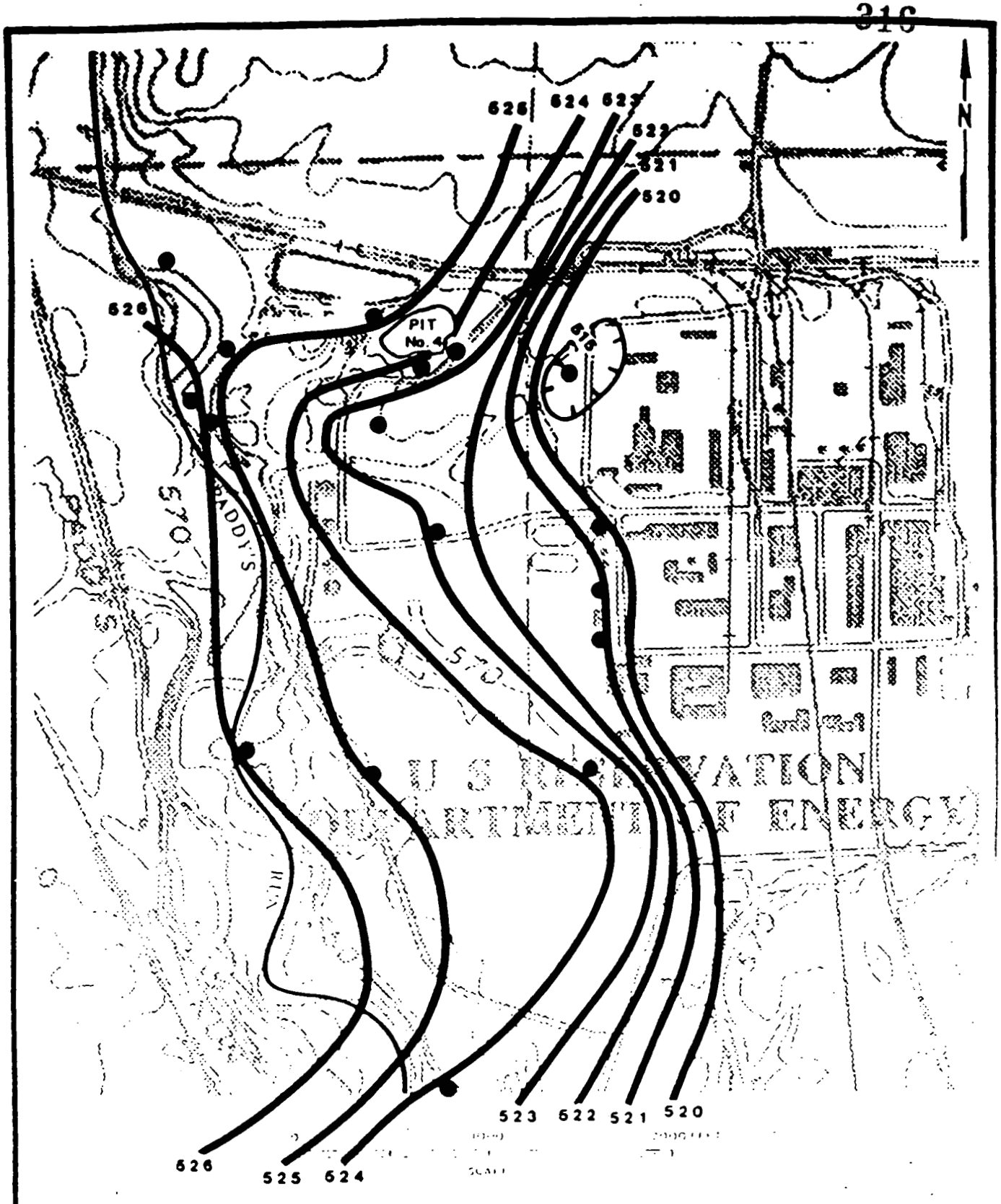
Transmissivities and hydraulic conductivities for the sand and gravel are reported to range from 35,000 gpd/ft to 300,000 gpd/ft and 270 ft/day to 370 ft/day respectively. Total porosities have been estimated at 25%. Average hydraulic gradients for the area measured by the USGS from water level measurements made in August, 1982 are low and were calculated to range from 0.001 ft/ft to 0.005 ft/ft. Using these data, the rate of groundwater movement (horizontal groundwater velocity) is calculated to range between 1.1 ft/day and 9.3 ft/day.

Figure 2 is a Dames & Moore water level contour map for the sand and gravel aquifer. This map shows that groundwater movement is generally to the south and southeast in the area around Pit 4. The upper 20 to 30 feet of the sand and gravel deposits are not saturated and water in this aquifer occurs approximately 60 to 90 feet below land surface depending upon surface elevation and thickness of till.

GLACIAL TILL

At the surface of the site and overlying the sand and gravel outwash deposits is a 20 to 50 foot thick layer of glacial till composed of a dense, olive-gray silty clay. The till varies in texture and composition both laterally and vertically and contains lenses of poorly sorted fine to medium grained sand and gravel. The base of the till occurs at about elevation of 540 ft MSL and overlies the sand and gravel outwash deposits.

To the west and south of the site, the silty clay till laterally grades into a sequence of silty sand and silt with some layers of silty clay. The silty clay till is continuous to the north and east of the site and directly overlies the bedrock in these areas. In the lower reaches of Paddy's Run and



WATER LEVEL CONTOUR MAP

SAND AND GRAVEL AQUIFER

KEY:

● MONITORING WELL LOCATION AS OF 5/86

REFERENCE: BASE MAP TAKEN FROM U.S.G.S. 7.5' TOPOGRAPHIC MAP, SHANDON, OHIO (1981) QUADRANGLE

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DAMES & MOORE

FIGURE 2

the Storm Sewer Outfall Ditch, the silty clay till has been eroded away and the underlying sand and gravel are exposed.

A saturated zone occurs within the silty clay till approximately 4 to 9 feet below land surface in some areas of the FMPC site. This saturated zone was encountered in three shallow wells around Pit 4 and is probably recharged by precipitation. A saturated zone was not detected in test pits near well clusters to the east and south of the Waste Pit Storage Area. This saturated zone may be present because of vertical variations of composition and texture of the till, or near-surface weathering or desiccation induced fracturing of the till.

Aquifer testing of this saturated zone has measured hydraulic conductivities of 0.2 ft/day to 2.5 ft/day with associated transmissivities of 3.5 gpd/ft to 150 gpd/ft.

CROSS-SECTIONS

In order to illustrate subsurface geologic conditions underlying and in the vicinity of Pit #4, two cross-sections have been prepared (Section A-A′ and B-B′). A cross-section is a two dimensional, cut-away view along a particular line. It provides a representation of what is known or inferred about geologic conditions along that line. They are typically used to illustrate both stratigraphy and the relationship of stratigraphy to structure and topography.

Cross-sections in the vicinity of Pit #4 have been prepared using subsurface geologic data gathered during:

- Excavation of Pit #4.
- NLO monitor well drilling program.
- Dames & Moore monitor well drilling program.

These cross-sections illustrate the existence of the four layered stratigraphic system underlying the Waste Pit Storage Area at the FMPC. A short description of each of these layers (from deepest to shallowest) is provided below:

- Lower sand - This is a layer of coarse sand and gravel approximately 60 feet to 80 feet thick which overlies a shale bedrock. It is the major aquifer in the vicinity of the FMPC and was deposited by the meltwaters of receding continental ice sheets (glaciers).
- "Blue Clay" - Occurring approximately 100 feet to 125 feet below ground in the vicinity of the Waste Pit Storage Area is a 10 foot to

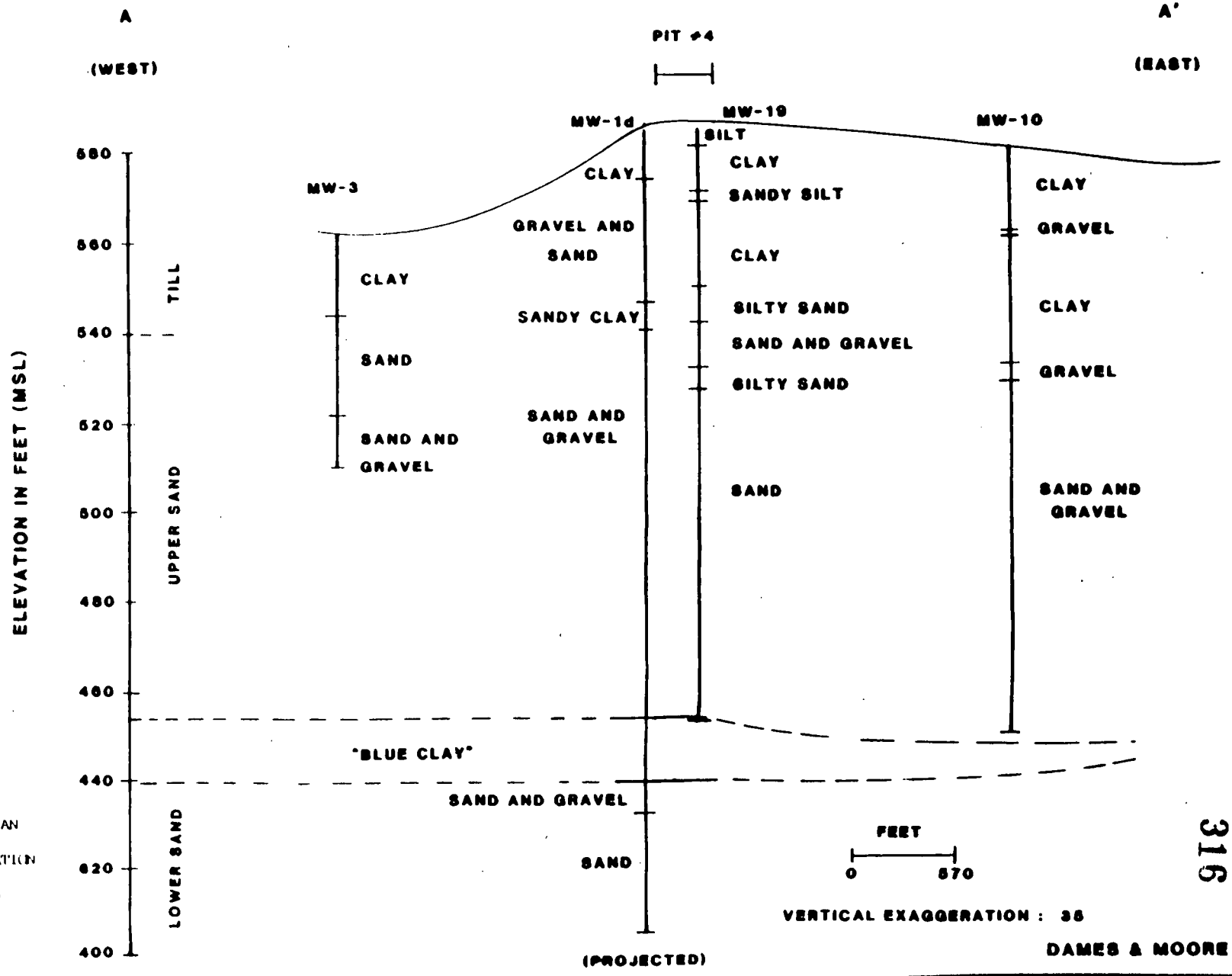
20 foot thick layer of greenish black silty clay. This has been referred to by several authors as the "blue clay". It was probably deposited in an ice marginal lake or as a backwater deposit of a glacial stream. The top of this layer lies about 125 feet below land surface. The "blue clay" layer is not extensive enough to act as an aquitard and no significant water table elevation differences exist between wells completed above and below this layer.

- Upper Sand - This is a layer of coarse sand and gravel approximately 80 feet to 100 feet thick which overlies the "blue clay". The upper 20 feet to 30 feet of these deposits are not saturated and water in this aquifer occurs approximately 60 feet to 90 feet below the land surface depending upon elevation and till thickness.

