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№ 0000002

OCT 16 1981

LEMBERGER LANDFILL SITE INC.
HORIZONTAL EXPANSION
FEASIBILITY REPORT

OCTOBER 1981

Stephen D. Johannsen
Hydrogeologist

Ted Juszczyk
Project Engineer

Robert T. Glebs, P.E.
Senior Project Engineer/Project Manager

John J. Reinhardt, P.E.
Vice President of Engineering

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2038X-7300/TJ/SDJ:jad (178)

Consultants in Industrial, Solid, and Hazardous Waste Management

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1. INTRODUCTION

1.1 Project Background

Harold and George Radandt have retained Residuals Management Technology, Inc. (RMT) to carry out the field investigation and engineering design to develop a horizontal expansion for the Lemberger Landfill Site, Inc. landfill. The existing site and expansion area were purchased from Lemberger Landfill Site Inc. by the Radandts on August 28, 1981. Before this date, Lemberger Landfill Site, Inc. owned and operated the site since it opened. The site was licensed by DNR (#2575) in 1976. The present Lemberger landfill is rapidly reaching its capacity and if current filling rates continue, will be closed between July and October 1982. This report, appendices, and accompanying plans present the feasibility study on a proposed horizontal expansion to the Lemberger Landfill Site, Inc. in the Town of Franklin, Manitowoc County, Wisconsin.

On behalf of Manitowoc County, Warzyn Engineering conducted a site selection study for a possible county-wide landfill for Manitowoc County in 1978 and 1979. The Lemberger Landfill horizontal expansion area was one of the sites selected and a feasibility report was submitted to DNR on December 10, 1979. A public hearing was held regarding the horizontal expansion report entitled Final Feasibility Study Report, Proposed Manitowoc County Sanitary Landfill, Expansion of the Lemberger Sanitary Landfill. In an August 6, 1980 feasibility review letter D.N.R. ruled against feasibility of the site as designed (Appendix A). The DNR's concerns may be summarized as follows:

1. The proposed design relied on both in-place clay soils and a recompacted clay base liner in the design, and relied heavily on the stratigraphic correlation of the in-place soils. Due to

the heterogeneous nature of the site geology, the complex design proposed in the feasibility study would be very difficult to construct and could increase the likelihood of a failure.

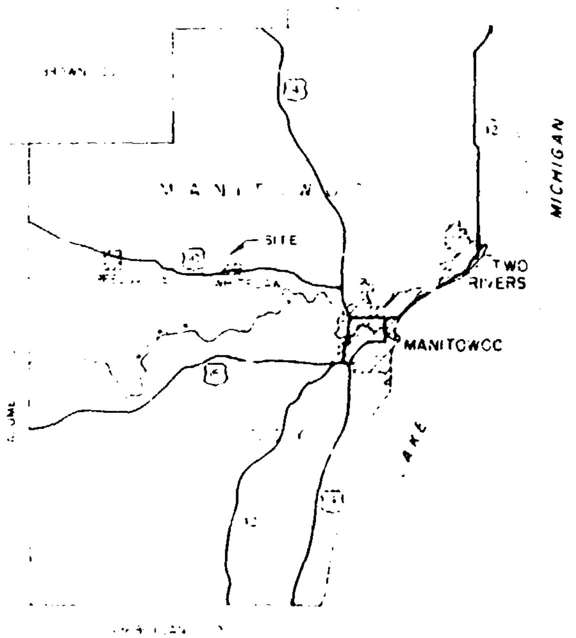
2. The water table in the bedrock aquifer to the north and east of proposed expansion area needs to be further defined in order to determine the ground water flow in the area for monitoring purposes.

3. The soils did not meet the Atterburg Limit criteria in the Department's liner materials specifications, and further testing or justification was needed to allow the use of on-site soils for a liner.

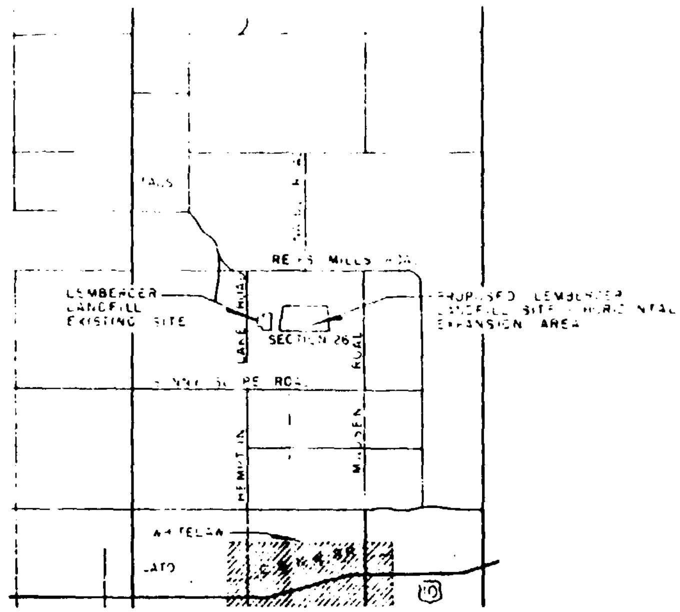
This study addresses the concerns presented in the DNR August 6, 1980 review letter by (1) presenting additional geotechnical data obtained during field investigations to better define the geologic and hydrogeologic environment at the site, (2) providing an engineering design which is compatible to the geology of the site and is not dependent on the interpretations of probable extent of various soil strata at the site, and (3) addressing the use of on-site clay soils for liner material. This has been done by additional data collection and analysis to supplement the original data collected by Warzyn Engineering for Manitowoc County. Much of Warzyn's data is contained in the appendices of this report, and has been used in our analysis with the permission of Manitowoc County.

1.2 Purpose of Scope

This report, appendices, and accompanying plans are presented to the Department of Natural Resources as a feasibility report in accordance with NR180.13(6) of the Wisconsin Administrative Code for the proposed Lemberger Landfill Site, Inc. horizontal expansion (Figure 1). The report, appendices, and plans summarize the results of



COUNTY MAP



VICINITY MAP

SITE LOCATOR MAPS

FIGURE 1-P3

several investigations and our conclusions on the feasibility of developing a landfill in the Lemberger horizontal expansion area.

Our study of the feasibility of the proposed horizontal expansion includes analysis of 1) regional data, 2) data obtained by borings, observation wells, and test pits, placed on the property during the initial Warzyn feasibility study, 3) subsequent additional field data obtained by RMT. We also developed a preliminary engineering design consistent with NR180, and determined general operating procedures and soil requirements for the site.

1.3 Findings and Conclusions

General:

1. RMT collected additional data, and reinterpretated the data presented in the Warzyn feasibility report on the Horizontal Expansion Area, (December 1980). This provided the answers to questions asked by the Department of Natural Resources in their August 6, 1980 feasibility review letter (Appendix A). Redefinition of the complex geologic and hydrogeologic conditions on the site have allowed the development of a feasible, environmentally safe landfill design.

Hydrogeologic Analysis:

2. The proposed horizontal expansion area is located immediately east of the existing site on a regional topographic high with approximately 60 feet of relief. This north-south ridge is a terminal glacial moraine which also reflects a bedrock ridge.

3. Fifty to One Hundred to 100 feet of glacial till and outwash deposits overlie the Niagara dolomite ridge. The bedrock surface was redefined in this study to insure that adequate separation of the landfill could be maintained. A conceptual geologic section (Figure 2) illustrates general soil conditions. The uppermost soil deposits consist of a red-brown, silty-clay glacial till which is interbedded with silty and sandy outwash deposits west of the ridge. A light gray to brown sandy, dolomitic glacial till and outwash underlies the red-brown till and is thickest east of the ridge.

4. A uniform, recompacted, clay-lined landfill is the most suitable design for this site based on the heterogeneous nature of the unconsolidated deposits.

5. The red-brown silty clay till is the primary low permeability material which will be used to construct the liner. The following table summarizes the compliance with DNR liner guidelines:

Physical Characteristic	DNR Guidelines	Available on Site
Hydraulic Conductivity	$1x10^{-7}$ cm/sec	$9x10^{-8}$ cm/sec
% P200	50	68
% Clay	25 (2um)	28 (5um) 19(2um)
Atterberg Limits Liquid Limit/ Plasticity Index	30/15	22/8
Unified Soil Classification	CL-ML, CL	CL-ML, CL

The average values for tests run on this soil meet all DNR liner guidelines except for the Atterberg Limits. The Atterberg Limits of this soil show that it can be remolded to form a low permeability liner, and that the soil is workable. Our experience on the existing site confirms this (RMT, June 1981). Wong liner efficiency calculations confirm this soil can be used in a system which will be efficient in the collection of leachate.

6. The light brown to gray, sandy, dolomitic glacial till and outwash has approximately 47% P200, an estimated CEC of 18 meq/100g, and a soil pH of 8.8. This material will provide an excellent attenuative and buffering capacity beneath the site.

7. The saturation in unconsolidated glacial soil is variable. Gradients are down and away from the proposed area. The water table is in the dolomite bedrock, approximately 50 feet below the proposed landfill base.

8. Ground-water flow in the bedrock aquifer (which is the water supply for residences in the area) has been further defined since the previous feasibility study. The site is in the recharge area for this aquifer and will be over a ground water divide, with ground water flowing southwest and southeast.

9. Ground water quality in the bedrock aquifer has not been affected by the existing landfill area.

10. Ground water quality will be protected by both a very conservative landfill design (double-liner on collection system) and approximately 50 feet of soils which have a considerable attenuative and buffering capacity.

11. There is a wetland south of the proposed area which can be protected from environmental damage during construction and operation of the landfill.

Preliminary Engineering

12. The proposed design maintains a recompacted clay base and sidewalls which are not dependent on the existing on-site clay soil strata. It also takes advantage of the granular (SM-SC) soils at the site by using them in exterior sidewalls to limit ground water infiltration.

13. The leachate management system which includes a layered final cover configuration to divert infiltration and a double clay liner and collection system, provides a collection efficiency of over 95% of the exfiltration using on-site soils. This system adequately addresses DNR's concerns regarding the adequacy of on-site clay soils for liner material and protection of the regional ground water.

14. The double clay liner and dual leachate collection systems provide adequate redundancy in the system to provide for effective leachate management at the site.

15. Enough clay soils are available from on-site excavations to construct the liners at the base and sidewalls, and for use in final cover of the proposed landfill.

16. Enough soils are available on-site to use as daily cover and to construct berms and roadways for development of the expansion area.

17. The proposed landfill will produce leachate during operation and after closure.

    a. During the 22-year site life, approximately 49,960,000 gallons of leachate will be produced.

    b. After closure, approximately 675,000 gallons of leachate will be produced per year.

1.4 Recommendations

We request that the Department of Natural Resources review this report, appendices, and accompanying plans with regard to the feasibility and environmental impact requirements of NR180.13(6) of the

Wisconsin Administrative Code and provide Harold and George Radandt with written comment and approval of the feasibility report and preliminary engineering plans.

1.5 General Site Information

- Primary contact

  George and Harold Radandt
  c/o Manitowoc Disposal, Inc.
  1800 Johnsten Drive
  Manitowoc, WI 54220
  (414) 682-7758

- Consultant:

  Residuals Management Technology, Inc.
  1406 East Washington Avenue, Suite 124
  Madison, WI 53703
  (608) 255-2134

- Property Owner:

  Harold and George Radandt

- Site Operator:

  Lemberger Landfill Site, Inc./George and Harold Radandt

- Site Location:

  North half Section 26, T20N, R22E,
  Town of Franklin, Manitowoc County, Wisconsin

- Proposed Acreage and Proposed Site Acreage:

  57.5 acres of land is involved in the actual fill area. However, including berms, ditches, borrow areas, and associated buffer zones, 91.6 acres of land are proposed to be licensed, as shown on Plan Sheet 4.

- Proposed Site Life and Disposal Capacity:

  22 years at current refuse fill rate
  4,250,000 cubic yards refuse capacity (2,125,000 Tons @1,000 lbs/cy)

2. HYDROGEOLOGICAL ANALYSIS

2.1 Overview

This section of the report provides the hydrogeological analysis of the proposed expansion area as required by NR180. However, since the Department of Natural Resources has reviewed and commented on a feasibility study of the area, we have emphasized those issues for which DNR suggested additional study and those most important to the feasibility of the site.

Because of the complexity of the geology and hydrogeology, we have assumed worst-case conditions in our interpretations. This conservative approach was also carried through to site design to insure protection of the environment and to meet the variable conditions found in the field.

Two important areas of site geology are emphasized in this section. First, the elevation of bedrock beneath the site is addressed to allow the design to place the base grades at least 20 feet above rock. Second, the stratigraphy of the unconsolidated surficial soils is redefined and the physical characteristics of the layers are summarized to determine the availability and suitability of on-site material for landfill construction.

Two major hydrogeological issues are also addressed. First, where does ground water occur and flow in the layered soils, and how does this affect landfill development? Second, the bedrock flow system is discussed, particularly in its relationship to monitoring and potential for contamination.

Finally, surface water quality and impact on wetlands are discussed in the Section 2.5.

2.2 Method of Investigation

This report incorporates and integrates the data and findings of several previous investigations of the Lemberger property. Much of this information was previously submitted to the Department of Natural Resources in a feasibility report (received by DNR on December 10, 1979) titled "Final Feasibility Study Report, Proposed Manitowoc County Sanitary Landfill, Expansion of the Lemberger Sanitary Landfill" prepared by Warzyn Engineering for Manitowoc County. All site investigations conducted before this date were described in the site investigations section of that report, which is included for reference as Appendix B. It describes the subsurface investigations and laboratory testing including detailed descriptions regarding soil borings, well installations, review of private well logs, and wetland investigation.

In its August 6, 1980 feasibility review letter (Appendix A), the DNR made several suggestions for an alternative course of action to obtain the feasibility approval of the proposed Lemberger expansion area. Additional work was recommended to define in more detail the complex site hydrogeology. Two bedrock borings were installed in the northwest (B57) and north (B58) side of the proposed landfill site. These borings were made to better define the depth to bedrock. Observation wells and piezometers were also installed in the holes. In B57, a bedrock water table well was installed. In Boring B58, two bedrock wells were installed: one observation well was installed to define the bedrock water table; and one deep bedrock piezometer was installed to define vertical gradients on the north side of the site. Soil samples and bedrock cores were collected from the 150-foot boring, B58, in order to obtain fresh samples for inspection and testing. The bedrock cores were used to examine the extent of bedrock fracturing.

After the installation of the borings and wells, we located them horizontally and vertically in the field. New water level readings were obtained from all on-site wells. We also examined the conditions of nearby wetland areas.

All new and old soil samples were examined and compared to the boring logs. Using the additional data and correlating this information with the data on the existing landfill site to the west, the site geology and hydrogeology was reinterpreted. The cross sections were redrawn to include the new borings and wells and two sets of borings and wells were added from the existing landfill which had not been included in the previous feasibility study. Additional soil tests were assigned as necessary to adequately define the suitability of the soils for the development of a landfill.

This additional investigation was designed both to determine the suitability of the site for landfill development, and also to answer the questions raised by the Department of Natural Resources in their previous evaluation of this site.

2.3 Geology

2.3.1 Regional Setting

The proposed Lemberger landfill expansion area is located in the central portion of the northern half of Section 26, T20N, R22E, Manitowoc County, Wisconsin. The Lemberger property is located on a regional topographic high; the highest point (942 feet USGS datum) is located just north of the proposed site (USGS quadrangle map in back pocket). The total relief within the proposed area is approximately 60 feet and is illustrated in the existing conditions map (Sheet 4). The topography at the proposed site is gently rolling and hilly with some depressions which have been drained for agricultural use. The north-south ridge on which the site is located is a terminal, glacial moraine which also reflects a dolomite bedrock ridge.

Surface water runoff drains southeast and southwest from this ridge and flows toward the Branch River. An intermittent stream occurs approximately 600 feet east of the Lemberger property, and drains to the Branch River approximately 1 1/2 miles east.

Since the property is located on a regional high, there are no nearby stream channels, and no portions of the property are located in a floodplain. This finding was substantiated in the previous feasibility report (Page 13).

2.3.2 Bedrock

Silurian age dolomite bedrock was encountered in several borings at the Lemberger site. Because the elevation of this dolomite varies dramatically across the site, two additional bedrock borings were installed and a bedrock contour map was prepared to show the location and elevation of bedrock more accurately (Sheet 5). Where borings did not reach bedrock, conservative interpretations were made, following the trend of the ridge. The bedrock map shows that the dolomite forms a ridge beneath the west central portion of the property. This ridge slopes rapidly toward the south from an elevation of approximately 870 at the north end of the proposed site to 830 at the south end of the proposed site. The east side of the ridge slopes to an elevation of less than 800 feet at the west edge of the property. Underlying the dolomite are the Magueketa shale (late Ordovician); Galena, Decorah, and Platteville dolomite formations (Middle Ordovician); and Cambrian sandstones.

The driller's reports and the bedrock cores from B58 show that the bedrock is somewhat fractured and that the fractures decrease in frequency with depth.

2.3.3 Surficial Material

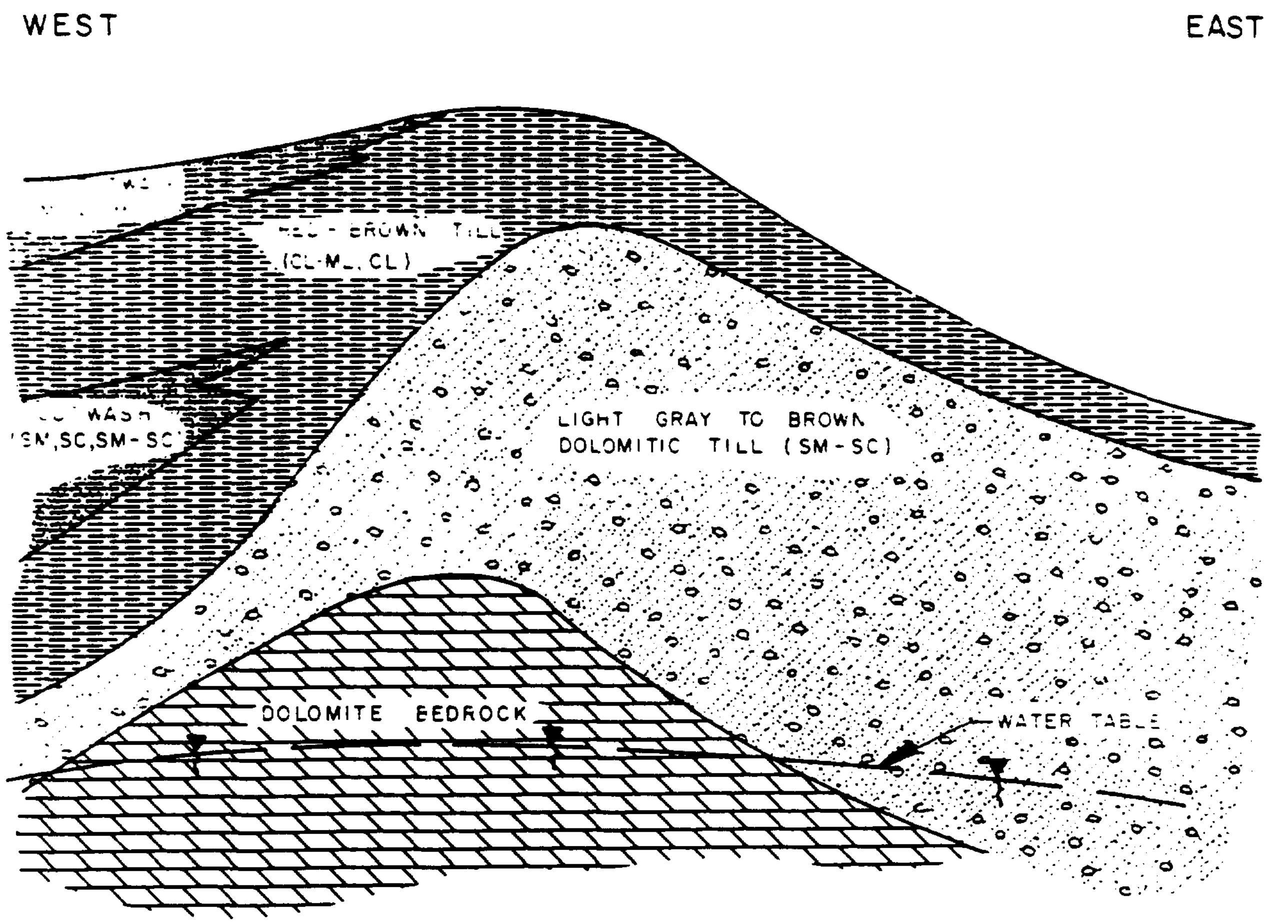
2.3.3.1 Distribution

The proposed landfill site is located on a terminal glacial moraine which lies between the areas where the Green Bay lobe and Michigan lobe of glacier advanced. Several glacial advancements from both the east and the west have left a series of glacial till and outwash deposits over a relatively shallow bedrock ridge. These soil deposits are described in detail in the following section.

Seven geologic cross sections illustrating our reinterpretation of the subsurface conditions at the site are presented on Plan Sheets 7-10. The cross section locations and boring locations are shown on Sheet 6 and the soil boring logs are included in Appendix C. In addition to reinterpreting the lab and boring data from the previous feasibility report, (Warzyn 1979), we added borings, ran more soil tests, and correlated all of this data with the information from the existing landfill site. A typical East-West geologic cross-section is shown in Figure 2.

The uppermost soil deposits consist mainly of a red-brown, silty clay glacial till. In the northeast portion of the site, this layer is relatively consistent in composition and roughly 5-15 feet thick. The layer is slightly thicker to the south and much thicker to the west of the bedrock ridge. Interbedded within the thick clay deposits west of the ridge are sand and silt outwash layers ranging from thin isolated pockets to relatively thick continuous layers. The cross sections show two major coarse outwash layers west of the site, one at ground surface and the other 20-40 feet below the surface. These outwash deposits interbedded within the glacial till layers are consistent with the layers found beneath the existing Lemberger landfill site.

Underlying the red/brown till and extending to Niagara bedrock is a gray to light brown gravelly, silty sand till and outwash deposit. This layer is easily distinguished from the upper till and outwash layers on the basis of: 1) higher percentages of sand and gravel; 2) high compressive strength indicated by blow counts typically greater than 60 per 12 inches; and 3) a high dolomitic mineral composition. The thickness of these deposits varies from roughly 10 feet in the western side of the site to greater than 50 feet on the eastern side of the site. These deposits form a ridge near the center of the site which follows the surface topography fairly closely,



TYPICAL
EAST — WEST
GEOLOGIC CROSS-SECTION

TYPICAL EAST-WEST
GEOLOGIC CROSS-SECTION

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FIGURE 2 - P. 14

except in the western side of the site where the upper till is quite thick. In Boring B39, there were 10 feet of silt and clay between this lower soil and the top of the bedrock.

2.3.3.2 Physical Characteristics

The physical characteristics of the soils found on the site are very important elements in the design of the landfill. The soils are used to form the base of the landfill site and the cover materials, and also provide attenuative capacity beneath the landfill. The soils found on this site will be used in two ways in the landfill design. First, the silty clay glacial till material will be used to form the base of the landfill. Second, the coarser materials from the outwash layers and the underlying sandy till and outwash will be used for construction of berms and sidewalls and as a granular blanket in the landfill liner. Table I summarizes the physical characteristics of the soils found in each layer. Laboratory soil test, laboratory permeability test, and field permeability data, along with soil conservation service interpretation sheets are located in Appendices D, E, F, and G respectively. Cation exchange capacity data from two layers are summarized in Appendix H.

TABLE I
SUMMARY OF SOIL CHARACTERISTICS

LAYER DESCRIPTION	BORING/ SAMPLE	DEPTH (FT)	ATTERBERGS LL	PI	NATURAL MOISTURE(%)	PERMEABILITY (CM/SEC)	D (PCF)	GRAIN SIZE GR-SA-SI-CL	UNIFIED CLASSIFICATION
Red-Brown,	27-9	25						0-29-26-35	CL
Silty Clay	27-12	40	28.0	13.3					CL
Glacial Till	27-14	50	20.0	5.5					ML-CL
	29	11				3.0×10^{-5}(H)			(CL)
	29 A-(Remolded)	10			19.6	9.2×10^{-8}(V)	108.7		CL*[1]
	29 A-S. T.	14			11.6	1.8×10^{-7}(V)	132.1		CL*[1]
	30-4	40	30.0	14.4				1-14-37-48	(CL)
	31	11				a-3.6×10^{-5}(H)			(CL,ML-CL)
	31	11				b-7.9×10^{-6}(H)			(CL,ML-CL)
	32-5	15	18.6	6.9				9-33-38-20	(CL-ML)
	OB 34-3	10	15.9	7.6				14-36-32-19	CL
	OB 34-7	30	15.4	5.9				8-32-37-23	CL-ML
	36-4	10	25.9	9.5	10.6			4-20-42-34	(CL)
	38B	17				1.0×10^{-6}(H)			(CL,ML-CL)
	40-5	15	29.5	13.4				7-28-41-24	(CL)
	42-S. T.	6			13.4	5.1×10^{-8}(V)	121.6		CL-ML*[1]
	42-9	40	22.3	4.5				0-7-68-25	(CL-ML)
	45-3	8	22.4	11.2				5-26-39-30	(CL)
	46A-(Remolded)	8			18.9	1.4×10^{-7}(V)	107.2		CL*[1]
	48-3	8	17.6	1.6	12.4			7-39-38-16	(ML)
	49-4 (Remolded)	10			18.6	5.6×10^{-8}(V)	108.4	3-37-(60)	CL*[2]
	51-6	20	23.1	8.6				5-30-40-25	(CL)
	51-11	45	18.7	0.7				0-9-(91)	(ML)
	53-3	8	15.4	3.9				2-42-39-17	(ML)
	55-3	8	30.2	13.3				2-16-36-46	(CL)
	56-2	5						1-35-(64)	CL*[1]
Brown Sand	27-10	30						36-45-(19)	SM-GM
and Silt	27-13	45						45-11-(14)	SM-GM
Outwash	32-3	8						0-79-18-3	SM*
Deposits	OB 34-4A	16	Non-Plastic					8-78-(14)	SM
	36-2	5						43-45-(12)	SM*
	40-3	8	30.0	14.2				11-47-29-13	(SC)
	41-7	25						14-61-23-2	SM-SC*[1]
	43-2	5	13.9	6.1				12-46-34-8	(SM-SC)
	49-S. T.	6			14.4	1.8×10^{-7}(V)	132.1		CL*[2]
	49-2	5			9.7			17-34-(49)	SM-SC*[1]
	51-2	5	16.9	1.9	9.1			8-42-(50)	(SM-ML)

178: See Note Page 2

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TABLE I (Cont'd)

SUMMARY OF SOIL CHARACTERISTICS

LAYER DESCRIPTION	BORING/ SAMPLE	DEPTH (FT)	ATTERBERGS LL	PI	NATURAL MOISTURE (%)	PERMEABILITY (CM/SEC)	D (PCF)	GRAIN SIZE GR-SA-SI-CL	UNIFIED CLASSIFICATION
Light Gray-	32-11	45						4-55-36-5	SM-SC*1
Brown Silty	36-7	25	13.6	1.3				0-32-(68)	(ML)
and Clayey	39-12	50						29-57-12-2	SM*1
sand	39-17	75	24.2	8.2				0-0-65-35	(CL)
(Dolomitic)	40	35				$2.4x10^{-4}$(H)			SM-SC
	40-9	35						20-56-20-4	SM-SC*1
	43	35				$4.0x10^{-4}$(H)			SM-SC
	45-10	40						30-42-22-6	SM-SC*1
	46A-S. T.	16			16.4	$5.2x10^{-8}$(V)	122.1		CL*1
	48-6	20						29-39-(32)	SM-SC*1
	49-7	25						16-47-32-5	SC*1
	56-7	25	25.8	10.6				4-18-42-46	(CL)
	56-10	40						25-43-(32)	SM-SC*1
Dolomite	29A	68				$3.6x10^{-6}$(H)			Dolomite
Bedrock	39	83				a-$7.5x10^{-5}$(H)			Dolomite
	39	83				b-$1.1x10^{-5}$(H)			Dolomite

NOTE: 1) Unbracketed classifications marked with an Asterisk ($*_1$) are estimated group symbols by Warzyn Engineering.
2) Unbracketed classifications marked with an Asterisk ($*_2$) are estimated group symbols by RMT.
3) (H) Indicates horizontal permeability measured by a field baildown test (a-, and b- are two slopes ($\Delta h/t$) for one well)
(v) Indicates vertical permeability measured by laboratory fail head tests.

The red-brown silty clay glacial till soil is the primary low permeability material which will be used for construction of the landfill base, sidewalls, and final cover. The physical characteristics in this soil are summarized as follows:

1. The mean grain size of these samples is 4.3% gravel, 27.1% sand, 39.5% silt, and 27.8% clay (5 micrometer).

2. The mean Atterberg Limits for these samples are: liquid limit - 22.2%, plasticity index - 8.0%. The mean natural moisture of several samples was 15.0%.

3. The geometric mean of three remolded and two shelby tube vertical permeability tests was 9.2×10^{-8} cm/sec.

4. The geometric mean of four horizontal permeability tests (baildown tests) was 9.6×10^{-6} cm/sec.

5. Soils in this layer were classified CL-ML, and CL under the Unified Soil Classification System.

6. The cation exchange capacity of silty samples from this layer averaged 12.5 meq/100 g. The more clayey till averaged 22 meq/100 g.

These data indicate that this red-brown silty clay glacial till can be used to construct a remolded clay landfill liner. The soil is plastic at its natural moisture content and can be remolded to form a low permeability barrier at the base, sidewalls, and top of the landfill. Although the soils do not exactly meet DNR guidelines for lining a site, our analysis indicates these soils meet commonly accepted criteria for liners and can provide an efficient, durable liner. The following table summarizes the compliance with DNR liner guidelines:

Physical Characteristic	DNR Guidelines	Available on Site
Hydraulic Conductivity	$1x10^{-7}$ cm/sec	$9x10^{-8}$ cm/sec
% P200	50	68
% Clay	25 (2 m)	28 (5um) 19(2 m)
Atterberg Limits Liquid Limit/ Plasticity Index	30/15	22/8
Unified Soil Classification	CL-ML, CL	CL-ML, CL

The average values for tests run on this soil meet all DNR liner guidelines except for the Atterberg Limits. The Atterberg Limits of this soil show that it can be remolded to form a low permeability liner, and that the soil is workable. Our experience on the existing site confirms this (RMT, June 1981). Wong liner efficiency calculations confirm this soil can be used in a system which will be efficient in the collection of leachate.

The 68 percent (silt and clay) and 28 percent clay will provide attenuative capacity in the landfill base as also indicated by the CEC results. The water budget and efficiency calculations in the design section show that very little leakage will occur from the base.

The sand and silt outwash layers which are interbedded within the clay glacial till were found to have the following characteristics:

1. The mean grain size of these samples was 19.4% gravel, 48.8% sand, 26.0% silt, 6.5% clay (5 micrometers).

2. The mean Atterburg limits for these samples are: liquid limit 20.3%, plasticity index 7.4%. The mean natural moisture of the three samples was 11.1%.

3. The vertical permeability (one shelby tube sample) was 1.8 x 10^{-7} cm/sec. No horizontal permeability tests were performed in this layer.

4. The soils in this layer were predominantly classified SM, SC, SM-SC under the unified soil classification system.

The data indicate that these outwash deposits will be suitable as a landfill base material. When these layers are encountered during excavation, these sandy layered soils should be set aside for use as cover material. Since the soils layers do have approximately 30% P200 (fine grain material), they will be suitable for use as a relatively low permeability daily cover material which will add attenuative capacity to the central landfill area. Segregation of and construction with these soils has been no problem on the existing landfill site and should not be difficult for the expansion area.

The light gray to light brown gravelly silty sand till and out wash material which underlies the upper till and out wash will also underlie most of the landfill site and separate the base of the site from the bedrock below. The physical characteristics of this soil layer are summarized below:

1. The mean grain size of ten samples of this material was: 15.7% gravel, 45.4% sand, 32.7% silt, and 14.7% clay (five micrometers).

2. The mean Atterburg limits for three samples of this material were: liquid limit 21.2%, plasticity index 6.7%. The mean natural moisture of a single sample was 16.4%.

3. A single vertical permeability test (shelby tube) showed a permeability of 5.2 x 10^{-8} cm/sec.

4. The geometric mean of four horizontal permeability tests (bail down tests) was 3.1 x 10^{-4} cm/sec.

5. Soils in this layer were predominantly classified SM-SC; other samples were classified ML, CL, SC under the Unified Soil Classification System.

6. The mean cation exchange capacity of four samples tested was 18 meq/100g.

7. The average pH of four samples was 8.8.

These data indicate that the dolomitic till and outwash material which underlies the surface till is more coarse-grained and has a higher permeability than the red-brown silty clay. That portion of this material which is excavated for construction of the landfill should be used for berms and sidewalls and should provide the majority of the daily cover material. This soil is easily recognized by its light gray and brown color and granular nature and should be easily segregated from other soils on site.

2.3.3.3 Suitability for Landfill Development

The distribution and characteristics of these soils show that this environment is not suitable for an unlined (natural attenuation) site. Landfill development on this site will require construction of a remolded clay liner along with the installation of leachate collection system. The thick unconsolidated soil deposits which overlie the bedrock in this area should provide adequate separation distance between the base of a landfill and the dolomite bedrock. The dolomitic till and outwash deposits which will separate the landfill base from the bedrock have a high pH and buffering capacity because of the high content of dolomite in the material. This would help neutralize the limited quantities of acidic leachate which pass through the landfill liner. In addition the fine-grained material present in this soil layer provides a relatively high attenuative capacity, as indicated by the cation exchange capacity measurements.

The clay till soils found at the surface can provide adequate material for a low permeability landfill liner. These soils used in the liner will also provide attenuative capacity beneath the landfill. Experience on the existing Lemberger landfill site shows these soils can be used effectively in landfill construction.

2.4. Hydrogeology

2.4.1 Water Table

Ground water conditions beneath the proposed expansion area were determined from data from many observations wells and piezometers installed on the site for this investigation. The construction of these wells and piezometers is illustrated the geologic cross sections (Plan Sheets 7-10 and Detail 2/20). Monitoring well construction data and private well logs are also included in Appendices I and J.

The ground water flow system can be divided into two primary parts:

1. The unconsolidated deposits, which have a variably saturated condition depending on the hydraulic conductivity of the soil. The red brown glacial till is saturated throughout the unit; however, the underlying gravelly silty sand till is only saturated in some locations.

2. The bedrock aquifer. The bedrock aquifer has a distinct water table which is part of the regional groundwater flow system. Wells in the area derive water from the bedrock groundwater system.

Although the unconsolidated soils are saturated to a variable degree, this should not prevent landfill construction in this zone. Both horizontal and vertical gradients away from the site will help maintain a dry excavation. The unsaturated zone in the coarse-grained soils beneath the site will allow slow unsaturated flow down to the bedrock. The water table is generally more than 50 feet below the base of the site.

2.4.2 Groundwater Flow

2.4.2.1 Unconsolidated Deposits

Groundwater flow in the unconsolidated deposits is complex because of both the stratigraphy and the variable hydraulic conductivity of the deposits. Head levels measured at various points within these deposits are illustrated on the geologic cross sections. Water levels measured over the entire period of investigation are listed in Appendix K.

Horizontal gradients and flow directions generally follow surface topography with flow tending toward the east, west, and south, away from the proposed landfill expansion area. Horizontal gradients are downward in all locations and very steep. Wells 45 and 46 were dry, which shows there is an unsaturated zone in the lower coarse till deposits and in the upper bedrock. The same complex and variable hydrogeologic conditions in the unconsolidated deposits were noted in the vertical expansion study on the existing landfill site (RMT, 1980).

While conditions are complex, they are adequately defined for the construction of a landfill and ground water monitoring. The DNR expressed concerns about this complexity in the 8/6/80 revew letter. However, some straight forward engineering modifications can simplify ground-water flow in the immediate vicinity of the site. A granular outer sidewall can be used to intercept inflow from sandy lenses within the till. This is discussed in detail in Section 3.2.5.

2.4.2.2 Bedrock Flow System

Flow in the bedrock aquifer has been further defined since the previous feasibility report. Data from additional wells has been used to draw a new water table map (Plan Sheet 5). With this further definition, the direction of ground-water flow in the bedrock beneath the site has been adequately determined to monitor ground-water quality.

The water table map shows that the groundwater divide is north of the site and that the water table contours generally follow the contours of the bedrock. This data concurs with regional water table information which shows groundwater in the Niagara aquifer recharging in this area and flowing to the southeast and southwest. Recharge or downward gradients vary from .03 to .15 foot per foot. Horizontal gradients vary from 0.01 to 0.03 feet per feet.

Private wells in the area use this dolomitic aquifer as a water supply. There are wells downgradient of the site, but they are all greater than 1200 feet away from the proposed site, as are the upgradient wells.

2.4.3 Groundwater Quality

Bedrock ground water quality in the vicinity of the Lemberger landfill site is generally quite good. Water quality testing on the site has shown no influence on the quality of water in the dolomite aquifer.

The existing landfill area was designed and built as a "natural attenuation" site in the red-brown glacial till. This site has shown only limited effect on the ground water in the sandy outwash layers near the site, as would be expected beneath a natural attenuation site.

The expansion will use a considerably more conservative landfill design in order to protect the bedrock aquifer. Each landfill module will have a double clay liner with separate leachate collection systems. This redundancy in the system will provide:

1) Back-up protection for the primary leachate collection system.

2) A method for monitoring the efficiency and attenuation of the primary liner.

3) Increased leachate collection efficiency.

In addition, the bedrock aquifer is separated from the bottom of the liner by approximately 40 feet of soils which have a considerable amount of attenuative and buffering capacity (Appendix H).

This landfill redesign also results in substantially less leakage from the fill, and increased recharge of "clean" water via the outer granular sidewalls. Consequently, the leakage from the landfill would not constitute a substantial portion of flow in the Niagara aquifer, and any exfiltrating leachate would be sufficiently attenuated and diluted.

As a result, the ground water resources will be protected by the landfill design and the natural environment and there is significant probability of ground water degradation.

2.5 Surface Water in the Wetlands

Surface water runoff from the site will be diverted to the southwest and to the east. Natural drainage channels in those areas will be protected by sedimentation basins and monitoring the conductivity of discharges from these basins.

Wetlands on the Lemberger property were investigated by representatives of both DNR and Warzyn Engineering. A letter summarizing DNR's May 29, 1980 inspection of the site is included in Appendix L for reference. Eight small wetland areas in the southern end of the site, which had formed in topographic depressions, were identified on maps. Those wetland areas range from a small cattail marsh surrounded by cultivated areas to a 3-foot deep pond surrounded by cattails and the wetland shrubs with white cedar and pines on the outside edge. Several of the areas were described as ditched or disturbed and at least partially dried up. Some were also described as being very low quality and having very little value as wetlands. Reclamation of these areas and the woods in this area as agricultural land has since been completed and only the largest and highest quality wetlands in the area remain.

We consider the area south of Module II between Borings 31 and 32 a high quality valuable wetland worth preserving. This wetland area is approximately 800 feet long and 500 feet wide. It was probably a sedge meadow at one time, and now has up to 3 feet of water in it. There is a large island of shrubs in the center of the area. The vegetation present was identified as cattails, scouring rush, three-way sedge, duck weed, water plantain, many sedges, and grasses. The wetland is surrounded by white cedar and pines. Water level monitoring indicates that the wetland is perched on the fine-grained soils beneath it and is maintained by surface runoff.

This wetland will be preserved from disturbance by the landfill operations in two ways. First, the construction and operation of the landfill will be designed and directed not to cause physical disturbance to the wetland as it is now. Second, drainage patterns during operation and after the landfill reaches final grade will be maintained to contribute the same amount of surface runoff to the wetland area.

In summary, we consider the probability that surface water and wetlands will be affected by this development to be slight.

3. PRELIMINARY ENGINEERING DESIGN

3.1. General

3.1.1 Locational Criteria/Zoning

The proposed Lemberger Landfill Horizontal Expansion meets all locational requirements in NR180.13 (3) of the Wisconsin Administrative Code. A list and analysis of locational criteria specified in NR180 is provided in Appendix M. A letter from the State Historical Society regarding the archeological aspects of the area is located in Appendix N. A letter outlining an archeological field survey which will take place at the expansion area is in Appendix O. Appendix P contains a letter which outlines the zoning regulations applicable to the site. The site is currently not zoned.

3.1.2 Waste Sources, Types, and Volumes

The proposed Lemberger Landfill Horizontal Expansion will accept municipal, commercial, and non-hazardous industrial wastes for disposal. Hazardous wastes will not be accepted at the site. The primary municipal users of the site are the Cities of Manitowoc and Two Rivers; the remainder of the municipal wastes come from other communities within Manitowoc County. Several communities outside of the county also dispose of their wastes at the Lemberger Landfill. There are several commercial and industrial users of the existing landfill, and they are expected to use the expansion also. As appropriate, industrial waste generators will be required to provide information on the physical and chemical properties of their wastes to insure that the wastes are suitable for disposal at the Lemberger Landfill Horizontal Expansion and to obtain approval as appropriate from WDNR. Approval from DNR has been received for disposal of ash, foundry sand, and papermill sludge from specific sources; this waste is currently disposed in the active landfill. These wastes will continue to be disposed in the proposed expansion area. A summary of waste types and quantities from the existing landfill is located in Appendix T. This varies from month to month and the design has been based on a high volume month (8000 tons/month).

The design capacity of the proposed expansion area is 4,250,000 cy (2,125,000 Tons @ 1000 lbs/cy) refuse volume. Assuming an average filling rate of 16,000 cy refuse per month (i.e. 8,000 tons/month @ 1000 lbs/cy), the site will provide about 22 years of disposal capacity. This 22-year loading rate was used in the water budget developed in Appendix Q. It should be noted that there are a number of potential customers in Sheboygan, Brown, and Kewaunee Counties who have asked to bring their waste to the present Lemberger landfill. These customers have been turned away because any increase in the loading rate of the existing facility would fill the site before an expansion could be developed, and continuity for local users would be broken. Given the number of potential additional users, the filling rate of the horizontal expansion could easily double the current rate and give the site an active life of only 11 years.

3.1.3 Major Design Concepts

Because of concern about the potential for groundwater contamination in the bedrock aquifer in the area, we adopted the following design concepts to provide an environmentally sound disposal facility at the proposed Lemberger Horizontal Expansion Site.

1. Minimize leachate production by using modular site phasing, minimum final grades of 5%, and 5 feet of final cover. The final cover will include a sand blanket over the clay cap in order to help divert infiltration from the fill area. Also, granular exterior side walls around the site will help prevent any ground water infiltration through the sidewalls.

2. Minimize leachate exfiltration by using the "dry base" concept. Granular blankets over a double clay liner system and appropriate base grades are used to provide an efficient leachate collection system.

3. Provide an effective gas venting system made up of granular berms and gas vents on the perimeter on the fill area.

4. Provide adequate environmental safeguard by maintaining an average of 40 feet of bedrock separation with soils having attenuative capacity, and provide an average ground water separation distance of over 50 feet.

5. Provide a workable long-range leachate management system following site closure when monitoring results show leachate quality is no longer detrimental to the environment. The granular sidewall construction at the perimeter of the site provides an effective overflow mechanism which prevents internal head build-up (i.e. sidewall failure).

6. Provide suitable final grades and final cover in order to return the land to limited agricultural use after the site is closed.

3.2 Preliminary Engineering

3.2.1 Topographic Mapping and Construction Control

The original topographic map was compiled by Aerometric Engineering, Inc. from 1975 photography. The map was updated by Warzyn Engineering, Inc. in 1979, primarily in the southern portion of the expansion area. The final base map used in the feasibility study was again updated (RMT, June 1981) to include the southwest corner of the site, which is being used as a borrow source for the existing landfill. RMT's topographic update also included the remainder of the southern portion of the site where the Lembergers had cleared, grubbed, and excavated in order to use this land for agricultural purposes.

The construction grid is parallel and perpendicular to the south line of the N1/2 of Section 26, T20N, R22E, Town of Franklin, Manitowoc County, Wisconsin, with Station 2+00N and 22+00E fixed through the southeast corner of the W1/2, W1/2, NE1/4 of said Section 26. Elevations are referenced to USGS mean sea level (1929).

3.2.2 Access

Access to the proposed Lemberger Horizontal Expansion will be identical to that of the current site. State Highway 10, which runs east-west through the north central portion of Manitowoc County, is approximately 2 miles south of the expansion area and the existing landfill. Hempton Lake Road, which intersects Highway 10 on the west side of the Town of Whitelaw, carries virtually all major truck traffic to the site.

The entrance to the landfill will not be changed by the proposed expansion. The gate at the landfill entrance on Hempton Lake Road will be used to restrict access to the expansion area. An all-weather access road (Detail 5/20) will route traffic along the south side of Cells 1 and 5 of the present landfill to the expansion area as shown on Plan Sheet 18.

3.2.3 Screening

During much of the development of the horizontal expansion, the wooded area to the south of the site and the topography on the north and west sides of the expansion area will provide natural screening. As appropriate, perimeter berms will be constructed in each module to provide screening and establish the horizontal limits of the fill for the operator.

3.2.4 Lateral Fill Limits

The proposed horizontal expansion fill area covers 57.5 acres of the 91.6 acres of licensed land. The lateral limits of the fill meet all NR180 setback requirements, such as the 1200-foot separation to private wells.

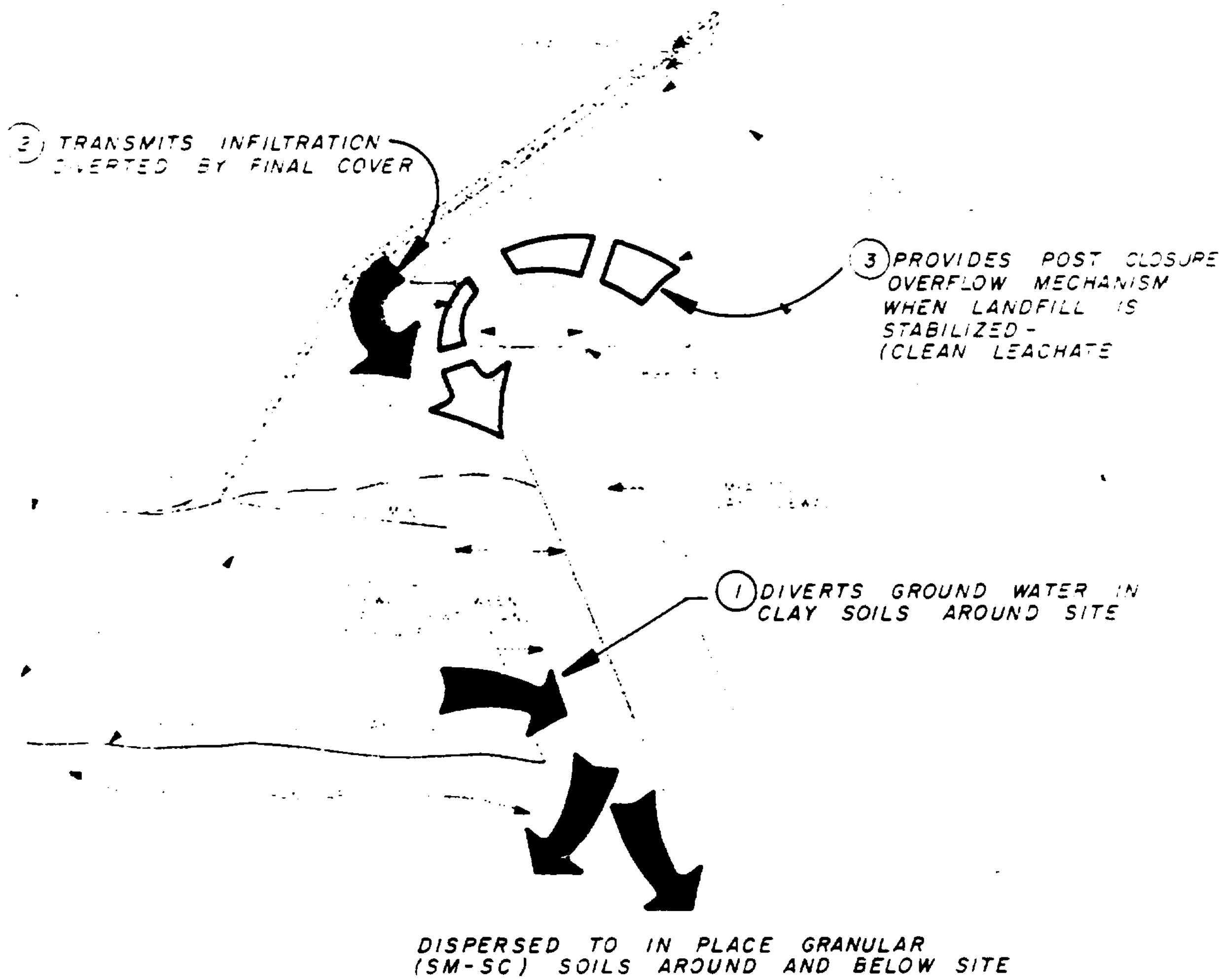
3.2.5 Base and Sidewall Construction

A double liner is proposed for the base of the horizontal expansion as shown in Detail 2/19. A 4 foot primary clay liner will be underlain by a 2 foot granular layer and a 2 foot secondary clay liner. This secondary liner provides a failure detection and backup system for the primary collection system for added environmental safeguards. Base grades for the top of the primary liner are shown on Sheet 11. With the 1 foot granular blanket over the primary liner, a dual leachate collection system, and the final cover, the leachate collection system is extremely efficient, according to the

the Wong equation. Site and liner efficiencies are further discussed in Section 3.4.1.

