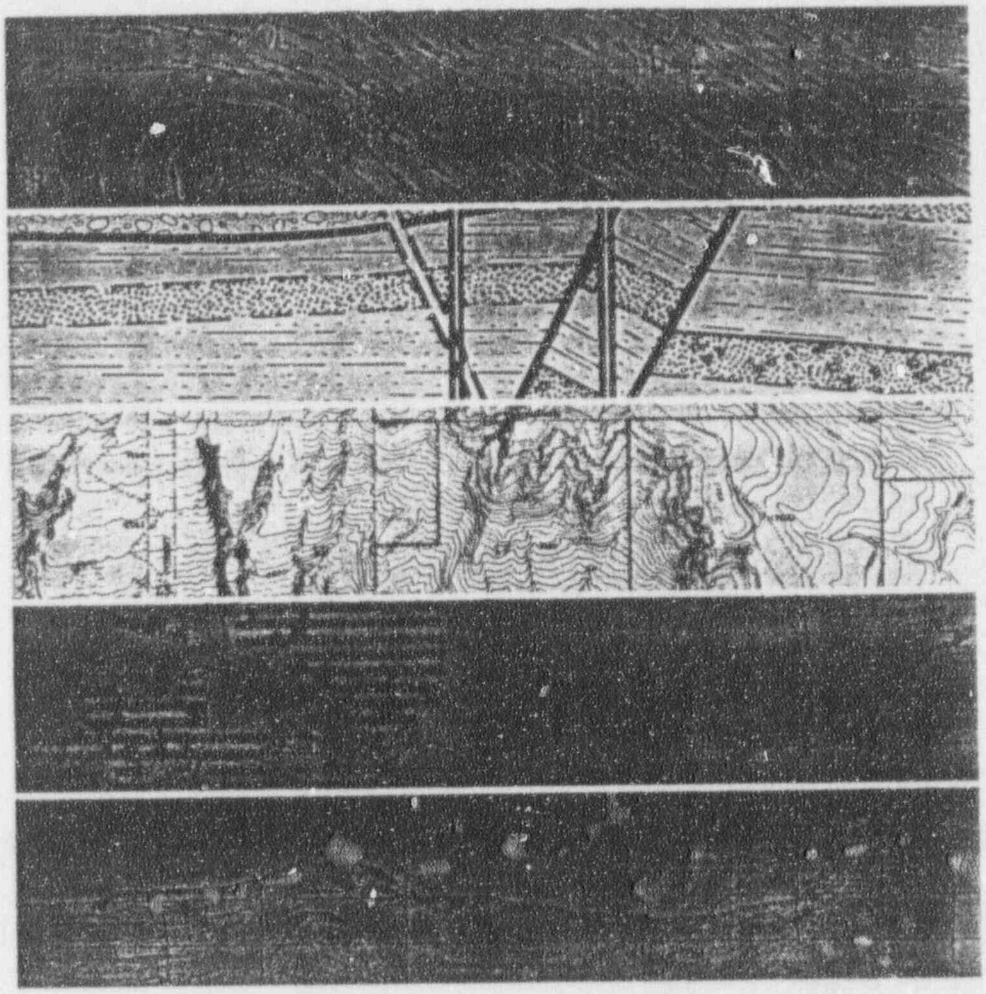

DRAFT LICENSE APPLICATION

ON-SITE THORIUM DISPOSAL AT THE

SALZBURG LANDFILL, MIDLAND, MICHIGAN

JANUARY 12, 1988

Dames & Moore

A/1

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1.0 SUMMARY OF PROPOSED ACTIVITIES

The Dow Chemical U.S.A. (Dow) is seeking the permission of the United States Nuclear Regulatory Commission (NRC) to dispose of limited quantities of radioactive material at a Dow facility near Midland, Michigan. Dow has decided to apply, under the provision of 10 CFR Part 20.302, to dispose of the material at a Dow owned and operated EPA/DNR licensed disposal area, the Salzburg landfill. Materials to be disposed are currently located at two nearby Dow facilities, referred to as the Midland and Bay City sites.

The proposed actions required to dispose of the thorium material include excavating the material at the Bay City and Midland sites to residual concentrations of less than 10 pCi/g of thorium-232 above background. This will allow the sites to be released for unrestricted use. The material will then be transported to the Salzburg Landfill, and disposed of in a cell meeting hazardous waste landfill design criteria. The disposal cell will be dedicated to the disposal of thorium contaminated material.

During excavation, health physics monitoring of personnel will be performed in accordance with applicable regulations. Dust suppression using water or other techniques will be employed on an as needed basis. Monitoring for potential airborne releases will be performed. However, due to the lack of residences near either site the potential for public exposures is minimal. Previous monitoring of earthmoving activities on the slag piles indicated airborne radiation levels to be well below Maximum Permissible Concentrations (MPC's).

Transportation from the two sites to Salzburg will be by truck. The trucks will be covered with tarpaulins to minimize dust releases during transportation. Monitoring of trucks for external contamination will be performed before they are allowed to leave any of the three sites.

The material will be placed in the disposal cell and compacted. Once all the material has been relocated to Salzburg, any portion of the cell remaining empty will be filled with non-hazardous fill to provide an added buffer between the top of the wastes and the environment.

It is expected that the proposed action could be completed within a one year period following NRC approval. The bulk of the thorium wastes can be moved to the Salzburg facility in approximately 1 month.

After closure, Dow expects that their license for the storage of the thorium-bearing material will be terminated.

2.0 JUSTIFICATION OF THE ON-SITE DISPOSAL ALTERNATIVE

Six alternative disposition schemes were investigated leading to the decision to proceed with an on-site disposal license application. These are:

- No Action
- Disposal at an existing commercial LLRW disposal site
- On-site temporary storage followed by off-site permanent disposal at a future commercial LLRW disposal site
- On-site disposal under 10 CFR Part 61
- Treatment of slag and soil by reprocessing to recover the thorium and then dispose of the residual wastes.
- On-site permanent disposal under 10 CFR Part 20.302 (the preferred alternative)

The advantages and disadvantage of these alternatives are briefly described below.

2.1 NO ACTION ALTERNATIVE

The no action alternative consists of maintaining the current status of the magnesium-thorium slag piles as continued long term storage with appropriate monitoring and maintenance.

Advantages

The primary advantage of the no action alternative is its low cost. The continued monitoring of ground and surface waters and long term maintenance of the caps on the slag piles would not require major allocation of resources beyond that required to maintain the other Dow facilities in the area. In addition, leaving the material in place minimizes the potential for increased occupational exposures during remediation and removal in the short term.

Disadvantages

The primary disadvantage of the no action alternative is its unacceptability as a long term solution under the NRC's guidance provided in SECY 81-576, for either the Bay City Site or the Midland site. Under SECY 81-576, the activity of most of the material would dictate excavation and reburial at another site and imposition of institutional constraints on future uses of the sites. The requirements for closure of the Midland Diversion Basin, a RCRA licensed facility adjacent to the Midland slag pile, necessitates slag pile removal from Midland within the next year.

The regulators, the public, and Dow are all apparently in agreement that the no action alternative is not an acceptable option, and it has been considered only to serve as a base case.

2.2 DISPOSAL AT AN EXISTING COMMERCIAL LLRW DISPOSAL SITE

This alternative consists of removing the material from both sites and transporting it off-site for disposal at one of the three LLRW disposal sites which are currently operating.

Advantages

This alternative complies with the currently accepted NRC requirements and would therefore not require NRC review and approval. Public and regulatory concern over ultimate disposition of the thorium bearing material would be alleviated.

Disadvantages

The primary disadvantages of proceeding with this alternative are high cost and uncertainty over waste acceptability. With the large volume of material involved, the cost associated with disposal at one of the currently operating LLRW disposal sites would be approximately $30,000,000. A cost estimate is provided in Appendix A. Additionally, there is some uncertainty over whether any of the sites would accept such a large volume of soil with such a low specific activity.

The three operating commercial burial sites are licensed to accept waste classified as Class A waste such as the slag. However, the Barnwell, South Carolina facility is operated under a set of burial practices which may exclude the slag. Recent experience has shown that the commercial burial sites and their host states are reluctant to accept high volume, low activity Class A material like the slag, primarily because it uses part of the limited amount of burial volume remaining at the site when it would be more profitable, and in the national interest, to reserve the available burial volume for higher activity waste. This situation is likely to persist until a number of other commercial sites have been developed under the compact programs thus substantially increasing the available burial space. A recent example tends to confirm this situation. The States of Nevada and Washington have prevented shipment of radium-contaminated waste from New Jersey to the Beatty or Richland sites run by U.S. Ecology. In a conversation on 6/24/87, with Dames & Moore, U.S. Ecology indicated that the radium shipment was refused because it was not licensed source material. However, U.S. Ecology also indicates that their burial facilities would accept Class A material processed under license (such as the slag) with special cost schedules imposed.

2.3 TEMPORARY STORAGE AND DISPOSAL AT A NEW COMMERCIAL LLRW DISPOSAL SITE

This alternative consists of maintaining the current status of the magnesium-thorium slag piles until the compact's LLRW disposal facility is available. Then, the waste would be excavated, removed, and shipped to the new facility for disposal.

Advantages

The primary advantage of this alternative is its regulatory acceptability. The material would be disposed in a secure facility which will be licensed under 10 CFR Part 61. The long term environmental and public impacts at the two storage locations would be reduced to negligible levels, and public and regulatory concern over the ultimate disposition of the two storage locations would be alleviated.

Disadvantages

The two major disadvantages of this alternative are the uncertainty associated with the compact siting and licensing process, and the costs associated with disposal at a future commercial LLRW facility. Disposal of the material at a commercial facility requires maintaining the current status of the material storage areas for an uncertain time period (at least 5-7 years) until the compact's site selection, licensing, and development process is completed. Since the EPA's RCRA requirements for closure of the Midland Diversion Basin necessitate removal of the Midland thorium pile, this material would have to be moved to an interim storage location in order to avoid closure delays. Proceeding with this alternative is likely to be the most costly of those considered since disposal fees at a new compact facility would likely exceed those at currently operating sites.

In summary, this alternative is not attractive since, although it could meet the regulatory objectives, there would be an uncertain waiting period associated with the start up of a new compact disposal site and the cost of disposal would be very high.

2.4 TREATMENT BY PROCESSING FOR THORIUM RECOVERY

The treatment and recovery alternative consists of processing the slag and soil to recover the thorium and then disposing of the residual waste at a licensed commercial LLRW disposal facility.

Advantages

The primary advantage of the treatment and recovery alternative is that the waste remaining to be disposed would have a reduced thorium concentration.

Disadvantages

There are many disadvantages to proceeding with this option. First, a site for processing the thorium pile would have to be selected, licensed by NRC, and developed. NEPA requirements for this alternative would have to be fulfilled and may include an environmental assessment (EA) or even an environmental impact statement (EIS). Following processing, the residual waste would still require disposal and it is likely that the total volume would not be reduced. In addition, the recovered thorium, which has no current economic value, would contain concentrated activity potentially preventing its disposal as LLRW.

In summary, although this alternative is potentially viable, the added cost of developing and licensing a processing facility, which may not reduce the total volume of materials to be disposed of, and could produce a waste stream which would be difficult to dispose of, does not make it a logical choice.

2.5 ON-SITE DISPOSAL UNDER 10 CFR PART 61

This on-site disposal alternative consists of removing the thorium-bearing material from its existing locations and disposing this material in a Dow facility which meets 10 CFR Part 61 standards.

Advantages

The primary advantage of this alternative is that it would alleviate public and regulatory concern over disposal since the potential long term environmental and health impacts would be reduced to ALARA. There would be no need to acquire additional lands for this purpose assuming that the material could be disposed on land already owned by Dow. The facility could be sited to maximize the distance to potential receptor locations. In addition, the volume of waste requiring shipment off-site would be minimized.

Disadvantages

The primary disadvantage associated with this alternative is the uncertainty of timing. Site selection, characterization, licensing, and facility design and construction could take 6 - 8 years before material could be disposed at the new facility. This means that the material stored at the Midland sited would have to be removed to an interim storage location to satisfy the closure requirements of the Midland Diversion Basin. This would tend to increase costs and occupational exposures. Additionally, given the existence of a state LLRW siting initiative, it is unlikely that a second facility for the Dow thorium-bearing material would be allowed by the State of Michigan.

In summary, while this alternative is potentially technically viable, the uncertainty associated with the regulatory process and the need to relocate the material at the Midland site for a temporary period make this alternative unattractive.

2.6 ON-SITE PERMANENT DISPOSAL UNDER 10 CFR PART 20.302

This on-site disposal alternative consists of removing the thorium-bearing material from its present locations and disposing this material in a Dow facility under the provisions of 10 CFR Part 20.302. The proposed action entails disposal of the material at Dow's Salzburg Landfill in a cell meeting hazardous waste landfill design criteria. The disposal cell will be dedicated to the thorium-bearing material.

Advantages

The primary advantage of this alternative is that the site has already been licensed to operate and currently accepts hazardous wastes. Therefore site selection and characterization has already been completed and approved as part of the company's RCRA Part B and Michigan Act 64 permits to operate the Salzburg Landfill. Therefore, the regulatory process associated with a 20.302 application is estimated to take less than six months. This is an acceptable time period to accommodate closure of the Midland Diversion Basin, and the material stored at the Midland site may not require removal to another temporary location for an interim period. In addition, the public and regulatory concern over disposition of the material would be alleviated because the environmental and public health impacts would be minimized to ALARA standards. There would be no need to acquire additional lands for this purpose since the material would be disposed of at an operating facility already owned by Dow. In addition, the occupational exposures associated with this option would be minimized. In preliminary discussions with State and Federal officials, no major regulatory impediments to this preferred alternative have been identified.

Disadvantages

The primary disadvantage associated with this alternative is the fact that there is no precedent in which similar volumes of thorium bearing material have been disposed of under 10 CFR Part 20.302.

This alternative is the preferred choice since: 1) this option will meet occupational, environmental and public ALARA objectives; 2) projected costs are much lower than for off-site disposal; and 3) no major unsolved regulatory issues have been identified.

3.0 DESCRIPTION OF WASTE

The radioactive material being considered for disposal at Salzburg consists primarily of foundry slag containing low levels of thorium. This material was produced in the period from 1940 to 1970 as the residual from the production of magnesium-thorium alloy. This lightweight alloy was used for defense purposes, including aircraft engines and aeronautical structural components. The slag was originally stored, with plans of reclamation, on two Dow properties in Michigan. Some other thorium contaminated material from a third site was added to the Bay City pile in 1985, under NRC review.

A single license was originally granted by the NRC in 1973 for the two sites (Bay City and Midland) to store up to 200,000 pounds of thorium as slag. This license expired in 1978, but has remained in effect under timely renewal. Currently, Dow is proposing to combine the two slag piles at the Dow-owned Salzburg Landfill under the provisions of 10 CFR 20.302, allowing the current license to be terminated. The Salzburg Landfill is licensed by the Environmental Protection Agency (EPA) under the requirements of the Federal Resource Conservation and Recovery Act, and by the Michigan Department of Natural Resources (DNR), under the state Hazardous Waste Management Act, Public Act 64 and Act 641.

3.1 ISOTOPIC ACTIVITY

The material slated for disposal originally consisted of magnesium with up to two percent thorium. In its present state, portions of the process slag have been mixed with soil or limited amounts of construction debris; in addition, there has been some environmental dispersal at the Bay City site. As a result of this mixing, the thorium concentrations, as determined by Dow soil sampling, vary from 2 - 7000 pCi/g at the Bay City site, and from 2 - 2000 pCi/g at the Midland site. As summarized in Table 3.1-1, the total activity of 4.3 Ci of Th-232 is distributed through ~20,000 cubic yards of slag, soil, and construction debris.

TABLE 3.1-1

Thorium-232 Activity and Concentrations

	Bay City	Midland
Total Activity (Ci)	3.6	0.7
Volume (cubic yards)	9000 - 15000	3000 - 5000
Average Concentration (pCi/g)	260	150
Maximum Concentration (pCi/g)	7000	2000

Since the thorium bearing material has been in-place for over 20 years, it is assumed that the thorium-232 daughters are in equilibrium. Table 3.1-2 lists the thorium-232 decay chain.

3.2 NUMBER OF BURIALS

The disposal activity proposed under this application covers only the thorium contaminated material at the Dow facilities in Bay City and Midland, Michigan. Excavation of the piles and subsequent burial at Salzburg is viewed as a single disposal, even considering the volume of material (approximately 2000 truck loads).

Disposal Cell 37 at Salzburg, designated to receive the thorium bearing material, will not accept any radioactive waste other than the cited piles from Bay City and Midland. Cell capping will begin upon completion of the disposal operations.

3.3 WASTE VOLUME

The material intended for disposal is presently in two locations. Over time, portions of the material have been mixed with clean soil and, at the Bay City site, with limited amounts of thorium-contaminated construction debris.

At Bay City, it is estimated that there is a total of up to 15,000 cubic yards of material with thorium concentrations above 10 pCi/g, including soil and construction debris. The average activity is estimated to be about 260 pCi/g of thorium-232, with a range of 2 to 7000 pCi/g. The total activity is estimated to be about 3.6 Ci.

At the Midland site, the total volume of thorium-bearing material is estimated to be a total of 3000-5000 cubic yards of thorium containing materials. Total thorium-232 inventory is about 0.7 Ci, with an average activity estimated at 150 pCi/g, in a range of 2 to 2000 pCi/g.

The total volume to be disposed of is approximately 20,000 cubic yards, with a total thorium-232 inventory of approximately 4.3 Ci.

Table 3.1-2
Thorium Decay Scheme

Element	Atomic Weight	Half-life	Radiation
Thorium	232	1.4×10^{10} yr	Alpha
Radium	228	6.7 yr	Beta
Actinium	228	6.13 hr	Beta
Thorium	228	1.9 yr	Alpha
Radium	224	3.64 days	Alpha
Radon	220	54.5 sec.	Alpha
Polonium	216	0.14 sec.	Alpha
Lead	212	10.6 hrs.	Beta
Bismuth	212	60.5 min.	Alpha Beta
Polonium	212	10 sec.	Alpha
Thallium	208	3.1 min.	Beta
Lead	208	Stable	

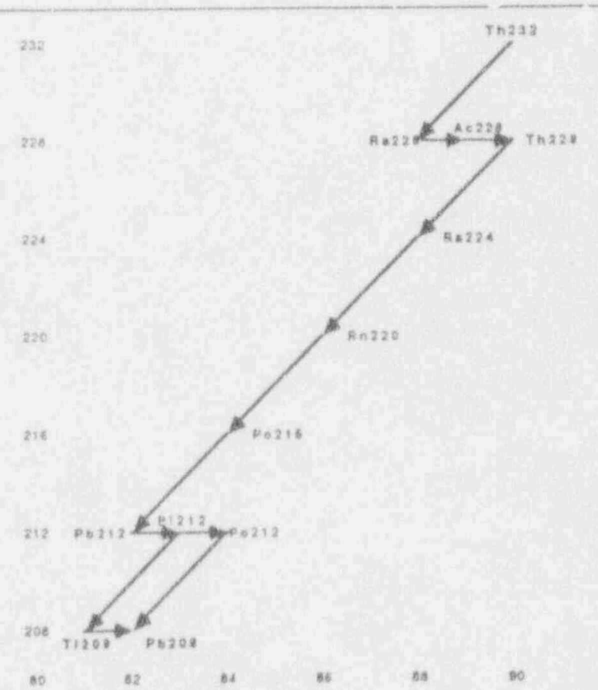


FIGURE 3.1-1

THORIUM DECAY SCHEME

3.4 WASTE FORM

The material originally consisted of magnesium with up to two percent thorium. In its present state, portions of the material have been mixed with soil or limited amounts of construction debris. The slag is a soil-like material.

The construction debris is found only at the Bay City site and also contains thorium. The debris came from the Wellman, Michigan site which was previously decontaminated. That decontamination program was completed under NRC review in 1985. The construction debris consists primarily of masonry with very limited amounts of organic material (wood).

3.5 CHELATING AGENTS

Material to be disposed of under this application consists of thorium-contaminated slag, soil, and construction debris. No chelating agents are known or suspected of having been used, nor will any be used in conjunction with the waste disposal.

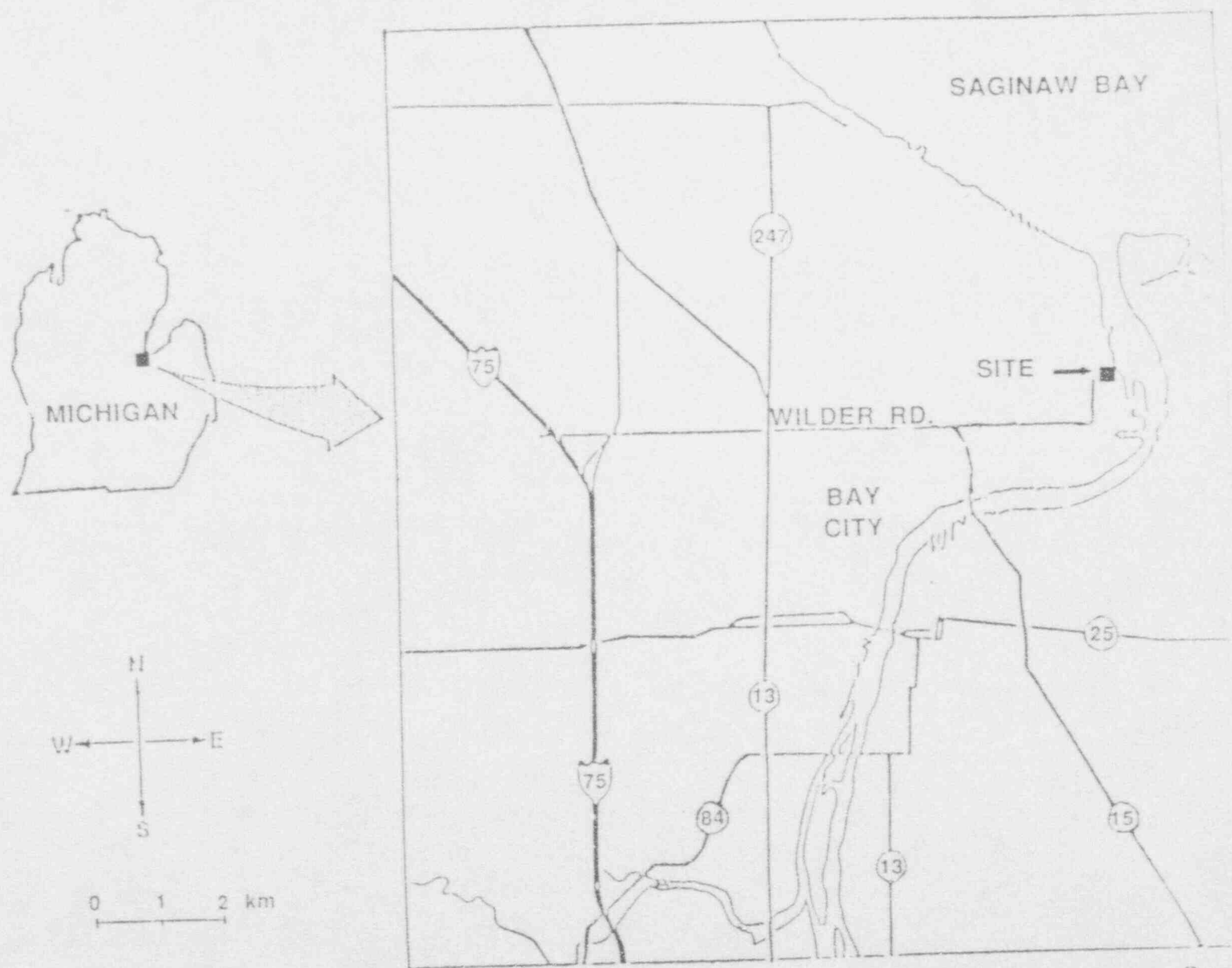
3.6 PROHIBITION OF HAZARDOUS WASTE

It is acknowledged that burial of waste defined as hazardous under the regulations of the Environmental Protection Agency, 40 CFR Parts 260 through 265, is not appropriate under 20.302. The radioactive material slated for disposal under this application is not characterized as hazardous. However, the proposed disposal facility is within a landfill sited, designed, constructed, and permitted for disposal of hazardous waste.

3.7 EXISTING STORAGE AREAS

3.7.1 Bay City Site

The Bay City site is located near the town of Bay City, Michigan. The site is on property owned by Dow Chemical U.S.A. about one mile south of Saginaw Bay. Figure 3.7-1 shows the site location. The site is about 20 miles east of the Salzburg facility.



MAP OF MICHIGAN AND BAY CITY

Dames & Moore
FIGURE 3.7-1

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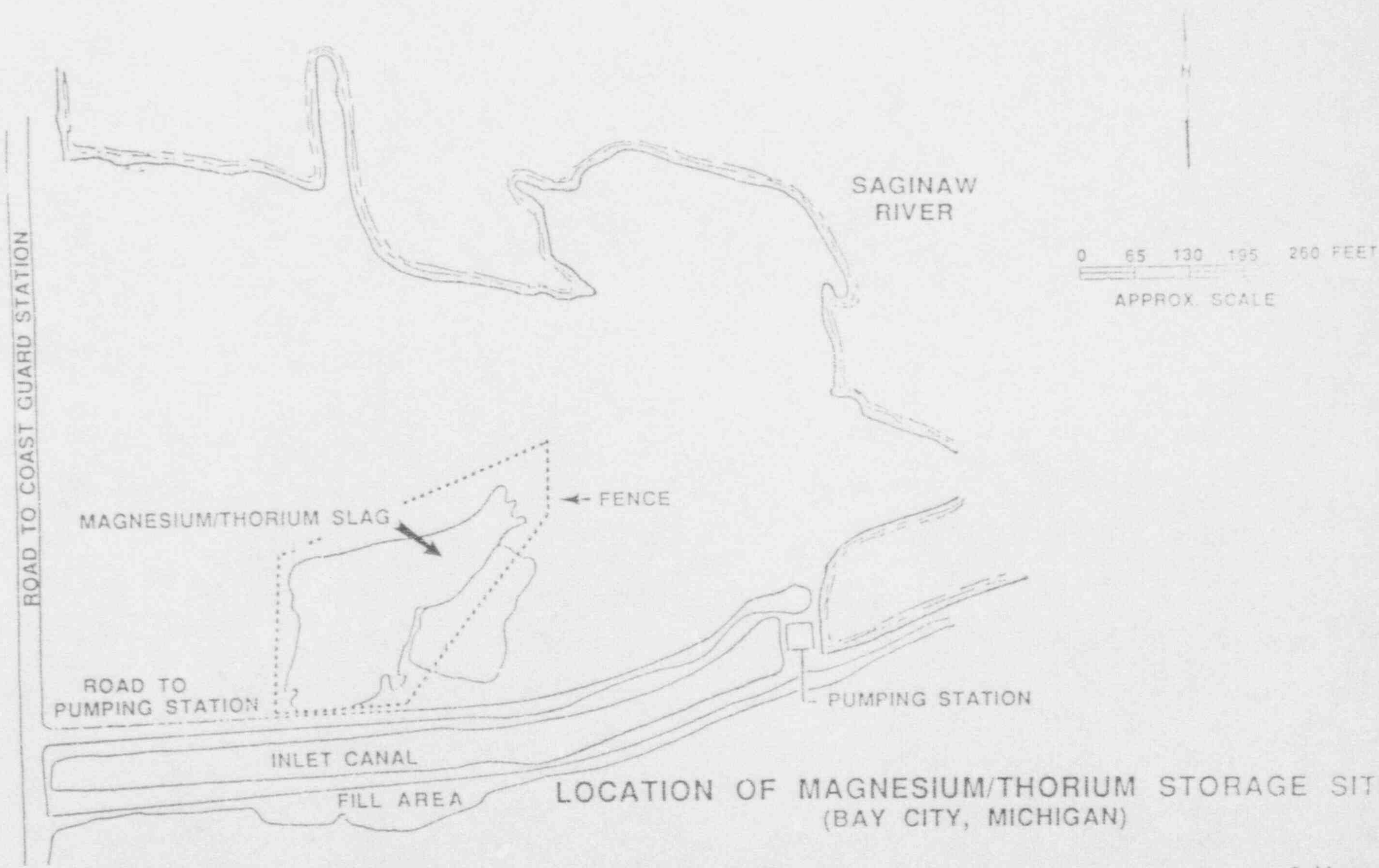

LOCATION OF MAGNESIUM/THORIUM STORAGE SITE
(BAY CITY, MICHIGAN)

Dames & Moore

FIGURE 3.7-2

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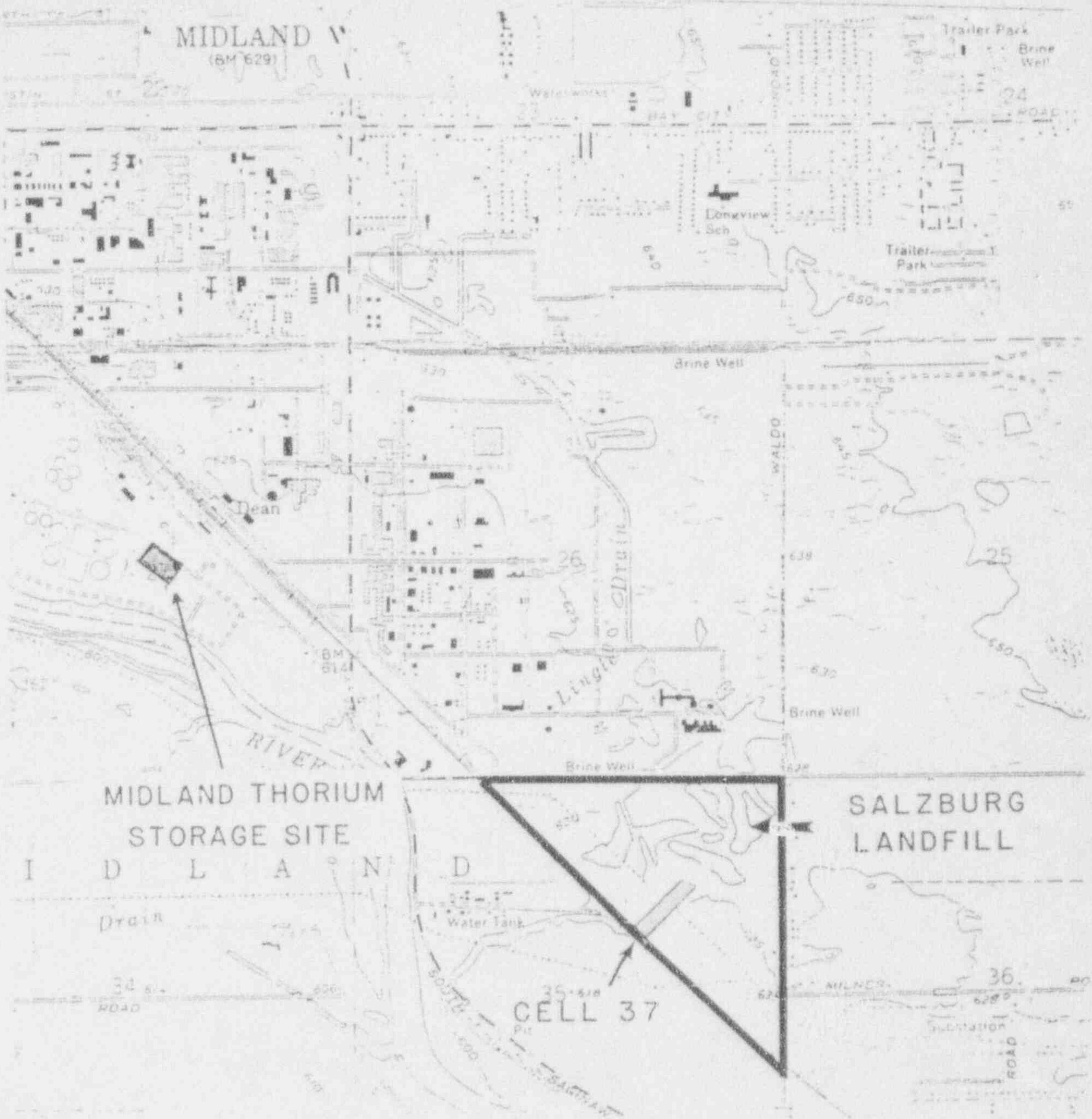


MIDLAND THORIUM STORAGE SITE LOCATION

Dames & Moore
FIGURE 3.7-3

The magnesium-thorium material is located adjacent to and north of an inlet canal, which enters the Saginaw River to the east. The Saginaw River, as shown on Figure 3.7-2, is located to the north and east of the material. The closest approach of the river to the material is about 200 feet.

The area surrounding the material is relatively level, with some marshy areas and ponds. The material sits approximately 5 to 10 feet above the water level in the inlet canal.

Most of the thorium activity in the material is contained within the fenced area shown on Figure 3.7-2. However, soil sampling conducted by Dow has shown that some thorium-containing material is also present to the north and west of the pile.

The Bay City material is currently partially covered with an asphaltic sealant. However, the cover contains cracks and has weathered, and is probably no longer impervious.

3.7.2 Midland Site

The Midland thorium storage site is located at Dow's Midland, Michigan manufacturing facility. The thorium material is located near a RCRA licensed surface impoundment previously used in waste water treatment. The Midland and Salzburg sites are shown on Figure 3.7-3.

Dow is currently in the process of closing the surface impoundment. The EPA and the DNR have approved a closure plan for the facility. In order to comply with the RCRA requirements, Dow must relocate the thorium contaminated material, since the material is adjacent to the surface impoundment and in an area where construction is required to comply with the closure design.

Surrounding the thorium storage site is the Midland manufacturing facility. The entire Midland facility is fenced, with access restricted to authorized personnel. The material is posted as a radiation control area and marked off with rope. This facility is about 1.5 miles from the Salzburg facility.

The material was covered with a clay cap in 1983. The cap averages about 1 to 2 feet thick with light vegetative cover.

4.0 PACKAGING OF WASTE

The applicant does not intend to package the thorium-bearing material prior to emplacement. The bulk nature of the material would lead to extra occupational radiation exposures during packaging that can be avoided by direct emplacement.

Bulk disposal of the material avoids creation of voids in the landfill which could ultimately lead to subsidence. Since the thorium contaminated materials are soil and soil-like slag, they can be compacted, a procedure which will minimize subsidence. If the slag and soil were placed in drums prior to disposal, a higher degree of subsidence would occur since the drums could not be filled 100%, the soil in the drums could not be compacted, and the space between canisters, even if backfilled with clean sand, would provide some additional space for subsidence. These negative factors would adversely effect cover performance. Therefore, no packaging is proposed.

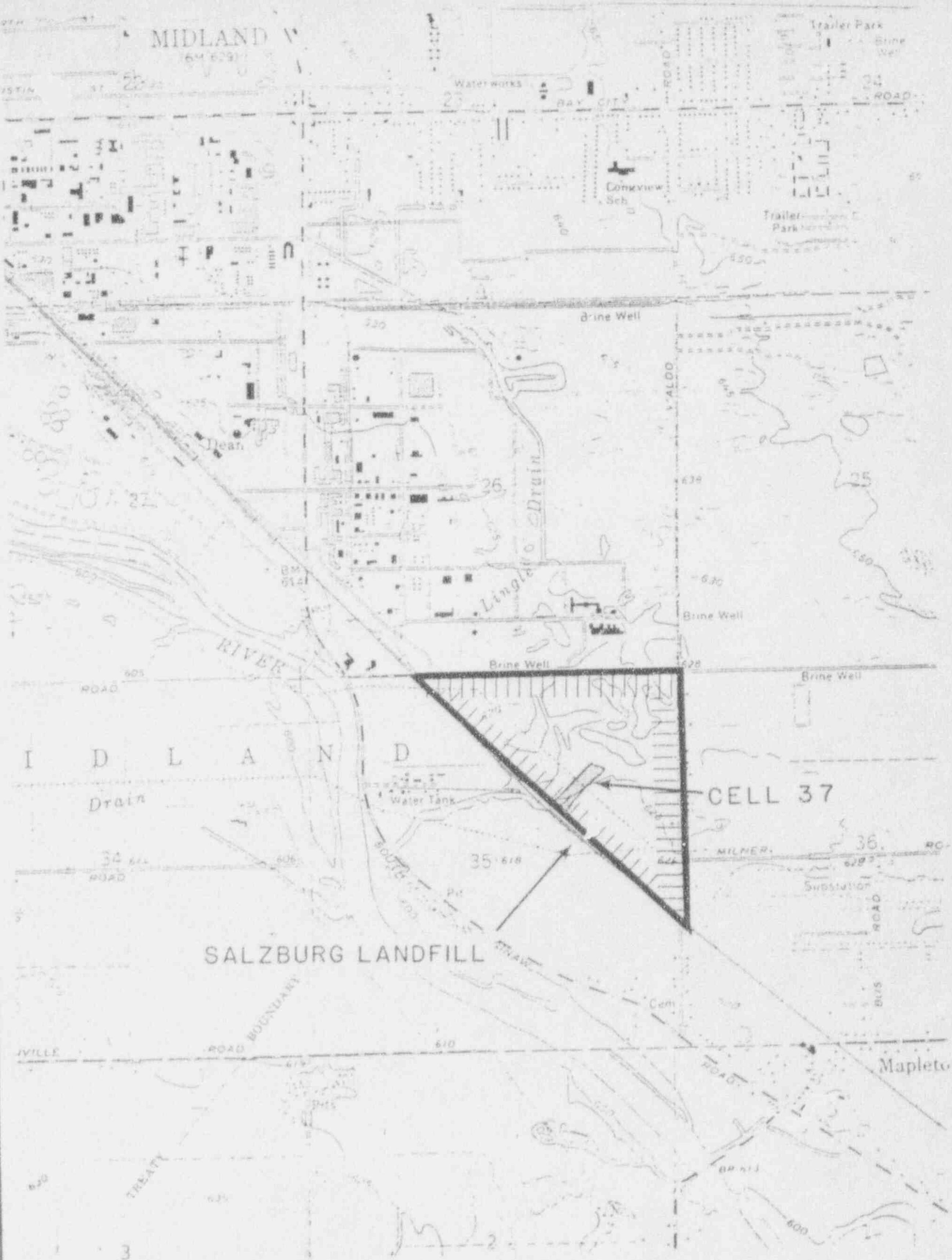
Thus, by foregoing packaging, the radiation exposure is lessened due to the reduction in handling; the integrity of the disposal site is more fully guaranteed; and an overall cost savings is realized.

5.0 BURIAL LOCATION

5.1 SITE LOCATION

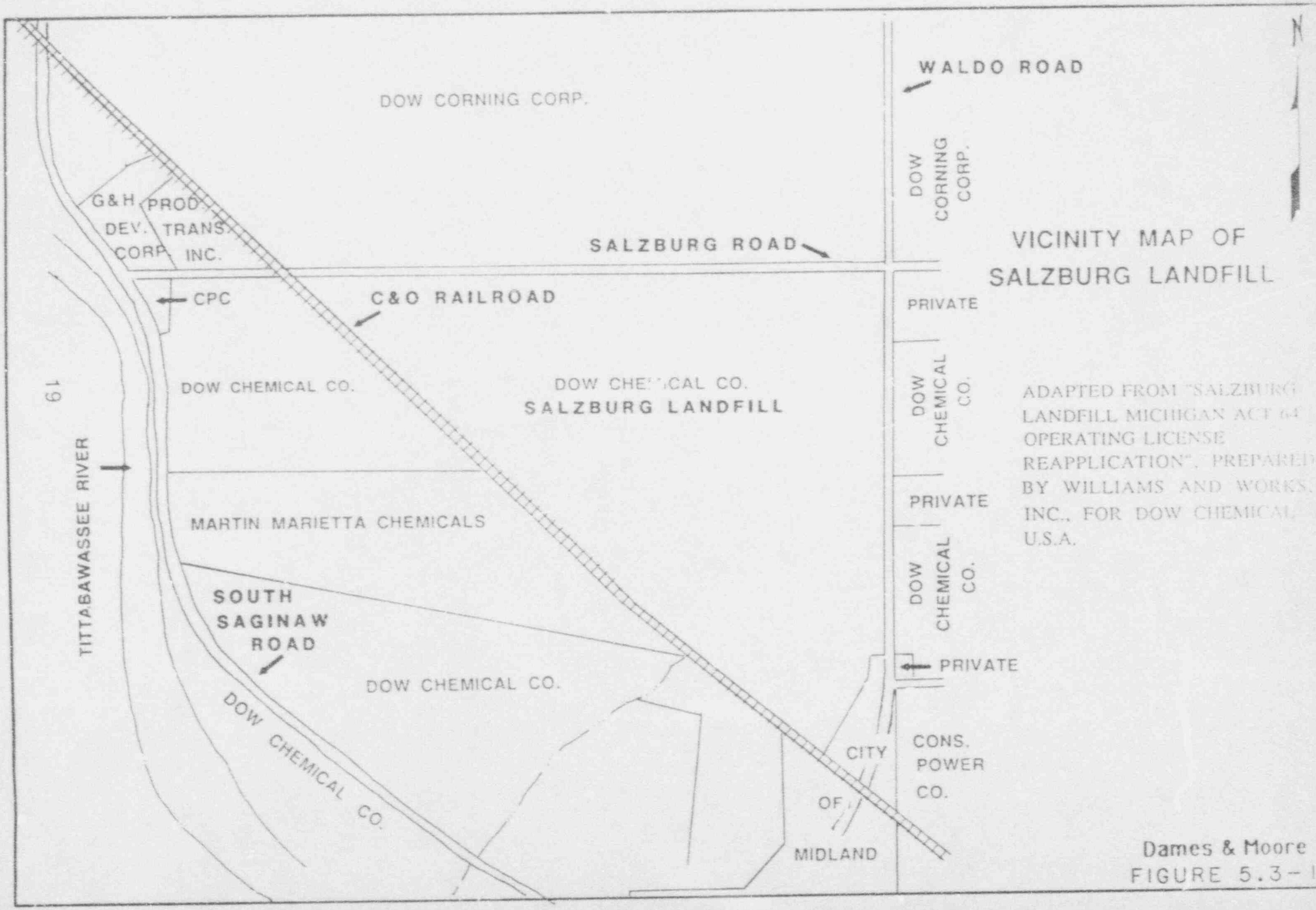
Dow proposes to place the contaminated material in Cell 37 of the Salzburg Landfill, a Dow owned and operated facility licensed by the U.S. EPA and Michigan DNR for disposal of both hazardous and non-hazardous waste. It accepts only wastes produced by Dow operations.

The Salzburg Landfill is located in the southeast portion of the City of Midland, Michigan, as indicated in Figure 5.1-1. The landfill is approximately 1.5 miles from the Midland thorium storage area, and about 20 miles from the Bay City site.



SALZBURG LANDFILL LOCATION

Dames & Moore
FIGURE 5.1-1



VICINITY MAP OF SALZBURG LANDFILL

ADAPTED FROM "SALZBURG LANDFILL MICHIGAN ACT 64 OPERATING LICENSE REAPPLICATION", PREPARED BY WILLIAMS AND WORKS, INC., FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 5.3-1

The thorium wastes will be placed only in Cell 37 of the Salzburg Landfill. The Cell location is also shown on Figure 5.1-1. The Salzburg Landfill site map in the upper right hand corner of drawing B2-001-22 of Appendix G, attached, shows the locations of the other burial cells in relation to Cell 37.

5.2 PROPERTY USES

The Salzburg Landfill is located on a 152 acre parcel of land owned by Dow Chemical Company. The only activity performed on-site is a state-of-the-art hazardous and non-hazardous waste disposal facility operated by the Michigan Division of Dow Chemical, U.S.A.

Operation of the landfill is regulated at the state level by the DNR under the Hazardous Waste Management Act, Public Act 64 and Act 641. On the Federal level, it is an EPA-licensed facility which exceeds the requirements of the Resource Conservation and Recovery Act (RCRA).

The facility is designed for disposal of the Dow Chemical U.S.A., Michigan Division, Midland location's incinerator ash, waste water treatment plant solids, and other solid production and demolition waste. Liquid wastes are not disposed at Salzburg.

The facility is a hazardous waste and non-hazardous waste co-disposal facility with each of these types of materials in separate cells. Included at the facility are landfill cells, and buildings containing a vehicle wash, spare parts, utilities, lunch room, locker room, and office.

The landfill was recognized by the National Society of Professional Engineers as one of the top ten outstanding engineering achievements of 1985.