- Glacial Till - At the surface of the site and overlying the Upper Sand is a 20 foot to 50 foot thick layer of glacial till. It is composed of a dense, olive gray silty clay. The till varies in texture and composition both laterally and vertically and contains lenses of poorly sorted fine to medium grained sand and gravel. A saturated zone occurs within the till approximately 4 feet to 9 feet below the land surface within portions of the Waste Pit Storage Area.

Additional details on the geology and hydrogeology of the Pit #4 area can be found in the Dames & Moore Task C Report.

CROSS SECTION A A'



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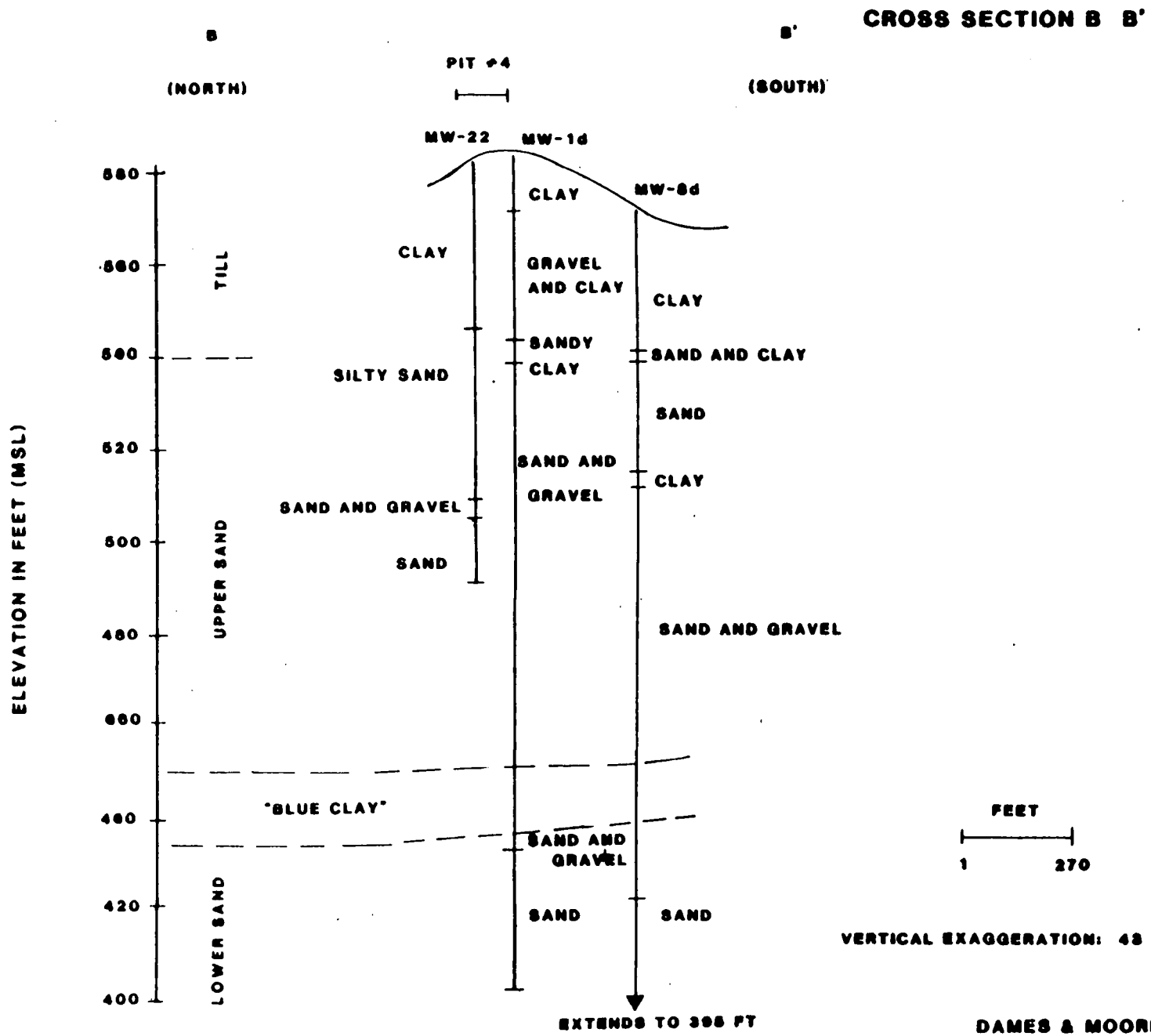

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III. HORIZONTAL AND VERTICAL COMPONENTS OF GROUNDWATER FLOW-GLACIAL TILL

Not enough information is available on groundwater movement in the glacial till to accurately characterize horizontal or vertical flow directions near Pit 4. Water table elevation data measured in the glacial till water bearing zone near Pit 4 for the past year are shown in Table 1. These data would indicate that groundwater flow is towards the northeast. However, groundwater table elevations in this water bearing zone may be influenced by:

- The fact that each well is screened in a different sedimentary facies
- Groundwater mounding effects from Pit 4.
- Other local flow derangements caused by the presence of Waste Pits 1, 2, 3, 5, and 6.
- Differing groundwater recharge mechanisms to the glacial till. This saturated zone may be present because of vertical variations of composition and texture of the till, or near-surface weathering or desiccation induced fracturing of the till.

Vertical components of groundwater flow in the glacial till can be estimated from laboratory test data of undisturbed sediment samples (Reference 1). However, as previously described, many of the sedimentary characteristics of the glacial till will tend to decrease the accuracy and representativeness of this estimate.

WMCO recognizes the importance of these glacial till characteristics and in order to gather the necessary data to measure horizontal and vertical groundwater flow components in the glacial till, an extensive drilling, monitoring well installation, soil sampling, and well testing program will be

TABLE 1

GROUNDWATER TABLE ELEVATIONS
FROM WELLS COMPLETED IN THE
GLACIAL TILL

DATE	WELL #	DEPTH TO WATER* (ft)	CASING ELEVATION	WATER TABLE ELEVATION
August, 1985	MW-12	33.16	639.67	606.51
	MW-19TP	7.46	584.96	577.50
	MW-21TP	5.46	585.61	580.14
	MW-22TP	8.96	588.91	579.95
May, 1986	MW-12	31.38	639.67	608.29
	MW-19TP	8.73	584.96	576.23
	MW-21TP	4.60	585.61	581.01
	MW-22TP	7.62	588.91	581.29
August, 1986	MW-12	34.88	639.67	604.79
	MW-19TP	7.42	584.96	577.54
	MW-21TP	4.72	585.61	580.89
	MW-22TP	7.30	588.91	581.61

* From Top of Casing

conducted. This program is part of the CIS investigation of the Waste Pit Storage Area which is expected to be completed in FY 1987.

HORIZONTAL AND VERTICAL COMPONENTS OF GROUNDWATER FLOW - SAND AND GRAVEL AQUIFER

Horizontal groundwater flow directions for the sand and gravel aquifer in the vicinity of Pit 4 are presented in Table 2. These rates have as their basis three things:

- Historic pump tests data recorded during the numerous government and private party hydrogeologic and water supply investigations in the site area.
- Pump test data developed during a recent groundwater study (Reference 1).
- Results of laboratory analysis of undisturbed sediment samples.

Hydrologically, the sand and gravel above and below the "blue clay" layer acts as a single unit. The "blue clay" layer is not sufficiently extensive to act as an aquitard and no significant head difference exists between wells completed above and below this layer. The upper 20 feet to 30 feet of the sand and gravel aquifer is not saturated and water in these deposits occurs approximately 60 feet to 90 feet below the land surface depending upon surface elevation and thickness of till.

These glacial outward deposits show only gross tendencies towards stratification, and therefore, the vertical components of groundwater flow in the sand and gravel should also be consistent with the horizontal rates provided in Table 2.

TABLE 2

HORIZONTAL AND VERTICAL GROUNDWATER FLOW RATES - SAND AND GRAVEL AQUIFER

BORING #	DEPTH (ft)	SOIL TYPE	HYDRAULIC CONDUCTIVITY (cm/sec)
13	36	SW-SC	1.50 E-7
	80	GP	2.58 E-3
14	22	SP	5.15 E-3
	55	GP	4.79 E-3
15	32	SP	8.41 E-4
	55	GP	4.02 E-3
16	35	SP	3.33 E-3
18	55	SW	1.10 E-2

Notes:

(1) Source of Data is Appendix 2 of Reference 1

(2) Test Method was by Falling Head Permeameter

(3) Key to Soil Types

SW - Well graded sands, gravelly sands, little or no fines

SC - Clayey sands, sand-clay mixtures

SP - Poorly graded sands, gravelly sands, little or no fines

GP - Poorly graded gravels, gravel-sand mixtures, little or no fines

POTENTIOMETRIC SURFACE MAP OF GROUNDWATER FLOW DIRECTIONS IN THE SAND AND GRAVEL AQUIFER

A potentiometric surface map illustrating groundwater flow directions in the sand and gravel aquifer in the vicinity of Pit 4 is shown in Figure 2.

This map indicates that groundwater flow directions are generally to the south and southeast. These findings are consistent with a USGS potentiometric surface map for the FMPC published in 1982 (Reference 2). These maps also indicate that wells used for RCRA monitoring are hydrologically downgradient of Pit 4. They are capable of detecting significant amounts of hazardous waste or hazardous waste constituents that may migrate from Pit 4 to the sand and gravel aquifer.

IV. GROUNDWATER MONITORING

The groundwater monitoring program related to Pit 4 has been designed to characterize the Pit's impact on the quality of groundwater in the uppermost (glacial till) aquifer underlying the Pit. In addition, groundwater monitoring is currently being conducted which also will characterize this Pit's impact on the quality of groundwater in the deeper sand and gravel aquifer.

The Pit 4 RCRA groundwater monitoring system consists of a set of nine wells: 7 downgradient (3 completed in the glacial till and 4 completed in the sand and gravel aquifer) and 2 upgradient (1 completed in the glacial till and 1 completed in the sand and gravel aquifer). Well locations are shown in Figure 3. As built construction specifications are shown on Figures 4A-E. A discussion of each well and the rationale for its location and monitoring are provided below.

MW-12: This well has been selected as the upgradient well for groundwater present in the glacial till. Well MW-12, which is screened in the glacial till water bearing zone, is located hydrologically upgradient of Pit 4, about 2100 feet north of Pit 4. The water table elevations in this well are about 30 feet higher than the Pit 4 wells (see Table 1). This elevation difference would isolate MW-12 from known FMPC waste sources. This well would provide representative background water quality data for the uppermost water bearing zone near Pit 4.