Five foot thick (vertical) clay side walls will be constructed to an elevation of 896 feet along the entire perimeter of the site. This wall on a 2:1 slope will be 10' wide. This clay sidewall will be constructed against an outer five-foot thick (vertical) granular (SM-SC) sidewall (Figure 3) which is connected to the granular (SM-SC) soils beneath the site allowing ground water to flow away from the site. This will (1) limit ground water infiltration into the site; (2) provide a conduit for surface water infiltration diverted by the sand blanket which is incorporated in the final cover; and (3) provide a possible future overflow mechanism for long-term leachate management upon site closure when monitoring results show that the landfill has stabilized and leachate collection is no longer necessary.

The granular sidewall will be constructed down to the granular subsoils beneath the site to allow any ground water to flow away from the site. Detail 3/20 shows the sidewall/final cover interface for areas where the existing ground elevation directly next to the horizontal limits of fill are greater than the 902 foot elevation. Detail 1/20 shows this interface where a berm is needed to construct the sidewall to the 896 elevation. Note that the sidewall/final cover interface provides an effective gas venting mechanism for the landfill because a more permeable contact surface is provided for gas generated in the confines of the clay final cover and base. The gas management system is further discussed in Section 3.4.4.



FUNCTIONS OF GRANULAR SIDEWALL

FUNCTIONS OF GRANULAR SIDEWALL

RESIDUALS MANAGEMENT TECHNOLOGY INC

FIGURE 3 - P. 34

As part of the Plan of Operations submittal, two additional engineering modifications will be addressed in detail:

1. Sealing the outwash deposits on the western portion of the site. These permeable deposits transmit ground water to the existing site during portions of the year and sealing them during the expansion area construction would help reduce ground water inflow into the expansion and existing site.

2. An additional recompacted clay outer sidewall to maintain the existing water level in the wetland directly south of Module II. This additional outer sidewall would decrease horizontal permeabilities between the expansion area and wetland. Since the water levels in the lowlands to the west are about 6 feet lower, this wetland appears to be well sealed from the surrounding area by in-place clays and organics, and this additional construction will probably be unnecessary.

3.2.6 Site Development

The horizontal expansion has been phased in 4 modules as shown on Sheet 11 and the engineering cross-sections (Sheets 14 through 17). Each module will be constructed as needed, with daily cover being excavated to the east from the next module to be constructed. This will account for the majority of the site excavation. The remaining materials will be appropriately sorted and stockpiled for future use (these procedures will be outlined in detail in the Plan of Operations). The liner, sidewall, leachate collection system, etc., will be constructed just before filling on the previous module is completed, allowing adequate time for construction documentation and approval from DNR. The preliminary materials balance in Section 3.3 provides a summary of the materials and quantities used during site development.

3.2.7 Final Grades

The final grades established in the preliminary engineering plan are designed to be compatible with surrounding topography and the plan to return virtually all of the site to limited agricultural use which requires limited tilling.

Surface water drainage patterns for the area will not be altered significantly by the proposed horizontal expansion. Drainage is controlled by the hill on the northern portion of the site, and flows to the south and east. The final topography and surface water drainage patterns will be consistent with the present area drainage patterns and are further discussed in Section 3.5.

Sideslopes range from 3:1 below the 902 foot elevation on the east, west, and south sides of the site where perimeter berm construction is necessary, to 4:1 slopes below the 940 elevation on the remainder of the slide slopes. Top slopes are 5% over the majority of the site, and 7.7% on the southwest corner of the site. These grades, along with the final cover configuration as discussed in Section 3.6.1, effectively limit infiltration at the site.

3.3 Preliminary Materials Balance

A summary of the preliminary materials balance for the proposed Lemberger horizontal expansion is presented in Table II. To develop the construction materials summary (quantities are listed in Table III), the following assumptions were used:

1. Daily cover will consist of granular (SM-SC) soils.

TABLE II

PRELIMINARY MATERIALS BALANCE SUMMARY

ITEM	MATERIALS (CY)		
	GRANULAR	CLAY AND TOPSOIL	TOTAL
Materials Available Within Excavation	1,428,000	1,738,000	3,166,000
Materials Needed for Site Construction	1,827,000	1,209,000	3,036,000
NET BALANCE	-399,000[1]	+529,000	+130,000

[1] Excess clays will be used at part of daily cover to maintain materials balance.

"Radandt 5"/TJ/SDJ:jad (178)

TABLE III

PRELIMINARY CONSTRUCTION MATERIALS SUMMARY

ITEM	MATERIALS NEEDED (CY)		
	GRANULAR	CLAY	TOPSOIL/TILL
Base/Liner	240,000	480,000	
Berms Between Modules		37,000	
Sidewalls & Perimeter Berm	380,000	57,000	
Intermediate Cover		242,000	
Final Cover	140,000	187,000	151,000
Daily Cover	1,067,000		
Borrow For Existing Site (Area 5)		55,000	
TOTALS	1,827,000	1,058,000	151,000

Total Material Needed = 3,036,000 cy
Total Material Available = 3,166,000 cy

"Radandt 5"/TJ/SDJ:jad (178)

2. All volumes are in place measure, neglecting shrink/swell factors.

3. A four to one refuse-to-daily cover ratio was used.

4. The equivalent of 3 layers of 1-foot intermediate clay cover over the entire site will be needed during site development.

3.4 Leachate and Gas Management

3.4.1 Design of Leachate Collection System

The Lemberger Landfill Horizontal Expansion is proposed as a "dry base" leachate collection system site. A double liner system, as shown in Detail 2/19, provides independent 4 foot and 2 foot clay liners for leachate collection at the base of the site. This double liner system provides redundancy in the leachate collection system so that any leachate which may escape the primary liner will be collected in the back-up system. Granular sumps in each module provide a second future back-up system so that another method of leachate extraction is available. Five foot (vertical) clay sidewalls are used to limit lateral migration of leachate within the site. Additional measures such as granular sidewalls to limit ground water infiltration (Section 3.2.5) and a layered final cover (Section 3.6.1), are used to limit infiltration to the site.

The leachate collection system consists of a single primary liner collection pipe and dual secondary liner pipes as shown in Detail 2/19 and Sheet 11. As can be seen on Sheet 12, all collection lines are straight single lines to minimize the possibility of clogs and to aid in pipe clean-out. The collection pipes are designed at a 2% grade and flow to the south end of each module. One method under consideration for extracting leachate from the base of the site is shown in Detail 1/19. There are two individual sumps in a manhole at the south end of each module to collect leachate. Dual sensor activated submersible pumps can then lift leachate to a force main near the surface as shown on Sheet 12. Dual sumps in each manhole are provided to (1) provide a back-up pump during servicing or failure and (2) prevent backup of the collection systems by having separate sumps including additional check valves. (Note: Leachate collection pipe clean-outs are also provided in each manhole as shown in detail 3/19). The force main, which is located in the perimeter berm below the frostline, carries the leachate to the above grade holding tank at the southwast portion of the site. The holding tank will be sized to provide adequate weekend and contingency storage, and will be installed during Module I construction providing immediate site leachate collection capabilities. Sensoples will be provided in the manhole sumps and holding tank to monitor leachate levels and warn operators of any failures in the collection system. The leachate collection system will be completed in the Plan of Operations; including pipe sizing, valves, pump specifications, etc.

The Wong equation was used to evaluate leachate management systems at the expansion site which would minimize leachate production and maximize leachate collection using on site soils. Based on our experience at the existing site and soils test results, (RMT Area 5 Construction Documentation Report - June 1981), the permeabilities used in the analysis (Appendix R) can be achieved using standard construction methods. To simplify the analysis for presentation in this feasibility report, we presented only the worst case (i.e. areas of the site with the flattest slopes)

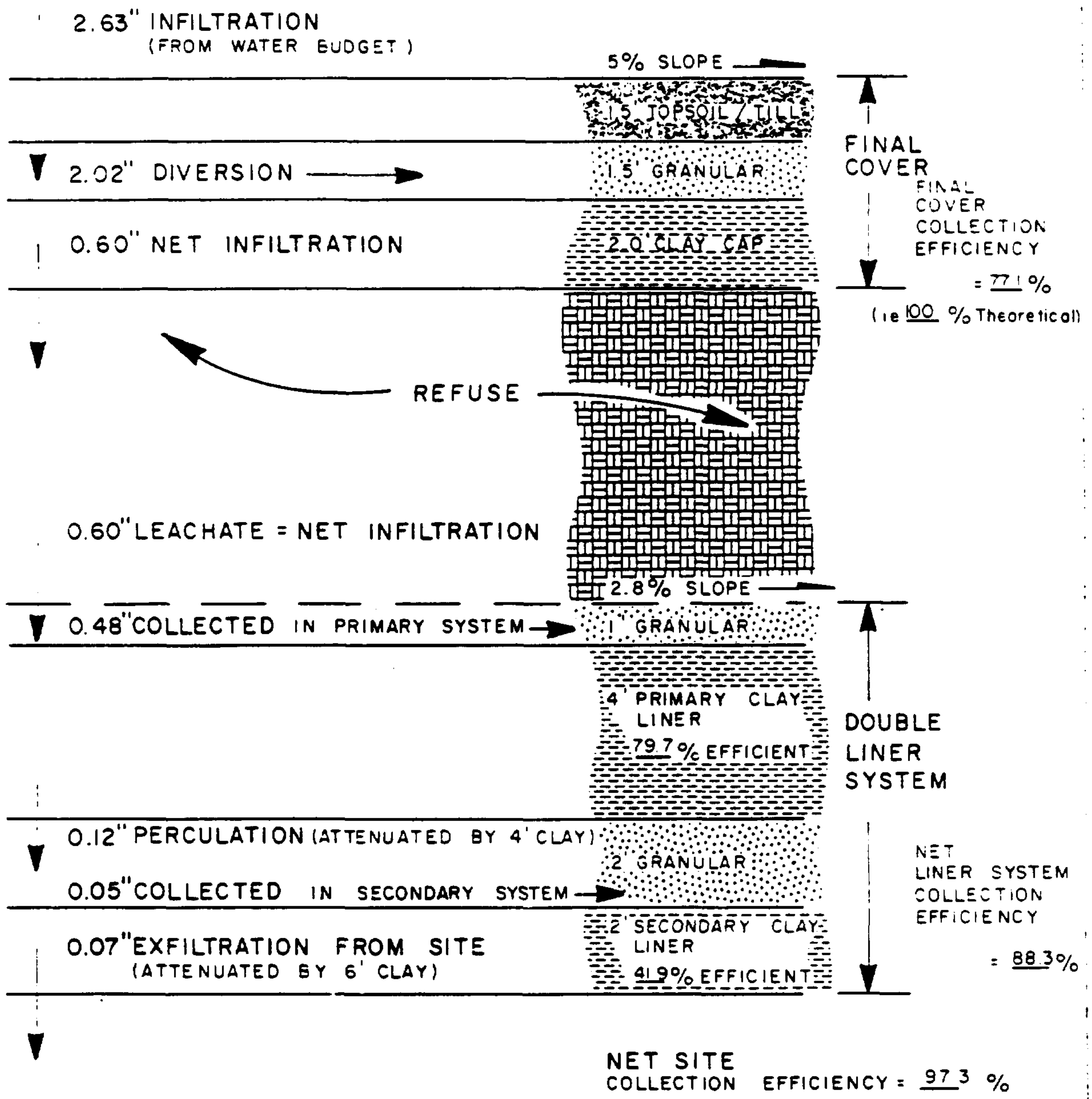
(Appendix R). If the final cover remains totally intact (i.e. is 100% of theoretical effectiveness), the post-closure net system efficiency according to the Wong method, is 97% (Figure 4, Case A). The granular blanket in the final cover diverts about 77% of infiltration away from the refuse, minimizing leachate production. As shown in Case A, due to the small amount of infiltration which is allowed to produce leachate, the primary and secondary liner efficiencies are 80% and 42%, respectively. The net double liner efficiency of 88% appears to be somewhat low for this configuration: this is because of the small quantity of leachate actually produced and available for collection by the liner system, since the Wong equation is sensitive to collectible volumes. Assuming that the final cover is 0% effective in diverting infiltration, (i.e. or only as effective as traditional landfill caps) as shown in Figure 5, Case B, the net double liner efficiency increases to 95%. Also note that the double liner collection efficiency will be even greater during site operations when infiltration increases, since only daily and intermediate cover are available to promote runoff, and the volume of leachate generated increases.

3.4.2 Water Budget

Several water balance methods were used to prepare a water budget to estimate leachate generation from the landfill during operation and after closure (Appendix Q). Leachate will be generated from moisture in the waste and percolation of water from rainfall. The amount of water available to generate leachate was

WONG EFFICIENCY ANALYSIS

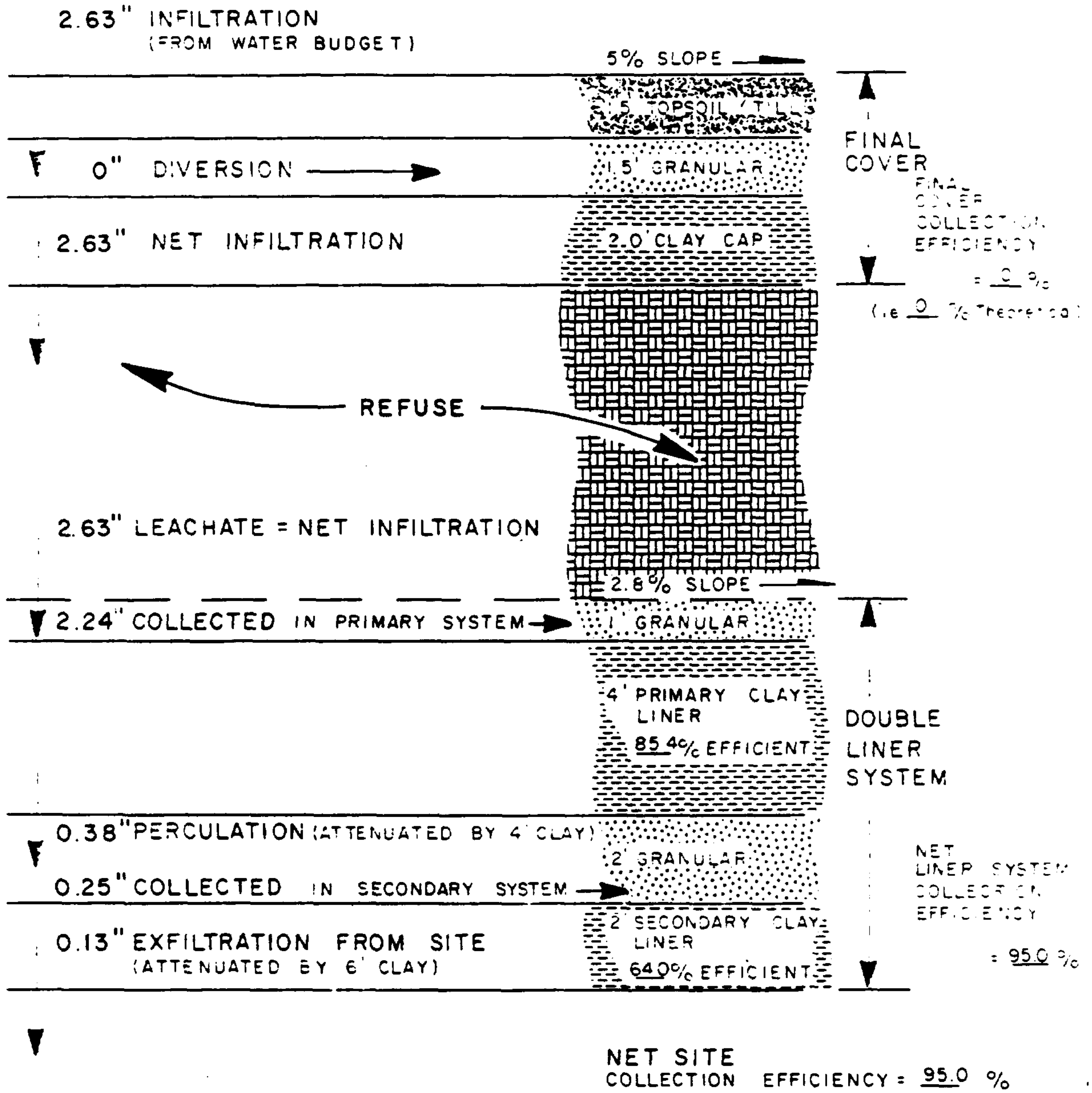
CASE A ✪



NOTE: CASE A ✪ FINAL COVER IS 100 % EFFECTIVE IN DIVERTING SITE INFILTRATION.

WONG EFFICIENCY ANALYSIS - CASE A

WONG EFFICIENCY ANALYSIS
CASE B ✪



NOTE: CASE B ✪
FINAL COVER IS 0 % EFFECTIVE
IN DIVERTING SITE INFILTRATION.

WONG EFFICIENCY ANAYSIS - CASE B

FIGURE 5 - P. 43

estimated from infiltration of rainfall during operations and after closure, and from the moisture content of the refuse. Due to the final cover configuration as discussed in Section 3.6.1, 77% of the infiltration, based on a Wong equation analysis (Section 3.4.1 and Appendix R), will be diverted from the refuse and this adjusted figure was used in the water budget. Since the site is designed with granular sidewalls to divert any ground water within the clay soils around the site, ground water was assumed not to contribute to leachate production.

A water budget for the proposed landfill during site operations has been developed assuming that the amount of infiltration into the landfill will depend on the amount and type of cover over the refuse and the final cover efficiency. To estimate infiltration, we assumed that there are three cover conditions influencing infiltration: (1) active areas with open refuse and no cover (the daily cell); (2) areas covered with 6 inches of bare soil (daily cover); and (3) areas closed and revegetated. Average yearly infiltration into the landfill under each of these cover conditions was estimated (Appendix Q). We assumed all precipitation would infiltrate into open areas with no cover. To estimate the amount of evaporation from bare soils, we used the EPA (1981) program. Infiltration into closed areas was estimated using the Thornthwaite and Mather (1957) method, and adjusting the amount available for leachate production by subtracting the amount diverted by the final cover developed in the Wong efficiency analysis (Section 3.4.1). Yearly infiltration into each module was calculated by determining the area of each module of the landfill under each of the cover conditions and adding the infiltration from each of the three cover areas in the module.

To estimate leachate production, we subtracted the moisture-holding capacity of the refuse in each module from the infiltration. The moisture-holding capacity of the refuse was assumed to be 30 gallons for each cubic yard of refuse (EPA, 1975). Yearly leachate production from the landfill was estimated by adding up the leachate generated in each of the four modules during operation (Table IV).

The operational water budget (Table IV, Appendix Q) indicates that approximately 49,960 x 10^3 gallons of leachate will be generated during the operating life of the landfill. During the first 5 years of operation, no leachate is projected due to the moisture-holding capacity of the refuse. Leachate will begin to be generated in the 6th year of operation, with a peak of 3,790,000 gallons/year (10,400± gallons/day), in years 16 through 22. Since some channeling will probably occur in the refuse, leachate will be produced sooner than predicted in the operational water budget. Therefore, the collection system has been designed to collect leachate as soon as it is generated and provisions will be made to treat it immediately.

A standard water budget estimating infiltration after closure was prepared using the Thornthwaite and Mather (1957) procedure, with modifications recommended by the USEPA (1975) (Appendix Q). Average monthly values for precipitation and temperature were computed for the 25-year period, (1955-1979), and were adjusted by the percent diverted by the final cover configuration (Section 3.6.1) as

TABLE IV
SUMMARY OF OPERATIONAL WATER BUDGET

YEAR	LEACHATE GENERATION IN GALLONS ($X10^3$)				
	MODULE I	MODULE II	MODULE III	MODULE IV	TOTAL
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	450	660	0	0	1,110
7	1,090	900	900	0	1,990
8	140	900	900	0	1,040
9	140	900	900	0	1,040
10	140	1,250	1,250	0	1,510
11	140	1,250	1,250	0	2,910
12	140	1,250	1,250	0	2,910
13	140	1,250	1,250	0	2,910
14	140	1,250	1,250	0	2,910
15	140	170	1,370	420	2,100
16	140	170	1,370	2,110	3,790
17	140	170	1,370	2,110	3,790
18	140	170	1,370	2,110	3,790
19	140	170	1,370	2,110	3,790
20	140	170	1,370	2,110	3,790
21	140	170	1,370	2,110	3,790
22	140	170	1,370	2,110	3,790

Total During Operating Life = 49,960,000 gallons
Annual Post-Closure Rate = 675,000 gallons

"Radandt 5"/TJ/SDJ:jad (178)

computed using the Wong analysis. For an average year, 2.63 inches of water will infiltrate the cover soils at a 5% slope into the landfill. Smaller areas of the final surface are designed at slopes of 4:1 or 25%. During an average year, the calculations show that only 0.1 inches of water will infiltrate the area with 25% slopes. (NOTE: Since only a small area of the landfill has final grades at greater than 7% slope, 5% slopes were used in these areas to simplify computations and providing a more conservative number).

Infiltration after closure for an extremely wet year was also calculated and adjusted by the Wong analysis. The Thornthwaite and Mather (1957) procedure was used to estimate infiltration for 1973, the year of highest precipitation between 1955 and 1979. During an average precipitation year, infiltration over the areas with 25% slopes is very small; however, in a high precipitation year, there would be a measurable amount of infiltration on the 25% slopes (6.17 inches). During a year of abnormally high precipitation such as 1959, 10.72 inches of water would infiltrate the 5% slopes.

Once field moisture capacity is reached, the landfill will produce leachate equal to the amount of infiltration entering the landfill. With an average percolation of 2.63 inches per year over the 5% slopes and 0.1 inches per year on the 25% slopes, the landfill will produce approximately 675,000 gallons of leachate per year after closure. However, leachate production during an abnormally wet year could be almost 2,570,000 gallons. Since the current daily volume of the City of Manitowoc Wastewater Treatment Plant is about 10 million gallons per day, even during an extremely wet year the projected leachate generation will be well below 1% of the current flow of the sewage treatment plant and even a smaller percentage of the actual of plant design capacity.

3.4.3 Leachate Treatment

At present, Lemberger Landfill Site Inc. has a contract with the City of Manitowoc Wastewater Treatment Facility to accept leachate. Similar arrangements are intended to be made with the City of Manitowoc for leachate for the horizontal expansion. A letter of acceptance or a signed contract from leachate treatment will be included in the expansion area Plan of Operations submittal.

3.4.4 Gas Management System

A conceptual design for a passive gas venting system to 1) control the lateral migration of gas from the site, 2) control the movement of gas within the site, and 3) promote its eventual venting into the atmosphere, is shown on Sheet 12. The granular material and sidewalls at the perimeter of the site will provide a more permeable contact surface compared to the clay sidewalls and final cover. The gas will migrate laterally along the clay base, sidewalls, and final cover, where it will enter the granular material and be collected in the perimeter gas collection pipe as shown in Details 1/20 and 3/20. This pipe will be continuous around the site at the 899± elevation and will be vented to the atmosphere periodically by risers. Since the interface between the final cover and clay sidewall is 12 feet (slope distance at 2:1), the radius of influence of the perimeter gas collection pipe should be adequate to prevent gas migration into the granular sidewall surrounding the site. If necessary, the existing gas venting risers could easily be retrofitted with blowers to provide a negative pressure system and increase the radius of influence of the gas collection pipe. The gas management system design will be finalized and discussed in more detail in the Plan of Operations.

3.5 Surface Water Drainage Control

As described earlier, the proposed site development will not significantly alter the surface water drainage patterns in the area. During site development and completion, surface water will continue to flow to the south and east in the existing drainage patterns. Perimeter runoff will collected in ditches as shown on Sheet 11. The final grade plan (Sheet 12) provides surface water diversion berms (Detail 4/20) and sodded drainage chutes to prevent sheet flow erosion on the side slopes in addition to the perimeter site drainage. Note that all surface water ditches and sedimentation control measures will be designed for a ten year, 24-hour storm and will be provided in detail in the Plan of Operations.

While the site is being filled, diversion berms will be used to divert surface water away from the active fill areas. Filling will take place in sequence to minimize the amount of surface water diversion necessary. Diversion berms will be used on both sides of the primary leachate collection line to divert surface water away from the collection system to the southern portion the site, where it will be removed. All lifts of refuse will be constructed so that surface water is channeled off the fill and into properly designed surface water drainage controls. Each lift of refuse will be sloped inward into the site to prevent lateral channeling of leachate through the final cover. The channel formed at the base of each module at the berm on the east, as shown in the north cross-sections (Sheets 14 and 15), will carry surface water to a sump outside each module.

3.6 Site Closure

3.6.1 Final Cover

Five feet of final cover will be used to bring the site to final grade, as shown on Plan Sheet 13. A 2-foot layer of compacted clay soil will be placed over the final lift of refuse. This will be covered with a 1.5-foot granular blanket and a 1.5-foot topsoil/till layer at the surface, as shown in detail 4/20. The granular blanket will help divert over 70% of the infiltration (according to the Wong analysis) away from the clay cap, and together with the topsoil/till layer, a three foot buffer between the final ground surface and the clay cap will be provided. This will help maintain the integrity of the clay cap during the surface disturbances which will occur when the site is closed and returned to limited agricultural use. The quantities of material needed as final cover are provided in Section 3.3. A more detailed description of phasing, stockpiling, etc. will be provided in the Plan of Operations.

3.6.2 Final Use

The final grades and cover used in the design of the proposed horizontal expansion will allow virtually all of the the land to be returned to limited agricultural use requiring limited tilling, after the site is closed. Due to the modular construction of the site, land within the fill area before development will continue to be farmed. Those modules which have been completed and properly closed will be returned to agricultural use as appropriate.

3.6.3 Financial Responsibility

Financial responsibility for the proposed Lemberger Horizontal Expansion, which includes payments for closure, long-term care, and contributions to the waste management funds, will be demonstrated as specified in NR180.15 (2). Given a refuse design in capacity of 4,250,000 cy (2,125,000 tons @ 1,000 lb/cy) over the life of the site, an estimated $75,000 will be contributed to the waste management fund. When detailed final engineering plans are developed as part of the Plan of Operations, closure and long-term care costs can be developed and a payment method addressed in detail.

3.6.4 Long-term Care and Maintenance

The long-term care and maintenance program for the proposed horizontal expansion will include: 1) a gas and water monitoring program; 2) leachate collection and treatment provisions after site closure; and 3) surface care and maintenance. All of these items will be discussed in detail in the Plan of Operations report. The landfill operators intend to enter into the 20-year, long-term care provisions outlined in NR180.15.

4. PRELIMINARY OPERATING PROCEDURES

4.1 Proposed Site Operation

The Lemberger horizontal expansion site will be operated according to the provisions of NR180.13 (10). The Plan of Operations for the expansion area will outline in detail the operating procedures for the site.

In general, daily operations will be confined to as small an area as possible. Filling will be from the high to low elevations in each module, with daily refuse cells constructed in six foot lifts. All daily cells will be sloped inward to prevent lateral leachate chanelling. Daily cover will be excavated from the next module to be constructed, with adequate stockpiles available for Module IV. One foot of intermediate cover will be placed in all areas which remain open for prolonged periods of time. An all-weather access road (Sheet 18 and Detail 5/20) will serve the expansion area. Access to the site will continue to be controlled by the gate at Hempton Lake Road.

4.2 Environmental Monitoring

4.2.1 Ground Water and Surface Water

Ground water in the vicinity of the expansion area will be monitored quarterly in accordance with NR180.13 (11)(a). The existing site has a monitoring program which was described in the DNR's June 24, 1981 review letter of the Lemberger landfill vertical expansion. This program is summarized on Table V and the environmental monitoring plan (Sheet 18) along with a proposed ground-water monitoring plan for each phase of landfill development. Wells which should be added or deleted from the program during successive phases are listed. The program is

TABLE V

ENVIRONMENTAL MONITORING PLAN

PHASE OF OPERATION	BEDROCK		UNCONSOLIDATED DEPOSITS		SURFACE WATER	WELLS TO ABANDON
	UPGRADIENT	DOWNGRADIENT	UPGRADIENT	DOWNGRADIENT		
PROGRAM ON EXISTING SITE[1]	43A	B32, B41, B42	28, 51	B7A, B7B, B35 B35A, B36, B37, B38 B39, B40		
THE FOLLOWING WELLS SHALL BE ADDED OR REMOVED DURING FILLING IN THE INDICATED MODULES						
MODULE I	58, 58A	29A	59	29, 30, 40 60, 60A	SW-1	28, 41
MODULE II		39, 39A	G5	31, 32 G6		40, 43, 43A
MODULE III		36, 61, 61A		33, 37		39, 39A 44, 45
MODULE IV			G7	34 G8, G9		37, 46, 46A

NOTES:

1. THE MONITORING PROGRAM ON THE EXISTING SITE WAS SPECIFIED IN THE JUNE 24, 1981 PLAN OF OPERATION REVIEW LETTER, LEMBERGER LANDFILL VERTICAL EXPANSION.

2. THESE WELLS SHALL BE SAMPLED QUARTERLY AND ANALYZED FOR: CHLORIDE, DISSOLVED IRON, COD, TOTAL ALKALINITY, TOTAL HARDNESS, FIELD PH AND FIELD CONDUCTIVITY, WITH RESULTS SUBMITTED TO DNR.

3. WATER LEVEL ELEVATIONS SHALL BE MEASURED ON ALL WELLS ON THE SITE QUARTERLY.

4. LEACHATE QUANTITIES COLLECTED AT THE SITE SHALL BE SUBMITTED QUARTERLY.

5. METHANE GAS CONCENTRATIONS IN THE GAS MONITORING WELLS (G1 THRU G9) AT THE SITE WILL BE SUBMITTED QUARTERLY.

designed to provide upgradient and downgradient ground-water quality in both the unconsolidated ground-water quality in both the unconsolidated deposits and the bedrock. Locations of several wells which will have to be added are illustrated on Sheet 18.

Surface water quality samples will be taken from the wetland south of Module II and the water level will be recorded. Water levels on all the wells will be measured quarterly.

The water samples will be analyzed for chloride, dissolved iron, COD, total akalinity, total hardness, field pH, and field conductivity.

4.2.2 Leachate Monitoring

A leachate quality testing program will be established to meet the requirements of the City of Manitowoc wastewater treatment facilty. Samples for this program will be taken from the holding tank which collects leachate from the force main. The leachate manholes at each module will also be sampled periodically to monitor the effectiveness of collection systems. These results will be submitted to the DNR with the quarterly ground water monitoring results. Quantities of leachate collected at the site will also be submitted to DNR quarterly. Should significant discrepancies exist between these volumes and predicted quantities, leachate monitoring wells will be drilled into the sumps at the base of each module (Sheet 12) to monitor head levels within the site.

4.2.3 Gas Monitoring

Methane gas concentrations in the gas monitoring wells which surround the site (Sheets 13 and 18) will be determined quarterly. Any areas where vegetative stressing appears to be occurring will also be investigated for methane. Gas monitoring results will be submitted along with the quarterly groundwater monitoring results.

5. ENVIRONMENTAL IMPACT ANALYSIS

5.1 Purpose and Need

The proposed Lemberger expansion will provide needed waste disposal capacity to the municipalities and industries in and around Manitowoc County. The Lemberger landfill is rapidly reaching capacity, and at current filling rates, the site will close between July and October 1982. The nearest alternate disposal facility which would accept this volume of waste is the WMI Omega Hills (Germantown) landfill, over 70 miles from the Lemberger site.

5.2 Probable Beneficial and Adverse Impacts of Site Development

We have evaluated the proposed horizontal expansion site and engineering design to determine the probable effects of site development (see Table VI). The primary beneficial and adverse impacts will take place within the landfill area. The secondary beneficial and adverse impacts affect the environment around the proposed site. The impacts are further categorized as physical, biological, social, economic, or aesthetic depending on the type of environment affected.

A brief discussion of the effect and its significance upon the environment of the area is provided for each of the categories. Additional discussion of several environmental categories to supplement Table VI is provided in the following sections.

5.2.1 Physical Environment

Surface Water: USGS quadrangle maps and air photographs show no major surface water bodies within 1.5 miles of the proposed Lemberger horizontal expansion. Surface water runoff during

TABLE VI

PROBABLE BENEFICIAL AND ADVERSE IMPACTS
OF THE PROPOSED LEMBERGER HORIZONTAL EXPANSION

IMPACT CATEGORIES / PROBABLE IMPACTS	PROBABLE BENEFICIAL IMPACTS		PROBABLE ADVERSE IMPACTS	
	PRIMARY*	SECONDARY**	PRIMARY*	SECONDARY**
PHYSICAL ENVIRONMENT				
Surface Water Quality	None expected.	None expected.	Surface water runoff will carry sediment due to construction activities on the landfill. Erosion will be greater over unrevegetated areas and will be accelerated by truck and machinery movements. Sediment loading will be confined to on-site areas through construction of berms, ditches, and sedimentation basins.	None expected. The sedimentation basins will remove sediment from the runoff prior to discharge from the site. Dredging or other means of sediment removal from the basins will be carried out as needed to maintain proper operation. Leachate will be treated at the City of Manitowoc Treatment Plant.
Groundwater Quality	None expected based on the proposed site design and operation.	None expected.	None expected.	None expected.
Land Use	Upon completion and closure of the Lemberger Horizontal Expansion, the land will be returned to agricultural use.	Establishment of the proposed Lemberger Horizontal Expansion will allow closure of the present landfill. Closure of the present landfill will minimize any possible future detremental effects on ground water quality at that site.	A small amount of crop land will be temporarily taken out of production at any one time. The design of the landfill will allow use of the entire site for crop production upon closure, however.	Some uses of the land within several hundred feet of the site will be restricted. For example, DNR regulations may prohibit the placement of future private wells within 1200 feet of the landfill boundaries. Most of the land surrounding the site is agricultural and land use problems in the near future are unlikely. This site is not part of an expanding urban area.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VI

PROBABLE BENEFICIAL AND ADVERSE IMPACTS
OF THE PROPOSED LEMBERGER HORIZONTAL EXPANSION

PROBABLE IMPACTS / IMPACT CATEGORIES	PROBABLE BENEFICIAL IMPACTS		PROBABLE ADVERSE IMPACTS	
	PRIMARY*	SECONDARY**	PRIMARY*	SECONDARY**
Air Quality (A) Dust	None expected.	None expected.	Truck and machinery operation may generate dust on the site during dry weather due to vehicular traffic over access roads. Berms will decrease wind velocities in the active area, reducing dust problems. Revegetation of completed or inactive areas will also aid in minimizing dust. No major problems have been noted at the existing landfill.	Dust generated on-site during filling operations in dry conditions may be carried offsite. Due to the remote nature of the site, (i.e. no homes exist within 1200 feet), this problem should be minimal.
(B) Engine Emissions	None expected.	None expected.	Truck and equipment operations on the site will result in increased emission of combustion products. No major problems have been noted at the existing landfill.	None expected.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VI

PROBABLE BENEFICIAL AND ADVERSE IMPACTS
OF THE PROPOSED LEMBERGER HORIZONTAL EXPANSION

PROBABLE IMPACTS / IMPACT CATEGORIES	PROBABLE BENEFICIAL IMPACTS		PROBABLE ADVERSE IMPACTS	
	PRIMARY*	SECONDARY**	PRIMARY*	SECONDARY**
Air Quality (cont'd.) (C) Odors	None expected.	None expected.	Odors due to decomposition of waste will occur. However, the proposed operations at the landfill will greatly reduce odor problems. The landfill will be operated in four phases, so only a small area will be filled at a time and wastes will be covered daily.	Odors from decomposition of waste may be carried a short distance downwind of the landfill. Since no private homes are within 1200 feet of the landfill boundary, distance should minimize any odor problems. Odor problems related to the landfill will be much less than those related to adjacent agricultural uses when manure is spread.
(D) Gas Production	None expected.	None expected.	Gas will be generated by decomposition of refuse. Gas vents will be installed to allow venting of gases produced during decomposition. Gas production will be monitored.	None expected. The site design with a clay liner and clay side walls will prevent lateral movement of gases.
Noise	None expected.	None expected.	Truck and equipment operation will produce on site noise. Standard noise protection devices will be sufficient for landfill operator safety.	The limitation on the size of the active fill area and restriction on vehicle movement over the site will reduce noise impacts on the surrounding area. Berms constructed for screening will also help mitigate any noise from the site. The large separation distance from the site is an attenuative mechanism for noise. Noise from vehicles traveling to and from site will continue in the area, although no major problems have been noted at the existing site.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VI

PROBABLE BENEFICIAL AND ADVERSE IMPACTS
OF THE PROPOSED LEMBERGER HORIZONTAL EXPANSION

PROBABLE IMPACTS / IMPACT CATEGORIES	PROBABLE BENEFICIAL IMPACTS		PROBABLE ADVERSE IMPACTS	
	PRIMARY*	SECONDARY**	PRIMARY*	SECONDARY**
BIOLOGICAL ENVIRONMENT				
Flora	None expected.	None expected.	Any vegetation currently found on site will be removed during filling operations. However, no known endangered or threatened species are found in the area of the proposed landfill.	None expected. Proper sedimentation control will prevent gradient of landfill bioligical impact. No known endangered species exist in or around the landfill (Appendix S).
Fauna	None expected.	None expected.	The operation of the landfill will disrupt the activities of any small animals or birds which currently live or visit the site. Since the area disturbed will be small, and abundant areas of similar habitat are found adjacent to the landfill, this impact will be minimal. No known threatened or endangered species are found in the area (Appendix _)	None expected.
SOCIAL AND ECONOMIC ENVIRONMENT				
Social	The Lemberger Horizontal Expansion will provide Manitowoc County with a long-term, environmentally sound, waste disposal facility.	None expected.	None expected.	During the life of the proposed landfill, additional vehicular traffic will continue near the site. No major problems have been noted at the existing landfill.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VI

PROBABLE BENEFICIAL AND ADVERSE IMPACTS
OF THE PROPOSED LEMBERGER HORIZONTAL EXPANSION

PROBABLE IMPACTS / IMPACT CATEGORIES	PROBABLE BENEFICIAL IMPACTS		PROBABLE ADVERSE IMPACTS	
	PRIMARY*	SECONDARY**	PRIMARY*	SECONDARY**
Economic	Horizontal expansion of existing Lemberger Landfill will provide users with an economic alternative to hauling to a more distant disposal site which would increase disposal costs.	None expected.	None expected.	None expected.
Aesthetic	None expected.	None expected.	Filling activities on the site may produce some noise, dust and at times an unattractive landscape. These activities and landforms will be temporary. All of these adverse impacts will be confined to the active area of the landfill.	Landfilling operations on-site may produce minor adverse aesthetic impacts off-site such as dust, noise and visual impacts of areas which have not yet received final cover soils or revegetation. Operations at the site will be conducted to minimize these impacts. Due to the remoteness of the site, these will be minimal.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

operation and after closure will be routed along the present surface water drainage patterns in the area. Runoff from the northeastern portion of the site will be directed to the southeast corner of the expansion area. Runoff from the remainder of the proposed landfill will be routed along drainage features to the east and southeast. As discussed in Section 3.5, design specifications for surface water drainage ditches and sedimentation controls will be included in the Plan of Operation. In addition, separation of surface water and leachate in the active fill area will eliminate discharge of contaminants to surface drainage patterns. These controls, and the natural attenuation properties of the soil and vegetation along the drainage flow, will protect surface waters from adverse environmental effects.

Leachate generated at the landfill will be treated at the City of Manitowoc Wastewater Treatment Plant. Since the projected yearly volume of leachate generated by the landfill, even during a year of abnormally high precipitation, will be much less than 1% of the yearly volume of wastewater handled at the Wastewater Treatment Plant, the leachate should be collected in the plant without any effect on surface water discharges.

Ground Water: The proposed Lemberger horizontal expansion is designed with a double clay liner and leachate collection system to limit the amount of leachate that percolates through the base of the landfill. The liner system (including final cover and the double liners) is over 70% efficient in diverting infiltration collecting leachate. In addition, an average of 40 feet of sandy silts or sandy clays below the clay liners will further restrict the percolation of leachate into the underlying soils and ground water. The ground water table is over 50 feet below the base of the site, allowing the attenuation of any leachate which percolates through the base of the site. Perched ground water in the clayey till surrounding the site is drained in granular outer sidewalls to limit infiltration. This helps minimize leachate generation (Section 3.2.5). An environmental monitoring program (Section 4.2), in compliance with NR180 regulations, has been developed to provide for early warning of any leachate movement from the site.

Land Use: The proposed expansion area is now used for agriculture. The expansion area will irreversibly alter the overall topography of the property. After closure, the site will have an elevation approximately 30 feet higher than surrounding ground surfaces (Sheet 13). However, upon closure the land will be returned to limited agricultural use, similar to conditions before the development of the landfill.

Air Quality: The proposed horizontal expansion will have a slight adverse effect on air quality within the landfill boundary. Dust, engine emissions, odor, and gases will affect air quality. However, the proposed design will minimize these effects (Section 3). Under the proposed design, about fifteen acres will be open to landfilling at one time. In addition, the large separation distance from neighboring homes (1200 feet minimum) will also mitigate any adverse effects. Any dust or odor problems will probably be much less severe than those caused by agriculture in the area; dust and odor have not caused any major problems at the present site. Problems with methane gas accumulation or migration are not expected because gas vents will be installed during construction of each phase and the clay liner along the base and sides of the landfill will minimize gas movement.

Noise: Operation of machinery at the site will increase noise levels in the area, but probably the noise will be less severe than that at the existing site since the expansion area is more remote. Also, berms constructed to screen the site will reduce some noise (Section 3.2.3).

5.2.2 Biological Environment

The proposed Lemberger horizontal expansion is designed to reduce the possibility of severe effects on the biological environment. The possibility of degradation of biological resources from surface water runoff is minimal (see Section 3.4.2). The wetland to the south will also be protected from the impact of the site development. In addition, the area proposed for landfilling is not known to be a habitat for endangered or threatened species (Appendix S).

5.2.3 Social and Economic Environment

Social: The proposed landfill will have an impact on surrounding residences very much like the effect of the present site. The refuse hauling vehicles increase traffic along Highway 10 through the Town of Whitelaw and Hepton Lake Road. This traffic is limited to the site's operating hours (7:00 a.m. to 3:00 p.m., Monday through Friday and 7:00 a.m. to 12:30 p.m. on Saturday).

Economic: The proposed Lemberger horizontal expansion will provide an economical long-term disposal facility for Manitowoc County and surrounding communities. Currently, the nearest sanitary landfill which could accept this volume of waste is over 70 miles from the Lemberger site. The horizontal expansion will save the communities in the area thousands of dollars in costs for hauling waste or developing a transfer station.

Aesthetic: The proposed landfill will have a minor effect on the appearance of the surrounding area due to dust, and the areas which have not yet been revegetated. The expansion area is over 1200 feet from the nearest road and will be screened by the existing fill, which will be closed and revegetated while the expansion area is being development.

5.3 Adverse Effects Which Cannot Be Avoided

The establishment of any landfill for the disposal of solid waste entails a number of inherent adverse effects which cannot be totally eliminated. Through proper design, engineering, and operation, however, these effects can be greatly reduced or mitigated. Table VII presents a list and brief discussion of unavoidable adverse effects which will probably accompany site development. Mitigation measures are also discussed in this table.

5.4 Irreversible, Irretrievable Commitments of Resources

Several resources will be irreversibly or irretrievably committed if the expansion area is developed. Several of these commitments are

TABLE VII

PROBABLE ADVERSE IMPACTS OF THE LEMBERGER HORIZONTAL EXPANSION SITE DEVELOPMENT THAT CANNOT BE AVOIDED

IMPACT CATEGORIES	PROBABLE ADVERSE IMPACTS DISCUSSION			
	PRIMARY*	AVOIDABLE/NONAVOIDABLE DISCUSSION	SECONDARY**	AVOIDABLE/NONAVOIDABLE DISCUSSION
Land Use	Some agricultural land will be removed from use during the life of the landfill, but will be returned to farming at site closure.	During site development, portions of the fill area will either be in the process of being filled, or under excavation for borrow and the next modual. These will be removed from crop production. This is only temporary since site design allows the entire area to return to agricultural use at closure.	Some adjacent properties to the site may have certain uses limited.	These limits on use would be primarily regulatory limitations, such as the possible denial of installing water supply wells within 1200 feet of the site. Major residential development nearby is unlikely due to land use patterns in the area.
Air Quality	Some dust and engine emissions may be generated by on-site operations.	Equipment movement and operation inherently causes dust to be raised and engine emissions to be produced. The screening berms should minimize these impacts and result in their containment on-site. The proposed design should also protect off-site areas from gas migration. Odors will be minimized by covering refuse daily. No major problems have been noted at the existing landfill.	Some dust may blow off-site during construction in dry periods, and some odors may migrate from the site.	Problems associated with dust blowing off-site will be minimal. Since the surrounding area is agricultural, with large amounts of bare ground for extended periods of time, the effects of dust from the landfill will be less than those from surrounding agricultural uses. Odor problems off-site should be minimal due to the distance to homes. Manure spreading on surrounding land will produce a far greater odor problem than the landfill. No major problems have been noted at the existing landfill.
Noise	Noise from truck and equipment operation will probably be audible in nearby areas during some times of the day.	Remoteness of the site, screening berms and vegetation should aid in the mitigation of these sounds. Due to the large separation distances to the adjoining residences, no major problems should occur.	Some noise from site operation may migration off-site. Truck traffic will be increased in the area due to landfill operation.	Some site operation including berms, etc. will limit and noise migration off-site. The vehicular traffic and patterns should not change since the landfill entrance will remain the same.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VII

PROBABLE ADVERSE IMPACTS OF THE LEMBERGER HORIZONTAL EXPANSION SITE DEVELOPMENT THAT CANNOT BE AVOIDED

IMPACT CATEGORIES	PROBABLE ADVERSE IMPACTS DISCUSSION			
	PRIMARY*	AVOIDABLE/NONAVOIDABLE DISCUSSION	SECONDARY**	AVOIDABLE/NONAVOIDABLE DISCUSSION
BIOLOGICAL ENVIRONMENT				
Flora and Fauna	Current plant and animal populations on the site will be displaced during filling operations.	These populations are very small and sufficient areas of similar habitat adjoin the proposed landfill to minimize these effects.	None Expected	None Expected
SOCIAL AND ECONOMIC ENVIRONMENT				
Social	None Expected	None Expected	There will be increased traffic near the site during site life.	Traffic in the landfill area will be larger than the normal load for this area due to vehicles traveling to the landfill. The additional volume will not be larger than the current landfill is generating. This additional traffic has not caused any major problems in the area due to the existing landfill. Since the landfill entrance is not changing, the additional traffic patterns will not change.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

TABLE VII

PROBABLE ADVERSE IMPACTS OF THE LEMBERGER HORIZONTAL EXPANSION SITE DEVELOPMENT THAT CANNOT BE AVOIDED

IMPACT CATEGORIES	PROBABLE ADVERSE IMPACTS DISCUSSION			
	PRIMARY*	AVOIDABLE/NONAVOIDABLE DISCUSSION	SECONDARY**	AVOIDABLE/NONAVOIDABLE DISCUSSION
Aesthetic	The active filling area on-site will probably not be aesthetically pleasing.	Once screening and revegetation operations have begun, on-site aesthetics are not a primary concern. Proper implementation of the Plan of Operation and aesthetics of site areas visible from the surrounding areas will be more important concerns.	Site construction will result in some periods where aesthetically unpleasing sights and sounds are produced. Some paper may be carried off-site during windy periods.	Construction of any project will result in some site areas being visually unattractive as well as noisy. During the construction of the screening berms such effects may be noticed. Once completed and revegetated, however, these berms will provide a beneficial impact. The remoteness of the site will also aid in minimizing this effect. Blowing paper problems will be minimized by proper site operations.