5.3 NEIGHBORING ENVIRONS

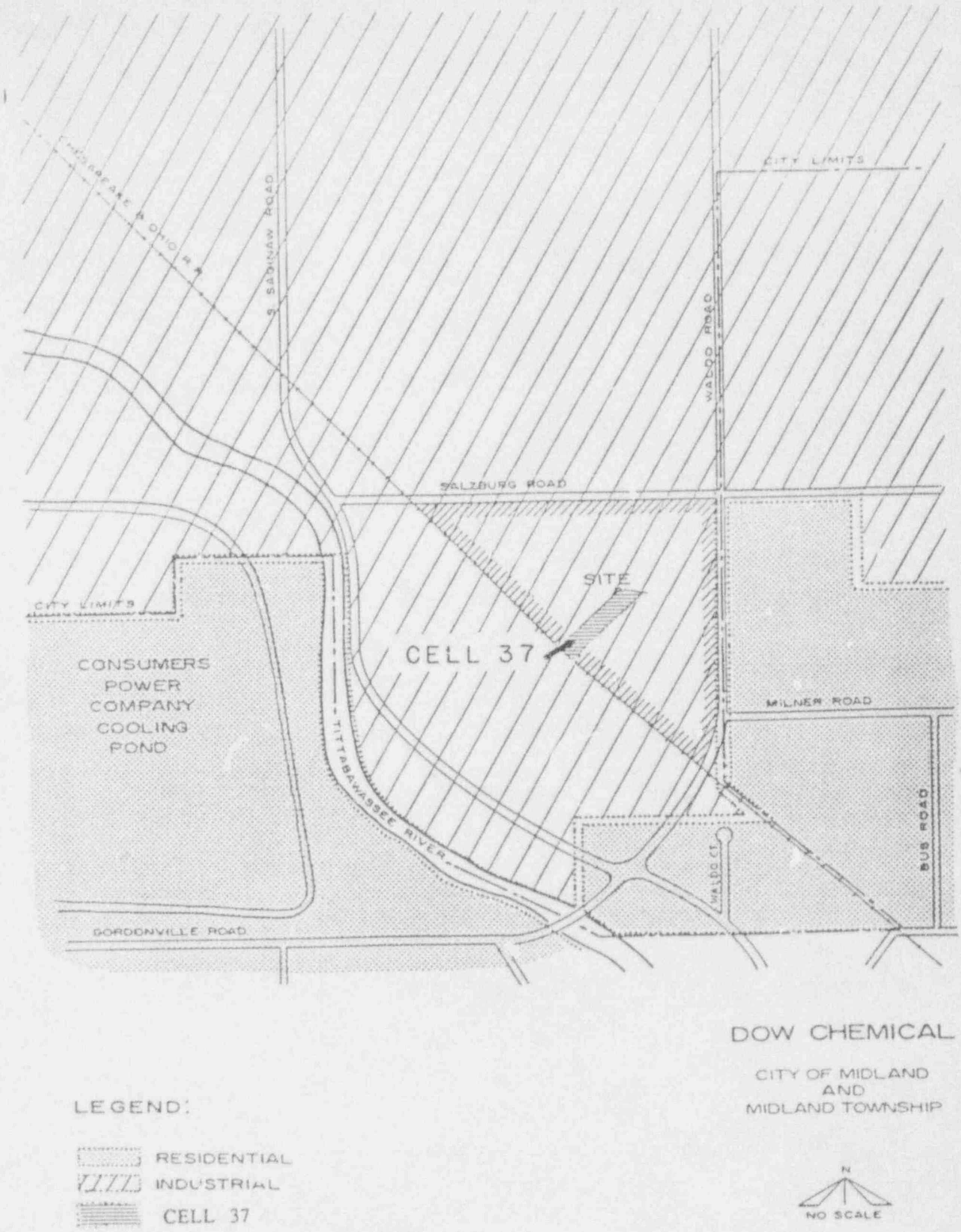
The proposed site for disposal of the thorium contaminated materials is the Salzburg Landfill, a 152 acre parcel of land owned by the Michigan Division of the Dow Chemical Company. As indicated on Figure 5.3-1, the triangular property is bounded on the north by Salzburg Road, on the east by Waldo Road, and on the southwest by C&O Railroad tracks.

5.3.1 Nearby Properties

The map in Figure 5.3-1 indicates use of the land surrounding the Salzburg Landfill. North of the facility is Dow Corning Corporation production facilities. South of the facility are inactive production facilities and vacant land. East of the facility are vacant land and residential housing . West of the facility is the Waste Water Treatment Plant facility of Dow Chemical, U.S.A., Michigan Division, Midland Location. To the northwest of the facility are the G&H Development Corporation and Prod. Trans, Inc. (EDI, 1983)

The reapplication for an operating license under Michigan Act 64 describes plans for proposed future uses of land in the vicinity of the Salzburg Landfill as follows:

> "The site is in the midst of an expanding industrial complex. The majority of property in the area is heavily industrialized. The exception to this is immediately east of Waldo Road where residential structures exist (Dow is purchasing these houses as they become available). The industrial uses in the area are consistent with City and Township development plans [Figures 5.3-2 and 5.3-3].
>
> "In August, 1979, the City of Midland Planning Commission approved a Comprehensive Development Plan to guide future growth in and adjacent to the City of Midland. Midland Township has also approved a development guide which generally corresponds to the City Plan. Contacts made with Midland Township Planning Commissioners and Midland City Planning Department during July, 1984, indicate zoning designations and land use have not changed since that time for the area surrounding the site.
>
> "Specifically, the site and adjacent property (City and Township) are designated for ultimate industrial development. These plans basically state that this land use category (industrial) provides for existing and future development of industry.
>
> "The City Zoning Ordinance (a development plan implementation tool) places the site into the Industrial "B" District. This zoning district is intended for a variety of intense industrial uses, including a landfill.
>
> "The Midland Township Zoning Ordinance has the property adjacent to the site zoned residential. This should only be considered a temporary zoning designation, since the Township Master Plan proposes this property be developed as industrial in the future". (EDI, 1984)



ZONING MAP

ADAPTED FROM "SALZBURG LANDFILL MICHIGAN ACT 64 OPERATING LICENSE REAPPLICATION", PREPARED BY WILLIAMS AND WORKS, INC., GRAND RAPIDS, MICHIGAN, FOR DOW CHEMICAL U.S.A.

Dames & Moore
FIGURE 5.3-2

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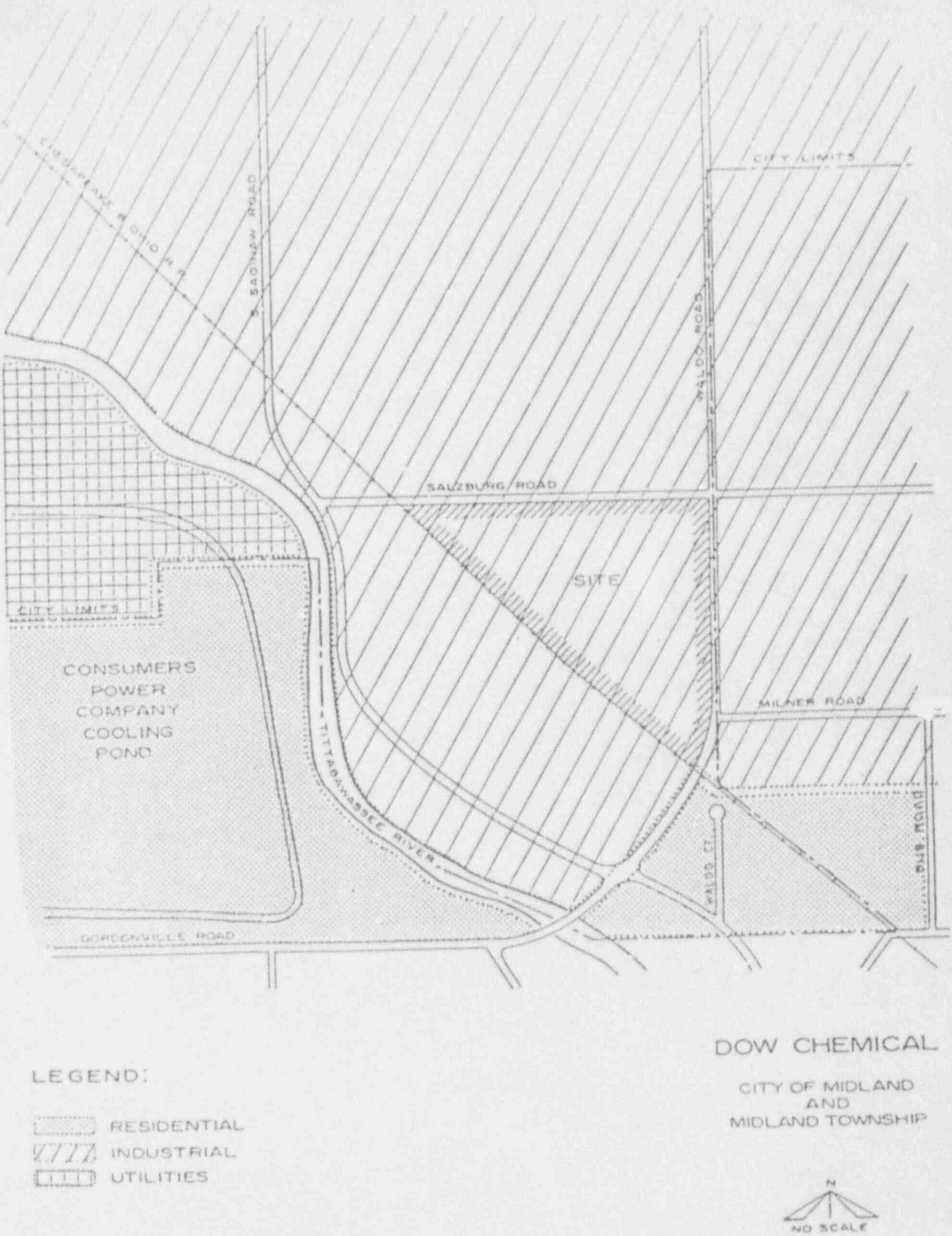

GENERALIZED DEVELOPMENT PLAN

ADAPTED FROM "SALZBURG LANDFILL MICHIGAN ACT 64 OPERATING LICENSE REAPPLICATION", PREPARED BY WILLIAMS AND WORKS, INC., FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 5.3-3

HOMES EAST OF WALDO ROAD

ADAPTED FROM "SALZBURG LANDFILL MICHIGAN ACT 64 OPERATING LICENSE REAPPLICATION", PREPARED BY WILLIAMS AND WORKS, INC., FOR DOW CHEMICAL U.S.A.

Dames & Moore
FIGURE 5.3-4

Table 5.3-1

RESULTS OF PRIVATE WELL SURVEY (1984)

Map Location	Owner Name	Well Depth	General Comments
	Louis F. Bober	35'	Well is a "dug well", approx. 30" in diameter and located right outside the basement wall in back of the house. Well has perhaps 10 ft of masonry at the top in back of the house. Well has perhaps 10 ft of masonry at the top. Below is an uncased and unscreened open hole. The well dries up sometimes in the summer, and the owner has to use bottled water. Well is 37 years old.
(Removed)	Kenneth Hutfilz	106'	They had a dug well, but that went dry in the summer, so in the early sixties this deep well was drilled.
36-11	James Trout	40' to 60'	Have had problems with their well. Water smells bad. Had an analysis done which said it was high in sulfur. Water at time of this survey has an H S odor.
36-8	John Hochstetler (Dow)	134'	Have a water softener. Water has a brine taste, and do not use it for drinking or cooking. Bring in water for those purposes. Log in Appendix C.
Removed	Frank May	?	Has plenty of water. Previous owner sold water to homes on Waldo from Salzburg to Milner Roads. Owner believes pipeline is still in because Mr. Trout hit an underground linn in his yard last year and Mr. May lost pressure in his water system until the line was capped.
36-7	J. Lewis Formerly Spencer	65'	Water quality is not adequate. Have trouble when neighbors make prolonged use of their well. Reported that many neighbors do their wash outside the because water supply is not adequate. Log in Appendix C.
36-5	Charles Witherspoon	160'	Well is 6" in diameter, but only yields 2 gals/min. Were out of water frequently until he lowered the drop-pipe. Water smells and has a lot of rust sediment in it. In 1973 drilled 232' in an attempt to develop a new well Log of this abandoned well in Appendix C.
36-9	Dow (Formerly Gutchak)	98'	Water is salty and has a "fishy" smell sometimes.
(Removed)	Frank Baker	141'	Owner reports plenty of good quality water. No problems with bad smell or taste.

5.3.2 Nearby Residences

"The nearest residences to the facility are along the east side of Waldo Road where there are homes that range in distance from 130 to 400 feet from the facility. Since February, 1980, nine of the homes along Waldo Road and Milner Road, adjacent to the facility, have been purchased by Dow Chemical U.S.A., Michigan Division, Midland location. Of the homes purchased, four were torn down and five homes continue to be occupied. Three of the homes remaining are owned by private individuals.

The remaining private residences are:

1. L. Bober, 4535 Milner Road
2. J. Trout, 1245 South Waldo Road
3. C. Witherspoon, 1131 South Waldo Road" (EDI, 1984)

5.3.3 Surface Waters

The only surface water in the vicinity of the Salzburg Landfill is the Tittabawassee River, which at closest approach is about 1200 ft. west of the landfill and over 2500 feet from Cell 37. The Tittabawasee flows southeast to join the Saginaw River at Saginaw, which then flows northeast to discharge into the Saginaw Bay at Bay City.

A 1983 FEMA Flood Insurance Study indicated that the maximum recorded flow occurred in 1916 with a flow of 34,800 cubic feet per second (cfs). This compares to 100 and 500 year flood flows of 47,000 and 62,000 cfs, respectively, in the river near the site, calculated by FEMA.

5.3.4 Water Wells

"All the residences across Waldo Road from the Salzburg Landfill have private wells. These wells range in depth from 35 to 155 feet, [note: some references indicate the deepest well is 160 feet] and the typical aquifer in which these wells are set consists of thin layers or pockets of sand in an otherwise clay formation. These private wells are the nearest to the facility.

"In February, 1980, a door-to-door survey was conducted at the homes along Waldo Road and Milner Road to obtain information on the depth and performance of their wells and to obtain a water sample for chemical analysis." (EDI, 1984)

The location of these homes and the owners names are shown on Figure 5.3-4. Table 5.3-1 summarizes the owner's responses to questions on well depth and performance.

The table has been updated to include the most recent information available. The wells range in depth from 35 to 160 feet.

> "In general, most of the wells are not capable of producing water in satisfactory quantity or quality. Many of the owners are dissatisfied with the taste and smell of the water, and several did their laundry outside the home because the wells will not produce enough water. Out of the nine residents surveyed, two said they had good wells. These owners, Mr. May and Mr. Baker, said they have plenty of water and they felt their wells are capable of supplying water to the entire neighborhood. In fact, Mr. May said the previous owner of his home sold water to residences on Waldo Road from Salzburg Road to Milner Road." (EDI, 1984)

5.4 Past Waste Burials

The proposed disposal site is a new single cell, Cell 37, in a currently operating EPA/DNR licensed hazardous waste disposal facility. The new cell (#37) has not yet been constructed, and therefore has not been the site of any waste disposal. The cell will receive the thorium bearing materials cited in this application. Typically, in the past, and as proposed for the future, only solid wastes generated by Dow Chemical's Michigan Division are buried in disposal cells elsewhere in the Landfill that are designed to a goal of no defects and no leaks.

As described in the RCRA Part B Application:

"Hazardous wastes which would be considered for disposal in other cells at this facility are of several types:

- Incinerator ash and dewatered wastewater treatment plant solids,
- Waste containing hazardous concentrations of E.P. Toxic compounds such as chromium,
- Certain soil and spill clean-up materials potentially containing relatively low concentrations of specifically listed hazardous wastes,
- Certain solids containing F, K, U and P RCRA listed hazardous wastes" (1986) such as:
  - Chlorobenzene
  - Benzanthracene
  - Acrylamide

It should be noted that the hazardous wastes for which the Landfill was designed, such as heavy metals, may remain hazardous for an indefinite period of time, since they do not radioactively decay. Therefore, control of the hazardous waste disposal areas by the EPA should be required for as long as the thorium slag may require control.

6.0 INSTITUTIONAL CONTROLS

6.1 Property Ownership

The proposed disposal site, the Salzburg Landfill, is owned and operated by the applicant, Dow Chemical U.S.A., Michigan Division.

The site is operated as a hazardous waste disposal facility, and appropriate notices have been included in the property deed (See Section 11.2).

6.2 PROPERTY ACCESS CONTROL

"The facility is surrounded by a twelve foot high perimeter fence. Normal access is through #90 gate, or #93 gate, the contractors' gate. Possession of radio transmitters and keys are controlled by Michigan Division of Environmental Services. All gates are kept locked/closed, or a gate guard is stationed at the gate. Anyone entering the facility must have business at the facility to gain entrance.

"Plant security maintains round-the-clock surveillance of the facility. Included in their responsibilities are routine inspection of fence lines, gate conditions, and surveillance for any unusual facility conditions. The perimeter fence is posted with signs reading "DOW", "PRIVATE PROPERTY NO TRESSPASSING", and "WARNING UNAUTHORIZED PERSONNEL KEEP OUT".

"Warning signs are posted at the entry point to the facility which instruct all personnel to report to the facility building prior to entering the area.

"During periods of operation, Dow personnel in the area provide surveillance for unauthorized personnel.

"All personnel are required to display an identification (ID) badge inside the fence line. Visitors are issued temporary badges which must be displayed while at the facility. Temporary ID badges are returned when the visitor leaves the facility. All contractor personnel must sign in and out of the facility at the contractor gate. All other personnel must sign in and out of the facility at the facility building." (Dow, 198[illegible])

6.3 PERIOD OF RESTRICTED ACCESS

The applicant intends to continue operation of the hazardous waste disposal facility beyond the emplacement of the thorium-bearing materials, though no further disposal of radioactive material is intended or anticipated. Dow Chemical has estimated, in the RCRA Part B Application, that final closure activities for the Salzburg Landfill shall begin in the year 2017. Access control beyond 2017 may be required as part of the EPA or State permitting process. Additionally, a covenant to the deed was prepared, which is included as Appendix B.

7.0 NATURE OF BURIAL SITE

7.1 TYPES OF SOILS

The soils at the Salzburg Landfill have been described and characterized as part of the RCRA Part B Permit Application and the supporting site investigations. Prior to the initiation of construction at the Salzburg Landfill, most of the site was covered with a surficial sand layer. This unit is described in Section E of the Part B Permit Application as follows:

> "This surface sand unit consists of highly stratified fine sand and silt and contains thin layers of clay. The unit is particularly silty and clayey near the bottom where it grades into the more massive clay unit which underlies it.
>
> "The 49 borings which were drilled for the landfill site evaluation show the surface sand layer to range from 0 to 13 feet in thickness with an average thickness of approximately 4 feet. Figure 7.1-1 is an isopach map showing the occurrence [of] the surface removed during excavation and construction of the liner failure detection system." (EDI, 1984)

As shown on Figure 7.1-1 the sand layer is approximately 2-3 feet thick at Cell 37.

Beneath the shallow sand layer is a lakebed clay layer ranging in thickness from 14 to 24 feet. This lakebed clay overlies glacial till. The lakebed clay in the area of the thorium disposal cell will be excavated during construction of the cell. The clay is then used in the subsequent construction of clay liners and caps for the cell.

> "During the original engineering study, sixty-three silt and clay samples from this [lakebed clay] unit were collected from the landfill site and analyzed for permeability, Atterberg limits, pH and particle size. Laboratory permeability ranged from 3.1×10^{-6} to 1.4×10^{-8} cm/sec, with 86 percent less than 1.0×10^{-7} cm/sec. Clay particles (less than 5 microns) comprise a significant fraction of all samples ranging from 23.4 to 96.2 percent with an average of 56.3 percent. The liquid limit ranged from 13.0 to 56.5 percent and average 36.2 percent. The plastic index ranged from non-plastic to 35.8 and averaged 16.6. The pH ranged from 7.3 to 8.9.

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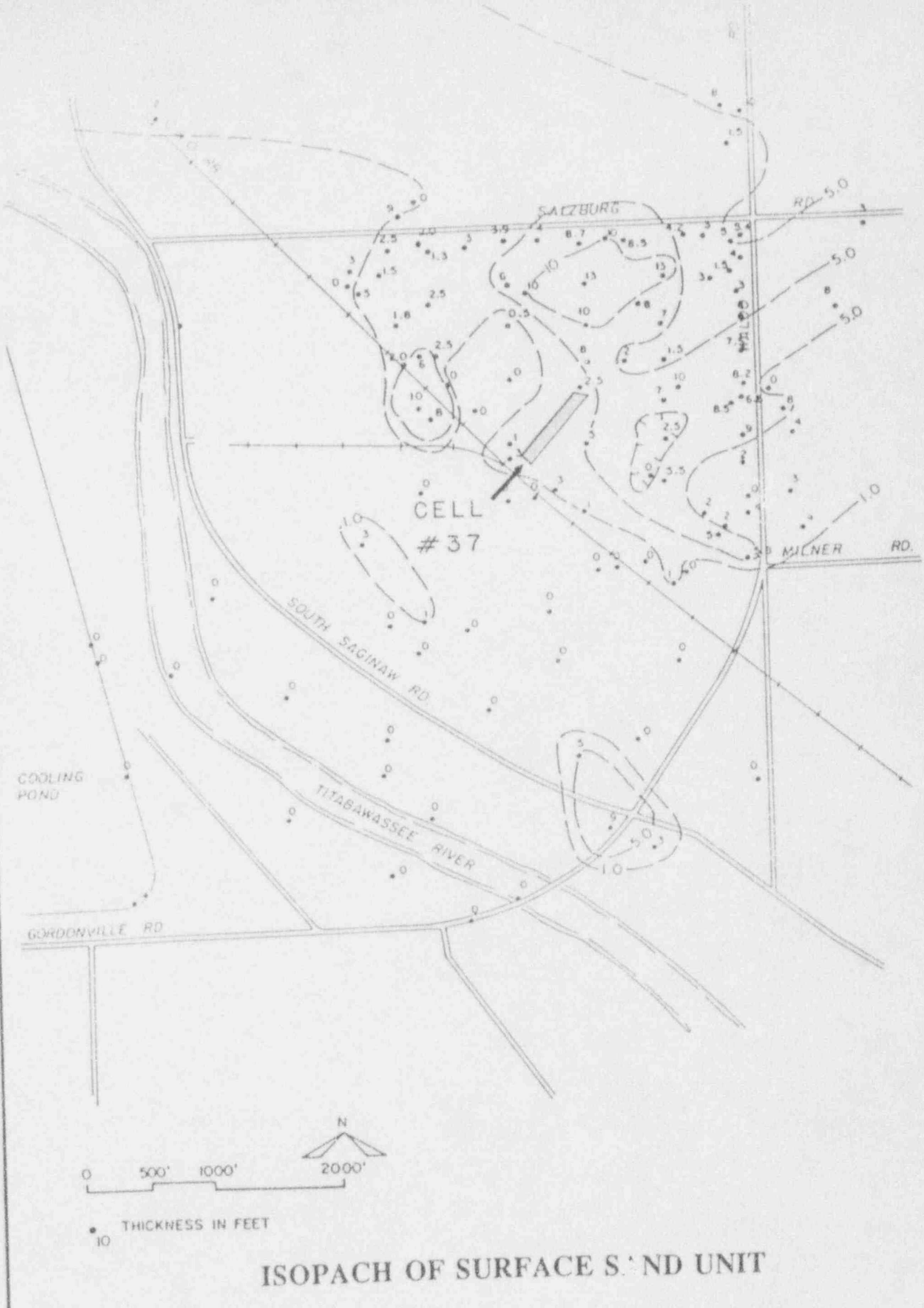

ISOPACH OF SURFACE S.'ND UNIT

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E" PREPARED BY EDI ENGINEERING & SCIENCES FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 7.1-1

Using the Unified Soil Classification, the unit is predominantly a CL clay with subordinate amounts of CH, SC, SP-SM, ML-CL, and ML soils.

"The [glacial till] unit lies directly below the Lakebed Clay unit and could be identified during drilling by rock fragments (pebbles), hard drilling, and a more uniform, sandy, siltier texture than the overlying Lakebed Clay unit.

"The matrix material of the Glacial Till unit is predominantly sand and silt, with a clay fraction that averages about 30 percent. This is in direct contrast to the Lakebed Clay unit where the clay fraction usually exceeded 50%. Twelve samples were collected from the upper 15 feet of the unit on the site and analyzed for permeability, Atterberg limits, pH, and particle size. Permeability ranged from 1.2×10^{-7} to 2.5×10^{-8} cm/sec, with 82% less than 1.0×10^{-7} cm/sec. The liquid limit and plastic index averaged 20.4 and 8.4, respectively, which are notably lower than for the Lakebed Clay. The pH ranged from 8.0 to 9.0, and the unit is a mix between the SM, SC, SC-SM, CL-ML and CL unified classes.

"The deeper rotary borings within the landfill (Dow boring #'s 2708, 3009, 3010, 3011, 3012) and the older coal borings penetrate the entire Glacial Till unit in several places. The borings indicate an average thickness of the unit is approximately 125 feet beneath the Salzburg Landfill." (EDI, 1984)

7.2 STRATIGRAPHY

The stratigraphy of the soil is partially described in Section 7.1. This section repeats some of that information along with a more detailed stratigraphic description including descriptions of the deeper sandy aquifer and bedrock found beneath the landfill.

"The glacial stratigraphy of the area underlying the Salzburg Landfill has been determined from coal boring and water well records dating back 80 years and from recent hydrogeological investigations conducted at the landfill. The deeper borings in these recent investigations were logged by geophysical methods which included electrical resistivity and gamma-ray methods. The records of these geophysical logs are included in Appendix [C]. During the original engineering study for the landfill, twenty-two continuous split-spoon borings were drilled on a 600-foot grid pattern. Although the original intention was to drill each of these borings to a depth of 40 feet, actual depths ranged between 21 and 40 feet due to hard drilling in the stiff till layer underlying the site. Twenty-one shallow auger borings were also drilled between the split-spoon borings to help determine the areal extent and depth of the surface layer of sand which blankets most of the site. These borings were drilled at least 5 feet into the clay and range from 8 feet to 19 feet in depth. From this information, four stratigraphic units have been identified above the bedrock. These units are termed, from top to bottom, "Surface Sand", "Lakebed Clay", "Glacial Till", and "Regional Aquifer". The unit names are derived from the relative position and/or geologic genesis of each unit.

"Four geologic cross-sections have been assembled from logs of wells and borings in the Salzburg Landfill area to aid in the interpretation of the hydrogeology and stratigraphy under the landfill [see Figures 7.2-1 through 7.2-4]. The cross section locations are shown on [Figure 7.2-5]. Geologic cross section A-A extends from the southwest corner of Section 35 across the Tittabawassee River and the Salzburg Landfill to the northeast corner of Section 35. Cross section B-B extends from the southeast corner of Section 35 north along the east boundary of the Salzburg Landfill, north along Waldo Road 3/4 mile in Section 26, to the north-northeast to Monroe Well #23 (24-2) in Section 24. Cross section C-C extends from west of Poseyville Road by the Westside Power Plant along the west bank of the Tittabawassee River, along the Consumers Power Cooling Pond berm, east-southeast across the Sludge Dewatering Facility, the Salzburg Landfill, and Waldo Road to the corner of Milner Road and Bus Road. Cross section D-D extends from west of the Sludge Dewatering Facility to the northeast corner of the Salzburg Landfill along the south side of Salzburg Road.

"<u>Surface Sand Unit</u>: A surficial sand layer covers most of the landfill site. This surface sand unit consists of highly stratified fine sand and silt and contains thin layers of clay. The unit is particularly silty and clayey near the bottom where it grades into the more massive clay unit which underlies it.

"The 49 borings which were drilled for the landfill site evaluation show the surface sand layer to range from 0 to 13 feet in thickness with an average thickness of approximately 4 feet. The landfill borings were drilled in late October and early November, 1979, following several months of dry weather, so the surface sand was dry. However, a seasonal saturated zone can be expected in this unit when water from rainfall or snowmelt is "perched" on the underlying clay. Figure [7.1-1] is an isopach map showing the occurrence the surface sand unit. Under the Salzburg Landfill, the Surface Sand will be completely removed during excavation and construction of the liner failure detection system.

"<u>Lakebed Clay Unit</u>: The Lakebed Clay unit underlies the entire site directly below the surface sand and ranges from 14 to 24 feet thick. The contact between the Lakebed Clay and the Glacial Till is very sharp and distinct in the geophysical logs, particularly the resistivity measurements. The top of the unit lies at elevations between 617 and 622 feet. Bottom elevations are between 594 and 605 feet. For comparison, the bottom of the landfill's liner failure detection system is at an approximate elevation of 600 feet.

"The unit is stratified and consists of clay layers mixed with varying fractions of sand and silt. Less than 10 percent of the unit consists of distinct sand, sandy gravel and silt layers. These layers are usually 0.5 feet or less in thickness and are interbedded within the clay. The sandy layers are often wet and are the source of most of the water in site borings. The clay is plastic due to high moisture content. During the excavation of the first 4 landfill cell groups (7 acres total), several saturated sand and gravel layers were encountered. The largest was about 25 feet wide, extending across several cells, and 2 to 3 feet thick on an average. These layers drained readily when first cut into, however the flow was temporary because there is essentially no hydraulic connection between layers.

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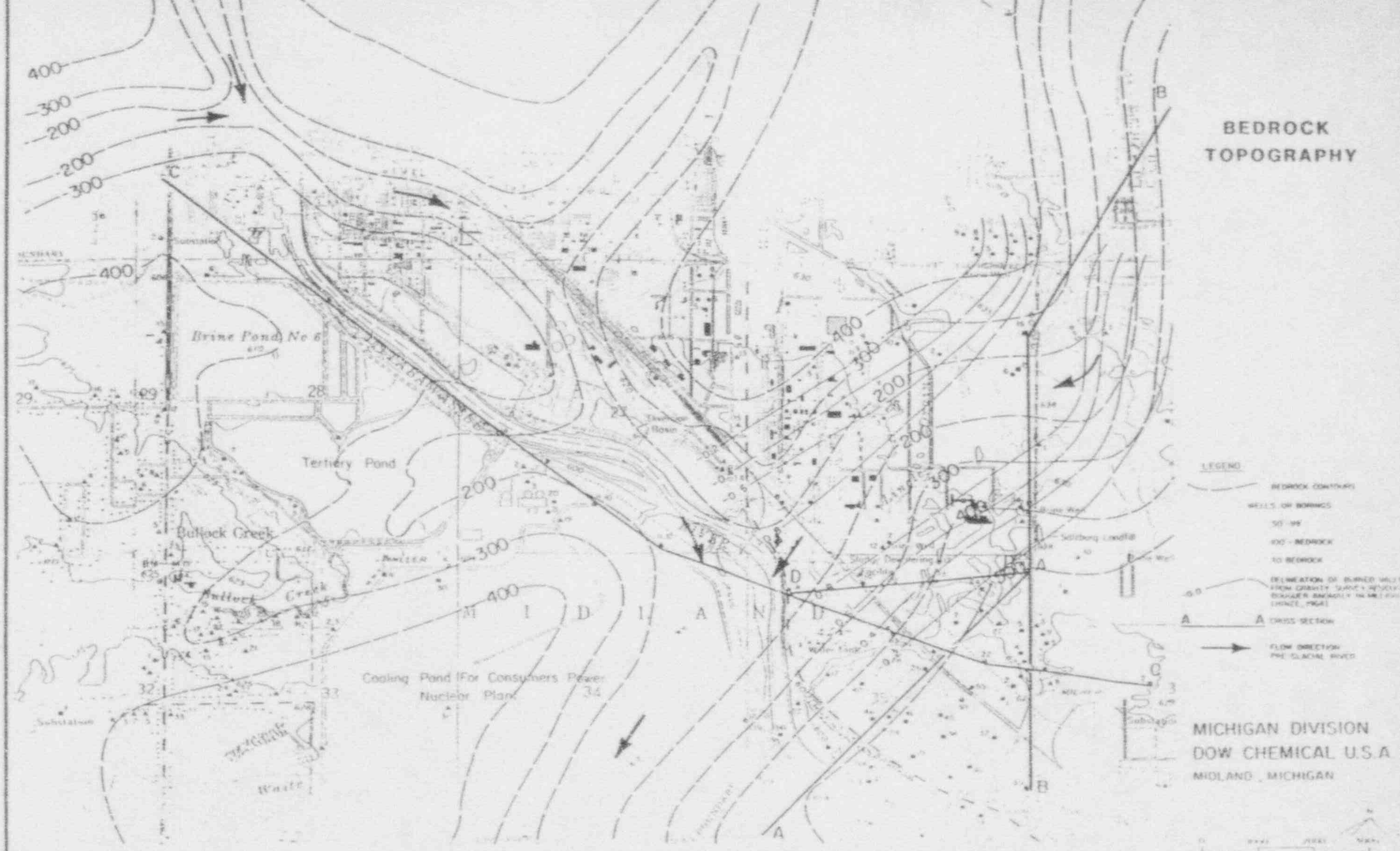

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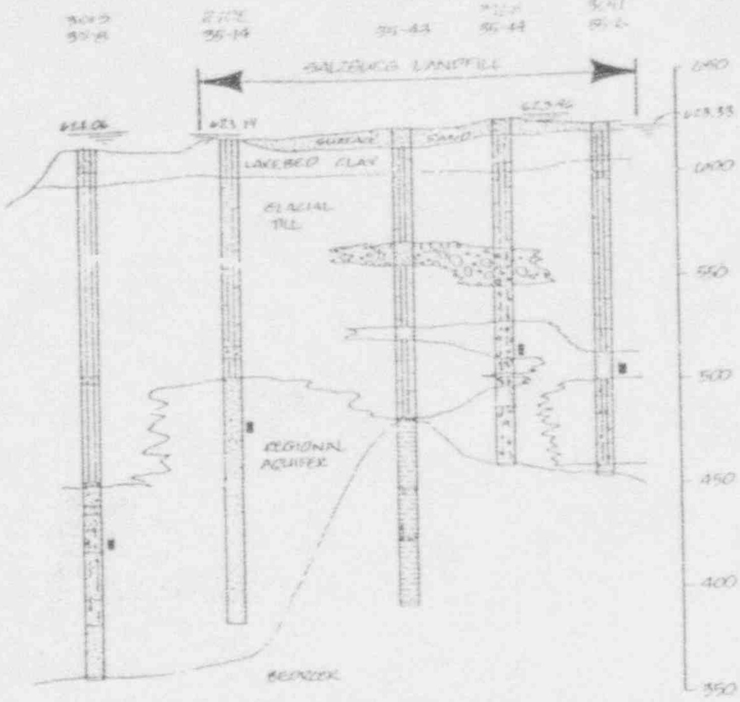
FIGURE 7.2-5
Dames & Moore



SECTION D

GEOLOGIC CROSS SECTION D

LEGEND

- REGIONAL AQUIFER
- FILL
- CLAY
- SAND
- SILT
- SAND AQUIFERS WITHIN GLACIAL TILL UNIT
- SEAMS OF SAND & SILT
- GRAVEL
- SANDSTONE
- SHALE
- WELL SCREEN
- STATIC WATER LEVEL

0 1000 FEET

SCALE

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FIGURE 7.2-4

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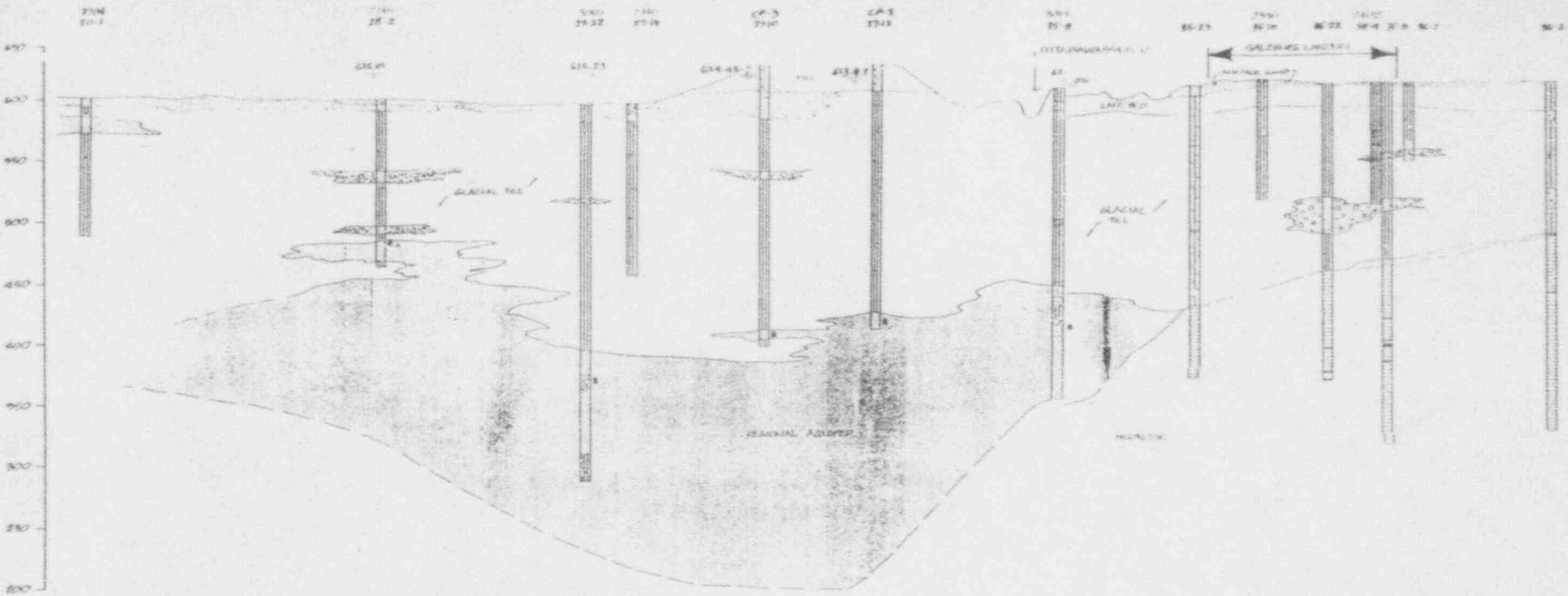

SECTION C

LEGEND

REGIONAL AQUIFER	SILT	SANDSTONE
FILL	SAND AQUIFERS WITHIN GLACIAL TILL UNIT	SHALE
CLAY	SEAMS OF SAND & SILT	WELL SCREEN
SAND	GRAVEL	STATIC WATER LEVEL

GEOLOGIC CROSS SECTION C

0 1400 FEET

SCALE APPROXIMATE

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FIGURE 7.2-3
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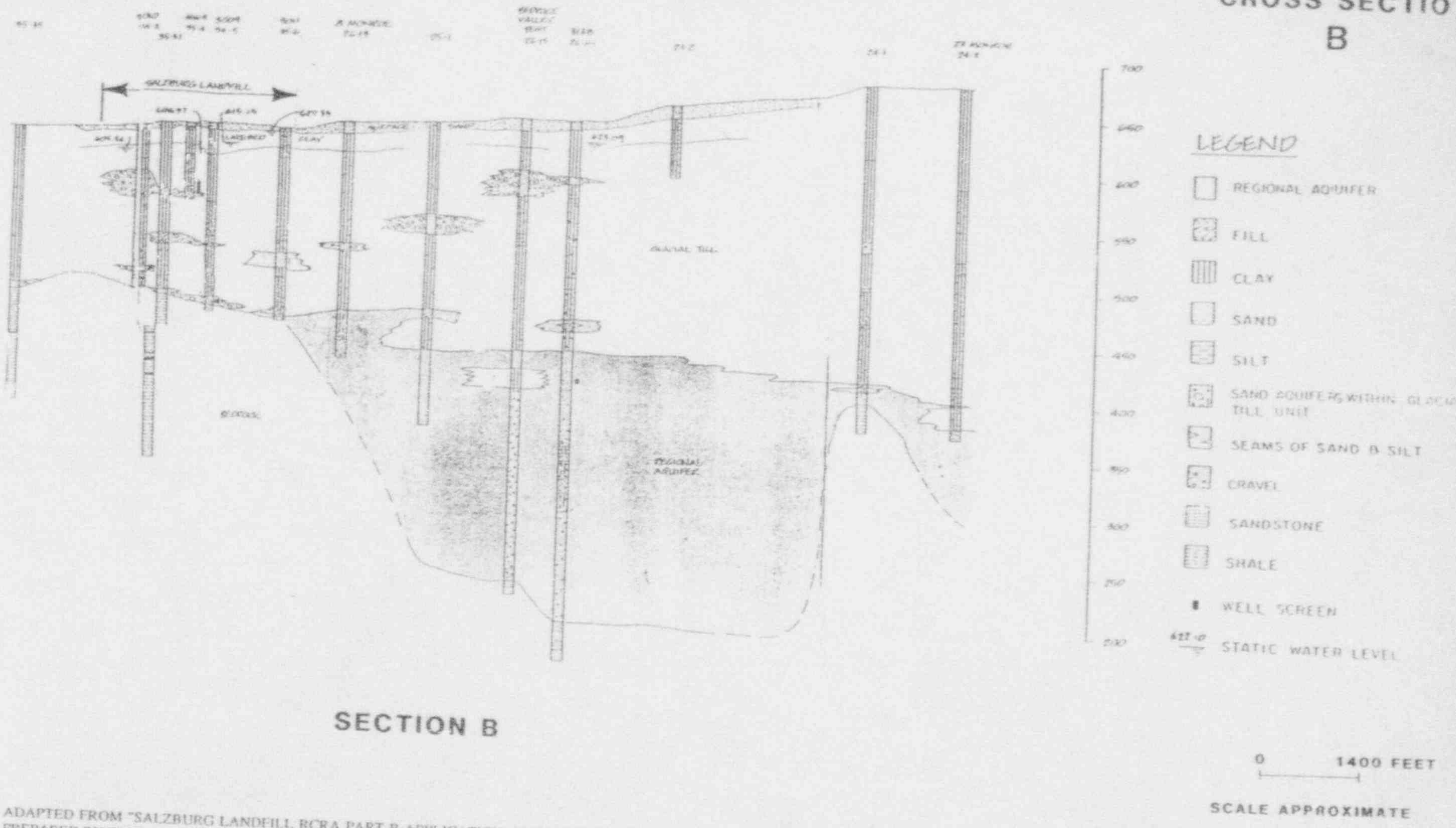
GEOLOGIC CROSS SECTIO B



SECTION B

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FIGURE 7.2-2

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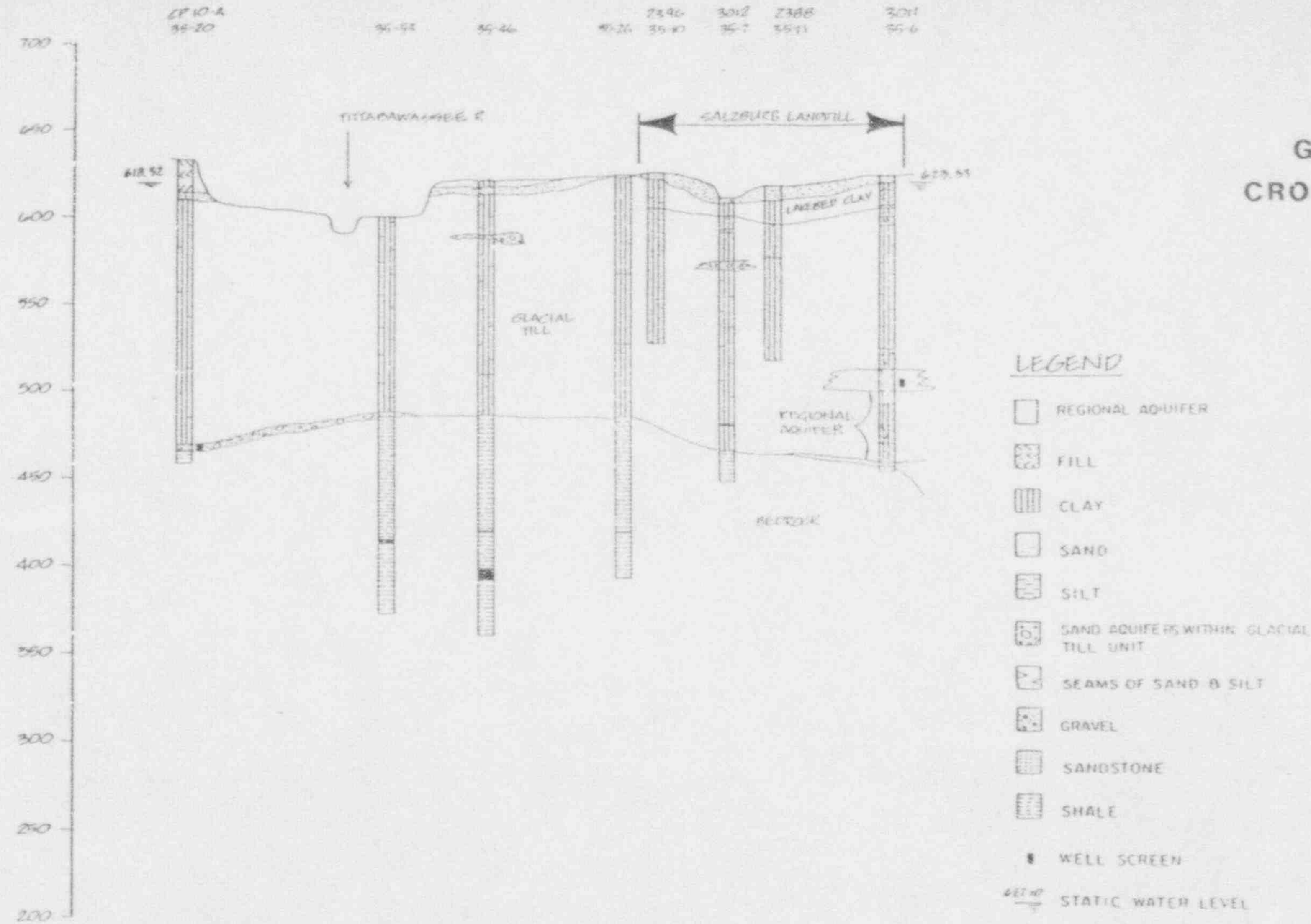
GEOLOGIC CROSS SECTION A



0 1000 FEET

SCALE

SECTION A

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E"
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FIGURE 7.2-

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"During the original engineering study, sixty-three silt and clay samples from this unit were collected from the landfill site and analyzed for permeability, Atterberg limits, pH and particle size. Laboratory permeability ranged form 3.1×10^{-6} to 1.4×10^{-8} cm/sec, with 86 percent less than 1.0×10^{-7} cm/sec. Clay particles (less than 5 microns) comprise a significant fraction of all samples ranging from 23.4 to 96.2 percent with an average of 56.3 percent. The liquid limit ranged from 13.0 to 56.5 percent and average 36.2 percent. The plastic index ranged from non-plastic to 35.8 and averaged 16.6. The pH ranged from 7.3 to 8.9. Using the Unified Soil Classification, the unit is predominantly a CL clay with subordinate amounts of CH, SC, SP-SM, ML-CL, and ML soils.