MW-19 TP: This well is completed in a layer of silty clay within the glacial till water bearing zone. It has been designed to intercept and monitor shallow groundwater flowing from the east side of Pit 4. The water table

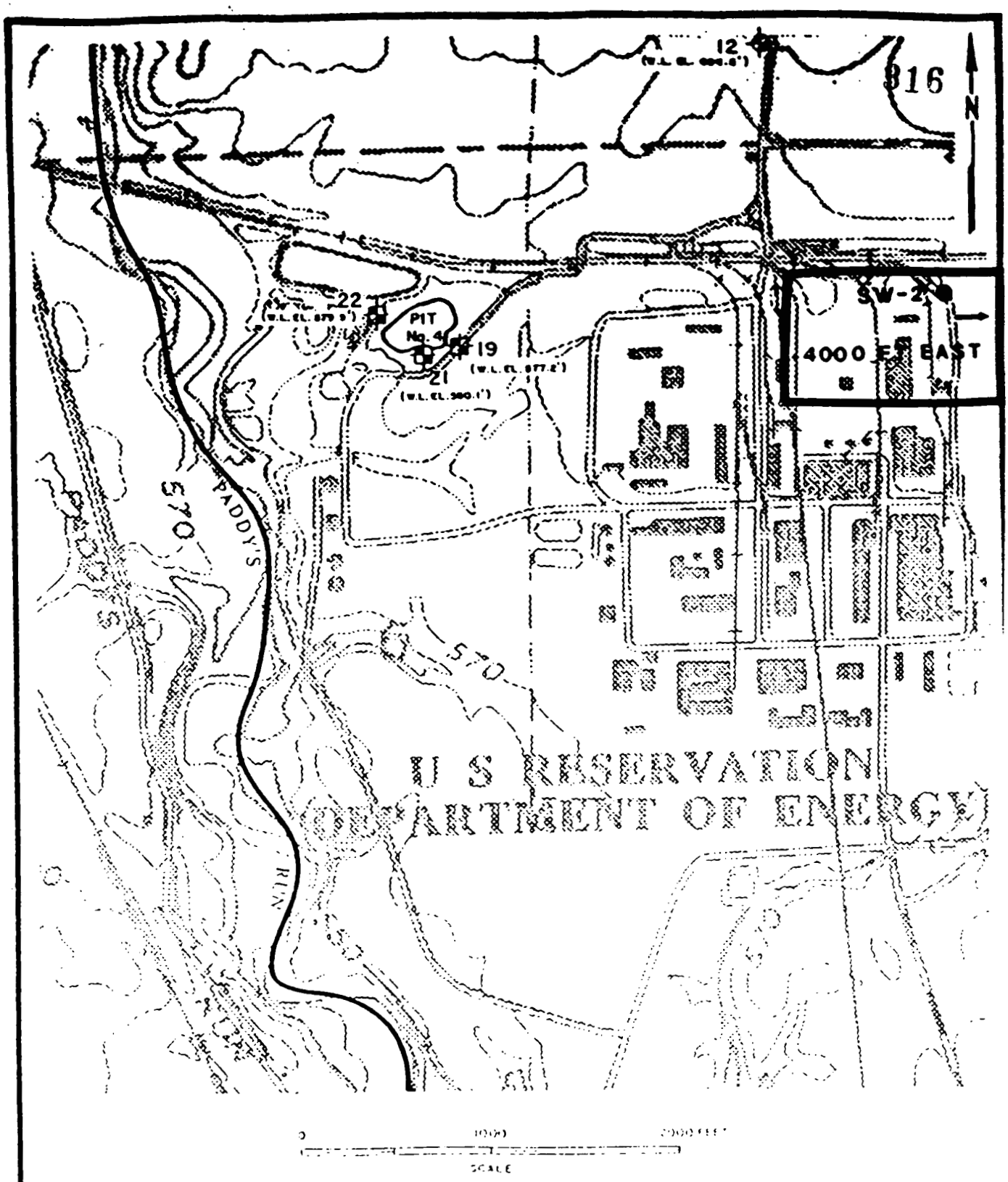
elevation (head) difference between MW-12 and MW-19 indicate that this well is hydrologically downgradient of Pit 4. Therefore, this well is capable of detecting statistically significant amounts of hazardous waste constituents that may migrate from Pit 4 in the glacial till water bearing zone.

MW-21 TP: This well is completed in a layer of clayey silt containing up to 5% sand and gravel. It has been designed to intercept and monitor shallow groundwater flowing from the south side of Pit 4. The head difference between MW-12 and MW-21 TP indicate that this well is hydrologically downgradient of Pit 4.

Therefore, this well is capable of detecting significant amounts of hazardous waste constituents that may migrate from Pit 4 into the glacial till water bearing zone.

MW-22 TP: This well is completed in a layer of silty clay with up to 1% coarse gravel. It has been designed to intercept and monitor shallow groundwater flowing from the west side of Pit 4. The head difference between MW-12 and MW-22TP and the presence of seeps in the clearwell and Waste Pit #3 indicate that this well is hydrologically downgradient of Pit 4. Therefore, this well is capable of detecting significant amounts of hazardous waste constituents that may migrate from Pit 4 into the glacial till water bearing zone.

SW-2: This well, located to the east of the FMPC has been selected as the upgradient well for the sand and gravel aquifer. In order to discuss the basis for the selection of this background well, a basic understanding of the regional geology is required. As previously mentioned, the sand and gravel aquifer beneath the FMPC is part of the New Haven Trough. This Trough is an



EXPLANATION:

SINGLE WELL LOCATION

CLUSTER WELL LOCATION

19 = TP, s, d
21 = TP, s
22 = TP, s

REFERENCE - BASE MAP TAKEN FROM U.S.G.S. 7.5' TOPOGRAPHIC MAP, SHANDON, OHIO (1961) QUADRANGLE

RCRA
WELL LOCATIONS

DAMES & MOORE

FIGURE 3

east-west trending subsurface feature which has been filled with alluvial deposited sands and gravels which are covered with till. The northern boundary of the feature corresponds roughly with the northern boundary of the FMPC. North of the Trough, till is deposited directly on bedrock.

At most RCRA regulated facilities, the background well would have been placed upgradient (north) of the waste disposal area, and screened in the sand and gravel aquifer. However, north of the site, the sand and gravel aquifer abruptly grades into a thick sequence of glacial till overlying shale bedrock. The chemistry of groundwater in the till will be quite different than that of groundwater in the sand and gravel. Groundwater in clays tends to have different natural concentrations of many constituents. Therefore, if a well completed in the clay were to be used as the background well, non-representative background concentrations may be identified for some of the constituents being analyzed.

Since an upgradient well screened in the till will not be representative of background water quality in the sand and gravel aquifer, a nearby water supply well was selected to characterize background ground-water quality. The Southwestern Ohio Water Company operates a well which is completed in the sands and gravels of the New Haven Trough, approximately 0.25 miles east of the site. Although the well (SW-2) is in an adjacent groundwater flow regime, the water from SW-2 will be more representative of the natural ground-water conditions beneath the FMPC rather than a geographically closer well completed in the till. Therefore, this well will provide representative background water quality for the sand and gravel aquifer which underlies Pit 4.

<u>MW-19s:</u> This well is located east of Pit 4 and is completed in the upper saturated portion of the sand and gravel aquifer. Based on the water table

contour map (Figure 2) this well is hydrologically downgradient of Pit 4. It is capable of detecting significant amounts of hazardous waste constituents that may migrate from Pit 4 into the sand and gravel aquifer.

MW-19d: This well is located along the east side of Pit 4 and is completed in the deeper portions of the sand and gravel aquifer, just above the "blue clay" layer. MW-19d is hydrologically downgradient of Pit 4 (see Figure 2 for water table contours) and is capable of detecting significant amount of hazardous waste constituents that may migrate from Pit 4 into the sand and gravel aquifer.

MW-21s: This well is located south of Pit 4 and is completed in a medium to course grained sand in the upper portions of the sand and gravel aquifer. It is hydrologically downgradient of Pit 4 (based on water table contours provided in Figure 2). It is capable of detecting significant amounts of hazardous waste constituents that may migrate from Pit 4 into the sand and gravel aquifer.

MW-22s: This well is located along the western border of Pit 4 and is completed in a silty sand (containing up to 15% gravel) in the upper portions of the sand and gravel aquifer. Figure 2 illustrates that this well is hydrologically downgradient of Pit 4. It is capable of detecting significant amounts of hazardous waste constituents that may migrate from Pit 4 into the sand and gravel aquifer.

In addition to the above described wells, the FMPC monitors 32 other wells in and around the Waste Pit Storage Area. These additional wells are also sampled for RCRA related parameters. Details regarding location and construction of these wells can be found in References 1 and 3.

MONITOR WELL CONSTRUCTION

All monitor wells have been constructed and cased in such a manner so that the integrity of the borehole is maintained. All wells have been screened and gravel packed to enable sample collection at depths where appropriate water bearing zones are present. Well construction procedures followed USEPA guidelines as described in References 4 and 5. The annular space of each well has been sealed with bentonite to prevent cross-contamination and all water quality results to date indicate that casing materials/annular space sealants are not influencing water quality.

WELL INSTALLATION PROCEDURES

This section of the Response provides a general description of monitor well drilling and installation procedures. Materials used in gravel packing and backfilling were sampled and analyzed for uranium. Only background concentrations were found. Two methods were used to install the Pit 4 monitoring wells - mud rotary drilling and backhoe excavation.

(A) Mud Rotary Drilling

Standard mud rotary drilling techniques were used to install monitoring wells MW-12, MW-19s, MW-19d, MW-21s and MW-22s. This involved the drilling of an 8-3/4 inch diameter borehole using a tri-cone bit and betonite muds. This method was chosen because of the nature of subsurface sediments, anticipated drilling depths, well diameter requirements, and site access conditions.

The drill rig, drill stem, bits and other down-hole equipment were cleaned prior to drilling and between each borehole. Water used in drilling operations was obtained from FMPC production Well #3. This water was sampled at regular intervals during drilling and found to contain only background concentrations of uranium. Split spoon samples were taken at 5 foot intervals and sediments were logged and used to assist in choosing the screen setting and in later geologic correlations.

After drilling to the described depth, ASTM Schedule 40 PVC flush joint threaded well screen and riser pipe was installed down the bore hole in 10 foot sections. The well screen was gravel packed with graded sand to a depth of 1 foot above the top of the screen. A 5 foot thick bentonite pellet seal was then installed on top of the gravel pack. During installation of the

gravel pack and bentonite pellet seal, the material was tamped periodically with a weighted ring collar to prevent bridging.

Subsequent to installation of the bentonite pellet seal, the borehole's annular space was backfilled with a mixture of either washed gravel and bentonite powder or cuttings and bentonite powder to a depth of about 20 feet to 40 feet below grade. At this depth, which was the bottom of the glacial till layer, another 5 foot thick bentonite pellet seal was installed. The borehole then was backfilled to within 5 feet of grade and a cement seal and locking protective pipe installed.

The above description is meant to provide general construction information for the Pit 4 wells. Slight variations or modifications to this method may have occurred during drilling of individual wells.

(B) Backhoe Excavation

A series of test pits were dug into the surficial till at various locations around the FMPC. This was done to provide information on surficial till composition and the location of the uppermost waterbearing zone. When water was encountered, a monitor well was installed in the excavation. Wells MW-19TP, MW-21TP and MW-22TP were installed in this manner. Monitor well installation proceeded along the following lines.

Upon completion of the test pit to the required depth, usually 10 feet to 15 feet below grade, the excavation was photographed and its side walls logged. The size of the excavation usually ranged from 3 feet to 6 feet long and about 2 feet wide.

Before well installation began, a 1 foot thick layer of washed gravel was installed over the bottom of the pit. ASTM Schedule 40, 4" i.d. PVC flush joint threaded well screen and riser pipe then was installed in 10 foot sections from atop a platform extending across the excavation. The excavation was filled with graded sand to a depth of 1 foot above the top of the screen. This sand pack was regularly tamped to prevent bridging. The next step in the well installation process was to backfill the excavation to within a few feet of grade with a mixture of washed gravel and benonite powder. Finally, a surficial cement seal was installed over the entire extent of the excavation and a locking protective casing emplaced over the PVC riser pipe.

It should be noted that this well installation technique, although somewhat unconventional, has provided a means of obtaining representative water quality data from the uppermost aquifer. The well screen for each of these wells are open and they yield water on a continuing basis. As would be expected, the water table elevations recorded in each well are flucuating with the seasons and as a result of variations in atmospheric pressure.

To account for the larger than typical sand pack, additional volumes of water are removed during well evacuation prior to sampling (approximately 9-12 well casing volumes).

WELL CONSTRUCTION SPECIFICATIONS

Table 3 provides information on as-built well construction specifications. The location of each of these wells is shown on Figure 3. Boring logs and as-built schematics for the Pit 4 monitoring well are provided in Figures 4A through 4E.