* Probable impacts within landfill boundary.
** Probable impacts beyond landfill boundary.

theoretically reversible, but due to the economics involved, will probably never be reclaimed.

Land Uses - Once filling is completed and the site is closed, some uses of the site will be somewhat limited. The construction of private or public wells in the area may be limited by the DNR, but since the area is overwhelmingly agricultural, any housing development nearby is highly unlikely. The landform and final cover chosen, however, will allow limited agricultural use of the area, again after the landfill is closed (Section 3.6).

Municipal Waste - Municipal waste has some beneficial uses which are lost when it is disposed in a landfill. Glass, metal, paper, and plastic and energy can be recovered from municipal waste. Once these materials are placed in a landfill, these resources are irretrievably lost.

Construction Materials - Materials used in construction of the landfill, including on-site soils and imported materials such as the leachate collection system, will be irretrievably committed to the landfill.

Energy - Gasoline and oil will be used during the operation of the site. This fuel will be used for hauling waste to the site, to remove leachate to the treatment plant and during construction of the site. Fuel will be an irretrievable resource commitment of the site.

5.5 Alternatives for Users of the Existing Lemberger Landfill

At current filling rates, the Lemberger landfill will be closed by October 1982. The expansion of the landfill will provide continuity in waste handling patterns for the current users of the existing landfill. Some long-term alternatives to the expansion are discussed below:

1. Using Another Licensed Landfill - The nearest licensed facility capable of handling the volume of refuse currently entering the existing Lemberger site is WMI Omega Hills (Germantown). This site is over 70 miles from the Lemberger landfill and would tremendously increase haul costs.

2. Recycling - Current literature indicates that high-technology waste recycling would not be economical for the volumes of waste currently entering the Lemberger landfill. In any event, a landfill site is still needed in conjunction with any type of recycling operation.

5.6 The Direct and Indirect Cumulative Effects of Site Development

The direct and indirect cumulative effects of developing the site are not expected to produce adverse environmental, social, or economic conditions. The proposed site design and operation will minimize detrimental effects on ground and surface water quality. The temporary removal of 57.5 acres of land from agricultural use will not significantly reduce the agricultural production of the area. Considerably greater amounts of agricultural land are permanently converted each year to residential and industrial use.

6. REFERENCES

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APPENDICES

Lemberger Landfill Site Inc.
Horizontal Expansion
Feasibility Report

October 1981

APPENDIX A

Proposed Manitowoc County Sanitary Landfill
DNR Feasibility Review Letter
August 6, 1980

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Anthony S. Earl
Secretary

BOX 7921
MADISON, WISCONSIN 53707

August 6, 1980

IN REPLY REFER TO: 4400

Mr. Howard Hamann, Chairman
Manitowoc Solid Waste Management Board
Manitowoc County Courthouse
1010 South 8th Street
Manitowoc, WI 54220

Dear Mr. Hamann:

Re: Feasibility Determination, Proposed Manitowoc County Expansion of the Lemberger Landfill

The Department of Natural Resources, Bureau of Solid Waste Management has completed its review of a final feasibility study for a proposed county solid waste disposal site located in the N 1/2 of Section 26 T20N, R22E, Town of Franklin, Manitowoc County, Wisconsin.

Based on this review, the Department has determined that the site is not feasible as proposed for a disposal facility. This denial is based on the findings of fact as detailed in the attached Determination of Site Feasibility.

The attached determination of site feasibility also includes the Department's recommendations for redesign and additional investigations which may increase the potential for receiving a favorable determination.

If you have any questions regarding this determination please contact Ken Quinn at (608)266-2178, Gene Mitchell at (608)266-0811 or Terry Hegeman at (414)497-4061.

Sincerely,
Bureau of Solid Waste Management

Daniel F. Kolberg, P.E., Chief
Residuals Management and Land Disposal Section

DFK:je
cc: Mr. Terry Hegeman - Green Bay Area
Mr. Doug Rossberg - Lake Michigan District
Mr. Henry Koch - Warzyn Engineering, Inc.
Ms. Alice Lemberger - Lemberger Landfill Site Inc.
Mr. Ron A. Kaminski

DETERMINATION OF SITE FEASIBILITY FOR THE PROPOSED MANITOWOC COUNTY SANITARY LANDFILL, EXPANSION OF THE LEMBERGER SANITARY LANDFILL

FINDINGS OF FACT

General Information:

Site Location: N 1/2, Section 26, T20N, R22E, Town of Franklin, Manitowoc County, Wisconsin.

Total Property Acreage: Approximately 120 acres.

Proposed Site Acreage: Approximately 40.5 acres.

Proposed Site Life and Capacity: The design capacity, which includes the refuse volume and daily and intermediate cover is approximately 2,579,000 cubic yards for an estimated 16 years of life.

Proposed Waste Types: Wastes proposed to be disposed at the proposed facility consist of municipal, commercial and some industrial wastes. No toxic or hazardous wastes would be accepted. The proposed site would be available for use by the entire county.

Mode of Operation: Area fill.

Covering Frequency: Daily

Plan Submission: The information submitted for review of the proposed site consists of the following:

1. A feasibility report titled "Final Feasibility Study Report, Proposed Manitowoc County Sanitary Landfill, Expansion of the Lemberger Sanitary Landfill", received on December 10, 1979 and prepared by Warzyn Engineering, Inc., consisting of a text, a separate set of appendices and a set of 21 drawings, numbered C8327-1 through C8327-21.

2. Revised engineering drawings replacing drawings C8327-8, 10, 11, 12, 13, 14 received on January 23, 1980.

3. Revised Water Budget Analysis received on February 25, 1980.

4. In addition to the submitted plans the April 17, 1980 hearing and hearing exhibits were reviewed.

Topography: The Lemberger property is located on a regional topographic high with the highest point of 942 feet (USGS Datum) located just north of the proposed site. The topography at the Lemberger site is gently rolling to hilly with many closed depressions, typical of glacial end moraine topography. The relief on the property is approximately 106 feet from a low of 836 in the southeast to the high of 942.

Geology: The Lemberger property is located on the terminal moraine, within the Lake Michigan Basin. The several glacial advances and retreats have deposited a series of grey and red tills over a relatively shallow bedrock high.

The surficial red brown till varies in composition from a sandy silt (SM-SC) as encountered at B-49-Sample 2, to a silty clay or clayey silt (CL, CL-ML) encountered in most of the other borings. Interbedded with this red brown till unit are sand layers ranging from thin isolated pockets to relatively thick, possibly continuous sand layers.

The correlation of the sand and silty clay units as presented by Warzyn are tenuous due to the heterogeneity of the deposits especially between borings 40 and 41.

The contact between the red brown and the underlying grey tills is somewhat uniform as interpreted on drawing C8327-7. In general the contact slopes from the topographic high in the north to lower elevations in the southeast and southwest. The thickness of the red brown till, however, does not vary accordingly (see drawing C8327-8). Rather it is irregular due to the irregular topography and sand layers contained within the till unit.

Underlying the red brown till is a brown to grey brown gravelly, silty, sand till. This unit is classified as an SM-SC soil with typical grain size proportions of gravel/sand/silt/clay of 21/50/24/4. This unit generally extends from below the red brown till to the Niagara Bedrock. In two borings a clayey till overlies the bedrock.

The Niagara dolomite varies dramatically in elevation across the site from a low of 796 to the east of the proposed site to a high of 910 a short distance to the north. The slope on the bedrock from the nob, centered around the 910 elevation in boring 52, is steep and irregular to the trough centered around the 796 elevation in MW-46A.

Hydrogeology: The unconsolidated deposits have a variable saturated condition which can be related to their hydraulic conductivity or their location within the stratigraphic column. The red brown till is saturated wherever a well is screened entirely within the unit. However, the underlying gravelly silty sand till is saturated in some wells, while unsaturated in other locations.

The hydraulic conductivity of the silty clay till, as measured by baildown methods, ranges from 0.1 to 4 x 10^{-5} cm/sec. Two tests performed in the underlying saturated gravelly silty sand averaged 3 x 10^{-4} cm/sec. This order of magnitude difference illustrates that the red till is consistently saturated because of the low hydraulic conductivity while the underlying till is only variably saturated. This condition does not appear to exist at the existing Lemberger Landfill.

A very general and incomplete water table, which can be compiled from submitted data, indicates the perched watertable is flowing to the south and southeast and is being recharged by the wetland areas on and offsite. The elevations range from a high of 883.85 feet in MW-41 to a low of 853.43 in MW-40.

The water table as mapped regionally occurs in the Niagara Dolomite aquifer. The Hydrologic Atlas, HA-432, indicates the proposed site is located approximately midway in the flowpath from the regional divide to the regional discharge. The regional map also shows the proposed site is located on a groundwater divide and in a recharge area. Based on this regional information, and the fact the site is located at least 4,000 feet upgradient from the Branch River, the site appears to be in a regional recharge zone to the Niagara aquifer. There are 23 private well locations shown on Drawing C8327-3 in the immediate vicinity of the proposed site.

The on-site bedrock water table information was obtained from six monitoring locations, two of which have a piezometer nested with the water table well. This on-site information substantiates the regional water table data. The site is shown to be in a recharge area by both the steep downward gradients (.03 to .15 ft/ft) and the arcuate shape of the water table contours.

The water table which occurs in the bedrock ranges in elevation from 805.41 to the east of the proposed site to 821.51 as measured in the center of the proposed site on October 25, 1979. The flow from the center of the proposed site is towards the east and south at approximately a 0.016 ft/ft horizontal gradient. The vertical gradient in the area is steeply downward ranging between 0.03 and 0.15 ft/ft. The hydraulic conductivity of the bedrock, as measured in the field, ranges from 4×10^{-6} cm/sec to 7×10^{-5} cm/sec. The most reliable estimate is an average of 5×10^{-5} cm/sec.

Flow on the north and northwest sides of the proposed site is not defined since only one monitoring well (B-51) was installed and was not incorporated into the water table map (C8327-9).

The depth to the bedrock water from the proposed base grade is a maximum of approximately 60 feet located in the southeast corner of module IV. The minimum depth is not defined due to inadequate monitoring on the north and northwest side of the proposed site.

<u>Preliminary Engineering</u>: The site is proposed as an excavated area fill. The design utilizes a combination of an in-place clay and a recompacted clay liner and a "dry base" leachate collection system.

The clay liner on the base and sidewalls is proposed as a combination of three designs. The base liner is proposed to consist of in-place clays with the upper two to three feet recompacted. The thickness of the in-place clays is proposed as five feet beneath areas of less than 30 feet of refuse, seven feet beneath 30 to 60 feet and 10 feet beneath areas of greater than 60 feet of refuse.

In areas where inadequate in-place clays exist below the proposed base grade a five-foot recompacted clay liner is proposed. The sidewalls are proposed to be overexcavated 10 to 12 feet (horizontally) and recompacted.

The proposed specifications for the physical properties of the recompacted baseliner is shown in Table 1 as "Proposed Specs". The sidewall clay specifications are limited to the liquid limit and plasticity index, and a hydraulic conductivity (K) of 1 x 10^{-8} cm/sec. In addition, specifications for field placement of the clay would be to achieve a minimum compaction of 90 percent Standard Proctor for the base liner and 85 to 90 percent for the sidewalls.

Table 1 also shows the guidelines which have been used by the Bureau of Solid Waste as specifications for other recompacted clay liners. The proposed specifications are generally below these. The compaction specification used by the Bureau has been 90 percent Modified Proctor.

Table 1 also shows the results of on-site testing of the silty clay soils which may be used for the liner which meet either the proposed or the DNR specifications with the total number of samples tested shown in the bottom row.

Table 1

	K	LL	PI	%P200	%.002 mm
Proposed Specs	1 x 10^{-7} cm/sec.	25	12	50	-
DNR Guidelines	1 x 10^{-7} cm/sec.	30	15	50	25
No. of samples that meet proposed specs	3	1	1	17	-
No. of samples that meet DNR specs	3	0	0	17	3
Total No. of samples	3	15	15	18	12

K - Hydraulic Conductivity
LL - Liquid Limit
PI - Plasticity Index
%P200 - Percent grain size passing number 200 sieve
%.002 mm - Percent grain size less than .002 mm

Table 1 demonstrates that a majority of the samples meet neither the DNR nor the proposed specifications. The one specification which is met consistently is the hydraulic conductivity. It should be pointed out that these three tests did not greatly exceed the specification as is commonly the case with silty clay soils.

The base grade elevations of the proposed fill varies from a low of 866 in Module I to a high of 980 in Module IV. The base grade slopes vary from 1 percent to 14 1/3 percent with an average of approximately three to five percent. The collection pipe spacing (the leachate flow distance) is on the average approximately 250 feet.

The proposed final elevation of this fill is a maximum of 960. This is approximately 20 feet higher than the maximum elevation on the property. However, on the average, the final grade is 80 feet above the surrounding topography. The depth of fill is quite variable due to the high base grade slopes but is a maximum of 85 feet of refuse and averages approximately 50 feet.

Water Budget: The water budget as calculated in the report and submitted in the revised water budget predicts that 81 gpd of percolation will occur over the entire 40.5-acre site after closure. The assumptions and methods used are described in the report. The water budget prepared for this site is very detailed and complete. However, the method used for determining the coefficient of runoff, in the Department's opinion, results in unrealistic values.

The method used is a modification of an SCS method designed to determine the peak discharge from a watershed for sizing water control structures. The peak discharge is calculated for a specific storm event using tables for different slopes, vegatation conditions and soil types. Admittedly, the method considers, independantly, three important watershed variables and is, therefore, more flexible than the table contained in EPA's method in Use of the Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites, EPA/530/SW-168.

However, the coefficient of runoff for a 10-year, 24-hour storm (the storm event used in the report) with high antecedent moisture conditions in the soil and a long-time of concentration (an important variable in the SCS method) will be much higher than a short gentle soaking rainfall on a dryer soil. This comparison can be shown using the graphs in Appendix K titled "Peak Rates of Discharge for Small Watersheds".

Therefore, a reanalysis of the water budget was performed by the Department using the same variables except the coefficients of runoff used were the upper limit from the EPA method, (0.35-steep slope and 0.22-moderate slope). The resultant percolation values were 3.70 and 2.22 inches per year for the steep and moderate slopes, respectively. The total leachate production is computed as 407,468 ft^3/year (8,350 gal/day).

The volume of groundwater flowing in the Niagara aquifer beneath the site was not computed in the submittal. However, this flow rate is very important to estimate the available dilution capacity in the aquifer for any leachate leakage through the liner or in the event of a failure. Using a gradient of 0.19 ft/ft a hydraulic conductivity of 5×10^{-5} cm/sec (.14 ft/day) and an area of 2,800 feet (flow width) by 84 feet (the average saturated thickness of the aquifer in two nearby private wells) the total flow in the aquifer beneath the site is 228,360 ft^3/yr (4,679 gal/day).

SUMMARY CONCLUSIONS

1. The applicant has not demonstrated that the site is within an area where there is a reasonable probability that the disposal of solid waste will not have a detrimental effect on groundwater quality for the following reasons:

    a. The site geology, which is very heterogeneous, makes correllations of soil types between borings somewhat tenuous. The bedrock surface has significant relief making it difficult to predict the depth to bedrock in all locations. This heterogeneous geology makes the ability to construct a complex site as designed very difficult and increases the likelihood of a failure.

b. The hydrogeology is equally complex and is not adequately defined. The perched water table system is not adequately defined, and based on the complex geology of the site may not be adequately defined without significantly more work. The water table in the bedrock is not defined in either the horizontal or vertical directions to the north of the site.

c. Based on regional and on-site information presented the site is located very near a regional groundwater divide and is in a groundwater recharge area. The water recharging the Niagara aquifer in the area of the proposed site flows at least 4,000 feet to the Branch River where it may be discharged from the Niagara aquifer. There are many private wells utilizing the Niagara aquifer within the vicinity of the landfill.

d. The location of the proposed site within the groundwater flow path, considering the possible fluctuation in flow directions associated with groundwater divides and the steep vertical gradients measured on-site increase the difficulty in monitoring and reduces the ability to detect a failure of the design or construction which would result in excessive leachate migration from the site.

e. The estimated quantity of leakage from the site as proposed (even assuming no failure) would comprise a substantial portion of the estimated flow within a reasonable depth in the Niagara aquifer. Therefore, the mobile constituents of the leachate exfiltrating from the site may not be sufficiently diluted.

2. The silty clay soils proposed for recompaction and lining the site do not exhibit properties, based on on-site testing, sufficient for an adequate clay liner.

CONCLUSIONS OF LAW

1. Manitowoc County has not established that the site, as proposed, would comply with NR 180.13, Wisconsin Administrative Code.

2. Based on the foregoing findings of fact, the Department has authority, pursuant to Section 144.44, Wisconsin Statutes, to issue the following determination.

DETERMINATION

Based on infield investigations and a review of the submitted information the Department hereby determines that the site, as proposed is not feasible for use as a land disposal facility.

ALTERNATIVE COURSE OF ACTION

The following points are the Department's recommendation for a redesign of the site and for further investigative work which may increase the likelihood of the site receiving a favorable feasibility determination. Prior to initiating the investigations outlined in point 4, we recommend that the liner specifications as outlined in point 3 and the economic impacts of the site redesign be evaluated.

1. The proposed design makes a very commendable effort to use the on-site geologic material for protection of the sensitive aquifer in the area. However, both the unconsolidated deposits and bedrock surface are heterogeneous and some important correlations are very tenuous. Therefore, the site should be designed with a uniform, completely recompacted five-foot clay base liner, so the design, construction and documentation does not heavily rely on stratigraphic correlations. Since this site is located in a regional groundwater recharge area, overlying a sensitive aquifer used by many private wells, the recommended design would be to utilize the site's geology to the maximum extent practible as a backup system.

2. In addition to the recompacted five-foot clay liner, the perforated collection pipe system should be redesigned with a closer pipe spacing. The spacing should be such that there is a maximum leachate flow distance of approximately 100 to 150 feet. This closer spacing would provide a shorter flow time to the collection pipe allowing less leakage through the liner to occur.

3. The properties of the on-site silty clay soils require further investigation to reverse the finding that they are inadequate for use as a liner material. The soils should either be in substantial compliance with the Department specifications or justification should be provided for establishing an alternate set of specifications.

4. The site's hydrogeology must be further defined in two areas. The water table of the bedrock aquifer must be investigated to the north and east of the proposed site in both the horizontal and vertical directions. This investigation must be sufficient to provide an understanding of the groundwater flow for monitoring purposes.

   The second area which needs additional work is the definition of the groundwater flow in the unconsolidated deposits. Specifically, the extent, flow directions and gradients of the perched water table and its degree of connection with the bedrock system on the east side of the proposed fill must be more completely defined.

Sincerely,
Bureau of Solid Waste Management

Kenneth J. Quinn, Hydrogeologist
Residuals Management and Land Disposal Section

Gene R. Mitchell, Engineer
Residuals Management and Land Disposal Section

Daniel F. Kolberg, P.E., Chief
Residuals Management and Land Disposal Section

KJQ:GRM:je

APPENDIX B

Site Investigation Section From
Warzyn Feasibility Report Submitted
December 10, 1979

SITE INVESTIGATIONS

A. Subsurface Exploration

1. Soil Borings and Test Pits

This report incorporates data obtained from soil borings and test pits performed in previous investigations of the Kafka-Eis properties. Six soil borings were performed by Soil Testing Services of Wisconsin in October, 1977, in their preliminary evaluation of the properties. The "Supplementary Site Evaluation Study" performed by Warzyn Engineering Inc., (January 1, 1979) included the performance of three additional borings and eighteen test pits. The present feasibility study included twelve additional boring locations on or adjacent to the Kafka-Eis properties in the spring of 1979. The boring and test pit locations are shown on Drawing C 7931-16 and were discussed with the County and DNR staff prior to their implementation.

Borings performed by Warzyn Engineering Inc., were advanced by auger or rotary drilling methods to depths ranging from 20' - 65'. Those borings located within and adjacent to the proposed fill area were extended to depths of 50' or more to verify the presence of a 30' minimum thickness of clay material below the anticipated base grade.

Split spoon samples were obtained as described in Appendix B during the performance of borings on the proposed site. Split spoon samples were generally obtained at 2.5' intervals from 0-10' and at 5' intervals thereafter. The sampling interval at boring locations located within the potential fill area were modified to obtain more detailed information in the vicinity of the proposed base grade. Split spoon samples, were obtained at 2.5' intervals from 15'-25' below the ground surface.

WARZYN ENGINEERING INC

A total of eighteen soil test pits were excavated on the Kafka-Eis properties in the fall of 1978 utilizing a County backhoe and operator to inspect shallow subsurface conditions. A geologist from Warzyn Engineering Inc., supervised the location and excavation of the test pits, logged the soil profiles, obtained samples and, where possible, documented subsurface conditions photographically. The test pits were located by a survey performed by Manitowoc County. The test pit logs are included in Appendix D.

2. Well Installations

A total of 34 groundwater monitoring wells have been installed in the vicinity of the proposed landfill to determine groundwater flow directions both horizontally and vertically. Water table wells were installed at twenty boring locations and are constructed of 2" I.D. PVC pipe with a 10' long 2" I.D. PVC well screen. Fourteen additional monitoring wells were installed as piezometers (wells sealed at prescribed depths below the water table) to evaluate vertical groundwater gradients and flow directions and allow development of groundwater flow lines.

Two groundwater monitoring wells and a staff gage were established adjacent to the intermittent stream on the Carsten's property located south of the proposed fill area to evaluate groundwater-surface water relationships. A similar installation was attempted along the same intermittent stream east of the Kafka-Eis properties but permission to gain access across private property to the stream was denied by the landowner.

Groundwater elevations in the observation wells have been routinely measured by Manitowoc County and Warzyn personnel (Appendix I). In-field permeability tests have also been performed at the most recently installed monitoring wells by Warzyn to provide further information on subsoil permeabilities. That data is contained in Appendix H. Boring locations and well elevations have been determined by various surveys performed by both Manitowoc County personnel and Warzyn. The well elevations have been established to a precision of ± 0.01 feet.

3. Review of Private Well Logs

Attempts were made to obtain well logs from the Department of Natural Resources (DNR) describing the construction of a number of private water supply wells in the vicinity of the fill area. Residents were contacted by telephone or in person. Those attempts were of limited success in that few landowners could supply us with the basic information necessary to retrieve the logs from the State files. In several cases, landowners refused to release this information. A log of our contacts with residents is contained in Appendix E along with a well log which was obtained from the DNR.

4. Wetland Investigation

An inspection of the Kafka-Eis properties and vicinity by an Environmental Specialist from Warzyn Engineering Inc., was performed on May 15, and 16, 1979 to locate and delineate wetland boundaries present in the area. The DNR, Sierra Club and Wisconsin Environmental Decade were invited to accompany Warzyn personnel during the wetland investigation, but were unable to attend due to scheduling conflicts or other reasons.

The wetland investigation included delineation of wetland areas, description of vegetation and identification of rare or endangered species. Observations made and photographs taken during the investigation were utlized to describe the current biologic characteristics.

Three groundwater observation wells were installed adjacent to the wetlands in the western wooded area in October, 1979 to investigate the relationship of groundwater to these wetlands and to obtain additional subsoil information in that area. The borings and observation wells were installed by hand augering methods so as not to disturb the wetlands and surrounding vegetation.

B. Laboratory Testing

The split spoon samples obtained during drilling were returned to the laboratory for visual classification by a hydrogeologist. Complete grain size distributions and Atterberg limits were obtained on a number of samples representative of the subsurface units present. The grain size analyses and Atterberg limit test results are shown on Drawings C 7931-A5 through C 7931-A15 in Appendix F. The soil testing was used to classify all soils to the Unified Soil Classification System.

Three inch (3") diameter thin wall Shelby tube samples were obtained as described in Appendix B for the purpose of evaluating subsoil permeabilities in a vertical direction. The Shelby tube samples were obtained at Borings W13, W14 and W15, located within the proposed fill area. The Shelby tube samples were obtained at a depth of 15 feet. Following extrusion of the samples from the core barrel, the samples were placed in a permeameter and tested by the falling head method for permeability.

Laboratory permeabilities were also performed on remolded composite samples representing the 0'-25' depth interval at two boring locations near the edge of the proposed fill area. These tests evaluated permeabilities of disturbed on-site clays which would be representative of daily and final cover materials as well as materials reconstructed during the process of excavation. All laboratory permeability results are contained in Appendix G.

APPENDIX C

Soil Boring Logs

LOG OF TEST BORING

General Notes

Descriptive Soil Classification

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12"	Larger than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	¾" to 3"	¾" to 3"
Fine	4.76 mm to ¾"	#4 to ¾"
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

GENERAL TERMINOLOGY

Physical Characteristics
Color, moisture, grain shape, fineness, etc.
Major Constituents
Clay, silt, sand, gravel
Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.
Geologic Origin
Glacial, alluvial, eolian, residual, etc.

RELATIVE DENSITY

Term	"N" Value
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

RELATIVE PROPORTIONS OF COHESIONLESS SOILS

Proportional Term	Defining Range By Percentage of Weight
Trace	0%- 5%
Little	5%-12%
Some	12%-35%
And	35%-50%

CONSISTENCY

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	Loss on Ignition
Non Organic	Less than 4%
Organic Silt/Clay	4-12%
Sedimentary Peat	12-50%
Fibrous and Woody Peat	More than 50%

PLASTICITY

Term	Plastic Index
None to Slight	0-4
Slight	5-7
Medium	8-22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" pentrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

Symbols

DRILLING AND SAMPLING

CS—Continuous Sampling
RC—Rock Coring: Size AW, BW, NW, 2" W
RQD—Rock Quality Designator
RB—Rock Bit
FT—Fish Tail
DC—Drove Casing
C—Casing: Size 2½", NW, 4", HW
CW—Clear Water
DM—Drilling Mud
HSA—Hollow Stem Auger
FA—Flight Auger
HA—Hand Auger
COA—Clean-Out Auger
SS—2" Diameter Split-Barrel Sample
2ST—2" Diameter Thin-Walled Tube Sample
3ST—3" Diameter Thin-Walled Tube Sample
PT—3" Diameter Piston Tube Sample
AS—Auger Sample
WS—Wash Sample
PTS—Peat Sample
PS—Pitcher Sample
NR—No Recovery
S—Sounding
PMT—Borehole Pressuremeter Test
VS—Vane Shear Test
WPT—Water Pressure Test

LABORATORY TESTS

q_p—Penetrometer Reading, tons/sq. ft.
q_u—Unconfined Strength, tons/sq. ft.
W—Moisture Content, %
LL—Liquid Limit, %
PL—Plastic Limit, %
SL—Shrinkage Limit, %
LI—Loss on Ignition, %
D—Dry Unit Weight, lbs./cu. ft.
pH—Measure of Soil Alkalinity or Acidity
FS—Free Swell, %

WATER LEVEL MEASUREMENT

▽—Water Level at time shown
NW—No Water Encountered
WD—While Drilling
BCR—Before Casing Removal
ACR—After Casing Removal
CW—Caved and Wet
CM—Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

UNIFIED SOIL CLASSIFICATION SYSTEM

COARSE-GRAINED SOILS

(More than half of material is larger than No. 200 seive size.)

Group	Symbol	Typical names
GRAVELS More than half of coarse fraction larger than No. 4 sieve size		**Clean Gravels** (Little or no fines)
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with Fines (Appreciable amount of fines)
	GM d/u	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS More than half of coarse fraction smaller than No. 4 sieve size		**Clean Sands** (Little or no fines)
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with Fines (Appreciable amount of fines)
	SM d/u	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

LABORATORY CLASSIFICATION CRITERIA

Symbol	Criteria	
GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} X D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} X D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

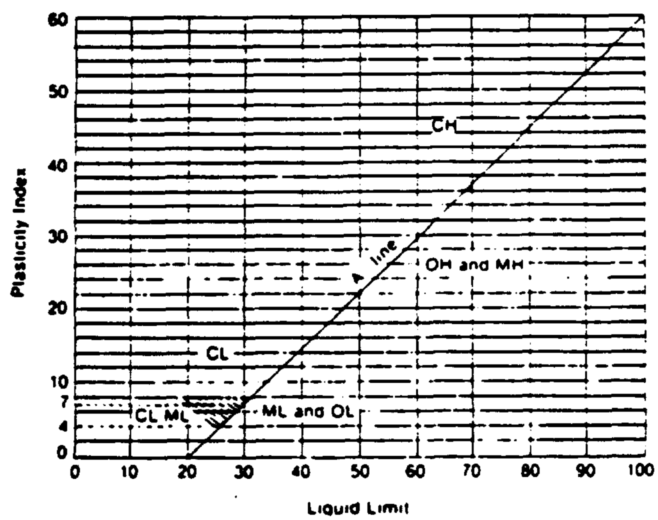
Less than 5 per cent	GW, GP, SW, SP
More than 12 per cent	GM, GC, SM, SC
5 to 12 per cent	Borderline cases requiring dual symbols

FINE-GRAINED SOILS

(More than half of material is smaller than No. 200 sieve.)

Group	Symbol	Typical names
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

PLASTICITY CHART



For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Equation of A-line: PI = 0.73 (LL - 20)

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LOG OF TEST BORING

Project: Lemberger Landfill
Location: Manitowoc, Wisconsin

Boring No.: C-1
Surface Elevation:
Job No.: C 8327
Sheet 1 of 1

SAMPLE: No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES: Qu	W	LL	PL	D
					0	6" Topsoil					
					0–27	Brown Silty CLAY Trace Fine Sand & Gravel					
					27–35	Fine to Medium SAND & GRAVEL					
					35	End Boring at 35'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/19/79 Complete 9/19/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-3

Surface Elevation

Job No. C 8327

Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0–4	Brown Fine to Medium Silty SAND					
					4–8	Brown Clayey SILT Trace Sand & Gravel					
					8–17	Brown Silty CLAY Trace Sand & Gravel Stone Chips					
					17–25	Brown Fine to Medium Silty SAND, Gravel, Boulders and Cobbles					
					25	End Boring at 25'					

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 9/20/79 Complete 9/20/79

Crew Chief JS Rig B-40

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No.: C-4

Surface Elevation:

Job No.: C 8327

Sheet 1 of 1

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SAMPLE: No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES: Qu	W	LL	PL	D
					0–20	Brown Silty CLAY Gravel, Cobbles & Boulders					
					20–25	Brown Fine to Medium Silty SAND Gravel, Boulders and Stone Chips					
					25	End Boring at 25'					

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 9/20/79 Complete 9/20/79

Crew Chief JS Rig B-40

Drilling Method

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LOG OF TEST BORING

Project Lemberger Landfill

Location Manitowoc, Wisconsin

Boring No. C-5
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					0	6" Topsoil ≈910					
					0–6	Brown Sandy SILT, Little Gravel & Stone Chips					
					6–10	Brown Fine to Medium Silty SAND, Gravel & Stone Chips ≈900					
					10–17	Brown Silty CLAY Trace Fine Sand, Gravel & Stone Chips ≈893					
					17–25	Brown Fine to Medium Silty SAND, Gravel & Stone Chips					
					25	End Boring at 25'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave in

GENERAL NOTES

Start 9/20/79 Complete 9/20/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-6
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0	8" Brown Fine to Medium Silty SAND					
					5	Brown Silty CLAY Trace to Little Sand & Gravel					
					10	Brown Very Fine Silty SAND, Trace Clay					
					15	End Boring at 15'					
					20						
					25						
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/20/79 Complete 9/20/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-7
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					0–12	Brown Silty CLAY, Trace to Little Fine Sand & Gravel					
					12–20	Brown Fine to Medium Silty SAND, Gravel & Stone Chips					
					20	End Boring at 20'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/21/78 Complete 9/21/78
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project Lemberger Landfill

Location Manitowoc, Wisconsin

Boring No. C-8
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE: No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks ~ 897	Qu	W	LL	PL	D
					0–17	Brown, Silty CLAY Gravel, Small Boulders, Little Sand, More Sandy and Silty at 6' Less Sand & Less Silt at 11' ~ 880					
					17–22	Brown Silty SAND, Wet					
						End Boring at 20'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/20/79 Complete 9/20/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-9

Surface Elevation

Job No. C 8327

Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0	Brown Fine to Medium Silty SAND					
					5	Brown Silty CLAY, Trace Gravel & Stone Chips					
					10						
					15	More Silty					
					20						
					25						
					30	Brown Fine to Medium Silty SAND					
					35	End Boring at 35'					
					40						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 9/21/79 Complete 9/21/79

Crew Chief JS Rig C-9

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-10
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Silty SAND					
						Reddish Brown Silty CLAY, Trace Sand & Gravel					
1	SS	X	M	-	5						
2	SS	X	M	-	10						
						Sand Gravel Seam					
3	SS	X	M	-	15						
						Brownish Red Silty CLAY, Some to Little Sand, Little Gravel					
4	SS	X	M	-	20						
5	SS	X	M	-	25						
						SAND, Little Gravel, Trace of Silt					
6	SS	X	M	-	30						
						End Boring at 30'					
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/28/79 Complete 9/28/79
Crew Chief JS Rig B-40
Drilling Method

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LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-11
Surface Elevation -
Job No. C 8327
Sheet 1 of 1

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0	4" Sandy Topsoil, Some Sand					
1	SS	X	M	-	5	Reddish Brown Silty CLAY, Some to Little Sand, Trace of Gravel, Occasional Stone Chips					
2	SS	X	M	-	10						
3	SS	X	M	-	15						
4	SS	X	W	-	20	Brown Silty CLAY, Little to Some Sand					
5	SS	X	M	-	25	Brown Silty CLAY, Trace of Sand & Gravel					
6	SS	X	M	-	30						
7	SS	X	M	-	35	Brown Medium SAND with Gravel & Stone Chips					
8	SS	X	M	-	40	Lacking Gravel & Stone Chips					
						End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling ____
Upon Completion of Drilling ____
Time After Drilling ____
Depth to Water ____
Depth to Cave In ____

GENERAL NOTES

Start 9/25/78 Complete 9/25/79
Crew Chief JS Rig B-40
Drilling Method

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LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-12
Surface Elevation
Job No. C 8327
Sheet 1 of 1

No.	Type	Recovery	Moisture	N	Depth	Visual Classification and Remarks	Qu	W	LL	PL	D
						Silty Brown Topsoil					
						Reddish Brown CLAY, Trace Sand & Gravel					
1	SS	X	M	-	5						
2	SS	X	M	-	10						
3	SS	X	M	-	15	Reddish Gray Silty CLAY, Trace Sand & Gravel					
4	SS	X	M	-	20						
5	SS	X	M	-	25	Brownish Gray Silty CLAY, Some Sand, Trace Gravel & Stone Chips					
6	SS	X	M	-	30	Brown Medium SAND, Some Silty Clay, Little Gravel & Stone Chips					
7	SS	X	M	-	35	Less Silty Clay					
8	SS	X	M	-	40	End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/25/79 Complete 9/25/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-13
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0–2.5	Silty SAND, Trace Gravel & Sand					
1	SS	X	M	-	5	Reddish Brown Silty CLAY, Trace Sand & Gravel					
2	SS	X	M	-	10						
3	SS	X	M	-	15	Grayish Brown Silty CLAY, Trace Sand & Gravel					
4	SS	X	M	-	20	Brown, Medium to Coarse SAND, Stone Chips					
						End Boring at 20'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ¼ hour
Depth to Water
Depth to Cave In: 17'

GENERAL NOTES

Start 9/25/79 Complete 9/25/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No.: C-14

Surface Elevation:

Job No.: C 8327

Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
						Dark Sandy SILT
1	SS	X	M	-	5	Reddish Brown Silty SAND
2	SS	X	W	-	10	Brown Silty CLAY, Some to Little Sand
3	SS	X	W	-	15	Trace Silty CLAY
4	SS	X	W	-	20	Silty CLAY, Trace to Little Sand & Gravel
5	SS	X	M	-	25	
6	SS	X	M	-	30	
7	SS	X	M	-	35	Silty CLAY, Some Sand
						End Boring at 35'
					40	

SOIL PROPERTIES: Qu | W | LL | PL | D

WATER LEVEL OBSERVATIONS

While Drilling	
Upon Completion of Drilling	
Time After Drilling	½ hour
Depth to Water	29'
Depth to Cave In	

GENERAL NOTES

Start 9/25/79 Complete 9/25/79

Crew Chief JS Rig B-40

Drilling Method

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LOG OF TEST BORING

Project: Lemberger Landfill
Location: Manitowoc, Wisconsin

Boring No. C-15
Surface Elevation
Job No. C 8327
Sheet 1 of 1

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Dark Brown Silty Topsoil					
						Brownish Gray Silty SAND, Trace Gravel					
1	SS	X	M	-	5	Reddish Brown Silty CLAY, Trace to Little Gravel & Sand Little Gravel					
2	SS	X	M	-	10						
						Some SAND					
3	SS	X	M	-	15	Brownish Gray Silty CLAY, Trace Sand & Gravel					
4	SS	X	M	-	20						
5	SS	X	M	-	25						
						Reddish Brown Silty CLAY, Trace Sand, Occasional Gravel					
6	SS	X	W	-	30	Brownish Gray Silty CLAY, Trace Sand, Occasional Gravel					
7	SS	X	VM	-	35	Light to Medium Brown Silt Little to Medium Sand with Some to Little Silt Trace Gravel					
8	SS	X	M	-	40	End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ½ hour
Depth to Water
Depth to Cave In 36.5'

GENERAL NOTES

Start 9/26/79 Complete 9/26/79
Crew Chief JS Rig B-40
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Landfill

Location: Manitowoc, Wisconsin

Boring No. C-16

Surface Elevation

Job No. C 8327

Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Little SILT, Trace of Gravel					
						Brown Fine to Medium SAND, Trace of Gravel					
1	SS	X	M	-	5						
2	SS	X	W	-	10	Brown Fine Silty SAND					
						Silty CLAY, Little Sand					
3	SS	X	W	-	15						
						End Boring at 15'					
					20						
					25						
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 9/25/79 Complete 9/25/79

Crew Chief JS Rig B-40

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 29
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					5	See Log Test Boring #30					
					22.5	End Boring at 22.5'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ½ hour
Depth to Water: 14.8'
Depth to Cave In

GENERAL NOTES

Start 6/25/79 Complete 6/25/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 29A

Surface Elevation

Job No. C 8327

Sheet 1 of 2

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SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery ↓	Moisture ↓	N	Depth		Qu	W	LL	PL	D
						See Log of Test Boring #30 0-40'					
						Shelby Tube Sample Collected 12.5-15.0'					

(Continued)

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LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 29A

Surface Elevation 875.3

Job No. C 8327

Sheet 2 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						See Log of Test Boring #30					
					52.9 (822.3)						
						Dolomite Bedrock					
					73	End Boring at 73'					

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85

WATER LEVEL OBSERVATIONS

While Drilling ______

Upon Completion of Drilling ______

Time After Drilling	½ hour	24 hours
Depth to Water	33'	49.4'
Depth to Cave In		

GENERAL NOTES

Start 9/12/79 Complete 9/12/79

Crew Chief WG Rig 550

Drilling Method

WARZYN
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LOG OF TEST BORING

Project: Lemberger Site
Location: Manitowoc County, Wisconsin

Boring No. 30
Surface Elevation
Job No. C 8327
Sheet 1 of 1

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						875.3					
1	SS	X	M	21		Brown Fine SAND, Trace Silt, Trace Gravel (SM)					
2	SS	X	M	27	5	29					
3	SS	X	M	26			1.0/1.0				
4	SS	X	M	30	10		1.5/1.5				
5	SS	X	M	29	15	~~Gray~~ SILTY CLAY, Little to Some Sand, Trace Gravel (CL) Red Brown	3.2/3.0				
6	SS	X	M	22	20		1.5/1.5				
7	SS	X	M	20			1.5/1.5				
1A	SS	X	M	16	25						
2A	SS	X	M	16	30	Red Brown ~~Gray~~ SILTY CLAY, Some Sand, Trace Gravel (CL)					
3A	SS	X	M	29	35						
4A	SS	X	M	17	40	835.3 End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ½ hour
Depth to Water: 32.8'
Depth to Cave In

GENERAL NOTES

Start 6/26/79 Complete 6/26/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 31
Surface Elevation
Job No. C 8327
Sheet 1 of 1

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SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	11			1.5/ 1.7				
2	SS	X	M	38	5		2.5/ 2.5				
3	SS	X	M	40		Reddish Brown SILT, Some Sand, Some Clay, Trace Gravel (CL,CL-ML)					
4	SS	X	M	26	10		3.5/ 4.0				
5	SS	X	M	21	15		2.5/ 2.7				
6	SS	X	M	22	20		3.0/ 3.5				
7	SS	X	M	21			3.0/ 3.0				
						End Boring at 22'					
					25						
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ½ hour
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 6/26/79 Complete 6/26/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 32
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	32		Reddish Brown SILT, Some Sand, Some Clay, Little Gravel (CL-ML)					
2	SS	X	M	18	5		1.5/1.5				
3	SS	X	M	19		Brown SAND, Some Silt, Trace Clay (SM)					
4	SS	X	M	15	10	Reddish Brown SILT, Some Sand, Some Clay Little Gravel (CL-ML)					
5	SS	X	M	24	15		1.5/2.0				
6	SS	X	M	60/2"	20						
7	SS	X	M	84	25						
8	SS	X	M	60/6"	30	Brown, SILTY SAND, Little Clay, Trace Gravel (SM-SC)					
9	SS	X	M	60	35						
10	SS	X	M	59	40						
11	SS	X	M	60	45						
						End Boring at 45'					

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 32

Surface Elevation

Job No. C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					50						
					55						
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water: 20'

Depth to Cave In

GENERAL NOTES

Start 6/27/79 Complete 6/27/79

Crew Chief JWG Rig 55-1

Drilling Method

W-5

WARZYN ENGINEERING INC

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LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 33

Surface Elevation

Job No. C 8327

Sheet 1 of 1

Sample No.	Type	Recovery	Moisture	N	Depth	Visual Classification and Remarks	Qu	W	LL	PL	D
					0	Topsoil					
1	SS	X	M	40		Brown SILT, Some Sand, Some Clay, Trace to Little Gravel (CL,CL-ML)					
2	SS	X	M	35	5						
3	SS	X	M	26							
4	SS	X	M	42	10		2.0				
5	SS	X	M	37	15		4.5+				
6	SS	X	M	28	20	Brown SAND and Silty Sand, Little Clay, Trace Gravel (SM-SC)					
7	SS	X	M	44	25						
8	SS	X	M	41	30						
9	SS	X	M	53	35						
10	SS	X	M	60	40	End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ¼ hour

Depth to Water: 40.9'

Depth to Cave In

GENERAL NOTES

Start 7/3/79 Complete 7/3/79

Crew Chief JHR Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 34
Surface Elevation
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	10		Brown SILT, Some Sand, Some Clay, Trace Gravel (CL,CL-ML)	1.7/2.0				
2	SS	X	M	12	5		0.7/1.0				
3	SS	X	M	35							
4	SS	X	M	45	10		2.5				
5	SS	X	M	29	15		2.5/3.5				
6	SS	X	M	21	20		2.5/3.5				
7	SS	X	M	55	25	Brown SAND, Some Silt and Clay, Trace Gravel (SM)					
8	SS	X	M	50/7"	30						
9	SS	X	M	50/5"	35	End Boring at 35'					
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ½ hour
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/6/79 Complete 7/6/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN

ENGINEERING INC

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LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 35

Surface Elevation

Job No. C 8327

Sheet 1 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					5	See Log of Test Boring #36	5.0				
					10						
					15						
					20						
					25						
					30						
					35						
					40						
					45						

(Continued)

WARZYN

ENGINEERING INC

LOG OF TEST BORING

Project Lemberger Site

Location Manitowoc County, Wisconsin

Boring No. 35

Surface Elevation

Job No. C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
						End Boring at 47'					
					50						
					55						
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 9/11/79 Complete 9/11/79

Crew Chief WG Rig 550

Drilling Method

WARZYN ENGINEERING INC

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 36

Surface Elevation

Job No. C 8327

Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks 850.8	SOIL PROPERTIES Qu	W	LL	PL	D
						8" Topsoil					
1	SS	X	M	58		Brown SAND and Gravel, Some Silt and Clay (SM)					
2	SS	X	M	70	5						
3	SS	X	M	39		Reddish Brown SILT, Some Clay, Some Sand, Trace Gravel (CL)	4.5+				
4	SS	X	M	48	10		4.5+				
5	SS	X	M	24	15		3.0/3.5+				
6	SS	X	M	21	20		1.5/2.0				
7	SS	X	M	48	25	Gray to Brown SILT and Sandy Silt, Some Clay (ML,CL-ML)					
8	SS	X	M	100/6"	30						
9	SS	X	M	60/6"	35						
10	SS	X	M	51	40	809.8					
11	SS	X	M	58	45	Brown SAND, Trace to Some Gravel, Trace Silt (SM)					

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project Lemberger Site

Location Manitowoc County, Wisconsin

Boring No. 36
Surface Elevation 850.80
Job No. C 8327
Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks *	Qu	W	LL	PL	D
						805.3'					
12	SS	X	M	24	50						
13	SS	X	W	22	55	Dolomite Bedrock					
14	SS	X	W	65	60						
15	No Sample			65/1"	65						
16	No Sample			65/1"	70						
					75	End Boring at 73'					
						* Brown SAND, Trace to Some Gravel, Trace Silt (SM)					
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling

Time After Drilling	½ hour	24 hours			
Depth to Water	32'	28'8"			
Depth to Cave In					

GENERAL NOTES

Start 8/29/78 Complete 8/29/79
Crew Chief WG Rig 550
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 37
Surface Elevation
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET · P.O. BOX 9538, MADISON, WIS. 53715 · TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	14		Reddish Brown SILT and Silty Clay, Trace Gravel (CL,CL-ML)	2.0/2.5				
2	SS	X	M	17	5		.7/.7				
3	SS	X	M	22			2.0/2.0				
4	SS	X	M	37	10		4.0/4.0				
5	SS	X	M	16	15		3.0/3.5				
6	SS	X	M	17	20		1.5/1.7				
7	SS	X	M	14	25		2.0/2.5				
8	SS	X	M	29	30		4.5/4.5				
						Gray to Brown SAND, Some Silt and Clay, Trace Gravel (SM-SC)					
9	SS	X	M	48	35	End Boring at 35'					
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ¼ hour
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/9/79 Complete 7/9/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc, Wisconsin

Boring No. 38B
Surface Elevation
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						See Log of Test Boring #39					
					22'	End Boring at 22'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/3/79 Complete 7/3/79
Crew Chief JR Rig
Drilling Method

WARZYN ENGINEERING INC

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No.: 39
Surface Elevation: 886.5
Job No.: C 8327
Sheet 1 of 3

No.	Type	Recovery	Moisture	N	Depth	Visual Classification and Remarks	Qu	W	LL	PL	D
						Black Topsoil					
1	SS	X	M	8		Brown SILT, Some Clay, Trace to Little Sand, Trace Gravel (CL,CL-ML)					
2	SS	X	M	28	5		4.5				
3	SS	X	W	47							
4	SS	X	W	23	10						
5	SS	X	M	17	15		5.0+				
6	SS	X	W	24	20						
7	SS	X	M	17	25						
8	SS	X	M	37	30	Brown SAND, Some Gravel, Some Silt, Trace Clay (SM-SC)					
9	SS	X	M	56	35						
10	SS	X	M	42	40						
11	SS	X	M	50/8"	45						

(Continued)

WARZYN ENGINEERING INC

Project: Lemberger Site
Location: Manitowoc County, Wisconsin

Boring No. 39
Surface Elevation 886.5
Job No. C 8327
Sheet 2 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Brown SAND, Some Gravel, Some Silt, Trace Clay (SM-SC)					
12	SS	X	M	60	50						
13	SS	X	M	60/4"	55	SAND, Some Gravel, Some Silt and Clay (SM-SC)					
14	SS	X	M	60/3"	60						
15	SS	X	W	39	65						
16	SS	X	W	40	70						
17	SS	X	W	34	75	Brown, Silty CLAY (CL)					
						Brown SILT Trace Fine Sand (ML)					
18	SS	X	W	40	80	Dolomite Bedrock					
19	SS	X	W	-	85						

(CONTINUED)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 39

Surface Elevation

Job No. C 8327

Sheet 3 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Dolomite Bedrock					
						End Boring at 87'					
					90						
					100						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 6/13/78 Complete 6/13/79

Crew Chief JVS Rig 55-1

Drilling Method

ENGINEERING INC

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 39A

Surface Elevation 886.5

Job No. C 8327

Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery ↓	Moisture ↓	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						0-87' See Log of Test Boring #39					
					90						
					95						
					100						
					105	Dolomite Bedrock					
					110						
					115						
					120	End Boring at 120'					
					125						

WATER LEVEL OBSERVATIONS

While Drilling ______

Upon Completion of Drilling ______

Time After Drilling ______

Depth to Water ______

Depth to Cave In ______

GENERAL NOTES

Start 9/20/78 Complete 9/20/79

Crew Chief LS Rig 550

Drilling Method ______

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 40

Surface Elevation

Job No. C 8327

Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	11		Brown SAND, Some Silt, Some Clay, Little Gravel (SC)	1.0/1.0				
2	SS	X	M	38	5		2.0/2.0				
3	SS	X	M	49			3.5/3.5				
4	SS	X	M	1[illegible]	10	Red Brown (handwritten, replacing "Gray") SILT, Some Clay, Some Sand, Little Gravel (CL) similar gravel content + plasticity as B-41 S1-S6 + S-9	3.0/3.0				
5	SS	X	M	21	15		3.0/3.0				
6	SS	X	M	69	20	Gray Brown SAND, Little Silt, Trace Gravel (SM-SC)					
7	SS	X	M	60/8"	25	Gray SILTY CLAY, Some Sand, Trace Gravel (CL) much more gravel than Red Br unit					
8	SS	X	M	60/3"	30						
9	SS	X	M	60/6"	35	SAND, Some Silt, Some Gravel, Trace Clay (SM-SC)					
10	SS	X	M	60/6"	40						
11	SS	X	W	60/6"	45						
						End Boring at 45'					

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 40

Surface Elevation

Job No. C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery ↓	Moisture ↓	N	Depth		qu	W	LL	PL	D
					50						
					55						
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ¼ hour

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 6/21/79 Complete 6/21/79

Crew Chief JWG Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Boring No. 41
Surface Elevation
Job No. C 8327
Sheet 1 of 1

Project Lemberger Site
Location Manitowoc County, Wisconsin

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Brown SAND, Some Silt, Little Gravel, Little Clay (SC)					
1	SS	X	M	15			1.2/ 1.5				
2	SS	X	M	34	5		2.0/ 2.0				
3	SS	X	M	58			2.5/ 3.0				
4	SS	X	M	17	10	Reddish Brown SILT, Some Sand, Some Clay, Trace to Little Gravel (CL,CL-ML)					
5	SS	X	M	40	15		1.5/ 1.5				
6	SS	X	M	24	20		1.5/ 1.5				
7	SS	X	W	26	25	Brown SAND, Some Gravel, Some Silt, Trace Clay (SM-SC)					
8	SS	X	W	27	30						
9	SS	X	M	~~16~~ 27	35	~~Gray~~ Red Brown SILTY CLAY, Some Sand, Trace Gravel (CL)	2.5/ 2.5				
					40	End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ¼ hour
Depth to Water
Depth to Cave in

GENERAL NOTES

Start 6/27/79 Complete 6/27/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 42

Surface Elevation

Job No. C 8327

Sheet 1 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	14							
2	SS	X	M	24	5	Shelby Tube Sample 5.5' to 7.0'					
3	SS	X	M	28	10	Reddish-Brown SILT and Silty Clay, Little to Some Sand, Trace to Little Gravel (CL,CL-ML)	3.0/3.0				
4	SS	X	M	27	15	very gravelly	4.5/4.5				
5	SS	X	M	44	20						
6	SS	X	M	20	25	Gray [somewhat siltier than] SILTY CLAY, Little Sand, Trace to Little Gravel (CL,CL-ML)	2.0/2.0				
					30						
7	SS	X	M	21			3.5/4.0				
8	SS	X	M	20	35	heavier clay - compared to S-5 but still ke...th	3.5/4.0				
						Gray Mottled SILT, Some Clay, Little Sand (CL-ML)					
9	SS	X	M	48	40		4.5+/4.0				
10	SS	X	M	50/4"	45	Gray to Brown SAND, Trace to Some Silt, Trace to Little Gravel, Trace Clay (SM-SC) Very gravelly near upper contact.					