"Glacial Till Unit: This unit lies directly below the Lakebed Clay unit and could be identified during drilling by rock fragments (pebbles), hard drilling, and a more uniform, sandy, siltier texture than the overlying Lakebed Clay unit. The unit is typically extremely tight, with local, infrequent saturated interbedded seams of permeable material. The geophysical logs in Appendix [C] show that considerable intervals of the glacial till unit have very uniform characteristics; however, there are also intervals which are clay rich and intervals which are more sandy. These sandy intervals form a sand subunit in the Glacial Till unit.

"It is difficult to find an aquifer within the Glacial Till unit. However, evaluation of the boring and well logs drilled to date indicate that there are areas where the sand subunit within the Glacial Till unit is more prevalent. Figure [7.2-6] outlines the area in which sand was found between the 590 and 550 foot elevations. Several residential wells along Waldo Road are screened in this sand subunit. Water chemistry suggests these localized aquifers are recharged from the higher head Regional Aquifer below.

"The matrix material of the Glacial Till unit is predominantly sand and silt, with a clay fraction that averages about 30 percent. This is in direct contrast to the Lakebed Clay unit where the clay fraction usually exceeded 50%. Twelve samples were collected from the upper 15 feet of the unit of the site and analyzed for permeability, Atterburg limits, pH, and particle size. Permeability ranged from 1.2×10^{-7} to 2.5×10^{-8} cm/sec, with 82% less than 1.0×10^{-7} cm/sec. The liquid limit and plastic index averaged 20.4 and 8.4, respectively, which are notably lower than for the Lakebed Clay. The pH ranged from 8.0 to 9.0, and the unit is a mix between the SM, SC, SC-SM, CL-ML and CL unified classes.

"The deeper rotary borings within the landfill (Dow boring #'s 2708, 3009, 3010, 3011, 3012) and the older coal borings penetrate the entire Glacial Till unit in several places. The borings indicate an average thickness of the unit is approximately 125 feet beneath the Salzburg Landfill.

"Regional Aquifer: This unit lies below the Glacial Till unit primarily in the bedrock valleys. The top of the unit lies at elevations between 420 and 460 feet in the area of the Salzburg Landfill. This unit pinches out against the bedrock hill under the landfill so that the Glacial Till rests directly on the bedrock hill. The elevation of the top of the hill under the landfill is approximately 500 feet. The elevations of the tops of the bedrock hills range

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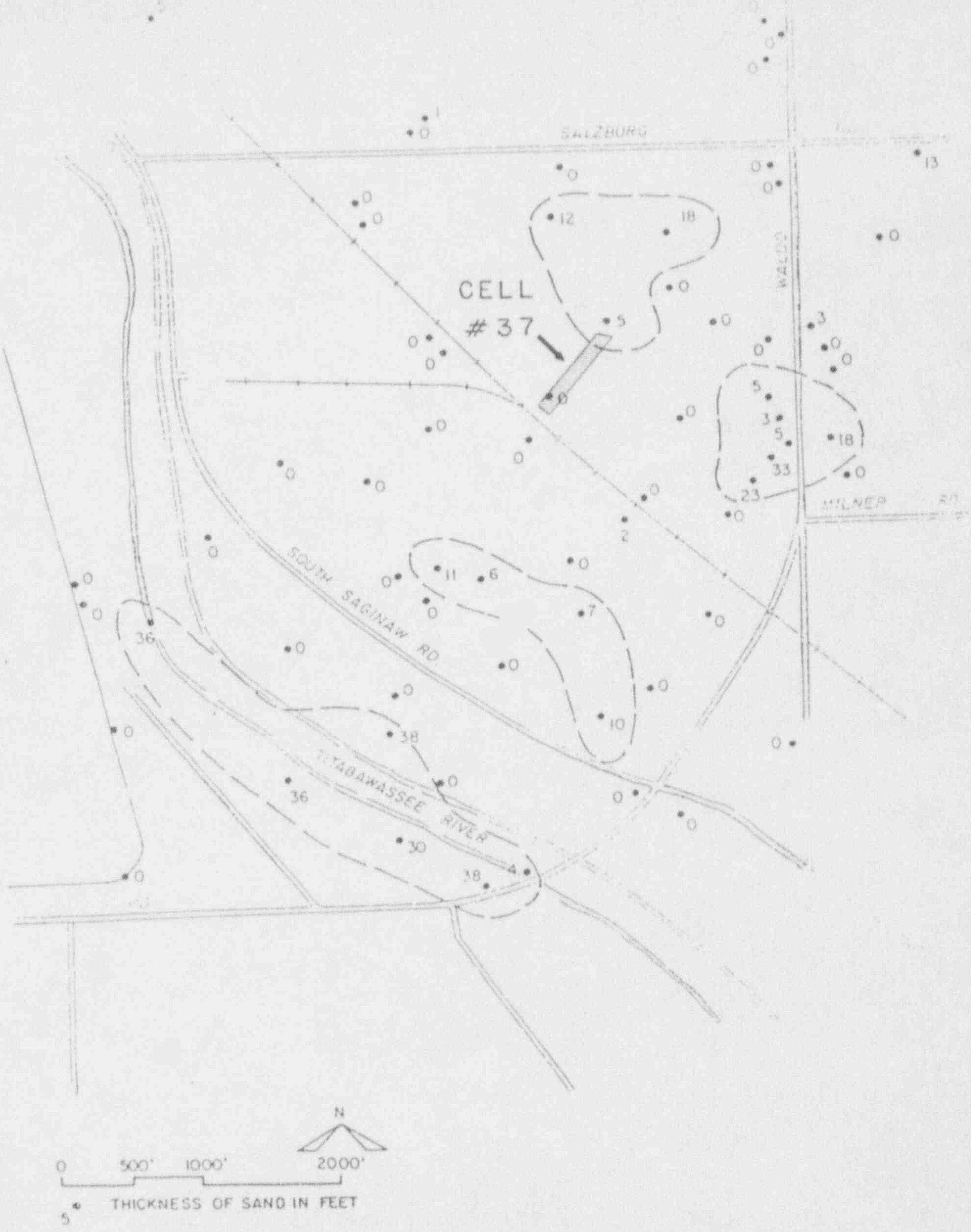

AREAS WITH SAND LAYERS BETWEEN 550 & 590 FOOT ELEVATIONS WITHIN THE GLACIAL TILL UNIT

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E" PREPARED BY EDI ENGINEERING & SCIENCES FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 7.2-6

between 400 and 520 feet. The bottoms of the bedrock valleys are between 150 and 200 feet above sea level. The Regional Aquifer underlies 30-35% of the area within the boundary of the landfill, or approximately the northwestern one-third of the landfill (Figure [7.2-7])". (EDI, 1984) The regional aquifer is not present beneath the proposed disposal cell.

"The sand and gravel which compose the regional aquifer were deposited as glacio-fluvial material in the bedrock valleys. The thickness of the aquifer in the center of the valley north of the landfill is on the order of 250 feet. The source area of the sand and gravel in the aquifer is not from the local shale in the bedrock formation except in the deepest parts of the valleys. The sand and rock fragments brought up in drilling are composed of a wide range of rock types. Igneous, metamorphic and sedimentary rocks are all represented in samples from Bedrock Valley Well #1 (26-15) and Dow well #3138 (26-16). The amount of shale in the samples from the Bedrock Valley Well #1 increased downward. Coal fragments began to be picked up at an elevation of 280 feet. At an elevation of 240 feet siltstone and sandstone recognizable as being of the Saginaw Formation were found in the sample. At an elevation of 225 feet, twenty percent of the sample was fine grained sandstone of the Saginaw formation. Drilling was terminated at this level in sandstone. In Dow Well #3138 (26-16) shale fragments began to be encountered at an elevation of 200 feet and were mixed with sand and clay down to an elevation of 165 feet where drilling was terminated. The driller indicated that drilling was not consistently slow as would be the case in solid shale. There are two possible explanations for the driller's findings, 1) he was drilling through interbedded shale and sandstone in the bedrock, 2) he was drilling into shale, sand and clay alluvium of the original bedrock valley. Either explanation would place the "bedrock" boundary near an elevation of 200 feet.

"The Regional Aquifer is composed dominantly of fine sand to gravel. In most locations the sand or gravel is well sorted and clean. The unit also has thin interbedded clay and silt stringers. These show clearly on the geophysical logs for Dow #3137 (22-3) and #3138. Some of these clays are only 1 to 2 feet thick but they comprise 10 to 15 percent of the unit. The stringers are discontinuous and, therefore, not identifiable over an extended area through either the drilling records or the geophysical logs.

Clay Mineralogy and Cation Exchange Capacity

"Samples from both the Lakebed Clay Unit and the Glacial Till Unit, collected from the landfill site, were analyzed for their clay mineralogy and cation exchange capacity. X-ray diffraction analyses indicated that 62 to 64 percent of the clay in both units is illite; 17 to 25 percent is chlorite plus kaolinite; and 11 to 20 percent are expandable clays, which, in these samples, are alteration products of chlorite. The cation exchange capacity measured low in all samples ranging from 6.2 to 14 milliequivalents (meq) per 100 grams.

"The structure of illite is characterized by "fixed" potassium ions between two planes of oxygen atoms. This forms a very rigid crystalline unit that impedes water penetration between crystal layers. Because of this rigid structure, only limited swelling occurs when saturated. The low cation exchange capacity is due to the high percentage of illite in which the

4 • THICKNESS OF REGIONAL AQUIFER IN FEET

> THICKNESS GREATER THAN MEASURED. WELL PENETRATION OF UNIT INCOMPLETE

BOUNDARY OF REGIONAL AQUIFER IN SECTION 35

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E"
PREPARED BY EDI ENGINEERING & SCIENCES FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 7.2-7

potassium ions between successive crystal layers are "fixed" or non-exchangeable.

"Calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) were also found in the samples, although no quantitative measurements were made. The presence of these minerals contributes to the buffering capacity of the clay, which means that the alkaline pH of the clay is not easily lowered.

"These tests, along with the permeability tests discussed in preceding sections, indicate that this clay is well suited for such uses as landfill or lagoon liners and as the natural soil base for land treatment, storage, and disposal facilities. It is basically a non-swelling clay with high chemical stability and low permeability. The clay will not swell or shrink appreciably with changing moisture content. Naturally occurring, continuous layers of this clay underlying the Salzburg Landfill site provide a barrier to prevent migration of chemicals to ground-water aquifers." (EDI, 1984)

7.3 PRECIPITATION

7.3.1 Climatic Conditions

The average annual precipitation is about 28.8 inches (EDI, 1983) as described in the RCRA Part B Application:

"The record maximum monthly amount of precipitation received was in August 1975, with a total of 12.76 inches. Minimum monthly precipitation was recorded in September 1979, with only a trace received for the month. The mean Total Annual Snowfall is 36.3 inches, with the maximum monthly amount being received in February 1949, which totaled 29.4 inches. The average date for Midland's first 1-inch snow depth is November 29; first 3-inch snow depth, December 20; and first 6-inch snow depth, January 8. The average date of the last freezing temperature in spring is May 12, while the average day of the first freezing temperature is October 2."

7.3.2 Water Balance

A water balance for the cover of Cell 37 was performed.

"Precipitation normals for the Midland area were obtained from the National Oceanic and Atmospheric Administration, National Climatic Center. Potential evapotranspiration (PE) estimates for a bare soil were made using the method of Mather and Rodriquez (1978). Potential evapotranspiration is obtained directly from the mean monthly air temperature by means of the following relation.

$$PE = 16(10t/I)^a$$

Where PE=monthly unadjusted potential water loss in millimeters (divide by 25.4 to obtain values in inches)

t=mean monthly temperature in °C

I=annual heat index. This value is the sum of the 12 monthly heat indices (i) where $i=(t/5)^{1.514}$

$a=6.75(E-7) \times I^3-7.71(E-5)\times I^2+1792(E-2)\times I+0.49239$"

(EDI, 1983)

The results of the calculations are presented in Table 7.3-1. The estimated amount of the annual precipitation available for infiltration into the drain above the clay cover is 8.07 inches. This will infiltrate primarily in the months of March and April. However, these calculations assume bare soil and no runoff. Actual infiltration should be somewhat lower.

The storage estimate was based on an assumption that two inches of water may be stored in one foot of soil used to cover the waste and that 18 inches of topsoil are used above the drain. The storage change is the month-to-month change in the moisture stored in the cover layer of soil placed over the drain following cell closure. The surplus is calculated as the excess of precipitation above the potential evapotranspiration for a month. The month of March has two values; the top value is the estimated snowmelt accumulated over the winter months.

7.3.3 Leachate Handling

The amount of radionuclides expected to be leached from the emplaced thorium-bearing material is minimal. However, the leachate system for Cell 37 (the intended disposal site) will be separate from the system serving the remainder of the Salzburg facility. Cell 37 leachate will be tested to assure conformance with 10 CFR 20 Appendix B criteria before release to the facility's main leachate treatment system.

If Cell 37 leachate exceeds the unrestricted release criteria, the applicant, after consultation with the NRC, intends to treat the material in a manner appropriate to allow ultimate disposal.

TABLE 7.3-1

AVERAGE CLIMATIC WATER BALANCE COMPUTATIONS FOR [illegible] LANDFILL

	MONTHS												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
P	1.46	1.31	2.18	2.86	2.47	2.92	2.56	3.37	2.83	2.57	2.19	2.03	28.75
PE	0	0	0	1.34	3.43	5.03	5.46	4.68	3.12	1.71	0.48	0	25.25
P-PE	1.46	1.31	2.18	1.52	-0.96	-2.11	-2.90	-1.31	-0.29	0.86	1.71	2.03	
Storage	3.00	3.00	3.00	3.00	2.04	0.00	0	0	0	0.86	2.57	3.00	
Storage Change	0	0	0	0	-0.96	-2.04	0	0	0	0.86	1.71	0.43	
Surplus	0	0	4.37 2.18	1.52	0	0	0	0	0	0	0	0	8.07

P = Precipitation
PE = Potential Evapotranspiration
PE estimated using the method of Mather and Rodriguez, 1978.
Assumption: 2 inches of water can be stored in 1 foot of soil used to cover the landfill. Assume 8 inches of soil used to cover the drainage media

REFERENCE: Mather, J.R. and P.A. Rodriquez. The Use of the Water Budget in Evaluating Solid Waste Landfills. Water Resources Center, Univertisty of Delaware, Newark, DE. 1978. NTIS Pub. No. PB 80-180888.

7.4 WATER WELLS

An inventory of wells and soil borings in the vicinity of the Salzburg landfill was made as part of the Part B Permit Application (EDI, 1984). Figure 7.4-1 presents the locations of wells and borings deeper than 50 feet within 3000 feet of the landfill. Table 7.4-1 lists each of these wells and borings and relevant data regarding them. The wells and borings are designated by the section in which they are located and a second number for each well in that section (i.e. 35-12 indicates a twelfth well in section 35). Other wells less than 50' in depth are described in section 7.4.1 and 7.4.2.

7.4.1 Domestic Wells

Table 7.4-2 provides some additional data and descriptions of the 9 current or former domestic wells found to the east of the Salzburg Landfill. The well descriptions are based on comments by the residents at the time of the survey and currently available data.

> "In general, most of the wells are not capable of producing water in satisfactory quantity or quality. Many of the owners are dissatisfied with the taste and smell of the water, and several did their laundry outside the home because the wells will not produce enough water. Out of the nine residents surveyed, two said they had good wells. These owners, Mr. May and Mr. Baker, said they have plenty of water and they felt their wells are capable of supplying water to the entire neighborhood. [Both wells have since been removed] In fact, Mr. May said the previous owner of his home sold water to residences on Waldo Road from Salzburg Road to Milner Road.
>
> "All of the wells have very hard water and, with the exception of the shallow Bober well, they all exceed U.S. EPA secondary maximum contaminant limits of 250 milligrams per liter for chloride. This limit is a taste threshold only and the high level of chloride found does not have adverse health implications. Sodium is also high and, with the exception of the Bober well, ranges from 230 to 470 milligrams per liter. At present, there are no maximum state or Federal levels for sodium; however, for persons on a sodium restricted diet, use of this water for drinking could present a problem.
>
> "All of the heavy metals, with the exception of zinc, were non-detectable. The low levels of zinc found are probably from well casings and household plumbing. The chemical oxygen demand was low in all wells although, relative to the other wells, the Dow (36-9) well was somewhat higher at 27 milligrams per liter. This is also the well of which the resident complained of a 'fish' odor." (EDI, 1984a)

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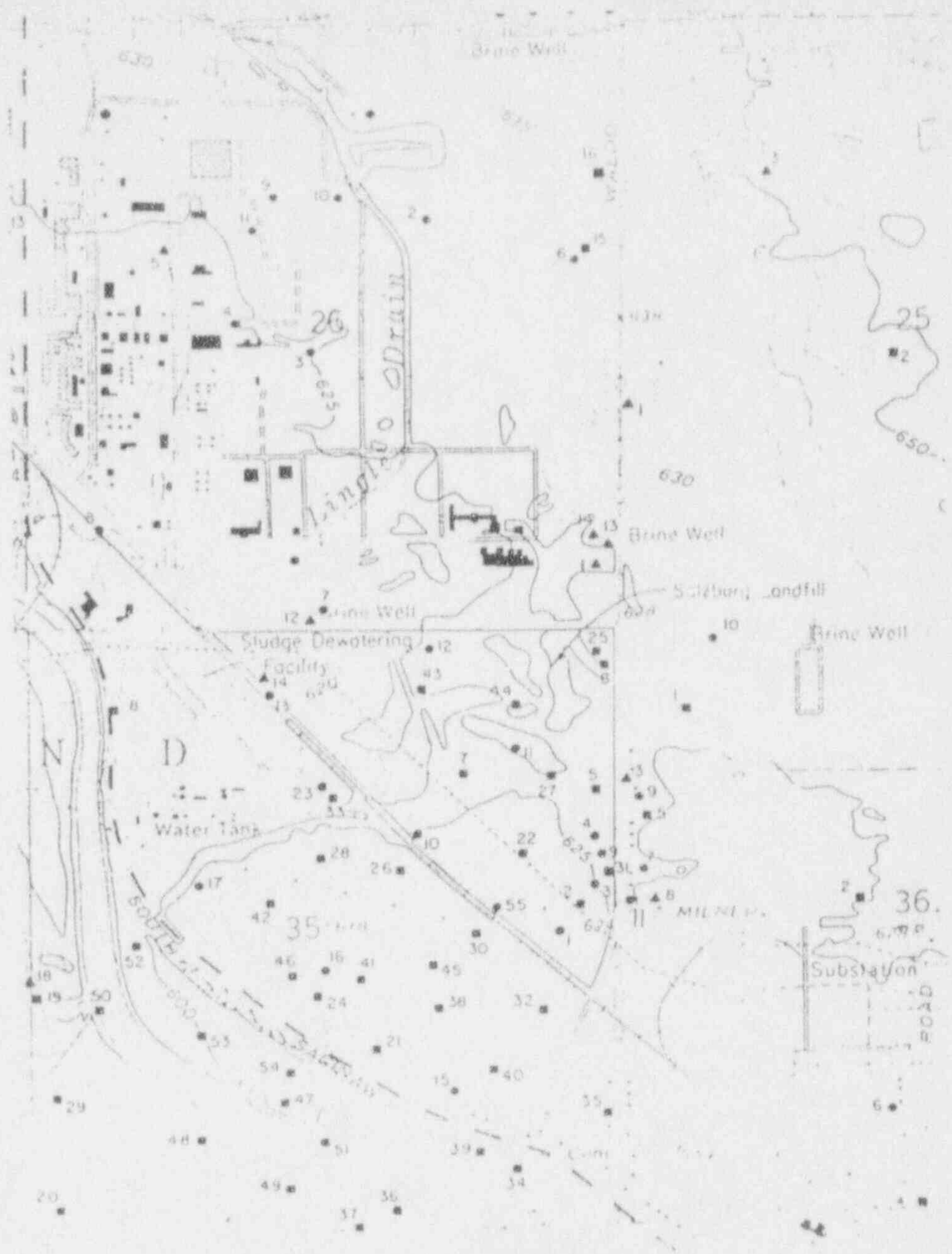

WELLS OR BORINGS

- ● 50'-99'
- ▲ 100'- BEDROCK
- ■ TO BEDROCK

WELLS ARE NUMBERED BY SECTION

N

0 1000' 2000' 3000'

TOPOGRAPHY AND LOCATION OF WELLS AND BORINGS DEEPER THAN 50 FT.

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E" PREPARED BY EDI ENGINEERING & SCIENCES FOR DOW CHEMICAL U.S.A.

Dames & Moore

FIGURE 7.4-1

TABLE 7.4-1

DOW CHEMICAL
BORING AND WELL LOG SUMMARY

Map Location	Well Log No.	Owner's Name	Location	Boring or Well	Approx. Elev.	Depth (Ft.)	Static W.L. Elev.	Drift or Rock	Remarks
25-1	----	Handy Bros.	NW NW SW	Boring	635	265	----	Drift	Coal Co. 1905
25-2	----	Handy Bros.	NE NE SW	Boring	648	310	----	Rock	Co l Co. 1906
25-3	----	Handy Bros.	SE NW NW	Boring	650	243	----	Drift	Coal Co.1906
26-1	DH-1	Dow Corning	SE SE SE	Boring	624	111	----	Drift	
26-2	DH-2	Dow Corning	NE SW NE	Boring	630	100	----	Drift	
26-3	DH-3	Dow Corning	NE NE SW	Boring	625	100	----	Drift	
26-4	DH-4	Dow Corning	SW SE NW	Boring	625	100	----	Drift	
26-5	DH-5	Dow Corning	NE SW NW	Boring	624	140	----	Drift	
26-6	MW-1	Dow Corning	NE SE NE	Observ.	628	100	581	Drift	Well set at 62'
26-7	MW-2	Dow Corning	SW SW SE	Observ.	615	100	Dry	Drift	Well set at 73'
26-8	MW-3	Dow Corning	NW SW SW	Observ.	615	85	----	Drift	Well set at 78'
26-9	MW-4	Dow Corning	NE SE NW	Observ.	630	75	620	Drift	
26-10	MW-5	Dow Corning	NW SW NE	Observ.	631	78	----	Drift	Well set at 68'
26-11	MW-6	Dow Chemical	NW SE NW	Observ.	627	78	----	Drift	Well set at 75'
26-12	7 Monroe	Dow Chemical	SE SE SW	Ind.	615	177	607	Drift	Well set at 177'
26-13	8 Monroe	Dow Chemical	SE SE SE	Ind.	632	207	624	Drift	Well set at 199'
26-14	----	Dow Chemical	NE SE SE	Ind.	630	155	618	Drift	Old Monroe #8
26-15	----	Dow Chemical	NE SE NE	Ind.	638.7	417	619.2	Rock	
26-16	3138	Dow Chemical	SE NE NE	Observ.	640	475		Rock	
35-1	MW-7	Dow Chemical	SE SE NE	Observ.	623.3	65	568.2	Drift	
35-2	3010	Dow Chemical	SE SE NE	Observ.	624.9	142	592	Drift	Well set at 127'
35-3	MW-8	Dow Chemical	SE SE NE	Observ.	625.4	68	605.8	Drift	
35-4	MW-9	Dow Chemical	NE SE NE	Observ.	628.7	63	605.6	Drift	
35-5	3009	Dow Chemical	NE SE NE	Observ.	628	166	609.5	Rock	Well set at 158'
35-6	3011	Dow Chemical	NE NE NE	Observ.	624.4	170	624	Rock	Well set at 122'
35-7	3012	Dow Chemical	SW NE NE	Boring	611	164	----	Rock	
35-8	3013	Dow Chemical	NE NW NW	Observ.	615.6	256	618.7	Rock	Well set at 193'

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TABLE 7.4-1
DOW CHEMICAL
BORING AND WELL LOG SUMMARY (continued)

Map Location	Well Log No.	Owner's Name	Location	Boring or Well	Approx. Elev.	Depth (Ft.)	Static W.L. Elev.	Drift or Rock	Remarks
35-9	2402	Dow Chemical	NE SE NE	Boring	624.9	100	616.9	Drift	
35-10	2396	Dow Chemical	NE SW NE	Boring	627.7	100	616.7	Drift	
35-11	2388	Dow Chemical	SW NE NE	Boring	626.8	100	617.8	Drift	
35-12	2366	Dow Chemical	NE NW NE	Boring	626.2	100	617.2	Drift	
35-13	2373	Dow Chemical	NE NE NW	Boring	620.9	100	615.9	Drift	
35-14	2708	Dow Chemical	NE NE NW	Observ.	620.0	235	620	Drift	Well set at 142'
35-15	2201	Dow Chemical	NE SW SE	Boring	618	50	----	Drift	
35-16	2202	Dow Chemical	NW NW SE	Boring	617	50	----	Drift	
35-17	2199-A	Dow Chemical	SW SE NW	Boring	625	50	----	Drift	
35-18	CP-7	Consumers Power	NW NW SW	Observ.	632.4	120	----	Drift	Well set at 115'
35-19	CP-8	Consumers Power	NW NW SW	Observ.	632.9	190	----	Rock	Well set at 180'
35-20	CP-10	Consumers Power	SW SW SW	Observ.	631.3	173	----	Rock	Well set at 168'
35-21	----	Consolidated Coal	SW NW SE	Boring	616	239	----	Rock	1913 Coal
35-22	----	Consolidated Coal	NW SE NE	Boring	623	241	----	Rock	1913 Coal
35-23	----	Consolidated Coal	NE SE NW	Boring	624	242	----	Rock	1913 Coal
35-24	----	Consolidated Coal	SE NE SW	Boring	619	240	----	Rock	1913 Coal
35-25	----	Consolidated Coal	NE NE NE	Boring	626	235	----	Rock	1913 Coal
35-26	----	Consolidated Coal	SW SW NE	Boring	622	230	----	Rock	1913 Coal
35-27	----	Consolidated Coal	S NE NE	Boring	624	238	----	Rock	1913 Coal
35-28	----	Consolidated Coal	W SW NE	Boring	622	233	----	Rock	1913 Coal
35-29	----	Consolidated Coal	NW SW SW	Boring	609	179	----	Rock	1913 Coal
35-30	3170	Dow Chemical	SW SE NE	Boring	620	136	----	Rock	No well set
35-31	----	Handy Bros.	SE SE NE	Boring	625	301	----	Rock	1907 Coal
35-32	----	Handy Bros.	SW NE SE	Boring	618	234	----	Rock	1904 Coal
35-33	----	Handy Bros.	NE SE NW	Boring	624	227	----	Rock	1906 Coal
35-34	----	Handy Bros.	SW SE SE	Boring	605	258	----	Rock	1904 Coal
35-35	----	Consolidated Coal	NE SE SE	Boring	619	239	----	Rock	1904 Coal

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TABLE 7.4-1

[illegible] CHEMICAL
BORING AND WELL LOG SUMMARY (continued)

Map Location	Well Log No.	Owner's Name	Location	Boring or Well	Approx. Elev.	Depth (Ft.)	Static W.L. Elev.	Drift or Rock	Remarks
35-36	----	Consolidated Coal	SW SW SE	Boring	595	220	----	Rock	1904 Coal
35-37	----	Handy Bros.	SW SW SE	Boring	605	210	----	Rock	1904 Coal
35-38	----	Handy Bros.	NE NW SE	Boring	617	223	----	Rock	1904 Coal
35-39	----	Handy Bros.	NW SE SE	Boring	605	230	----	Rock	1904 Coal
35-40	----	Handy Bros.	SW NE SE	Boring	617	254	----	Rock	1904 Coal
35-41	----	Handy Bros.	NW NW SE	Boring	616	265	----	Rock	1904 Coal
35-42	----	Handy Bros.	SE SE NW	Boring	622	230	----	Rock	1904 Coal
35-43	----	Handy Bros.	NE NW SE	Boring	625	232	----	Rock	1901 Coal
35-44	3168	Dow Chemical	NW NE NE	Observ.	627	168	623.46	Rock	Screen set at 1??
35-45	----	Handy Bros.	NE NW SE	Boring	615	19?	----	Rock	1904 Coal
35-46	----	Handy Bros.	NE NE SW	Boring	619	200	----	Rock	1904 Coal
35-47	----	Handy Bros.	NE NE SW	Boring	595	215	----	Rock	1904 Coal
35-48	----	Handy Bros.	SW SE SW	Boring	505	233	----	Rock	1904 Coal
35-49	----	Handy Bros.	SE SE SW	Boring	605	210	----	Rock	1904 Coal
35-50	----	Handy Bros.	SW NW SW	Boring	595	226	----	Rock	1904 Coal
35-51	----	Handy Bros.	NE SE SW	Boring	600	209	----	Rock	1904 Coal
35-52	----	Handy Bros.	NE NW SW	Boring	605	204	----	Rock	1904 Coal
35-53	----	Handy Bros.	SW NE SW	Boring	600	228	----	Rock	1904 Coal
35-54	----	Handy Bros.	SE NE SW	Boring	600	214	----	Rock	1904 Coal
35-55	3169	Dow Chemical	SW SE NE	Boring	621	96	----	Drift	No well set
36-1	----	Handy Bros.	SW NW NW	Boring	630	290	----	Rock	1906 Coal
36-2	--	Handy Bros.	SW SE NW	Boring	625	287	----	Rock	1905 Coal
36-3	----	Handy Bros.	NW SW NW	Boring	626	173	----	Drift	1905 Coal
36-4	----	Dow Chemical	SW SW SE	Oil-Brine	621.5	4406	----	Rock	Dry
36-5	1131 Waldo	C.W. Witherspoon	NW SW NW	Dom.	625	232	535	Rock	Salt Water at [illegible] Well set at [illegible]
36-6	1428 Bus	W. LaFever	NE SE SW	Dom.	620	50	608	Drift	
36-7	1185 Waldo	J. Lewis	SW SW NW	Dom.	625	65	609	Drift	

TABLE 7.3-1

DOW CHEMICAL
BORING AND WELL LOG SUMMARY (continued)

Map Location	Well Log No.	Owner's Name	Location	Boring or Well	Approx. Elev.	Depth (Ft.)	Static W.L. Elev.	Drift or Rock	Remarks
36-8	1215 Waldo	M. Hochstetler	NW NW SW	Dom.	623	134	603	Drift	
36-9	1119 Waldo	Dow Chemical	SW NW NW	Dom.	625	98	595	Drift	
36-10	Salzburg Rd	Central Transport	NE NW NW	Comm.	630	75	608	Drift	
36-11	----	J. Trout		Dom.	----	40-60	----	Drift	

The currently used domestic wells are all regularly sampled as part of the landfill's monitoring program. No contamination of these wells has been detected.

7.4.2 Monitoring Wells

RCRA and Act 64 monitoring wells surround the Salzburg Landfill. Selected logs from these wells are included in Appendix D.

> "From these wells, ground-water elevations are measured in the Lakebed Clay unit and in a localized aquifer found in the Glacial Till unit. The Act 64 monitor wells were constructed with a thick sand pack so that the wells are open to approximately 25 feet of formation in most cases. The exceptions are monitor wells 3, 4 and 7A which are open to a thickness of 15 feet, and monitor well 8 which is open to 35 feet of formation. For all of the monitor wells, except 7A, 8, and 9, the depth is 41 feet or less and the open interval straddles the boundary between the Lakebed Clay and the Glacial Till units. Because of this method of well construction, the water in these monitor wells can be either from the Lakebed Clay or the Glacial Till or both. Because the Lakebed Clay contains saturated silty layers and the Glacial Till or both. Because the Lakebed Clay contains saturated silty layers and the Glacial Till generally yields very little water, the source of most of the water to the monitor wells is expected to be the Lakebed Clay.
>
> "Monitor wells 8 (35-3) and 9 (35-4) are in a localized aquifer within the Glacial Till unit at an approximate elevation of 560 feet. This is the only sand layer (aquifer) found within the Glacial Till unit that is known to underlie the waste management boundary". (EDI, 1984)

Monitor well 5 is the well closest to Cell 37, the cell which will be used for the disposal of the thorium contaminated materials.

7.5 GROUND WATER

There are no useable sources of groundwater beneath Cell 37. Based on the boring logs and wells in the vicinity, Cell 37 will be underlain by a recompacted lakebed clay layer, dense glacial till and bedrock. No aquifers are found below the proposed disposal cell.

The surficial sand layer and lakebed clay layers are not known to be used as a water source by any of the residential wells to the east of the site. The sand layer is generally unsaturated and hence these are no groundwater discharge points. The lakebed clay is generally saturated. Several of the Act 64 monitor wells are screened across the lakebed clay and till interface and yield limited quantities of water. The yields are very low and the unit is not considered an aquifer. Groundwater flow directions and discharge locations have not been identified within the lakebed clay. However, it is likely that flow is toward the Tittabawassee River, south of the site. No springs or seeps have been identified on or adjacent to the site.

Water levels and their fluctuations in the Act 64 wells from 1981, '82 and '83 are shown on Figure 7.5-1.

Currently, flow in the sand lense within the till to the east of the landfill is eastward toward the domestic wells along Waldo Road. However, it is not known if this is the natural gradient or a gradient imposed by the pumping of these wells.

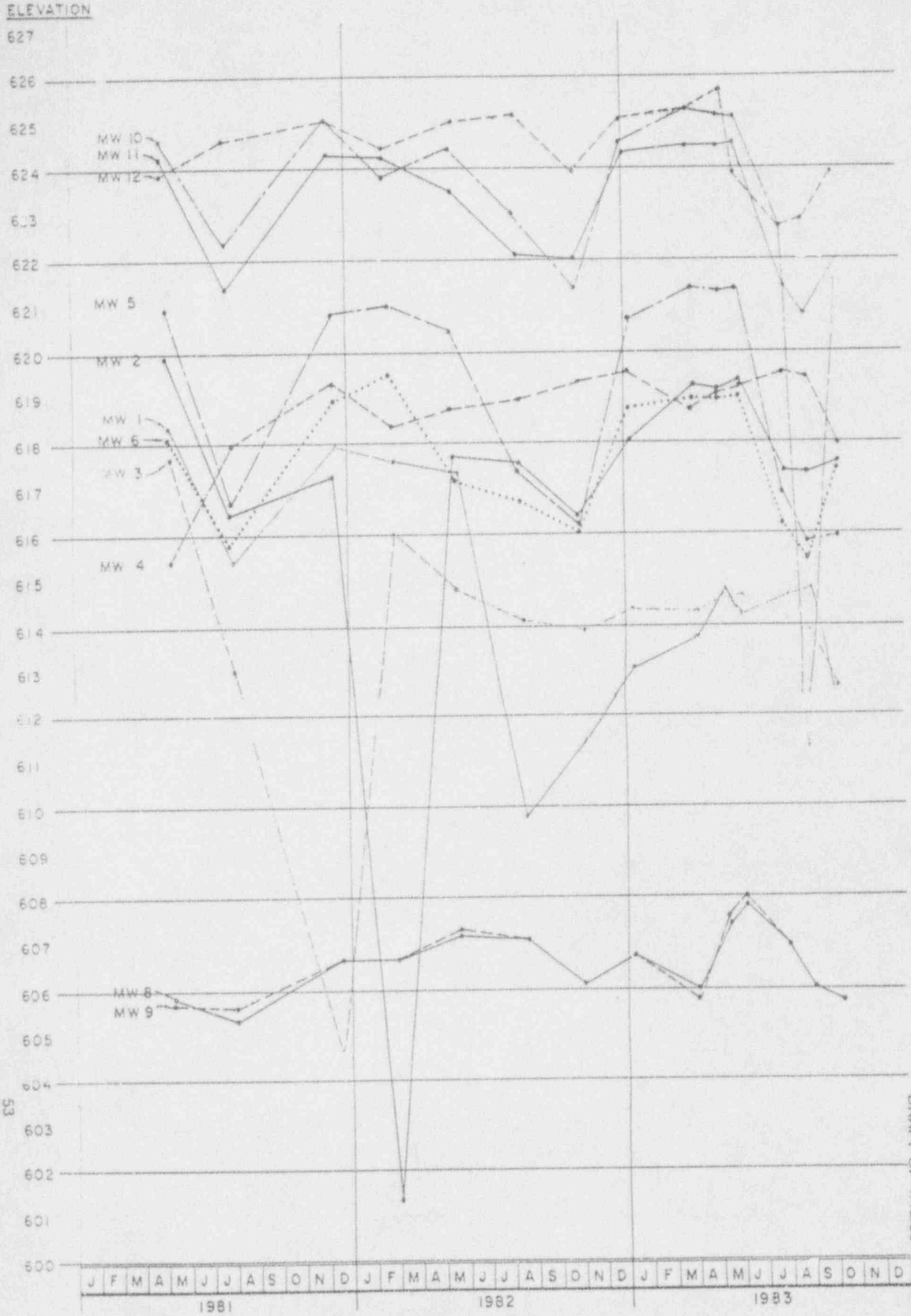
Bedrock composed predominantly of shale is found below the till beneath Cell 37. This bedrock unit is not used as a source of water in the area.

West of the disposal cell, below the till is a locally thick, sand aquifer. The aquifer is found at a depth of over 125 feet. Figure 7.2-7 shows the extent and thickness of this unit in the vicinity of the site. The discharge location of the aquifer is not known but is suspected to be the Saginaw Bay. However, the aquifer is confined, and some water is undoubtedly lost to the overlying till. Flow is generally to the northeast in the aquifer, as shown on Figure 7.5-2. This aquifer is used as a drinking water supply.

7.6 SURFACE WATERS

The only surface water in the vicinity of the Salzburg Landfill is the Tittabawasee River, which at closest approach is about 1200 ft. west of the Landfill and 2,500 feet from Cell 37. The Tittabawasee flows southeast to join the Saginaw River at Saginaw, which then flows northeast to discharge into the Saginaw Bay at Bay City.

A 1983 FEMA Flood Insurance Study indicated that the maximum recorded flow occurred in 1916 with a flow of 34,800 cubic feet per second (cfs).



WATER LEVEL FLUCTUATIONS OF MONITOR WELLS

ADAPTED FROM "SALZBURG LANDFILL RCRA PART B APPLICATION, SECTION E"
PREPARED BY EDI ENGINEERING & SCIENCES FOR DOW CHEMICAL U.S.A.

FIGURE 7.5-1
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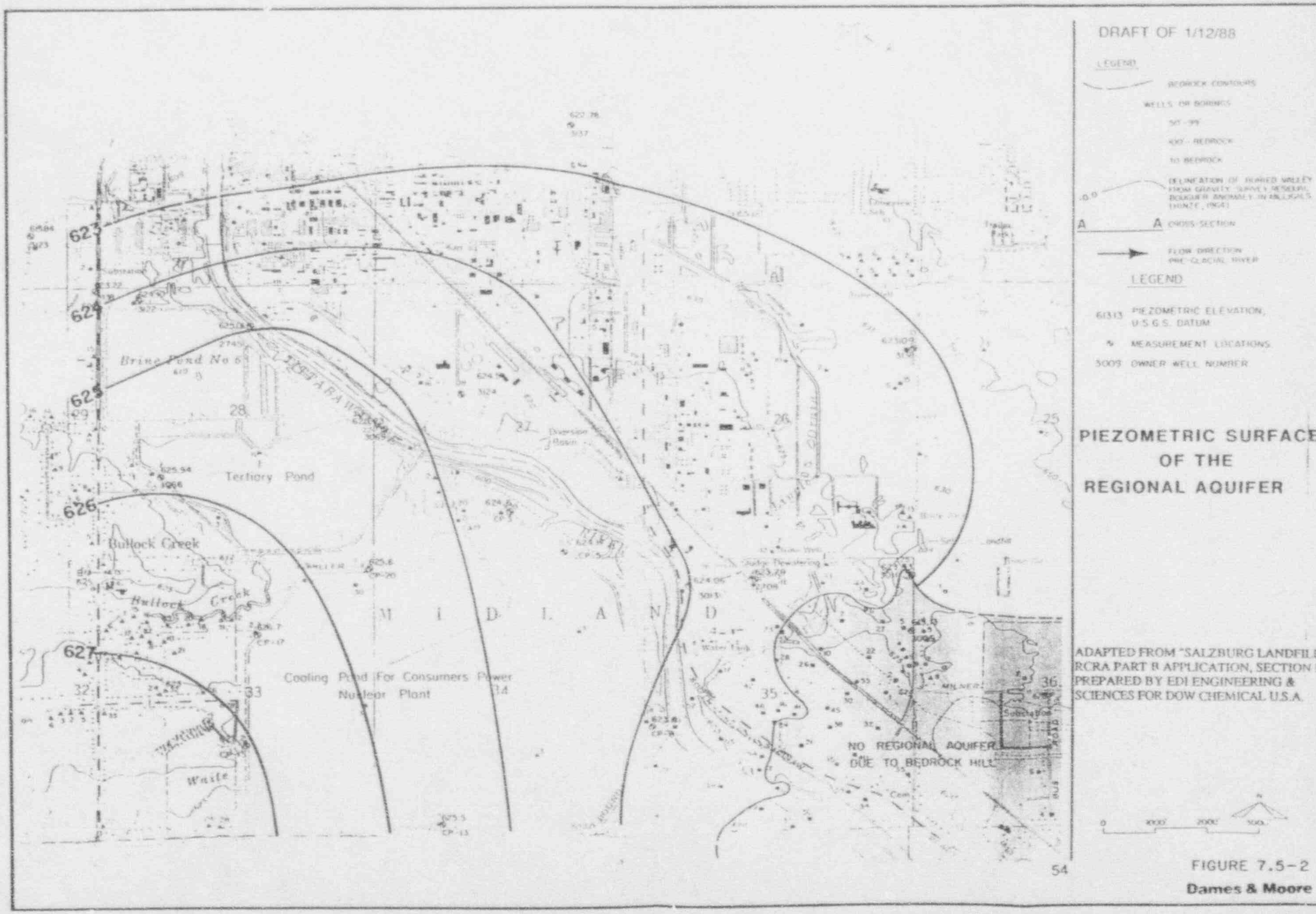

PIEZOMETRIC SURFACE OF THE REGIONAL AQUIFER

FIGURE 7.5-2

Dames & Moore

7.7 HYDROGEOLOGIC DATA

7.7.1 Ground-Water Occurrence

Although ground water is present in all four of the stratigraphic units at the Salzburg Landfill site, the circumstances and characteristics of those waters are different. The occurrence of ground water can be divided into the following three categories:

"1. Surface Sand and Lakebed Clay Waters: Ground water seasonally saturates the lower portion of the surface sand above the Lakebed Clay. Precipitation forms a seasonally variable perched saturated zone, as the water is retarded from downward infiltration by the Lakebed Clay.

The Lakebed Clay is saturated as well. However, due to its clay content and highly stratified nature, the water is held within the clay and thin lenses of silt, sand and sandy gravel. These seams are poorly connected; however, they will seep water into wells placed in the Lakebed Clay.

2. Glacial Till Waters: The Glacial Till unit is composed dominantly of low permeable till which will not yield water to wells and through which water can move only very slowly. Within the till, however, are saturated sand and silt layers. The amount of water available to a well that penetrates one of these layers is extremely variable. Some of them provide little more than a seep; others in a sand subunit will support pumping rates greater than 15 gallons per minute. The permeability and the extent of the sand and silt layers affect the yield of wells in the unit as well as the degree of connection with a source of recharge. Most of these layers are apparently not interconnected or poorly so, and water chemistry suggests that the recharge which does occur is largely from the underlying Regional Aquifer.

3. Regional Aquifer Water: The Regional Aquifer is an artesian (confined) aquifer. It fills the bedrock valleys and pinches out against the bedrock hills. Wells penetrate this unit around the Consumers Power cooling pond, the landfill, and throughout the south Midland industrial area. In all cases the artesian head is high, on the order of 625 feet elevation. Where the land surface elevations are low, the artesian head is above the land surface and flowing wells result. The artesian head is 35 feet above the river west of the Salzburg landfill site." (EDI, 1984)

7.7.2 Ground-Water Movement

"Static ground-water elevations can be used as an aid to determine the degree of hydraulic connection between various occurrences of ground water. Also, the direction of ground-water movement in an aquifer can be estimated with knowledge of the difference in static water elevations measured at various locations. To determine the rate of flow, the permeability of the aquifer has to be known as well. The water elevations only have meaning for flow rate calculations when all measurements are in the same or hydraulically connected aquifer(s). Recent water level data for the Consumers Power cooling pond wells and Dow monitoring wells are given in [Table 7.4-1].

"In the Surface Sand unit, the water table is variable in time and location due to topographic control of discharge (i.e., location of drainage ditches), and variation in infiltration of precipitation and evapotranspiration. This seasonal, perched water table is generally a subdued image of the topography. In the general area of the Salzburg Landfill, the discharge is south to the Tittabawassee River or northwest to Lingle Drain in Section 26.