Table 3

SUMMARY OF PIT 4 RCRA MONITORING WELL
CONSTRUCTION SPECIFICATIONS (1)

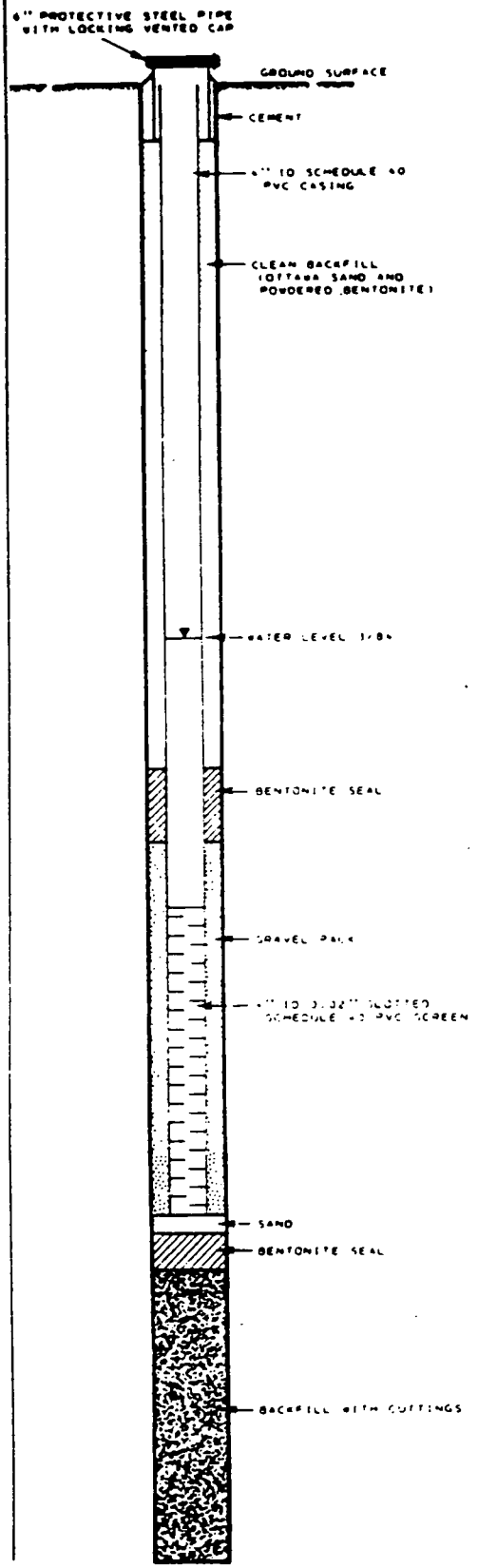
Well #	Well Dia. (in.)	Casing Elevation (ft.)	Depth to Water (ft.)(2)	Groundwater Table Elevation (ft.)	Screen Length (ft.)	Elevation at Top of Screen (ft.)	Construction Material	Total Depth (ft.)	Screen Slot Size (in.)	Screened Zone (3)
MW-12	4	639.67	31.38	608.29	15	594.67	PVC	60	0.020	G
MW-19TP	4	584.96	8.73	576.23	5	580.00	PVC	10	0.020	G
MW-19s	4	585.38	61.00	524.38	5	515.38	PVC	75	0.020	S
MW-19d	4	585.25	61.00	524.25	5	465.25	PVC	125	0.020	S
MW-21TP	4	585.61	4.60	581.01	5	580.61	PVC	10	0.020	G
MW-21s	4	586.02	61.53	524.49	5	516.02	PVC	85	0.020	S
MW-22TP	4	588.91	7.62	581.29	5	582.91	PVC	11	0.020	G
MW-22s	4	587.95	63.26	524.62	5	502.95	PVC	90	0.020	S
SW-2	35 Ft.	540.00	31.33 (4)	508.67 (4)	NA	NA	Steel	130	NA	G

Notes:

(1) See Figures 4A through 4E for As-Built Schematics of These Wells
(2) Measured in May, 1986
(3) S: Sand and gravel aquifer; G: Glacial Till
(4) Water level measurements taken in August, 1986

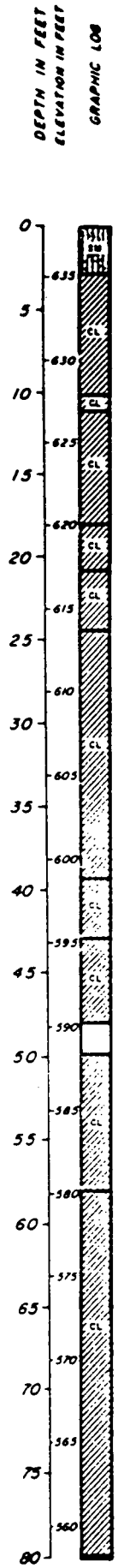
WELL SCHEMATICS

12D



BORING 12 316

SURFACE ELEVATION 637.0'



DESCRIPTIVE GEOLOGIC NOTES

GRASS, SILTY SAND WITH UNDERLYING RIP-RAP LIMESTONE COBBLES

PALE OLIVE (10Y6/2) MASSIVE CLAY WITH SOME IRON STAINED FRACTURES

MEDIUM BLUISH-GRAY CLAY (5B5/1) MASSIVE, DENSE, DRY, NO FRACTURES

MEDIUM BLUISH-GRAY CLAY (5B5/1) WITH SOME GRAVEL, IRON OXIDE STAINING

MEDIUM BLUISH-GRAY CLAY (5B5/1) WITH SOME SAND

MEDIUM BLUISH-GRAY CLAY (5B5/1) MORE FRIABLE THAN ABOVE

MEDIUM BLUISH-GRAY CLAY (5B5/1), MASSIVE, VARVED, FRIABLE

OLIVE GRAY (5Y3/2) CLAY WITH SILT

DARK GREENISH-GRAY (5GY4/1) CLAY WITH THIN GRAVEL LENS (1/4" THICK) OF IRON STAINED QUARTZ & FEW SHALE FRAGMENTS, 3" DIAMETER PRESENT

DRILL BIT CHATTERING, CUTTINGS [illegible] FRAGMENTS, 8 SMALL BOULDERS IN DEPTH

DARK GREENISH GRAY (5GY4/1) CLAY [illegible] THINLY BEDDED, SOFT, ALMOST A SHALE

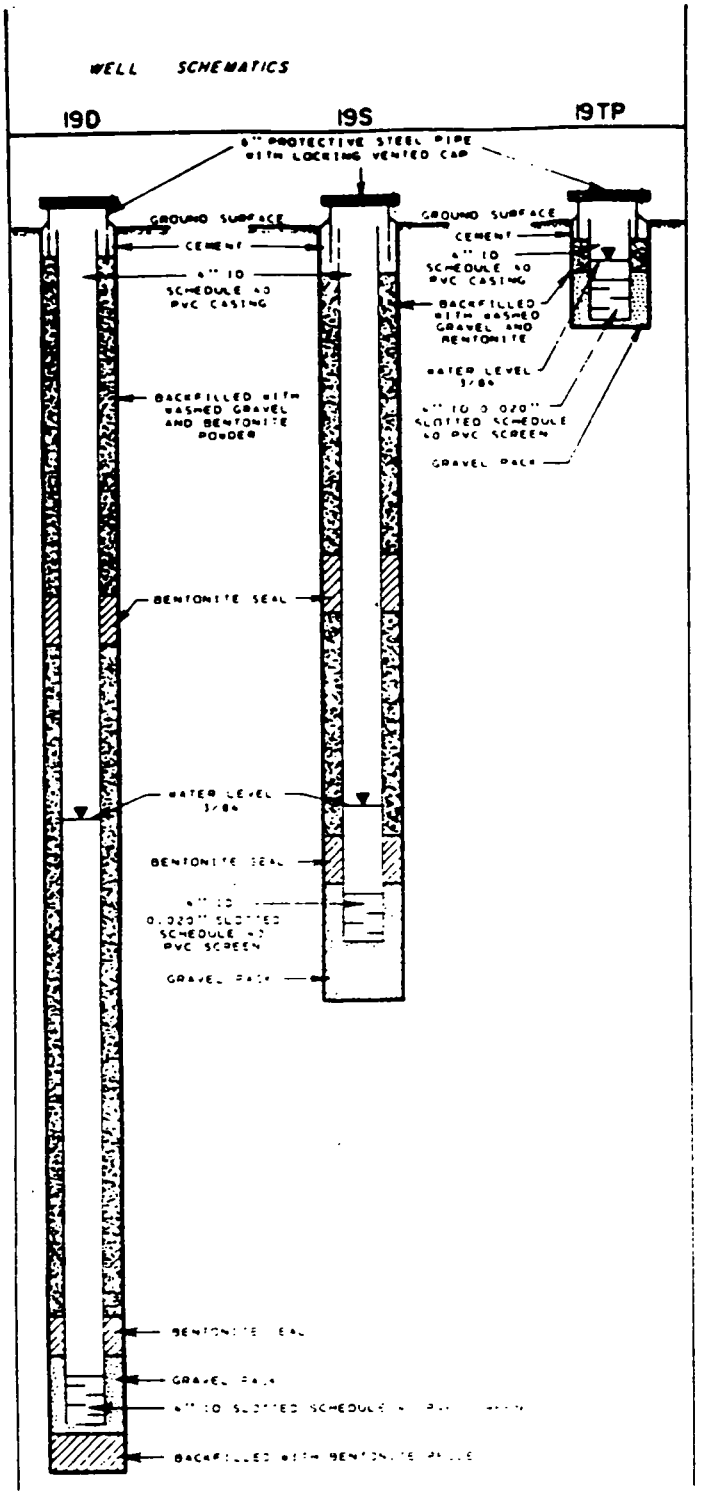
NO SAMPLE, SOFT GREENISH GRAY SHALE

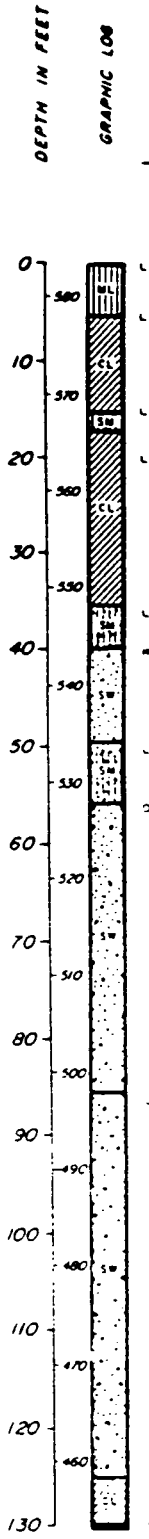
BORING TERMINATED AT A DEPTH OF 80 FEET

30

Figure 4A

DAMES & MOORE





BORING 19

316

SURFACE ELEVATION 19D 583.70'
19S 583.76'
19TP 582.98'

DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) CLAYEY SILT, CONTAINS STREAKS OF DUSKY YELLOW SILT, SOME GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY, CONTAINS DUSKY YELLOW SILT, NO GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SANDY SILT WITH UP TO 5% GRAVEL. CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY WITH 2% GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH 1% GRAVEL

MODERATE OLIVE BROWN (5Y4/4) GRAVELLY SAND MEDIUM TO COARSE GRAINED, SOME GRAVEL. CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/4) [illegible] MEDIUM GRAINED WELL SORTED SILTY SAND

OLIVE GRAY (5Y3/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND

LIGHT OLIVE BROWN [illegible] WELL SORTED SAND

GREENISH GRAY [illegible] CLAY [illegible]

BORING TERMINATED [illegible]

31

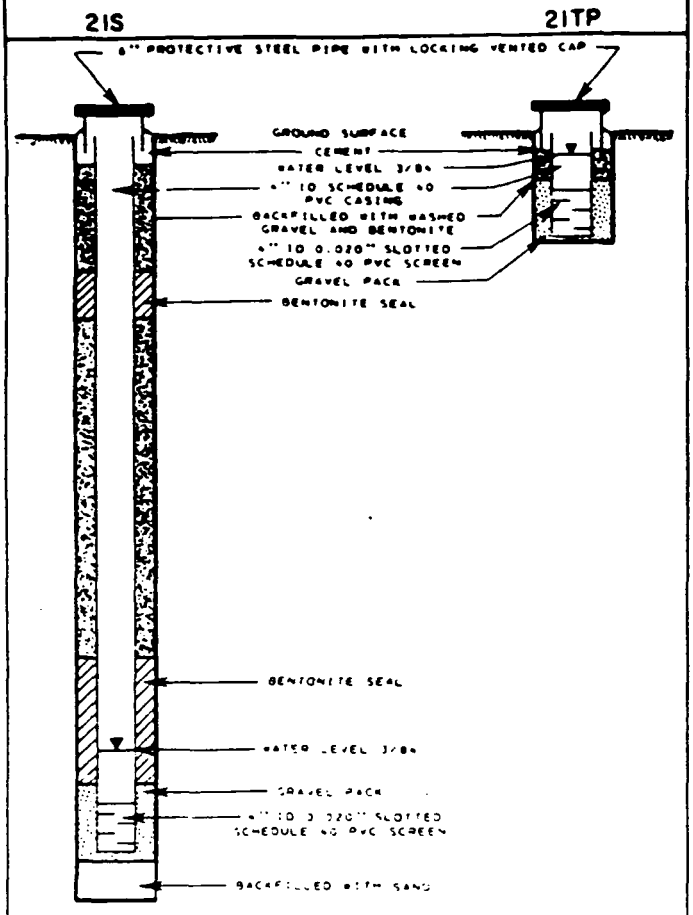
Figure 4B

DAMES & MOORE

BORING 21

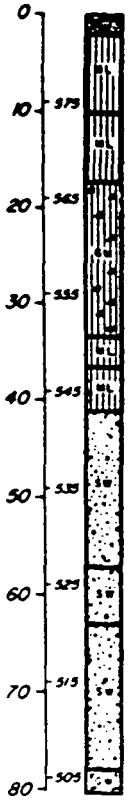
SURFACE ELEVATION 21S 584.42'
21TP 584.06'