(Continued)

ENGINEERING INC

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 42

Surface Elevation

Job No. C 8327

Sheet 2 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
11	SS	X	M	60/11"	50						
12	SS	X	M	60/6"	55						
						Gray to Brown SAND, Trace to Some Silt, Trace to Little Gravel (SM-SC)					
13	SS	X	M	60/6"	60	grades from hi gravel % to higher sand + silt back to higher gravel at S-16					
14	SS	X	M	60/5"	65						
15	SS	X	M	60/0"	70	S-19 - Much browner than rest					
16	SS	X	M	60/3"	75						
17	SS	X	M	60/4"	80						
18	SS	X	M	60/1"	85						

(CONTINUED)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 42

Surface Elevation

Job No. C 8327

Sheet 3 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Gray to Brown SAND, Trace to Some Silt, Trace to Little Gravel (SM-SC)					
19	SS	X	M	60/8"	90						
						End Boring at 90'					
					95						
					100						
					105						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 7/10/79 Complete 7/10/79

Crew Chief JWG Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lembenger Site

Location: Manitowoc County, Wisconsin

Boring No. 43
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Topsoil					
1	SS	X	M	9		Brown SAND, Some Silt, Little to Some Gravel, Little Clay (SC)					
2	SS	X	M	21	5						
3	SS	X	M	37		Brown SILT, Some Clay, Some Sand, Trace to Little Gravel (CL)					
4	SS	X	M	27	10						
5	SS	X	M	17	15						
6	SS	X	M	16	20	Brown SAND, Some Silt, Some Gravel, Trace to Little Clay (SM-SC)					
7	SS	X	M	60/71	25						
8	SS	X	W	60/73	30						
9	SS	X	W	60/73	35						
10	SS	X	W	60/74	40						
11	SS	X	W	60/72	45						

(Continued)

WARZYN ENGINEERING INC
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LOG OF TEST BORING

Project: Lemberger Site
Location: Manitowoc County, Wisconsin

Boring No. 43
Surface Elevation
Job No. C 8327
Sheet 2 of 2

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
						Brown SAND, Some Silt, Some Gravel, Trace to Little Clay, (SM-SC)					
						End Boring at 47'					
					50						
					55						
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ½ hour
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 6/14/79 Complete 6/14/79
Crew Chief JVS Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 43A
Surface Elevation
Job No. C 8327
Sheet 1 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery ↓	Moisture ↓	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
					0–7.5	Brown SAND, Some Silt, Little to Some Gravel, Little Clay (SC)					
					7.5–16	3" Shelby Tube Brown SILT, Some Clay, Some Sand, Trace to Little Gravel (CL)					
					16–	Brown SAND, Some Silt, Some Gravel, Trace to Little Clay (SM-SC)					

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

(Continued)

ENGINEERING INC

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 43A

Surface Elevation 923.9

Job No. C 8327

Sheet 2 of 3

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
						Brown SAND, Some Silt, Some Gravel, Trace to Little Clay (SM-SC)					
						856.9					
					50						
					55						
					60						
					65	Dolomite Bedrock					
					70						
					75						
					80						
					85						

(CONTINUED)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 43A

Surface Elevation

Job No. C 8327

Sheet 3 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					90	Dolomite Bedrock					
					95						
						End Boring at 97.5'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 9/18/79 Complete 9/18/79
Crew Chief LS Rig 550
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 44
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES Qu	W	LL	PL	D
1	SS	X	M	14		Reddish Brown SILT, Some Clay, Little to Some Sand, Trace Gravel (CL-ML)	2.0/2.0				
2	SS	X	M	17	5		2.5/2.0				
3	SS	X	M	18							
4	SS	X	M	35	10		2.5/2.0				
5	SS	X	M	60/12"	15	Brown, SAND, Some Silt, Some Gravel, Trace Clay (SM-SC)					
6	SS	X	M	60/8"	20						
7	SS	X	M	58	25						
8	SS	X	M	60	30						
9	SS	X	M	60/5"	35						
10	SS	X	M	60/8"	40						
11	SS	X	M	60/6"	45						
						End Boring at 45'					

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No.: 44

Surface Elevation:

Job No.: C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					50						
					55						
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 6/19/79 Complete 6/19/79

Crew Chief JWG Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 45
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Topsoil					
1	SS	X	M	17		Reddish Brown SILT, Some Clay, Some Sand Little Gravel (CL)	2.5/2.5				
2	SS	X	M	23	5		2.5/2.5				
3	SS	X	M	36			4.5+/4.5+				
4	SS	X	M	40	10		4.0/4.5				
5	SS	X	M	24	15		4.5/4.5+				
6	SS	X	M	60/6"	20	Gray to Brown SAND, Some Gravel, Some Silt, Little Clay (SM-SC)					
7	SS	X	M	60/6"	25						
8	SS	X	M	60/6"	30						
9	SS	X	M	50	35						
10	SS	X	M	40	40						
11	SS	X	M	60/1"	45						

(Continued)

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1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 45
Surface Elevation
Job No. C 8327
Sheet 2 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	qu	W	LL	PL	D
						Gray to Brown SAND, Some Gravel, Some Silt, Little Clay (SM-SC)					
12	SS	X	M	30	50						
13	SS	X	M	41	55						
14	SS	X	W	14	60						
						End Boring at 60'					
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ½ hour
Depth to Water
Depth to Cave In

GENERAL NOTES

Start 7/11/78 Complete 7/11/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 46

Surface Elevation

Job No. C 8327

Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Topsoil					
1	SS	X	M	21		Brown SILT, Some Sand, Some Clay, Trace Gravel (CL)	1.5				
2	SS	X	M	24	5		2.5/2.0				
3	SS	X	M	24			2.5/3.0				
4	SS	X	M	38	10						
5	SS	X	M	60/10"	15						
6	SS	X	M	60/1"	20	Brown SAND, Some Silt, Trace to Some Clay Trace to Some Gravel (SM-SC)					
7	SS	X	M	60/10"	25						
8	SS	X	M	60/6"	30						
9	SS	X	M	60/1"	35						
10	SS	X	M	60/9"	40						
11	SS	X	M	60/12"	45						

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 46
Surface Elevation
Job No. C 8327
Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Brown SAND, Some Silt, Trace to Some Clay Trace to Some Gravel (SM-SC)					
12	SS	X	M	60/7"	50						
13	SS	X	M	60/11"	55						
14	SS	X	W	60/3"	60						
15	SS	X	W	60/0"	65						
						End Boring at 65'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling ½ hour
Depth to Water 15'
Depth to Cave In

GENERAL NOTES

Start 6/28/78 Complete 6/28/78
Crew Chief JHR Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 46A
Surface Elevation 879
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
					0-65	0-65' See Log of Test Boring #46					
					65-83	Brown SAND, Some Silt, Trace to Some Clay, Trace to Some Gravel (SM-SC)					
					83-93	796 Dolomite Bedrock					
					93	End Boring at 93'					

WATER LEVEL OBSERVATIONS

While Drilling ______
Upon Completion of Drilling ______
Time After Drilling ______
Depth to Water ______
Depth to Cave In ______

GENERAL NOTES

Start 9/18/79 Complete 9/18/79
Crew Chief LS Rig 550
Drilling Method ______

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No.: 47

Surface Elevation:

Job No.: C 8327

Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Topsoil					
1	SS	X	M	17							
2	SS	X	M	27	5	Reddish Brown SILT and Silty Clay, Little to Some Sand (CL,CL-ML)					
3	SS	X	M	37							
4	SS	X	M	16	10						
5	SS	X	M	12	15						
6	SS	X	M	60/8"	20	Brown SAND, Little to Some Silt, Little to Some Gravel, Trace to Little Clay (SM-SC)					
7	SS	X	M	60/8"	25						
8	SS	X	M	60/10"	30						
9	SS	X	M	60/11"	35						
10	SS	X	M	60/3"	40						
11	SS	X	M	60/0"	45						

(Continued)

WARZYN ENGINEERING INC

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 47

Surface Elevation 910.60

Job No. C 8327

Sheet 2 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks *	Qu	W	LL	PL	D
						865.1					
12	SS	X	M	60/2"	50	Lt Br silty sand!					
13	SS	X	M	60/6"	55	Lt Br fine sand!					
14	SS	X	M	60/6"	60	Dolomite Bedrock Lt Br fine sand					
15	SS	X	M	60/4"	65						
16	SS	X	M	60/3"	70						
17	SS	X	M	60/1"	75	End Boring at 75'					

* Brown SAND, Little to Some Silt, Little to Some Gravel, Trace to Little Clay (SM-SC)

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water: 8'

Depth to Cave In

GENERAL NOTES

Start 6/15/79 Complete 6/15/79

Crew Chief JWG Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 48
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	14		Reddish Brown Sandy SILT and Silty Sand, Some Clay, Little Gravel (ML)	4.5/ 4.5+				
2	SS	X	M	24	5		1.5/ 1.5				
3	SS	X	M	20			1.5/ 1.5				
4	SS	X	M	19	10		4.5/ 4.5+				
5	SS	X	M	12	15		2.5/ 2.5				
6	SS	X	M	51	20	Gray Brown SAND, Some Silt and Clay, Some Gravel (SM-SC)					
7	SS	X	M	28	25						
8	SS	X	M	80	30						
9	SS	X	M	36	35						
10	SS	X	M	38	40						
11	SS	X	M	45	45						

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 48

Surface Elevation

Job No. C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	Type	Recovery	Moisture	N	Depth		Qu	W	LL	PL	D
						Gray Brown SAND, Some Silt and Clay, Some Gravel (SM-SC)					
1	SS	X	M	75	50						
13	SS	X	M	78	55						
14	SS	X	M	70	60						
						Dolomite Bedrock					
						End Boring at 62'					
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling: ½ hour

Depth to Water

Depth to Cave In: 58'M

GENERAL NOTES

Start 8/27/78 Complete 8/27/79

Crew Chief JWG Rig 55-1

Drilling Method

ENGINEERING INC

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 49

Surface Elevation

Job No. C 8327

Sheet 1 of 2

SAMPLE

No.	Type	Recovery	Moisture	N
1	SS	X	M	23
2	SS	X	M	22
3	SS	X	M	71
4	SS	X	M	37
5	SS	X	M	60/4"
6	SS	X	M	60/9"
7	SS	X	M	60/8"
8	SS	X	M	60/6"
9	SS	X	M	60/4"
10	SS	X	M	60/5"

Depth: 5, 10, 15, 20, 25, 30, 35, 40, 45

VISUAL CLASSIFICATION and Remarks

6" Topsoil

Reddish Brown Sandy SILT, Some Gravel (SC-SM)

Reddish Brown SILT, Some Clay, Some Gravel, Some Sand (CL-ML)

Brown SAND and Silty Sand, Some Clay, Trace to Some Gravel, Cobbles & Boulders (SM-SC)

SOIL PROPERTIES

Qu	W	LL	PL	D

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 49

Surface Elevation

Job No. C 8327

Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Brown SAND and Silty Sand, Some Clay, Trace to Some Gravel, Cobbles & Boulders (SM-SC)					
						872					
					50	Dolomite Bedrock					
					55	End Boring at 55'					
					60						
					65						
					70						
					75						
					80						
					85						

WATER LEVEL OBSERVATIONS

While Drilling

Upon Completion of Drilling

Time After Drilling ½ hour

Depth to Water

Depth to Cave In

GENERAL NOTES

Start 8/23/79 Complete 8/23/79

Crew Chief JHR Rig 55-1

Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site
Location: Manitowoc County, Wisconsin

Boring No. 51
Surface Elevation
Job No. C 8327
Sheet 1 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	18		Brown SILTY SAND, Some Clay, Little Gravel (SM-SC)					
2	SS	X	M	21	5						
3	SS	X	M	31							
4	SS	X	M	39	10						
5	SS	X	M	21	15	Brown SILT, Some Sand, Some Clay, Trace to Little Gravel (CL)					
6	SS	X	M	36	20		2.5/2.5				
7	SS	X	M	31	25		3.0/3.0				
8	SS	X	M	70	30	Brown SILTY SAND, Some Clay, Little Gravel (SM-SC)					
						~~Gray~~ SILT, Some Clay, Some Sand, Trace Gravel (CL-ML)					
9	SS	X	W	28	35	Gray SAND, Some Silt, Trace to Little Gravel (SM)	1.0/3.0				
10	SS	X	M	28	40	Gray SILT, Some Clay, Some Sand, Trace Gravel (CL)	2.0/2.0				
11	SS	X	W	25	45	Reddish Brown SILT, Some Clay (ML)	2.0/1.5				

(Continued)

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 51
Surface Elevation 901.4
Job No. C 8327
Sheet 2 of 2

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Reddish Brown SILT, Some Clay (ML)					
						851.9					
12	SS	X	W	50/0"	50	Dolomite Bedrock					
						End Boring at 52'					

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85

WATER LEVEL OBSERVATIONS

While Drilling ______
Upon Completion of Drilling ______
Time After Drilling: ¼ hour
Depth to Water: 38.9'
Depth to Cave In ______

GENERAL NOTES

Start 8/15/78 Complete 8/15/79
Crew Chief JWG Rig 55-1
Drilling Method ______

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 52
Surface Elevation
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	8		Reddish Brown SILT, Some Clay, Little Sand (CL)					
2	SS	X	M	20	5						
3	SS	X	M	27							
4	SS	X	M	47	10	Brown SAND, Some Silt, Trace to Little Gravel, Trace to Little Clay (SM-SC)					
5	SS	X	M	60/6"	15						
6	SS	X	M	35	20						
7	SS	X	M	38	25						
8	SS	X	M	60/0"	30	≈910					
9	SS	X	M	60/8"	35	Weathered Dolomite Bedrock					
10	SS	X	M	60/4"	40	End Boring at 40'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ½ hour
Depth to Water: 8'
Depth to Cave In

GENERAL NOTES

Start 6/11/79 Complete 6/11/79
Crew Chief JVS Rig 55-1
Drilling Method

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 53
Surface Elevation
Job No. C 8327
Sheet 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						Topsoil					
1	SS	X	M	10		Reddish Brown SILTY SAND, Some Clay, Trace Gravel (ML)					
2	SS	X	M	18	5						
3	SS	X	M	19							
4	SS	X	M	29	10						
						Gray, SILTY CLAY, Some Sand, Trace Gravel (CL)					
5	SS	X	M	13	15						
6	SS	X	M	60/6"	20	Gray to Brown SAND, Some Silt, and Clay, Some Gravel (SM-SC)					
7	SS	X	M	60/7"	25						
8	SS	X	M	60/6"	30	Dolomite Bedrock					
9	SS	X	M	160/4"	35	End Boring at 35'					
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ¼ hour
Depth to Water: 12'
Depth to Cave In

GENERAL NOTES

Start 6/7/79 Complete 6/7/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN ENGINEERING INC
1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 55
Surface Elevation
Job No. C 8327
Sheet 1 of 1

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
1	SS	X	M	9		Reddish Brown SILTY CLAY, Some Sand, Trace Gravel (CL)					
2	SS	X	M	13	5		3.0/ 3.0				
3	SS	X	M	19			2.5/ 3.0				
4	SS	X	M	19	10		3.0/ 3.5				
						Brown SAND, Some Silt & Clay, Trace Gravel (SM-SC)					
5	SS	X	M	60	15						
						Dolomite Bedrock					
6	SS	X	M	60/6"	20						
						End Boring at 20'					
					25						
					30						
					35						
					40						

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling: ¼ hour
Depth to Water
Depth to Cave In: 18'M

GENERAL NOTES

Start 6/6/79 Complete 6/6/79
Crew Chief JWG Rig 55-1
Drilling Method

WARZYN
ENGINEERING INC
1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No. 56
Surface Elevation
Job No. C 8327
Sheet 1 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						1'6" Topsoil Brown Clayey SILT	1.0/ 1.0				
1	SS	X	M	12							
2	SS	X	M	28	5	Brown SANDY SILT, Trace to Some Clay, Trace Gravel (CL).					
3	SS	X	M	17		sandy silt					
4	SS	X	M	16	10	sand					
						~~Gray~~ Rd.-Brn SILTY CLAY, Some Sand, Trace Gravel (CL,CL-ML)					
5	SS	X	M	24	15		2.5/ 2.5				
						Brown SILTY SAND, With Stone Chips, Trace Gravel (SM-SC)					
6	SS	X	M	32	20						
						Brown SILTY CLAY, Some Sand, Trace Gravel (CL)					
7	SS	X	M	29	25						
8	SS	X	M	70	30	Gray to Brown SAND, Trace to Some Gravel Trace to Some Silt and Clay (SC-SM)					
9	SS	X	M	37	35						
10	SS	X	M	37	40						
11	SS	X	M	78	45						

(Continued)

WARZYN
ENGINEERING INC
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LOG OF TEST BORING

Project: Lemberger Site

Location: Manitowoc County, Wisconsin

Boring No.: 56
Surface Elevation: 872.9
Job No.: C 8327
Sheet 2 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks	Qu	W	LL	PL	D
						* 827.4					
12	SS	X	M	99	50						
					55						
					60	Dolomite Bedrock					
					65						
					70						
					75						
					80	End Boring at 80'					
					85						

* Gray to Brown SAND, Trace to Some Gravel Trace to Some Silt & Clay (SC-SM)

WATER LEVEL OBSERVATIONS

While Drilling ______
Upon Completion of Drilling ______
Time After Drilling: ½ hour
Depth to Water ______
Depth to Cave In ______

GENERAL NOTES

Start 8/28/79 Complete 8/28/79
Crew Chief JWG Rig 55-1
Drilling Method ______

OIL TII SER ES WI NS IN — AU ..., SHEL... ... 5431.. — Sheet ___ of ___

GREEN BAY PHONE (414) 494-9656
WAUSAU PHONE 845-8386
MARQUETTE PHONE 906—225-1417

TECHNICIAN: RZ
DRILLER: E T
HELPER: RJ
RIG NO.: 8

SURFACE ELEV. ___
BORING STARTED 7-13-81
BORING COMPLETED 7-15-81
STATION ___
OFF SET ON LOC

50' HW
CASING USED 7' SIZE 6"

WATER LEVEL OBSERVATIONS
WL: ___ WS OR WD
WL: ___ BCR ___ ACR
WL: ___ AB ___ Hr. AB
WL: ___ 24 Hr. AB

JOB NO. 11086 BORING NO. MW-5T CLIENT LEMBERGER LANDFILL WEATHER HOT

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	Penetration Record Split Spoon Blows 6"	6"	6"	6"	R Length Recovered in Feet	Qp Penetrometer Test in TSF	Strata Change	Sample Description
	0	5.0	PA								BR FI-C SI SA W/GR
	0	7.0	6"								MIXED BENTONITE
	0	48.0	RB								SA & GR / SMALL COBBLES
	48.0	50.0	RB							48.0	~~[illegible]~~ BEDROCK
	50.0	92.0	RB								LIMESTONE 2 15/16" BIT
	52.0	70.0	RB								SAME 3 7/8" BIT
	0	50.0	HW								
	50.0	100.0	RB								SAME 3 7/8 BIT

INSTALLED WELL

EOB

ABBREVIATIONS
F.T.-Fish Tail
W.O.-Wash Out
S.T.-Shelby Tube
S.S.-Split Spoon
D.B.-Diamond Bit
P.A.-Power Auger
R.B.-Rock Bit
W.S.-While Sampling
W.D.-While Drilling
B.C.R.-Before Casing Removal
A.C.R.-After Casing Removal
A.B.-After Boring

DRILL CREW CHECK LIST
Topsoil Thickness ___
Fill Thickness ___
CAVE IN LEVEL:
While Drilling and Sampling ___
After Boring Completion ___
WATER LOSS:
At ___ To ___
Percent Loss ___
At ___ To ___
Percent Loss ___
BOULDERS OR OBSTRUCTIONS
At 48.0 To ___
At ___ To ___
ARTESIAN PRESSURE:
Depth ___
Height of Soil Rise In Casing ___

SOI EST SI ICE V ON I — 540 BEA GR BAY 54

Sheet 1 of

TECHNICIAN
DRILLER
HELPER
RIG NO.

SURFACE ELEV.
BORING STARTED 7-6-81
BORING COMPLETED 7-7-81
STATION
OFF SET

GREEN BAY PHONE (414) 494-9656
WAUSAU PHONE 845-8386
MARQUETTE PHONE 906—225-1417

85 NW

CASING USED 56 SIZE HW

WATER LEVEL OBSERVATIONS
WL: ______ WS OR WD
WL: ______ BCR ______ ACR
WL: ______ AB ______ Hr. AB
WL: ______ 24 Hr. AB

JOB NO. 11056 BORING NO. CLIENT WEATHER

Sample No.	Depth or Elevation From	To	Sampling Method	Penetration Record Split Spoon Blows 6"	6"	6"	6"	R Length Recovered in Feet	Qp Penetrometer Test in TSF	Strata Change	Sample Description
1	0	1.5	SS	6	12	16		.7			DARK BR SI W/F SH
	0	5.0	PA								
2	5.0	6.5	SS	5	5	8		1.5			REDDISH BR SI SH CLAY W/GR
	5.0	10.0	PA								
3	10.0	11.5	SS	4	8	13		1.5			SAME
	0	15.0	HW								
4	15.0	15.7	SS	20	40/3"			.5		15.0	YELLOWISH BR SI SH W/GR
	15.0	20.0	RB								
5	20.0	21.0	SS	34	44			.6			BR SI SH W/GR
	20.0	25.0	RB								
6	25.0	26.0	SS	28	40			.4			SAME
	15.0	25.0	HW								
	25.0	30.0	RB								
7	30.0	31.0	SS	23	44						NO REC
	25.0	30.0	HW								
	30.0	35.0	RB								
8	35.0	36.0	SS	28	40			.2			SAME
	35.0	40.0	HW								
9	40.0	40.8	SS	35	36/4"			.5			SAME
	40.0	45.0	HW								
10	45.0	45.7	SS	38	31/3"			.4			SAME
	45.0	50.0	HW								

ABBREVIATIONS
F.T.-Fish Tail
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D.B.-Diamond Bit
P.A.-Power Auger
R.B.-Rock Bit
W.S.-While Sampling
W.D.-While Drilling
B.C.R.-Before Casing Removal
A.C.R.-After Casing Removal
A.B.-After Boring

DRILL CREW CHECK LIST
Topsoil Thickness
Fill Thickness

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At ______ To ______
Percent Loss
At ______ To ______
Percent Loss

BOULDERS OR OBSTRUCTION
At ______ To ______
At ______ To ______

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

BBS-53172

SOIL TESTING SERVICES OF WISCONSIN, INC. — 540 LAMBEAU ST., GREEN BAY, WIS. 54303

GREEN BAY PHONE (414) 494-9656 · WAUSAU PHONE 845-8386 · MARQUETTE PHONE 906—225-1417

Sheet 2 of 3

TECHNICIAN [illegible]
DRILLER [illegible]
HELPER [illegible]
RIG NO. 8

SURFACE ELEV.
BORING STARTED 7-6-81
BORING COMPLETED 7-7-81
STATION
OFF SET [illegible]

85' NW

CASING USED 56' SIZE HW

WATER LEVEL OBSERVATIONS
WL: ____ WS OR WD
WL: ____ BCR ____ ACR
WL: ____ AB ____ Hr. AB
WL: ____ 24 Hr. AB

JOB NO. 11086 BORING NO. MW 28 CLIENT [illegible] WEATHER [illegible]

Sample No.	Depth or Elevation From	To	Sampling Method	Penetration Record 6"	6"	6"	6"	R Length Recovered in Feet	Qp Penetrometer Test in TSF	Strata Change	Sample Description
11	50.0	50.2	SS	70/2"				.1			GRAVEL
	50.0	55.0	HW								
12	55.0	55.3	SS	67/4"				.5			BRUSH LR SI FI SA W/GR
	55.0	56.0	HW								
	56.0	60.0	RB								
13	60.0	61.0	SS	48	69			.3			LR SI FI SA W/GR TR/CLAY
	60.0	65.0	RB								
14	65.0	65.7	SS	78/6"				.4			SAME
	65.0	70.0	RB								MIXED BENTONITE
15	70.0	71.0	SS	28	52			.4			
	70.0	75.0	RB								BOULDER 72.0-73.0 / 73.5-75.0 OR SLABS
	75.0	75.8	RB								
	75.8	81.0	RB								LAIDS
	81.0	85.0	RB								
	0	85.0	NW								
	85.0	85.5	RB		~~RUN #1~~						
	85.5	90.5	NX		RUN #1			4.7			LIMESTONE
	90.5	95.2	NX		RUN #2			5.0			SAME PICKED UP .3 FROM PREVIOUS RUN
	95.2	100.2	NX		RUN #3			5.0			SAME
	100.2	105.2	NX		RUN #4			5.0			SAME
	105.2	110.2	NX		RUN #5			5.0			SAME
	110.2	115.2	NX		RUN #6			5.0			SAME

ABBREVIATIONS
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P.A.-Power Auger
R.B.-Rock Bit
W.S.-While Sampling
W.D.-While Drilling
B.C.R.-Before Casing Removal
A.C.R.-After Casing Removal
A.B.-After Boring

DRILL CREW CHECK LIST
Topsoil Thickness ____
Fill Thickness ____

CAVE IN LEVEL:
While Drilling and Sampling ____
After Boring Completion ____

WATER LOSS:
At 75.0 To 85.0
Percent Loss 100
At ____ To ____
Percent Loss ____

BOULDERS OR OBSTRUCTIONS
At ____ To ____
At ____ To ____

ARTESIAN PRESSURE:
Depth ____
Height of Soil Rise In Casing ____

BBS-53172

SOI[illegible] TEST[illegible]G S[illegible]ICE[illegible] OF W[illegible]CONSIN, INC. — 540 LAMBEAU ST., GREEN BAY, WIS. 54303

Sheet [illegible] of [illegible]

TECHNICIAN [illegible]
DRILLER [illegible]
HELPER [illegible]
RIG NO. 2

SURFACE ELEV.
BORING STARTED 7-6-81
BORING COMPLETED 7-7-81
STATION
OFF SET [illegible]

GREEN BAY PHONE (414) 494-9656
WAUSAU PHONE 845-8386
MARQUETTE PHONE 906—225-1417

65' NW

CASING USED [illegible] SIZE [illegible]

WATER LEVEL OBSERVATIONS
WL: ______ WS OR WD
WL: ______ BCR ______ ACR
WL: ______ AB ______ Hr. AB
WL: ______ 24 Hr. AB

JOB NO. [illegible] **BORING NO.** [illegible] **CLIENT** [illegible] **WEATHER** HOT

Sample No.	Depth or Elevation: From	Depth or Elevation: To	Sampling Method	Penetration Record – Split Spoon Blows 6"	6"	6"	6"	R: Length Recovered in Feet	Qp: Penetrometer Test in TSF	Strata Change	Sample Description
	195.2	[illegible]	RX		Run #7			[illegible]			[illegible] stone [illegible]
	[illegible]	[illegible]	[illegible]		Run #8			[illegible]			Same
	[illegible]	[illegible]	[illegible]		Run #9			[illegible]			Same
	[illegible]	[illegible]	[illegible]		Run #10			5.0			Same
	[illegible]	[illegible]	NB								
	[illegible]88	[illegible]	RX		Run #11			5.0			Limestone
	[illegible]	[illegible]	[illegible]		Run #12			[illegible]			Same
	[illegible]	[illegible]	[illegible]		Run #13			5.0			Same
											Installed wells
											EOB

ABBREVIATIONS
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S.T.-Shelby Tube
S.S.-Split Spoon
D.B.-Diamond Bit
P.A.-Power Auger
R.B.-Rock Bit
W.S.-While Sampling
W.D.-While Drilling
B.C.R.-Before Casing Removal
A.C.R.-After Casing Removal
A.B.-After Boring

DRILL CREW CHECK LIST

Topsoil Thickness ______
Fill Thickness ______

CAVE IN LEVEL:
While Drilling and Sampling ______
After Boring Completion ______

WATER LOSS:
At [illegible] To [illegible]
Percent Loss 100
At ______ To ______
Percent Loss ______

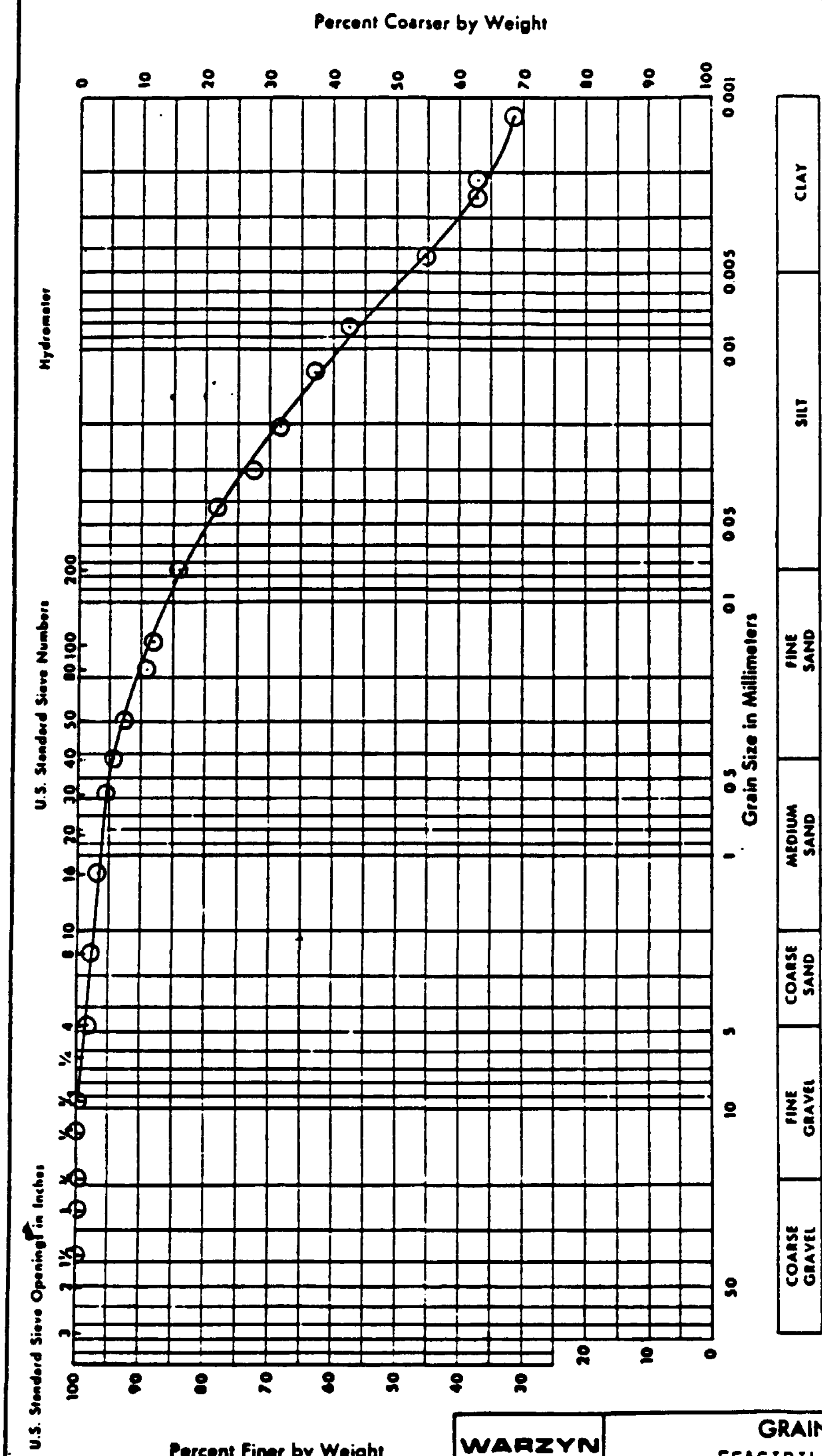
BOULDERS OR OBSTRUCTIONS
At ______ To ______
At ______ To ______

ARTESIAN PRESSURE:
Depth ______
Height of Soil Rise In Casing ______

[illegible]

APPENDIX D

Laboratory Soil Test Data



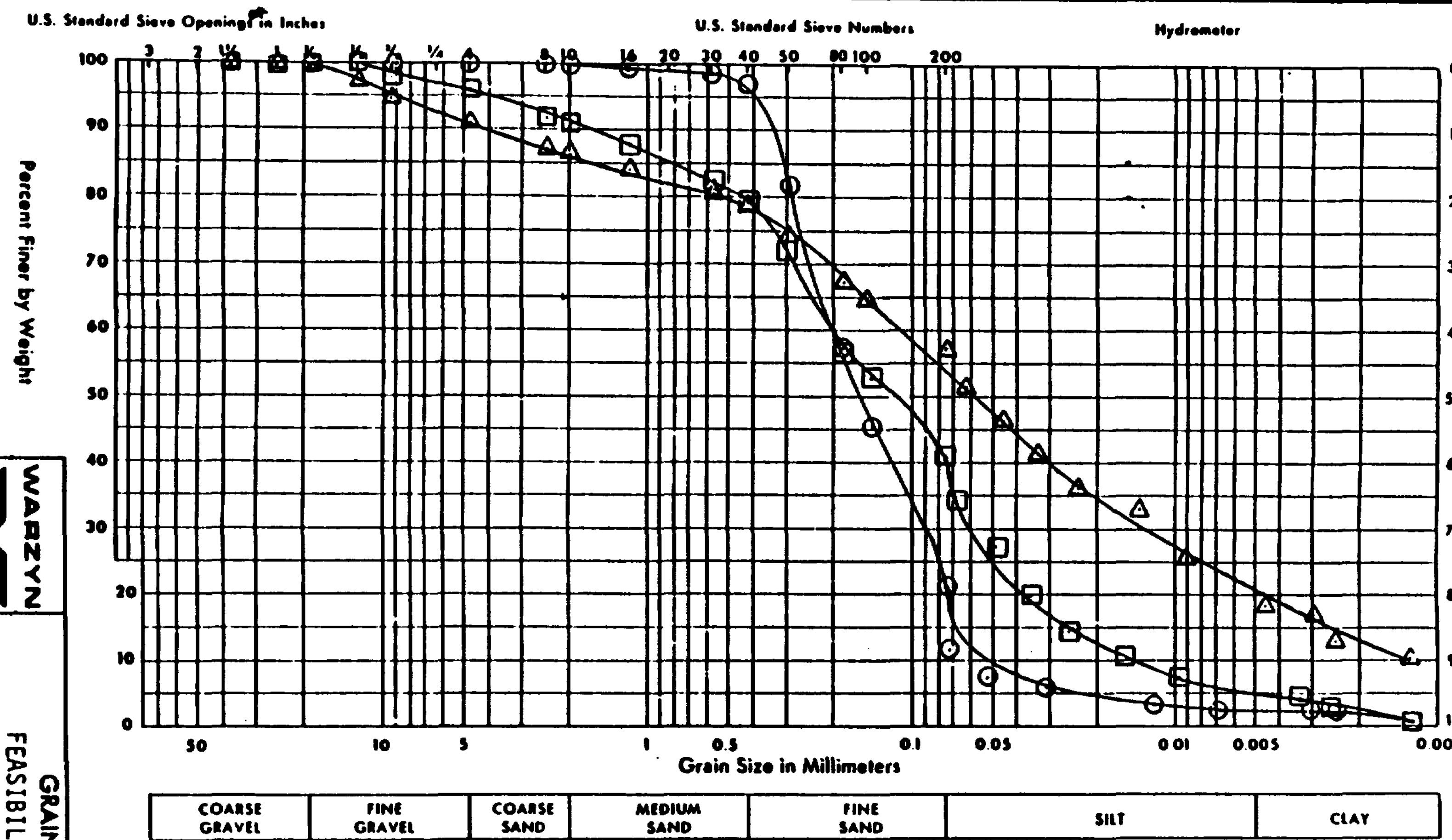
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	330-54A	40'		30.0	14.4	1	14	37	48	SILTY CLAY, SOME CLAY, TRACE GRAVEL (CL)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF	CHK'D CGK	APP'D [illegible]	DATE [illegible]	C8327-A1



Unified Classification System (ASTM D2487)

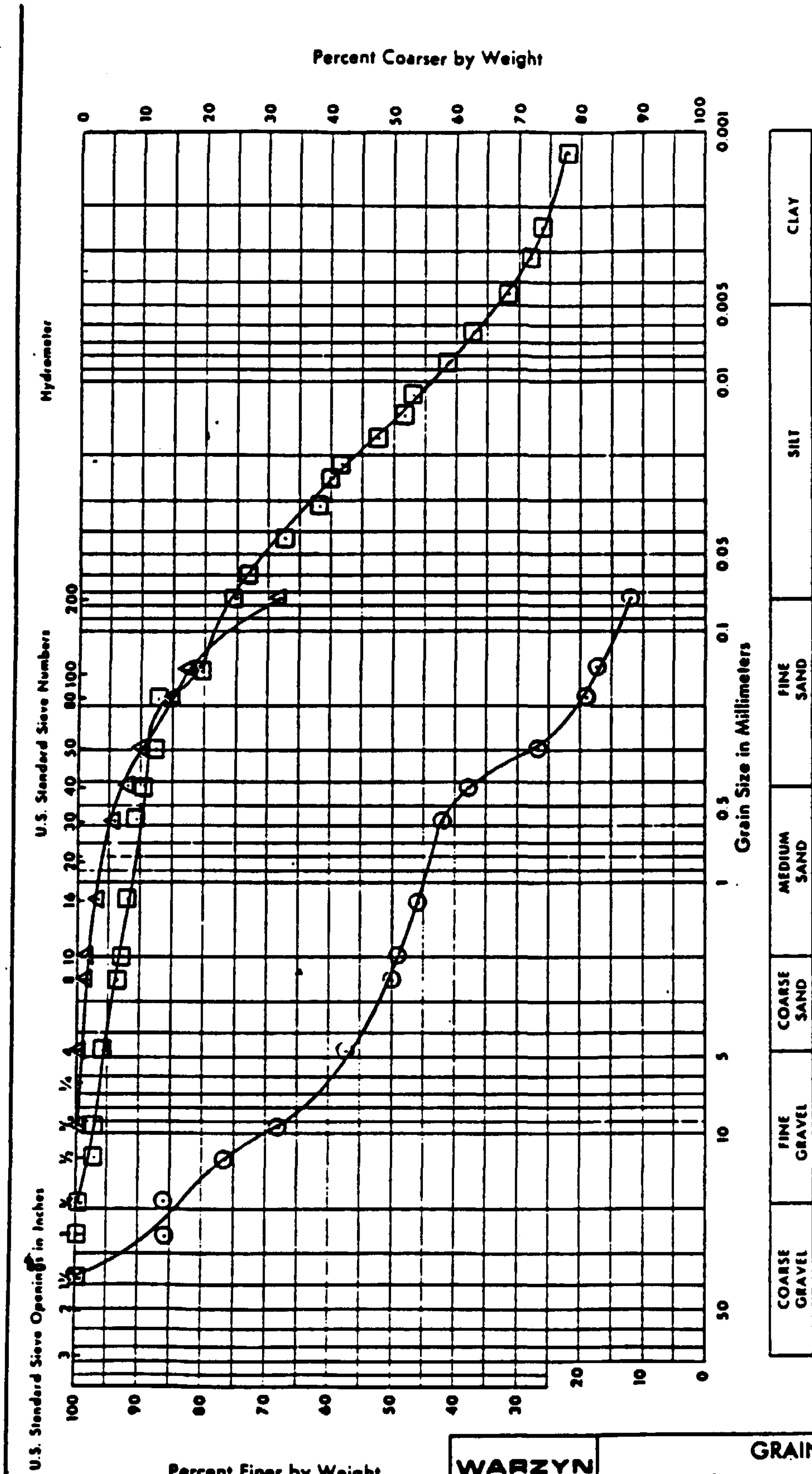
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B32-S3	7.5'				0	79	18	3	SAND, SOME SILT, TRACE CLAY
								19	2	(SM)
△ ▢	B32-S5	15'		18.6	6.9	9	33	38	20	SILT, SOME SAND, SOME CLAY,
?								45	13	LITTLE GRAVEL (CL-ML)
▢ △'	B32-S11	45'				4	55	36	5	SILTY SAND, LITTLE CLAY,
								38	3	TRACE GRAVEL (SM-SC)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN	CHK'D	APP'D	DATE	
DLF	CGK	[illegible]	[illegible]	C8327-A2