"The locations of the current monitoring wells (required for licensing the landfill under Michigan Act 64) are shown in Figure [7.4-2], and the logs for these monitoring wells are included in Appendix [D]. From these wells, ground-water elevations are measured in the Lakebed Clay unit and in a localized aquifer found in the Glacial Till unit. The Act 64 monitor wells were constructed with a thick sand pack so that the wells are open to approximately 25 feet of formation in most cases. The exceptions are monitor wells 3, 4 and 7A which are open to a thickness of 15 feet, and monitor well 8 which is open to 35 feet of formation. For all of the monitor wells, except 7A, 8, and 9, the depth is 41 feet or less and the open interval straddles the boundary between the Lakebed Clay and the Glacial Till units. Because of this method of well construction, the water in these monitor wells can be either from the Lakebed Clay or the Glacial Till or both. Because the Lakebed Clay contains saturated silty layers and the Glacial Till generally yields very little water, the source of most of the water to the monitor wells is expected to b[illegible] the Lakebed Clay.

"Monitor wells 8 (35-3) and 9 (35-4) are in a localized aquifer within the Glacial Till unit at an approximate elevation of 560 feet. This is the only sand layer (aquifer) found within the Glacial Till unit that is known to underlie the waste management boundary.

"The original monitor well 7 (35-1) yielded very little water and was easily bailed dry. This well was screened in clay within the Glacial Till, so there was very little seepage into the well. Monitoring well 7 was abandoned in November of 1985 and monitoring well 7A was installed in January of 1986 to yield more representative samples of the groundwater quality. Monitoring well 7A is screened at the base of the Glacial Till.

"The static water elevations of the Act 64 monitor wells for the years 1981 through 1983 are plotted in Figure [7.5-1]. The water elevations from these wells plot into five distinct groups. The wells which straddle the boundary between the Lakebed Clay and Glacial Till (Wells 1 through 6 and 10 through 12) comprise three of these groups. Monitor wells 10, 11, and 12 (Group 1) have the highest water elevations and reflect the higher elevation of the ground surface where these wells are located; i.e., the northeast part of the landfill site. These water elevations exhibit a seasonal variation of approximately four feet. The differing seasonal response of the individual wells of Group 1 indicate poor or no hydraulic connection between these wells.

"Monitor wells 2, 4, 5, and 6 form Group 2. Here the average water elevations are about six feet lower than the Group 1 wells. These lower water elevations reflect the lower land elevations of the southwest side of the landfill, which is the area where these wells are located. The seasonal water level variation for these wells is approximately five feet.

"Monitor wells 1 and 3 form Group 3. These wells appear to be affected by the construction and operation of the landfill. These wells are located close to the active part of the landfill. The construction and operation of the landfill may have diminished some of the recharge to these wells. All of the precipitation that falls on the active and developed portions of a landfill is collected and is no longer available for ground-water recharge. In addition, the liner failure detection system has probably lowered the hydrostatic head in the Lakebed Clay adjacent to the landfill. Although there is a definite trend of decreasing static water level in the Group 3 wells, there still is some seasonal variation.

"The wells in the first three groups indicate that sand lenses in the Lakebed Clay are poorly connected hydraulically, and their seasonal response indicates that the recharge of water is from precipitation.

"Monitor wells 8 and 9 form the fourth group and are in a localized aquifer within the Glacial Till. The correlation of elevations and fluctuations of water levels in these two wells is much greater than for any of the other wells in Figure [7.5-1]. The average water elevation is approximately 606 feet. The fluctuation of the water elevations is two feet in range, which is half that of the shallower wells. In addition to the difference in water elevations, the water from monitor wells 8 and 9 has a distinctly different water quality than the other monitor wells. The water quality is similar to that of the Regional Aquifer.... There is insufficient data to correlate the fluctuation of these water levels with that of the Regional aquifer below.

"Based on water level measurements from monitor wells 8 and 9 and the well at 1207 Waldo Road, ground water in this localized aquifer has an easterly flow direction, with a gradient of approximately 0.002, or ten feet per mile. Whether this direction of flow is a natural gradient or the result of ground water withdrawal from private wells along Waldo Road is not known.

"The flow rate of ground water in this localized aquifer can be estimated from the measured gradient (dh/dl) of the water. The estimated hydraulic conductivity (K) of the fine sands is 100 gallons per day per square foot. The porosity (θ) is estimated at 25%. The velocity of flow is given by the following equation:

$$V = \frac{K}{\theta} \; \frac{dh}{dl} \; \frac{cf}{gal} = \text{velocity in ft/day}$$

$$V = \frac{100 \text{ gal/day/sf} \times 0.002}{0.025 \times 7.48 \text{ gal/cf}} = 0.1 \text{ ft/day}$$

"This is very rough approximation of ground water flow rate; however, it is the best that can be given until the variability of the gradient with time is known.

"Based on similarities in water chemistry, it is concluded that localized aquifers in the lower portion of the Glacial Till unit are hydraulically connected to the Regional Aquifer. These sands can be hydraulically connected to the Regional Aquifer by two means. First, the boundary between the two units is not uniformly flat, but varies in elevations so that a sand which appears separated in one well is connected at another point. Secondly, some of the Glacial Till sand layers may be separated from the Regional Aquifer by sediment which is more sandy and permeable than is typical of the upper section of Glacial Till unit, thereby allowing some hydraulic connection with the Regional Aquifer. The sand which is screened at 120 feet in Well 3011 (35-6) is an example of the first type. It appears disconnected in cross sections A and B [Figures 7.2-1 and 7.2-2] but is connected in the area of Well 3168 (35-44) in cross section D [Figure 7.2-4]. The screen in Well 3168 was set at 112 feet to 117 feet of depth (elevation 510 to 515) in a sand and gravel zone with some clay. The static water elevation is 623.46, which is that of the Regional Aquifer. Above the sand and gravel zone is clay and stone and above that is a sandy clay and gravel zone which is part of a sand layer within the Glacial Till Unit. This section from 560 feet to the Regional Aquifer drilled faster than the normal Glacial Till, indicating it may be a zone of marginal hydraulic connection between the Regional Aquifer and the localized sand layer within the Glacial Till.

"[Figure 7.5-2] is a contour map of the static water levels in wells that penetrate the Regional Aquifer. The most striking feature of this aquifer is the high static water level or head. This aquifer must have a high recharge area which supplies the head. The contours on Figure [7.5-2] show the head is the highest southwest of the landfill in the area of the Consumers Power cooling pond. This indicates a recharge area that must be to the south and/or west. The direction of flow in the Regional Aquifer is to the northeast under the cooling pond. The flow then diverges to the northwest and northeast into the branches of the bedrock valley. The limit of the Regional Aquifer against the bedrock hill in Sections 35 and 36 is indicated on the map. Water level data from the wells in the Regional Aquifer around the Consumers Power cooling pond for the years 1979 through 1981 show a fluctuation range of three feet. The recent water elevations are near the top of that range, and the record indicates that neither the gradient direction nor steepness have changed appreciably from 1979 to the present. The gradient under the cooling pond is approximately 0.00033 or 1.7 feet per mile based on the most recent data.

"The flow rate of the water in the Regional Aquifer can also be roughly estimated. The estimated value for K is 100 gal/day/sf and the porosity is estimated at 25%. Given these values,

$$V = \frac{100 \text{ gal/day/sf} \times 0.00033}{0.25 \times 7.48 \text{ gal/cf}} = 0.018 \text{ ft/day}$$

"Within the study area, the Regional Aquifer does not discharge directly to any surface water body; unless the aquifer extends all the way to Saginaw Bay, it is unlikely to have a direct surface water discharge anywhere. It is believed that the primary discharge for the Regional Aquifer is to shallower aquifers in the Glacial Till. (EDI, 1984)

7.7.3 Hydrogeologic Properties

"Surface Sand Unit: A surficial sand layer covers most of the landfill site. This surface sand unit consists of highly stratified fine sand and silt and contains thin layers of clay. The unit is particularly silty and clayey near the bottom where it grades into the more massive clay unit which underlies it.

"The 49 borings which were drilled for the landfill site evaluation show the surface sand layer to range from 0 to 13 feet in thickness with an average thickness of approximately 4 feet. The landfill borings were drilled in late October and early November, 1979, following several months of dry weather, so the surface sand was dry. However, a seasonal saturated zone can be expected in this unit when water from rainfall or snowmelt is "perched" on the underlying clay. Figure [7.1-1] is an isopach map showing the occurrence the surface sand unit. Under the Salzburg Landfill, the Surface Sand will be completely removed during excavation and construction of the liner failure detection system.

"Lakebed Clay Unit: The Lakebed Clay unit underlies the entire site directly below the surface sand and ranges from 14 to 24 feet thick. The contact between the Lakebed Clay and the Glacial Till is very sharp and distinct in the geophysical logs, particularly the resistivity measurements. The top of the unit lies at elevations between 617 and 622 feet. Bottom elevations are between 594 and 605 feet. For comparison, the bottom of the landfill's liner failure detection system is at an approximate elevation of 600 feet.

"The unit is stratified and consists of clay layers mixed with varying fractions of sand and silt. Less than 10 percent of the unit consists of distinct sand, sandy gravel and silt layers. These layers are usually 0.5 feet or less in thickness and are interbedded within the clay. The sandy layers are often wet and are the source of most of the water in site borings. The clay is plastic due to high moisture content. During the excavation of the first 4 landfill cell groups (7 acres total), several saturated sand and gravel layers were encountered. The largest was about 25 feet wide, extending across several cells, and 2 to 3 feet thick on an average. These layers drained readily when first cut into, however the flow was temporary because there is essentially no hydraulic connection between layers.

"During the original engineering study, sixty-three silt and clay samples from this unit were collected from the landfill site and analyzed for permeability, Atterberg limits, pH and particle size. Laboratory permeability ranged from 3.1×10^{-6} to 1.4×10^{-8} cm/sec, with 86 percent less than 1.0×10^{-7} cm/sec. Clay particles (less than 5 microns) comprise a significant fraction of all samples ranging from 23.4 to 96.2 percent with an average of 56.3 percent. The liquid limit ranged from 13.0 to 56.5 percent and average 36.2 percent. The plastic index ranged from non-plastic to 35.8 and averaged 16.6. The pH ranged from 7.3 to 8.9. Using the Unified Soil Classification, the unit is predominantly a CL clay with subordinate amounts of CH, SC, SP-SM, ML-CL, and ML soils.

"Glacial Till Unit: This unit lies directly below the Lakebed Clay unit and could be identified during drilling by rock fragments (pebbles), hard drilling, and a more uniform, sandy, siltier texture than the overlying Lakebed Clay unit. The unit is typically extremely tight, with local, infrequent saturated interbedded seams of permeable material. The geophysical logs in Appendix [C] show that considerable intervals of the glacial till unit have very uniform characteristics; however, there are also intervals which are clay rich and intervals which are more sandy. These sandy intervals form a sand subunit in the Glacial Till unit.

"It is difficult to find an aquifer within the Glacial Till unit. However, evaluation of the boring and well logs drilled to date indicate that there are areas where the sand subunit within the Glacial Till unit is more prevalent. Figure [7.2-6] outlines the area in which sand was found between the 590 and 550 foot elevations. Several residential wells along Waldo Road are screened in this sand subunit. Water chemistry suggests these localized aquifers are recharged from the higher head Regional Aquifer below.

"The matrix material of the Glacial Till unit is predominantly sand and silt, with a clay fraction that averages about 30 percent. This is in direct contrast to the Lakebed Clay unit where the clay fraction usually exceeded 50%. Twelve samples were collected from the upper 15 feet of the unit of the site and analyzed for permeability, Atterberg limits, pH, and particle size. Permeability ranged from 1.2×10^{-7} to 2.5×10^{-8} cm/sec, with 82% less than 1.0×10^{-7} cm/sec. The liquid limit and plastic index averaged 20.4 and 8.4, respectively, which are notably lower than for the Lakebed Clay. The pH ranged from 8.0 to 9.0, and the unit is a mix between the SM, SC, SC-SM, CL-ML and CL unified classes.

"The deeper rotary borings within the landfill (Dow boring #'s 2708, 3009, 3010, 3011, 3012) and the older coal borings penetrate the entire Glacial Till unit in several places. The borings indicate an average thickness of the unit is approximately 125 feet beneath the Salzburg Landfill.

"Regional Aquifer: This unit lies below the Glacial Till unit primarily in the bedrock valleys. The top of the unit lies at elevations between 420 and 460 feet in the area of the Salzburg Landfill. This unit pinches out against the bedrock hill under the landfill so that the Glacial Till rests directly on the bedrock hill. The elevation of the top of the hill under the landfill is approximately 500 feet. The elevations of the tops of the bedrock hills range between 400 and 520 feet. The bottoms of the bedrock valleys are between 150 and 200 feet above sea level. The Regional Aquifer underlies 30-35% of the area within the boundary of the landfill, or approximately the northwestern one-third of the landfill [Figure 7.2-7].

"The sand and gravel which compose the regional aquifer were deposited as glacio-fluvial material in the bedrock valleys. The thickness of the aquifer in the center of the valley north of the landfill is on the order of 250 feet. The source area of the sand and gravel in the aquifer is not from the local shale in the bedrock formation except in the deepest parts of the valleys. The sand and rock fragments brought up in drilling are composed of a wide range of rock types. Igneous, metamorphic and sedimentary rocks are all represented in samples from Bedrock Valley Well #1 (26-15) and Dow well #3138 (26-16). The amount of shale in the samples from the Bedrock Valley Well #1 increased downward. Coal fragments began to be picked up at an elevation of 280 feet. At an elevation of 240 feet, siltstone and sandstone recognizable as being of the Saginaw Formation were found in the sample. At an elevation of 225 feet, twenty percent of the sample was fine grained sandstone of the Saginaw formation. Drilling was terminated at this level in sandstone. In Dow Well #3138 (26-16) shale fragments began to be encountered at an elevation of 200 feet and were mixed with sand and clay down to an elevation of 165 feet where drilling was terminated. The driller indicated that drilling was not consistently slow as would be the case in solid shale. There are two possible explanations for the driller's findings, 1) he was drilling through interbedded shale and sandstone in the bedrock, 2) he was drilling into shale, sand and clay alluvium of the original bedrock valley. Either explanation would place the "bedrock" boundary near an elevation of 200 feet.

"The Regional Aquifer is composed dominantly of fine sand to gravel. In most locations the sand or gravel is well sorted and clean. The unit also has thin interbedded clay and silt stringers. These show clearly on the geophysical logs for Dow #3137 (22-3) and #3138. Some of these clays are only 1 to 2 feet thick but they comprise 10 to 15 percent of the unit. The stringers are discontinuous and, therefore, not identifiable over an extended area through either the drilling records or the geophysical logs." (EDI, 1984)

7.7.4 Ground Water Quality

"Water quality information can be used in conjunction with the previous data to determine which ground waters are hydraulically connected.

"One method for comparison of water quality is to plot the primary constituents in a form that provides a distinct geometric shape for different waters. One type of geometric plots are termed Stiff diagrams after their originator. Stiff diagrams of inorganic parameter concentrations from many ground-water samples are discussed below.

"<u>Shallow Ground Water:</u> Diagrams for shallow wells (around 22 to 50 feet deep) at the landfill, Consumers Power, and the residential wells along Waldo Road were prepared. The analyses fall into three distinct groups; 1) $Ca^{++}:HCO^{-}_{3}$ rich waters, 2) $Na^{+}:HCO^{-}_{3}$ rich waters, and 3) a special situation for the Consumers Power cooling pond shallow wells.

1. The largest group of waters have calcium and bicarbonate (HCO^{-}_{3}) as the predominant chemical species and exhibit a normal range of concentration for waters in glacial sediments.

2. The second group has a higher concentration of sodium than calcium. This may be is the result of a ground-water process of cation exchange with the glacial clays. Calcium is adsorbed and sodium released by the clays. Because it takes time for this process to occur, it is logical that

these waters have been in the ground longer than the waters in the first group.

3. The third group is from three shallow (22 to 28 feet) wells around the Consumers Power cooling pond. Some of the near surface groundwater from the Consumers Power cooling pond show effects of the materials used to build the pond and line the berm. The waters are highest in calcium and sulfate. The levels of magnesium and bicarbonate are high also. A possible source of these ions is dolomitic limestone containing gypsum used as bank protection for the pond.

"Regional Aquifer: The waters of the Regional Aquifer show a trend of increasing salinity from the upgradient wells on the southwest corner of the Consumers Power cooling pond to the northeast under the landfill.

"Consumers Power Wells 13 (34-2) and 15 (33-1) have unusually high pH values of 9 to 11. The sample from Well 15 is very low in total dissolved solids (TDS) as well as NaCl. The sample from Well 13 appears similar except for higher values of NaCl. Samples from 1979-1980 show both of these wells had higher TDS and Well 15 had a pH range of 7.5 to 8.1. The reason for this recent change in water quality is unknown. Consumers Power wells 17 (33-2), 20 (33-4), 3 (27-10), 5 (27-12), and 10 (35-20) show water similar to the shallow ground water.

"As water moves east-northeast the total dissolved solids increases primarily by accumulation of sodium and chloride. The exact cause of this increase is not known. Possible explanations are:

1. A permeable sandstone bed in the Saginaw Formation in direct contact with the Regional Aquifer, resulting in a zone where the bedrock brine flows into the Regional Aquifer.

2. Upward leakage of bedrock brine through the many old coal borings. Most of the coal borings were drilled in Section 35, which is also the area where most of the higher sodium and chloride concentrations are found.

"Total dissolved solids (TDS) also increase with depth. Bedrock Valley Test Well #1 (26-15) was sampled at several depths. The TDS increased from 1,000 mg/l at the 200 feet depth to 2,700 mg/l at the 270 feet depth. From 270 to 336 feet the TDS fluctuated around 3,000 mg/l. Below 336 feet the TDS was 4,800 mg/l. The well at building 1803 (22-4) was also sampled at several depths when it was drilled. The stiff diagrams for these samples show a strong salinity increase with depth. The source of this salinity is the bedrock.

"Sand Subunit of the Glacial Till Unit: Water from sand layers in the Glacial Till unit in the area of the Salzburg Landfill at depths of 50 to 100 feet shows Stiff diagrams that resemble those of the Regional Aquifer. Around the Consumers Power cooling pond, samples from sand layers in the Glacial Till at depths ranging from 96 to 151 feet show water quality similar to the Regional Aquifer in this area." (EDI, 1984)

7.8 RESOURCES

The proposed site for disposal of the thorium contaminated materials is the Salzburg Landfill, a 152 acre parcel of land owned by the Michigan Division of the Dow Chemical Company. As indicated on Figure 5.3-1, the triangular property is bounded on the north by Salzburg Road, on the southeast by Waldo Road, and on the southwest by C&O Railroad tracks. There are no known mineral resources on or beneath the site.

7.8.1 Local Land Use

As described in Section 5.3.1, most of the surrounding area is heavily industrialized, with some residential housing.

North of the facility is Dow Corning Corporation production facilities. South of the facility are inactive production facilities and vacant land. East of the facility is vacant land and residential housing. West of the Landfill is the Waste Water Treatment Plant of Dow Chemical U.S.A., Michigan Division, Midland locations. To the northwest of the facility are the G&H Development Corp. and Prod Trans, Inc.

7.8.2 Nearby Residences

Nearby residences are described in the Michig . Act 64 Operating License Reapplication:

> "The nearest residences to the facility are along the east side of Waldo Road where there are homes that range in distance from 130 to 400 feet from the facility. Since February, 1980, nine of the homes along Waldo Road and Milner Road, adjacent to the facility, have been purchased by Dow Chemical U.S.A., Michigan Division, Midland location. Of the homes purchased, four were torn down and five homes continue to be occupied. Three of the homes remaining are owned by private individuals.
>
> The remaining private residences are:
>
> 1. L. Bober, 4535 Milner Road
> 2. J. Trout, 1245 South Waldo Road
> 3. C. Witherspoon, 1131 South Waldo Road" (EDI, 1984a)

7.9 MAPS

The proposed disposal site has previously been reviewed and judged suitable for the location of a waste disposal facility based on topographical, hydrological, and geological criteria.

7.9.1 Topography

As described in the Act 64 Operating License Reapplication:

"The topography of the facility is shown on Figure [7.9-1]. In general, the facility slopes slightly from northeast to southwest with approximately five feet of elevation difference. Most surface elevations range between 620 feet and 625 feet, USGS Datum. However, localized elevations both higher and lower do occur. The highest elevation is 636.8 feet and is located on a small-mound near the center of the facility. The lowest elevations are about 617 feet and occur along the western side in localized depressions." (EDI, 1984).

7.9.2 Hydrology & Geology

Maps of the hydrologic and geologic characteristics of the site are included in the Figures in Sections 7.1, 7.2, 7.4, and 7.5.

7.10 SITE STABILITY AND PERFORMANCE

The Salzburg Landfill and Cell #37 (to be used for the disposal of the thorium contaminated materials) have been sited and designed to minimize the possibility of natural hazards impacting the long-term stability of the facility. No flooding, subsidence or erosion of cover materials at the site have been recorded or are anticipated at the facility.

7.10.1 Flooding

The Salzburg Landfill and Cell 37 are designed to be above the 500-year flood plain of the Tittabawasee River and to minimize ponding of surface water on the site during periods of rainfall. The revised preliminary "Flood Insurance Study, City of

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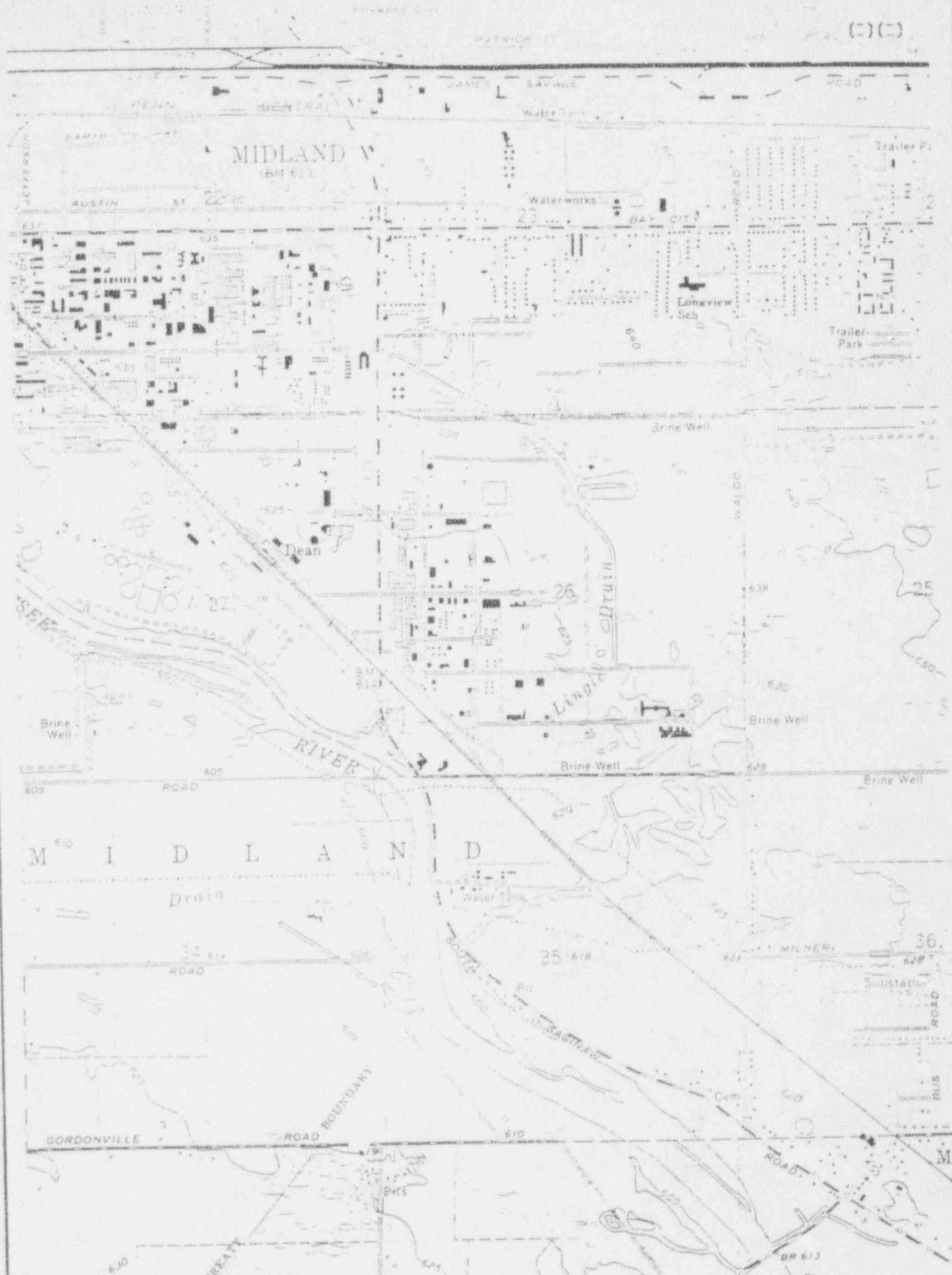

TOPOGRAPHIC MAP OF MIDLAND AREA

ADAPTED FROM USGS MIDLAND SOUTH QUADRANGLE
7.5 MINUTE TOPOGRAPHIC SERIES, 1973

Dames & Moore

FIGURE 7.9-1

Midland Michigan" prepared by the Federal Emergency Management Agency (FEMA) includes an evaluation of the 500-year flood plain on the Tittabawasee River adjacent to the Salzburg Landfill. The 500 year flood elevation is only 613 feet MSL, compared to natural site elevations of 620 to 625 fee.. Final grades on the site are somewhat higher. There is a small Dow dam, approximately 2 miles upstream from the landfill on the Tittabawassee River. Based on the FEMA report, the top of the dam is at elevation 596 ft and the 500 year flood elevation, over the dam, is 617 ft. If a dam break were to occur, the site would still not be flooded, even if it is assumed that the water levels did not decrease between the dam and the site.

The site is graded to minimize or eliminate ponding of water on the site during periods of precipitation. The covers of disposal units, including proposed Cell 37, are graded with a minimum slope of 1% to promote runoff. Drainage between cells is promoted by drainage swales which are inspected annually for signs of erosion or deposition. No ponding of water or erosion has been noted at the site in graded areas.

7.10.2 Subsidence

Subsidence due to long-term settlement of the thorium contaminated materials or liquefaction of soils beneath or adjacent to the disposal cell are not likely to affect the integrity of the disposal cell or drainage of precipitation from the site. In the event of an earthquake, liquefaction of soils is unlikely to occur due to the dense nature of the subsurface till and the relative absence of sands. Although isolated sand lenses are encountered in the till, the high standard penetration resistance values encountered in the borings (see Appendix D) indicate that the sands are too deep and dense to liquify. The soils in the lakebed clay stratigraphic unit are clayey, a soil type not subject to liquefaction.

The thorium contaminated material, as described in Section 3 of this license application, are predominantly soil-like materials (the slag) with limited volumes of construction debris, primarily masonry. These materials will be placed in the disposal cell and compacted as each lift is added. Compaction of the material will minimize void space, and hence settlement, within the cell. This will in turn minimize the effects of settlement (such as changes in site grading) on the disposal cell cover, providing continuation of site drainage in the long term. Thorium bearing construction debris to be disposed of in the cell is generally in small pieces (less than 6" diameter) which will not create large void spaces during compaction. The few isolated pieces of debris as large as 12" will be spread apart from each other.

Organic materials in the construction debris are limited to a few pieces of wood and soil. The wood, like the layer pieces of masonry, will purposely be spread across the disposal cell. The amount of wood is extremely small, and should average much less than 1" in thickness across the cell. Even assuming complete decomposition of the wood, the induced void space and settlement would be minimal.

7.10.3 Drainage and Erosion Control

The following description of drainage and erosion control is from the Salzburg Landfill RCRA Part B Application approved by the U.S. EPA. The entire landfill, and not just Cell 37 which contains the thorium materials, has been designed to control erosion. To ensure compatibility of Cell 37 and the rest of the Salzburg Landfill's erosion control system, the same controls are proposed. Drainage and erosion are primarily controlled by planting and maintaining a vegetative cover of a type which does not require continuing fertilizers and irrigation to insure viability and by establishing a cover slope between 1% and 2% over the actual cell areas. Steeper slopes may occur outside the cell walls where erosion can be tolerated and repaired. Stone and paved drainways for run-off may be provided as maintenance experience demonstrates this need during post-closure. The existing peripheral drain system which is continually developed as the landfill cells are constructed will provide the drainage system for run-off for the active and post-closure periods.

The site is not on the flood plain of the Tittabawassee River (See Section 7.10.1). Therefore, flood erosion will be extremely unlikely.

7.11 PAST DISPOSALS

There have been no previous disposals of radioactive material at the proposed site. However, the site is currently operating as an EPA-licensed hazardous waste disposal facility. In operation since 1982, the Salzburg Landfill receives solid waste from operation of Dow Chemical plants. As described in the RCRA Part B Application:

"The three main types of hazardous wastes placed in the cells include:

(1) incinerator ash

(2) primary waste water treatment plant solids
(3) secondary waste water treatment plant solids

Incinerator ash; primary waste water treatment plant solids and secondary waste water treatment plant solids are considered hazardous waste by application of the provisions of 40 CFR 261.3 and 40 CFR 261.4(a) (2). Because the Dow Chemical USA, Michigan Division, Midland location incinerator is a hazardous waste incinerator, ash from the facility is, by definition, a hazardous waste. In addition, because the Dow Chemical USA, Michigan Division, Midland location waste water treatment facility treats waste water that includes listed waste streams; primary solids and secondary solids form the waste water treatment plant are, by definition, hazardous wastes.

"None of these wastes would meet the characteristic definition of hazardous waste." (Dow, 1986)

The Landfill operators continuously monitor the disposal cells and site groundwater.

There has been no cell leakage or loss of integrity during operation of the facility. There have been several incidents of waste contamination of monitored liquids. Further investigations determined that the liner systems have not failed, and attribute the observed contamination to linkage of the leachate collection system and liner failure detection system. One incident was due to improper handling during placement of a monitoring well. These incidents are summarized in Appendix E.

7.12 PERFORMANCE ASSESSMENT

7.12.1 Intruder Impacts

As mandated by 10 CFR Part 20.302a and the guidance in NUREG-1101, Dames & Moore has assessed the impacts of inadvertent human intrusion by modeling the site and intrusion scenarios using the ONSITE/MAXI1 computer code. These intrusion scenarios include external exposure from the waste mass and internal exposure due to inhalation of airborne particulates and ingestion of potentially contaminated food products raised on the site.

The latest version of the code has been adapted for use on an IBM PC/XT/AT computer. This is the version which was used for the calculation of impacts. This version also permits the user to optionally select data given by the International Commission on Radiological Protection (ICRP) in their Publication No. 30 (ICRP 1979-1982) in place of those given by the ICRP in Publication No. 2 (1959) and supplied with the original ONSITE/MAXI1 computer software. This version of the ONSITE/MAXI1 computer program uses the same methodology (with the addition of ICRP Publication No. 30 methods) and produces essentially the same results as earlier versions of the computer program documented by Napier et. al. (1984) and Kennedy et. al. (1986). Inhalation doses varied from those in earlier versions, because default inhalation parameter values were changed to be consistent with those used in ICRP Publication No. 30. Six sample problems are presented in the documentation. The inputs of these sample problems were executed by Dames & Moore and compared with the documentation as a quality assurance check.

The ONSITE computer program is the interactive user interface that allows the end-user to create and use the radiation exposure scenarios. The MAXI1 computer program is then used with the scenario information to calculate the maximum annual dose to the exposed individual from selected pathways. Intermediate dose conversion factors for the external exposure pathways, ICRP Publication No. 2 internal dose conversion factors (ICRP, 1959), and ICRP Publication No. 30 effective dose equivalent factors for internal inhalation and ingestion (ICRP, 1979-1982) are stored in data files. These factors can be found in the ICRP publications. The inhalation dose conversion factors are derived from the model in ICRP Publication No. 2 (ICRP, 1959) and are calculated using the Task Group Lung Model (TGLM) (ICRP, 1966) as contained in the DACRIN (Houston, Strenge and Watson 1974) computer program. Additional metabolic data for the inhalation calculations were obtained from ICRP Publication No. 19 (ICRP, 1972). The external dose conversion factors for various waste disposal geometries and densities are calculated using the ISOSHLD (Engel, Greenborg and Hendrickson, 1966) shielding program.

Default data files and input parameters which are provided with the code package have been used except where site-specific information is readily available. Table 7.12-1 shows a list of parameters which were chosen to model the Salzburg Landfill disposal scheme.

The scenario developed using the ONSITE program begins in 1990 A.D., the year that the thorium trench is anticipated to be capped. The scenario ends 50 years later, the maximum length of time allotted by the code.

INPUT PARAMETERS FOR ONSITE/MAXI COMPUTER CALCULATIONS

Table 7.12-1

Parameter	Value Input
Scenario Begins	1990 A.D.
Scenario Ends	2040 A.D.
Surface Inventory Dilution Factor	1.0 (unitless)
Size of Disposal Area	1.0 E + 04 m^2
Fraction of Total Diet Grown on Site	1.0 (unitless)
Hours of External Exposure to Contamination	8760 hours/yrs
Hours of Inhalation of Airborne Contamination	8760 hours/yrs
Breathing Rate	270 cm^3/sec
Resuspension Model Used	Mass loading
Density of Resuspended Soil	2.0 E + 06 g/m^3
Mass Loading Factor	1.0 E- 04 g/m^3
Fraction of Roots in Upper Soil	1.0 (unitless)
Concentration of Thorium-232 in Deeply Buried Waste	2.15 E + 08 pCi/m^3
Minimum Depth of Waste	1.0 m

The source term assumed for the thorium-bearing material is 2.2E+08 pCi/m^3 buried 1 meter below the ground surface.

The surface inventory dilution factor was set at 1.0 which means that no credit is taken for environmental turnover or dilution of the contaminated material with clean soil.

Continuous exposure (8760 hours/year) is assumed for external and inhalation pathways. A breathing rate of 270 cm^3/sec is the default value used by the code. Mass loading was selected as the model used for the resuspension source term available for inhalation.

It was assumed that the site is 10,000 m^2 in size, sufficient to generate the entire annual diet for a family of four. The fraction of roots in the upper soil is assumed to be 1.0.

The output file generated by the ONSITE/MAXI1 code is provided as Appendix F. As shown, the maximum annual effective dose equivalent to a hypothetical farmer-agricultural intruder is 1.6 E-04 Rem per year using the ICRP-30 methodology; the maximum annual dose calculated using the ICRP-2 methodology is 1.3 E-03 Rem per year. These hypothetical impacts are much less than the 2.5 E-02 Rem per year which is recommended as a design basis for radioactive waste disposal per 10 CFR Part 61; these impacts also meet the guidelines suggested by NRC (Neuder, et al., 1987) for On-Site disposal under 10 CFR Part 20.302. It should also be noted that the dose is entirely from direct radiation exposure through the cover. However, due to a model limit of 3 feet of cover, compared to an actual cover thickness of over 5 feet, this dose is overstated for the Salzburg Landfill. Therefore, the impacts from the proposed disposition scheme are judged to be acceptably low.

7.12.2 Groundwater

The environmental transport of radionuclides from the Salzburg Landfill through the groundwater is not considered a viable pathway due to the natural site geologic conditions and the design of the disposal cell. Either the natural conditions, or the design, independent of the other, should be fully adequate to minimize or prevent releases through the groundwater. Both in combination provide an even higher margin of safety in protection against the migration of radionuclides through the groundwater pathway. Since groundwater transport of radionuclides is not a viable pathway, MOCMOD has not been used to model transport.

7.12.2.1 Engineered Barriers

The Salzburg Landfill, including Cell 37, has been designed to meet state and Federal regulations for the successful operation of a hazardous waste disposal facility. The Federal, EPA and state regulations were written to provide for zero release from disposal facilities through the use of natural (clay) and man-made materials (PE), leak detection systems, and redundancy in the design. Operating experience at the Salzburg Landfill has shown that the cells constructed to date are functioning as designed and no releases to the environment have been detected.

The first design barrier to the generation and release of leachate to the groundwater is the cover system. As described in Section 8.0, the cover system includes from top to bottom: two feet of topsoil, a sloping, horizontal drainage layer, a polyethylene (PE) infiltration barrier, and 3 feet of compacted clay. Most precipitation falling on the cell will either be diverted as runoff, or evapotranspire. Water migrating through the topsoil to the drainage layer (estimated to be a maximum of 8 inches, Section 7.3) will be diverted by the impermeable PE liner through the drainage media. Even if the PE liner were to fail locally, the clay layer beneath the PE will have a permeability less than 1×10^{-7} cm/sec which would severely limit downward infiltration. Water migrating to the drainage layer will move horizontally through the drain if saturation occurs.

Infiltration through the 3 feet of clay, assuming future failure of the PE, will probably be on the order of 0.026 in/yr (0.08 cm/year). This is calculated assuming a permeability in the clay of 1×10^{-7} cm/sec, a hydraulic gradient of 0.1, and water being available for infiltration during 3 months of the year. The permeability is taken directly from the minimum design specification. Availability of water for 3 months of the year is from the water balance contained in Section 7.3. However, it is likely that infiltration would only occur some days during the 3 months, and not every day, further lowering the infiltration estimate. The hydraulic gradient used in the calculation is probably also higher than would be encountered. However, even if higher gradients were present, they should not be higher than 1. Even using this unrealistically higher estimate of hydraulic gradient results in a calculated maximum infiltration of only 0.26 in/year (0.8 cm/year).

If the PE fails, and limited quantities of water infiltrate through the thorium bearing wastes, a leachate collection system and a clay and synthetic liner are in place to eliminate discharges to the environment. The leachate collection system and synthetic liner should totally prevent releases. As with the cover, if it is assumed the synthetic layer fails, a clay layer is present to severely inhibit migration. In the RCRA Part B permit application approved by the EPA it has been calculated that it would take 15,000 years for water to migrate through the 5 foot thick clay liner assuming no chemical retardation (EDI, 1986). Since thorium has been found by numerous research efforts to have high Kd values (>2700 in clays and 40 to 470 in sands), in soil water mixtures with a pH greater than 6 (Teknekron Research, 1982) the time required for the thorium to migrate through the liner would be significantly longer than the 15,000 years for water, and breakthrough of the thorium would take much longer.

The half-lives of the daughter products of thorium-232 total only 8.6 years (see Table 3.1-2). The migration of the daughters would therefore be for a limited distance before they decay, because of the slow transport of water through the liner and chemical retardation of the elements in clay.

It is unrealistic to anticipate any releases of thorium from the disposal facility to the groundwater. The synthetic and clay liners and covers should prevent the generation and/or migration of leachate bearing thorium-232 or its daughters from the facility.

7.12.2.2 Geologic Barriers

As discussed in Section 7.12.2.1, it is not anticipated that any leachate will be produced or released from Cell 37 in the long term. However, if such a release should occur, no contamination of an aquifer would occur.

There are two partially connected stratigraphic units which are considered aquifers in the vicinity of the Salzburg Landfill: the regional artesian aquifer, locally found beneath the till; and some sand lenses of limited areal extent which are used for domestic water supply. Neither of these two aquifers, as shown on Figures 7.2-6 and 7.2-7, are located directly beneath Cell 37.

The lakebed clay and glacial till (excluding the sand lenses mentioned above) have such low permeabilities that cannot be considered as potentially useable sources of water. Their hydraulic conductivities, as discussed in Section 7.5 are less than 1×10^{-7} cm/sec, far too low to be considered as a potential source of drinking water.

In order for thorium bearing leachate to reach the regional aquifer it would have to migrate downward at least 125 feet and horizontally at least 350 feet. However, as discussed in Sections 7.5 the aquifer is artesian and water migration is actually from the aquifer upward into the till, which will prevent any migration of leachate into the aquifer. Additionally the high clay content of the till (over 30%) and the high pH of groundwater (8.0 to 9.0) would retard thorium migration to extremely low rates. Retardation coefficients for thorium, reported by a number of researchers by Teknekron Research (1982), in clay with high pH in the water are 2,700 or greater. This is essentially equivalent to no migration. Therefore, even if the hydraulic gradient could be reversed, neither thorium-232 nor its short lived daughter products could reach the aquifer.

Migration of thorium-232 and its daughters to the sand lenses used as domestic water supply is unlikely to occur because of the design of the waste disposal cell. However, if a release were to occur, the till should mitigate the likelihood of migration.

The sand lense used as a source of water is approximately 50-75 feet lower than the base of the disposal cell, and 1000 feet to the east. The measured hydraulic gradient in the sand lense east of the till is 0.002 (see Section 7.7.2) and the hydraulic conductivity 1×10^{-7} cm/sec.

The velocity of water in soil can be calculated using the formula

$$V = \frac{Ki}{N_e}$$

Where: K=hydraulic conductivity
i=hydraulic gradient;
N_e=the effective porosity; and
V= the velocity of the water

The effective porosity of a clay is typically in the range of 0.01 to 0.10. Assuming the porosity is 0.01, it would take approximately 50,000 years for water to migrate from the cell to the edge of the sand layer. Thorium, due to its high retardation coefficient, would take much longer.

Another small sand lense, not considered an aquifer in the RCRA Part B permit, is present beneath the northern end of the disposal cell. This lense is restricted to a small area entirely beneath the Salzburg Landfill which will be administratively controlled in the future, preventing its use. The yield from the sand lense is low enough that it isn't considered useable even for domestic use. Additionally, the high retardation of thorium in the 50-75 feet of clayey till above the sand, should prevent the migration the thorium to the sand lense, even if leakage from the cell should occur.

If, in the event of the failure of manmade and natural barriers to migration, some thorium did reach one of the aquifers, concentrations should be extremely low. In 1977, at the request of the State of Michigan, Division of Radiological Health, the solubility of the thorium from the sludge was measured in water of pH 2, 7 and 10. As stated in the analysis of the results, (Dow, 1977): "The solubility at all pH's tested was found to be less than 0.1 micrograms/milliliter or less than 1.1×10^{-8} microcuries/milliliter". This compares to 10 CFR Part 20, Appendix B Table II Column 2 water concentrations of 2×10^{-6} μCi/ml. The Part 20 concentrations are a factor of 182 times higher. It is reasonable to assume that leachate from the thorium slag to be disposed of in Cell 37 would contain activities no higher than those measured in the test since the tests spanned a range of pH's greater than those likely to be encountered in natural conditions.

7.12.3 Surface Water and Bathtubbing

Groundwater transport of thorium to surface water in the vicinity of the Salzburg Landfill is unlikely to occur because of a lack of surface water in the immediate vicinity of the site, the protective nature of the design of Cell 37, and the naturally low permeability of the lakebed clay and till which surround the burial cell.

The potential for "bathtubbing" of the trench, resulting in surficial release of leachate is also unlikely due to the presence of both institutional and design controls. The EPA approved design, used for the Salzburg Landfill including Cell 37, provides controls to minimize or eliminate the generation of leachate, and design features to allow the detection and collection of any leachate which is collected.

The first defense against bathtubbing is the presence of the cover system, described in Sections 8.0 and 7.12.2.1 which should minimize or eliminate infiltration into the disposal cell. The presence of a 30 mil minimum PE cover should provide complete protection against infiltration. As discussed in Section 8.0 the PE is installed under a strict quality assurance and testing program to ensure the reliability of the installed cover.

If, at some point in the future limited leachate was to be generated, due to an unlikely partial failure of the cover, a leachate monitoring and collection system is in place. This system allows for the complete removal of leachate which has migrated through the thorium bearing materials. Since all leachate produced can be removed, bathtubbing cannot occur as long as the site is maintained in the future.

If, in the long term, the PE liners should fail, and institutional control of the leachate collection system should stop, the clay covers and liners will limit the potential for bathtubbing. The top clay cover will be built to have a permeability of less than 1 x 10^{-7} cm/sec. The overlying topsoil and drainage layers have been designed to provide protection to the clay layer from frost damage (Dow, 1986). Since the thorium bearing material to be buried below the clay will be compacted, subsidence should be minimal, protecting the clay cover from subsidence-induced cracking.

If both the top and bottom PE liners fail, infiltration and leachate loss should be balanced since the top and bottom liners have the same permeabilities. If some build-up of water were to occur in the trench this would merely act as an additional driving force to ensure that water would leave the cell as fast as it enters.

As discussed in Section 7.12.2.1, infiltration through the cover should be limited to 0.026 in/yr, even if the PE completely fails. If the cover PE liner completely failed, and the bottom PE liner remained 100 % intact (an unlikely combination) it would still take 100's or 1000's of years for the cell to fill with water.

It is estimated that the compacted thorium slag will have a porosity of at least 20%. The slag thickness in the cell is planned to be between 13.5 and 17.5 feet. If the infiltration is 0.026 inches of water per year, it would fill the cell at a rate of 0.13 in/year since 80% of the cell will already be occupied with the slag solids. At that rate, it would take over 1000 years to fill the trench. However, it is unrealistic to assume that the top PE liner completely fails while the bottom remains [illegible]etely intact.

Therefore, even if the bottom liner remains relatively intact compared to the top liner, it should take thousands of years for the cell to fill with water.

Since bathtubbing and overflow to the surface will not occur at the site, the potential for surface contamination through surface water transport of thorium is extremely low.

8.0 BURIAL PROCEDURES

The applicant intends to bury the thorium-bearing material in a cell of similar design and construction to the cells used for hazardous waste disposal at the Salzburg Landfill. The disposal cell is described in the RCRA Part B Application, and the relevant portions are included in this application as Section 8.1. Drawings of the cell construction and cap are included as Appendix G.