WELL SCHEMATICS



DEPTH IN FEET / ELEVATION IN FEET / GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



ROAD FILL, COARSE GRAVEL

DARK YELLOWISH BROWN (10YR4/2) CLAYEY SILT UP TO 5% SAND AND GRAVEL

LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, WITH UP TO 5% SAND OR GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL

MIXTURE OF DARK YELLOWISH BROWN (10YR4/2) AND LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, UP TO 5% GRAVEL, MEDIUM TO COARSE GRAINED SAND ENCOUNTERED AT 40.5'

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND, UP TO 3% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED SAND, SOME GRAVEL, CONTAINS THIN LAYER OF BROWNISH-YELLOW FINE SAND

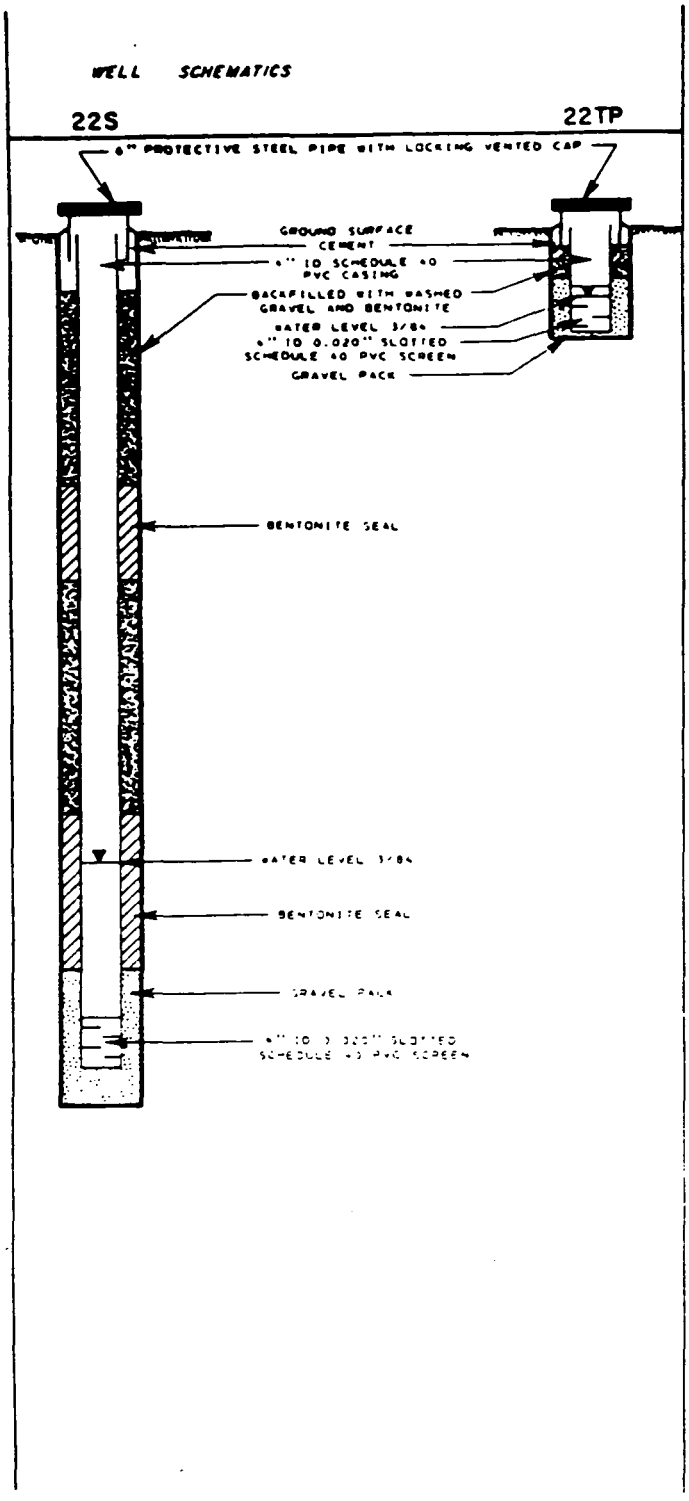
LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SAND (LESS THAN 1% GRAVEL) WITH SOME SILT

COARSE GRAVEL WITH SOME SAND
BORING TERMINATED AT A DEPTH OF 80.3' ON 2/13/85

32

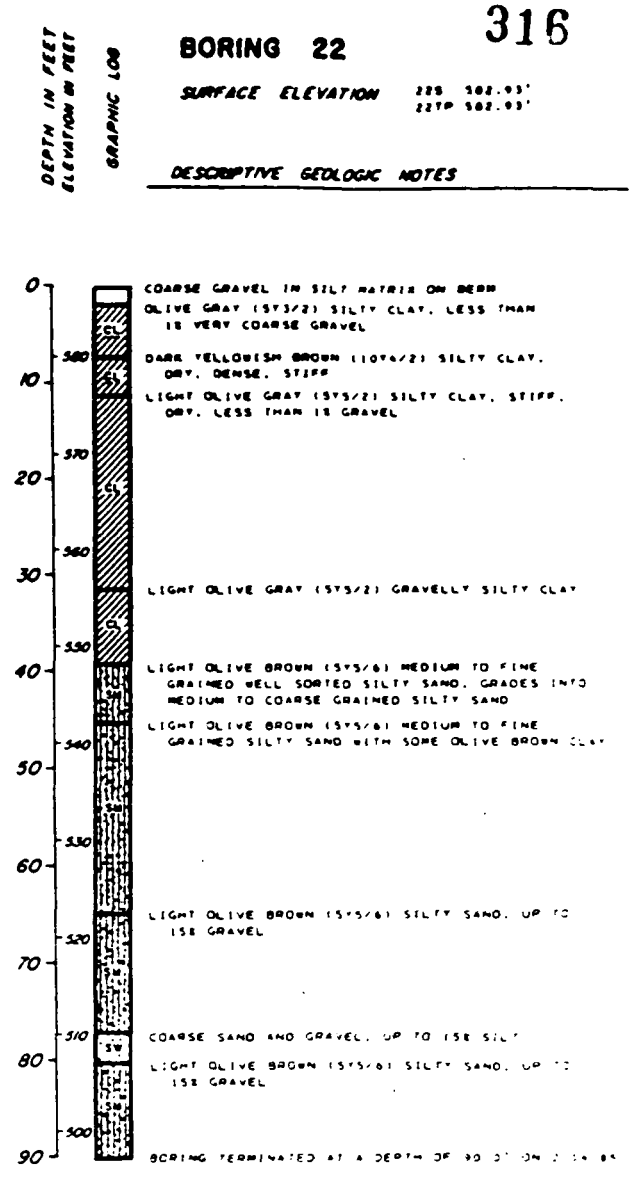
Figure 4C

DAMES & MOORE



BORING 22

SURFACE ELEVATION 22S 582.93'
22TP 582.93'



33

Figure 4D

DAMES & MOORE

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.

SOIL CLASSIFICATION CHART

UNIFIED SOIL CLASSIFICATION SYSTEM

34

NOTE: Color designations are based on
The Geological Society of America's
Rock Color Chart (Reference 13).

Figure 4E

DAMES & MOORE

REFERENCES

1) Dames & Moore, 1985, Groundwater Study Task C Report, Feed Materials Production Center, Department of Energy, Prepared for NLO, Inc., July, 1985.

2) Sedam, Alan C., 1984, Occurrence of Uranium in the Vicinity of the U.S. Department of Energy Feed Materials Production Center, Fernald, Ohio, United States Geological Survey Administrative Report, Prepared for the Department of Energy.

3) Dames & Moore, 1986, RCRA Groundwater Monitoring Reports: 1985-1986 Volume 1, Round 1, Phases 1-2-3. Prepared for Westinghouse Materials Company of Ohio.

4) Scalf, Marion R., McNabb, James F., William J. Dunlap, Roger L. Cosby, and John Fryberger, 1981, Manual of Groundwater Sampling Procedures, USEPA/NWWA Series.

5) U.S. Environmental Protection Agency, 1980, Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities, USEPA Publication No. SW-611.

APPENDIX

RCRA SAMPLING AND ANALYSIS PLAN

FOR

WASTE PIT #4

LOCATED AT THE

FEED MATERIALS PRODUCTION CENTER

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References Cited

Attachment 1 - Howard Labs QA/QC Program

TABLES

1 Monitor Well Sampling Order

2 Preservation of Groundwater Samples Prior to Laboratory Analysis

3 Analytical Methods and Detection Limits for Groundwater Samples - Water Quality Indicators

4 Analytical methods and Detection Limits for Groundwater Samples - Volatiles

5 Analytical Methods and Detection Limits for Groundwater Samples - Radionuclides

FIGURES

1 Field Sampling Record

2 Chain of Custody Record

1.0 Introduction

Waste Pit #4 at the Feed Materials Production Center in Fernald, Ohio is subject to regulations of the Resource Conservation and Recovery Act (RCRA). Interim status regulations (as described in Task B.5 of the Federal Facilities Compliance Agreement (FFCA)) are addressed by this Response which presents a Sampling and Analysis Plan (SAP) prepared in conformance with 40 CFR 265.92.

The SAP presents information on:

- Groundwater sample collection from both monitoring and water supply wells.
- Sample preservation and shipment procedures.
- Analytical procedures and chain of custody controls.

The groundwater sampling program at the FMPC is a dynamic one. As such, field procedures described herein, may from time to time be modified based on weather and other conditions at the well. However, all sampling procedures utilized are designed to be consistent with USEPA/OEPA objectives and guidelines.

2.0 Scope of Plan

This document presents the Sampling and Analysis Plan required by Subpart F, Section 265.92 of the Resource Conservation and Recovery Act (RCRA).

This plan has been developed in accordance with specific regulations and guidelines. The following references have been used in its preparation:

(1) Procedures Manual for Ground Water Monitoring at Solid Wastes Disposal Facilities, 1979, U.S. EPA-530/SW-611 (reprinted 1980).

(2) Manual of Ground Water Sampling Procedures, 1981, Marion R. Scalf, et. al., NWWA/EPA Series.

(3) Standard Methods for Analysis of Water and Wastewater, 1985, 20th Edition, APHA-AWWA-WPCF.

(4) RCRA Ground Water Monitoring Enforcement Guidance, 1985, U.S. EPA.

As required by the referenced regulation, this plan for groundwater monitoring contains procedures for sample collection, sample preservation and shipment, analytical procedures and chain of custody controls.

3.0 SAMPLE COLLECTION

This section of the sampling and analysis plan presents procedures use to evacuate, sample and preserve groundwater samples collected from the FMPC monitoring well networks.

3.1 Sampling Order

In order to minimize the possibility for cross contamination, samples will be collected beginning at the well least likely to contain elevated levels of hazardous wastes or their constituents (upgradient well) and ending at the well most likely to contain elevated levels of hazardous wastes or their constituents. The sampling order for monitor well locations is indicated in Table 1. During field sampling activites, wells are grouped into on-site and off-site locations. Each sampling team then samples its series of wells in the prescribed order.

3.2 Sampling Technique

The sampling technique can be divided into three separate stages:

- Pre-sampling measurements
- Well evacuation
- Sample acquisition

Figure 1 is an example of a Field Sampling Record, used during the well sampling activities. This form follows the three stages mentioned above and is completed for each well sampled.