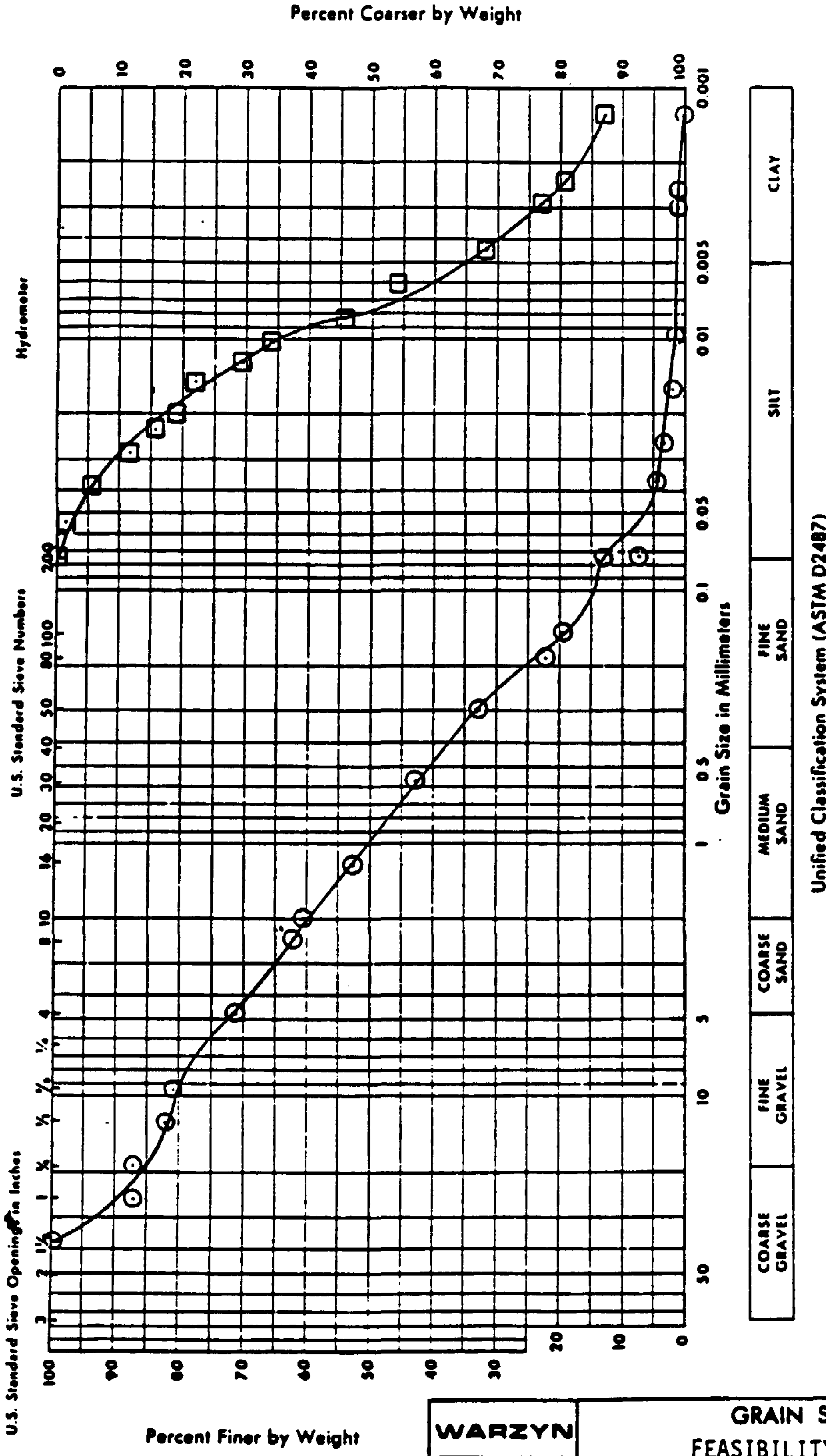
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B36-52					43	45		12	SAND AND GRAVEL, SOME SILT AND CLAY (SM)
⊡	B36-54		10.6	25.9	9.5	4	20	42	34	SILT, SOME CLAY, SOME SAND, TRACE GRAVEL (CL)
△	B36-57			13.7	1.3	0	32		68	SILT, SOME CLAY, SOME SAND (ML)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF	CHK'D CGK	APP'D [illegible]	DATE [illegible]	C8327-A3



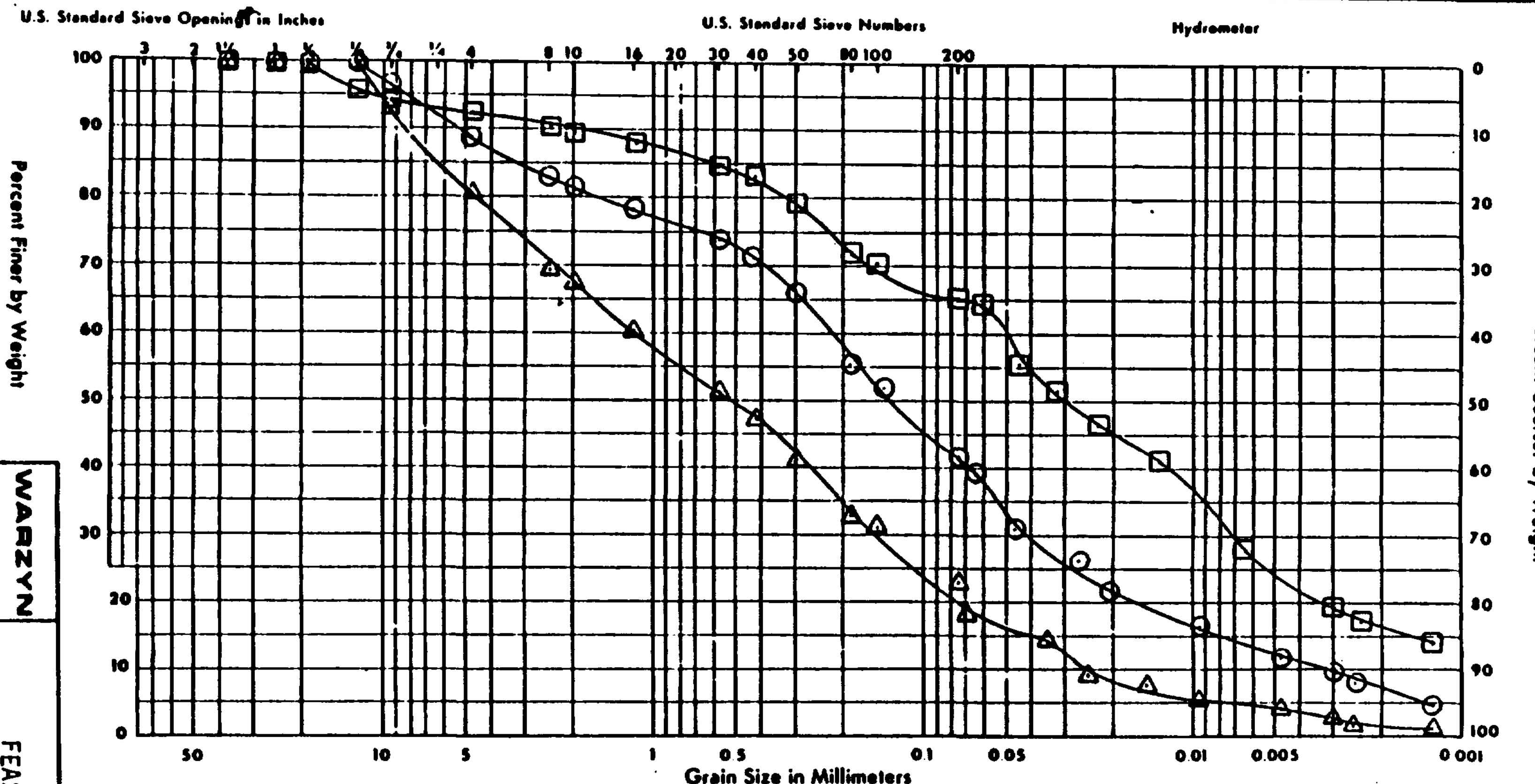
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	339-512	50'				29	57	12	2	SAND, SOME GRAVEL, SOME
								13	1	SILT, TRACE CLAY (SM)
□	339-517	75'		24.2	8.2	0	0	65	35	SILTY CLAY (CL)
								71	1c	

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF	CHK'D CGK	APP'D [illegible]	DATE 11-5-77	C8327-A4



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

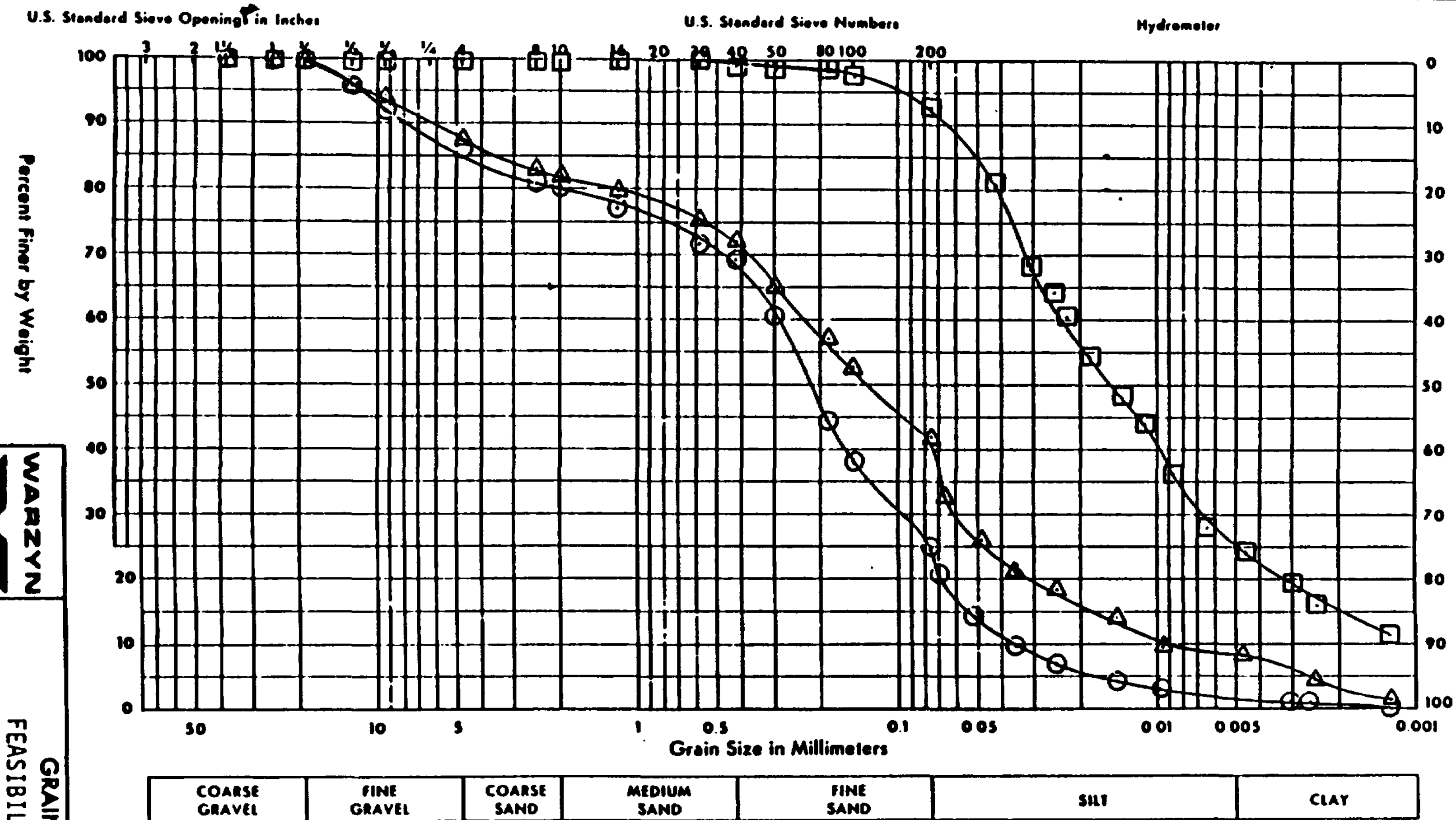
Unified Classification System (ASTM D2487)

Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B40-S3	11.5'		30.0	14.2	11	47	29	13	SAND, SOME SILT, SOME CLAY
								35	7	LITTLE GRAVEL (SC)
⊡	B40-S5	15'		29.5	13.4	7	28	41	24	SILT, SOME CLAY, SOME SAND,
								[illegible]	[illegible]	LITTLE GRAVEL (CL)
△	B40-S9	35'				20	56	20	4	SAND, SOME SILT, SOME GRAVEL
								[illegible]	2	TRACE CLAY (SM-SC)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN	CHK'D	APP'D	DATE	
DLF	CGK	Daniel W. [illegible]	[illegible]	C8327-A5



Unified Classification System (ASTM D2487)

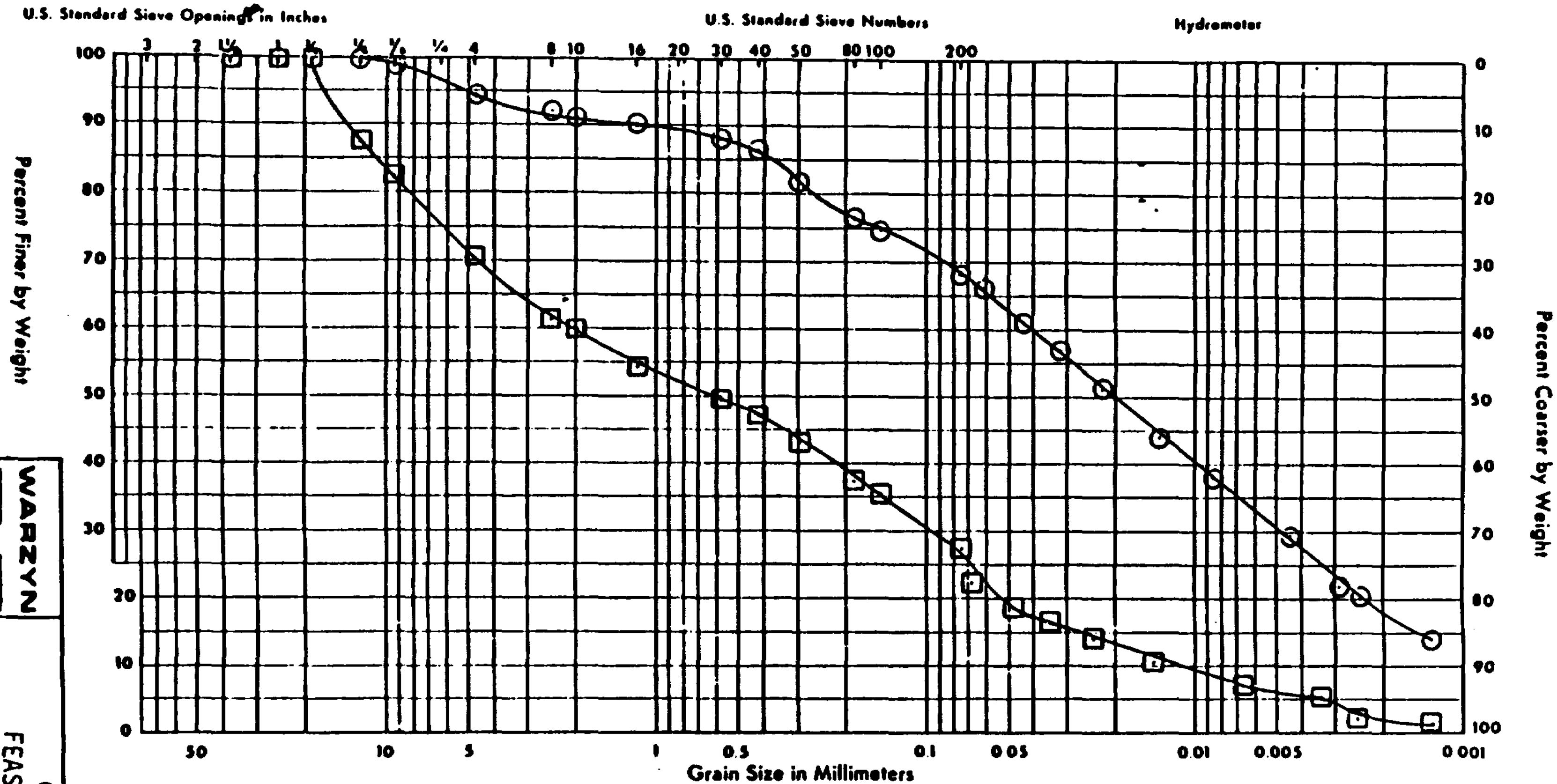
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	341-57	25'				14	61	23	2	SAND, SOME SILT, SOME GRAVEL
								24	1	TRACE CLAY (SM)
☐	342-59	40'		22.3	4.5	0	7	68	25	SILT, SOME CLAY, LITTLE SAND
								72	15	(CL-ML)
△	343-52	5'		13.9	6.1	12	46	34	8	SAND, SOME SILT, SOME GRAVEL
										LITTLE CLAY (SC-SM)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF | CHK'D CGK | APP'D Daniel W. Hall | DATE [illegible] | C8327-A6



COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY

Unified Classification System (ASTM D2487)

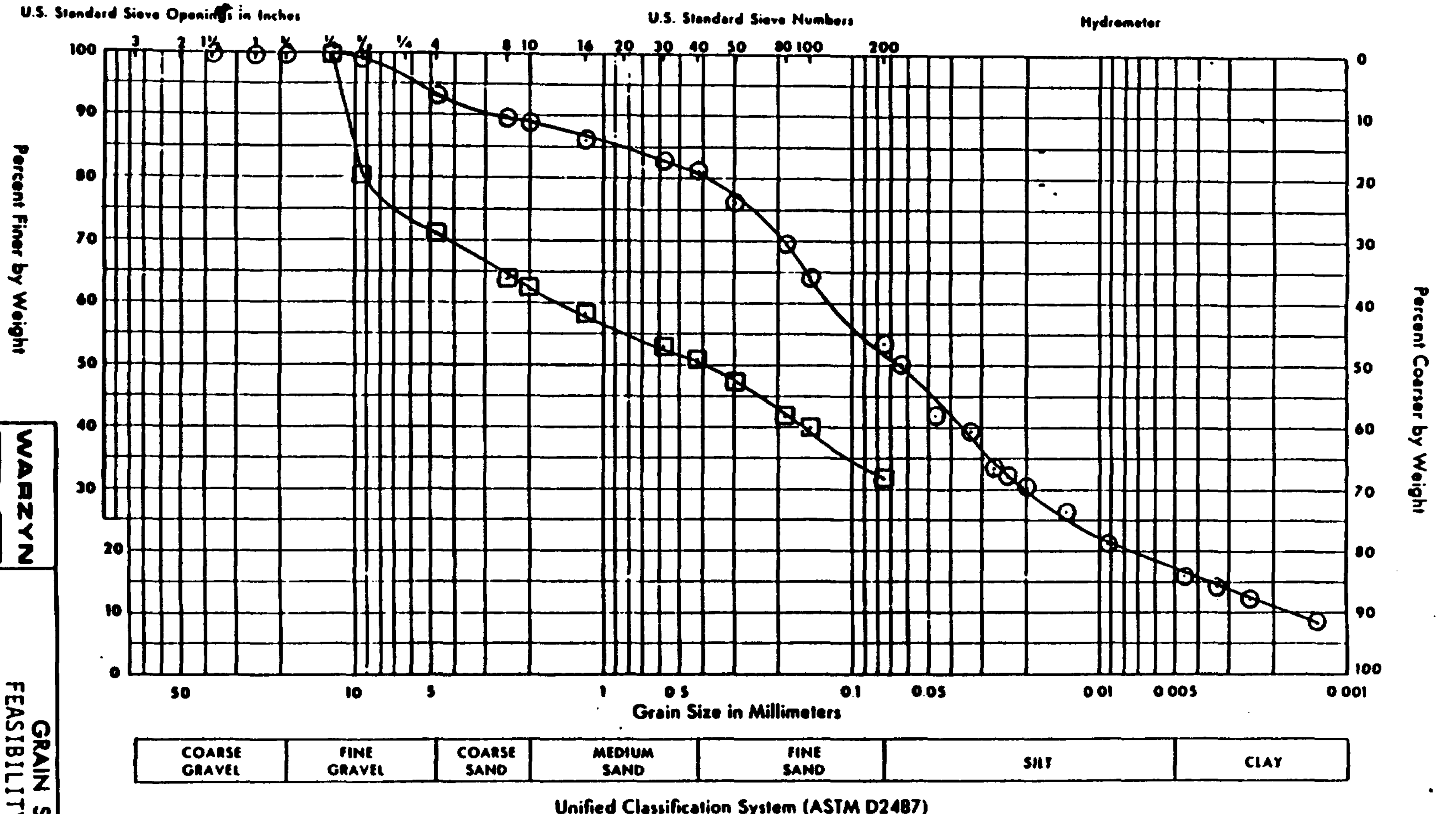
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B45-S3	7.5'		22.4	11.2	5	26	39	30	SILT, SOME CLAY, SOME SAND,
								[illegible]	18	LITTLE GRAVEL (CL)
⊡	B45-S10	40'				30	42	22	6	SAND, SOME GRAVEL, SOME SILT,
										LITTLE GRAVEL (SM-SC)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF | CHK'D CGK | APP'D [illegible] | DATE [illegible] | C8327-A7

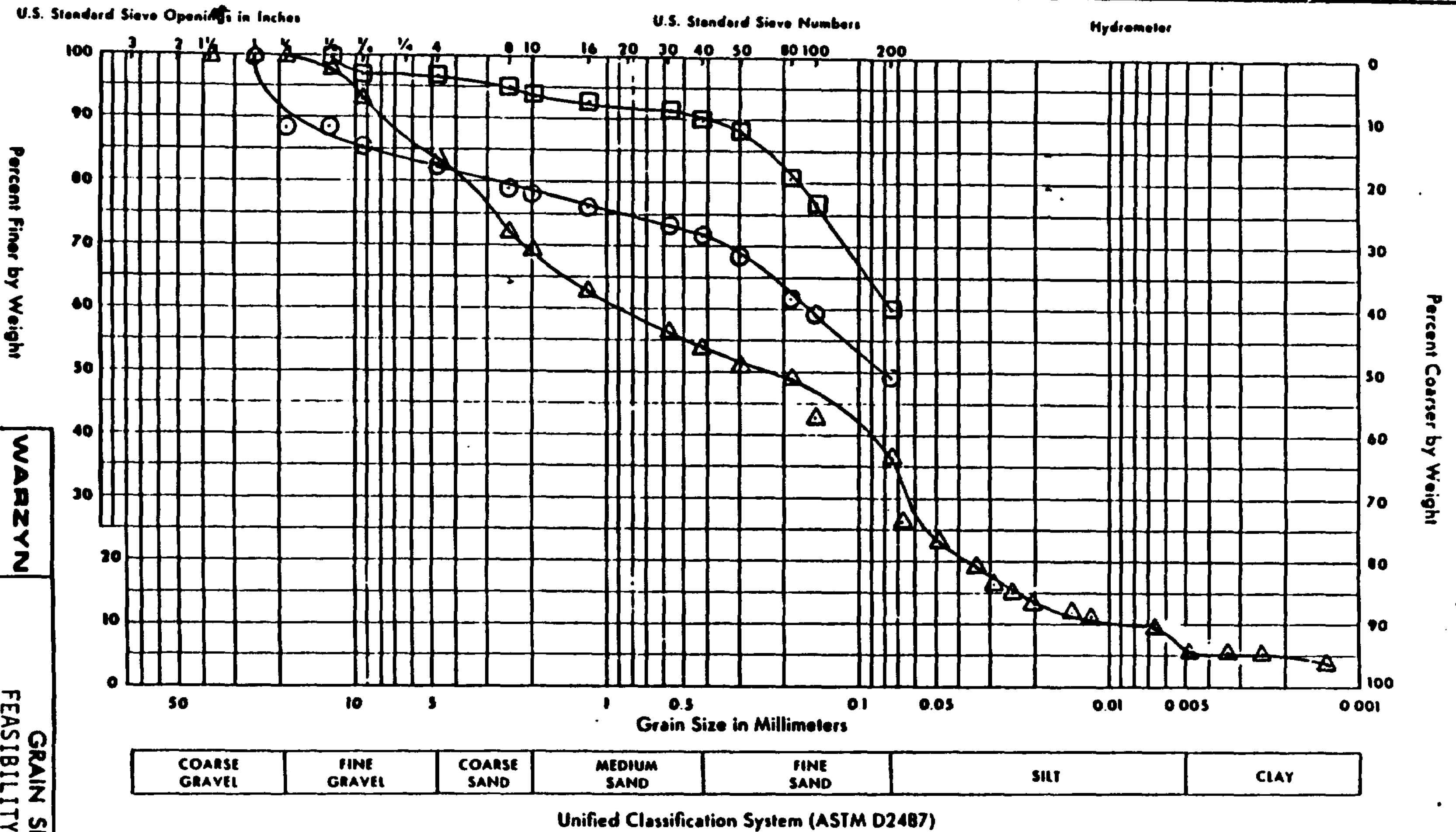


Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B48-53		12.4	17.6	1.6	7	39	33	16	SANDY SILT, SOME CLAY, LITTLE
								"	"	GRAVEL (ML)
⊡	B48-56					29	39	32		SAND, SOME SILT AND CLAY,
										SOME GRAVEL (SM-SC)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN	CHK'D	APP'D	DATE	
DLF	CGK	[illegible]	[illegible]	CB327-A8

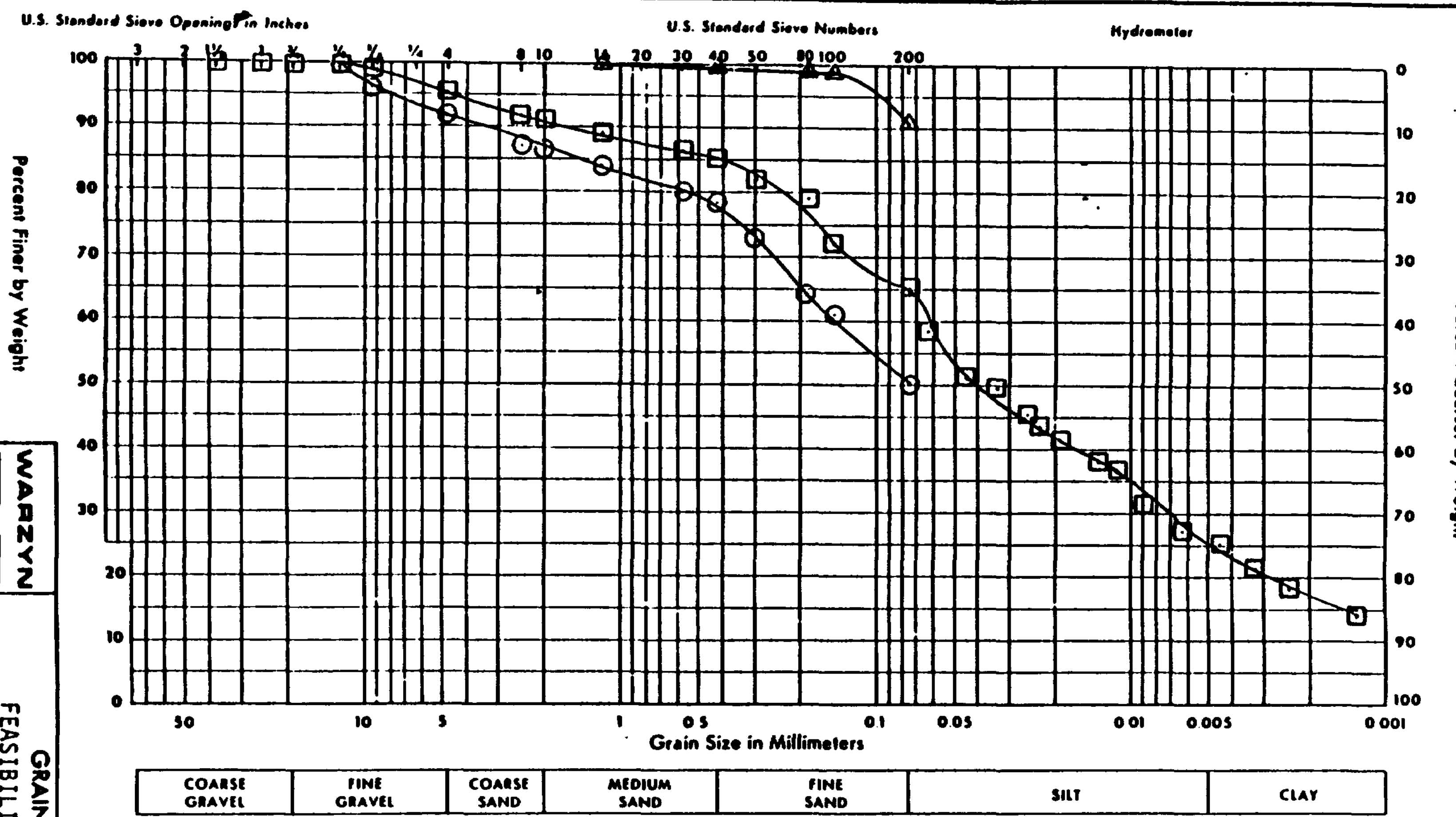


Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B49-S2		9.7			17	34	49		SILTY SAND, SOME CLAY, SOME GRAVEL (SM-SC)
⊡	B49-S4					3	37	60		SANDY SILT, SOME CLAY, TRACE GRAVEL (ML-CL)
△	B49-S7					16	47	32	5	SAND, SOME SILT, SOME GRAVEL, LITTLE CLAY (SM)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN	CHK'D	APP'D	DATE	
DLF	CGK	Daniel W. [illegible]	[illegible]	C8327-A9



Unified Classification System (ASTM D2487)

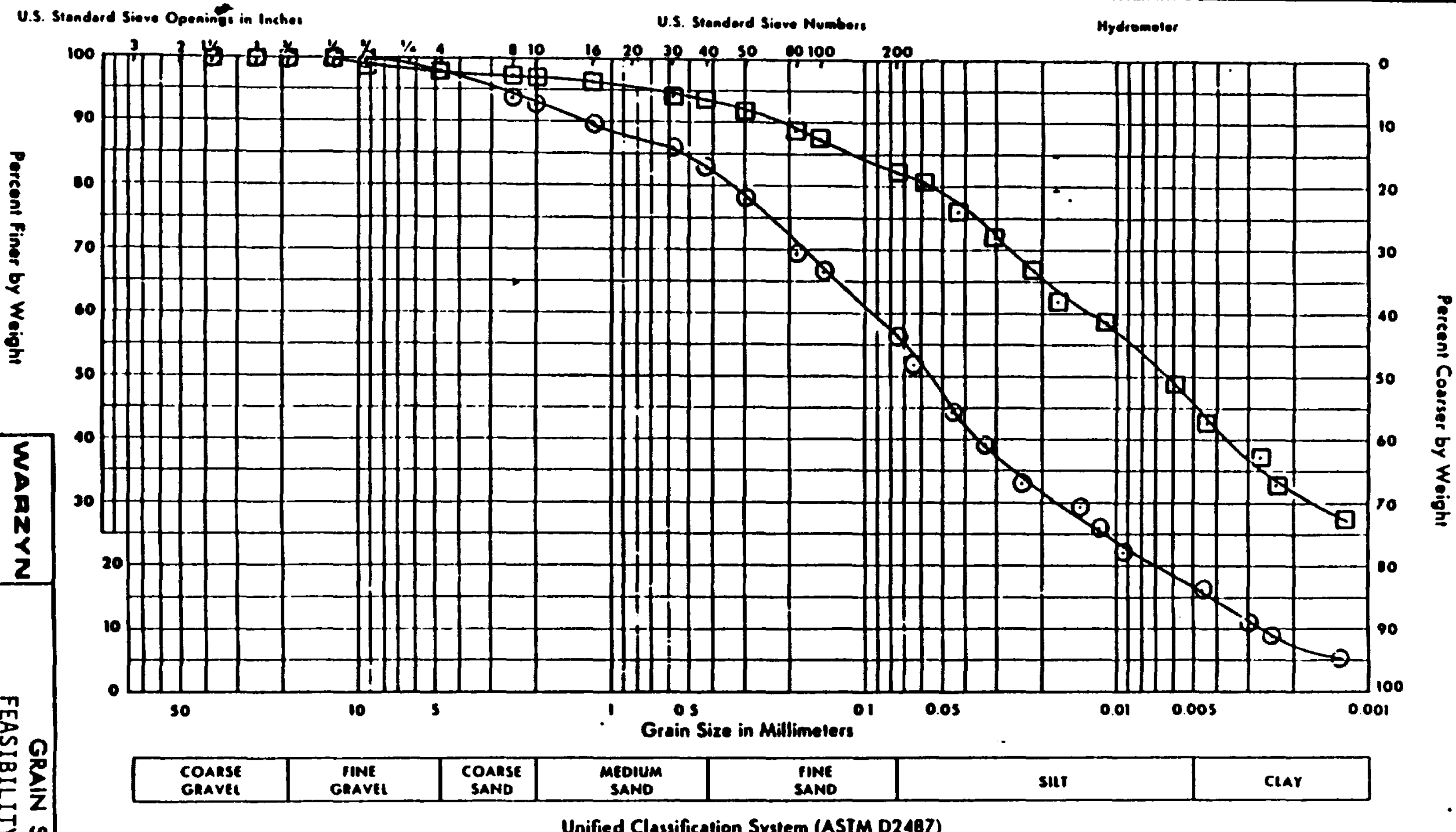
Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	351-52		9.1	16.9	1.9	8	42	50		SILTY SAND, LITTLE GRAVEL
										(SM-SC)
⊡	351-56			23.1	8.6	5	30	40	25	SILT, SOME SAND, SOME CLAY
								48	17	LITTLE GRAVEL (CL)
△	351-511			18.7	0.7	0	9	91		SILT, SOME CLAY, LITTLE
										SAND (ML)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN	CHK'D	APP'D	DATE	
DLF	CGK	[illegible]	[illegible]	C9327-A10

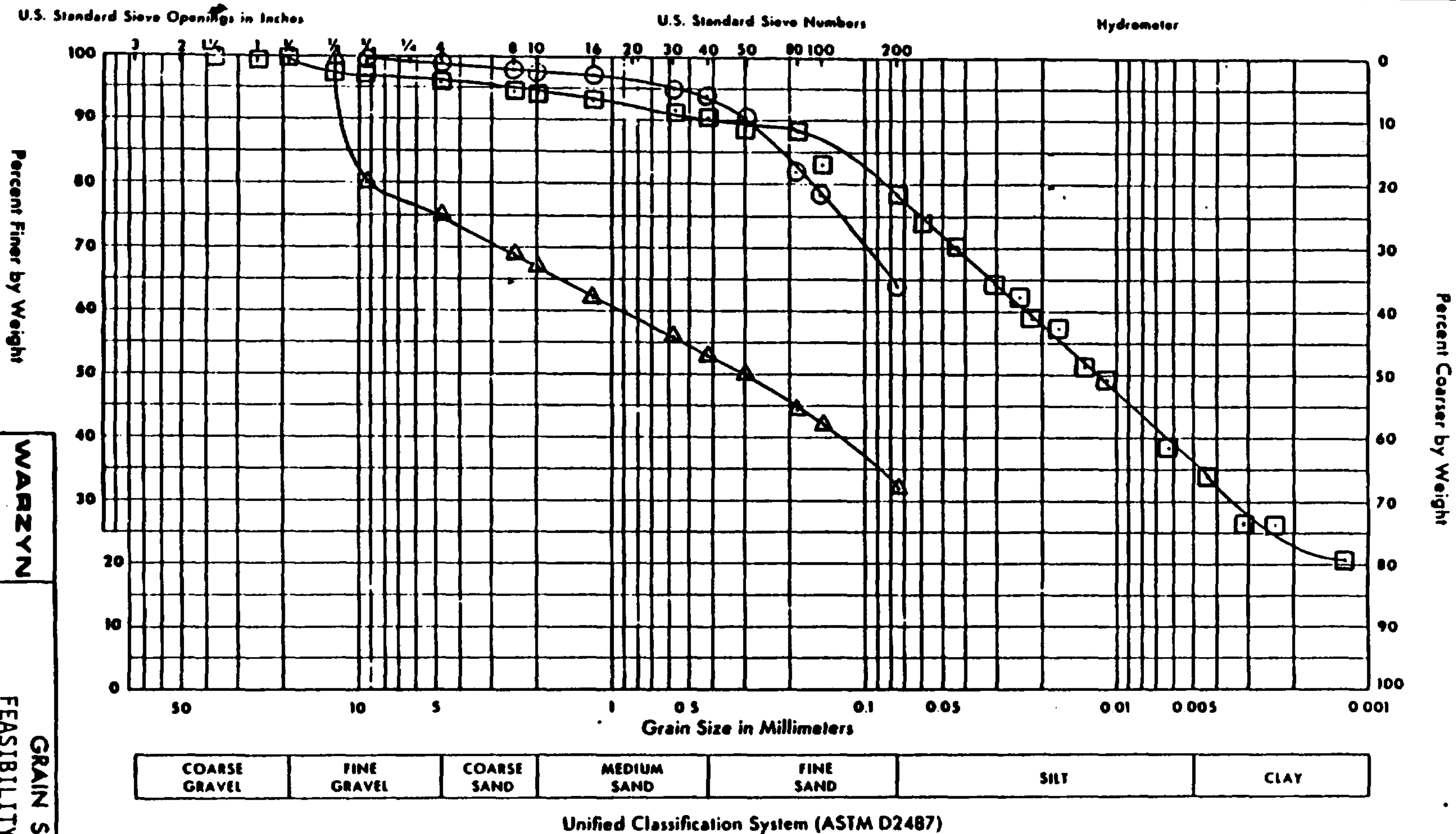


Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	353-53	7.5'		15.4	3.9	2	42	39	17	SILTY SAND, SOME CLAY,
								41	7	TRACE GRAVEL (ML)
⊡	B55-53	7.5'		30.2	13.3	2	16	36	46	SILTY CLAY, SOME SAND,
								[illegible]	[illegible]	TRACE GRAVEL (CL)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS
FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF | CHK'D CGK | APP'D [illegible] | DATE [illegible] | C8327-A11



Curve	Sample	Depth	N.M.	L.L.	P.I.	% Grav	% Sand	% Silt	% Clay	Soil Classification
⊙	B56-S2		16.9			1	35	64		SANDY SILT, SOME CLAY, TRACE GRAVEL (CL)
⊡	B56-S7			25.9	10.6	4	18	42	36	SILTY CLAY, SOME SAND, TRACE GRAVEL (CL)
△	B56-S10					25	43	32		SAND, SOME GRAVEL, SOME SILT AND CLAY (SM-SC)

WARZYN ENGINEERING INC

GRAIN SIZE ANALYSIS

FEASIBILITY STUDY REPORT
PROPOSED MANITOWOC CO. SANITARY LANDFILL
LEMBERGER PROPERTY

DWN DLF | CHK'D CGK | APP'D [illegible] | DATE [illegible] | C8327-A12

APPENDIX E

Laboratory Permeability Test Data

WARZYN ENGINEERING INC

FALLING HEAD PERMEABILITY TEST RESULTS

PROJECT: Lemberger Site

LOCATION: Manitowoc, Wisconsin

Test No. ______
Job No. 8327
Date ______
Sheet 1 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE	Boring 29A Shelby Tube		Boring 49 Shelby Tube		Boring 42 Shelby Tube	
DEPTH	13.0 -15.0		5.5-7.0		5.5-7.0	
SOIL DESCRIPTION	Gray silty clay, Little to some sand, Trace gravel (CL)		Reddish-brown sandy silt, some gravel (SC-SM)		Reddish-brown silt and silty clay, (CL, CL-ML)	
SAMPLE DIAMETER (cm)	7.24		7.24		7.24	
SAMPLE AREA, A (cm²)	41.16		41.16		41.16	
SAMPLE LENGTH, L (cm)	15.29		15.29		21.61	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
MOISTURE CONTENT, %	11.53	11.85	14.22	14.59	13.17	13.60
DRY DENSITY (PCF)	132.10	132.10	122.13	122.13	121.65	121.65

COEFFICIENT OF PERMEABILITY, k (cm/sec)			
RUN NO. 1	9.54×10^{-7}	1.77×10^{-6}	3.07×10^{-7}
2	9.78×10^{-7}	1.11×10^{-6}	2.08×10^{-7}
3	6.46×10^{-7}	7.55×10^{-7}	1.00×10^{-7}
4	2.48×10^{-7}	2.69×10^{-7}	1.00×10^{-7}
5	1.59×10^{-7}	2.58×10^{-7}	9.31×10^{-8}
6	1.32×10^{-7}	1.93×10^{-7}	6.90×10^{-8}
7	1.06×10^{-7}	1.81×10^{-7}	5.64×10^{-8}
8	1.14×10^{-7}	1.99×10^{-7}	4.66×10^{-8}
9	1.94×10^{-7}	1.54×10^{-7}	5.44×10^{-8}
10	3.07×10^{-7}	1.77×10^{-7}	4.59×10^{-8}
AVERAGE k, (cm/sec)	1.76×10^{-7} a.	1.81×10^{-7} a.	5.08×10^{-8} b.

FORMULA: $k = \frac{2.3\,a\,L}{A\,t} \log_{10} \frac{h_0}{h_1}$, Where a = cross-sectional area of standpipe,
t = time for water level to fall from initial height, h_0, to final height, h_1
(All other terms are defined above)

REMARKS:

a. Average of last 5 runs.

b. Average of last 4 runs.

WARZYN ENGINEERING INC

FALLING HEAD PERMEABILITY TEST RESULTS

PROJECT: Lemberger Site

LOCATION: Manitowoc, wisconsin

Test No. ______
Job No. 8327
Date ______
Sheet 2 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE	Boring#46A Shelby tube					
DEPTH	15.0 - 17.0					
SOIL DESCRIPTION	Brown silt, some sand some clay, trace gravel (CL)					
SAMPLE DIAMETER (cm)	7.23					
SAMPLE AREA, A (cm²)	41.16					
SAMPLE LENGTH, L (cm)	14.48					
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
MOISTURE CONTENT, %	16.19	16.70				
DRY DENSITY (PCF)	122.0	122.3				

COEFFICIENT OF PERMEABILITY, k (cm/sec)			
RUN NO. 1	2.57×10^{-7}		
2	1.16×10^{-7}		
3	1.41×10^{-7}		
4	1.05×10^{-7}		
5	2.68×10^{-7}		
6	9.08×10^{-8}		
7	5.09×10^{-8}		
8	5.55×10^{-8}		
9	4.12×10^{-8}		
10	5.89×10^{-8}		
AVERAGE k, (cm/sec)	5.16×10^{-8} a.		

FORMULA: $k = \frac{2.3\,a\,L}{At} \log_{10} \frac{h_0}{h_1}$, Where a = cross-sectional area of standpipe.
t = time for water level to fall from initial height, h_0, to final height, h_1
(All other terms are defined above)

REMARKS:

a. Average of last 4 runs.

WARZYN
ENGINEERING INC

FALLING HEAD PERMEABILITY TEST RESULTS

PROJECT: Lemberger Site

LOCATION: Manitowoc, Wisconsin

Test No. ____
Job No. 8327
Date ____
Sheet 3 of 3

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE	Boring 29A-Remolded		Boring 49- Remolded		Boring 46A Remolded	
DEPTH	~10'		~10'		~5-10	
SOIL DESCRIPTION	Gray silty clay, Little to some sand, trace gravel (CL)		Reddish -brown sandy silt, trace gravel (CL-ML)		Brown silt, some sand some clay, trace gravel (CL)	
SAMPLE DIAMETER (cm)	10.16		10.16		10.16	
SAMPLE AREA, A (cm^2)	81.07		81.07		81.07	
SAMPLE LENGTH, L (cm)	11.64		11.64		11.64	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
MOISTURE CONTENT, %	19.00	20.33	18.00	19.11	18.00	19.83
DRY DENSITY (PCF)	108.91	108.45	108.60	108.30	107.80	106.65

COEFFICIENT OF PERMEABILITY, k (cm/sec)			
RUN NO. 1	7.99×10^{-7}	1.64×10^{-7}	1.62×10^{-7}
2	3.55×10^{-7}	6.67×10^{-8}	1.39×10^{-7}
3	2.68×10^{-7}	6.75×10^{-8}	1.86×10^{-7}
4	1.41×10^{-7}	6.54×10^{-8}	1.70×10^{-7}
5	1.17×10^{-7}	7.33×10^{-8}	2.13×10^{-7}
6	8.78×10^{-8}	5.98×10^{-8}	1.42×10^{-7}
7	8.29×10^{-8}	6.07×10^{-8}	1.63×10^{-7}
8	8.76×10^{-8}	5.65×10^{-8}	1.63×10^{-7}
9	7.46×10^{-8}	5.69×10^{-8}	1.36×10^{-7}
10	1.07×10^{-8}	5.08×10^{-8}	1.36×10^{-7}
AVERAGE k, (cm/sec)	9.18×10^{-8} a.	5.65×10^{-8} b.	1.36×10^{-7} c.

FORMULA: $k = \frac{2.3\,a\,L}{At} \log_{10} \frac{h_0}{h_1}$, Where a = cross-sectional area of standpipe, t = time for water level to fall from initial height, h_0, to final height, h_1 (All other terms are defined above)

REMARKS:

a. Average of last 6 runs.

b. Average of last 5 runs.

c. Average of last 2 runs.

FORM NO. 30-05

APPENDIX F

Field Permeability Test Data

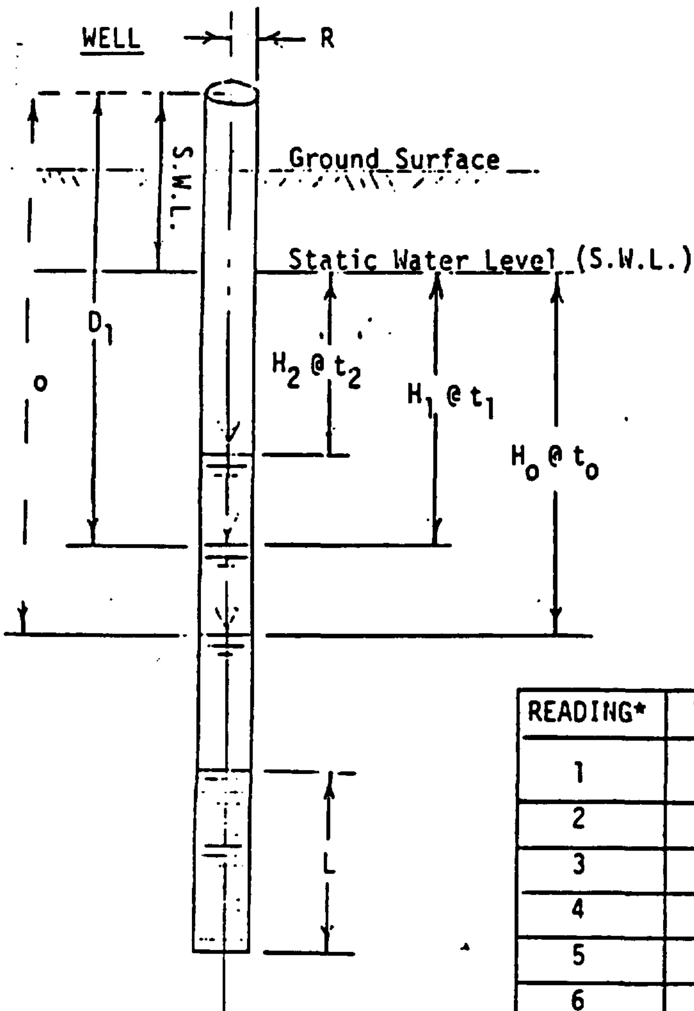
1) Project: ______________________________

2) Location: ______________________________ 4) Job No: ______________

3) Client: ______________________________ 5) Date: ______________

6) Well or Boring No: ______________

7) Personnel: ______________



8) R=Radius of well= ______________ (in.)

9) L=Length of Screen ______________ (ft.)
(from well detail sheet)

10) Static Water Level ______________ (ft.)
(Depth to Water)

11) Baildown Data (From Test)-Record Information in Minutes and Feet

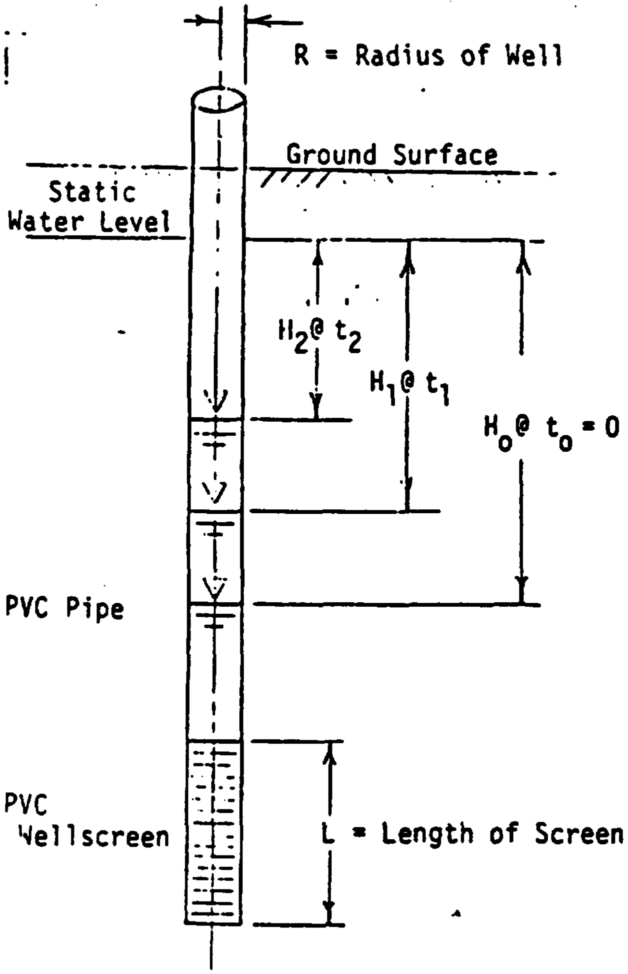
READING*	TIME (Start)	DEPTH TO WATER (After Baildown) D_t	2+ D_t -SWL=Ht	3+ Ht/H_o
1	t_o	D_o	H_o	
2	t_1	D_1	H_1	
3	t_2	D_2	H_2	
4	t_3	D_3	H_3	
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

* Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary

+Disregard Columns 2 and 3 during baildown test. They are for office calculations.