The burial cell into which the material from both storage locations will be disposed has the following approximate dimensions: Length-785 ft; width-115 ft; depth-13.5-17.5 ft. The cell will be filled from the bottom of the cell up. The minimum distance to another burial cell used for disposal of non-radioactive materials is ten feet.

The material will be transported to the Salzburg landfill by truck. The material, mostly in soil form, will be covered with tarpaulins to minimize fugitive dust during transport.

8.1 DISPOSAL CELL DESCRIPTION

Introduction and Scope

"This section describes the construction plan for Salzburg Landfill, owned and operated by the Dow Chemical U.S.A., Michigan Division, Midland Location, EPA Facility I.D. number MID 980617435.

"The plan describes activities related to construction of the liner failure detection system, compacted clay liner, synthetic liner installation, leachate collection system, and operational activities required during operation of the cell. This plan is intended to satisfy the requirements for construction of Cell [37] in accordance with interim status regulations and the Hazardous and Solid Waste Amendments of 1984.

Construction Performance Standard

"The construction plan is designed to ensure that after construction is complete and operation of Cell [37] has commenced, the threat to human health and the environment is minimized or eliminated by preventing release of [radioactive] waste constituents into the ground, groundwater, surface water, or air. If evidence of leaks or spills is detected, samples will be taken and analyzed to determine the extent, if any, of contamination in the ground, groundwater, surface water, or air.

"If contamination is determined to be present, and

1. the contamination is at concentrations sufficient to pose a threat to human health or the environment, and

2. the contamination can be attributed to the operation and/or closure of the facility,

"The most suitable alternative to remedy such contamination will be implemented to insure protection of public health and the environment.

Construction Plan Activities

Drawing B2-001-122 details the cell construction (see Appendix G). "The complete liner system consists of a three foot thick compacted clay liner which has a permeability of 1×10^{-7} centimeter per second or less.

"Above this will be a liner failure detection system consisting of a drainage mat up the walls and drilled collection tubes running horizontally on top of the three foot thick compacted clay liner. The collection tubes will be covered with drainage media to an overall depth of twelve inches. This drainage media will also cover the entire surface of the bottom compacted clay liner to a depth of twelve inches. The liquid collected by the liner failure detection system will gravity drain to a collection sump. Accumulated liquid will be sampled and analyzed when liquid is withdrawn from this collection sump.

"Above the liner failure detection system, a five foot thick compacted clay liner which has a permeability of 1×10^{-7} centimeter per second or less will be constructed.

"On top of the five foot thick compacted clay liner, a 100 mil synthetic membrane will be installed over the entire active surface of the cell.

"The leachate collection system, consisting of perforated pipe covered by a twelve inch thick drainage layer, will be installed above the synthetic liner on the base of the cell.

Liner Characteristics

"The material used for the three foot and five foot clay liners meets the following specifications:

1. Permeability coefficient of 1 x 10^{-7} cm/sec or less.
2. Greater than 25 percent of the particles are less than five microns in diameter.
3. Unified soil classification of CL or CH.

"Soil testing methods, location and frequency [have been reviewed by the EPA in the RCRA Part B Application.]

"The synthetic liner is polyethylene, 100 mil thick.

Equipment Decontamination Steps

"All activities for the construction of Cell [37] are being conducted outside of the active portion of the current waste hauling area. No equipment decontamination before, during, or after construction is necessary.

Erosion Prevention

"Erosion of the clay liner is eliminated by the installation of the synthetic liner on top of it. Run-on from adjacent land areas into the cells is eliminated by having the top of liner five feet above adjacent grade.

Site Preparation

"The cells to be constructed will be prepared by excavating to the desired subgrade profile, per drawings. Topsoil material excavated will be stockpiled for future use in capping. Sandy and off-grade clay soils excavated will be stockpiled separately for use as daily cover in landfill operations.

"Clay soils excavated, suitable for liner construction, will be stockpiled at a location adjacent to the site. This stockpile will be shaped and graded to facilitate precipitation run-off and ease of access for reuse in construction.

"A soil sampling program will be undertaken to confirm the quality of the sub grade material. [This sampling program will be consistent with that approved by the EPA for the remainder of the Landfill.]

"Sufficient soil test data will be generated to ensure that 6 meters of soil with a maximum permeability of 1.0 x 10^{-6} cm/sec is available at all points below and lateral to the bottom of the landfill.

"Techniques to be utilized in obtaining the required soil data may include soil borings and/or resistivity survey to replace or supplement borings.

Benchmark Protection

"Inspection of the facility benchmark is performed every three years by cross-checking the benchmark elevation to the elevation readings of the nearest Dow Chemical U.S.A. Michigan Division, Midland location benchmark. The Dow benchmarks are checked at least every three years against the USGS benchmark located west of the Tittabawasee River along Poseyville Road, near the Dow facility." (Dow, 1986)

8.2 WATER TABLE

The extent of the water table under the Salzburg Landfill is described in the RCRA Part B Application as follows:

> "The Regional Aquifer is found under about one-third of the Landfill approximately 120 feet below the ground surface [but not below Cell 37]. The piezometer head in this aquifer is in the 623-624 (USGS datum) range but this Aquifer is confined by the Glacial Till found everywhere under the facility. The localized water bearing sand units are depleted during construction and the landfill cells are constructed above any geological units which could be considered aquifers." (Dow, 1986)

8.3 WASTE EMPLACEMENT PROCEDURES

The thorium-bearing material is placed in the disposal cell in the same manner as hazardous waste is buried in other cells. This procedure is described in the RCRA Part B Application as follows:

> "When the facility is operating, waste is brought to the open cell area via trucks. The trucks transfer the waste to the face of the current cell lift and a compactor is used to compact the waste and to maintain the lift height. Each lift is fifty feet wide, eight feet high and is the length of the Landfill cell. The lifts are placed using two feet deep compacted layers, in parallel with the leachate collection system.
>
> "At the end of each working day about six inches of cover material is place over the waste to prevent wind dispersal of particulate matter. The cover is inspected each operating day." (Dow, 1986)

8.4 CELL CLOSURE PLAN ACTIVITIES

> "The Closure Plan for the cells requires that completed areas be finished with final cover, top soil, and vegetative growth. The Closure Plan minimizes the need for further maintenance. This reduces the potential for contamination, and allows a monitoring record to be established before post-closure monitoring begins.
>
> "The plan identifies the steps that will be necessary to close the cells at the facility." (Dow, 1986)

8.4.1 Site Preparation

"The cells to be closed will be prepared for clay capping by shaping and grading to meet the desired subgrade profile. The existing clay wall will be located before grading and shaping. The wall will serve as the baseline and starting point for constructing the clay cap. Surveyors will place corner stakes to mark the wall initially. All subsequent field stakes will be placed by the capping contractor. The contractor will shape and grade an area capable of being capped with the first clay lift each day. Threatening weather may alter the schedule.

"All equipment used for transporting waste material in the shaping and grading work will be thoroughly cleaned before it will be allowed to work with clay." (Dow, 1986)

8.4.2 Final Cover

Drawing B2-002-122 details the cap construction (see Appendix G). "The final cover consists of a three foot thick (minimum) compacted clay layer which has a permeability of 1×10^{-7} centimeters per second or less and a 30 mil minimum polyethylene synthetic liner. This composite cap will have a permeability equivalent to the bottom liner.

"Over the top of the synthetic liner, either (1) a 12-inch drainage layer will be placed or (2) a geonet, equivalent to Tensar DN1, will be installed.

"To prevent plugging of this drainage layer, a needle punched, non-woven geotextile, eight ounces minimum, will be placed over the top of the drainage layer.

"Soil capable of supporting vegetative growth will be placed to a total depth of 24 inches.

"After placement of this soil, the cover will be seeded and fertilized to established vegetative cover as soon as possible to minimize erosion.

"The final surface contours were chosen to minimize pooling water on top of the clay cap.

"The design of the cap, three feet of clay and a 30 mil (minimum) synthetic liner was chosen so the permeability of the clay cap would be equivalent to the permeability of the bottom clay liner.

"The drainage layer over the clay cap was chosen to drain any water that had percolated through the top vegetated cover so that it would drain away from the capped area.

"The cover material over the drainage layer, twenty four inches of soil, was chosen to provide adequate support of the vegetation and to minimize erosion of the cover itself.

"The slope of one percent minimum was chosen to reduce the velocity of the run-off from the cover material, yet still allow drainage of run-off from the cover to eliminate ponding.

"Also aiding in the removal of water from the cover is the installation of the peak on the area being capped. This reduces the travel time of any run-off thereby reducing the chance for permeation of water into the cover.

Vegetative Cover

"Vegetation on the cover material has been chosen for survival in the Midland, Michigan climate and will consist of a mixture of several grass strains, and be seeded in the procedure and mix shown below.

1) Spread 20-26-6 fertilizer at 250 pounds/acre.

2) Seed 200 pounds/acre of the following custom blend:

Annual Rye	20%
Wintergreen Fescue	15%
Common Kentucky Bluegrass	30%
Ruby Creeping Red Fescue	15%
Scaldis Hard Fescue	20%

3) Cover side slopes with HOLD GRO[R] or equivalent erosion control fabric to hold seed and minimize erosion. (Dow, 1986)

8.5 Radiation Exposure Rate

The post-emplacement exposure rate, as calculated using ONSITE/MAXI, is 0.15 microrem-per-hour. This calculated exposure rate is conservative due to the under-statement of soil shielding used in the calculation (3.3 ft (1m) versus a reality of at least 5 ft).

9.0 RADIATION SAFETY PROCEDURES

The radiation safety procedures which will be developed for the transfer of material from the Bay City and Midland Storage areas will conform with the regulations provided in 10 CFR Part 19. Procedures will be prepared to keep doses to workers and the public as low as reasonably achievable (ALARA).

The areas to be decommissioned will be posted with appropriate caution signs, labels, signals and controls to comply with 10 CFR Part 20.203.

Individuals working on the Bay City and Midland decommissioning operations with a potential for contamination will wear protective clothing (coveralls, boots and gloves). Respirator requirements will be based on the requirements from similar work at the Bay City site and on the result of air samples taken during excavation. During previous work at the Bay City site, no thorium was detected on the personal air samples. The detection limit was reported to be 0.40 pCi which indicated the airborne thorium concentration was less than 6×10^{-12} μCi/ml Th-232.

Individuals working on the decommissioning operations also will be monitored using radiation dosimeters. In addition, radiation detection equipment such as a micro-R meter will be used to monitor work areas, equipment and trucks leaving the restricted area. Contaminated equipment will be decontaminated prior to use in unrestricted areas.

Likewise, procedures will be prepared to keep doses to individuals working at the Salzburg Landfill as low as reasonably achievable. The same standards for personnel monitoring and protection applicable to the decommissioning operations will also apply to the operations at the Salzburg Landfill and trucks leaving the Salzburg facility site will also be monitored for external contamination.

10.0 RECORD KEEPING

10.1 PERIOD OF STORAGE

Records of disposals made under the requested license will be maintained by the licensee until the commission authorizes disposal of such records.

10.2 RECORD CONTENTS

The requirements for records are simplified by the nature of the waste. All of the contaminated waste will be disposed of in one disposal cell, and transported in bulk from the storage sites. Records of the disposal activities will be maintained in conjunction with those of the hazardous waste facility.

The movement of all materials to Cell 37 will be tracked using a waste disposal manifest. The following information is contained on each record:

1. Originating site.
2. Shipment destination (Salzburg Landfill)
3. Material description
4. Material quantity
5. Shipment number
6. Shipment date
7. Receiving date

The record also provides the data base for:

1. Reporting to governmental agencies the material received by the facility.
2. Facility operating log

A daily operating log is maintained at the facility. The log is used to record facility activities and other requirements of the RCRA, MI Act 64, and the facility operating license.

10.3 DISPOSAL SITE IDENTIFICATION

The cell used for disposal of the thorium-bearing material will be specially identified on the Salzburg site through use of the international radiation symbols.

The records of the Salzburg Landfill will contain a complete description of the disposal cell used for the th..rium material, including a map of the site, to scale, indicating the location of the burial cell and the site boundaries.

11.0 STATE AND LOCAL REQUIREMENTS

11.1 OTHER RELEVANT ENVIRONMENTAL PERMITS

There is no intention to comingle hazardous wastes with the thorium-bearing material discussed in this license application. The Salzburg Landfill is, however, operated by Dow Chemical USA, Michigan Division, as a hazardous waste disposal facility. The following permits and licenses are relevant to such operations:

A. Michigan Act 64 Construction Permit
  1. Issued : 09/15/81
  2. No expiration date

B. Michigan Act 64 Operating License/RCRA Part B Permit
  1. Issued : 01/87
  2. Expires: 01/92

C. Michigan Act 641 Operating License

D. National Pollution Discharge Elimination System Permit
  1. Issued: 05/17/84
  2. Expires: 06/30/88

11.2 RESTRICTIVE COVENANTS

Restrictive covenants have been placed on the use of the Salzburg Landfill in recognition of the hazardous waste disposal activities conducted there. The covenants were recorded on July 3, 1984 by the Register of Deeds, Midland County, Michigan.

A copy of the covenants is included as Appendix B.

Prior to burial of radioactive waste under this license application, further covenants shall be included on the Landfill deed to the effect that radioactive material has been disposed of on the site.

12.0 Certificate

The applicant and any official executing this application on behalf of the applicant certifies that this application and all information contained herein, including any supplements attached is true and correct to the best of our knowledge and belief.

____

Signature

Randy Croyle
Environmental Manager
Michigan Division
Dow Chemical U.S.A.

13.0 REFERENCES

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APPENDIX A
COST ESTIMATE FOR OFFSITE DISPOSAL

DAMES & MOORE
ONE BLUE HILL PLAZA, STE 332, PEARL RIVER, NEW YORK 10965-8668 (914) 735-1200

July 21, 1987

Mr. Richard A. Olson
Senior Environmental Specialist
Environmental Services Department
Dow Chemical U.S.A.
628 Building
Midland, MI 48667

Subject: Cost Estimate for Alternative of Disposal of Mg-Th Slag in Commercial Burial Facility

Dear Rick:

As requested, we have developed detailed cost estimates for the alternative of removal of the slag, onsite handling and packaging, transport, and disposal in a commercial burial facility. The cost components are based on direct quotes from vendors and the site operator (U.S. Ecology) and our experience in performing similar work.

The costs, which are broken down into components in Attachment I, total $32.8 million for disposal at the Richland facility and $29.7 million for disposal at Beatty. I believe these estimates to be accurate to within ± 10%.

Sincerely,

DAMES & MOORE

Bob Berlin

Robert E. Berlin
Consultant

Attachment

REB/ms

Attachment I

Cost Estimate - Removal and Disposal in Commercial Facility

Waste Volumes - Bay City - 15,000 yd^3; Midland - 3,100 yd^3

Cost Item		Estimate($1,000)	
1.	Preparation of Remediation Plan	25	
2.	Preparation of HP Plan	15	
3.	HP Monitoring Program	250	
4.	Radiation Surveys to Define Removal Requirements	115	
5.	Post Closure Monitoring - One Year	60	
6.	Waste and Soil Excavation	130	
7.	Closure of Remediation Sites/Maintenance	530	
8.	Onsite Movement, Packaging, Loading	8,650 (Packaged in 55 gallon drums)	
9.	Transport Costs to Richland or	4,900	
	Transport Costs to Beatty		4,500
10.	Disposal Costs - Richland	$18,082(1)	
	Disposal Costs - Beatty		$15,394(2)
	TOTAL	$32,757	$29,669

(1) Based on $37/ft^3 burial cost (including $10/ft^3 surcharge)

(2) Based on $31.50/ft^3 burial costs (including $10/ft^3 surcharge)
Burial cost quoted in telecon with U.S. Ecology - 9/87

APPENDIX B
RESTRICTIVE COVENANTS

RESTRICTIVE COVENANTS

THE DOW CHEMICAL COMPANY (Name), a Delaware corporation with executive offices at (Company, Partnership, etc. Address) 2030 Dow Center in Midland County, Michigan, is the record owner of the following described premises in the Township of Midland, Midland County, Michigan, to wit:

SEE ATTACHED EXHIBIT-A

The Dow Chemical Company (Name) is in the process of constructing a hazardous waste landfill on a portion of its property above described, pursuant to 1979 PA 64 and the rules promulgated thereunder, the location of the facility being described in Exhibit A, attached hereto, and hereby

NOW, THEREFORE, these Restrictive Covenants are executed by The Dow Chemical Co. (Name) to insure the integrity of said disposal facility for the safety of the people of the State of Michigan, to-wit:

(1) No vehicles, except vehicles needed and actually used for maintenance and inspection, shall be allowed within the areas which are enclosed by a sound and secure fence, pursuant to Paragraph (4), below, except as indicated in Paragraph (8) below.

(2) No excavation or construction, except as necessary to maintain the integrity of the facility, shall be allowed after closure of the facility in the areas which are enclosed by a sound and secure fence, pursuant to Paragraph (4), below, except as indicated in Paragraph (8) below.

(3) No uses of the property shall be made which may or will impair the integrity of the facility.

RECORDED

JUL 3 4 13 PM '84

RICHARD C. CLMENT
REGISTER OF DEEDS
MIDLAND COUNTY, MICH

3/81 R 4906

(4) The Dow Chemical Company shall erect, and it and its successors in
Name
interest, shall thereafter continuously maintain until further order of the Department of Natural Resources: (i) a secure and sound fence enclosing the area containing the disposal facility at least FIFTY (50) feet measured from all edges of the disposal facility; and (ii) a sign stating: "Warning, Hazardous Waste Disposal Area, KEEP OUT," inside the fence, visible from each side.

(5) The Dow Chemical Company shall notify the Director of the Michigan
Name
Department of Natural Resources of its intent to convey any interest in land located in City of Midland, Section 35 in Midland Township, Midland County, Michigan. No conveyance of title, easement, or other interest in the property shall be consummated by The Dow Chemical Company
Name
without adequate and complete provision for continued maintenance of the facility and monitoring systems described in the Closure and Post Closure Maintenance and Monitoring Plans described in Exhibit B, attached hereto and hereby made a part hereof. For the purpose of assuring adequate maintenance of the facility's monitoring system(s), no property owned by The Dow Chemical Co., described in
Name
Exhibit A shall be conveyed without prior written approval of the Director of the Michigan Department of Natural Resources. Such approval by the Director is not to be unreasonably withheld.

(6) Until further notice from the Director of the Michigan Department of Natural Resources, set forth above, The Dow Chemical Co., and its successors in
Name
title will maintain and monitor the facility as described in Section 41(1) of 1979 PA 64.

(7) Any governmental agency adversely affected by any violations of these restrictions may enforce them by legal actions in the Circuit Court.

(3) The property described in Exhibit A is subject to an existing easement of record granted to Consumers Power Company for electric transmission lines.

These Restrictive Covenants shall run with the land and be binding upon first party, its successors, and assigns.

DATED: This 6th day of July, 1961.

THE DOW CHEMICAL COMPANY

By ______________________

Its I. F. HARLOW, VICE PRESIDENT

____

Director, Michigan Department of Natural Resources

WITNESSES:

____
Cheryl A. Johnson

____
Lu Ellen Joslyn

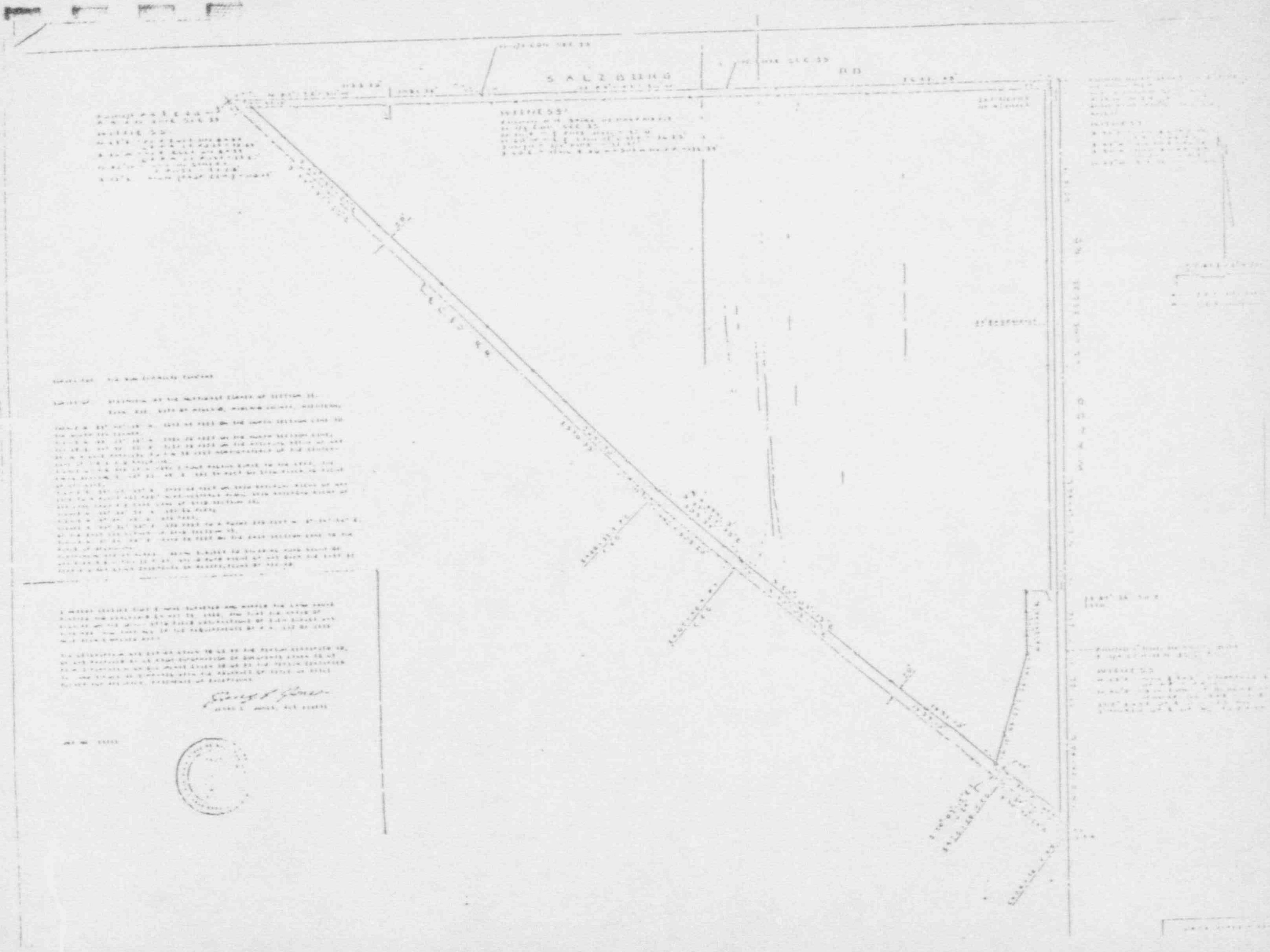
STATE OF MICHIGAN)
) ss.
COUNTY OF MIDLAND)

The foregoing insturment was acknowledged before me this 6th day of July, 1981, by I. F. Harlow, of The Dow Chemical Company corporation, on behalf of the Corporation.

The information necessary to complete this instrument was supplied by The Dow Chemical Company, however, the instrument was prepared by the Michigan Department of Natural Resources.

____
NOTARY PUBLIC

CHERYL A. JOHNSON
Notary Public, Midland County, Michigan
My Commission Expires June 1, 1983


SALZBURG RD
WITNESS

APPENDIX C
GEOPHYSICAL LOGS

GEOPHYSICAL LOG

Project No. 85553 Well or Boring No. 2336 Date 11-27-79

Client DOW CHEMICAL COMPANY Tested by MEB

LOCATION

State MICHIGAN County MIDLAND Township MIDLAND

NE 1/4 NW 1/4 NE 1/4 Section 35 T 14 N R 2 E

Distance GRID COORDINATES - 62+77 S, 77+66 E

OWNER DOW CHEMICAL COMPANY Address MIDLAND, MICHIGAN

CONTRACTOR KLEINFELT DRILLING CO. Address CHARLOTTE, MICHIGAN

WELL AND LOG DATA

Type of Well EXPLORATORY BORING Depth 100 ft. Diameter 6 1/4 in.

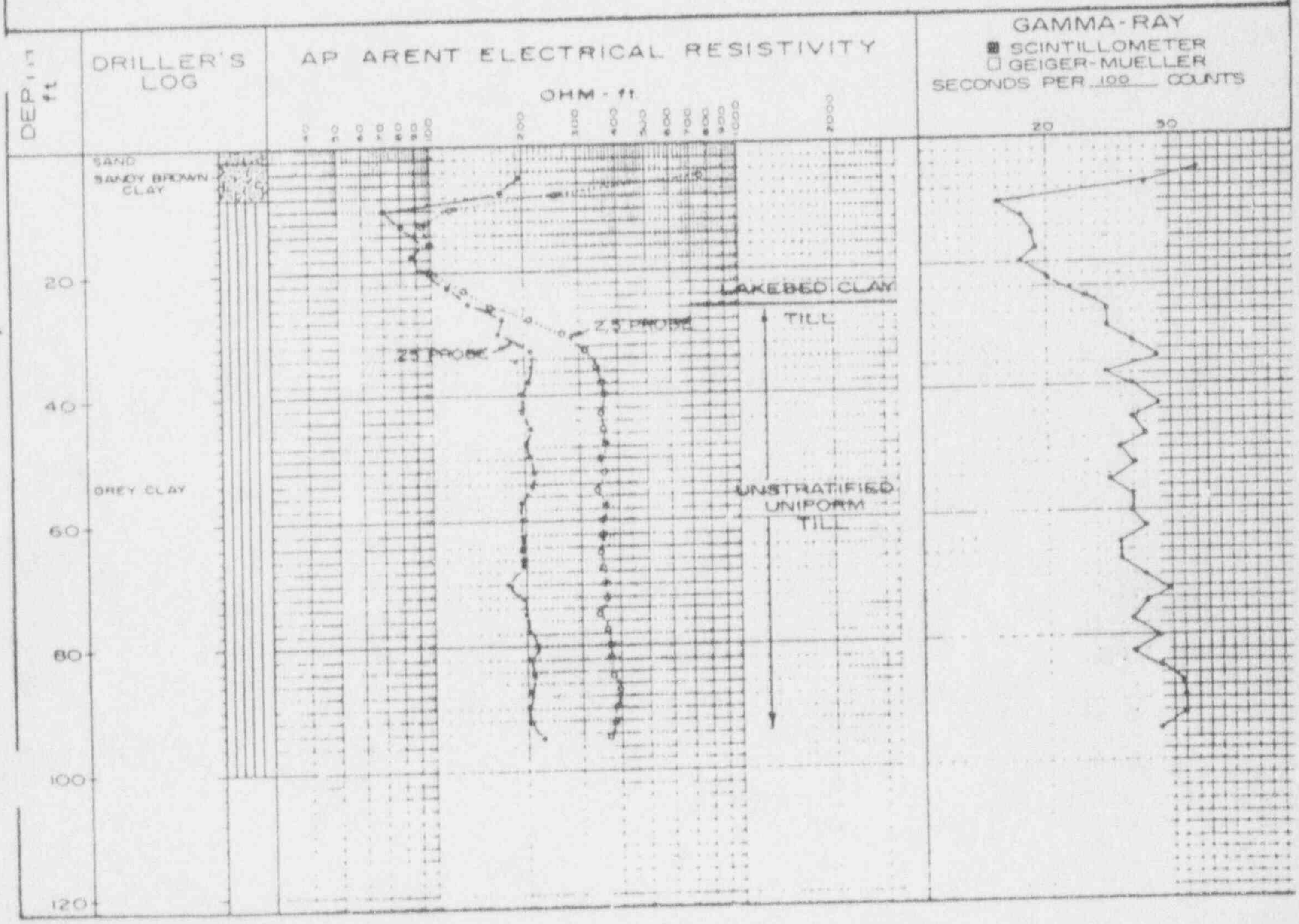
ELEVATIONS

Land Surface 626.2 ft. ABOVE M.S.L. (~~Est'd, Rept'd,~~ Meas'd)

Top of Casing ____ ft. ABOVE/BELOW Land Surface

Log Datum LAND SURFACE

Water Table Depth 9 FEET



GEOPHYSICAL LOG

Project No. 85553 Well or Boring No. 2373 Date 11-28-79

Client DOW CHEMICAL COMPANY Tested by MEB

LOCATION

State MICHIGAN County MIDLAND Township MIDLAND

NE 1/4 NE 1/4 NW 1/4 Section 35 T 14 N R 2 E

Distance GRID COORDINATE- 66+17S, 63+56E

OWNER DOW CHEMICAL COMPANY Address MIDLAND, MICHIGAN

CONTRACTOR KLEINFELT DRILLING CO. Address CHARLOTTE, MICHIGAN

WELL AND LOG DATA

Type of Well EXPLORATORY BORING Depth 100 ft. Diameter 6 1/4 in.

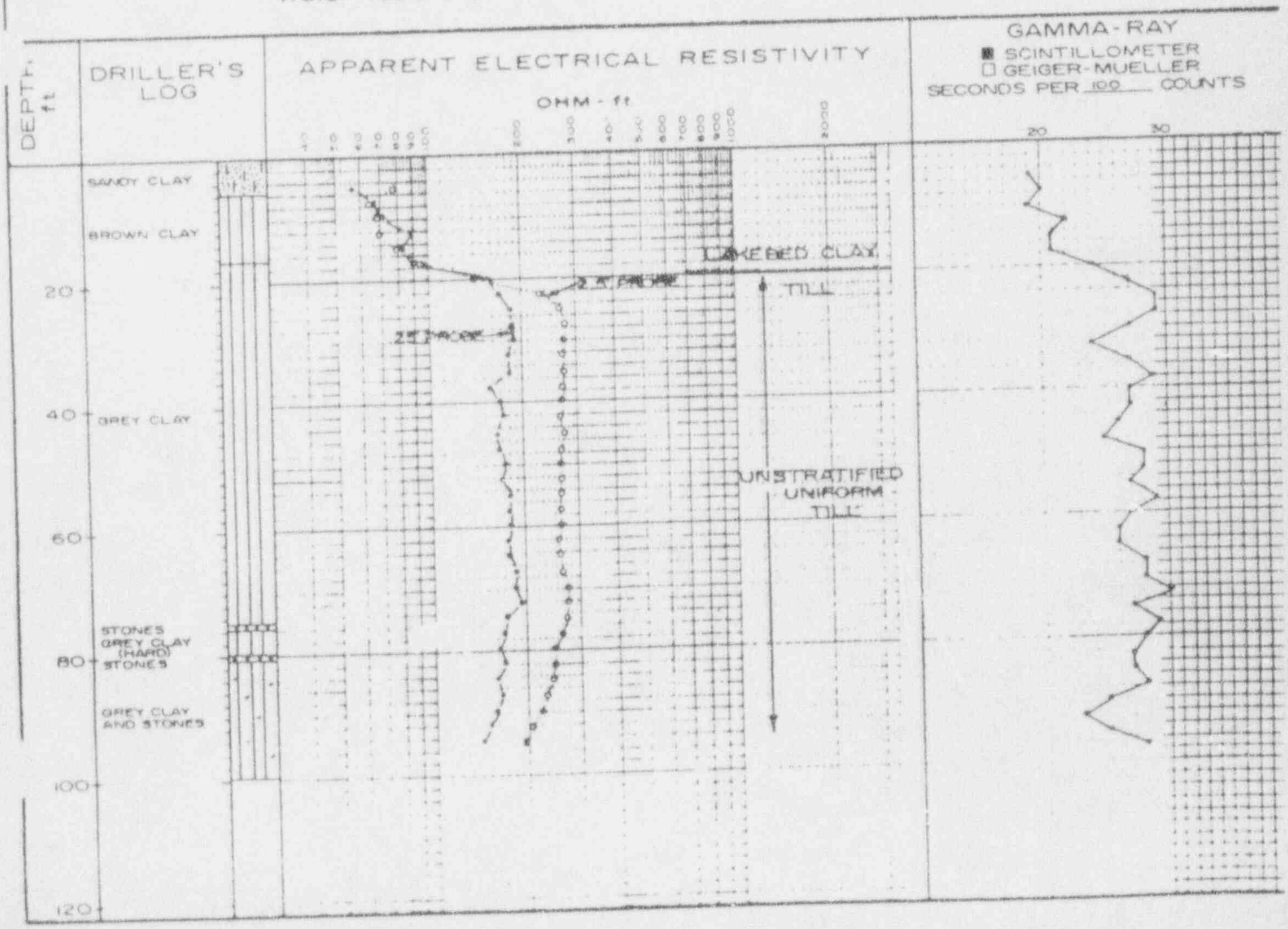
ELEVATIONS

Land Surface 620.9 ft. ABOVE M.S.L. (~~Est'd, Rep'd~~, Meas'd)

Top of Casing ____ ft. ABOVE/BELOW Land Surface

Log Datum LAND SURFACE

Water Table Depth < 5 FEET



GEOPHYSICAL LOG

Project No. 85553 Well or Boring No. 2388 Date 11-29-79

Client DOW CHEMICAL COMPANY Tested by MEB

LOCATION

State MICHIGAN County MIDLAND Township MIDLAND

SW 1/4 NE 1/4 NE 1/4 Section 35 T 14 N R 2 E

Distance GRID COORDINATES - 72+17 S, 84+06 E

OWNER DOW CHEMICAL COMPANY Address MIDLAND, MICHIGAN

CONTRACTOR KLEINFELT DRILLING CO. Address CHARLOTTE, MICHIGAN

WELL AND LOG DATA

Type of Well EXPLORATORY BORING Depth 100 ft. Diameter 6 1/4 in.

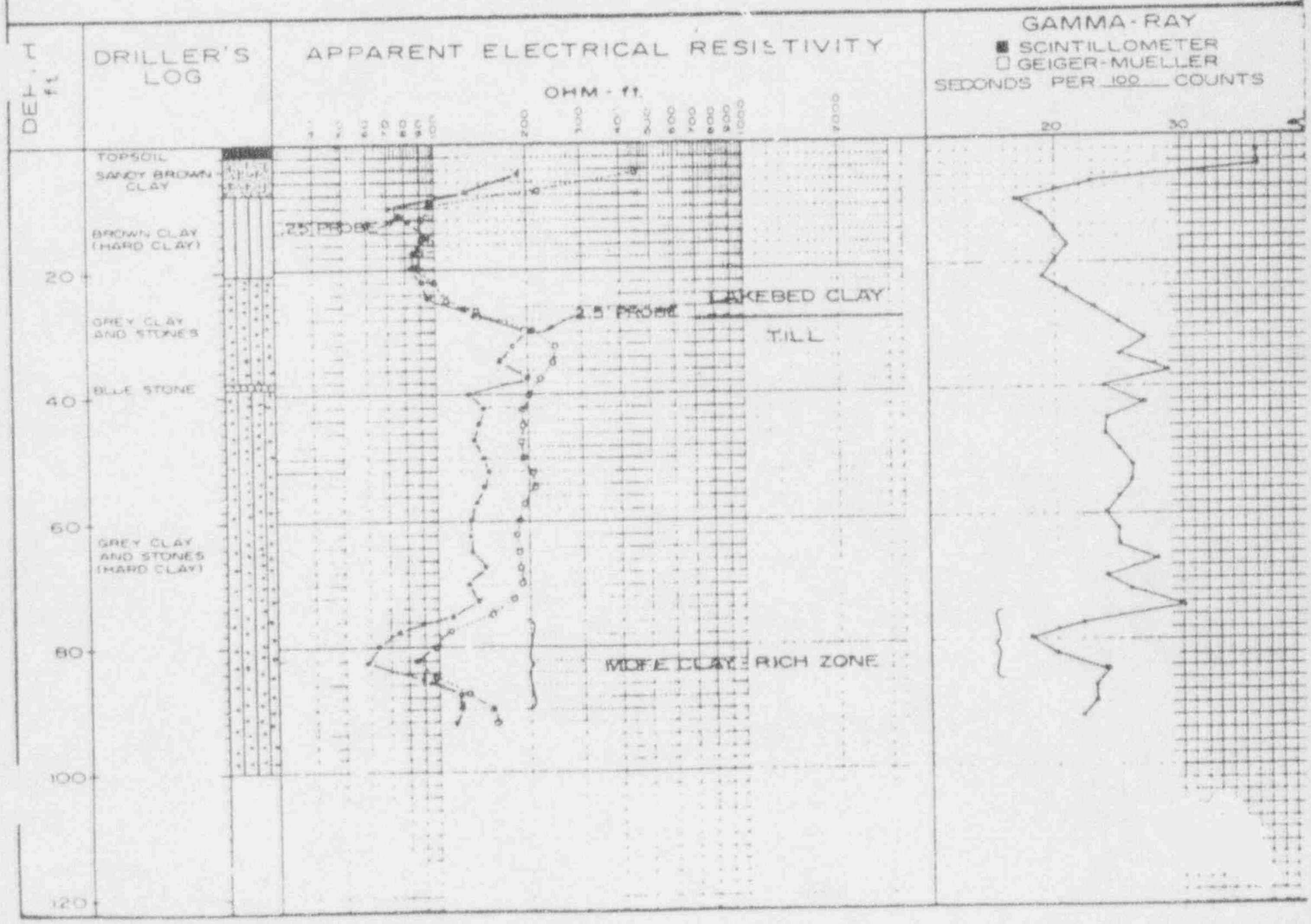
ELEVATIONS

Land Surface 626.8 ft. ABOVE M.S.L. (~~Est'd, Rep'td~~, Meas'd)

Top of Casing ____ ft. ABOVE/BELOW Land Surface

Log Datum LAND SURFACE

Water Table Depth APPROX. 9 FT



GEOPHYSICAL LOG

Project No. 85553 Well or Boring No. 2396 Date 11-28-79

Client DOW CHEMICAL COMPANY Tested by MEB

LOCATION

State MICHIGAN County MIDLAND Township MIDLAND

NE 1/4 SW 1/4 NE 1/4 Section 35 T 14 N R 2 E

Distance GRID COORDINATES - 79+14S, 74+98E

OWNER DOW CHEMICAL COMPANY Address MIDLAND, MICHIGAN

CONTRACTOR KLEINFELT DRILLING CO. Address CHARLOTTE, MICHIGAN

WELL AND LOG DATA

Type of Well EXPLORATORY BORING Depth 100 ft. Diameter 6 1/4 in.

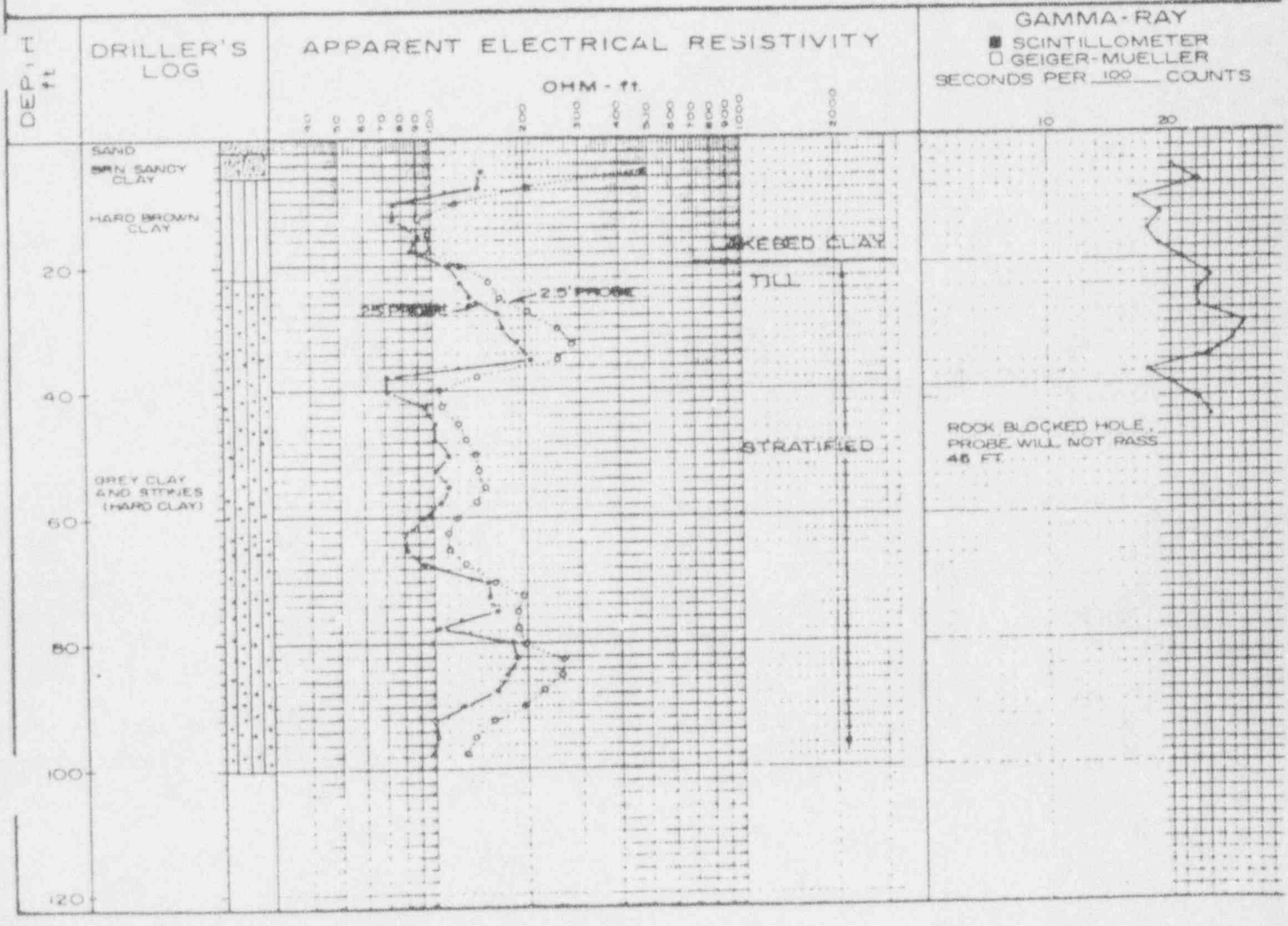
ELEVATIONS

Land Surface 627.7 ft. ABOVE M.S.L. (~~Est'd, Rep'td,~~ Meas'd)

Top of Casing ______ ft. ABOVE/BELOW Land Surface

Log Datum LAND SURFACE

Water Table Depth APPROX. 11 FEET



GEOPHYSICAL LOG

Project No. 85553 Well or Boring No. 2402 Date 11-27-79

Client DOW HEMICAL COMPANY Tested by M.E.B.

LOCATION

State MICHIGAN County MIDLAND Township MIDLAND

SE 1/4 SE 1/4 NE 1/4 Section 35 T 14 N R 2 E

Distance GRID COORDINATES -

OWNER DOW CHEMICAL COMPANY Address MIDLAND, MICHIGAN

CONTRACTOR KLEINFELT DRILLING CO. Address CHARLOTTE, MICHIGAN

WELL AND LOG DATA

Type of Well EXPLORATORY BORING Depth 100 ft. Diameter 5 1/4 in

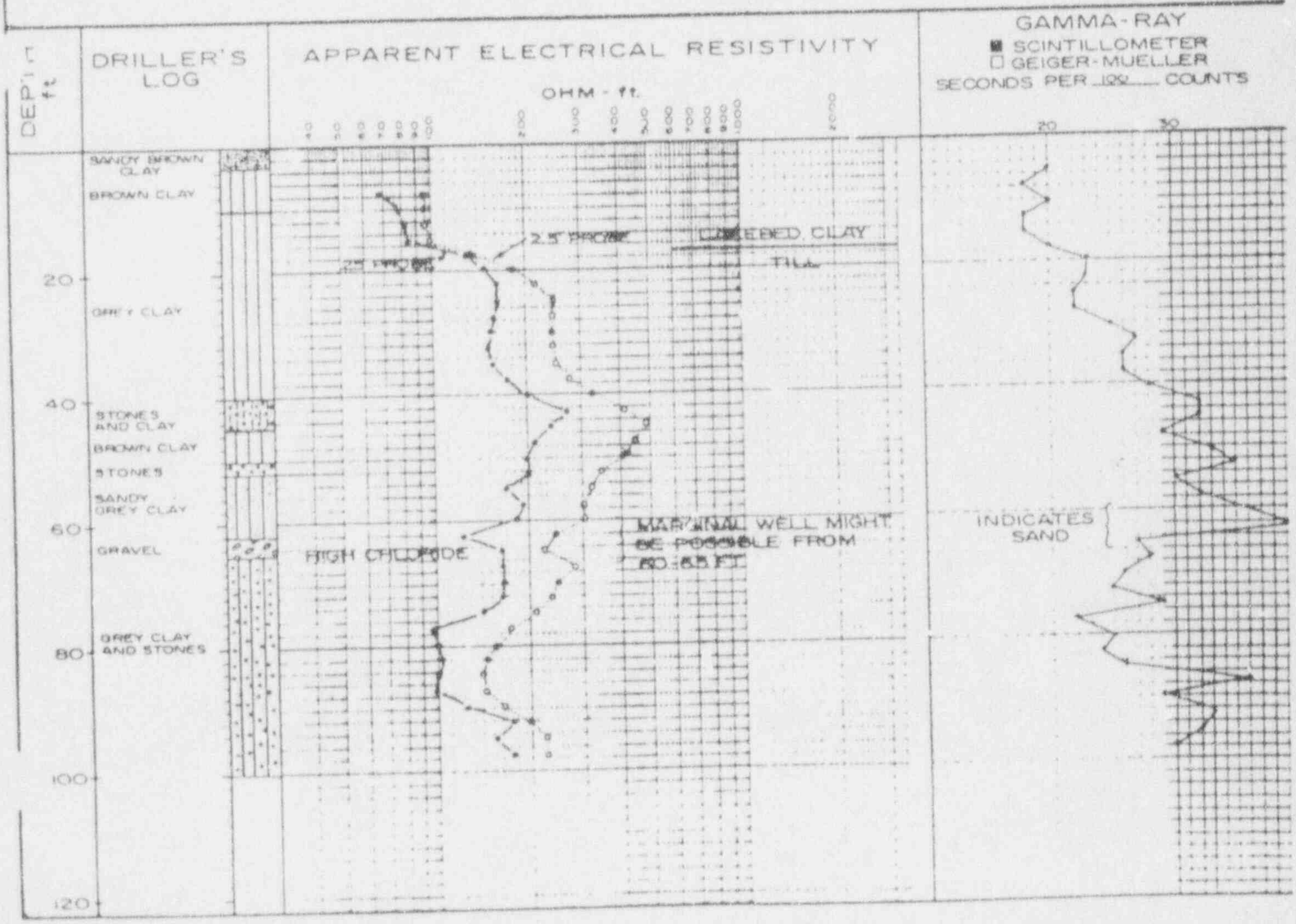
ELEVATIONS

Land Surface 624.9 ft. ABOVE M.S.L. (~~Est'd, Rep'd~~, Meas'd)

Top of Casing ______ ft. ABOVE/BELOW Land Surface

Log Datum LAND SURFACE

Water Table Depth <8 FT.