Prior to pre-sampling measurements, the following information is recorded in permanent ink on the Field Sampling Record.

- Facility Name
- Name of sampling personnel, affiliation, date and time of sampling
- Well number, location and well diameter
- Short description of weather conditions

3.2.1 Pre-sampling measurements

Pre-sampling measurements consist of recording total depth of the well, depth to water, well diameter and other well characteristics as indicated on the Field Sampling Record.

Measurement of total well depth is made with a weighted tape, divided into feet, inches and tenths of an inch. The accuracy of the measurement is to the 0.01 ft.

The water level measurement is made with a water level indicator model 51453 made by Slope Indicator Co. (or equivalent). The accuracy of this measurement is also to the nearest 0.01 ft.

Both measurements are made from the same chisel mark on the top of the outer protective (metal) well casing.

Subtracting the depth to the water table from the total well depth, the height of the water column in the well can be calculated. Multiplying this by the well conversion factor (based on well diameter) the number of gallons of water in the well can be estimated.

3.2.2 Well Evacuation

The composition of the water within the well casing and in close proximity to the well (e.g. the gravel pack) is usually not representative of the overall ground water quality at the sampling site. This is because important geochemical conditions such as the oxidation-reduction potential may differ drastically near the well from those in the surrounding water bearing materials. For this reason it is essential that a well be pumped or bailed until the well is thoroughly flushed of standing water and contains fresh water from the aquifer.

The recommended amount of water required to be pumped or bailed from the well before sampling is dependent on many factors including the characteristics of the well, the hydrogeological nature of the aquifer, the type of evacuation equipment being used, and the parameters being sampled. The time required may range from the time needed to pump or bail one casing volume to the time needed to pump several casing volumes. At the FMPC, between 4 and 10 casing volumes of water are removed prior to sampling the well. Well water will be evacuated either by purge pumping or bailing.

<u>Pumping</u>

The majority of monitoring wells currently in place at the FMPC have dedicated 3.75" submersible pumps and discharge tubing installed in them. These pumps are used to purge and sample the wells. As each of these pumps are dedicated to a single well, no special cleaning at the pump or discharge tubing prior to or after sampling is required.

Purge water withdrawn from the wells within the plant production area is collected in a tank truck and eventually fed into the FMPC's wastewater

treatment system. Purge water withdrawn from outside the plant production area is discharged onto the ground surface and directed away from the casing.

For those wells that do not have a dedicated pump, a 3.5" portable submersible pump is used to purge the wells. The pump and associated tubing is cleaned after each use by pumping water with a non-phosphate detergent, tap water and then distilled water through the pump and tubing prior to its use in another well.

The pumping start time is marked on the field sampling record and the pumping rate is monitored with a flow meter or by the time needed to fill a vessel (bucket) of known volume. Based on the pumping rate, pumping time is established to remove 4 to 10 volumes of water from the well.

Bailing

There are several shallow wells in the surficial till layer which have recoveries too slow to allow for continuous pumping. In this case, wells are evacuated using a 2 foot long, 1.75 inch i.d. stainless steel bailer with a teflon check valve. If the well is bailed dry prior to removing the required volumes it is allowed to reach 80% of recovery and then immediately sampled.

New nylon weave rope is used in the manipulation of the bailer and separate lengths are dedicated to each well. The rope is bagged and disposed after use on the site.

A biodegradable, non-phosphate cleaning solution (e.g., ALCONOX) is used to clean the bailers upon completion of well evacuation. The bailer is triple rinsed with distilled water and wrapped in aluminum foil prior to reuse. Bailed water from wells within the plant production area is collected in a tanker and disposed in the FMPC's wastewater treatment system. Bailed water

from wells outside the plant production area, as well as wash and rinse water is discharged to the nearby ground surface.

3.2.3 Sample Collection

After removal of the required volumes from the well, the sample bottles are clearly labelled in permanent ink.

For collection of samples from pumps, the pump discharge tubing is placed near the bottom of the sample bottle and gradually withdrawn as the container fills. All sample bottles are filled to the top without overflowing, and the caps are firmly hand tightened to prevent leakage. Because of the relatively low turbidity of the ground water at this site, no field filtering of samples is performed.

In the case of sampling with a bailer, the water sample from the bailer is minimally handled and transferred immediately to the sample bottle.

As each full set of samples is collected from each monitoring point, they are stored in sampling kits comprised of an insulated container containing ice and appropriate shipping and handling instructions.

3.2.4 Field Blanks

As part of the ongoing QA program, samples are accompanied to the lab by field blanks. Field blanks are divided into cleaning blanks and trip blanks.

Cleaning blanks are made prior to each round of sampling, at least one each day of sampling. They consist of distilled, deionized water which is collected from the bailers after cleaning. They are analyzed and values are used to interpret the effectiveness of the cleaning procedures and bottle handling procedures.

In addition to the cleaning blanks, two types of trip blanks accompany the samples. These consist of sample bottes filled with distilled, deionized water and capped in the laboratory. One trip blank remains capped and accompanies the sample at all times until returning to the laboratory where it is opened and tested along with the other samples. The other trip blank is set aside during the sampling of the wells and left open to the atmosphere. The purpose of these trip blanks is to ensure that proper sample bottle preparation and handling techniques have been employed, and to evaluate the potential for atmospheric influences on sampling equipment.

TABLE 1

Monitoring Well Sampling Order

Sampling Order	Well Number	Location
1	12	Off North access road
2	SW-2	Southwest collector
3	P-1	West side production area
4	P-2	West side production area
5	P-3	Water treatment Plant
6	OS-1 deep	Farm house on Willey Road
7	OS-1 dug	Farm house on Willey Road
8	15s	Pasture on Willey Road
9	16d	Guard training area
10	16s	Shooting range
11	17d	Willey Road Bridge
12	17s	Willey Road Bridge
13	18d	South of production area
14	18s	South of production area
15	20d	Southwest of production area
16	20s	Southwest of production area
17	20TP	Southwest of production area
18	14d	Confluence of SSOD with Paddy's Run
19	14s	Confluence of SSOD with Paddy's Run
20	9	Paddy's Run-East bank
21	11	North of production area
22	13d	East of scrap metal site
23	13s	East of scrap metal site
24	8d	South of waste pit storage area
25	8s	South of waste pit storage area
27	3	East of pit 3 area
28	4	South of pit 3
29	5	South of pit 3
30	1d	North of K-65 tanks
31	1s	North of K-65 tanks
32	19d	East of pit 4
33	19s	East of pit 4
34	19TP	East of pit 4
35	21s	South of pit 4
36	21TP	South of pit 4
37	22s	West of pit 4
38	22TP	West of pit 4
39	OS-1	Exterior tap in yard of farm house off Willey Road
40	OS-2	East side of Paddy's Run Road
41	OS-3	East side of Paddy's Run Road

4.0 Sample Preservation and Shipment

In order that laboratory results be representative of the actual sample condition at the time of collection, it is important that proper methods be used for the preservation and transport of the samples prior to their delivery to the lab. These procedures are summarized below and are consistent with USEPA requirements as described in References 1 and 2.

4.1 Sample Containers

Proper types and materials must be utilized for the sample containers (bottles) in order to ensure that the samples, and in particular the parameters to be analyzed from that particular bottle, do not react with the container material and alter the concentration or values of the parameter. Sample bottles are supplied by the subcontracted laboratory and have been carefully selected to meet these performance objectives. A variety of materials, such as amber glass, clear glass, and polyethylene are employed as required. Where necessary, specialized sample bottles are utilized, such as for VOC measurements.

4.2 Sample Preservation

In addition to selection of proper container materials, other methods are often required in order to reduce the possibility of chemical reactions and/or precipitations occuring within the container which could alter analytical results. Those sample bottles which require chemical perservatives (e.g. acid) have the preservatives added by the laboratory prior to shipment of the bottles to the site. In addition, all sample bottles are placed in iced thermal coolers and kept as close to 4°C as possible during the period of time between collection and delivery to the lab. This refrigeration aids in the

suppression of bacterial growth in the samples. Table 2 lists various preservatives used and their applications.

TABLE 2

Preservation of Groundwater Samples Prior to Laboratory Analysis

Perservative	Action	Applicable to:
$HgCl_2$	Material Inhibitor	Nitrogen forms, Phosphorous forms
Acid (HNO_3)	Metals solvent, prevents precipitation	Metals
Acid (H_2SO_4)	Bacterial Inhibitor	Organic samples (COD, oil & grease, organic carbon)
	Salt formation with organic bases	Ammonia, amines
Alkali (NaOH)	Salt formation with volatile compounds	Cyanides, organic acids
Refrigeration	Bacterial Inhibitor	Acidity-alkalinity, organic materials, BOD, color, odor, organic Phosphorous, organic Nitrogen, carbon, etc. biological organisms (coliform, etc.)

4.3 Sample Shipment

In order to minimize the potential for loss, destruction, or tampering, all samples are delivered personally to the lab by a member of the sampling team. Sample bottles in their coolers are loaded onto a truck. The truck is kept locked with only the sampling team possessing a key. The bottles are then delivered directly to the lab and turned over to lab personnel. Chain-of-custody control is exercised throughout the sampling and sample shipment process as described in Section 6.0.

5.0 Analytical Procedures

All analyses of ground water samples in connection with RCRA groundwater sampling is conducted by Howard Labs, Inc. of Dayton, Ohio. Howard Labs is certified by both USEPA and OEPA to conduct such analyses. Analyses are conducted according to USEPA protocols and procedures as outlined below.

5.1 Constituents Being Monitored

A list of constituents that should be tested for in the FMPC groundwater was developed prior to the initiation of expanded monitoring in August, 1985 to meet RCRA requirements. This list addresses five (5) types of parameters:

- Parameters used to evaluate general water quality. These include chloride, iron, manganese, phenols, sodium and sulfate.

- Indicators of groundwater contamination. These include pH, specific conductance, total organic carbon and total organic halogen. These parameters are tested in quadruplicate as required by 40 CFR Part 264.90.

- Constituents evaluating drinking water suitability. These include 11 metals, 3 radionculides, 6 pesticides/herbicides and coliform bacteria.

- Parameters related specifically to past or current FMPC operations. This list includes 8 metals, 31 synthetic organic compounds, total dissolved solids and chemical oxygen demand (COD).

- Radionuclides related to past or current FMPC operations. Fifteen are analyzed, including isotopes of uranium, radium, thorium and plutonium.

A complete list of all parameters being tested for in the FMPC groundwater is provided on Table 3. Appendix VIII of 40 CFR 261 parameters are to be analyzed for selected RCRA wells as part of the Weston Characterization Investigation Study (CIS) for the Waste Pit Storage Area.

5.2 Analytical Methods

Chemical analysis of the samples is conducted according to methods specified in EPA-600/4-79-020, "Methods for Chemical Analysis of Water and Wastes". Radiological analyses are performed in accordance with procedures specified in EPA-600/4-80-032, Prescribed Procedures for Measurement of Radioactivity in Drinking Water." Where no EPA-approved method exists, analyses are conducted according to generally accepted standards and practices of the analytical profession under direct supervision of a chemistry Ph.D. The parameters analyzed, detection limits and the methods utilized are summarized in Tables 4, 5, and 6.

TABLE 3

PARAMETERS TO BE ANALYZED

A. For General Water Quality [1]

1. Chloride
2. Iron
3. Manganese
4. Phenols
5. Sodium
6. Sulfate

B. For Indicators of Contamination (Quadruplicate Analysis) [1]

1. pH
2. Specific Conductance
3. Total Organic Carbon (TOC)
4. Total Organ Halogen (TOX)

C. For Drinking Water Suitability [1]

1. Arsenic
2. Barium
3. Cadmium
4. Chromium - Hexavalent
   - Total
5. Fluoride
6. Lead
7. Mercury
8. Nitrate
9. Selenium
10. Silver
11. Gross Alpha
12. Gross Beta
13. Radium

14. Endrin
15. Lindane
16. Methoxychlor
17. Toxaphene
18. 2,4-D
19. 2,4,5-TP
20. Coliform Bacteria

D. Site Specific Parameters [2]

1. Nickel
2. Cyanide
3. Copper
4. Zinc
5. Magnesium
6. Calcium
7. Phosphorus
8. Chlorobenzene
9. Chlorodibromomethane
10. Chloroethane
11. 2-chloroethylvinyl
12. Chloroform
13. Dichlorobromomethane
14. Dichlorodifluoromethane
15. Total Dissolved Solids (TDS)
16. Total Potassium
17. Chemical Oxygen Demand (COD)
18. per Chloroethylene
19. cis 1,2 Dichloroethylene
20. Tributylphosphate
21. Acrolein
22. Acrylonotrille
23. Benzene
24. bis (chloromethyl) Ether
25. Bromoform
26. Bromodichloromethane
27. Bromomethane
28. Carbon tetrachloride
29. Chloromethane
30. 1,2 Dichlorobenzene
31. 1,3 Dichlorobenzene
32. 1,4 Dichlorobenzene

Table 3 (Con't.)