BAILDOWN TEST (Analysis)

Condition C, Table 4-3: Shape Factors for Computation of Permeability From Variable Head Tests NAVFAC DM-7, March 1971



PROCEDURE FOR BAILDOWN
(unconfined aquifer)

1) Record - from well detail

R = well radius = ________ (in.)

L = length of screen = _____ (ft.)

2) Record from plot of recovery (H) vs. time (t)

H_1, H_2 > Unbalanced Head

t_1, t_2 > Time since beginning of measurement

H_o = Initial unbalanced head

$t_o = 0$ Time elapsed at start of test

3 Calculation

isotropic

$$K = \frac{R^2}{2L(t_2-t_1)} \ln\left(\frac{L}{R}\right) \ln\left(\frac{H_1}{H_2}\right)$$

for $\frac{L}{R} > 8$

anisotropic

$$m = \sqrt{K_h/K_v} \quad \text{(estimate)}$$

$$K = \frac{R^2}{2L} \ln\left(\frac{mL}{R}\right) \frac{\ln H_1/H_2}{(t_2-t_1)}$$

WELL # 29.0

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	7.38
1	12.27	0	1.000	0.000	19.650
2	11.92	70	0.971	-0.029	19.300
3	11.52	150	0.939	-0.063	18.900
4	10.57	350	0.861	-0.149	17.950
5	9.42	577	0.768	-0.264	16.800
6	7.27	1005	0.593	-0.523	14.650
7	5.87	1279	0.478	-0.737	13.250
8	4.87	1487	0.397	-0.924	12.250
9	3.62	1785	0.295	-1.221	11.000
10	2.56	2126	0.209	-1.567	9.940
11	1.62	2570	0.132	-2.025	9.000
12	1.14	2938	0.093	-2.376	8.520
13	0.73	3445	0.059	-2.822	8.110
14	0.18	5875	0.015	-4.222	7.560
15	0.09	7409	0.007	-4.915	7.470
16	0.07	9230	0.006	-5.166	7.450
17	0.06	13434	0.005	-5.321	7.440

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 2126 0.209
T2,H2: 7409 0.007

K = 2.97E-05 CM/SEC
LOG(K) =-4.53E+00 CM/SEC

WARZYN ENGINEERING INC

WELL # 29A

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	57.81
1	15.41	0	1.000	0.000	73.220
2	15.19	108	0.986	-0.014	73.000
3	14.64	392	0.950	-0.051	72.450
4	13.76	791	0.893	-0.113	71.570
5	13.54	893	0.879	-0.129	71.350
6	13.26	1118	0.860	-0.150	71.070
7	11.19	2545	0.726	-0.320	69.000
8	9.65	4295	0.626	-0.468	67.460
9	8.80	6323	0.571	-0.560	66.610
10	8.00	10103	0.519	-0.656	65.810

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 1118 0.860
T2,H2: 6323 0.571

K = 3.64E-06 CM/SEC
LOG(K) =-5.44E+00 CM/SEC

WARZYN ENGINEERING INC

WELL # 31.0

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	14.43
1	6.15	0	1.000	0.000	20.580
2	5.63	82	0.915	-0.088	20.060
3	4.75	260	0.772	-0.258	19.180
4	4.17	399	0.678	-0.389	18.600
5	3.57	550	0.580	-0.544	18.000
6	3.07	725	0.499	-0.695	17.500
7	2.27	1265	0.369	-0.997	16.700
8	1.99	1653	0.324	-1.128	16.420
9	1.57	2540	0.255	-1.365	16.000
10	1.07	4660	0.174	-1.749	15.500
11	0.83	6760	0.135	-2.003	15.260
12	0.44	10600	0.072	-2.637	14.870

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 0 1.000
T2,H2: 1265 0.369

a K = 3.64E-05 CM/SEC
LOG(K) =-4.44E+00 CM/SEC

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 1653 0.324
T2,H2: 6760 0.135

b K = 7.9[illegible]E-06 CM/SEC
LOG(K) =-5.10E+00 CM/SEC

WARZYN
ENGINEERING INC

WELL # 38B

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	13.93
1	10.76	0	1.000	0.000	24.690
2	10.46	100	0.972	-0.028	24.390
3	10.19	193	0.947	-0.054	24.120
4	9.91	319	0.921	-0.082	23.840
5	9.68	457	0.900	-0.106	23.610
6	9.46	602	0.879	-0.129	23.390
7	9.17	902	0.852	-0.160	23.100
8	8.93	1576	0.830	-0.186	22.860
9	8.80	2207	0.818	-0.201	22.730
10	8.64	3546	0.803	-0.219	22.570

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 902 0.852
T2,H2: 3546 0.803

K = 1.04E-06 CM/SEC
LOG(K) =-5.98E+00 CM/SEC

WELL # 39.0

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	
					74.01
1	5.08	0	1.000	0.000	79.090
2	4.73	40	0.931	-0.071	78.740
3	3.65	260	0.719	-0.331	77.660
4	3.23	400	0.636	-0.453	77.240
5	2.75	650	0.541	-0.614	76.760
6	2.30	1325	0.453	-0.792	76.310
7	2.07	2665	0.407	-0.898	76.080

```
FOR-  RADIUS:      2.413 CM  =   0.950 IN.
      SCREEN:    152.400 CM  =   5.000 FT.
      T1,H1:        0     1.000
      T2,H2:      650     0.541

aK =        7.48E-05   CM/SEC
LOG(K) =-4.13E+00   CM/SEC

FOR-  RADIUS:      2.413 CM  =   0.950 IN.
      SCREEN:    152.400 CM  =   5.000 FT.
      T1,H1:      650     0.541
      T2,H2:     2665     0.407

bK =        1.12E-05   CM/SEC
LOG(K) =-4.95E+00   CM/SEC
```

WARZYN ENGINEERING INC

WELL # 43.0

READING	HT	TIME(SEC)	HT/HO	LOG HT/HO	22.27
1	26.17	0	1.000	0.000	48.440
2	10.55	425	0.403	-0.908	32.820
3	4.63	520	0.177	-1.732	26.900
4	2.93	556	0.112	-2.190	25.200
5	1.75	610	0.067	-2.705	24.020
6	0.73	738	0.028	-3.579	23.000
7	0.53	867	0.020	-3.899	22.800
8	0.54	1018	0.021	-3.881	22.810
9	0.01	1275	0.000	-7.870	22.280
10	0.01	2610	0.000	-7.870	22.280

FOR- RADIUS: 2.413 CM = 0.950 IN.
SCREEN: 304.800 CM = 10.000 FT.
T1,H1: 425 0.403
T2,H2: 738 0.028

K = 3.94E-04 CM/SEC
LOG(K) =-3.40E+00 CM/SEC

WARZYN ENGINEERING INC

WELL # 40.[illegible]

READING	H1	TIME(SEC)	HT/HO	LOG HT/HO	31.55
1	10.[illegible]	0	1.000	0.000	42.000
2	8.[illegible]	70	0.833	-0.183	40.250
3	7.[illegible]	122	0.761	-0.273	39.500
4	6.[illegible]	178	0.665	-0.408	38.500
5	6.[illegible]	207	0.617	-0.483	38.000
[illegible]	5.[illegible]	263	0.522	-0.651	37.000
[illegible]	4.[illegible]	319	0.426	-0.854	36.000
[illegible]	3.[illegible]	374	0.330	-1.108	35.000
[illegible]	2.[illegible]	434	0.234	-1.451	34.000
10	1.[illegible]	527	0.139	-1.975	33.000
11	0.[illegible]	767	0.043	-3.145	32.000
[illegible]	0.[illegible]	2135	0.001	-6.952	31.560

FOR RADIUS: 2.413 CM = 0.950 IN.
SCREEN: ?04.300 CM = 10.000 FT.
T1,H1: 319 0.426
T2,H2: 767 0.043

K = 2.3[illegible] CM/SEC
LOG(K) =-3.6[illegible] CM/SEC

WARZYN ENGINEERING INC

APPENDIX G

Soil Conservation Service Interpretation Sheets

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS [1/]

SERIES Cathro
STATE Wisconsin
MLRA 51, 88, 90, 91, 93, 94, 96, 98, 99

Very poorly drained, nearly level organic soils, 16 to 50 inches thick over loams. These soils are moderately rapidly permeable in the organic portion and moderate in the mineral substratum with a high available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability In./hr.	Avail. Water Capac. In./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-23	mucky peat	pt	—	-	-	-	-	-	-	-	2.0-6.0	.25-.35	5.5-6.5	low
23-60	sl	SM	A-2	-	100	100	60-70	25-35	10-20	1-4	0.6-2.0	.11-.13	4.5-6.5	low

Flooding: Frequent for brief periods
Hydrologic group: D
Depth to water table: Seasonal high water table, 0-1 feet
Depth to bedrock: more than 5 feet
Corrosivity - uncoated steel: high - wet soil; alkaline
Corrosivity - concrete: Moderate

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - high compressibility of organic material; very poorly drained
Sand	Poor - very little sand
Gravel	Unsuitable - very little gravel
Topsoil	Poor - oxidizes rapidly; very poorly drained

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Very Severe - seasonal high water table; frequent flooding
Sewage Lagoons	Very Severe - seasonal high water table; moderate to moderately rapid permeability
Shallow Excavations	Very Severe - seasonal high water table; frequent flooding
Dwellings: With Basements / Without Basements	Very Severe - seasonal high water table; frequent flooding
Sanitary Landfill	Very Severe - seasonal high water table; frequent flooding
Local Roads and Streets	Very Severe - seasonal high water table frequent flooding; high compressibility
Potential Frost Action	Moderate - seasonal high water table; frequent flooding; high compressibility

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Seasonal high water table; moderately rapid permeability.
Embankments, Dikes, and Levees	Organic material not suitable for embankments; loamy substratum has medium strength and low to medium compressibility
Drainage of Cropland and Pasture	Moderately rapid permeability in organic soil; moderately permeable substratum
Irrigation	Not applicable
Terraces and Diversions	Not applicable
Grassed Waterways	Not needed
Golf Course Fairways:	Very poorly drained; frequent flooding; low stability; high compressibility

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

MAP SYMBOL 87, 96

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES Brookston
STATE Wisconsin
MLRA 95, 97, 98, 99, 111

Very poorly drained, nearly level, loamy soils, 24 to 40 inches thick, over calcareous loam till. These soils have moderately slow permeability and high available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-14	sicl	ML	A-4	-	100	100	95-100	85-95	30-40	5-10	0.6-2.0	.21-.23	6.6-7.3	Low
14-46	cl	CL	A-6	0-1	100	95-100	90-100	70-80	30-40	15-25	0.2-0.6	.15-.19	6.6-7.3	Moderate
46-60	l	CL, CL-ML	A-4	0-5	95-100	90-100	70-80	50-60	15-25	5-10	0.6-2.0	.17-.19	7.9-8.4	Low

Flooding: Frequent flooding for brief periods.
Hydrologic group: D

Depth to water table: Seasonal high water table, 0-1 foot
Depth to bedrock: More than 6 feet

Corrosivity - uncoated steel: High
Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor - very poorly drained; low shear strength.
Sand	Poor - small pockets of poorly graded sand occur in glacial till.
Gravel	Poor - Very little gravel present.
Topsoil	Poor - Very poorly drained; thin surface.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Very severe - seasonal high water table.
Sewage Lagoons	Severe - moderate permeability in substratum; seasonal high water table.
Shallow Excavations	Severe - seasonal high water table.
Dwellings: With Basements	Very severe - seasonal high water table.
Dwellings: Without Basements	Severe - seasonal high water table.
Sanitary Landfill	Severe - seasonal high water table; frequent flooding.
Local Roads and Streets	Severe - seasonal high water table; frequent flooding.
Potential Frost Action	High - seasonal high water table; strong capillary action.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderately slow permeability; seasonal high water table.
Embankments, Dikes, and Levees	Low shear strength; medium compressibility; moderately slow permeability.
Drainage of Cropland and Pasture	Seasonal high water table; moderately slow permeability.
Irrigation	Not applicable.
Terraces and Diversions	Not needed.
Grassed Waterways	Not needed.
Golf Course Fairways	Seasonal high water table; moderately slow permeability; frequent flooding.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

MNTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES Syaco
STATE Wisconsin
MLRA 95

The Syaco series consists of somewhat poorly drained, nearly level and gently sloping silty soils that formed in till plains and ground moraines. These are moderately slowly permeable soils with high available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification USDA Texture	Unified	AASHO	Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.-- 4	10	40	200	LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
0-11	sil	ML	A-6	-	100	100	90-95	80-90	20-30	2-4	0.6-2.0	.22-.24	7.4-8.4	Low
11-25	cl	CL	A-6	0-5	95-100	90-100	80-90	65-75	35-40	15-20	0.2-0.6	.15-.19	7.9-8.4	Moderate
25-60	l	CL, CL-ML	A-4	0-5	95-100	90-100	75-85	60-70	20-25	5-10	0.6-2.0	.16-.18	7.9-8.4	Low

Flooding: Rare

Hydrologic group: B

Depth to water table: 1 to 3 feet

Depth to bedrock: More than 5 feet

Corrosivity - uncoated steel: High - free carbonates; wet soil.

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair - low shear strength; seasonal high water table.
Sand	Unsuitable - little or no sand present.
Gravel	Unsuitable - little or no gravel present.
Topsoil	Fair - thin layer.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - seasonal high water table; lower end of moderate permeability.
Sewage Lagoons	Severe - seasonal high water table.
Shallow Excavations	Severe - seasonal high water table.
Dwellings: With Basements	Severe - seasonal high water table.
Dwellings: Without Basements	Moderate - seasonal high water table.
Sanitary Landfill	Moderate - seasonal high water table.
Local Roads and Streets	Severe - seasonal high water table; high frost action.
Potential Frost Action	High - strong capillary action; high water table.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderate permeability.
Embankments, Dikes, and Levees	Low shear strength; subject to piping.
Drainage of Cropland and Pasture	Lower end of moderate permeability.
Irrigation	High available water capacity; moderate permeability; seasonal high water table.
Terraces and Diversions	Not needed.
Grassed Waterways	Not needed.
Golf Course Fairways	Seasonal high water table.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS[1]

SERIES Hortonville
STATE Wisconsin
MLRA 95

Deep, well drained silty soils underlain by calcareous till at 20 to 40 inches. These are nearly level to steep with high available water capacity. They are at the lower end of the moderate permeability.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No. -				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-12	sil	ML	A-4	-	100	100	95-100	80-90	20-30	1-4	0.6-2.0	.20-.22	5.6-6.5	Low
12-35	sicl	CL	A-7	-	100	100	95-100	80-90	30-40	15-25	0.6-2.0	.16-.18	5.6-6.0	Mod.
35-60	sicl	CL	A-6	-	95-100	90-95	80-85	80-85	25-35	10-15	0.6-2.0	.16-.18	7.4-8.4	Low

Flooding: None

Hydrologic group: B

Depth to water table: ~~More~~ Greater than 5 feet

Depth to bedrock: ~~More~~ Greater than 5 feet

Corrosivity - uncoated steel: Low

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair; pipes readily; medium to low shear strength.
Sand	Unsuitable - little or no sand present.
Gravel	Unsuitable - little or no gravel present.
Topsoil	Good.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Moderate for 0 to 12% slopes; severe for steeper soils; lower end of moderate permeability.
Sewage Lagoons	Moderate for 0 to 6% slopes; severe for steeper soils; lower end of moderate permeability.
Shallow Excavations	Slight for 0 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils.
Dwellings: With Basements) Without Basements)	Slight for 0 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils.
Sanitary Landfill	Slight for 0 to 12% slopes; moderate for steeper soils.
Local Roads and Streets	Moderate - fair to poor compaction; moderate shrink-swell potential.
Potential Frost Action	Moderate - strong capillary action.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderate permeability.
Embankments, Dikes, and Levees	Medium to low shear strength; pipes readily; fair to poor compaction.
Drainage of Cropland and Pasture	Drainage is adequate.
Irrigation	High available water capacity; moderate permeability.
Terraces and Diversions	Moderately permeable.
Grassed Waterways	Moderately erosive; moderately permeable.
Golf Course Fairways:	Lower end of moderate permeability; steep slopes.

1/ Use in connection with Guide to Soil Survey Interpretation Sheets.

SERIES Seelyeville
STATE Wisconsin
MLRA 88, 89, 91, 103

SOIL SURVEY INTERPRETATIONS 1/

These are deep, organic soils that are nearly level. They are formed in decomposed organic materials in bogs or in the lower parts of outwash plains and glacial moraines. They have moderately rapid permeability and very high availabel water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-60	muck	Pt	-	-	-	-	-	-	-	-	2.0-6.0	.35-.45	5.6-7.3	-

Flooding: None

Hydrologic group: D

Depth to water table: 0-1 foot

Depth to bedrock: More than 5 feet.

Corrosivity - uncoated steel: High - wet soil.

Corrosivity - concrete: Moderate - wet soil.

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Unsuitable - organic soils; very low bearing capacity.
Sand	Unsuitable
Gravel	Unsuitable
Topsoil	Poor - low trafficability; subject to blowing.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Very severe - high water table.
Sewage Lagoons	Very severe - high water table.
Shallow Excavations	Very severe - high water table.
Dwellings: With Basements	Very severe - high water table.
Dwellings: Without Basements	Severe - high water table; very low bearing capacity.
Sanitary Landfill	Very severe - high water table; moderately rapid permeability.
Local Roads and Streets	Severe - high water table; very low bearing value; unstable.
Potential Frost Action	High - strong capillary action; wet soil.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	High water table; moderately rapid permeability.
Embankments, Dikes, and Levees	Organic materials not suitable.
Drainage of Cropland and Pasture	Moderately rapid permeability.
Irrigation	High water table; moderately rapid permeability; very high available water capacity.
Terraces and Diversions	Not needed.
Grassed Waterways	Not needed.
Golf Course Fairways:	High water table; poor trafficability.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

APPENDIX H

Cation Exchange Capacity Results

LEMBERGER HORIZONTAL EXPANSION
CATION EXCHANGE CAPACITY RESULTS

LAYER DESCRIPTION	BORING SAMPLE	DEPTH (FT)	CATION EXCHANGE CAPACITY (LABORATORY ESTIMATE IN MILLIEQUIVALENTS/100 GRAMS SOIL)	SOIL pH
Red-Brown Silty Clay Glacial Till	41	7.5	21	8.0
	42	10	23	8.1
	47	5	13	8.1
	49	2.5	12	8.1
Light Gray-Brown Silty and Clayey Sand (Dolomitic Till and Outwash)	32	40	18	8.8
	40	25	17	8.6
	42	60	19	9.0
	47	35	17	8.7

APPENDIX I

Monitoring Well Construction Data

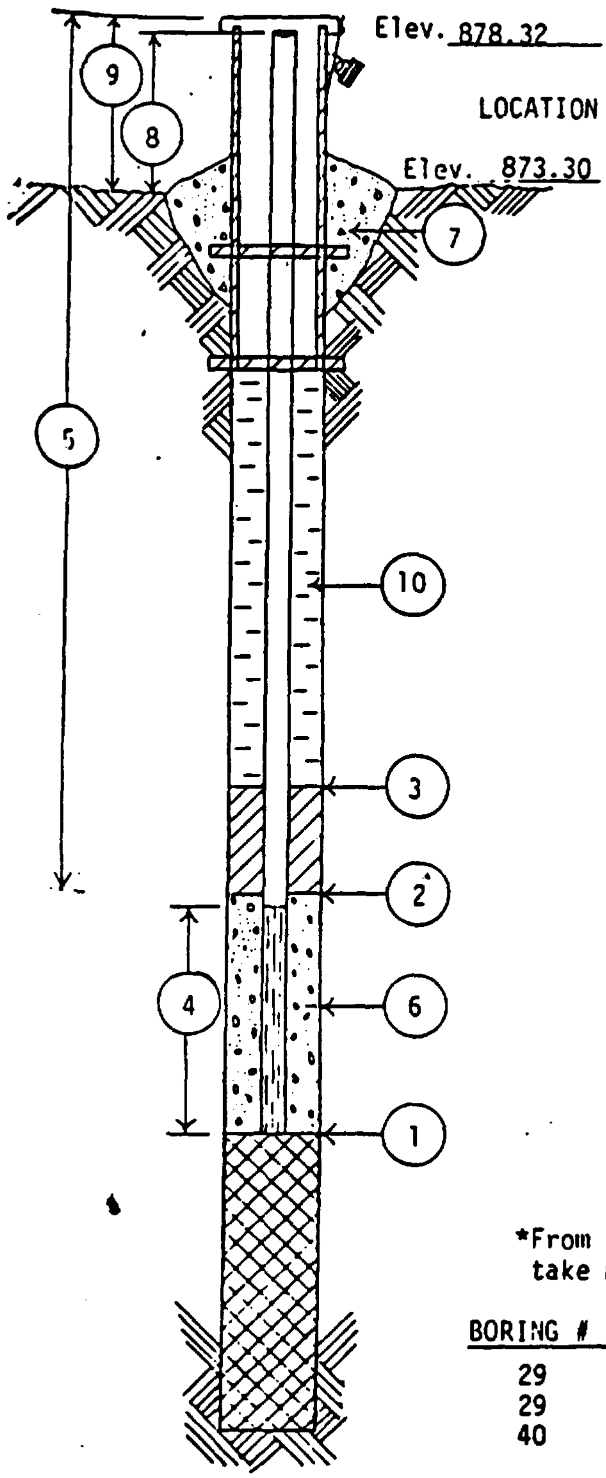
WELL DETAIL INFORMATION SHEET

JOB NO. 8327

BORING NO. 29

DATE 6/25/79

CHIEF Jim Grieger



LOCATION Lemberger Site Manitowoc County, WI

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 16 FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 4.0 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0.0 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 12 FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3.0 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ____.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
29	6/25/79	PM	14.0	From Top
29	6/26/79	AM	5.0	After Bail
40	6/26/79	AM	21.5	From Top of Stick up
44	6/26/79	AM	42.2	From Top

WARZYN ENGINEERING INC

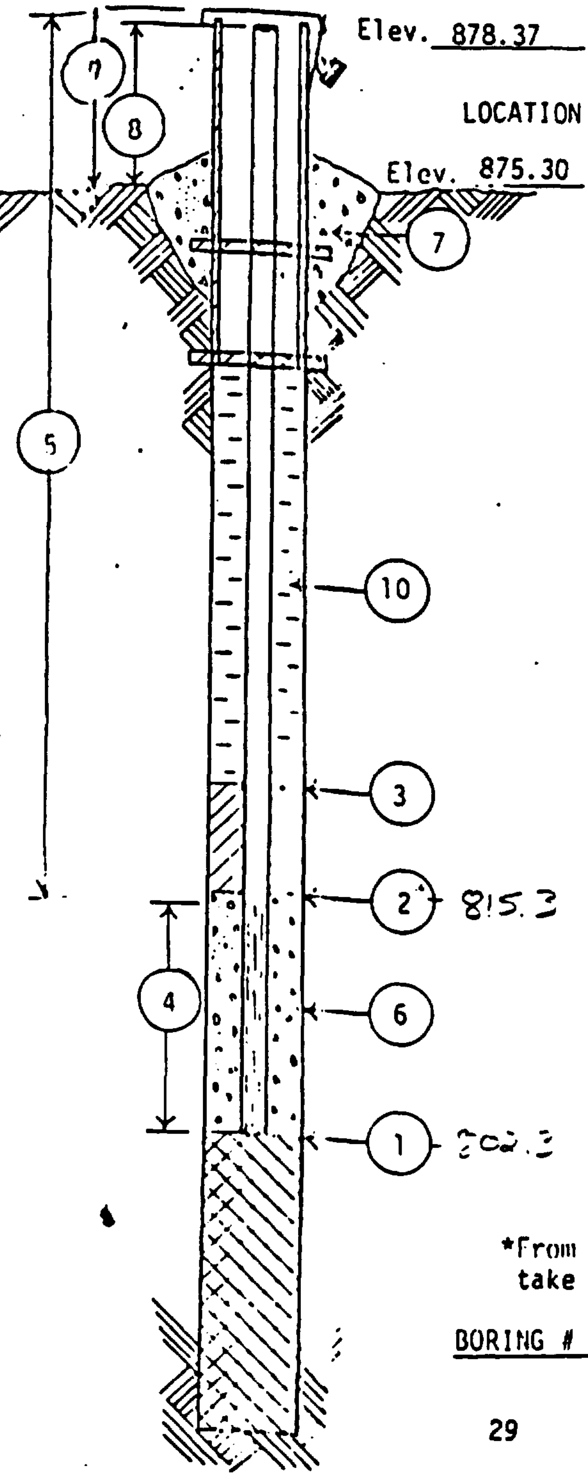
JOB NO. 8327

BORING NO. 29A

DATE 9/12/79

CHIEF W. Graville

LOCATION Lemberger Site Manitowoc County, WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 73 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 60 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 58 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 66 FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
29	9/12/79	PM	49.7	

WARZYN

WELL DETAIL INFORMATION SHEET

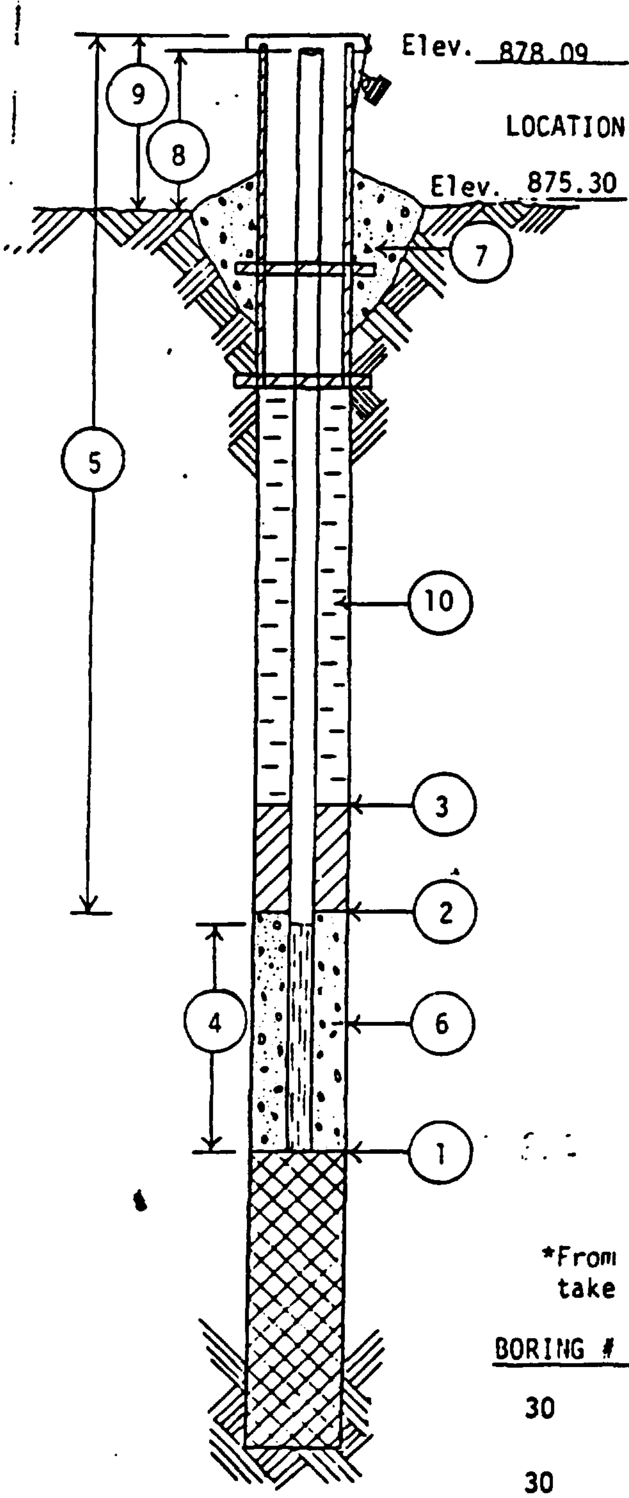
JOB NO. 8327

BORING NO. 30

DATE 6/26/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc County, WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 37' FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 28 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 26 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN) OR SLOTTED PIPE 5 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 38' FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ____.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
30	6/26/79	PM	32.8	From Top After Bail
30	6/27/79	AM	18.2	From Top

WARZYN

WELL DETAIL INFORMATION SHEET

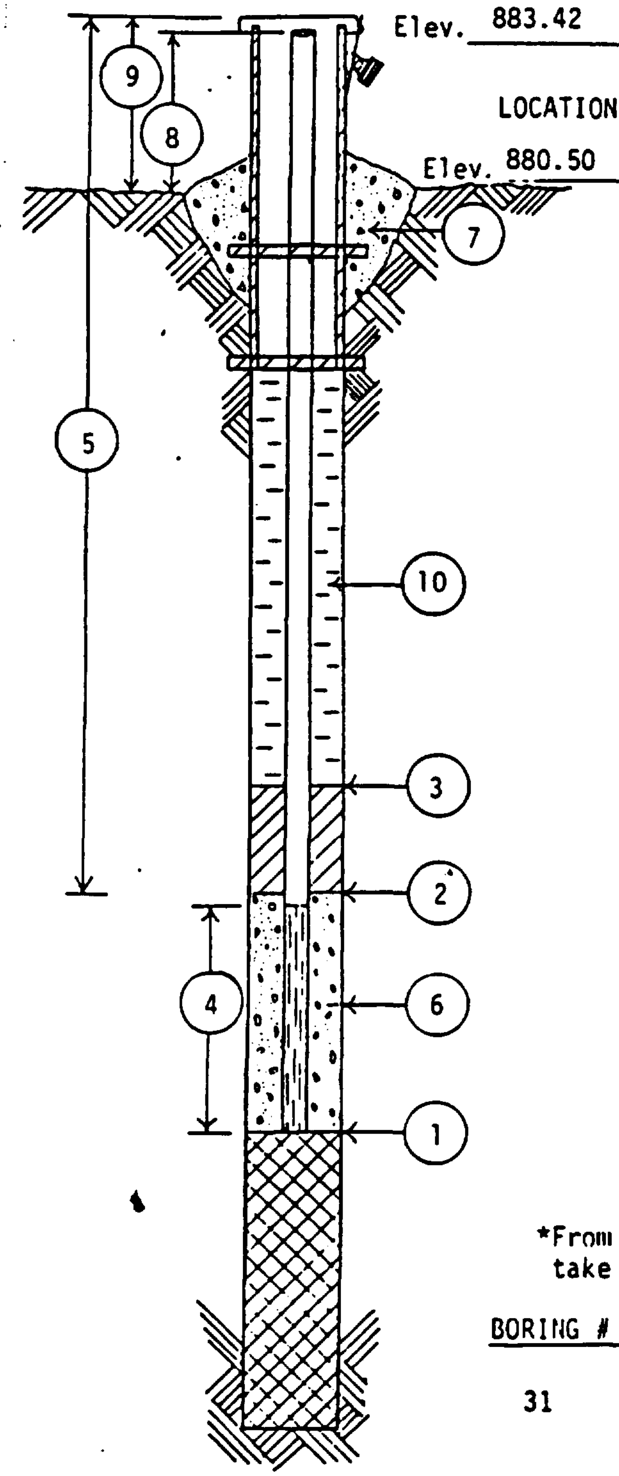
JOB NO. C 8327

BORING NO. 31

DATE 6/26/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 16 FEET.
2. 3' Blank
   DEPTH OF BOTTOM OF SEAL (if installed) 6' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0' FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN,) OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 12' FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One)
   HEIGHT ABOVE GROUND _____.
10. LOCKING CAP? YES (NO) (Circle One)
    TYPE OF BACKFILL: Spoils

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
31	6/26/79	PM	15.0	After Bail From Top
31	6/27/79	AM	9.2	" "

WARZYN

WELL DETAIL INFORMATION SHEET

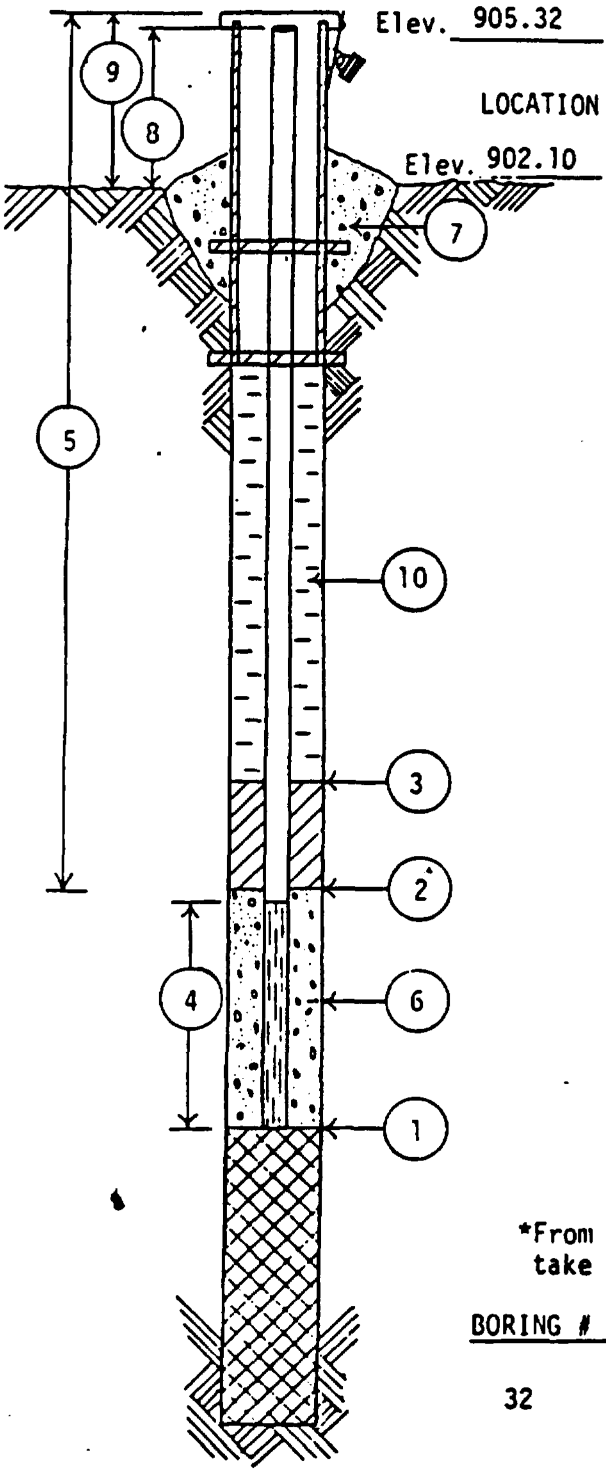
JOB NO. C 8327

BORING NO. 32

DATE 6/28/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 36.0 FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 15' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0' FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN, circled) OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 32' FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO, circled) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO, circled) (Circle One)
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO, circled) (Circle One)
    TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
32	6/28/79	AM	20'	After Bail From Top

WARZYN

WELL DETAIL INFORMATION SHEET

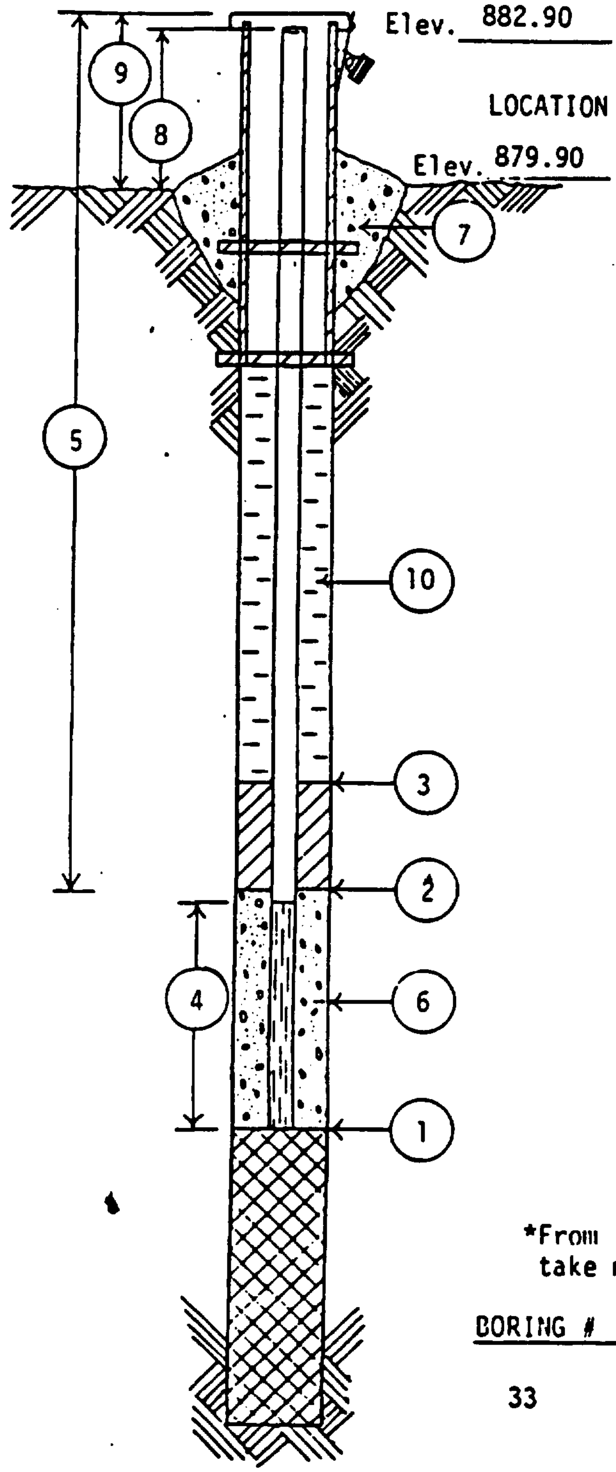
JOB NO. C 8327

BORING NO. 33

DATE 7/5/79

CHIEF James Rech

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 40 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 29' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 27 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN, circled) OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 33' FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES (NO, circled) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO, circled) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO, circled) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
33	7/5/79	5:00	40.9'	Bailed Down
	7/6/79	8:00	16' - 6"	

WARZYN

WELL DETAIL INFORMATION SHEET

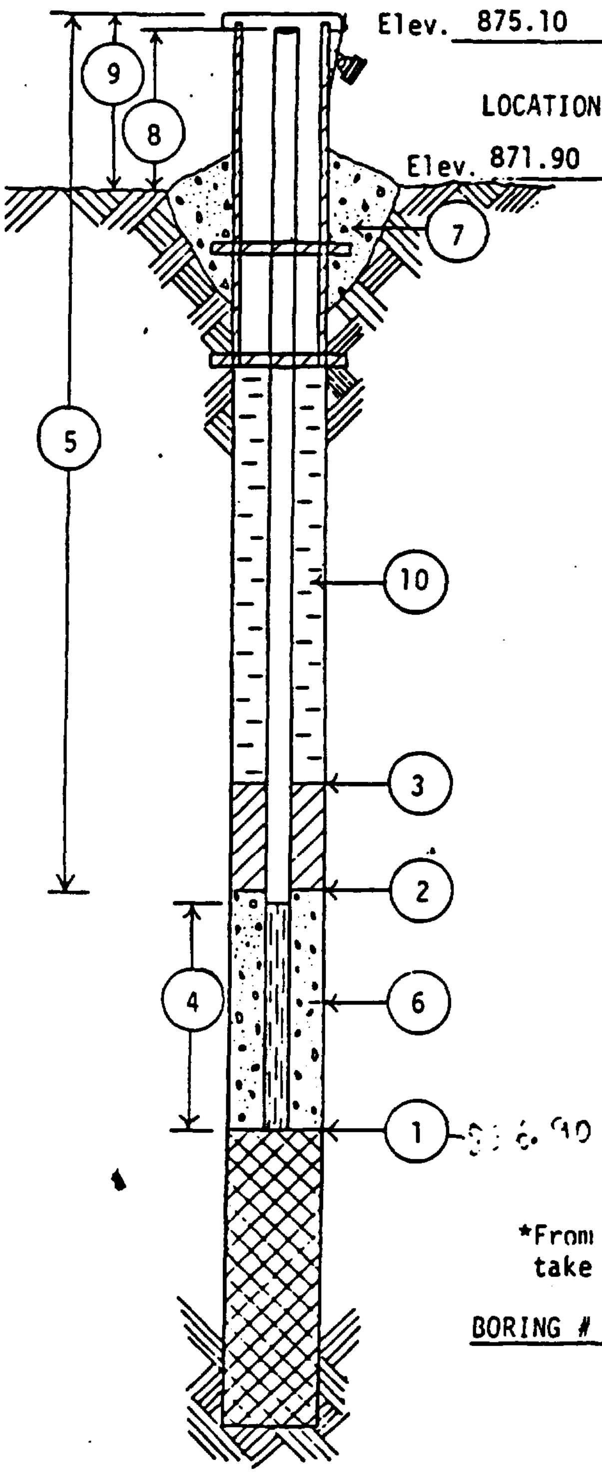
JOB NO. C 8327

BORING NO. 34

DATE 7/6/79

CHIEF James Rech

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 35 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 25 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 23 FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN (circled) OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 28 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES NO (circled) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (circled) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (circled) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS

WARZYN

WELL DETAIL INFORMATION SHEET

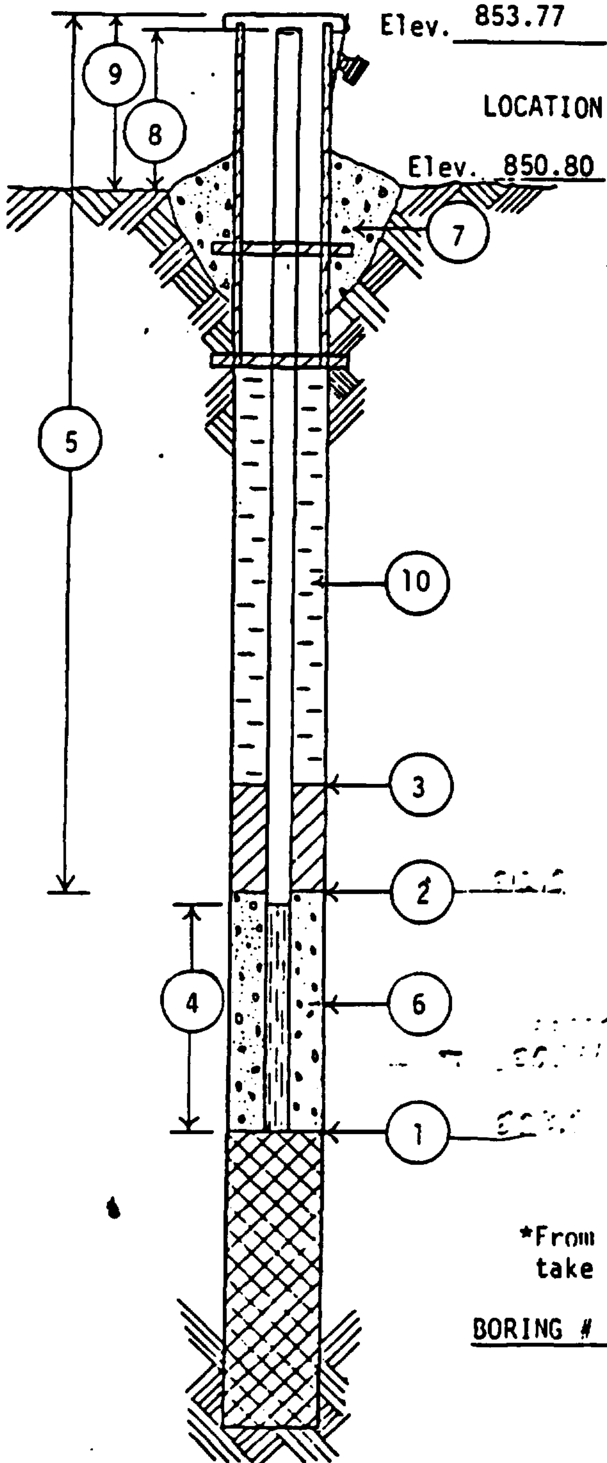
JOB NO. C 8327

BORING NO. B# 35

DATE 9/11/79

CHIEF Wayne Graville

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 47 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 38 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 35 FEET.
4. LENGTH OF WELL POINT (PVC WELL SCREEN) OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 40' FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
	9/11/79	PM	32'	Then Bailed dow to 28'.
35	9/12/79	AM	39'	

WARZYN

WELL DETAIL INFORMATION SHEET

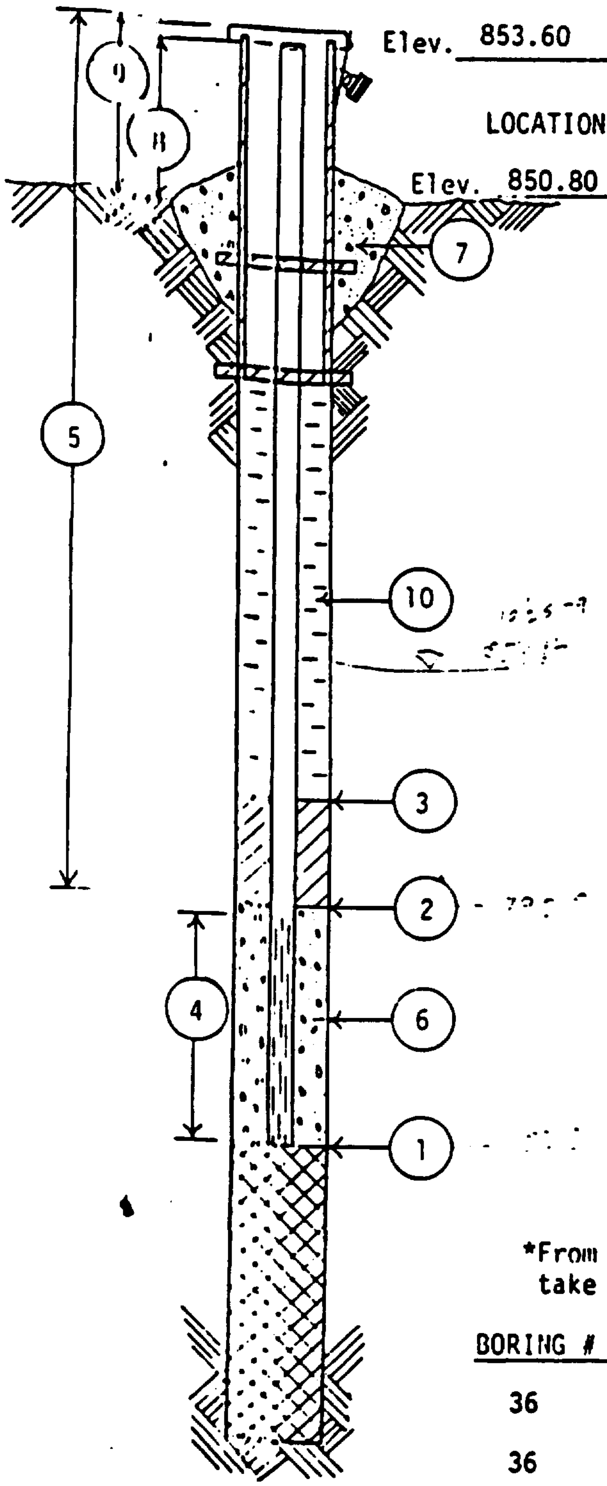
JOB NO. C 8327

BORING NO. 36

DATE 9/10/79

CHIEF Wayne Graville

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 68 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 60 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 58 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 5 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 60 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ________.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
36	9/10/79	PM	28.8, 24 Hr.	
36	9/12/79	AM	46.9 FT., 48 Hr.	