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ENGINEERS · GEOLOGISTS · BIOLOGISTS · CHEMISTS

WILLIAMS & WORKS
611 CASCADE W. PKWY. S.E.
GRAND RAPIDS, MI 49506

PROJECT NO. 20245
OWNERS WELL NO. 3009
CLIENT DOW CHEMICAL CO
DATE 9/27/83
FIELD DATA BY G.S.

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND
NE 1/4 SE 1/4 NE 1/4 SECTION 33 T 14N R 2E
DISTANCE

OWNER: DOW CHEMICAL CO. ADDRESS MIDLAND, MICHIGAN
CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

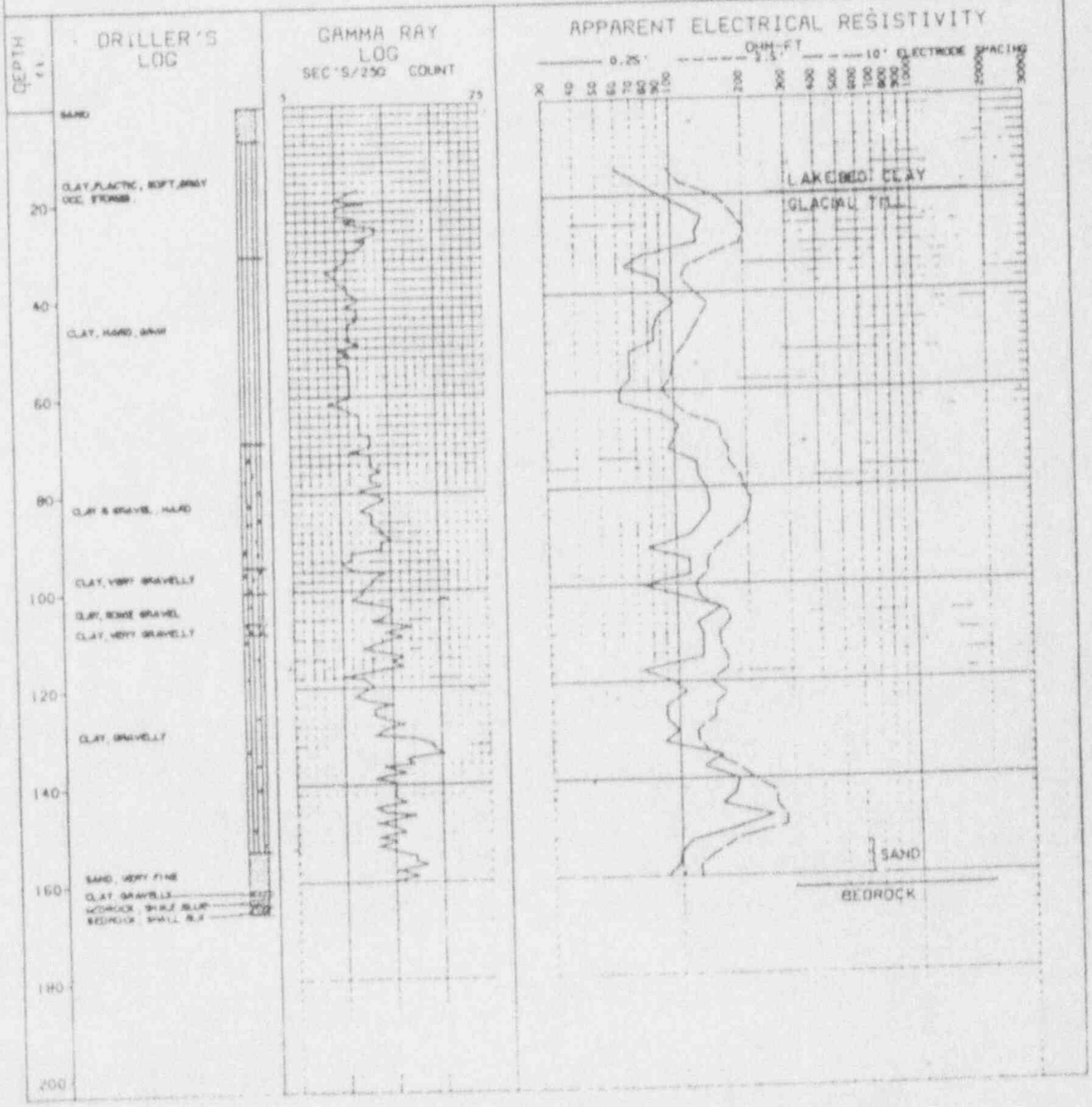
WELL & LOG DATA: TYPE OF WELL OBSERVATION WELL DEPTH 166 FT. DIA. 4 IN.
ELEVATIONS: LAND SURFACE 620 FT. ABOVE M.S.L. (MEAS'D)
TOP OF CASING 630.74 FT. ABOVE LAND SURFACE
LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) V8-63 (MODEL) GAMMA LOGGER KECK (MAKE) GR-73 (MODEL)

PROBE:

WATER TABLE DEPTH
UNCONSOLIDATED SOILS
15 FT. BELOW GROUND
CONSOLIDATED SOILS
____ FT. BELOW GROUND

INTERVAL LOGGED: 160 FT. TO 15 FT. BELOW LAND SURFACE
FLUID LEVEL: UNCONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE
CONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE
TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL
CONSOLIDATED SOILS



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WILLIAMS & WORKS
611 CASCADE W. PKWY. S.E.
GRAND RAPIDS, MI 49506
Ph. (616) 942-0870/942-9600

PROJECT NO. 20245
OWNERS WELL NO. 3010
CLIENT DOW CHEMICAL
DATE 9/21/83
FIELD DATA BY DJG, GS

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND

SE 1/4 SE 1/4 NE 1/4 SECTION 36 T 14N R 2E

DISTANCE ______

OWNER: DOW CHEMICAL CO. ADDRESS MIDLAND, MICHIGAN

CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

WELL & LOG DATA: TYPE OF WELL OBSERVATION DEPTH 142 FT. DIA. 4 IN.

ELEVATIONS: LAND SURFACE 624.9 FT. ABOVE M.S.L. (MEAS'D.)

TOP OF CASING 625.59 FT. ABOVE LAND SURFACE

LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VB-63 (MODEL) GAMMA LOGGER KECK (MAKE) GR-73 (MODEL)

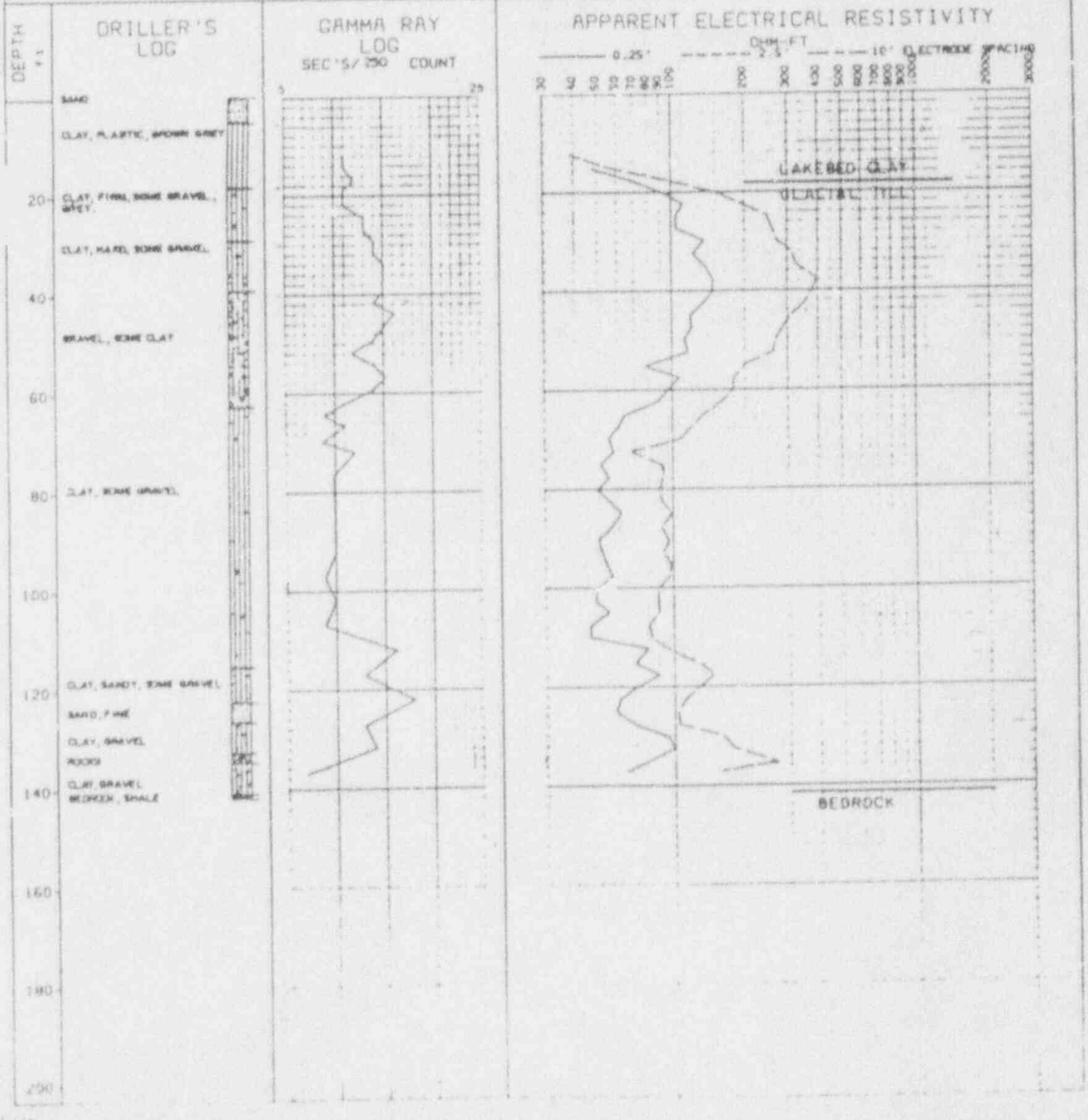
PROBE: ______

WATER TABLE DEPTH
UNCONSOLIDATED SOILS
18 FT. BELOW GROUND
CONSOLIDATED SOILS
______ FT. BELOW GROUND

INTERVAL LOGGED: 137 FT. TO 12 FT. BELOW LAND SURFACE

FLUID LEVEL: UNCONSOLIDATED SOILS ______ FT. BELOW LAND SURFACE
CONSOLIDATED SOILS ______ FT. BELOW LAND SURFACE

TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL
CONSOLIDATED SOILS ______



Environmental Data Inc.
WILLIAMS & WORKS
611 CASCADE W. PKWY. S.E.
GRAND RAPIDS, MI 49506

PROJECT NO. 20237
OWNERS WELL NO. 3011
CLIENT DOW CHEMICAL
DATE 9/28/84
FIELD DATA BY G.S.

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND
NE 1/4 NE 1/4 NE 1/4 SECTION 35 T 14 N R 2E
DISTANCE

OWNER: DOW CHEMICAL ADDRESS MIDLAND, MICHIGAN
CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

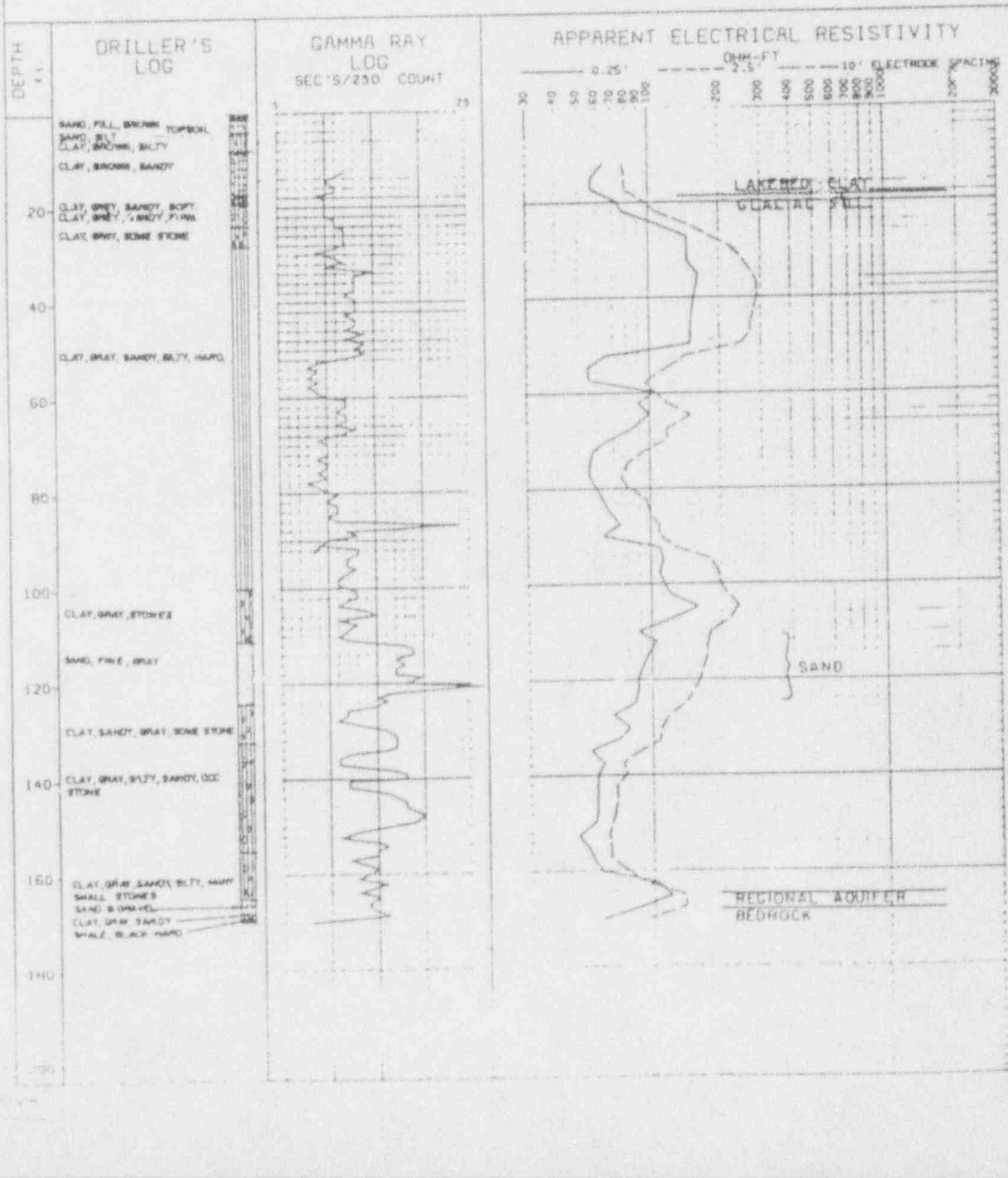
WELL & LOG DATA: TYPE OF WELL OBSERVATION DEPTH 170 FT. DIA. 4 IN.
ELEVATIONS: LAND SURFACE 624.4 FT. ABOVE M.S.L. (MEAS'D)
TOP OF CASING 627.39 FT. ABOVE LAND SURFACE
LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VR-63 (MODEL) GAMMA LOGGER KECK (MAKE) GR.-73 (MODEL)

PROBE:

WATER TABLE DEPTH
UNCONSOLIDATED SOILS
____ FT. BELOW GROUND
CONSOLIDATED SOILS
____ FT. BELOW GROUND

INTERVAL LOGGED: 170 FT. TO 12.5 FT. BELOW LAND SURFACE
FLUID LEVEL: UNCONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE
CONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE
TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL
CONSOLIDATED SOILS



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WILLIAMS & WORKS

PROJECT NO. 20237

OWNERS WELL NO. 3012

CLIENT DOW CHEMICAL

DATE 10/3/83

FIELD DATA BY G.S.

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND

SW 1/4 NE 1/4 NE 1/4 SECTION 33 T 14 N R 2E

DISTANCE ______

OWNER: DOW CHEMICAL CO. ADDRESS MIDLAND, MICHIGAN

CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

WELL & LOG DATA: TYPE OF WELL BORING DEPTH 162 FT. DIA. 6⅝ IN.

ELEVATIONS: LAND SURFACE 611 FT. ABOVE M.S.L. (MEAS'D.)

TOP OF CASING ____ FT. ABOVE LAND SURFACE

LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VB-63 (MODEL) GAMMA LOGGER KECK (MAKE) GP-73 (MODEL)

PROBE:

WATER TABLE DEPTH

UNCONSOLIDATED SOILS ____ FT. BELOW GROUND

CONSOLIDATED SOILS ____ FT. BELOW GROUND

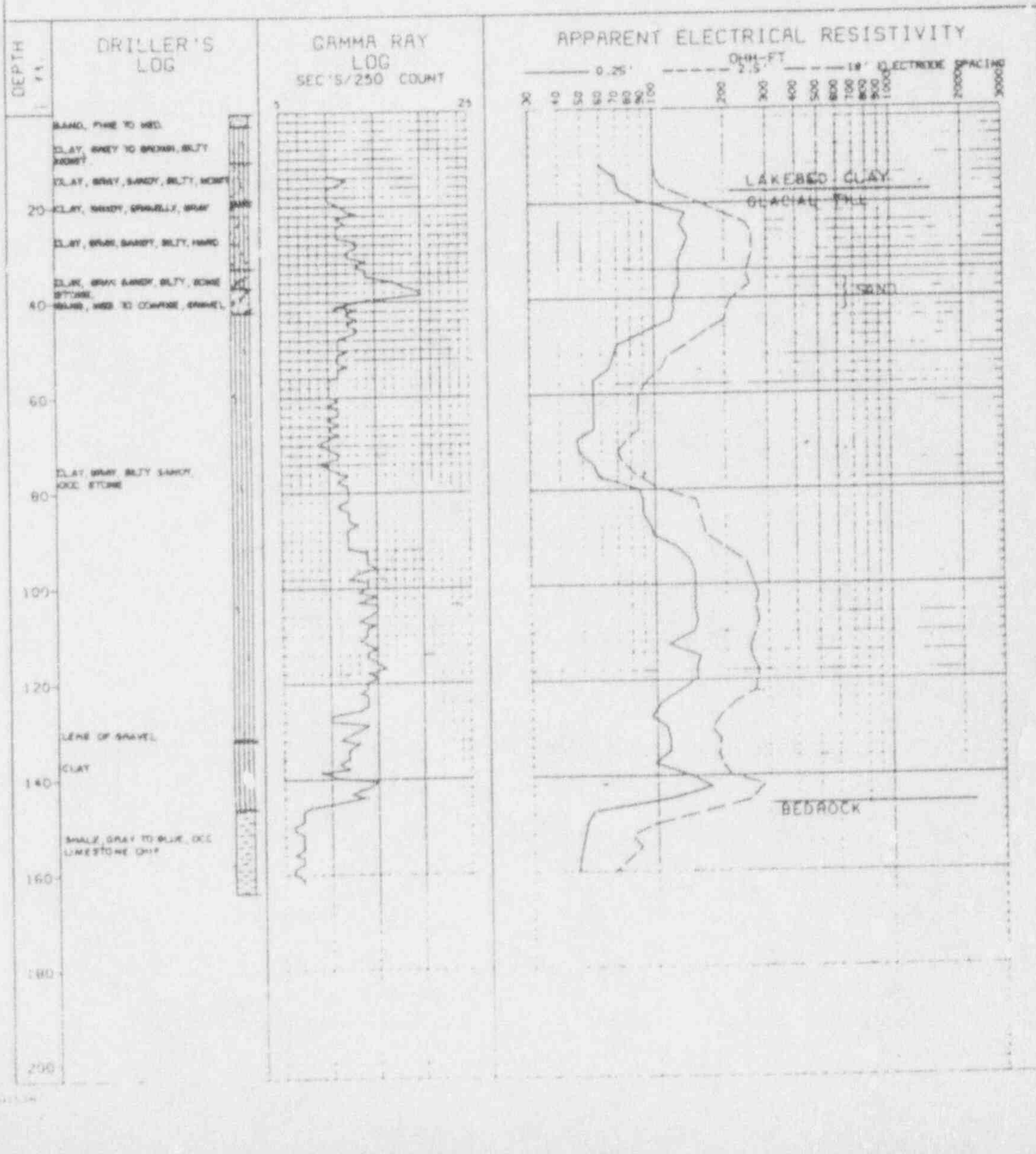
INTERVAL LOGGED: 162 FT. TO 14 FT. BELOW LAND SURFACE

FLUID LEVEL: UNCONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE

CONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE

TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL

CONSOLIDATED SOILS ______



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PROJECT NO. 20237
OWNER: WELL NO. 3013
CLIENT DOW CHEMICAL CO
DATE 10/8/83
FIELD DATA BY G.S.

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND

NE 1/4 NW 1/4 NW 1/4 SECTION 35 T 14N R 2E

DISTANCE

OWNER: DOW [C]HEMICAL CO. ADDRESS MIDLAND, MICHIGAN

CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

WELL & LOG DATA: TYPE OF WELL OBSERVATION DEPTH 256 FT. DIA. 4 IN.

ELEVATIONS: LAND SURFACE 615.6 FT. ABOVE M.S.L. (MEAS'D.)

TOP OF CASING 616.45 FT. ABOVE LAND SURFACE

LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VB-63 (MODEL) GAMMA LOGGER KECK (MAKE) GR-73 (MODEL)

PROBE:

WATER TABLE DEPTH
UNCONSOLIDATED SOILS
FLOWING FT. BELOW GROUND
CONSOLIDATED SOILS
_____ FT. BELOW GROUND

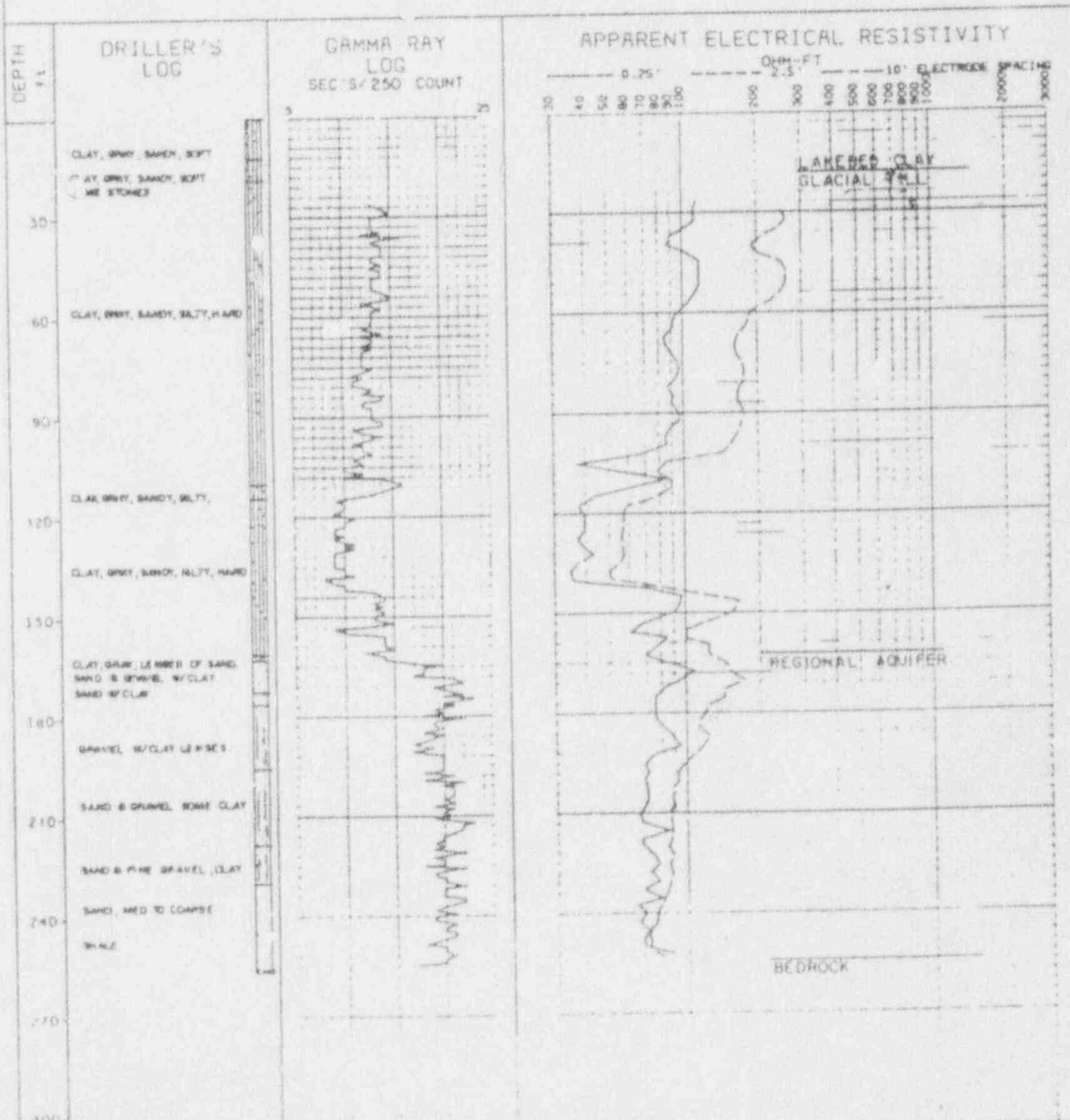
INTERVAL LOGGED: 254 FT. TO 26 FT. BELOW LAND SURFACE

FLUID LEVEL: UNCONSOLIDATED SOILS _____ FT. BELOW LAND SURFACE

CONSOLIDATED SOILS _____ FT. BELOW LAND SURFACE

TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL

CONSOLIDATED SOILS _____



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WILLIAMS & WORKS

PROJECT NO. 20245

OWNERS WELL NO. 3065

CLIENT DOW CHEMICAL

DATE 11/9/83

FIELD DATA BY G.S.

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND

NW 1/4 NW 1/4 SW 1/4 SECTION 27 T 14N R 2E

DISTANCE

OWNER: DOW CHEMICAL COMPANY ADDRESS MIDLAND, MICHIGAN

CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

WELL & LOG DATA: TYPE OF WELL OBSERVATION DEPTH 310 FT. DIA. 4 IN.

ELEVATIONS: LAND SURFACE 598 FT. ABOVE M.S.L. (MEAS'D)

TOP OF CASING 60/64 FT. ABOVE LAND SURFACE

LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VB-63 (MODEL) GAMMA LOGGER ____ (MAKE) ____ (MODEL)

PROBE: LATERAL LOG

WATER TABLE DEPTH

UNCONSOLIDATED SOILS

FLOWING FT. BELOW GROUND

CONSOLIDATED SOILS

____ FT. BELOW GROUND

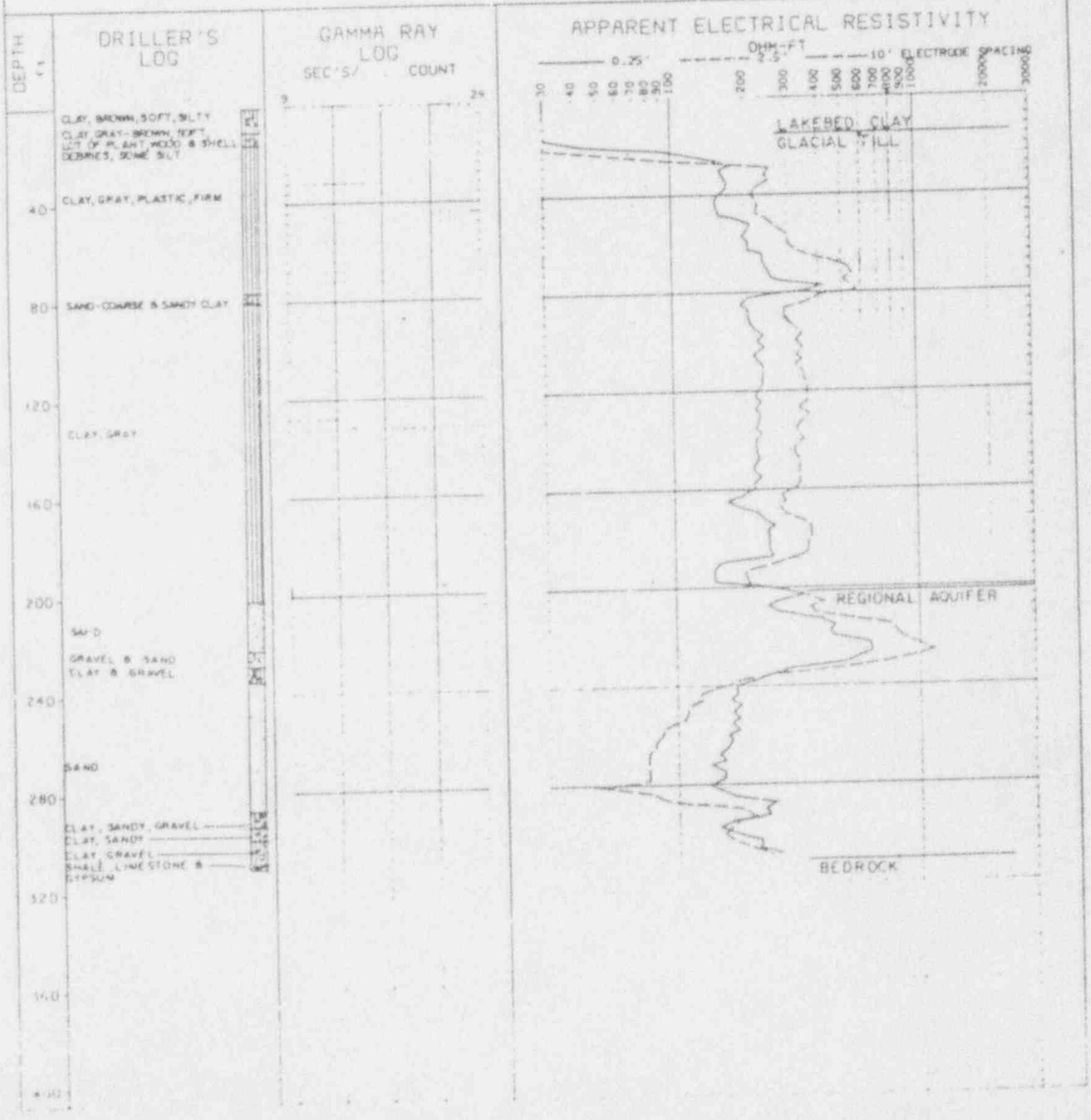
INTERVAL LOGGED: 310.0 FT. TO 1.5 FT. BELOW LAND SURFACE

FLUID LEVEL: UNCONSOLIDATED SOILS 1 FT. BELOW LAND SURFACE

CONSOLIDATED SOILS ____ FT. BELOW LAND SURFACE

TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA-GEL

CONSOLIDATED SOILS ____



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PROJECT NO. 20245
OWNERS WELL NO. 3066
CLIENT DOW CHEMICAL
DATE 12/7/83
FIELD DATA BY G S

GEOPHYSICAL LOG OF WELL

LOCATION: STATE MICHIGAN COUNTY MIDLAND TOWNSHIP MIDLAND

S.E. 1/4 N.W. 1/4 S.W. 1/4 SECTION 20 T 14 N R 2E

DISTANCE ______

OWNER: DOW CHEMICAL CO. ADDRESS MIDLAND, MICHIGAN

CONTRACTOR: RAYMER CO. ADDRESS GRAND RAPIDS, MICHIGAN

WELL & LOG DATA: TYPE OF WELL OBSERVATION DEPTH 230 FT. DIA. 4 IN.

ELEVATIONS: LAND SURFACE 614 FT. ABOVE M.S.L. (EST'D. REPT'D. MEAS'D)

TOP OF CASING 617.05 FT. ABOVE LAND SURFACE

LOG DATUM LAND SURFACE

INSTRUMENT DATA: E-LOGGER KECK (MAKE) VB-63 (MODEL) GAMMA LOGGER ______ (MAKE) ______ (MODEL)

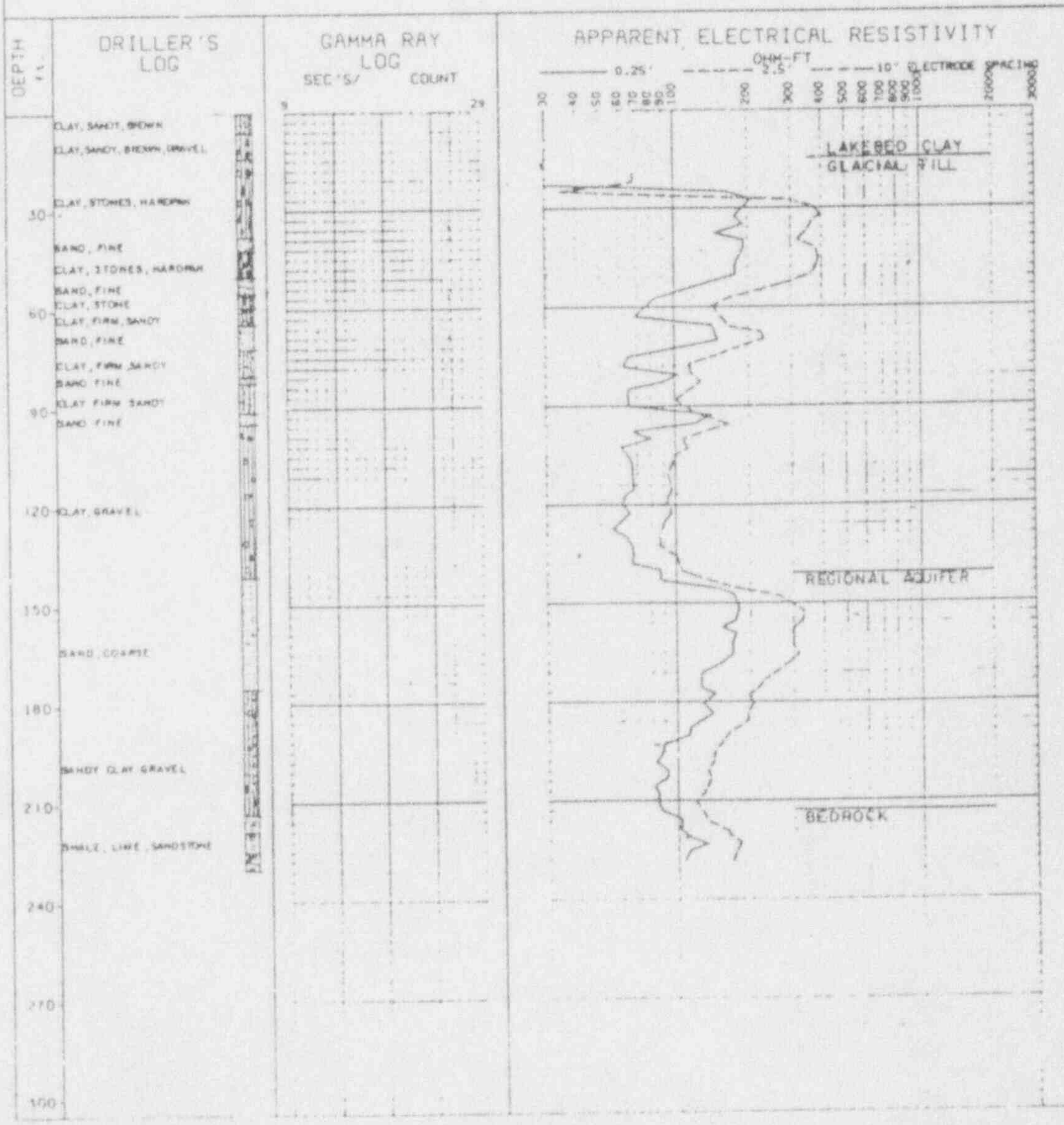
PROBE:

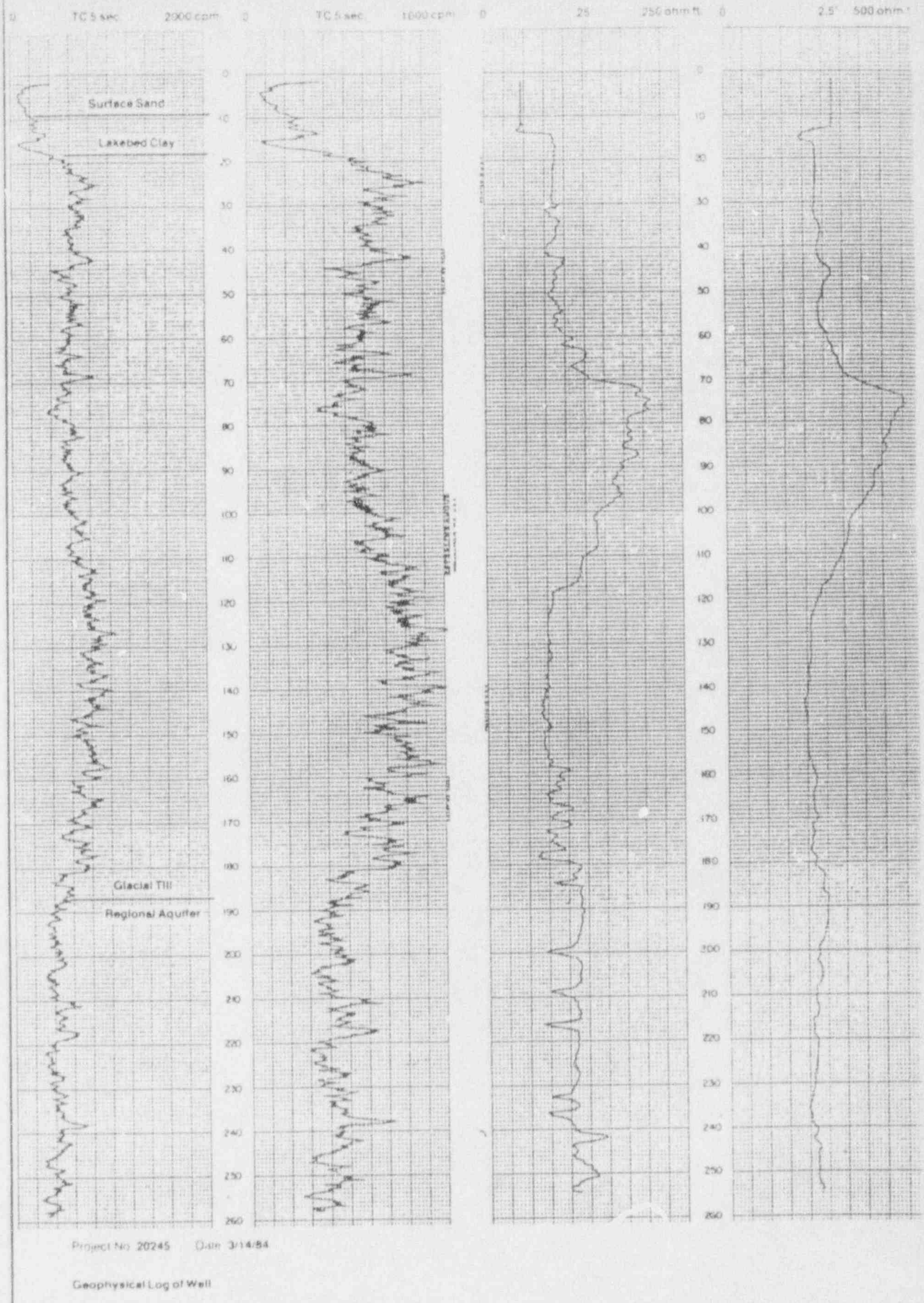
WATER TABLE DEPTH
UNCONSOLIDATED SOILS
FLOWING FT. BELOW GROUND
CONSOLIDATED SOILS
______ FT. BELOW GROUND

INTERVAL LOGGED: 230 FT. TO 20 FT. BELOW LAND SURFACE

FLUID LEVEL: UNCONSOLIDATED SOILS ______ FT. BELOW LAND SURFACE
CONSOLIDATED SOILS ______ FT. BELOW LAND SURFACE

TYPE OF FLUID: UNCONSOLIDATED SOILS AQUA - GEL
CONSOLIDATED SOILS ______





Project No 20245 Date 3/14/84

Geophysical Log of Well

Location Midland, Michigan, Midland Township SE¼, SW¼, NE¼, Section 22, T 14N, R 2E
Owner Dow Chemical Co., Midland, Midland Township Raymer Co., Grand Rapids, Michigan
3137 Observation Depth 275 Feet 4 Inches Land Surface 628, Top of Casing 630.95
Land Surface, Field Data by JN 6 Feet Below Ground 256 Feet to 15 Feet Aqua Gel

EDI ENGINEERING & SCIENCE

EDI Engineering & Science

Project No. 20245
Date 3/27/84

Geophysical Log of Well

Location
Midland, Michigan
Midland Township
SE¼, NE¼, NE¼, Section 35,
T 14N, R 2E

Owner
Dow Chemical Co.,
Midland, Midland Township

Contractor
Raymer Co.,
Grand Rapids, Michigan

Well No. 3138

Type Observation

Depth 475 Feet

Diameter 4 Inches

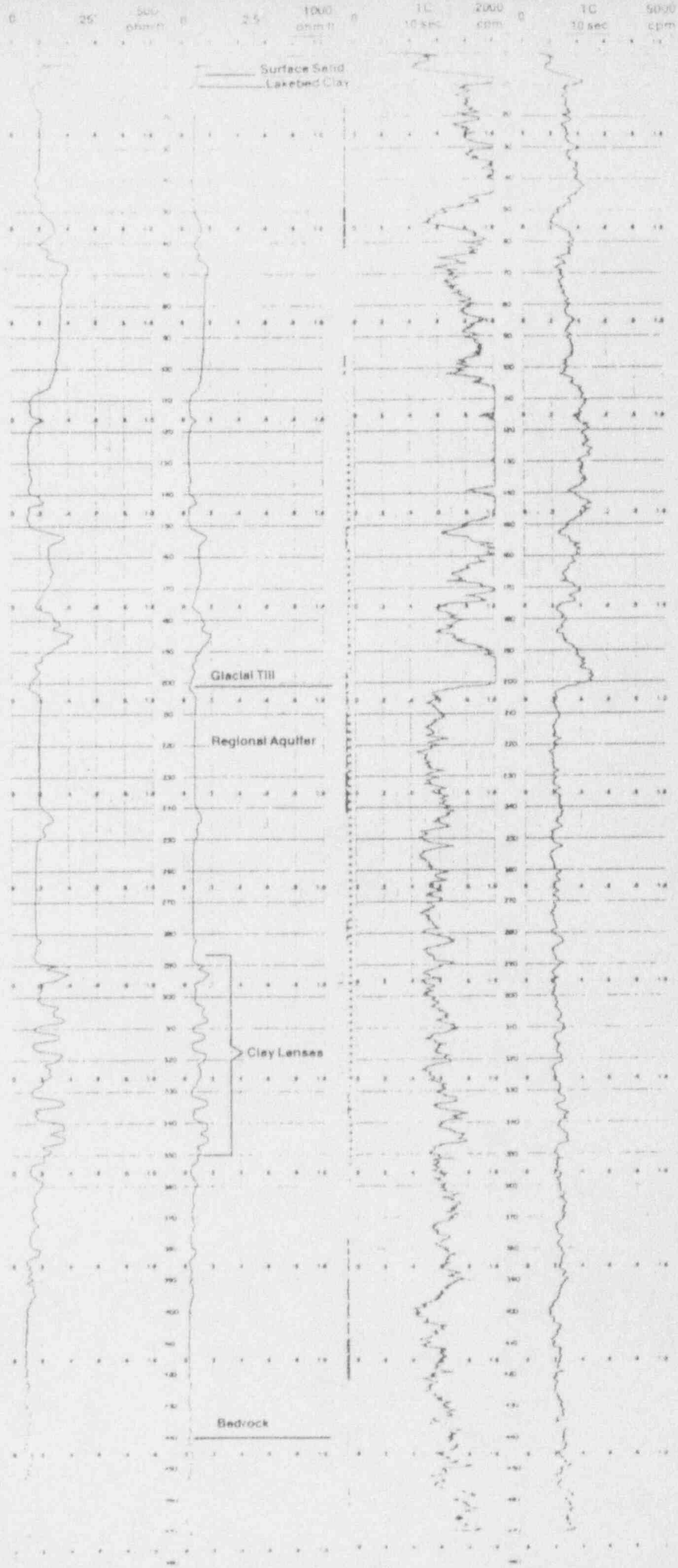
Elevations
Land Surface 639
Top of Casing 641.92