33. 1,1 Dichloroethane
34. 1,2 Dichloroethane
35. 1,1 Dichloroethylene
36. 1,2 Dichloropropane
37. 1,2 Dichloropropylene
38. Ethylbenzene
39. Methylbromide
40. Methylchloride
41. trans-1,2 Dichloroethylene
42. 1,3 Dichloropropene
43. 1,1,2,2 Tetrachloroethane
44. Tetrachloroethylene
45. Toulene
46. 1,1,1 Trichloroethane
47. 1,1,2 Trichloroethane
48. Trichloroethylene
49. Trichlorofluoromethane
50. Vinyl Chloride

E. Radionuclide [2]

1. Potassium 40
2. Total Uranium
3. Radium 226
4. Radium 228
5. Technetium 99
6. Thorium 228
7. Thorium 230
8. Thorium 232
9. Cesium 137
10. Strontium 90
11. Ruthenium 106
12. Neptunium 237
13. Plutonium 238
14. Plutonium 239
15. Plutonium 240

F. Schedule - Quarterly for one (1) years, semiannual thereafter (or as necessary according to regulations).

[1] Required for RCRA and analyzed for each sample

[2] Not required for RCRA, but also analyzed for each sample

TABLE 4

Analytical Methods and Detection Limits for Groundwater Samples
Water Quality Indicators

Parameter	Detection Limit	Analytical Method**
Chloride	1 ppm	325.3
Iron	50 ppb	236.2
Manganese	20 ppb	243.2
Phenols (total)	5 ppb	420.3
Sodium	50 ppb	273.2
Sulfate	1.0 ppb	375.2
pH	0.1 std./units	150.1
Specific Conductance	1 umho/cm	120.1
Total Organic Carbon (TOC)	1 ppb	415.1
Total Organic Halogen (TOX)	10 ppb	*
Arsenic	5 ppb	206.2
Barium	200 ppb	208.2
Cadmium	2 ppb	213.2
Chromium-Hexavalent	5 ppb	218.4
Chromium-Total	5 ppb	218.2
Fluoride	10 ppb	340.2
Lead	5 ppb	239.2
Mercury	2 ppb	245.2
Nitrate (as N)	20 ppb	352.1
Selenium	2.5 ppb	270.2
Silver	30 ppb	272.2
Gross alpha	15 pCi/l	900.0
Gross beta	5 pCi/l	900.0
Radium	5 pCi/l	900.1
Endrin	0.2 ppb	608
Lindane	0.2 ppb	608
Methoxychlor	0.2 ppb	608
Toxaphene	0.5 ppb	608
2,4-D	0.2 ppb	608
2,4,5-TP Silvex	0.2 ppb	608
Coliform Bacteria	2/100 ml	*
Nickel	5 ppb	249.2
Cyanide	5 ppb	335.3
Copper	25 ppb	220.2
Zinc	25 ppb	289.2
Magnesium	10 ppb	242.1
Calcium	50 ppb	215.1
Phosphorus	20 ppb	365.4
Total Dissolved Solids (TDS)	10 ppb	*
Total Potassium	50 ppb	258.1

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

** As described in References 3, 4 and 5.

TABLE 5

Analytical Methods and Detection Limits for Groundwater Samples - Volatiles

	Detection Limit	Analytical Method
Chlorobenzene	2.0 ppb	1624
Chlorodibromomethane	2.0 ppb	1624
Chloroethane	2.0 ppb	1624
2-Chloroethlvinyl Ether	2.0 ppb	1624
Chloroform	2.0 ppb	1624
Dichlorobromomethane	2.0 ppb	1624
Dichlorodifluoromethane	2.0 ppb	1624
Chemical Oxygen Demand (COD)	10 ppb	405.1
per Chloroethlyene	2.0 ppb	*
cis 1,2 Dichloroethylene	2.0 ppb	1624
Tributylphosphate	2.0 ppb	*
Acrolein	2.0 ppb	*
Acrylonitrille	2.0 ppb	*
Benzene	2.0 ppb	1624
bis (Chloromethyl)Ether	2.0 ppb	*
Bromoform	2.0 ppb	1624
Bromodichloromethane	2.0 ppb	1624
Bromomethane	2.0 ppb	1624
Carbon tetrachloride	2.0 ppb	1624
Chloromethane	2.0 ppb	1624
1,2 Dichlorobenzene	2.0 ppb	1625
1,3 Dichlorobenzene	2.0 ppb	1625
1,4 Dichlorobenzene	2.0 ppb	1625
1,1 Dichloroehtane	2.0 ppb	1624
1,2 Dichloroethane	2.0 ppb	1624
1,1 Dichloroethylene	2.0 ppb	1624
1,2 Dichloropropane	2.0 ppb	1624
1,2 Dichloropropylene	2.0 ppb	*
Ethylbenzene	2.0 ppb	1624
Methylbromide	2.0 ppb	1624
Methylchloride	2.0 ppb	1624
Trans 1,2 Dichloroethylene	2.0 ppb	1624
1,3 Dichloropropene	2.0 ppb	*
1,1,2,2 Tetrachloroethane	2.0 ppb	1624
Tetrachloroethylene	2.0 ppb	1624
1,1,1 Trichloroethane	2.0 ppb	1624
1,1,2 Trichloroethane	2.0 ppb	1624
Trichloroethylene	2.0 ppb	1624
Trichlorofluoromethane	2.0 ppb	1624
Vinyl Chloride	2.0 ppb	1624

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

TABLE 6

Analytical Methods and Detection Limits for Groundwater Samples - Radionuclides

Parameter	Detection Limit	Analytical Method
Cesium 137	5 pCi/l	901.0
Strontium 90	5 pCi/l	905.0
Ruthenium 106	5 pCi/l	*
Neptunium 237	5 pCi/l	*
Plutonium 239	5 pCi/l	*
Plutonium 240	5 pCi/l	*
Potassium 40	5 pCi/l	*
Radium 226	5 pCi/l	903.1
Radium 228	5 pCi/l	904.0
Technetium 99	5 pCi/l	*
Thorium 228	5 pCi/l	*
Thorium 230	5 pCi/l	*
Thorium 232	5 pCi/l	*
Uranium 233/234	5 pCi/l	*
Uranium 235	5 pCi/l	*
Uranium 238	5 pCi/l	*

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

5.3 QA/QC Controls

Field QA/QC control is exercised through the routine collection of three types of QA blanks. Cleaning blanks are collected by pouring distilled water into clean bailers and then into sample bottles for lab analysis. Trip blanks of two types are collected. The first involves sample bottles of distilled water, provided by the lab, which are opened at each sample collection point and then resealed and sent to the lab for analysis. This type of trip blank allows for evaluation of possible input of the parameters of interest to the sample via contact with the atmosphere. Additional trip blanks remain sealed throughout field program. They allow evaluation of sample bottle preparation and sample handling procedures in the lab.

Howard Labs, Inc. of Dayton, Ohio has been contacted to provide laboratory analytical services for this study. They maintain a complete house QA/QC program, which is summarized in Attachment 1. Howard Labs is certified by both USEPA and OEPA to perform the analyses required by RCRA.

6.0 Chain of Custody Control

A chain-of-custody control program is employed in order to provide for tracing of possession and handling of individual samples from the field collection through laboratory analysis. The various components of that program are summarized below.

6.1 Sample Labels

In order to avoid misidentification of the sample containers, each container has an adhesive label attached which indicates the sample identification number (well number), date and time of collection, and identification of the facility from which the sample was taken.

6.2 Sample Seals

As each thermal cooler is filled with sample bottles it is sealed by placing an adhesive band entirely around the cooler. This seal is then signed by the member of the collection team emplacing it. The seal is placed and signed such that opening of the cooler will result in obvious disruption of the seal.

6.3 Chain-of-Custody Records

In order to establish the documentation necessary to trace sample possession from time of collection, chain of custody information is recorded for each sample on a standard Chain-of-Custody form.

These data includes:

- Sample I.D. number
- Reason for sampling
- Witnesses

- o Collection Procedure
- o Method of Preservation
- o Name, Signature, and Affiliation of each person taking possession of sample
- o Date and time of each transfer
- o Purpose of each transfer
- o Other pertinent remarks

An example of the Chain-of-Custody record presently in use is provided in Figure 2.

6.4 Field Sampling Records

In addition to the Chain-of-Custody forms, additonal dates regarding the circumstances of sample collection are recorded in the Field Sampling Records. These were discussed in Section 3.2.

References Cited

1. Manual of Ground Water Sampling Procedures, 1981, Marion R. Scalf, James F. McNabb, William J. Dunlap, Roger L. Cosby, John Fryberger, NWWA/EPA Series.

2. Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilites, USEPA, 1980 #SW-611.

3. USEPA, 1983, Methods For Chemical Analysis Of Water and Wastes, Publication Number 600/4-79-020.

4. USEPA, 1980, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Publication Number 600/4-80-032.

5. Howard Laboratories, Inc., 1986, Quality Assurance/Quality Control Program, Publication Number HLI-QC.EF.

DAMES & MOORE
FIELD SAMPLING RECORD

Job _____ Date _____
Job # _____

Well # _____ Well Diameter _____
Location _____

I Water Level Measurements (From Top of Casing) in Feet.
Total Well Depth:
Depth to Water:
Height of Water Column:
Volume Conversion Factor:
Gallons in Well:

Conversion Factor
0.16 = 2" ID
0.65 = 4" ID
1.47 = 6" ID

II Well Evacuation
Pumping: Submersible
Nitrogen
Centrifugal

Bailing: Kemmerer
Bucket Bailer
: Other (Describe)

Pump On:
Pump Off:
Pumping Time:
Pumping Rate:
Gallons Removed:

Bailing Started:
Bailing Stopped:
Gallons Removed:

III Sampling
Withdrawal: Pumped (describe)
Bailed (describe)

Time: Date:
Sample I.D. #:
Trip Blank #:
No. of containers filled (primary lab):
No. of containers filled (replicate samples):
Physical appearance and odor:

Refrigerated: Date:
Time:

Field Tests (Before After Evacuation)
Temperature (°C/°F):
pH:
Spec Cond (umhos/cm):
Dissolved oxygen (mg/l):

Weather:

Comments:

FIGURE 1

Dames & Moore

30 Hazelton Avenue,
White Plains, New York 10605
(914) 761-6320
TWX: 710-569-6325

SAMPLE LOG NO. 316

DAY, MONTH, YEAR

Chain of Custody Record

REASON FOR SAMPLING

WITNESSES

COLLECTION PROCEDURE

METHOD OF PRESERVATION

REMARKS:

COLLECTED BY

PRINTED NAME	UNIT	PURPOSE OF TRANSFER
SIGNATURE X	TIME AND DATE	

CUSTODY TRANSFERRED TO

PRINTED NAME	UNIT	PURPOSE OF TRANSFER
SIGNATURE X	TIME AND DATE	

CUSTODY TRANSFERRED TO

PRINTED NAME	UNIT	PURPOSE OF TRANSFER
SIGNATURE X	TIME AND DATE	

CUSTODY TRANSFERRED TO

PRINTED NAME	UNIT	PURPOSE OF TRANSFER
SIGNATURE X	TIME AND DATE	

RECEIVED IN LABORATORY BY

PRINTED NAME	UNIT	PURPOSE OF TRANSFER
SIGNATURE X	TIME AND DATE	

STORED IN BY

PRINTED NAME	UNIT	ACCESSION NO.
SIGNATURE X	TIME AND DATE	63

FIGURE 2

ATTACHMENT 1

HOWARD LABS QA/QC PROGRAM

HOWARD LABORATORIES. INC.
Quality Assurance/Quality Control Program

INTRODUCTION: The Quality Assurance/Quality Control Program (QA/QC) utilized by Howard Laboratories, Inc., is a comprehensive program which utilizes the same concept in each of the different departments within the lab. Each department, however, differs in their QC portion due to the different parameters analyzed in each of the different departments.