WARZYN

WELL DETAIL INFORMATION SHEET

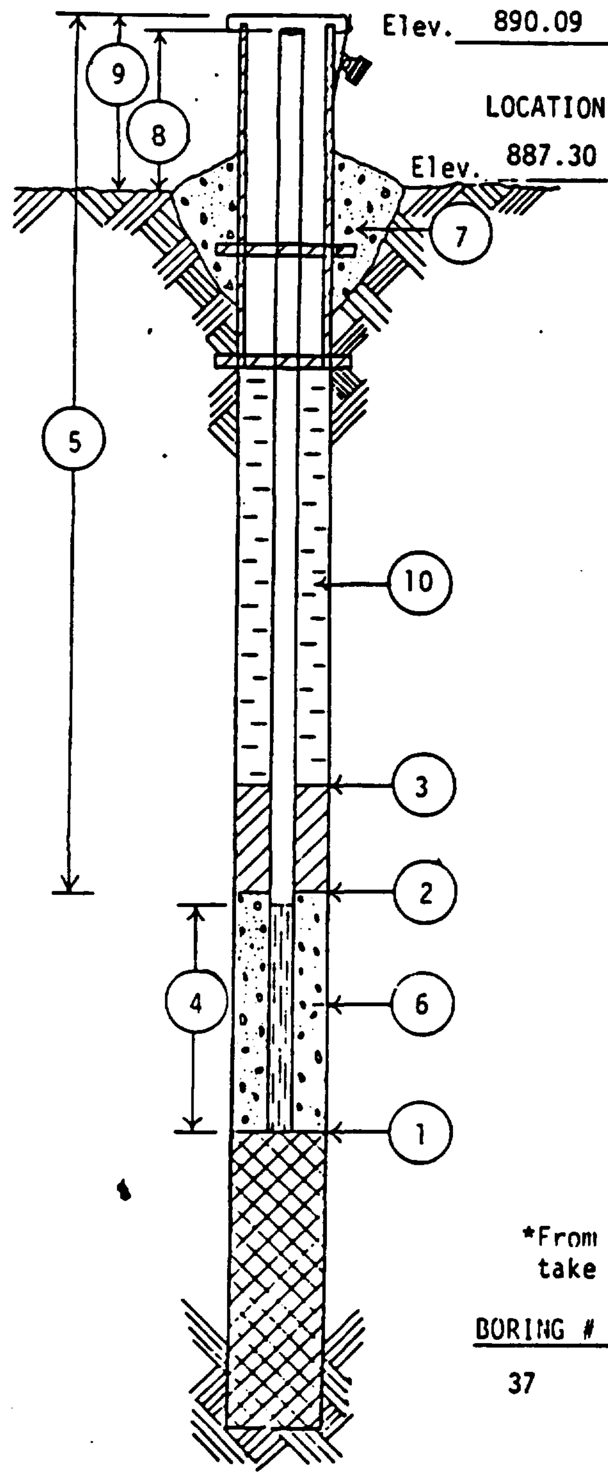
JOB NO. C 8327

BORING NO. 37

DATE 7/10/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 32' FEET.
   3' blank under well screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 15' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 25 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One)
   HEIGHT ABOVE GROUND ____.
10. LOCKING CAP? YES (NO) (Circle One)
    TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
37	7/10/79	AM	29.3	From top of Stickup. After Bail

WARZYN

WELL DETAIL INFORMATION SHEET

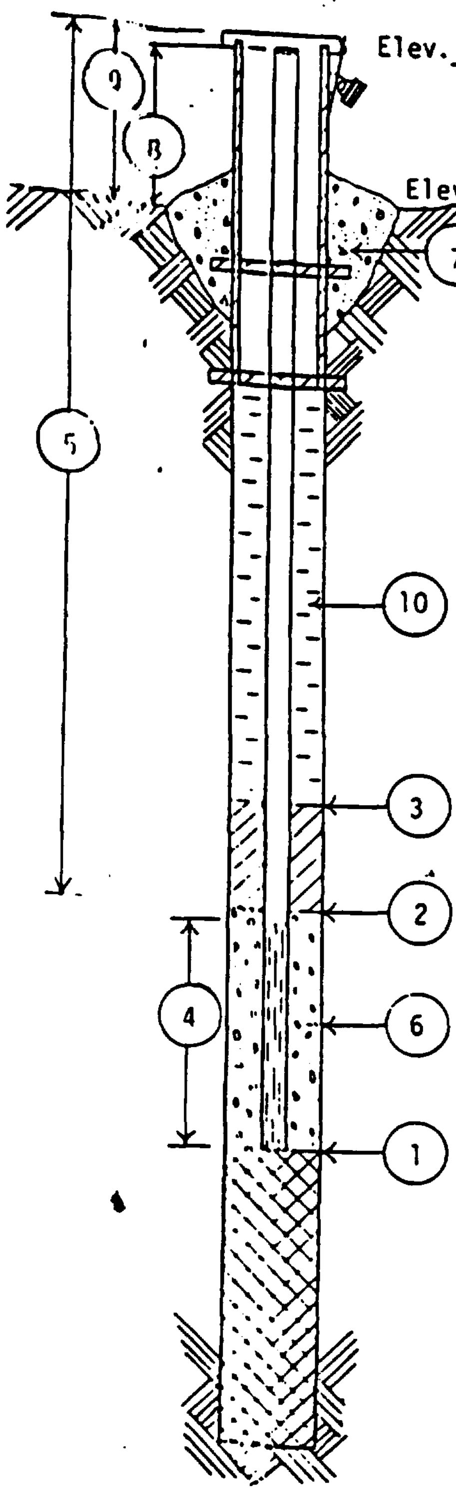
JOB NO. C 8327

BORING NO. 38B

DATE 7/3/79

CHIEF James Rech

LOCATION Lemberger Site, Manitowoc Co., WI



Elev. 889.40

Elev. 886.50

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

(1) DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 22' FEET.

(2) DEPTH OF BOTTOM OF SEAL (if installed) 9 FEET.

(3) DEPTH TO TOP OF SEAL (if installed) 8 FEET.

(4) LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10 FEET. (Circle One)

(5) TOTAL LENGTH OF PIPE 15 FEET @ 2" IN. DIAMETER.

(6) TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.

(7) CONCRETE CAP, YES (NO) (Circle One)

(8) HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.

(9) PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.

(10) LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
38B	7/3/79	11:30	22'	Bailed down

WARZYN

WELL DETAIL INFORMATION SHEET

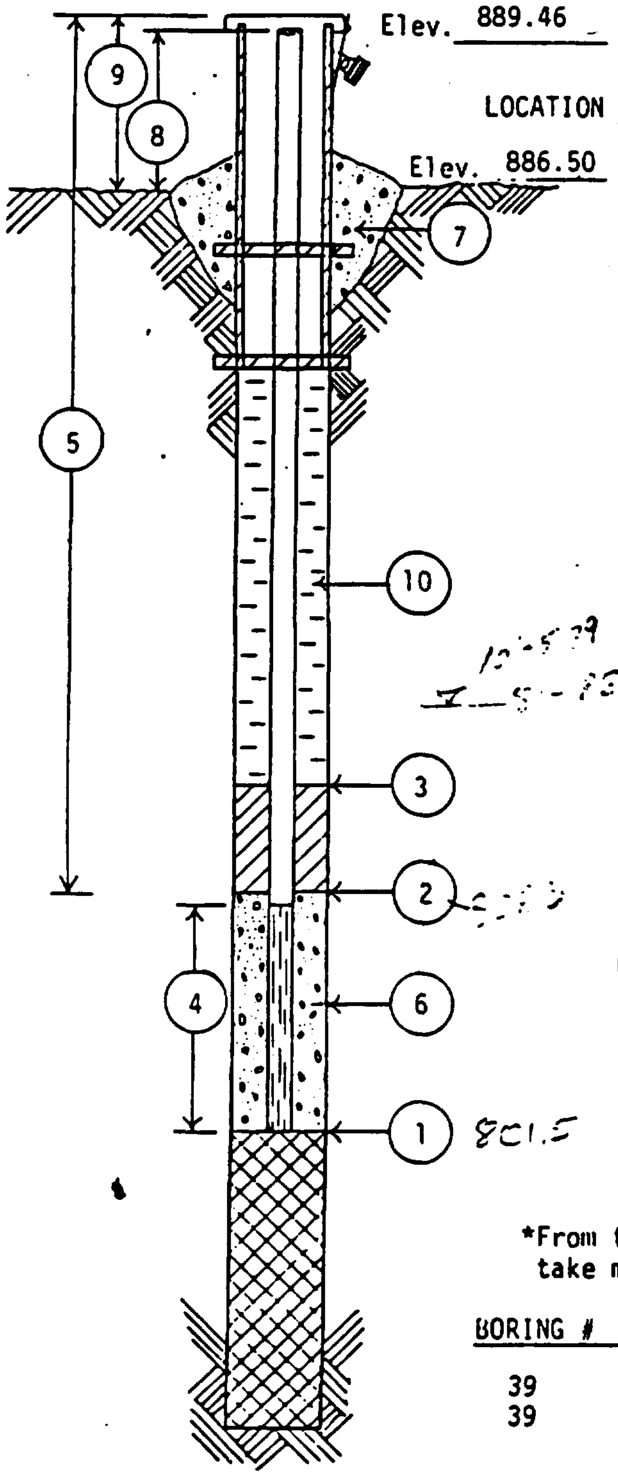
JOB NO. C 8327

BORING NO. 39

DATE 6/13/79

CHIEF J. Spurley

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 85 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 78 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 76 FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 5 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 83 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
39	6/14/79	¼ Hr.	72'	Bailed Down to 72'
39	6/15/79	24 Hr.	73	

WARZYN

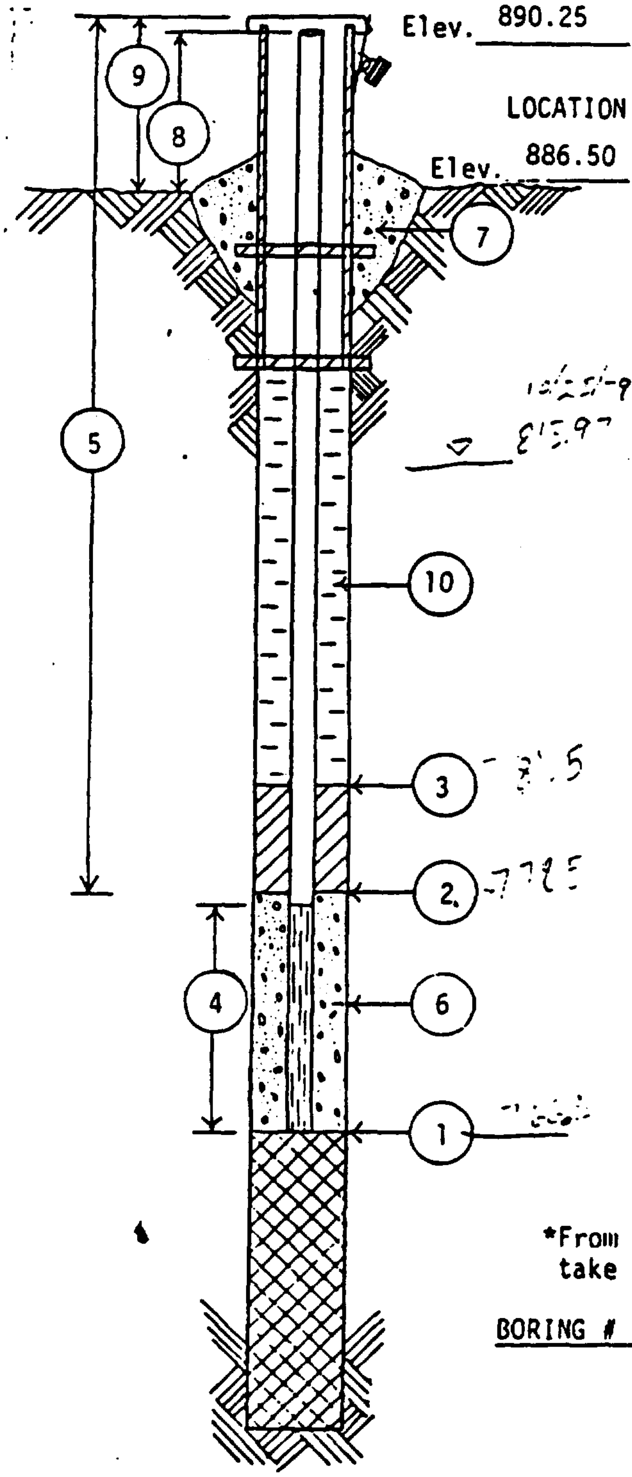
JOB NO. 8327

BORING NO. 39A

DATE 9/20/79

CHIEF L. Smith

LOCATION Lemberger Site, Manitowoc County, Wisconsin



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 120 FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 108 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 105 FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 10 FEET. (Circle One) [PVC WELL SCREEN circled]
5. TOTAL LENGTH OF PIPE 119 FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES NO (Circle One) [NO circled]
8. HEIGHT OF WELL CASING ABOVE GROUND 3 FEET.
9. PROTECTIVE CASING? YES NO (Circle One) [NO circled]
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (Circle One) [NO circled]
    TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS

WARZYN

WELL DETAIL INFORMATION SHEET

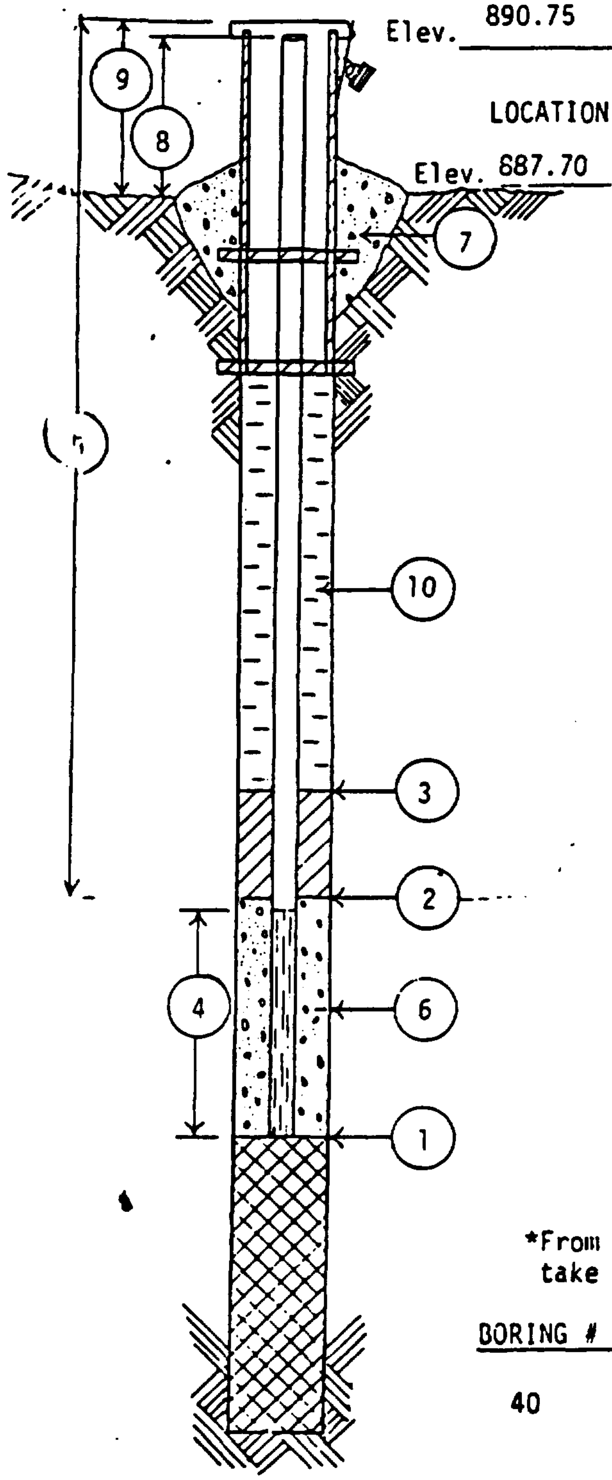
JOB NO. C 8327

BORING NO. 40

DATE 6/22/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 40 FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 5' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 36 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES NO (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (Circle One)
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (Circle One)
    TYPE OF BACKFILL: Spoils & Bentonite

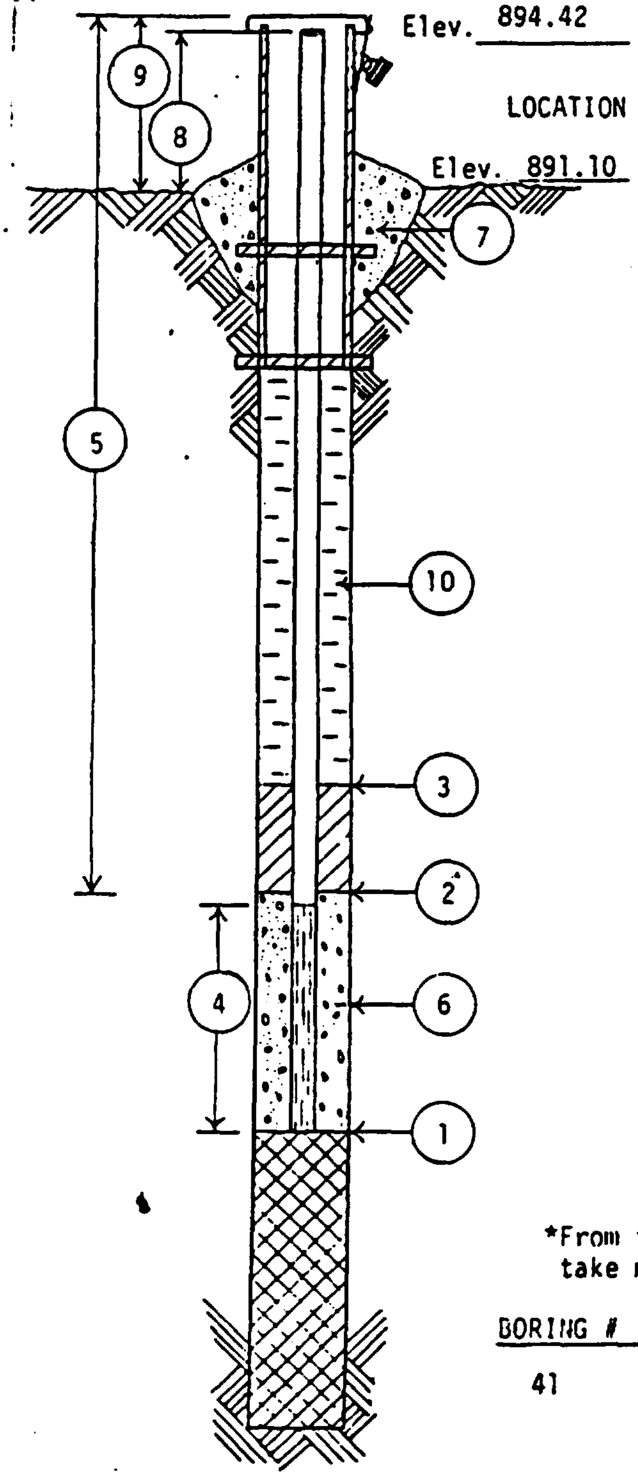
WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
40	4/22/79	AM	27.0	Bail/top of stickup
		5 min.	22.5	
		10 min.	21.0	

WARZYN

WELL DETAIL INFORMATION SHEET



JOB NO. C 8327

BORING NO. 41

DATE 6/27/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 31' FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 6' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 0' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 27 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES NO (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (Circle One)
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (Circle One)
    TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
41	6/27/79	AM	21'	From top After Bail

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WELL DETAIL INFORMATION SHEET

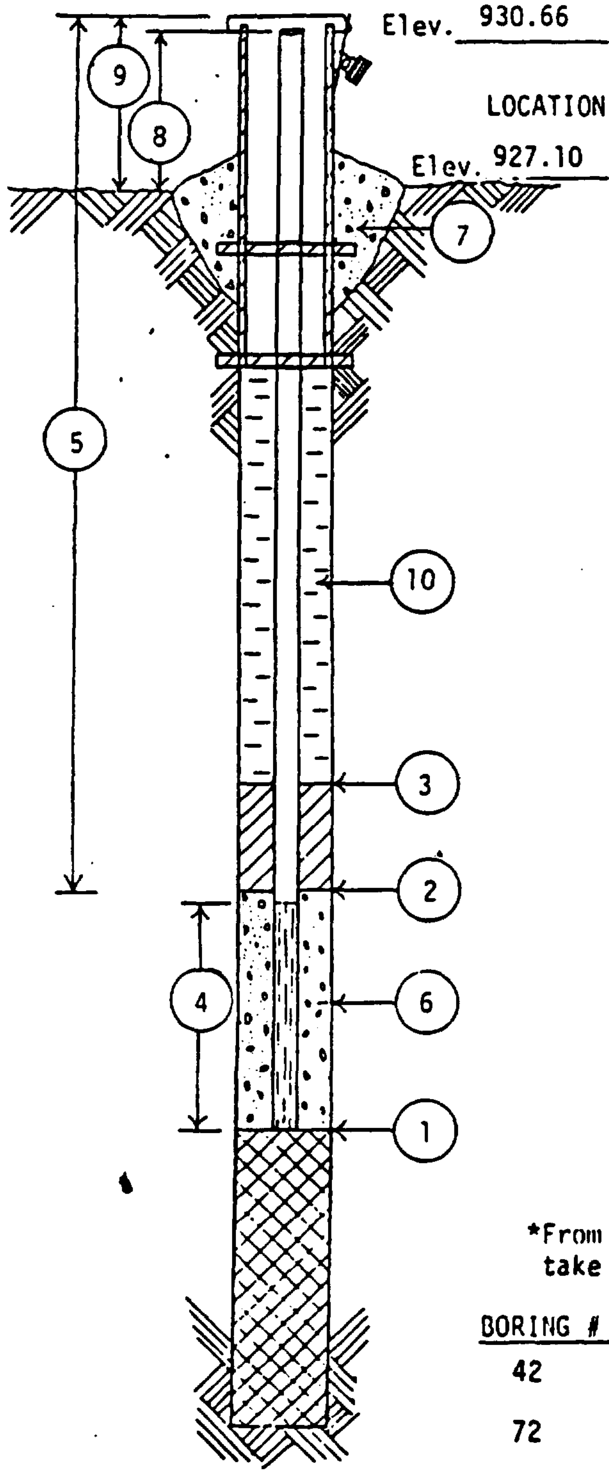
JOB NO. C 8327

BORING NO. 42

DATE 7/11/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 89' FEET. 86.6
   3' blank under well screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 70' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 65' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE ___ FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 83 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint.
7. CONCRETE CAP, YES NO (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3'6" FEET.
9. PROTECTIVE CASING YES NO (Circle One) HEIGHT ABOVE GROUND ___.
10. LOCKING CAP? YES NO (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECK

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
42	7/11/79	PM	72'	From top After Bail
72	7/12/79	AM	50.[illegible]	" "

WARZYN

WELL DETAIL INFORMATION SHEET

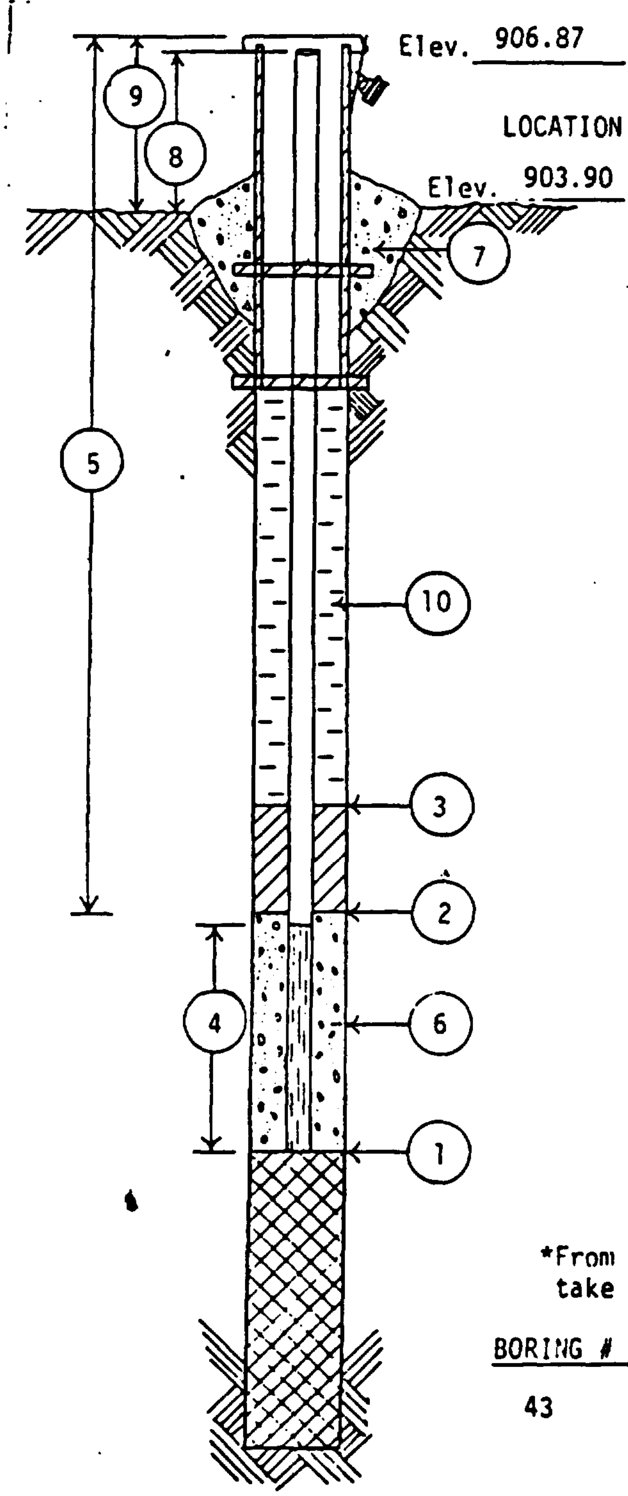
JOB NO. 8327

BORING NO. 43

DATE 6/14/79

CHIEF J. Spurley

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 40 FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 28 FEET.
3. DEPTH TO TOP OF SEAL (if installed) 26 FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN (circled), OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 33 FEET @ 2 IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES NO (circled) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (circled) (Circle One) HEIGHT ABOVE GROUND ________.
10. LOCKING CAP? YES NO (circled) (Circle One) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
43	6/15/79	24 Hr.	13'	

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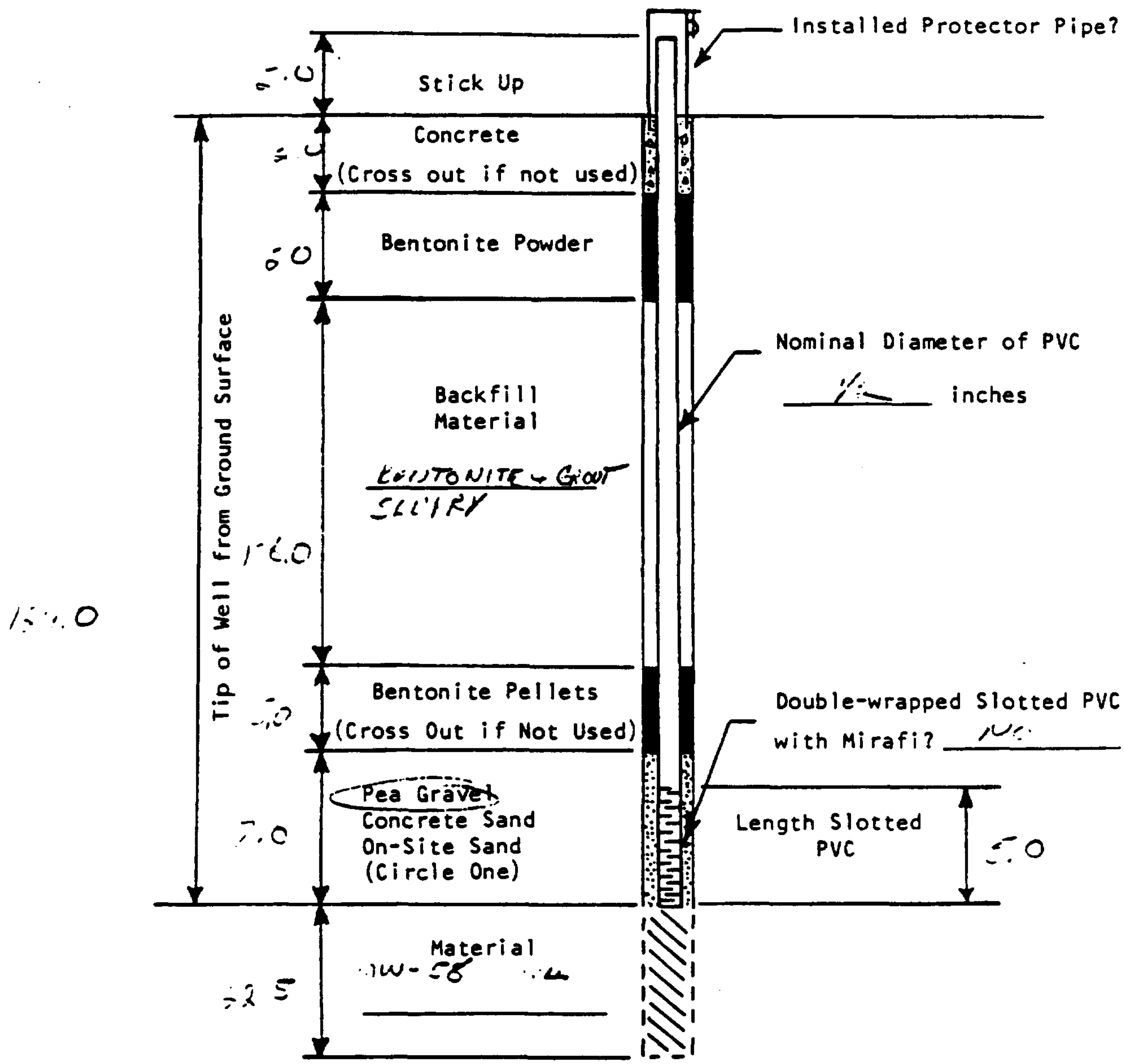
FIELD WELL INSTALLATION DIAGRAM - AS INSTALLED

STS JOB NO. 11646 JOB ______

CLIENT Lancaster Landfill

WELL NO. MW-5A DATE INSTALLED 7-9-81



INSTALLATION

1. Did the bentonite pellets hang up? Some
2. Did you have to drive the protector pipe? NO
3. Did you install a lock on the protector pipe? YES
   If so, who has the keys? CLIENT
4. Did the PVC come up when you removed the casing? NO
5. Was the well bailed? [illegible]
6. Were water level readings taken after the well was installed? NO
7. Was a PVC cap installed on bottom of well? YES

BBS101978

APPENDIX J

Private Well Logs

PRIVATE WELL INFORMATION
LEMBERGER SITE

Adeline Baroun	Joseph or Adeline Baroun original owners Driller - Halverson; Drilled - late May or early June, 1969; Est. Depth 148' (rock 128')
Lee G. Brandenberg	Original Owner; Drilled about 3 years ago owner has no other data.
Norbert Braun	Charles Frittenberger original owner. Driller was probably Heartlob. Est. Depth 123'
John Burke	Mr. Siebert original owner; Est. Depth 197'
*John Denor (S. side Reifs Mills Rd.)	No information
*John Denor (N. side Reifs Mills Rd.)	Original owner; Driller - Joe Rehme; Drilled about 15 years ago; Est. Depth 161'
Terry Lemberger	Well at least 50 years old; Est. Depth 150' (cased 135')
Wayne Menza	Would not release information
Erwin Naidl	Edward Naidl original owner; Well at least 70 years old; Depth 193'
*Vern Oswald	Original owner; Driller - Joe Rehme Drilled June or July, 1968
Frank Polifka (S. side Reifs Mills Rd.)	Not original owner; Driller - George Zowerick; Est. Depth 150'
Frank Polifka (N. side Reifs Mills Rd.)	Not original owner; Driller - Frank Norbert; Drilled 1925; Est. Depth 140'
Joan Riechardt	Frank Naidl original owner; Driller - Heartlob; Drilled 1937; Est. Depth 100'
Victor Shavlik	Joseph Himmick original owner; Driller - George Zowerick or Heartlob; Est. Depth 124' (cased 114')
Robert Shamburek	Original owner; Drilled - 1965; Est. depth 160'-180'
Addie Siebert	Mr. Siebert original owner; Driller - Joe Fisher; Drilled 1917 or 1918

*See State Well Constructor's Report

WARZYN
ENGINEERING INC

Victor Tisler	Est. Depth 140' (cased 100')
Robert Wellner	Original owner; Driller - Joe Rehme; Drilled 1969; Est. Depth 300'
Scott Wellner	No Information
Wisconsin Fittings	Frank Naidl original owner; well 75 to 100 years old; Est. Depth 100'
Charles Oswald	John Oswald original owner; Driller - Heartlob; Est. Depth 82'

WARZYN ENGINEERING INC

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Anthony S. Earl
Secretary

BOX 7921
MADISON, WISCONSIN 53707

November 5, 1979

IN REPLY REFER TO: 3320

Mr. Robert Karnauskas
Warzyn Engineering, Inc.
1409 Emil Street
P.O. Box 9538
Madison, Wisconsin 53715

Ed

Dear Mr. Karnaukas:

Enclosed are copies of the only two well construction reports I could find for the wells listed in your October 26, 1979 letter. The vast majority of the wells listed pre-date the Water Supply program (1936)and therefore no logs are available. The others I could not locate, based upon the information supplied.

You or a member of your staff are welcome to come to the office and search our records. Please give me a few days notice if you plan to do this so arrangements can be made with the Record Center if necessary.

Sorry we couldn't be more helpful.

Sincerely,
Bureau of Water Quality

Roger A. Gerhardt
Private Water Supply Section

RAG:ijs

WELL CONSTRUCTOR'S REPORT — DEPARTMENT OF RESOURCE DEVELOPMENT — Wel 6

COUNTY: Manitowoc
CHECK ONE: [X] Town [ ] Village [ ] City
NAME: Franklin

LOCATION (Number and Street or ¼ section, section, township and range. Also give subdivision name, lot and block numbers when available.)
NW ¼ of Sec. 25 T 20 N R 22 E

OWNER AT TIME OF DRILLING
Vernon Oswald

OWNER'S COMPLETE MAIL ADDRESS
Rt 1 Whitelaw Wisc.

Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY SEWER C. I.	SANITARY SEWER TILE	FLOOR DRAIN C. I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C. I.	WASTE WATER DRAIN TILE
15	—	—	—	—	—	X	—	—

CLEAR WATER DRAIN C. I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE
—	—	—	—	—	—	—	—	—	—

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)

Well is intended to supply water for: Home use

DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	20	6	20	162

CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	steel std 19.45 lb per foot new black pipe	Surface	89

GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
drill slurry	Surface	20

10. FORMATIONS

Kind	From (ft.)	To (ft.)
Clay	Surface	76
Sand gravel	76	89
limestone	89	162

MISCELLANEOUS DATA
Yield test: 3 Hrs. at 17 GPM
Depth from surface to normal water level 22 ft.
Depth to water level when pumping 28 ft.

Well construction completed on Aug 3 - 1968
Well is terminated 18 inches [X] above [ ] below final grade
Well disinfected upon completion [X] Yes [ ] No
Well sealed watertight upon completion [X] Yes [ ] No

Water sample sent to Madison laboratory on: Aug 6 1968

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, subsurface pumprooms, access pits, etc., should be given on reverse side.

Approv Sampl 8-12-68

SIGNATURE: Joseph Riebe Registered Well Driller
COMPLETE MAIL ADDRESS: 4217 Conrad St. Manitowoc Wis.

Please do not write in space below

COLIFORM TEST RESULT	GAS — 24 HRS.	GAS — 48 HRS.	CONFIRMED	REMARKS

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH
See Instructions on Reverse Side

1. County Manitowoc — Town ☒ Village ☐ City ☐ Franklin
Check one and give name

RECEIVED

2. Location Sec. 23 T 20 N R 22 E
Name of street and number of premise or Section, Town and Range numbers

3. Owner ☒ or Agent ☐ John Dickson
Name of individual, partnership or firm

4. Mail Address Rt. 1 Mishicot Wis.
Complete address required

SANITARY ENGINEERING

5. From well to nearest: Building 10 ft; sewer 30 ft; drain 90 ft; septic tank 85 ft; dry well or filter bed 115 ft; abandoned well 174 ft.

6. Well is intended to supply water for: Home & Farm

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	0	20	6	0	174

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	Std. Stl.	0	54

9. GROUT:

Kind	From (ft.)	To (ft.)
Puddled Clay	0	20

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
Clay	0	54
Limestone	54	174

11. MISCELLANEOUS DATA:

Yield test: 3 Hrs. at 20 GPM.

Depth from surface to water-level: 25 ft.

Water-level when pumping: 35 ft.

Water sample was sent to the state laboratory at: Manitowoc (City) on 12/24 1944

Construction of the well was completed on: Dec. 1944

The well is terminated 10 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes x No

Was the well sealed watertight upon completion? Yes x No

Signature Joseph Pelkin — Registered Well Driller

4417 Conrad St. Manitowoc Wis. — Complete Mail Address

Please do not write in space below

Rec'd No.

Ans'd

Interpretation

	10 ml	10 ml	10 ml	10 ml	10 ml
	Approx. Survey #862				
Gas—24 hrs.		6.4	72		
48 hrs.					
Confirm					
B. Coli					

Examiner

APPENDIX K

Water Level Elevations

LEMBERGER - HORIZONTAL EXPANSION
WATER LEVEL ELEVATIONS

WELL MW	TOP OF PVC PIPE	GROUND WATER ELEVATION													
		6/28/79	7/2/79	8/15/79	8/22/79	8/30/79	9/7/79	9/12/79	9/14/79	9/18/79	9/27/79	10/6/79	10/25/79	6/17/81	7/27/81
28	912.70								871.36	870.69	870.75	870.51	870.68	901.07	--
29	878.32	873.02	872.92	--	872.32	872.44	872.19	--	841.29	821.05	808.60	810.08	809.94	871.71	--
29A	878.37							862.29	862.36	862.19	861.94	861.64	861.40	812.10	812.14
30	878.09	864.89	864.79	--	862.99	863.14	862.58	871.72	872.35	872.34	868.81	868.53	868.65	862.48	--
31	883.42	872.02	870.72	--	870.72	871.17	871.26	Dry	876.55*	Dry	876.61*	Dry	Dry	869.36	--
32	905.32				Dry	876.58*	876.56*	Dry	Dry	Dry	--	Dry	Dry	876.47	--
33	882.90			847.25	Dry	854.37*	845.54	841.50	841.46	Dry	841.00	Dry	Dry	854.33	--
34	875.10			848.45	846.20	844.98	843.00	810.77	807.31	805.58	805.48	805.55	805.41	861.86	858.38
35	853.77							806.90	804.09	804.06	803.58	803.69	803.14	--	Dry
36	853.60							Dry	Dry	Dry	868.07*	Dry	Dry	--	798.75
37	890.09			Dry	867.59*	868.06*	867.97*	--	875.54	875.47	874.14	874.08	873.41	868.02	--
38B	889.40			876.40	876.40	876.18	875.82	815.26	815.45	815.45	814.96	814.98	814.88	879.03	--
39	889.46			816.06	815.16	Dry	815.57	859.15	--	--	814.66	814.69	813.97	813.48	813.49
39A	890.25							859.65	859.64	859.34	858.69	858.02	853.43	812.75	812.37
40	890.75	869.05	868.35	861.65	861.05	860.82	860.19	884.72	884.77	884.71	884.56	884.34	883.43	863.20	--
41	894.42		886.62	884.92	885.02	885.19	844.97	Dry	840.10	Dry	850.33*	840.13	Dry	885.29	--
42*	930.66			840.10	Dry	849.90*	850.24*	883.77	883.93	884.27	884.06	883.47	882.29	--	--

Datum: mean sea level
*Knocked Out

LEMBERGER - HORIZONTAL EXPANSION (Cont'd)
WATER LEVEL ELEVATIONS

WELL MW	TOP OF PVC PIPE	GROUND WATER ELEVATION													
		6/28/79	7/2/79	8/15/79	8/22/79	8/30/79	9/7/79	9/12/79	9/14/79	9/18/79	9/27/79	10/6/79	10/25/79	6/17/81	7/27/81
43	906.84	887.07	886.87	885.07	884.67	884.55	884.09	--	--	--	822.87	822.57	821.51	884.47	--
43A	906.75		891.02	--	--	--	--	Dry	Dry	Dry	Dry	Dry	Dry	819.64	819.40
44	897.66			Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	--
45	897.66			Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	--
46	881.94			Dry	Dry	Dry	Dry	--	--	Dry	Dry	Dry	Dry	819.40	Dry
46A	881.39			Dry	Dry	Dry	Dry	--	--	837.32	814.26	814.20	813.58	813.29	812.98
47	913.55	849.75*	849.55*	848.55*	849.45*	Dry	Dry	Dry	Dry	849.88*	Dry	Dry	Dry	849.85	--
51	904.88				865.98	864.62	863.79	ND	863.74	863.75	863.73	863.46	862.04	859.96	--
56	876.79						814.25	ND	814.05	813.94	813.85	813.89	813.24	--	--
57														--	814.40
58	930.58													--	833.20
58A	930.70													--	832.60

Datum: mean sea level
*Knocked out

APPENDIX L

DNR Wetland Analysis
July 25, 1980

File

CORRESPONDENCE/MEMORANDUM

STATE OF WISCONSIN

Date: July 25, 1980

File Ref: 4400

To: Files

From: Mark Walstrom MW

Subject: Wetland Analysis of Areas Adjacent to the Proposed Lemberger Landfill Site, Manitowoc County.

On May 29, 1980, Ken Quinn, Gene Mitchell and the author of the Bureau of Solid Waste Management visited the Lemberger proposed landfill site in Manitowoc County. The purpose of the visit was to roughly determine the quality and types of wetland vegetation communities adjacent to the proposed landfill.

Vegetation communities were analyzed by noting species composition in the field, the relative amount of disturbance, and age and apparent stability of the stands. Physical conditions, such as standing water, relative elevation, etc., were also noted.

Vegetation communities observed are noted on the attached drawings (Appendix A), as is the route we walked.

1. Notes: The wetland just east of staff gauge 1 was very wet with standing water at least ankle-deep. The area was very disturbed, with trees tipped and uprooted and numerous torn-up areas. The plant community was of little value and of very low quality.

Vegetation Present[1]: Trees - White Cedar, Green Ash

Groundlayer - Grasses, Sedges, Marsh Marigold, Skunk Cabbage.

2. Notes: This wetland was very disturbed along the northern edge. The trees along this edge were tipped into the wetland and the area was dug-up. The community was at one time a good White Cedar swamp, but was recently disturbed substantially. The water was at least knee-deep. White Cedar was the most common plant in this area.

3. Notes: This was the largest and highest quality wetland in the area, but was disturbed along the northern edge. The disturbance did not appear to have affected the wetland substantially, and if no more pertebation occurs, this could remain a good quality wetland. We saw a small Heron in the area, so it obviously has some wildlife value. The standing water was at least knee-deep.

[1] A species list is included in this report as Appendix B.

The area was probably a wet sedge meadow at one time. The physical disturbance (and possibly water level changes) appeared to have allowed the introduction of cattails, which were abundant in the northern protion. The center portion of the wetland consisted of a dense group of shrubs; possibly willow.

Vegetation Present: Cattails, Scouring rush, Three-Way Sedge, Duckweed, Water Plantain, many sedges and grasses.

The wetland was surrounded by White Cedar and Pines.

4. Very disturbed, dried-up area, with few plants except some dry mosses, grasses and sedges. This area has little value as a wetland.

5. Dried-up, small area with sedges, cattails, grasses, green ash, white cedar, trembling aspen, American Elm, and Willows. This area is of good quality and relatively undisturbed.

6. Moist, small area of good quality with little disturbance. Vegetation present was sedges, grasses, Water Plantain, Cattails and Willows.

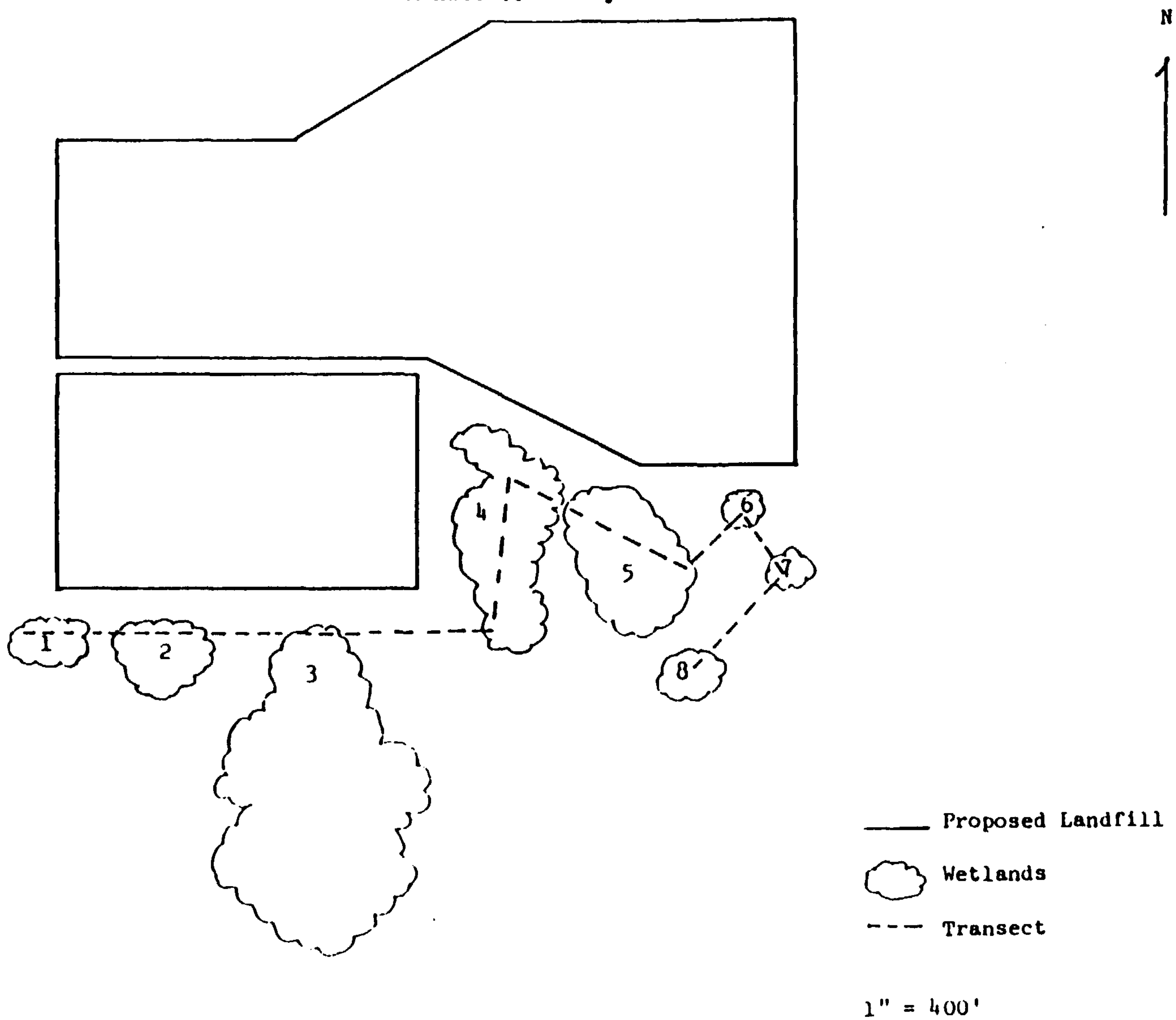
7. This is a small glacial pot hole, surrounded by cornfield. It is disturbed and was recently ditched down the center. The major area is not of much value or consequence, due to small size and disturbance. The area contained a homogenous stand of sedge, with a few grasses, mustards and willows.