Log Datum
Land Surface, Field Data by JN

Water Table Depth
16 Feet Below Ground

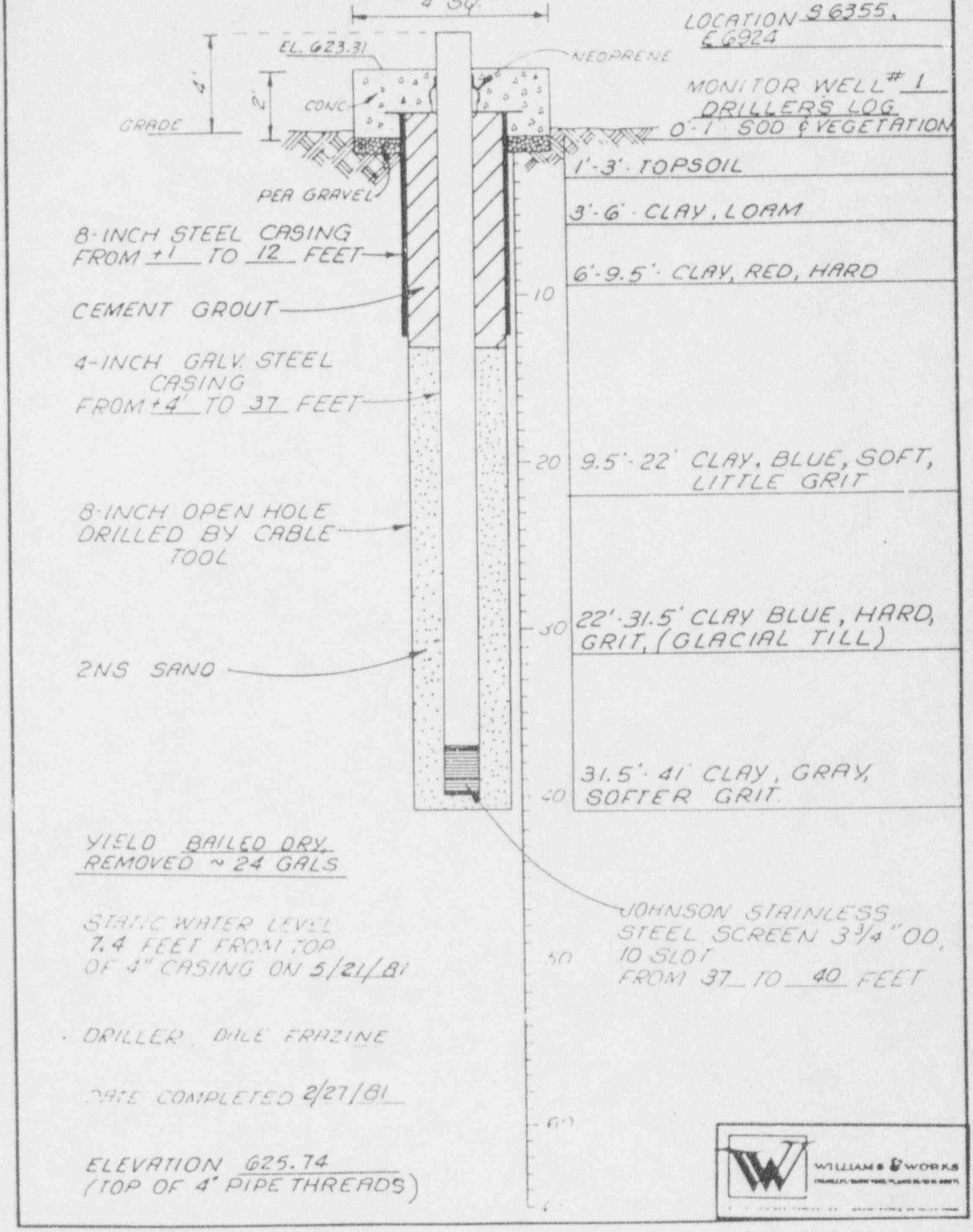
Interval Logged
470 Feet to 5 Feet

Fluid Aqua-Gel

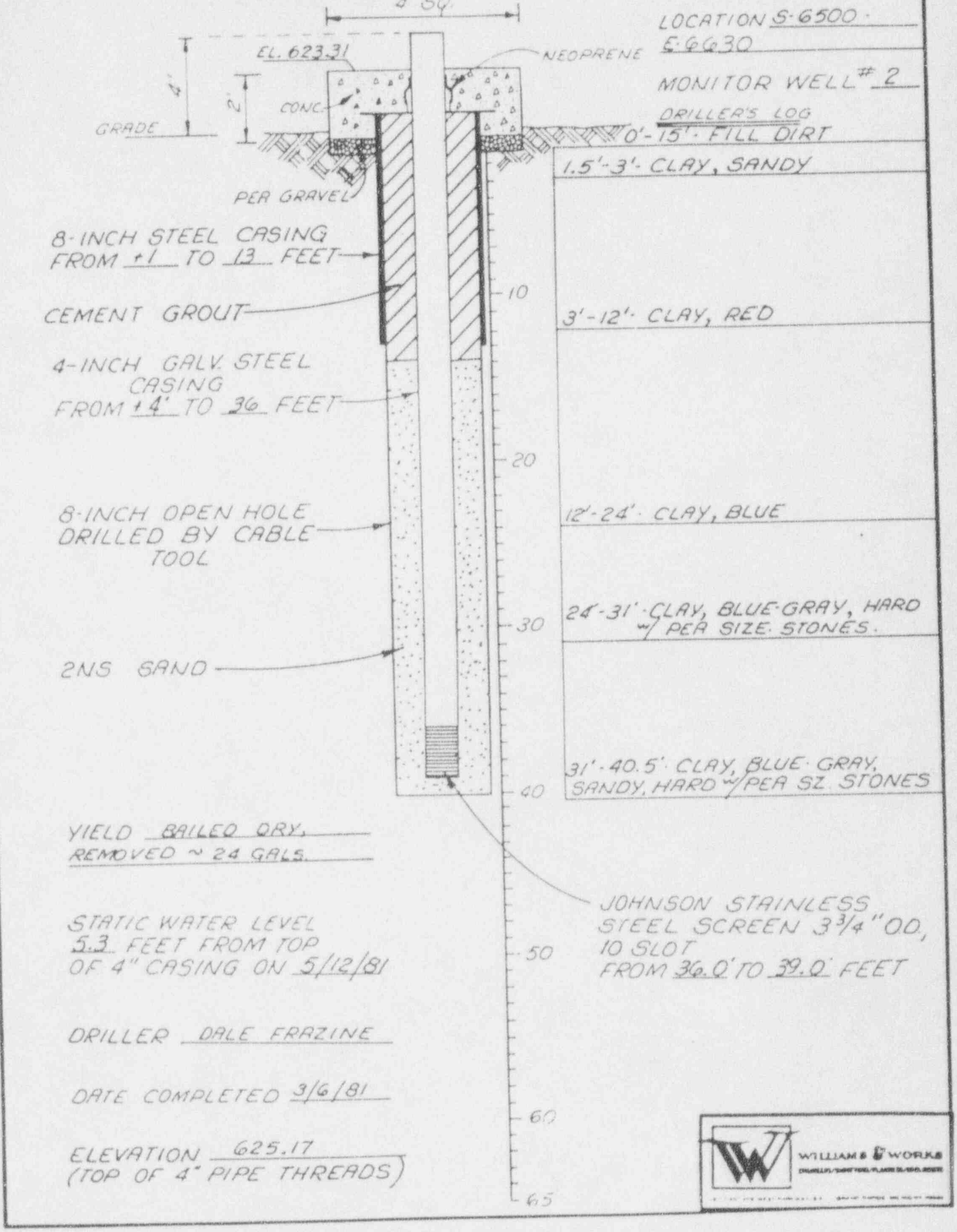


APPENDIX D
ACT 64 WELL LOGS

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)



AS-BUILT RECORD OF MONITOR WELL (SALZBURG RD. LANDFILL)



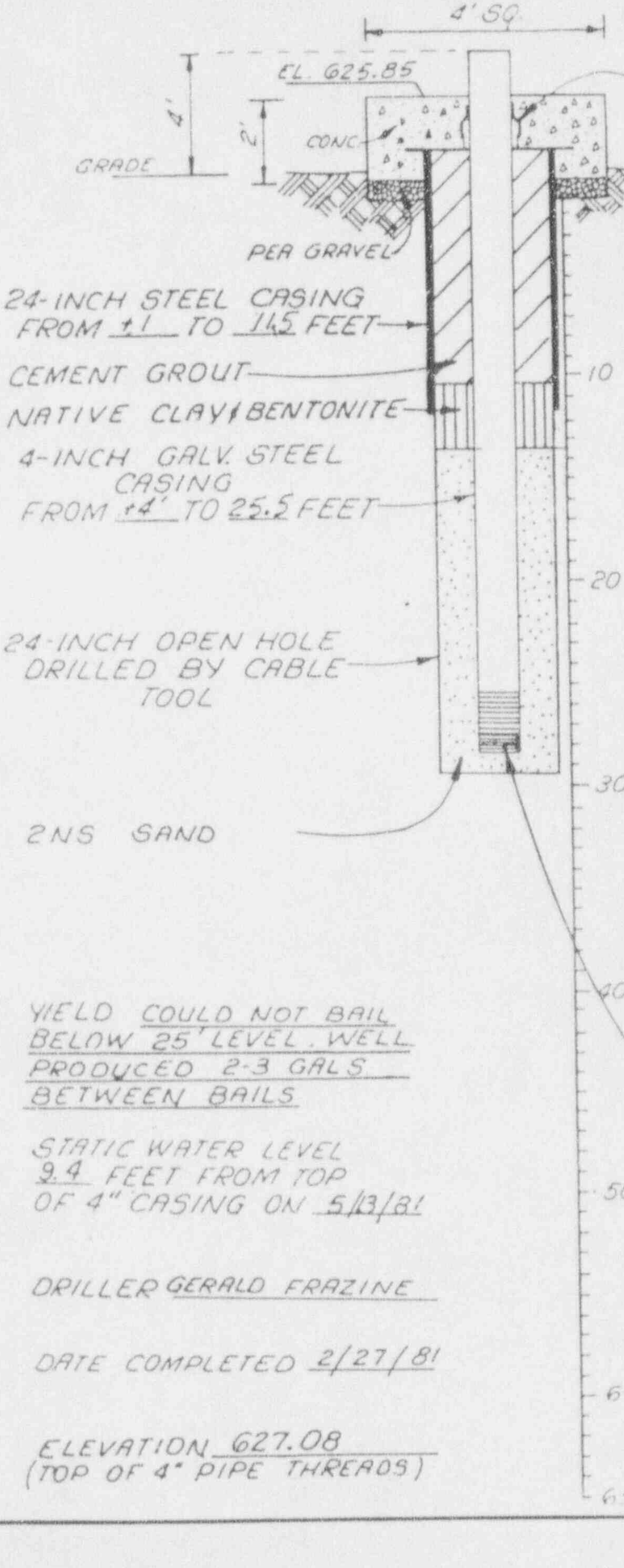
AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)

LOCATION S 7125, E 6744

MONITOR WELL # 3

DRILLER'S LOG

- 0'-3' CLAY
- 3'-5' SAND DRY
- 5'-22' CLAY, RED TO BLUISH SOFT
- 22'-29.5' CLAY, BLUE, VERY HARD, GRAVELLY



YIELD COULD NOT BAIL BELOW 25' LEVEL. WELL PRODUCED 2-3 GALS BETWEEN BAILS

STATIC WATER LEVEL 9.4 FEET FROM TOP OF 4" CASING ON 5/13/81

DRILLER GERALD FRAZINE

DATE COMPLETED 2/27/81

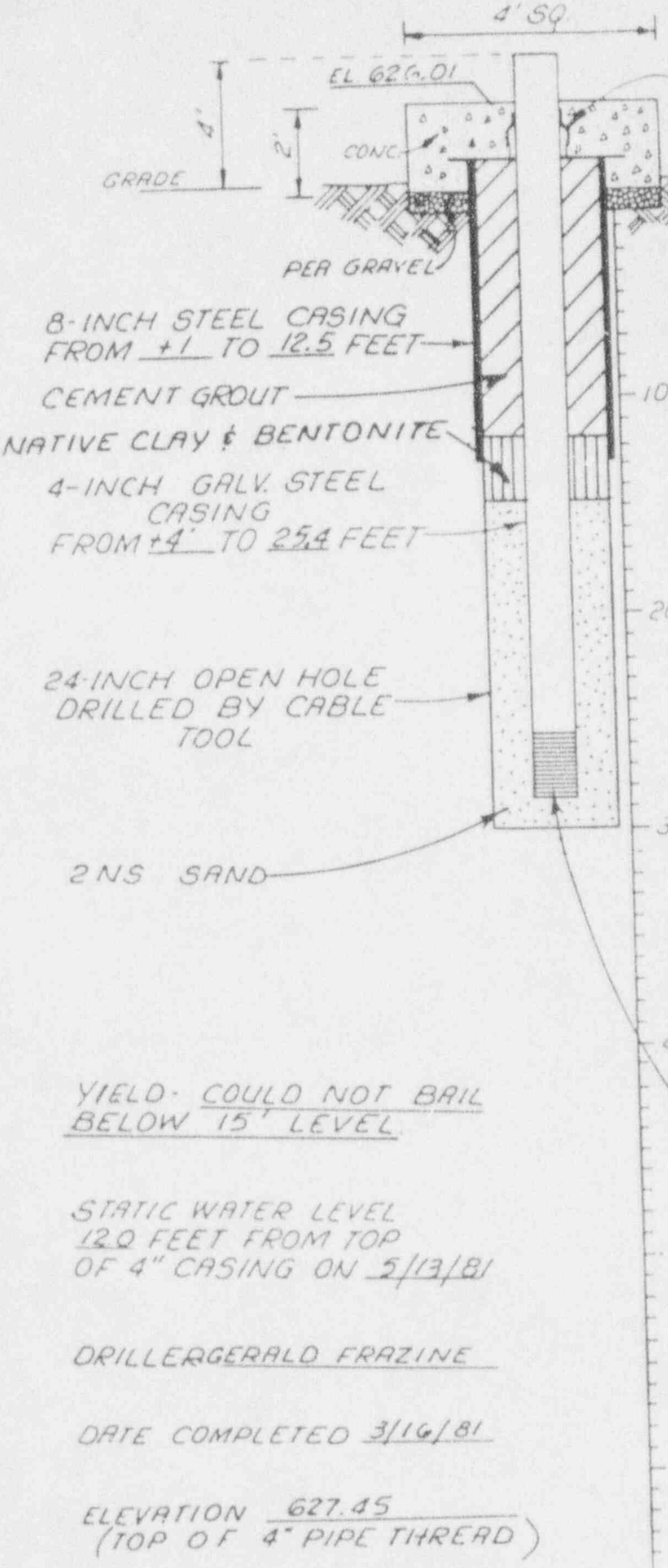
ELEVATION 627.08 (TOP OF 4" PIPE THREADS)

WILLIAMS & WORKS

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)

LOCATION S 7097, E 7010

MONITOR WELL # 4



DRILLER'S LOG

0'-2' CLAY, FILL
2'-4' SAND, DRY
4'-4.5' SAND, WET
4.5'-9' CLAY, RED
9'-21' CLAY, BLUE
21'-24' CLAY, BLUE w/ GRAVEL
24'-30' CLAY, BLUE w/ LARGE ROCKS

YIELD- COULD NOT BAIL BELOW 15' LEVEL

STATIC WATER LEVEL 12.0 FEET FROM TOP OF 4" CASING ON 5/13/81

DRILLER GERALD FRAZINE

DATE COMPLETED 3/16/81

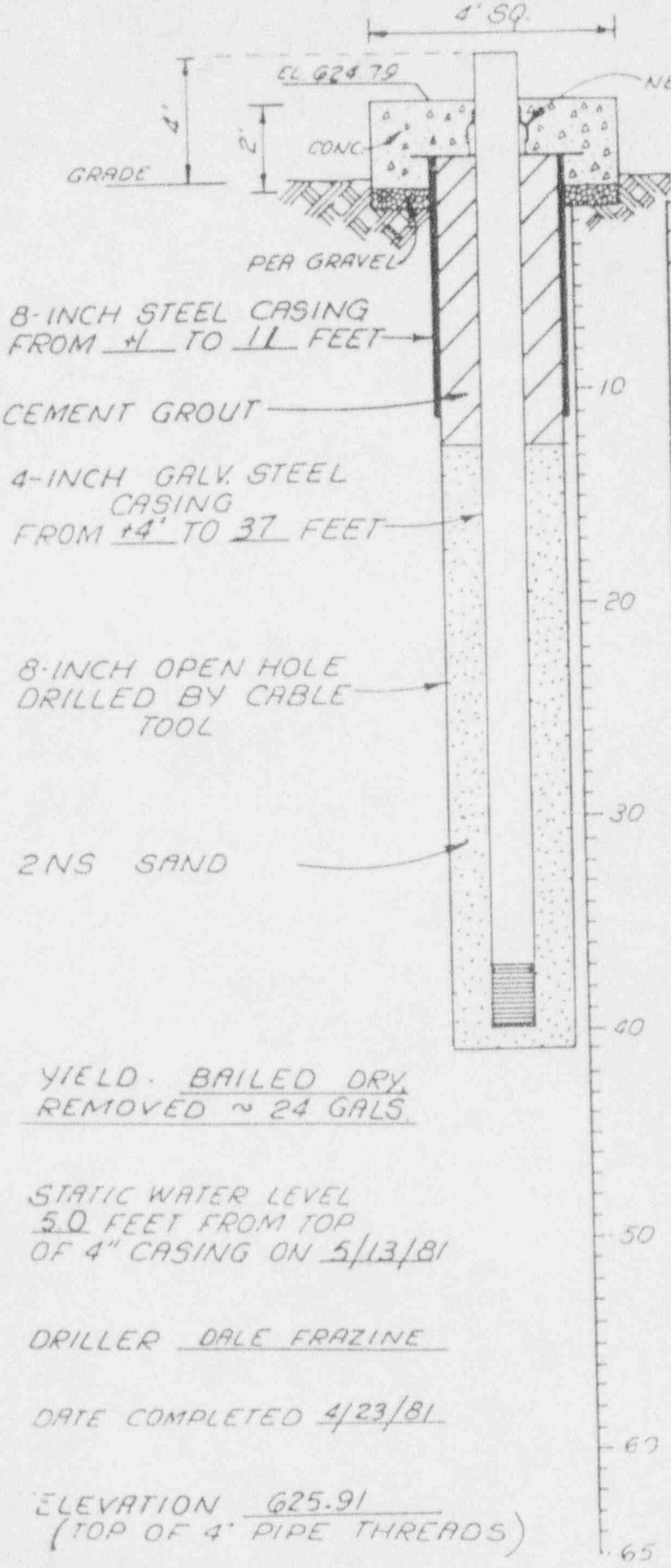
ELEVATION 627.45 (TOP OF 4" PIPE THREAD)

WILLIAMS & WORKS

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)

LOCATION S 8145, E 7738

MONITOR WELL # 5



DRILLER'S LOG

- 0'-1.5' SAND & GRAVEL, FILL
- 1.5'-2'. TOPSOIL
- 2'-4'. CLAY & MUCK
- 4'-10' CLAY, RED
- 10'-18'. CLAY GRAY, SOFT
- 18'-22.7'. CLAY, GRAY, SOME GRIT
- 22.7'-26'. CLAY, GRAY, GRITTY, HARD
- 26'-33' CLAY, GRAY, SANDY w/ LARGE STONES, HARD
- 33-41' CLAY, REDDISH, PEA SIZE GRAVEL & LARGE STONES

YIELD. BAILED DRY, REMOVED ~ 24 GALS.

JOHNSON STAINLESS STEEL SCREEN 3 3/4" OD, 10 SLOT FROM 37' TO 40 FEET

STATIC WATER LEVEL 5.0 FEET FROM TOP OF 4" CASING ON 5/13/81

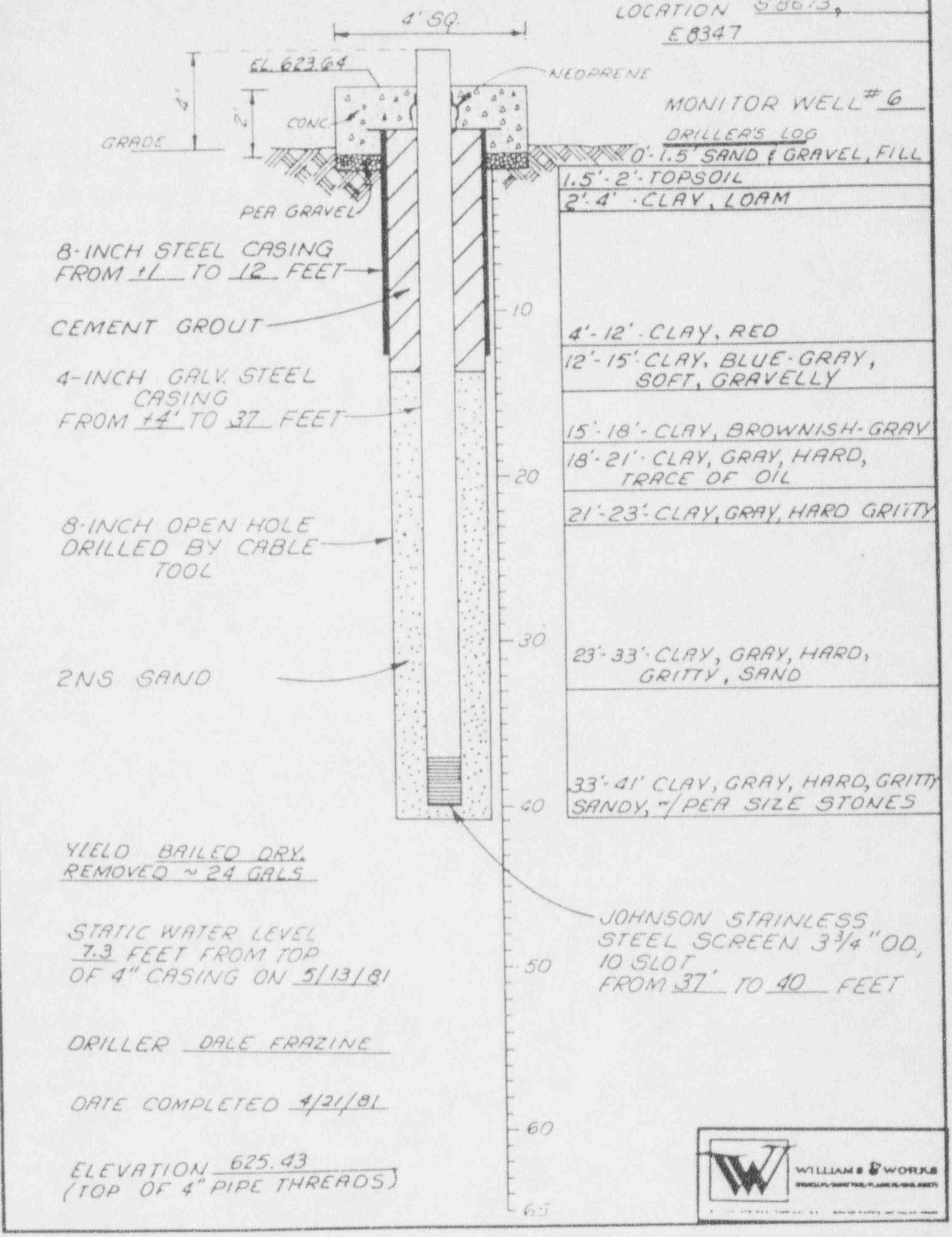
DRILLER DALE FRAZINE

DATE COMPLETED 4/23/81

ELEVATION 625.91 (TOP OF 4' PIPE THREADS)

WILLIAMS & WORKS

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)



EDI ENGINEERING & SCIENCE
ENGINEERS / GEOLOGISTS / BIOLOGISTS / CHEMISTS
511 CASCADE W. PKWY, S.E., GRAND RAPIDS, MI 49508 (616) 942-0970

Page ____ of ____
Well/Boring No. MW #7A
Client: Dow
Project No.: 20245
Permit No.: ____
Date Started: 1/22 Finished: 1/24

Well / Boring Log Sheet

County	Township	Fraction	Section	T	R
		1/4 1/4 1/4			

Contractor: Raymer
Address: Grand Rapids

Equipment: ____

Supervisor: Ed Culver

Drilling Method(s) — **Depth**
6½" rotary — 133.0'

Grouting/Seal

Depth	To	Material
0	77.5'	cement/bentonite
77.5	79.0'	bentonite pellets
79.0	133'	#7 sand-pak

Development: purged with air

Water Level: ____ Ft. Below ____
Measured On: ____

Screen:
Manufacturer: Johnson
Material: stainless steel
Model: Water Mark
Slot/Gauze: 10 slot Dia.: 4"
Length: 60"
Depth Set: 118.0' To: 123.0'

Casing

Dia.	Type	Depth Set
4"	galv.	+4.0' To 118.0'
		To

Elevation
Casing: ____
Ground: ____
Ref. Pt.: ____

Remarks (include here, other data available)

Location Sketch

Thickness	Depth To Base	Description	Remarks
2.0	2.0	Sand	
1.0	3.0	Topsoil	
10.0	13.0	Clay - brown, sandy	
4.5	17.5	Clay - gray, sandy, silty, soft	
0.5	18.0	Clay - gray, sandy, silty, lenses of fine wet sand	
23.5	41.5	Clay - gray, very sandy, pebbles, firm (occasional lenses of fine wet sand)	
23.5+	65.0+	Clay - gray, silty	
15.0	80.0	Clay - gray, silty, trace of sand	
15.0	95.0	Clay - gray	
28.0	123.0	Clay - grayish brown, very hard	
10.0	133.0	Clay - reddish brown, silty, layers of gray, silty clay	

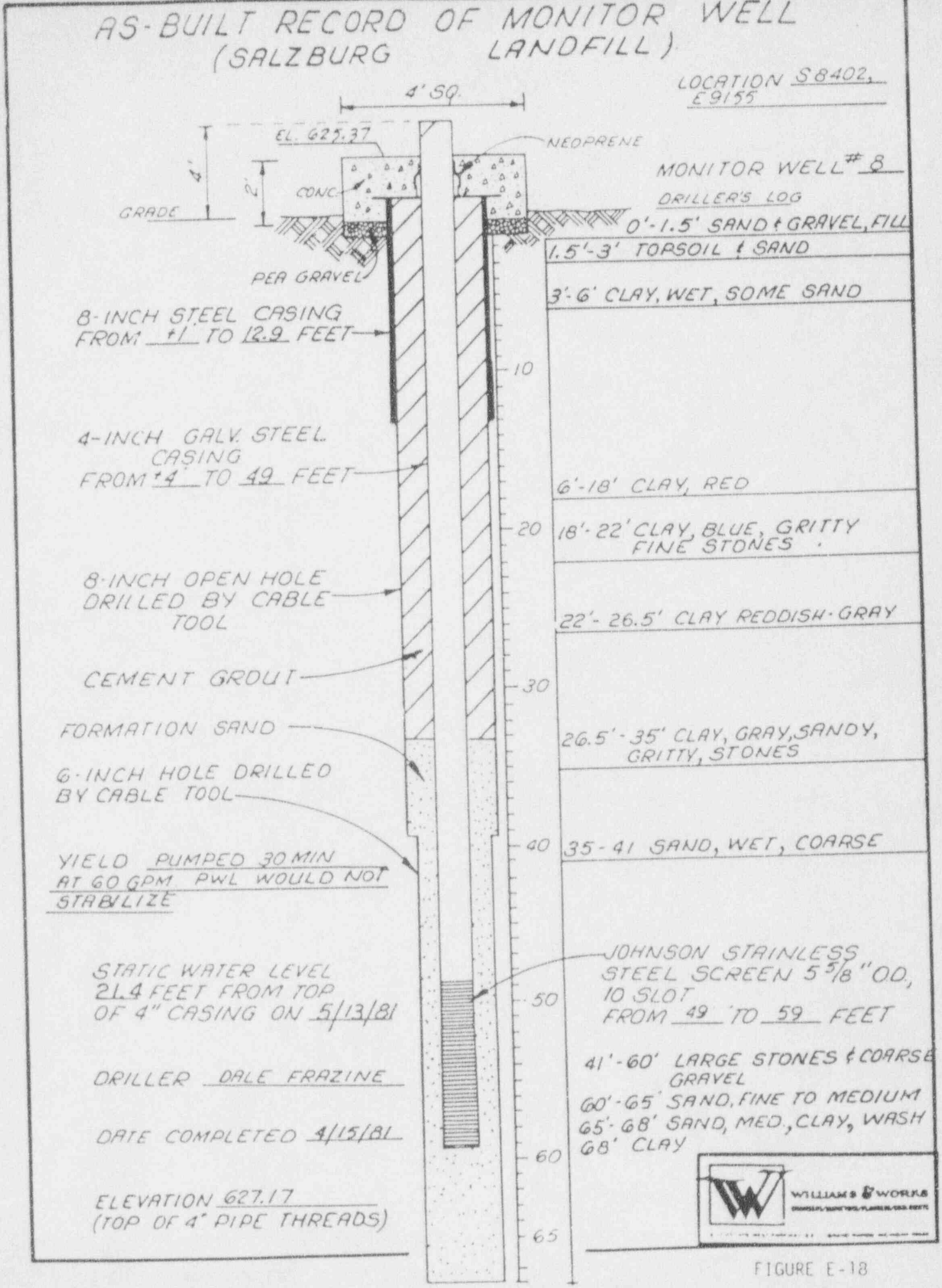

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG LANDFILL)
LOCATION S8402, E9155
4' SQ.
EL. 625.37
NEOPRENE
4'
2'
CONC.
GRADE
PEA GRAVEL
MONITOR WELL # 8
DRILLER'S LOG
0'-1.5' SAND & GRAVEL, FILL
1.5'-3' TOPSOIL & SAND
3'-6' CLAY, WET, SOME SAND
8-INCH STEEL CASING FROM +1 TO 12.9 FEET
4-INCH GALV. STEEL CASING FROM +4 TO 49 FEET
6'-18' CLAY, RED
18'-22' CLAY, BLUE, GRITTY FINE STONES
8-INCH OPEN HOLE DRILLED BY CABLE TOOL
22'-26.5' CLAY REDDISH-GRAY
CEMENT GROUT
FORMATION SAND
26.5'-35' CLAY, GRAY, SANDY, GRITTY, STONES
6-INCH HOLE DRILLED BY CABLE TOOL
35-41 SAND, WET, COARSE
YIELD PUMPED 30 MIN AT 60 GPM PWL WOULD NOT STABILIZE
JOHNSON STAINLESS STEEL SCREEN 5 5/8" O.D., 10 SLOT FROM 49 TO 59 FEET
STATIC WATER LEVEL 21.4 FEET FROM TOP OF 4" CASING ON 5/13/81
41'-60' LARGE STONES & COARSE GRAVEL
DRILLER DALE FRAZINE
60'-65' SAND, FINE TO MEDIUM
65'-68' SAND, MED., CLAY, WASH
68' CLAY
DATE COMPLETED 4/15/81
ELEVATION 627.17 (TOP OF 4" PIPE THREADS)
10
20
30
40
50
60
65
WILLIAMS & WORKS

FIGURE E-18

AS-BUILT RECORD OF MONI[illegible]OR WELL
(SALZBURG LANDFILL)

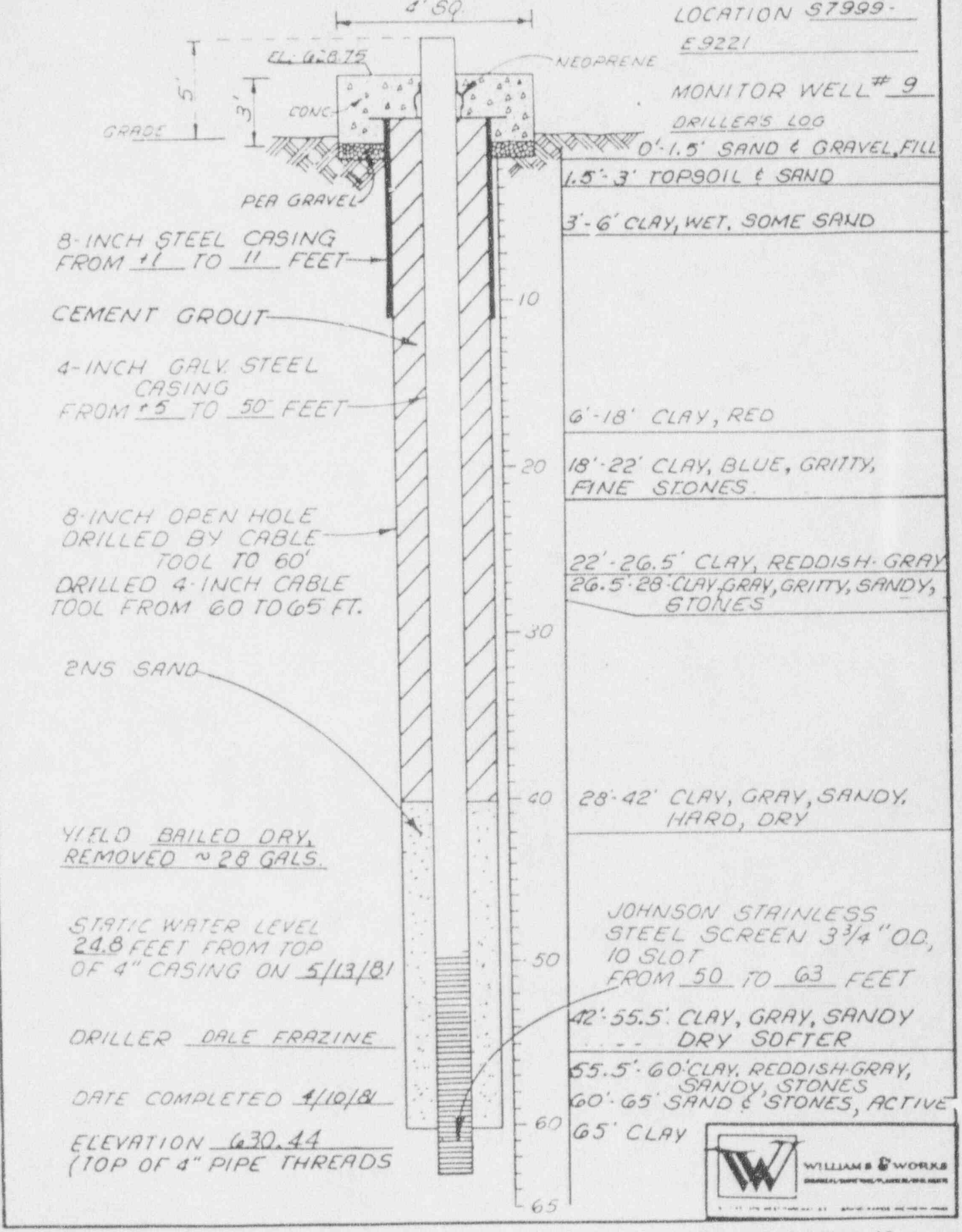
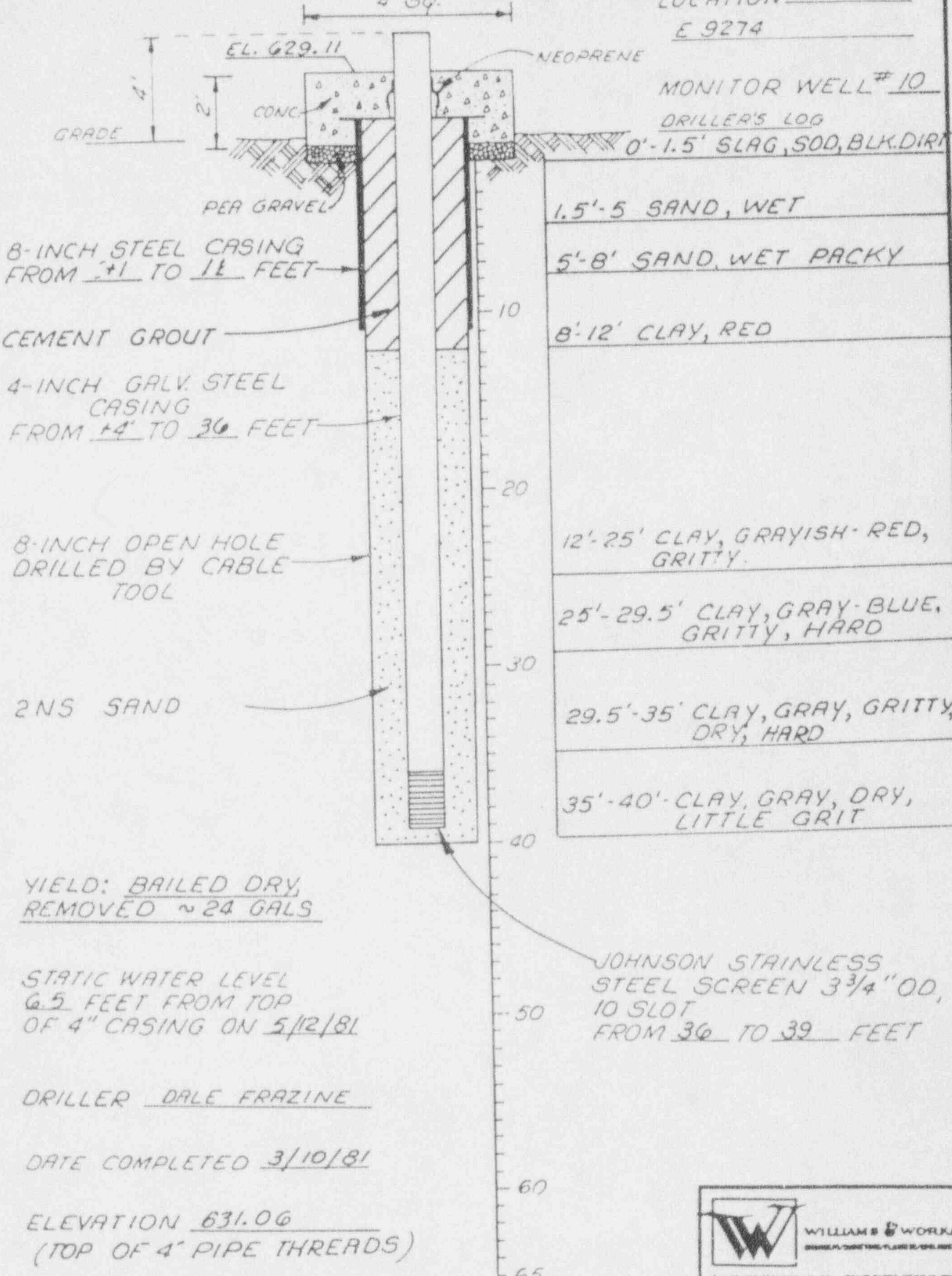


FIGURE E-19

AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)

LOCATION S7400, E 9274

MONITOR WELL # 10



YIELD: BAILED DRY, REMOVED ~24 GALS

STATIC WATER LEVEL 6.5 FEET FROM TOP OF 4" CASING ON 5/12/81

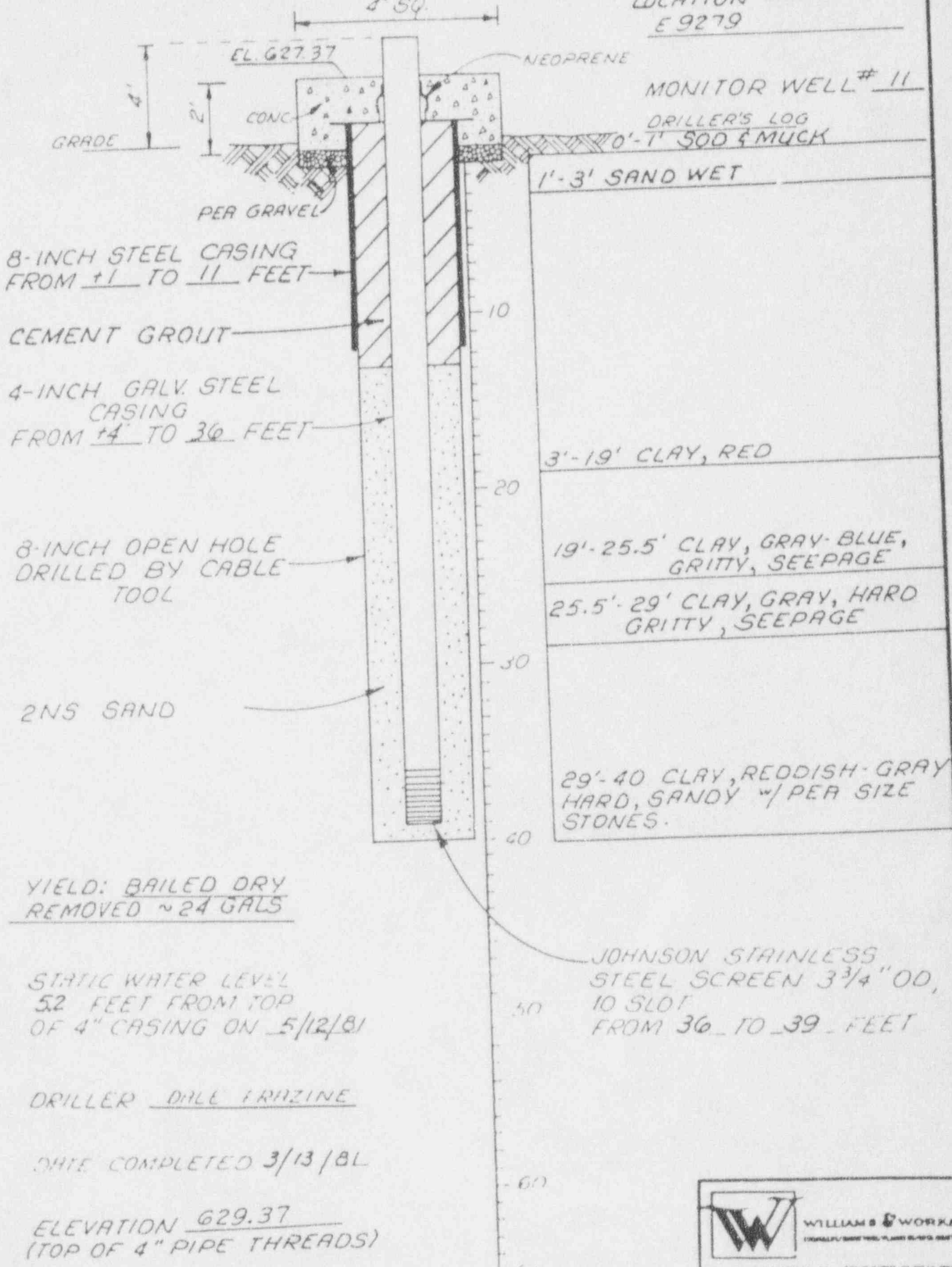
DRILLER DALE FRAZINE

DATE COMPLETED 3/10/81

ELEVATION 631.06 (TOP OF 4" PIPE THREADS)

WILLIAMS & WORKS

AS-BUILT RECORD OF MONITOR WELL (SALZBURG RD. LANDFILL)

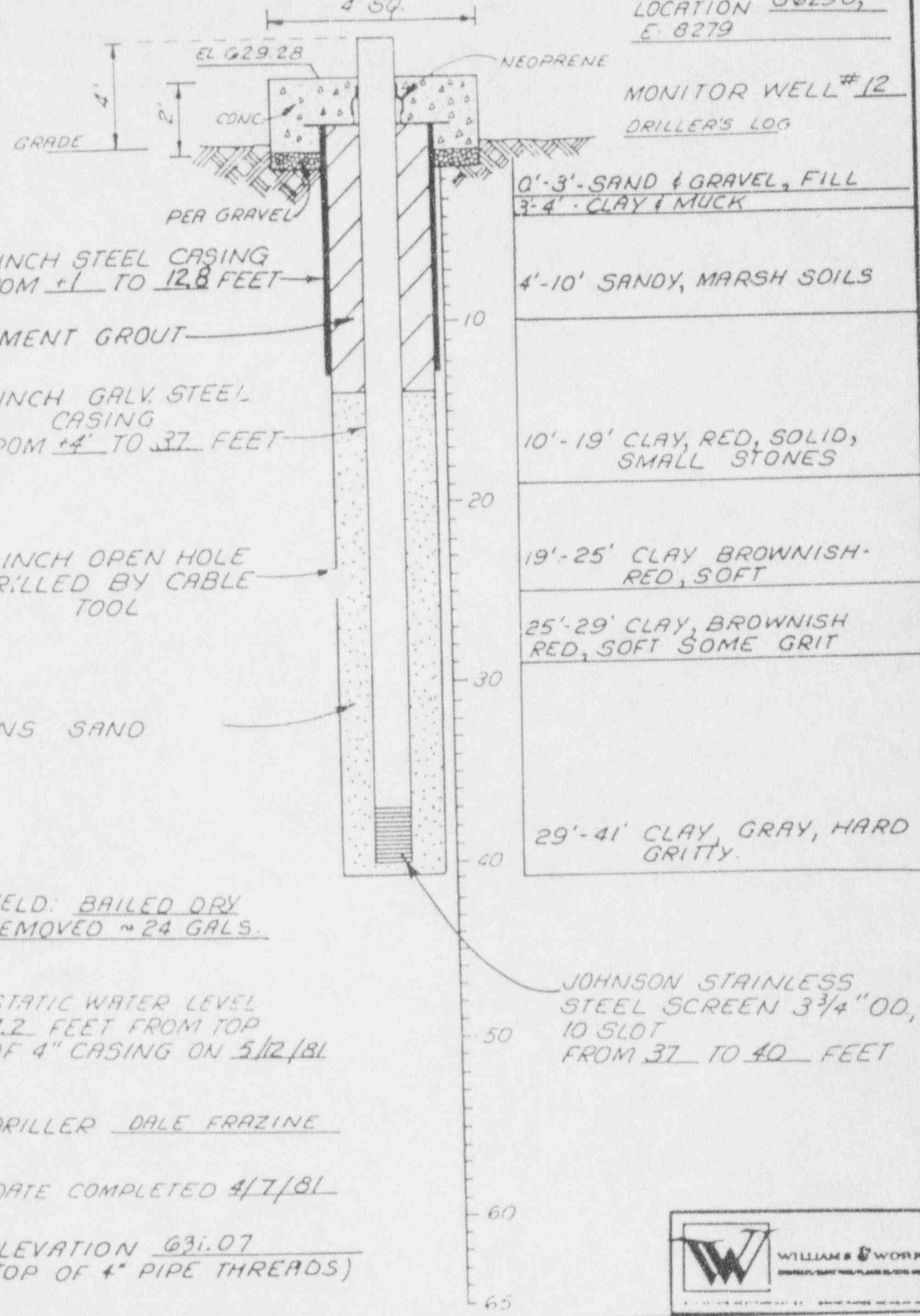


AS-BUILT RECORD OF MONITOR WELL
(SALZBURG RD. LANDFILL)

LOCATION S6290, E 8279

MONITOR WELL # 12

DRILLER'S LOG



YIELD: BAILED DRY REMOVED ~ 24 GALS.