Basically, the QA program insures that the chemicals utilized for different standards are consistent and correct within strict limitations. All standards are prepared or purchased such that at least two different sources of standards are utilized to insure the precision of the standard(s) utilized in all analyses. Due to the vast number of parameters which are determined by HLI, not all standards are directly tracable to NBS standards or US EPA standards. All standards which are available from regulatory agencies are utilized within the QA program to insure precision in preparation and control of internally prepared or externally purchased standards. All standards are stored per regulatory recommendations, or where no such recommendations exist, storage has been limited to insure reliability. Further, instruments utilized in the analysis at HLI are calibrated continuously, not just on a day-to-day basis, but throughout the day and throughout the analytical run. These instruments are all state-of-the-art and are automated to reduce human error. Most instruments are controlled by computers. Calibration of these instruments includes the recommendations by the manufacturer and/or regulatory agencies.

The QC program consists of utilizing the standards described above, calibration of instruments on a multi-level calibration curve within a linear range of the instrument being utilized and comparing this response to previous calibration curves and standards. Due to the different departmental requirements, all samples and/or standards are analyzed in at least duplicate. Many are run in triplicate.

For example, the AA Department for metals determines all metals in triplicate. The MS department determines all samples in duplicate and some in quadruplicate, as required by the parameter. Each department has determined the specific acceptance criteria for each parameter. These acceptance criteria have been determined to be those recommended by regulatory agencies where applicable. Where regulatory agencies do not recommend an acceptance criteria, HLI has determined its own acceptance criteria based upon three levels of QC. These include percent recovery of spiked samples, reproducibility of replicate analyses and recovery of known standards. The following are specific QC/QA criteria:

WET CHEMISTRY -

pH	Instrument standardized three to four times daily with commercially purchased buffer standards plus HLI Stds.
Residue	Precision and accuracy data are not applicable to these tests. However, periodic replicates of samples are run for evaluation purposes.
Color	No precision or accuracy data are applicable to this test. Color standards are prepared according to Standard Methods, 15'th edition, method 204.A.
Fecal Coliform	3 dilutions per sample set are employed. Quarterly count comparisons are performed. Records are kept for incubator temperature, pH, autoclave use, and water suitability.
Bromide	One quality control sample per five samples analyzed. Acceptable limits are +/- 10% of true value.
Chloride	One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
1 - 10 mg/L	+/- 15

10 - 50	+/- 10
50 - 125	+/- 5

Cyanides

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.005 - 0.050 mg/L	+/- 20
0.050 - 0.300	+/- 10

Fluorides

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.02 - 0.05 mg/L	+/- 20
0.05 - 2.00	+/- 10

Ammonia

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.250 mg/L	+/- 20
0.250 -25.000	+/- 10

TKN

One quality control sample per five samplea analyzed. Acceptable limits:

Conc. Range	% True Value
0.10 - 0.25 mg/L	+/- 20
0.25 - 25.00	+/- 10

Nitrate/ Nitrite

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.250 mg/L	+/- 20
0.250 -25.000	+/- 10

Phosphorus

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.500 mg/L	+/- 20
0.500 - 2.000	+/- 10

Sulfate

One quality control sample per five samples analyzed. Acceptable limits not established by US. EPA.

COD	One quality control sample per five samples analyzed. Acceptable limits: Low level +/- 20% High level +/- 10%
BOD	Controls, blanks and standards run with each lot. Acceptable limits: +/- 10% of True Value
PHENOLS	One quality control sample per five samples analyzed. Acceptable limits: Conc. Range % True Value 0.005 - 0.050 mg/L +/- 20% 0.050 - 0.250 +/- 10%

METALS

Three levels of quality control samples are employed over the linear working range of the parameter. One entire series is run with each lot analysis. Acceptable limits:

Furnace range	+/- 20%
Flame range	+/- 10%

One calibration check sample is performed every sixth analysis to verify calibration curve. Acceptable range:

Furnace	+/- 20%
Flame	+/- 10%

Out of limit condition requires re-standardization of instrument.

Exceptions -

Mercury - One quality control check every nine samples. Acceptable limits +/- 20% of true value. Analysis of all samples run in triplicate.

Arsenic & Selenium - Three levels of quality control are run twice per lot analysis. Acceptable results are +/- 20%. All analysis are run with spike. Acceptable limits of recovery +/- 20%

In addition to the above procedures, samples analyzed for

EP Toxicity are run by the method of additions, which entails running each sample at three levels of spike addition. The results of expected versus observed values are calculated in a linear regression analysis, and the slope of the line expressed as a percent. Acceptable limits are between the values of 80 to 120 % for all EP Toxic metals.

ORGANIC ANALYSIS

Standards are maintained in groups for purgibles, acid extractable, base/neutral, and pesticide/PCB's. These groups are subdivided into lower groups to facilitate identification and reduce costs in standard preparation.

The quality control procedures listed in the December 3, 1979 Federal register are utilized to maintain instrument specifications. These procedures utilize deuterated anthracene and purgibles not on the priority pollutant list. In addition Howard Laboratories utilizes the following procedures to further improve upon detection limits and quality control:

1. Each sample is duplicated where required
2. A standard of known value is analyzed at least every ten samples along with a blank
3. In the case of PCB's, quantitation is duplicated on a second column.
4. Acceptable limits of recovery must meet the following:

   a. Recovery of known standards:

      80% at a level 5 times the detection limit
      50% at a level 2 times the detection limit

   b. Recovery of spike values:

      80% at a level 5 times the detection limit
      50% at a level 2 times the detection limit

   NOTE: PCB analysis have more stringent requirements.

PCB ANALYSIS

a. Recovery of known standards:

1. Aqueous standards -

0.01 - 0.05	+/- 0.005
0.05 - 0.50	+/- 0.01
0.50 - 5.00	+/- 0.05
Above 5.00	+/- 0.50

2. Oil standards -

Below 1.00	as appropriate
1.0 - 10.0	+/- 0.2 to +/- 2.0
10.0 - 50.0	+/- 2.0 to +/- 5.0
50.0 -500.0	+/- 5.0 to +/- 50.0
Above 500.0	as appropriate

b. Recovery of Spike values:

1. Aqueous -

0.01 - 0.05	>50%
0.05 - 0.50	>80%
0.50 - 5.00	>80%
Below 1.0	as appropriate
1.0 - 10.0	20%
10.0 - 50.0	10 to 20%
50.0 -500.0	10%
Above 500.0	10%

Duplication of samples

Duplicate samples must be reproducible at the same dilution by the following factors:

1. Aqueous -

0.01 - 0.05	+/- 0.005 - 0.01
0.05 - 0.50	+/- 0.01 - 0.05
0.50 - 5.00	+/- 0.05 - 0.10
Above 5.00	+/- 0.10

2. Oils -

Below 1.0	as appropriate
1.0 - 10.0	+/- 0.2 to 1.0
10.0 - 50.0	+/- 1.0 to 5.0
50.0 -500.0	+/- 5.0 to 50.0
Above 500.0	+/- 50.0 for each 500.0

GCSCAN ANALYSES:

GCSCAN is a code for multiple analyses utilizing gas chromatography along with a specified methodology. That methodology may be ASTM, EPA, NIOSH, AOAC or other method widely recognized in the analytical field. The specific method is specified with the results when applicable. The same QA/QC is provided as for PCBs and when peaks cannot be identified, QC/MS is utilized. Quantitation is by GC using multiple level calibration.

GCMS ANALYSES:

GCMS is a code for multiple methods of analyses utilizing a gas chromatograph equipped with mass spectrometer detector. This method identifies compounds and quantitates the same with external or internal standards, as appropriate. Specific methods will be specified when such methods are recognized by the scientific community or regulatory agencies. Since not all procedures are specified, the use of GCMS for organic analyses will be performed by an academically trained analyst with experience in the application of GC and ability to interpret data which may not be found on NBS or other recognized spectral libraries. The operation of GCMS will be under the direct supervision of a Ph.D.

PRIORITY POLLUTANT ANALYSES:

Priority pollutants, TTO's or fractions of these compounds will be by the method described in the December 3, 1979 Federal Register. Exact specifications for all parameters will be by protocol. QA includes recovery of spiked samples, reproducibility of the same sample, duplicate standards and at least one other source of comparison standards derived from the US EPA, NBS, or other recognized source.

Base Neutral Fraction: Method 1625 (capillary column use of Method 625) will be utilized. Internal standards will include D-10 Anthracene or D-10 Phenanthrene, with other recognized internal standards to determine retention times,

insure proper spectral retrival and maintain quality control on the internal standards themselves. Quantitation will be based upon each individual parameter and not grouped or quantitated based upon area of a known amount of internal standard. The charge/mass ratio of the internal standards is not the same for the internal standards as it is for the compounds in question; therefore internal standards will be utilized to determine recovery while quantitation will be based upon known standards when recoveries have been met satisfactorily.

Acid Fraction: Method 1625 will be utilized and the same information as that utilized for Base Neutrals will be followed.

Volatile Fraction: Method 1624, utilizing cryogenic purge and trap will be utilized for the volatile parameters. The entire system is automated to reduce human error, and each sample group will be spiked to determine recovery and acceptability of the data. We have found that Method 624, which utilizes a packed column will not satisfactorily quantitate the very volatile purgibles, and for that reason, have chosen to use liquid nitrogen trap to collect the sample. This method also allows the detection of more compounds than that listed in the volatile fraction.

Pesticide/PCB Fraction: GC/ECD will be utilized to screen the Pesticide/PCB (PESTPP) fraction, utilizing US EPA Method 608. This method is more than 10 times as sensitive as the GC/MS method. If compounds are detected, GC/MS analyses are utilized to identify such compounds. Quantitation will be by GC.

Special Parameters: Although the above methods are recognized for all priority pollutant parameters, the detection limits for certain of these parameters is quite high (e.g. 2,3,7,8-Dioxin). The recommended US EPA procedure of utilizing GC for screening of this parameter will be utilized.

8000 SERIES METHODS:

SW 846 Manual covers the analyses of hazardous wastes. The methods cited in SW 846 for organic analyses have not been approved by US EPA but are only recommended at this time. This firm has spent many weeks performing such analyses and in determining recoveries of each of the parameters under the 8000 series recommended procedures. We have been unsuccessful in finding 13 of the compounds for standards. All others are available. We have further modified (added to) the methods of analyses in SW 846 to better determine certain parameters. These methods are being prepared to submit to US EPA for their information. Certain methods of preparation have been reversed in addition to normal extraction procedures. For example, base neutral/acid fraction normally requires the base fraction be extracted first, then the acid fraction. In addition to this normal method, we include the acid extraction first followed by base neutral. This allows confirmation of certain organic salts by GCMS which are not normally capable of being analyzed by GC or GC/MS.

SUMMARY:

This firm maintains all of the equipment listed for US EPA methods. This includes GC/MS, GC, HPLC and all of the special detectors required for these analyses. Further, we maintain automatic equipment which operates on a 24 hour basis, 7 days per week. Such automation and continued operation have proven to provide better data (free of human error) and better operation of equipment. We have found that startup and shutdown of equipment promotes poor operation of the equipment and causes greater problems in stability of that equipment.

Organic analyses are conducted by protocol where recommended protocol exists. Otherwise, scientifically recognized procedures are utilized for such analyses. All organic analyses are performed under the direction of a Ph.D., with many years of experience, and well over 100,000 analyses.

Data is provided on formats utilizing the largest laboratory data management system available. Such data

is stored on 9 track mag tapes and archived per US EPA requirements.

Specific questions concerning these methods and data should be directed to the Laboratory Director.