STATIC WATER LEVEL 7.2 FEET FROM TOP OF 4" CASING ON 5/12/81

DRILLER DALE FRAZINE

DATE COMPLETED 4/7/81

ELEVATION 631.07 (TOP OF 4" PIPE THREADS)

WILLIAMS & WORKS

APPENDIX E

LANDFILL CONTAMINATION INCIDENTS

APPENDIX E LANDFILL CONTAMINATION INCIDENTS

E.1. Contamination Incident #1

Late in March, 1983, routine monthly monitoring of the Salzburg Landfill indicated that certain waste constituents had entered the liner failure detection system (underliner system). Upon further investigation, it was determined that the landfill liner had not failed but rather that leachate had been siphoned into the liner failure detection sump from the leachate collection system sump. The sequence of events surrounding this incident is given below.

On March 16, a sample was taken from the sump which collects liquid from the liner failure detection system of the Salzburg Landfill. Ground water slowly seeps into this system from the saturated Lakebed Clay unit in which the landfill is built. This liquid is sampled monthly as required by the Michigan Act 64 operating permit for the landfill. Gas chromatographic analysis must show the liquid to be free of certain specified contaminants. The total volume of accumulated liquid in the sump is transferred to Dow's waste treatment plant for treatment.

The sample was prepared for analysis on March 22. After opening the sample bottle, the laboratory analyst discerned an odor similar to that of samples taken from the landfill's leachate collection system. It was assumed that the wrong sample had been obtained and the liner failure detection sump was resampled. Subsequent analysis of this sample, which occurred on March 23, confirmed the presence of constituents normally found in the leachate.

This sudden occurrence of essentially full strength leachate in the liner failure detection system when the landfill had been receiving wastes for less than one year suggested a problem other than liner failure. Further review of sample data, together with drawings and site inspection, led to the conclusion that leachate had been siphoned from the leachate collection system sump to the liner failure detection sump.

The liner failure detection sump was emptied on February 28 by pumping the liquid through a downcomer line which extends into the leachate collection sump. The forwarding pump impeller, as well as the system check valves on the main pump in the leachate collection sump, were in need of replacement; therefore, the leachate level in the sump was higher than normal, resulting in the submergence of the downcomer line from the liner failure detection sump. A hydraulic connection was established between the two sumps. When the liner failure detection sump pump was turned off on the morning of March 1, 1983, a syphon back action developed, resulting in the flow of leachate from the leachate collection system to the liner failure detection sump. A hydraulic connection was established between the two sumps. When the liner failure detection sump pump was turned off on the morning of March 1, 1983, a syphon back action developed, resulting in the flow of leachate from the leachate collection system to the liner failure detection sump and also into the liner failure detection sand layer, estimated to have been up to seven feet, occurred for 4 to 6 hours.

The situation was relieved when the faulty leachate pump was replaced during the afternoon of March 1. As the liquid from the leachate sump was pumped to the waste treatment plant, the liner failure detection sump was also pumped down due to the siphon connection. When the level of liquid in the leachate sump dropped below the point to which the downcomer from the liner failure detection sump was extended, the syphon was broken. Leachate remained undetected in the liner failure detection sump until the March monthly sampling procedures were completed.

As required by the Michigan Act 64 permit, the Michigan Department of Natural Resources (MDNR) was informed of the liner failure detection contamination incident as soon as the contamination of the liner failure detection system was substantiated. Transportation of hazardous wastes to the landfill was also discontinued. Cleanup operations began on March 25 and consisted primarily of flushing the liner failure detection system and sump with city water. The MDNR also approved the resumption of landfill operations, although no wastes were taken to the landfill until March 28. The flushing attempts resulted in very rapid reduction (approximately 90%) of the concentration of the parameters being tested; however, on the afternoon of March 28, the MDNR requested that disposal operations at the landfill again be stopped.

An Order to Cease and Desist was issued to Dow on April 12, 1983. In summary, the order required Dow to do the following:

1. Cease all disposal activities.
2. Sample all monitoring wells at the facility and report the results to the MDNR.
3. Determine the cause of contamination of the liner failure detection system as soon as possible.
4. Provide daily oral and bi-weekly written reports to MDNR.
5. Submit to the MDNR a program to test the integrity of the landfill liner, leachate collection system, and liner failure detection system.

6. Take all steps necessary to identify any ground-water contamination which may have resulted or is likely to result from the contamination incident.
7. After review of all pertinent engineering plans, submit plans, specifications, and an implementation schedule for correction of all design failures identified.

The information requested by the Order was supplied to the MDNR on April 19, 1984. On May 25, 1983, Dow received a modification of Order to Cease and Desist and Consent Agreement which allowed the reopening of cells 3, 4 and 5 for receipt of hazardous wastes at the landfill but requested that an investigation be performed to demonstrate the following:

1. The liner under Cells 3 through 8 had not failed.
2. The liner failure detection system would insure that leaks in the landfill liner could be detected.
3. There was no contamination in the soils below the liner failure detection system.
4. The ground water had not been contaminated under the Salzburg Landfill.

Corrective actions taken to eliminate a similar contamination incident from occurring again included drilling a "syphon break" vent in the downcomer pipe. A leachate flow meter and audible alarms for the leachate sump high level and liner failure detection sump high level were also installed.

Bi-weekly reports were sent to the MDNR regarding the concentrations of specific compounds which were being tested in the waters used to flush the liner failure detection system. The wash waters were sampled daily. The landfill's internal leachate collection system was also flooded with city water and fluorescent tracer dye. Samples from the liner failure detection sump were then analyzed for the presence of the dye and demonstrated that no detectable levels could be found in the liner failure detection system. It was also determined at this point that a more accurate parameter to be used to monitor for liner failure would be fluorescent dye, since analysis of the liner failure detection water continued to show the presence of trace amounts of the leachate constituents which had initially contaminated the liner failure detection system.

The investigation of the integrity of the landfill also included a separate testing of each individual segment of the landfill. Excavation, soil testing, and sediment chemical analysis demonstrated that no contamination existed in the soils below the liner failure detection system. An additional monitoring well was also installed. Samples from this well and existing wells 1, 2, 3 and 4 were collected monthly and analyzed for specific leachate constituents. The soil samples and the ground water showed no contamination.

On December 23, 1983, Dow received notification from the MDNR that the requirements of the May 17, 1983 Consent Agreement had been satisfied and were authorized to begin full use of Cells 3, 4, 5, 6, 7, and 8 for permanent disposal of hazardous waste in accordance with the provisions of the original operating license.

E.2 CONTAMINATION INCIDENT #2

On August 23, 1983, dilute leachate was detected outside of the landfill cells, resulting in the implementation of the Salzburg Landfill groundwater monitoring contingency procedure. Excavation was underway for new Cells #9 and #10 at the landfill. It was necessary to open the trench containing the collection header lines which convey leachate and liner failure detection drainage from Cells #6, #7 and #8. When this was done, liquid drained from the gravel surrounding the drainage piping. This water was sampled and found to contain 80 ppb of tracer dye and also low ppb levels fo some of the organic constituents of the landfill leachate. The liner failure detection sump at the landfill was immediately sampled and showed no detectable dye, indicating that the liner failure detection layer had not been affected. In compliance with the Michigan Act 64 Landfill Operating Permit, operation of the landfill was stopped and the MDNR was notified.

The leachate and liner failure detection collection sewer lines from Cells #6, #7, and #8 had been terminated and capped during their original installation in 1982 and lay in a gravel bed. The initial investigation into the cause of the contamination involved examination of these pipes. It was determined that the liquid was coming from the gravel bed and not from the pipes. Because the gravel bed was surrounded by natural clay, no immediate danger to human health or the environment existed.

When the investigation was resumed on the following day, the excavated area was found to contain a pool of liquid which had accumulated overnight. The level of the pool was estimated to be approximately the same as that inside Cells #6, #7, and #8 which indicated that the gravel bed was being fed by liquid from inside the cells. Further investigation showed that one of the manholes of the leachate collection piping system was headed up with liquid. The elevation of the liquid level in the manhole was taken and found to be comparable to the liquid level inside Cells #6 through #8. The liquid level inside an associated manhole was observed to be low, suggesting that a restriction existed between the two manholes. A short piece of polyethylene pipe was discovered crossways in the line between the manholes blocking the flow. When this pipe was removed, the flow rate increased immediately from approximately 10 gpm to 118 gpm through the leachate collection sump. The leachate levels inside Cells #6 through #8 also began to change.

A detailed engineering analysis followed the investigation and concluded that the leakage had occurred from the manhole connections. Typically, manholes and their piping connections are not designed to withstand pressure such as occurred when the manhole was blocked. The manholes were therefore eliminated from the system and replaced with short runs of pipe.

On September 6, 1983, Dow received a letter from the MDNR, indicating that the MDNR concurred with the results fo the investigation and the actions taken at the Salzburg Landfill. The reopening of the landfill was thereby authorized.

Several dewatering wells were installed into the gravel bed and the contaminated gravel bed and surrounding areas are being flushed with City water. The water is pumped into the leachate collection sump. Flushing operations will continue until the monthly analysis for leachate constituents and fluorescent dye show nonquantifiable levels.

Analyses of samples from the ground-water monitoring wells were analyzed for volatile organics. The results were all nondetectable.

E.3 CONTAMINATION INCIDENT #3

On September 26, 1983, perchloroethylene was detected in the liner failure detection system of the Salzburg Landfill. The contamination was discovered during the analysis of samples collected from the liner failure detection sump prior to the monthly discharge of collected liquids to the leachate sump.

The landfill was not receiving wastes at the time the contamination was discovered due to inclement weather; hazardous waste activity did not resume at the landfill until approval was received from the MDNR on October 17, 1983.

Activities to determine the source of the contamination were initiated immediately. The liquid in the liner failure detection sump was again sampled and analyzed to confirm the presence of perchloroethylene. All of the liner failure detection sample ports closest to the sump pump showed dirt or clay deposits which, upon analysis, contained concentration of perchloroethylene higher than that of the initial sump sample.

On September 30, the liner failure detection sump was drained and hydroblasted. A system of flushing individual liner failure detection lines and sampling ports was then devised and implemented. The resulting analytical data showed decreasing levels of contamination as the flushing progressed and perchloroethylene levels were eventually reduced to nondetectable levels.

At no time did analysis of samples from the liner failure detection system show detectable levels of methylene chloride, a major constituent of the landfill leachate. If the liner system had failed, this contaminant, as well as other major leachate constituents, would have been found. A liner integrity test had also been recently completed. Since samples from the liner failure detection sump as well as carbon packs did not show any fluorescence, failure of the landfill liner system was proven unlikely.

It was concluded that the problem which resulted in perchloroethylene contamination of the liner failure detection sump was a single, isolated event in which the contamination began in the sump and traveled back through the liner failure detection piping. However, while it is evident from the data that contamination of the sump occurred from an external source, the exact means of contamination has not been determined.

On October 17, 1983, the MDNR approved resumption of disposal operations at the landfill under conditions of the March 17, 1983 Consent Agreement which was still in effect. An additional requirement included the continued monitoring of perchloroethylene levels in the liner failure detection system. Perchloroethylene was not detected in any samples taken from the ground-water monitoring wells located around the landfill.

E.4 CONTAMINATION INCIDENT #4

In the second quarter of 1985, phenol was detected in the original monitoring well 7 at a concentration of 1.4 ppm. Monitoring well 7 was screened at a depth of 65 feet in the Glacial Till unit. The original intent of screening monitoring well 7 at this depth was to sample groundwater from the sand subunit in the Glacial Till. As detailed in the discussion on groundwater movement in Section 7, monitoring wells 8 and 9 are screened in a sand subunit of the Glacial Till and, therefore, yield sufficient amounts of groundwater to supply representative samples of the groundwater and to fully recover between sampling periods. However, the sand subunit of the Glacial Till which extends under monitoring wells 8 and 9 does not extend under monitoring well 7. Thus, monitoring well 7 was screened in the low permeable Glacial Till and did not yield adequate groundwater to fully recover between sampling or to be properly purged to yield representative samples of the groundwater.

Due to the very low yield, and thus insufficient purging prior to sampling, and to the distance of monitoring well 7 from the active portion of the landfill, the phenol in the groundwater sampled from monitoring well 7 was suspected to be from contamination of the well during its construction. A work plan to evaluate the well as the possible source of phenol was drafted and agreed upon by the Hazardous Waste Division of the Michigan Department of Natural Resources. The action described below was taken under this agreement.

On October 14 and 15, 1985, a temporary monitoring well 7A was drilled next to the original monitoring well 7 to analyze for phenol in the groundwater at the same elevation as monitoring well 7. This well was drilled with hollow-stem auger, and a rigid quality assurance-quality control program was followed. This program included steam cleaning the casing, screen, auger and drill rig prior to entering the site and taking wipe samples for phenol analysis of a 100 cm^2 area of the casing, screen, auger, drill pipe, split spoon, and blank. All of the wipe samples taken had no detectable phenol at a detection limit of 10 ug per wi[illegible] Groundwater samples from this well also did not contain any detectable phenol.

After it was determined that the groundwater in the temporary monitoring well 7A did not contain phenol, the original monitoring well 7 was to be pulled, if possible, and groundwater samples taken from the open hole. On November 11, 1985, the 13-foot long outer 8" casing and 20 feet of the inner 4" casing from the original monitoring well 7 were pulled. However, due to the depth of the cement grout around the 4" casing, this casing separated at a coupling 20 feet deep, leaving 46 feet of 4" casing in the ground. Wipe tests for phenol were taken on the inside of the 4" casing and on the threads. The sample taken on the [illegible] of the casing gathered 16 ug of phenol and the wipe test on the popped threads gathered 14 ug of [illegible] since much of the casing remained in the hole, a groundwater sample was not collected.

The phenol on the casing from the original monitoring well 7 and the absence of phenol in temporary monitoring well 7A both support the source of phenol being from contamination during construction of monitoring well 7 [illegible] on this conclusion, the hole for the original monitoring well 7 was plugged from the bottom up wi[illegible]ure of bentonite and cement and monitoring well 7A was deepened to be screened in sediments which yield sufficient groundwater for the proper purging of the well prior to sampling.

APPENDIX F
ONSITE/MAXI RESULTS

ICRP-2 and ICRP 26/30 Maximum Annual Dose Calculation
(MAXI Version IBM 1.12 19-May-87)

Case title: SALZBURG LANDFILL TRENCH 37
Executed on: 11/23/1987 at 10:24:35 Page 1

PATHWAYS/OPTIONS CONSIDERED:
External exposure/root penetration for waste modeled as slab (volume) source
External exposure to surface contamination modeled as a plane source
Inhalation of resuspended material
Farm product ingestion
Committed effective dose equivalent (CEDE) calculation

TITLES OF LIBRARY FILES ACCESSED:

10: RMDLIB - Radionuclide Master Library (21-Nov-86 H3 & C14 [W] RAP)
11: ORGAN DATA LIBRARY UPDATED BY RA PELOQUIN 8-Jul-86
12: FOOD TRANSFER COEFFICIENT LIBRARY (RAP/WTF 04-APR-86 C1 Update)
13: Committed Dose Equivalents (Sv/Bq) ICRP Publication 30 (22-Nov-86 RAP)
22: OVERBURDEN: 0.0M
SOURCE: 0.15 M (DEN: CONCRETE/1.8): MR/HR 5-Jul-86 RAP
23: DACRIN (DIFDOS) DOSE INCREMENT FILE ONSITE/MAXI 20-Apr-87 RAP
27: OVERBURDEN: 1.0m
SOURCE: 1.0M (DEN: CONCRETE/1.8): MR/HR 16-Jul-86 RAP

NUMBER OF YEARS AFTER WASTE IS DISPOSED THAT:
Scenario begins: 3
Scenario ends: 52

INVENTORY:
Release Term Input units: (1-pCi 2-uCi 3-mCi 4-Ci) 1 pCi
Soil source units: (0- m**2 1- m**3 2- kg) 1
Number of radionuclides in inventory: 7

Release Terms (per m**3)	Soil Source (per L)	Irrigation /Aquatic (per L)	Drinking Water (per yr)	Atmospheric Release
TH232	2.2E+08	.0E+00	.0E+00	.0E+00
RA228	2.2E+08	.0E+00	.0E+00	.0E+00
AC228	2.2E+08	.0E+00	.0E+00	.0E+00
TH228	2.2E+08	.0E+00	.0E+00	.0E+00
RA224	2.2E+08	.0E+00	.0E+00	.0E+00
PB212	2.2E+08	.0E+00	.0E+00	.0E+00
BI212	2.2E+08	.0E+00	.0E+00	.0E+00

INVENTORY MODIFICATION FACTORS: (multipliers)
Surface inventory dilution factor: 1.
Irrigation/aquatic inventory modification factor: 1.
Size of site (fractional ha): 1.0E+00
Fraction of total diet grown on site: 1.

EXTERNAL/INHALATION EXPOSURE:

Hours of external exposure to contamination (h/yr): 8.8E+03
Hours of inhalation of airborne contamination (h/yr): 8.8E+03
Breathing rate (cm**3/sec): 2.7E+02

RESUSPENSION PARAMETERS:

Model used: Mass Loading
Soil density (g/m**3): 1.8E+06
Mass loading factor (g/m**3): 1.0E-04

AGRICULTURAL PARAMETERS:

Fraction of roots in upper soil: 1.00
Fraction of roots in deeply buried waste: .000
Ratio of ext. contamination in surface/subsurface soil: .000
Months per year irrigated: 6
Irrigation rate (L/m**2/mo): 1.5E+02
Years of irrigation w/ contaminated water prior to the beginning of the dose calculation period: 0
Number of food types: 10

FOOD TYPE INDEX	FOOD TYPE	GROWING PERIOD (days)	YIELD (kg/m**3)	HOLDUP (days)	CONSUMPTION (kg/yr)	TRANS-LOCATION FACTOR
1	LEAFY VEG.	90.	1.50	1.	9.5	1.00
2	O.A.G.VEG.	60.	.70	1.	9.5	.10
4	OT.RT.VEG	90.	4.00	10.	76.0	.10
7	ORCH.FRUIT	90.	2.00	10.	42.0	.10
9	OT.GRAIN	90.	1.00	1.	51.0	.10
10	EGGS	90.	.84	1.	19.0	.10
11	MILK	30.	1.30	1.	110.0	1.00
12	BEEF	90.	.84	15.	39.0	.10
13	PORK	90.	.84	15.	29.0	.10
14	POULTRY	90.	.84	1.	8.5	.10

Input prepared by: Joseph W. Drake Date: 11/23/87

Input checked by: William C. Duggan Date: 11/24/87

*******PLEASE NOTE ANY SPECIAL CONSIDERATIONS IN THIS SPACE*******

CALCULATED VALUES:

Ingestion area correction factor:	1.0
External/inhalation area correction factor:	1.0
Inhalation exposure modification factor:	1.0
External exposure modification factor:	1.0

SOIL
AIR
AND WATER CONCENTRATION SUMMARY FOR YEAR: 3

Radio-nuclide	Surface Soil pCi/m2	Deep Soil pCi/m3	Air pCi/m3	Irrigation pCi/L	Drink Water pCi/L
TH 232	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
RA 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
AC 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
TH 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
RA 224	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
PB 212	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
BI 212	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00

SOIL
AIR
AND WATER CONCENTRATION SUMMARY FOR YEAR: 52

Radio-nuclide	Surface Soil pCi/m2	Deep Soil pCi/m3	Air pCi/m3	Irrigation pCi/L	Drink Water pCi/L
TH 232	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
RA 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
AC 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
TH 228	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
RA 224	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
PB 212	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00
BI 212	.0E+00	2.2E+08	.0E+00	.0E+00	.0E+00

Annual Effective Dose Equivalent (AEDE): 1.3E-03

Maximum Annual Dose (ICRP-2):

To Organ:	TOTAL BODY	at Year 4	1.3E-03 rem
To Organ:	BONE	at Year 4	1.3E-03 rem
To Organ:	LUNGS	at Year 4	1.3E-03 rem
To Organ:	THYROID	at Year 4	1.3E-03 rem
To Organ:	LLI	at Year 4	1.3E-03 rem

DOSES FROM 1 YEAR OF EXPOSURE (REM)

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	.0E+00	2.5E-01	.0E+00
Breast	.0E+00	1.5E-01	.0E+00
R Marrow	.0E+00	1.2E-01	.0E+00
Lungs	.0E+00	1.2E-01	.0E+00
Thyroid	.0E+00	3.0E-02	.0E+00
Bone Surf	.0E+00	3.0E-02	.0E+00
St Wall	.0E+00	6.0E-02	.0E+00
SI Wall	.0E+00	6.0E-02	.0E+00
ULI Wall	.0E+00	6.0E-03	.0E+00
LLI Wall	.0E+00	6.0E-02	.0E+00
Kidneys	.0E+00	6.0E-02	.0E+00
Effective Dose Equivalent			.0E+00
External Dose			1.3E-03
Annual Effective Dose Equivalent			1.3E-03

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 4 FOR TOTAL BODY

RADIO-NUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINK WATER REM	%
TH232	.0E+00	0	.0E+00	0	1.3E-33	0	.0E+00	0	.0E+00	0
RA228	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0
AC228	.0E+00	0	.0E+00	0	1.2E-05	0	.0E+00	0	.0E+00	0
TH228	.0E+00	0	.0E+00	0	2.3E-13	0	.0E+00	0	.0E+00	0
RA224	.0E+00	0	.0E+00	0	2.1E-10	0	.0E+00	0	.0E+00	0
PB212	.0E+00	0	.0E+00	0	1.3E-10	0	.0E+00	0	.0E+00	0
BI212	.0E+00	0	.0E+00	0	1.3E-03	99	.0E+00	0	.0E+00	0

TOTAL	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINK WATER	
1.3E-03	.0E+00	0	.0E+00	0	1.3E-03	100	.0E+00	0	.0E+00	0

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 4 FOR BONE

RADIO-NUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINK WATER REM	%
TH232	.0E+00	0	.0E+00	0	1.3E-33	0	.0E+00	0	.0E+00	0
RA228	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0
AC228	.0E+00	0	.0E+00	0	1.2E-05	0	.0E+00	0	.0E+00	0
TH228	.0E+00	0	.0E+00	0	2.3E-13	0	.0E+00	0	.0E+00	0
RA224	.0E+00	0	.0E+00	0	2.1E-10	0	.0E+00	0	.0E+00	0
PB212	.0E+00	0	.0E+00	0	1.3E-10	0	.0E+00	0	.0E+00	0
BI212	.0E+00	0	.0E+00	0	1.3E-03	99	.0E+00	0	.0E+00	0

TOTAL	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINK WATER	
1.3E-03	.0E+00	0	.0E+00	0	1.3E-03	100	.0E+00	0	.0E+00	0

ICRP-2 and ICRP-26/30 Maximum Annual Dose Calculation
(MAXI Version IBM 1.12 19-May-87)

Case title: SALZBURG LANDFILL TRENCH 37
Executed on: 11/23/1987 at 10:24:35

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 4 FOR LUNGS

	EXPOSURE PATHWAY									
RADIO-NUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINK WATER REM	%
TH232	.0E+00	0	.0E+00	0	1.3E-33	0	.0E+00	0	.0E+00	0
RA228	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0
AC228	.0E+00	0	.0E+00	0	1.2E-05	0	.0E+00	0	.0E+00	0
TH228	.0E+00	0	.0E+00	0	2.3E-13	0	.0E+00	0	.0E+00	0
RA224	.0E+00	0	.0E+00	0	2.1E-10	0	.0E+00	0	.0E+00	0
PB212	.0E+00	0	.0E+00	0	1.3E-10	0	.0E+00	0	.0E+00	0
BI212	.0E+00	0	.0E+00	0	1.3E-03	99	.0E+00	0	.0E+00	0

TOTAL	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINK WATER	
1.3E-03	.0E+00	0	.0E+00	0	1.3E-03	100	.0E+00	0	.0E+00	0

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 4 FOR THYROID

	EXPOSURE PATHWAY									
RADIO-NUCLIDE	INGESTION REM	%	INHALATION REM	%	EXTERNAL REM	%	AQUATIC FOOD REM	%	DRINK WATER REM	%
TH232	.0E+00	0	.0E+00	0	1.3E-33	0	.0E+00	0	.0E+00	0
RA228	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0
AC228	.0E+00	0	.0E+00	0	1.2E-05	0	.0E+00	0	.0E+00	0
TH228	.0E+00	0	.0E+00	0	2.3E-13	0	.0E+00	0	.0E+00	0
RA224	.0E+00	0	.0E+00	0	2.1E-10	0	.0E+00	0	.0E+00	0
PB212	.0E+00	0	.0E+00	0	1.3E-10	0	.0E+00	0	.0E+00	0
BI212	.0E+00	0	.0E+00	0	1.3E-03	99	.0E+00	0	.0E+00	0

TOTAL	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DSINK WATER	
1.3E-03	.0E+00	0	.0E+00	0	1.3E-03	100	.0E+00	0	.0E+00	0

MAXIMUM ANNUAL DOSE SUMMARY FOR THE YEAR 4 FOR LLI

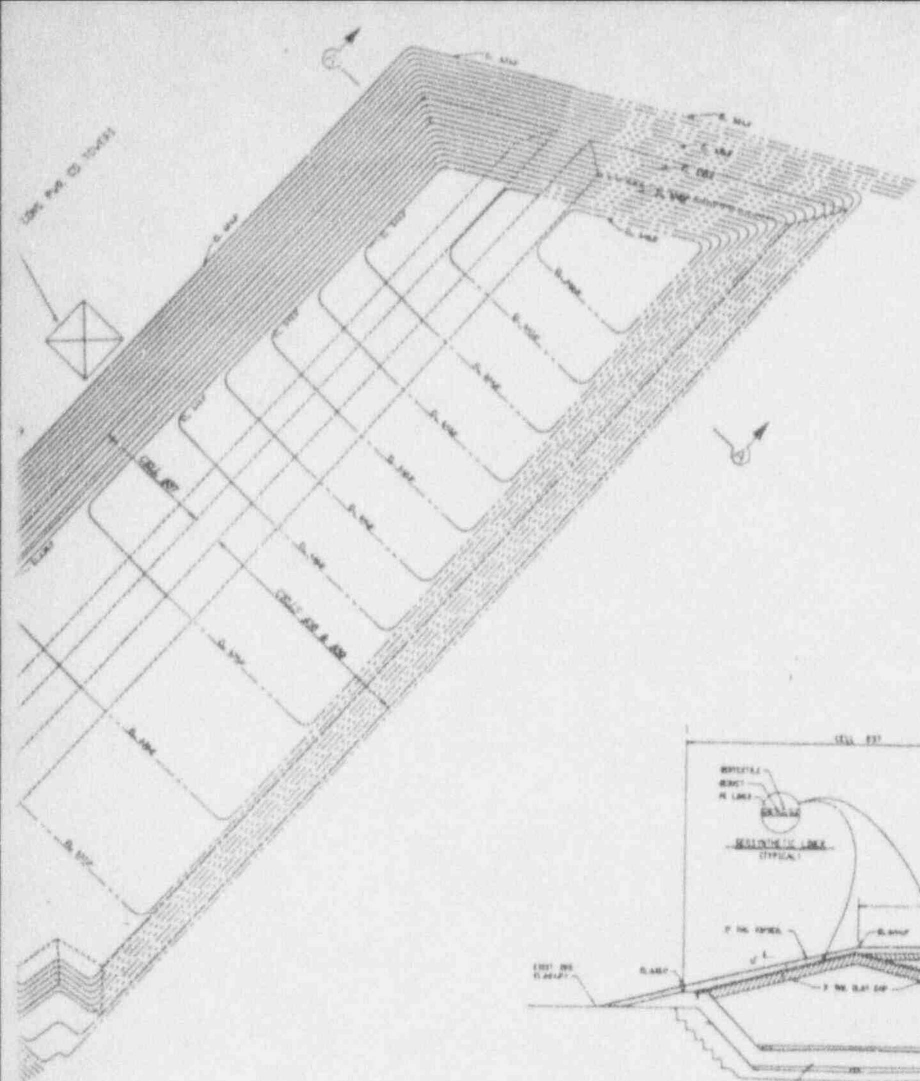
	EXPOSURE PATHWAY									
RADIO-	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINK WATER	
NUCLIDE	REM	%	REM	%	REM	%	REM	%	REM	%
TH232	.0E+00	0	.0E+00	0	1.3E-33	0	.0E+00	0	.0E+00	0
RA228	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0	.0E+00	0
AC228	.0E+00	0	.0E+00	0	1.2E-05	0	.0E+00	0	.0E+00	0
TH228	.0E+00	0	.0E+00	0	2.3E-13	0	.0E+00	0	.0E+00	0
RA224	.0E+00	0	.0E+00	0	2.1E-10	0	.0E+00	0	.0E+00	0
PB212	.0E+00	0	.0E+00	0	1.3E-10	0	.0E+00	0	.0E+00	0
BI212	.0E+00	0	.0E+00	0	1.3E-03	99	.0E+00	0	.0E+00	0
TOTAL	INGESTION		INHALATION		EXTERNAL		AQUATIC FOOD		DRINK WATER	
1.3E-03	.0E+00	0	.0E+00	0	1.3E-03	100	.0E+00	0	.0E+00	0

APPENDIX G

DISPOSAL CELL CONSTRUCTION AND CAP DRAWINGS

DRAWINGS

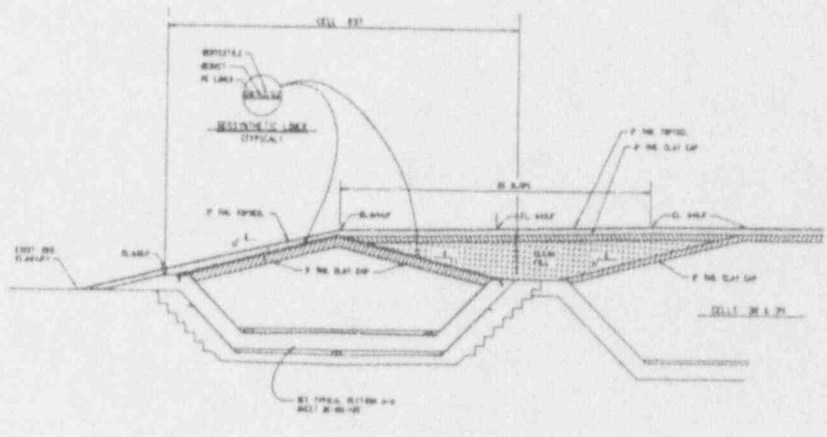
B2-001-122 AND B2-002-122



PLAN FOR CELL #37

(BL INTO CAP FOR CELLS #38 & #39)

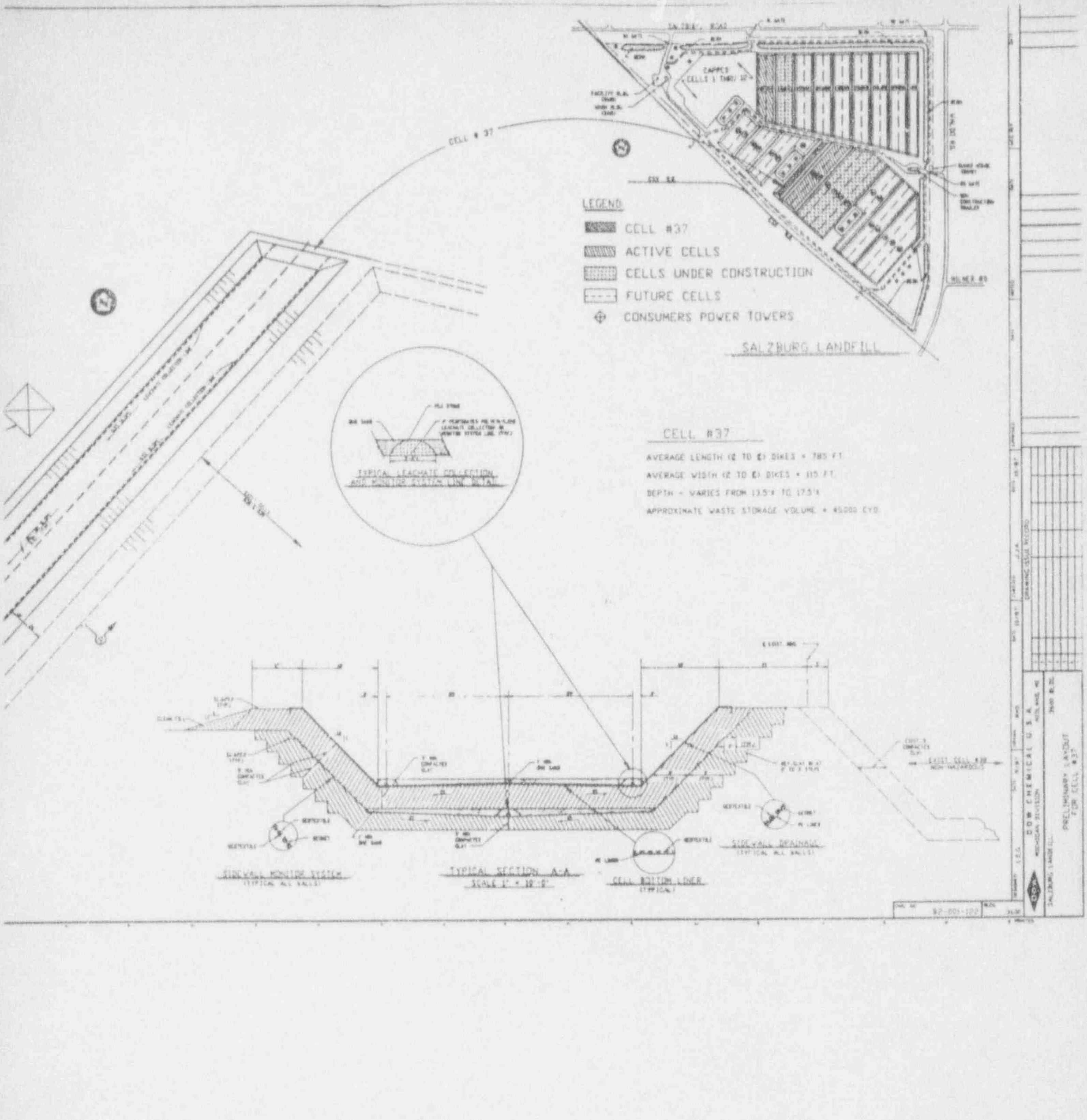
SCALE: 1" = 30'-0"

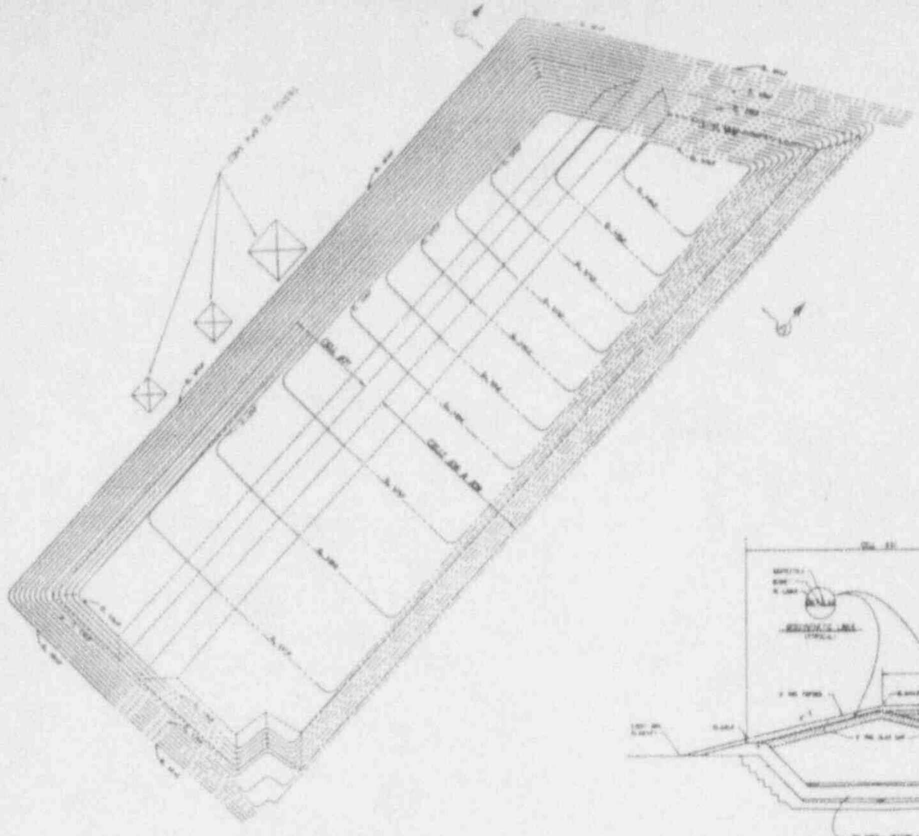


TYPICAL SECTION A-A

SCALE: 1" = 20'-0"

DOW CHEMICAL U.S.A.
MICHIGAN DIVISION
MIDLAND, MI
SALZBURG LANDFILL
PRELIMINARY CAPPING PLAN
FOR CELL #37
DRAWING ISSUE RECORD
82-002-177

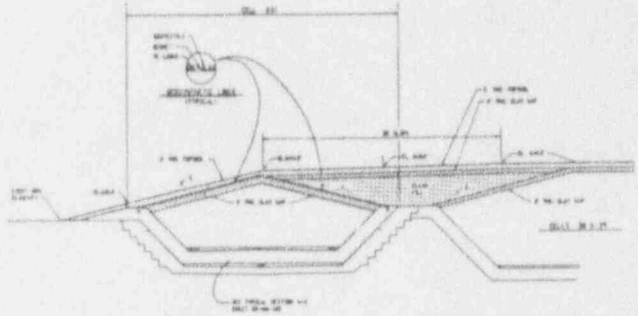

SALZBURG ROAD
CAPPED CELLS 1 THRU 12
CELL # 37
LEGEND
CELL #37
ACTIVE CELLS
CELLS UNDER CONSTRUCTION
FUTURE CELLS
CONSUMERS POWER TOWERS
SALZBURG LANDFILL
CELL #37
AVERAGE LENGTH (℄ TO ℄) DIKES = 785 FT.
AVERAGE WIDTH (℄ TO ℄) DIKES = 115 FT.
DEPTH - VARIES FROM 13.5'± TO 17.5'±
APPROXIMATE WASTE STORAGE VOLUME = 45000 CYD.
TYPICAL LEACHATE COLLECTION AND MONITOR SYSTEM LINE DETAIL
SIDEWALL MONITOR SYSTEM
(TYPICAL ALL WALLS)
TYPICAL SECTION A-A
SCALE 1" = 10'-0"
CELL BOTTOM LINER
(TYPICAL)
SIDEWALL DRAINAGE
(TYPICAL ALL WALLS)
EXIST. CELL #38
NON HAZARDOUS
DOW CHEMICAL U.S.A.
MICHIGAN DIVISION
SALZBURG LANDFILL
PRELIMINARY LAYOUT FOR CELL #37
82-005-122



CAPPING PLAN FOR CELL #37

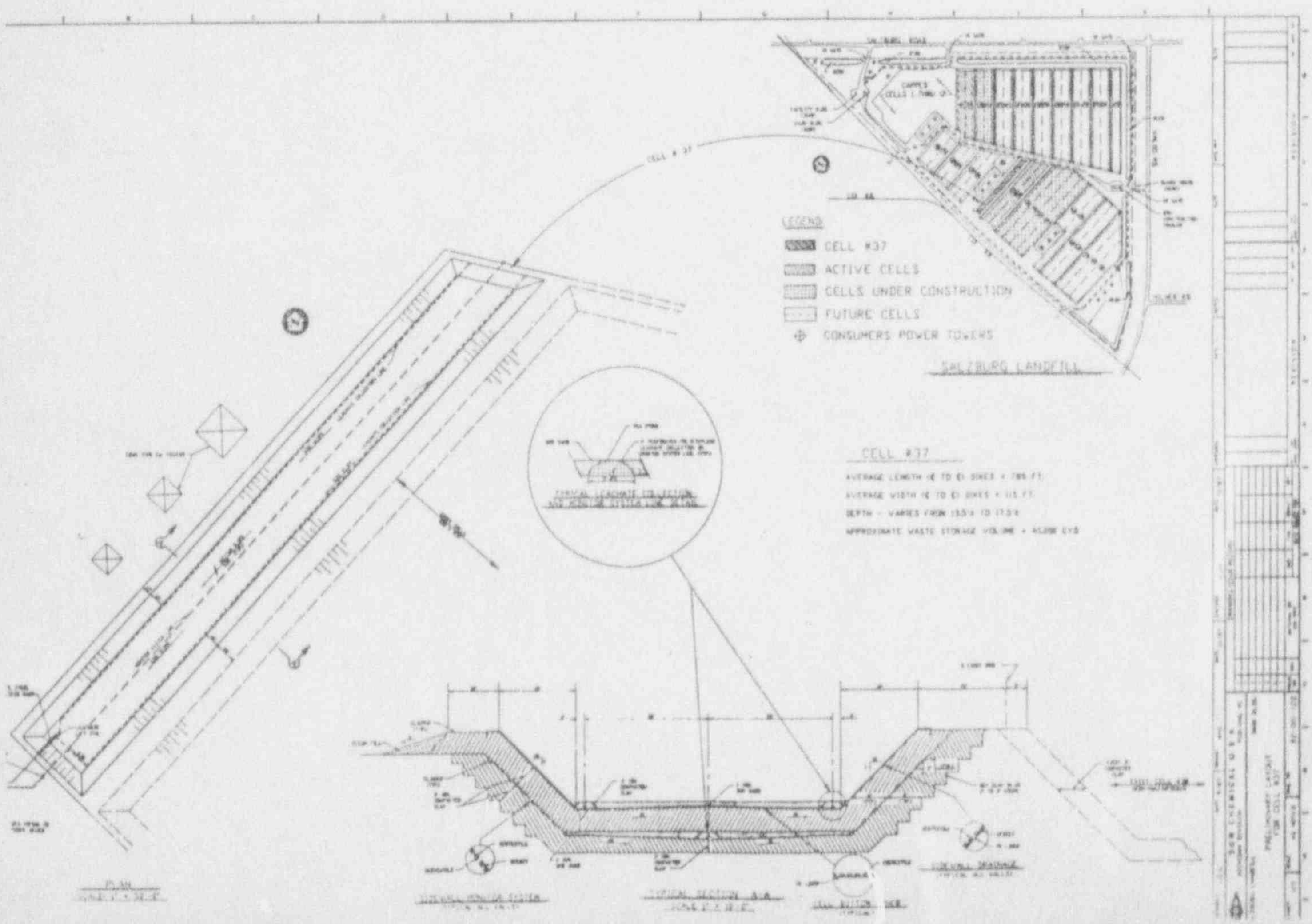
(SHOWING TRANSITION INTO CAP FOR CELLS #36 & #35)

SCALE 1" = 50'-0"



TYPICAL SECTION A-A

SCALE 1" = [illegible]


LEGEND
CELL #37
ACTIVE CELLS
CELLS UNDER CONSTRUCTION
FUTURE CELLS
CONSUMERS POWER TOWERS
SALZBURG LANDFILL
CELL #37
DOW CHEMICAL U.S.A.
PRELIMINARY LAYOUT FOR CELL #37