8. A small pot hole with some standing water, mostly consisting of sedges. This area was small and relatively undisturbed.

7/24/80

LEMBEGER PROPOSED LANDFILL SITE

Manitowoc County



Appendix B

Species List

White Cedar	Thuja occidentalis
Green Ash	Fraxinus pennsylvanica vas. subintegerrima
Willow	Salix spp.
Trembling aspen	Populus tremuloides
American Elm	Ulmus americana
Marsh Marigold	Caltha palustris
Skunk Cabbage	Symplocarpus foetidus
Cattails	Typha latifolia
Scouring Rush	Equisetum hymale
Three-Way Sedge	Dulichium arundinaceum
Duckweed	Lemna minor
Water Plantain	Alisma plantago - aquatica

APPENDIX M

NR180
Locational Criteria

NR180 LOCATIONAL CRITERIA

Locational Criteria for NR180.12(3)	Does the proposed expansion site violate the criteria?
1. Within 1,000 feet of any navigable lake, pond or flowage.	No
2. Within 300 feet of a navigable river or stream.	No
3. Within a flood plain.	No
4. Within 1,000 feet of the nearest edge of the right-of-way of any state trunk highway, interstate or federal aid primary highway or the boundary of any public park, unless the site is screened by natural objects, plantings, fences or other appropriate means so as not to be visible from the highway or park.	No
5. Within wetlands.	No (See Appendix L & Section 2.5)
6. Within critical habitat areas.	No (See Appendix R)
7. Within an area where the department after investigation finds that there is a reasonable probability that disposal of solid waste within such an area will have a detrimental effect on any surface water.	No, based on design, see Section 2.5
8. Within an area where the department after investigation finds that there is a reasonable probability that disposal of solid waste within such an area will have a detrimental effect on ground water quality.	No, based on design, see Section 2.4.3 No, based on design
9. Within 10,000 feet of any airport runway used or planned to be used by turbojet aircraft or within 5,000 feet of any airport runway used only by piston type aircraft or within such other area where a substantial bird hazard to aircraft would be created, unless a waiver is granted by the Federal Aviation Administration, but these criteria are only applicable where such site or facility is used for disposing of putrescible waste such that a bird hazard to aircraft would be created.	No
10. Within 1,200 feet of any public or private water supply well.	No (See Plan Sheet 2)

APPENDIX N

State Historical Society Letter
November 2, 1979

HISTORIC PRESERVATION DIVISION

November 2, 1979

Mr. Steven Wittmann
Warzyn Engineering, Inc.
1409 Emil Street
P.O. Box 9538
Madison, Wisconsin 53715

SHSW: 758-79
RE: County-wide Sanitary Landfill Site
Manitowoc County

Dear Mr. Wittmann:

We are in receipt of your letter of 22 October 1979 regarding the above referenced project.

Based on the information you submitted, the construction of a sanitary landfill on the Lemberger property will not affect any buildings listed on, or eligible for inclusion on, the National Register of Historic Places.

No systematic archeological survey work has been done in this part of Manitowoc County, so we do not know the location of all such sites that might be affected by this project. What information we do have indicates that there are two known prehistoric campsites (Mn-320 and Mn-108) in Section 26 adjoining the project area, as well as a number of additional sites in neighboring sections. Considering the proximity of these sites to the project area, we feel that it is highly probable that archeological material may be present on the property.

We recommend that the Lemberger property be surveyed by a qualified archeologist to locate and evaluate the significance of any cultural material that may be present. This survey is required for compliance with Section 106 of the National Historic Preservation Act of 1966 (PL 89-665) and the federal regulations concerning the Protection of Historic and Cultural Properties (36 CFR Part 800). A copy of the archeologist's report should be forwarded to our office for our review and comments.

Should you have any questions on this matter, please contact me. My telephone number is (608) 262-2732.

Sincerely,

Richard W. Dexter

Richard W. Dexter
Compliance Coordinator

RWD:dbd

APPENDIX O

Site Archeologist Letter
August 13, 1981

13 August 1981

Mr. Ted Juszczyk
Project Engineer
Residuals Management Technology
1406 East Washington Avenue
Suite 122
Madison, WI 53703

Dear Mr. Juszczyk:

This letter is to confirm our correspondence and conversation regarding an archaeological survey of the proposed Lemberger Landfill expansion site in Manitowoc Co., Wisconsin. I will be available to conduct the survey of the project area in accordance with the requirements of the State Historical Society. Because the project area is presently in high corn, archaeological survey would not be effective. I therefore propose to conduct the survey of the area after the crop is taken. I would estimate that the actual field survey will be conducted in October of this year.

Prior to the actual field survey, I will conduct the necessary literature search and examine the site codification files of the State Historical Society. This research is a necessary part of any cultural resources survey and can be completed prior to the field project.

The field work will be conducted by myself and a crew of three. I anticipate that the fieldwork will take one to two days and additional literature review and project report preparation will require another two days. I will submit the final report on the cultural resources survey within one week of the completion of the field survey.

If you would like additional information on the nature of the cultural resources survey, please do not hesitate to contact me.

Cordially,

T. Douglas Price, Ph.D.

Department of Anthropology
5240 Social Sciences Building
University of Wisconsin
Madison, WI 53706

Home: 258-8346
Office: 262-4343

APPENDIX P

Manitowoc County Planning and
Park Commission Zoning Letter
August 12, 1981

Manitowoc County Planning and Park Commission
1701 MICHIGAN AVENUE MANITOWOC, WISCONSIN 54220
PLANNING AND PARK 414-684-1252
CODE ADMINISTRATION 414-684-3411

August 12, 1981

TO WHOM IT MAY CONCERN:

Manitowoc County, Wisconsin has adopted certain ordinances pursuant to Wisconsin State Statutes. Those ordinances are: Manitowoc County Setback Ordinance, Manitowoc County Zoning Ordinance, Manitowoc County Shoreland-Floodplain Zoning Ordinance, Manitowoc County Sanitary Ordinance, Manitowoc County Subdivision Regulations.

The Township of Franklin, Manitowoc County, Wisconsin has not adopted the Manitowoc County Zoning Ordinance, nor has it adopted a Town Zoning Ordinance. Other ordinances, however, do apply.

Specifically, Section 26, T20N-R22E, located in the Town of Franklin, Manitowoc County, Wisconsin is not under the jurisdiction of the Manitowoc County Zoning Ordinance or the Manitowoc County Shoreland-Floodplain Zoning Ordinance. Other County Ordinances do apply.

If there are further questions on this matter, please contact this office.

Very truly yours,

J. Thomas McCarty

J. Thomas McCarty
Code Administrator
rms

APPENDIX Q

Operational and Post-Closure Water Budget

LEMBERGER HORIZONTAL EXPANSION

The data sources used to prepare the information used in the following tables are:

DATA	SOURCE
Mean Monthly Air Temperatures (1951-1980)	Climate of Wisconsin NOAA
Mean Monthly Precipitation (1951-1980)	Climate of Wisconsin NOAA
Conversion and Computation Tables	Thornthwaite and Mather (1957)
Runoff Coefficients	ASCE (1969) and Thornthwaite and Mather
Water Holding Capacity of Soil	USDA (1976)
Moisture Holding Capacity of Refuse	USEPA (1975)
Evaporation from Bare Ground	USEPA (1981)

OPERATIONAL WATER BUDGET

1. Assumptions

   A. All rainfall falling on each daily cell will infiltrate.
   B. Part of the rainfall falling on the covered part of the active area will evaporate

2. Methodology

   A. Leachate Produced by Each Daily Cell in One Year

      1. Each daily cell is assumed to be 61 ft x 61 ft ($3,780\ ft^2$)
      2. Since one cell is open each day, over one year all the rainfall falling over this area will produce leachate
         $3,780\ ft^2 \times \frac{28.82"/year}{12"/ft} \times 7.48\ gal/ft^3 = 68,000\ gal/yr$
         (mean yearly precipitation)

   B. Evaporation From Covered Active Area

      1. EPA model indicates that, for a cover of 6" of sandy loam with a slope of .1% and no vegetation, the 5-year average evapotranspiration will be 15.3" (see pages Q-15 to Q-20).

2. The 20-year average annual precipitation at Manitowoc is 28.82" slightly lower than the 32.1" used in the EPA program. Therefore, we assumed that the average evapotranspiration was 13.7"/yr.

C. Infiltration into Covered Area

1. During the time the first lift of each module is filled with refuse, leachate will be produced over only that portion of the module filled with refuse. We assumed that on the average, during the time taken to fill the first lift with refuse only half the area of the module produced leachate. For each succeeding lift, leachate will be produced over the total area of the module.

2. Infiltration into covered area = Average Yearly Precipitation - Average Evapotranspiration

28.8" - 13.7" = 15.1"

D. Infiltration After Closure

1. The final grades of the landfill have two different slopes above the refuse. Since the amount of infiltration is dependent on slope, the amount of each module covered by slopes of 5% and 25% was calculated to estimate infiltration into the refuse.

2. Tables showing the calculations for infiltration on 5% and 25% slopes are on pages Q-10 and Q-11.

3. Since the final cover will be constructed with an underdrain, only a small proportion of the infiltration through the clay cap will actually reach the refuse. Wong's analysis was used to compute how much of the infiltration through the clay cover would drain off in the granular layer. Wong's analysis Appendix R shows that theoretically only 0.6" of infiltration would reach the refuse beneath the 5% slopes and only 0.05" of infiltraton would reach refuse beneath the 25% slopes.

4. Since only a small portion of the final grades are 7.7%, 5% grades were used in these areas to simplify computations. This will result in a more conservative estimate for leachate generation.

3. <u>Calculations for Operational Water Budget</u>

A. Post-Closure Infiltration (Average Year)

1. Module I

Years 5-9

$173{,}000\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 64,700 gallons
(Area 5%)

$184{,}000\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 5,700 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 70,000

Years 10+

$359{,}000\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 134,300 gallons
(Area 5%)

$228{,}000\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 7,100 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 141,000

2. Module II

Years 10-14

$261{,}800\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 97,900 gallons
(Area 5%)

$68{,}600\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 2,100 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 100,000

Year 15+

$453{,}500\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 169,600 gallons
(Area 5%)

$121{,}600\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 3,800 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 173,000

3. Module III

Years 15-22

$305{,}000\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 114,000 gallons
(Area 5%)

$81{,}000\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 2,500 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 116,500

Years 23+

$510{,}000\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 190,700 gallons
(Area 5%)

$131{,}200\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 4,100 gallons
(Area 25%)

TOTAL GALLONS/YEAR: 195,000

4. Module IV

Years 23+

$430{,}000\ ft^2 \times \frac{0.6"}{12"/ft} \times 7.48\ gal/ft^3 =$ 160,800 gallons
(Area 5%)

$273{,}400\ ft^2 \times \frac{0.05"}{12"/ft} \times 7.48\ gal/ft^3 =$ 8,500 gallons

TOTAL GALLONS/YEAR: 169,000

B. Infiltration During Active Life of Each Module

1. Module I (Area = $587{,}000\ ft^2$)
Year 1
a. Covered Area
- Lift 1
$1/2 \times 587{,}000\ ft^2 \times \frac{155\ days}{365\ days/yr} \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3 =$
1,173,000 gal

- Lift 2+
$587{,}000\ ft^2 \times \frac{(365-155)\ days}{365\ days/yr} \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3 =$
3,179,000 gal

b. Open Area 68,000 gal

Total: 4,420,000 gal

Years 2-4

a. Covered Area

$587,000\ ft^2 \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3$ = 5,525,000 gal

b. Open Area — 68,000 gal

Total: 5,590,000 gal/yr

Years 5-9

a. Covered Area

$230,000\ ft^2 \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3$ = 2,165,000 gal

b. Closed Area = 70,000 gal

Total: 2,235,000 gal/yr

Years 10+

a. Closed Area — Total: 140,000 gal/yr

2. Module II (Area = 575,100 ft^2)

Year 5

a. Covered Area

- Lift 1

$1/2 \times 575,100\ ft^2 \times \frac{152\ days}{365\ days/yr} \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3$ = 1,127,000 gal

- Lift 2

$575,100\ ft^2 \times \frac{(365-152)\ days}{365\ days/yr} \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3$ = 3,159,000 gal

b. Open Area = 68,000 gal

Total: 4,350,000 gal

Years 6-9

a. Covered Area

$575,100\ ft^2 \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3$ = 5,413,000 gal

b. Open Area — 68,000 gal

Total: 5,480,000 gal/yr

Years 10-14

a. Covered Area

$244{,}700 \text{ ft}^2 \times \frac{15.1"}{12"/\text{ft}} \times 7.48 \text{ gal/ft}^3 =$

2,303,000 gal

b. Closed Area — 100,000 gal

Total: 2,403,000 gal

Years 15+

a. Closed Area — **Total:** 173,000 gal/yr

3. Module III (Area = 641,200)
   1. Year 10

a. Covered Area

- Lift 1

$0.5 \times 641{,}200 \text{ ft}^2 \times \frac{15.1"}{12"/\text{ft}} \times \frac{170 \text{ days}}{365 \text{ days/yr}} \times 7.48 \text{ gal/ft}^3 =$

1,405,000 gal

- Lift 2

$641{,}200 \text{ ft}^2 \times \frac{(365-170) \text{ days}}{365 \text{ days/yr}} \times \frac{15.1"}{12"/\text{ft}} \times 7.48 \text{ gal/ft}^3 =$

3,224,000 gal

b. Open Area — 68,000 gal

Total: 4,700,000 gal

Year 11-14

a. Covered Area

$641{,}200 \text{ ft}^2 \times \frac{15.1"}{12"/\text{ft}} \times 7.48 \text{ gal/ft}^3 =$ 6,035,000 gal

b. Open Area — 68,000 gal

Total: 6,100,000 gal

Years 15-22

a. Covered Area

$255{,}200\text{ft}^2 \times \frac{15.1"}{12"/\text{ft}} \times 7.48 \text{ gal/ft}^3 =$

2,402,000 gal

b. Closed Area — 116,500 gal

Total: 2,520,000 gal

Years 23+

a. Closed Area — **Total:** 195,000 gal

4. Module IV (Area = 703,400 ft^2)

Year 15

a. Covered Area

- Lift 1

$$1/2 \times 703{,}400\ ft^2 \times \frac{15.1"}{12"/ft} \times \frac{186\ days}{365\ day/yr}\ 7.48\ gals/ft^3 =$$

1,687,000 gal

- Lift 2

$$703{,}400\ ft^2 \times \frac{15.1"}{12"/ft} \times \frac{(365-186)\ days}{365\ days/yr} \times 7.48\ gal/ft^3 =$$

3,247,000 gal

b. Open Area — 68,000 gal

Total: 5,000,000 gal

Years 16-22

a. Covered Area

$$703{,}400\ ft^2 \times \frac{15.1"}{12"/ft} \times 7.48\ gal/ft^3 =$$

6,621,000 gal

b. Open Area — 68,000 gal

Total: 6,690,000 gal

Years 23+

a. Closed Area

Total: 170,000 gal

C. Moisture Holding Capacity of Refuse

Assume 191,000 cy of refuse landfilled/year

191,000 cy x 30 gal/cy = 5,730,000 gal/year moisture holding capacity of refuse

Module I

Years 1-4

Volume Available/Year of Phase I = 5,730,000 gal/yr

Years 5-9

1/5 Volume Available/Year of Phase II = 1,146,000 gal/yr

Years 10+ = 0

Module II

Years 5-9

4/5 Volume Available/Year of Phase II = 4,584,000 gal/yr

Years 10-14

1/5 Volume Available/Year of Phase III = 1,146,000 gal/yr

Years 15+ = 0

Module III

Years 10-14

4/5 Volume Available/Year of Phase III = 4,584,000 gal/yr

Years 15-22

1/5 Volume Available/Year of Phase IV = 1,146,000 gal/yr

Years 23+ = 0

Module IV

Years 15-22

4/5 Volume Available/Year of Phase IV = 4,584,000 gal/yr

Years 23+ = 0

4. SUMMARY OF LEACHATE GENERATION DURING OPERATION

Year	Module I		Module II		Module III		Module IV		Total Leachate Generation (x 10^3 gal)
	Infiltration	Leachate*	Infiltration	Leachate*	Infiltration	Leachate*	Infiltration	Leachate*	
1	4,420,000	0	0	0	0	0	0	0	0
2	5,590,000	0	0	0	0	0	0	0	0
3	5,590,000	0	0	0	0	0	0	0	0
4	5,590,000	0	0	0	0	0	0	0	0
5	2,235,000	0	4,350,000	0	0	0	0	0	0
6	2,235,000	450,000	5,480,000	660,000	0	0	0	0	1,110
7	2,235,000	1,090,000	5,480,000	900,000	0	0	0	0	1,990
8	2,235,000	140,000	5,480,000	900,000	0	0	0	0	1,040
9	2,235,000	140,000	5,480,000	900,000	0	0	0	0	1,040
10	140,000	140,000	2,400,000	1,250,000	4,700,000	120,000	0	0	1,510
11	140,000	140,000	2,400,000	1,250,000	6,100,000	1,520,000	0	0	2,910
12	140,000	140,000	2,400,000	1,250,000	6,100,000	1,520,000	0	0	2,910
13	140,000	140,000	2,400,000	1,250,000	6,100,000	1,520,000	0	0	2,910
14	140,000	140,000	2,400,000	1,250,000	6,100,000	1,520,000	0	0	2,910
15	140,000	140,000	170,000	170,000	2,520,000	1,370,000	5,000,000	420,000	2,100
16	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
17	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
18	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
19	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
20	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
21	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
22	140,000	140,000	170,000	170,000	2,520,000	1,370,000	6,690,000	2,110,000	3,790
23+	140,000	140,000	170,000	170,000	195,000	195,000	170,000	170,000	675

* Leachate = Percolation - Moisture Holding Capacity

Total Leachate Generation During 22-Year Site Life 49,960,000 gallons

Total Yearly Leachate Generation After Closure 675,000 gallons

MEAN 30-YEAR PRECIPITATION
MANITOWOC, WISCONSIN
5% SLOPES

PARAMETER	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL INCHES
TEMP F°	18.4	21.8	30.8	43.5	54.2	64.0	69.7	68.8	60.8	50.2	36.8	24.7	
HI	0	0	0	1.45	3.92	6.82	8.75	8.44	5.82	2.91	0.39	0	
UNADJ PE	0	0	0	0.04	0.07	0.11	0.14	0.13	0.10	0.06	0.02	0	
PET	0	0	0	1.34	2.67	4.26	5.46	4.68	3.12	1.71	0.48	0	23.72
P	1.30	1.25	2.21	2.82	2.92	3.14	3.20	3.11	2.79	2.22	2.05	1.81	28.82
$C_{R/O}$	0	0	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	-
R/O	0	0	3.28	0.56	0.58	0.63	0.64	0.62	0.56	0.44	0.41	0	7.72
I	0	0	3.29	2.26	2.34	2.51	2.56	2.49	2.23	1.78	1.64	0	21.10
I-PET	0	0	3.29	0.92	-0.33	-1.75	-2.90	-2.19	-0.89	0.07	1.16	0	-2.62
ΣNEG (I-PET)	-	-	-	-	-0.33	-2.08	-4.98	-7.17	-8.06	-	-	-	-
ST	1.42	1.42	3.0	3.0	2.67	1.46	0.54	0.26	0.19	0.26	1.42	1.42	-
ΔST	0	0	+1.58	0	-0.33	-1.21	-0.92	-0.28	-0.07	+0.07	1.16	0	0
AET	0	0	0	1.34	2.67	3.72	3.48	2.77	2.30	1.71	0.48	0	18.47
PERC	0	0	1.71	0.92	0	0	0	0	0	0	0	0	2.63

TEMP - Temperature
HI - Heat Index
UNADJ PE - Unadjusted Potential evapotranspiration
PET - Potential Evapotranspiration
P - Precipitation
$C_{R/O}$ - Coefficient of Runoff

R/O - Runoff
I - Infiltration
ST - Soil Moisture Storage
ΔST - Change in Storage
AET - Actual Evapotranspiration
PERC - Percolation

ANNUAL TEMPERATURE & PRECIPITATION DATA--NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION STATION LOCATED IN

2038X-7300/D102

MEAN 30-YEAR PRECIPITATION
MANITOWOC, WISCONSIN
25% SLOPES

PARAMETER	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL INCHES
TEMP F°	18.4	21.8	30.8	43.5	54.2	64.0	69.7	68.8	60.8	50.2	36.8	24.7	
HI	0	0	0	1.45	3.92	6.82	8.75	8.44	5.82	2.91	0.39	0	
UNADJ PE	0	0	0	0.04	0.07	0.11	0.14	0.13	0.10	0.06	0.02	0	
PET	0	0	0	1.34	2.67	4.26	5.46	4.68	3.12	1.71	0.48	0	23.72
P	1.30	1.25	2.21	2.82	2.92	3.14	3.20	3.11	2.79	2.22	2.05	1.81	28.82
$C_{R/O}$	0	0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0	-
R/O	0	0	3.94	1.69	1.75	1.88	1.92	1.87	1.67	1.33	1.23	0	17.28
I	0	0	2.63	1.13	1.17	1.26	1.28	1.24	1.12	0.89	0.82	0	11.54
I-PET	0	0	2.63	-0.21	-1.50	-3.0	-4.18	-3.44	-2.0	-0.82	0.34	0	-12.18
ΣNEG (I-PET)				-0.21	-1.71	-4.71	-8.89	-12.33	-14.33	-15.15			-
ST	0.47	0.47	3.0	2.79	1.66	0.59	0.13	0.13	0.13	0.13	0.47	0.47	-
ΔST	0	0	+2.53	-0.21	-1.13	-1.07	-0.46	0	0	0	+0.34	0	0
AET	0	0	0	1.34	2.30	2.33	1.74	1.24	1.12	0.89	0.48	0	11.44
PERC	0	0	0.1	0	0	0	0	0	0	0	0	0	0.1

TEMP - Temperature
HI - Heat Index
UNADJ PE - Unadjusted Potential evapotranspiration
PET - Potential Evapotranspiration
P - Precipitation
$C_{R/O}$ - Coefficient of Runoff

R/O - Runoff
I - Infiltration
ST - Soil Moisture Storage
ΔST - Change in Storage
AET - Actual Evapotranspiration
PERC - Percolation

ANNUAL TEMPERATURE & PRECIPITATION DATA--NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION STATION LOCATED IN

2038X-7300/D102

HIGHEST PRECIPITATION YEAR (1959)
1951-1980
MANITOWOC, WISCONSIN
5% SLOPES

PARAMETER	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL INCHES
TEMP F°	14.4	18.8	29.7	45.6	57.3	67.0	69.9	73.8	63.4	48.0	29.8	32.3	
HI	0	0	0	1.87	4.77	7.82	8.82	10.22	6.62	2.39	0	0	
UNADJ PE	0	0	0	0.04	0.09	0.12	0.13	0.15	0.11	0.05	0	0	
PET	0	0	0	1.34	3.43	4.64	5.07	5.40	3.43	1.42	0	0	24.73
P	1.50	3.55	4.33	3.27	3.96	2.40	4.51	4.90	5.31	5.38	2.83	4.49	46.43
$C_{R/O}$	0	0	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	-
R/O	0	0	8.35	0.65	0.79	0.48	0.90	0.98	1.06	1.08	0	0	14.29
I	0	0	8.35	2.62	3.17	1.92	3.61	3.92	4.25	4.30	0	0	32.14
I-PET	0	0	8.35	1.28	-0.26	-2.72	-1.46	-1.48	0.82	2.88	0	0	7.41
ΣNEG (I-PET)	-	-	-	-	-0.26	-2.98	-4.44	-5.92	-	-	-	-	-
ST	3.0	3.0	3.0	3.0	2.74	1.07	0.65	0.39	1.21	3.0	3.0	3.0	-
ΔST	0	0	0	0	-0.26	-1.67	-0.42	-0.26	+0.82	+1.79	0	0	0
AET	0	0	0	1.34	3.43	3.59	4.03	4.18	3.43	1.42	0	0	21.42
PERC	0	0	8.35	1.28	0	0	0	0	0	1.09	0	0	10.72

TEMP - Temperature
HI - Heat Index
UNADJ PE - Unadjusted Potential evapotranspiration
PET - Potential Evapotranspiration
P - Precipitation
$C_{R/O}$ - Coefficient of Runoff

R/O - Runoff
I - Infiltration
ST - Soil Moisture Storage
ΔST - Change in Storage
AET - Actual Evapotranspiration
PERC - Percolation

ANNUAL TEMPERATURE & PRECIPITATION DATA--NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION STATION LOCATED IN

2038X-7300/D102

HIGHEST PRECIPITATION YEAR (1959)
(1951-1980)
MANITOWOC, WISCONSIN
25% SLOPES

PARAMETER	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL INCHES
TEMP F°	14.4	18.8	29.7	45.6	57.3	67.0	69.9	73.8	63.4	48.0	29.8	32.3	
HI	0	0	0	1.87	4.77	7.82	8.82	10.22	6.62	2.39	0	0	
UNADJ PE	0	0	0	0.04	0.09	0.12	0.13	0.15	0.11	0.05	0	0	
PET	0	0	0	1.34	3.43	4.64	5.07	5.40	3.43	1.42	0	0	24.73
P	1.50	3.55	4.33	3.27	3.96	2.40	4.51	4.90	5.31	5.38	2.83	4.49	46.43
$C_{R/O}$	0	0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0	0	-
R/O	0	0	10.02	1.96	2.38	1.44	2.71	2.94	3.19	3.23	0	0	27.87
I	0	0	6.68	1.31	1.58	0.96	1.80	1.96	2.12	2.15	0	0	18.56
I-PET	0	0	6.68	-0.03	-1.85	-3.68	-3.27	-3.44	-1.31	0.73	0	0	-6.17
ΣNEG (I-PET)	-	-	-	-0.03	-1.88	-5.56	-8.83	-12.27	-13.58	-	-	-	-
ST	0.86	0.86	3	2.97	1.57	0.43	0.14	0.13	0.13	0.86	0.86	0.86	-
ΔST	0	0	+2.14	-0.03	-1.40	-1.14	-0.29	-0.01	0	+0.73	0	0	0
AET	0	0	0	1.34	2.98	2.10	2.09	1.97	2.12	1.42	0	0	14.02
PERC	0	0	4.54	0	0	0	0	0	0	0	0	0	4.54

TEMP - Temperature
HI - Heat Index
UNADJ PE - Unadjusted Potential evapotranspiration
PET - Potential Evapotranspiration
P - Precipitation
$C_{R/O}$ - Coefficient of Runoff

R/O - Runoff
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AET - Actual Evapotranspiration
PERC - Percolation

ANNUAL TEMPERATURE & PRECIPITATION DATA--NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION STATION LOCATED IN

2038X-7300/D102

POST CLOSURE WATER BUDGET

1. <u>Calculations for Average Year</u>

   (see Operational Water Budget Pages Q-3 and Q-4)

2. <u>Calculations for Year of High Precipitation</u>

   a. Between 1951 and 1980, 1959 was the year of highest precipitation.

   b. The tables on Pages Q-12 and Q-13 were used to estimate infiltration into the waste. Wong's analysis was used to calculate how much of the water infiltrating the clay cap would actually seep into the waste (Appendix R). Wong's analysis showed that only 2.32" of the 10.72" infiltrating the clay cap on the 5% slopes would enter the waste and 0.08" of the 4.54" infiltrating the clay cap on the 25% slopes would enter the waste.

   c. Area at 5% slope = $1{,}752{,}500\ ft^2 \times \frac{2.32''}{12''/ft} \times 7.48\ gal/ft^3 =$ 2,534,000 gallons

      Area at 25% slope = $754{,}200\ ft^3 \times \frac{0.08''}{12''/ft} \times 7.48\ gal/ft^3 =$ 38,000 gallons

      Total = 2,570,000 gallons

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*                                                              *
*      HYDROLOGIC SIMULATION ON SOLID WASTE DISPOSAL SITES     *
*                                                              *
*                          WRITTEN BY                          *
*           EUGENE R. PERRIER AND ANTHONY C. GIBSON            *
*                                                              *
*                            OF THE                            *
*             WATER RESOURCES ENGINEERING GROUP                *
*                 ENVIRONMENTAL LABORATORY                     *
*             USAE, WATERWAYS EXPERIMENT STATION               *
*                       P.O. BOX 631                           *
*                   VICKSBURG, MS 39180                        *
*                                                              *
****************************************************************
*                                                              *
*              USER'S MANUAL AVAILABLE UPON REQUEST            *
*              FOR CONSULTATION CONTACT AUTHORS AT             *
*                        (601) 634-3710                        *
*                                                              *
****************************************************************
****************************************************************


 DO YOU WANT TO USE DEFAULT CLIMATOLOGIC AND HYDROLOGIC DATA?
    ENTER YES OR NO


yes


 DEFAULT DATA IS PROVIDED ONLY FOR THE FOLLOWING CITIES AND STATES
                              ----


ALASKA            ILLINOIS           NEVADA            RHODE ISLAND
  ANNETTE           CHICAGO            ELY               PROVIDENCE
  BETHEL            E. ST. LOUIS       LAS VEGAS       SOUTH CAROLINA
  FAIRBANKS       INDIANA            NEW JERSEY          CHARLESTON
ARIZONA             INDIANAPOLIS       EDISON          SOUTH DAKOTA
  FLAGSTAFF       IOWA                 SEABROOK          RAPID CITY
  PHOENIX           DES MOINES       NEW MEXICO        TENNESSEE
  TUCSON          KANSAS               ALBUQUERQUE       NASHVILLE
ARKANSAS            DODGE CITY       NEW YORK            KNOXVILLE
  LITTLE ROCK       TOPEKA             SYRACUSE        TEXAS
CALIFORNIA        KENTUCKY             CENTRAL PARK      BROWNSVILLE
  SACRAMENTO        LEXINGTON          ITHACA            EL PASO
  FRESNO          LOUISIANA            SCHENECTADY       DALLAS
  SAN DIEGO         LAKE CHARLES       NEW YORK CITY     MIDLAND
  LOS ANGELES       NEW ORLEANS      NORTH CAROLINA      SAN ANTONIO
  SANTA MARIA       SHREVEPORT         GREENSBORO      UTAH
COLORADO          MAINE              NORTH DAKOTA        CEDAR CITY
  DENVER            CARIBOU            BISMARK           SALT LAKE CITY
  GRAND JUNCTION    PORTLAND         OHIO              VIRGINIA
FLORIDA           MASSACHUSETTS        CLEVELAND         LYNCHBURG
  TALLAHASSEE       BOSTON             COLUMBUS          NORFOLK
  W. PALM BEACH   MICHIGAN             CINCINNATI      WASHINGTON
  JACKSONVILLE      E. LANSING         PUT-IN-BAY        YAKIMA
  MIAMI AIRPORT     SAULT STE. MARIE OKLAHOMA            PULLMAN
  TAMPA           MINNESOTA            OKLAHOMA CITY     SEATTLE
  ORLANDO           ST. CLOUD          TULSA           WISCONSIN
GEORGIA           MISSOURI           OREGON              MADISON
  ATLANTA           COLUMBIA           PORTLAND        WYOMING
  WATKINSVILLE    MONTANA              MEDFORD           LANDER
HAWAII              GLASGOW            ASTORIA           CHEYENNE
  HONOLULU          GREAT FALLS      PENNSYLVANIA      PUERTO RICO
IDAHO             NEBRASKA             PITTSBURGH        SAN JUAN
  BOISE             GRAND ISLAND       PHILADELPHIA
  POCATELLO         NORTH OMAHA

 ENTER NAME OF STATE OF INTEREST


wisconsin

 ENTER NAME OF CITY OF INTEREST


madison


                          CLIMATOLOGICAL DATA WILL BE ENTERED

 ARE YOU USING DEFAULT CLIMATOLOGICAL DATA?
 ENTER YES OR NO
yes

 CLIMATOLOGICAL DATA FROM MADISON            WISCONSIN          ARE ON
 FILE.


 DO YOU WANT CLIMATOLOGY, HYDROLOGY OR OUTPUT?

 ENTER 1 FOR CLIMATOLOGICAL INPUT,
       2 FOR HYDROLOGICAL INPUT,
```

```
. FOR ... ...UT [redacted]
4 TO STOP PROGRAM.


2

*****************************************************************
          USE ONLY ENGLISH UNITS OF ACRES,INCHES, AND DAYS
                    UNLESS OTHERWISE INDICATED

 ##########################ENTER ALL ZEROS########################
*****************************************************************
          A VALUE **MUST** BE ENTERED FOR EACH COMMAND
*****************************************************************


 ENTER TITLE ON LINE 1,
       LOCATION OF SOLID WASTE SITE ON LINE 2
       AND TODAY'S DATE ON LINE 3.


green county landfill
green county
february 1981

 DO YOU HAVE A LAYERED SOIL COVER?
 (ONLY 2 LAYERS PERMITTED VEGETATIVE PLUS BARRIER)
         ENTER YES OR NO


no

 SELECT THE TEXTURE CLASS OR GROUP SYMBOL OF SOIL MATERIAL

 ENTER NUMBER (1)            COARSE SAND        GW
              (2)     COARSE SANDY LOAM        GM
              (3)                  SAND        SW
              (4)             FINE SAND        SM
              (5)            LOAMY SAND        SM
              (6)       LOAMY FINE SAND        SM
              (7) LOAMY VERY FINE SAND         SM
              (8)            SANDY LOAM        SM
              (9)       FINE SANDY LOAM        SM
             (10) VERY FINE SANDY LOAM         MH
             (11)                  LOAM        ML
             (12)             SILT LOAM        ML
             (13)       SANDY CLAY LOAM        SC
             (14)             CLAY LOAM        CL
             (15)       SILTY CLAY LOAM        CL
             (16)            SANDY CLAY        CH
             (17)            SILTY CLAY        CH
             (18)                  CLAY        CH


8

 ENTER DEPTH OF SOIL COVER (INCHES)


6

  SELECT THE TYPE OF VEGETATIVE COVER

 ENTER NUMBER (1) BAREGROUND
              (2) GRASS (EXCELLENT)
              (3) GRASS (GOOD)
              (4) GRASS (FAIR)
              (5) GRASS (POOR)
              (6) ROW CROP (GOOD)
              (7) ROW CROP (FAIR)


1

 ENTER 2 VALUES, SURFACE AREA OF SOLID WASTE SITE(ACRES)
                 AND DEPTH OF SOLID WASTE (INCHES).


3
300

 IS THERE AN IMPERMEABLE LINER AT THE INTERFACE?
         ENTER YES OR NO


no

 ENTER 2 VALUES, SITE SLOPE (FT/FT),
                 AND SITE CHANNEL LENGTH(FT)
```

\ )1
125

```
*************************************************************
              HYDROLOGICAL INPUT IS COMPLETE
*************************************************************
```

DO YOU WANT CLIMATOLOGY, HYDROLOGY OR OUTPUT?

ENTER 1 FOR CLIMATOLOGICAL INPUT,
2 FOR HYDROLOGICAL INPUT,
3 FOR OUTPUT OR
4 TO STOP PROGRAM.

3

HOW MANY YEARS OF OUTPUT DO YOU WANT?

TWO (2) YEARS MINIMUM AND
FIVE (5) YEARS OF PRECIPITATION ARE MAXIMUM

5

DO YOU WANT DAILY PRECIPITATION OUTPUT?
(NO PRINTS THE ANNUAL SUMMARIES)
ANSWER YES OR NO

no

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*************************************************************
*************************************************************
```

HYDROLOGIC OUTPUT

(DAILY PRECIPITATION VALUES)

GREEN COUNTY LANDFIL
GREEN COUNTY
13FEBRUARY 1981

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.51	20.89	29.72	42.62	56.16	66.60
71.39	69.01	60.18	47.28	33.74	23.22

MONTHLY MEAN RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
139.34	204.42	301.51	404.61	486.09	524.11
508.49	443.42	346.32	243.22	161.74	123.72

LEAF AREA INDEX TABLE

DATE	LAI
1	0.0
366	0.0

WINTER C FACTOR = 1.00
LAI-DAYS = 0.0

SOLID WASTE AREA	=	3.00000 ACRES
EFFECTIVE HYDRAULIC COND SOIL	=	0.24120 IN/HR
EFFECTIVE HYDRAULIC COND BARRIER	=	0.24120 IN/HR
FIELD CAPACITY	=	0.23865 VOL/VOL
CHANNEL SLOPE	=	0.00100 FT/FT
SCS CURVE NUMBER	=	85.56900
SITE CHANNEL LENGTH	=	125.00000 FT
UPPER LIMIT OF STORAGE	=	0.26400 IN
INITIAL SOIL WATER STORAGE	=	0.13200 IN

UPPER LIMIT OF STORAGES IN COVER (INCHES)

DEPTH	0.167	1.000	2.000	3.000	4.000	5.000	6.000
	0.007	0.037	0.044	0.044	0.044	0.044	0.044

INITIAL SOIL WATER STORAGE IN COVER (INCHES)

DEPTH	0.167	1.000	2.000	3.000	4.000	5.000	6.000

ANNUAL TOTALS FOR 1974 (INCHES)

PRECIPITATION	=	36.04
PREDICTED RUNOFF	=	2.44
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	16.6527
TOTAL ET	=	17.05
BEGIN SOIL WATER	=	0.13
FINAL SOIL WATER	=	0.03
WATER BUDGET BAL.	=	0.00

ANNUAL TOTALS FOR 1975 (INCHES)

PRECIPITATION	=	34.53
PREDICTED RUNOFF	=	2.95
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	14.1829
TOTAL ET	=	17.42
BEGIN SOIL WATER	=	0.03
FINAL SOIL WATER	=	0.0
WATER BUDGET BAL.	=	0.00

ANNUAL TOTALS FOR 1976 (INCHES)

PRECIPITATION	=	21.08
PREDICTED RUNOFF	=	0.67
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	9.7507
TOTAL ET	=	10.66
BEGIN SOIL WATER	=	0.0
FINAL SOIL WATER	=	0.00
WATER BUDGET BAL.	=	0.00

ANNUAL TOTALS FOR 1977 (INCHES)

PRECIPITATION	=	32.26
PREDICTED RUNOFF	=	3.42
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	11.3118
TOTAL ET	=	17.53
BEGIN SOIL WATER	=	0.00
FINAL SOIL WATER	=	0.00
WATER BUDGET BAL.	=	0.0

ANNUAL TOTALS FOR 1978 (INCHES)

PRECIPITATION	=	36.44
PREDICTED RUNOFF	=	6.93
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	15.7547
TOTAL ET	=	13.74
BEGIN SOIL WATER	=	0.00
FINAL SOIL WATER	=	0.02
WATER BUDGET BAL.	=	-0.00

AVERAGE ANNUAL VALUES (INCHES)

PRECIPITATION	=	32.07
PREDICTED RUNOFF	=	3.40
TOT SOIL DRAIN	=	0.0
TOT WASTE DRAIN	=	13.5305
TOTAL ET	=	15.28

HYDROLOGY SUMMARY

GREEN COUNTY LANDFILGREEN COUNTY   13FEBRUARY 1981

1974

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	2.43	0.05	0.75	0.0	1.6891	0.11
FEB	1.17	0.0	0.81	0.0	0.4345	0.08
MAR	3.43	0.21	1.58	0.0	1.5602	0.08
APR	4.24	0.50	2.01	0.0	1.0298	0.06
MAY	5.77	0.38	2.60	0.0	2.8454	0.06
JUN	3.86	0.75	1.83	0.0	1.3353	0.03
JUL	2.69	0.01	1.72	0.0	0.9603	0.03
AUG	4.60	0.46	2.19	0.0	1.8921	0.04
SEP	1.08	0.0	0.84	0.0	0.1901	0.06
OCT	3.18	0.16	1.08	0.0	1.8527	0.05
NOV	1.29	0.0	0.83	0.0	1.0084	0.06
[illegible]	[illegible]	0.06	0.80	0.0	1.0548	0.12

[redacted]

MONTH	RAIN	[redacted] RUNOFF	[redacted] ET	[redacted] IL DRAIN	WAS DRA	AVG SW
JAN	2.43	0.05	0.75	0.0	1.4891	0.11
FEB	1.17	0.0	0.81	0.0	0.4345	0.08
MAR	3.43	0.21	1.58	0.0	1.5602	0.08
APR	4.24	0.50	2.01	0.0	1.8298	0.06
MAY	5.77	0.38	2.60	0.0	2.8454	0.06
JUN	3.86	0.75	1.83	0.0	1.3353	0.03
JUL	2.69	0.01	1.72	0.0	0.9603	0.03
AUG	4.60	0.46	2.19	0.0	1.8921	0.04
SEP	1.08	0.0	0.84	0.0	0.1901	0.06
OCT	3.10	0.16	1.08	0.0	1.8527	0.05
NOV	1.79	0.0	0.83	0.0	1.0084	0.06
DEC	1.60	0.06	0.80	0.0	1.0548	0.12
TOT/AVE	36.04	2.58	17.05	0.0	16.65	0.06

1975

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	0.98	0.0	0.73	0.0	0.2532	0.08
FEB	1.54	0.0	0.91	0.0	0.5855	0.08
MAR	3.09	0.0	1.60	0.0	1.5383	0.07
APR	4.19	1.12	1.50	0.0	1.5352	0.05
MAY	4.57	0.11	2.07	0.0	2.3885	0.04
JUN	4.30	0.19	2.99	0.0	1.1572	0.05
JUL	6.05	1.49	1.35	0.0	3.2121	0.02
AUG	5.25	0.11	3.49	0.0	1.7516	0.08
SEP	0.84	0.0	0.77	0.0	0.0575	0.04
OCT	0.64	0.0	0.51	0.0	0.0920	0.06
NOV	2.79	0.0	1.03	0.0	1.6118	0.10
DEC	0.29	0.0	0.47	0.0	0.0	0.03
TOT/AVE	34.53	3.02	17.42	0.0	14.18	0.06

1976

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	0.56	0.0	0.50	0.0	0.0	0.03
FEB	1.72	0.03	0.53	0.0	1.1967	0.05
MAR	4.75	0.35	1.30	0.0	2.8959	0.07
APR	4.80	0.35	2.14	0.0	2.5685	0.05
MAY	1.95	0.04	1.09	0.0	0.8564	0.02
JUN	[illegible]	0.0	[illegible]	0.0	[illegible]	[illegible]
JUL	1.46	0.0	0.86	0.0	0.6669	0.03
AUG	1.99	0.0	1.34	0.0	0.7174	0.03
SEP	0.50	0.0	0.42	0.0	0.0756	0.03
OCT	1.49	0.0	0.70	0.0	0.6570	0.03
NOV	0.11	0.0	0.25	0.0	0.0000	0.00
DEC	0.37	0.0	0.37	0.0	0.0	0.02
TOT/AVE	21.08	0.77	10.64	0.0	9.75	0.04

1977

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	0.53	0.0	0.53	0.0	0.0	0.04
FEB	1.44	0.03	0.43	0.0	0.9461	0.05
MAR	3.03	0.28	1.52	0.0	1.0804	0.09
APR	2.59	0.28	1.50	0.0	1.0623	0.05
MAY	2.33	0.03	1.41	0.0	0.8841	0.03
JUN	1.96	0.0	1.70	0.0	0.3055	0.03
JUL	7.49	2.05	3.11	0.0	2.3210	0.06
AUG	5.11	0.83	2.81	0.0	1.5803	0.04
SEP	2.36	0.15	1.51	0.0	0.7136	0.06
OCT	1.89	0.0	1.29	0.0	0.6700	0.04
NOV	2.20	0.04	0.91	0.0	1.1199	[illegible]
DEC	1.33	0.0	0.83	0.0	0.6276	0.11
TOT/AVE	32.26	3.70	17.53	0.0	11.31	0.06

1978

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	1.30	0.04	0.69	0.0	0.4975	0.09
FEB	0.24	0.0	0.31	0.0	0.0000	0.02
MAR	0.28	0.0	0.28	0.0	0.0	0.00
APR	3.50	0.20	1.98	0.0	1.3792	0.07
MAY	3.96	1.51	1.22	0.0	1.1947	0.04
JUN	7.45	2.00	1.71	0.0	3.8214	0.05
JUL	6.89	1.44	2.24	0.0	3.2442	0.04
AUG	1.78	0.0	1.28	0.0	0.4962	0.05
SEP	5.44	1.53	1.54	0.0	2.3956	0.05
OCT	1.11	0.0	0.88	0.0	0.2325	0.03
NOV	3.05	0.17	0.88	0.0	1.8560	0.11
DEC	1.44	0.03	0.72	0.0	0.6373	0.07
TOT/AVE	36.44	6.93	13.73	0.0	15.75	0.05

OCT	1.[illegible]	[illegible]	[illegible]88	[illegible]	[illegible]	0[illegible]
NOV	3.05	0.17	0.88	0.0	1.8560	0.11
DE[illegible]	1.44	0.03	0.72	0.0	0.6373	[illegible]07
TOT/AVE	36.44	6.93	13.73	0.0	15.75	0.05

ANNUAL AVERAGES

MONTH	RAIN	RUNOFF	ET	SOIL DRAIN	WASTE DRAIN	AVG SW
JAN	1.16	0.02	0.64	0.0	0.4880	0.07
FEB	1.22	0.01	0.60	0.0	0.6326	0.06
MAR	2.92	0.17	1.26	0.0	1.4150	0.06
APR	3.86	0.49	1.82	0.0	1.6750	0.06
MAY	3.72	0.42	1.68	0.0	1.6338	0.04
JUN	3.79	0.59	1.87	0.0	1.3472	0.05
JUL	4.92	1.00	1.85	0.0	2.0809	0.04
AUG	3.75	0.28	2.22	0.0	1.2875	0.05
SEP	2.04	0.34	1.02	0.0	0.6865	0.05
OCT	1.66	0.03	0.89	0.0	0.7010	0.04
NOV	1.99	0.04	0.78	0.0	1.1192	0.07
DEC	1.05	0.02	0.64	0.0	0.4639	0.07
TOT/AVE	32.07	3.40	15.28	0.0	13.53	0.05

```
ENTER RUNHYDRO TO RERUN PROGRAM OR
TYPE LOGOFF TO LOGOFF COMPUTER SYSTEM


ERROR FROM DAIR: ENTRY CODE: 18 RETURN CODE: 04
        CN.EPABRD.MSRS.CLIST                          USER59 NOT FREED
READY
logoff

EPABRD/MSRS off TSO 02/13/81 at 11:20:05, 76.00 TUU
 2.23 Connect Hrs., 0:26.52 TCB, 822 Page-Seconds
 EXCPS: 1380 DA, 0 MT, 3844 Term, 0 Other, 5224 Total
 Charges: $0.00 Connect, $42.56 TUU, $42.56 Total

EPABRD LOGGED OFF TSO AT 11:20:08 ON FEBRUARY 13, 1981

enter TSO or WYL
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APPENDIX R

Summary of Wong Efficiency Analysis

SUMMARY OF WONG EFFICIENCY ANALYSIS

A. Assumptions:

1. The analysis reflects system performance without channeling effects through the refuse.

2. Site exfiltration rates assume saturated refuse condition in entire site.

3. Refuse porosity was computed as: $1 - \frac{100}{2.65 \times 62.4} = .40$

4. Net efficiency of a multi-layered system is calculated by successively computing the annual leakage rate through the collection layers (final cover system, primary and secondary liners) and then dividing the final exfiltration rate by the infiltration rate.

5. For simplification, only the 5% final cover and 2.8% liner portions of the site were used in the analysis. Since all remaining portions of the site are steeper (i.e., 4:1 side slopes and 2:1 sidewalls), the results can be considered conservative or worst case for the site as a whole.

B. Data:

1. From the water budget, annual infiltration rates for the top of the landfill (i.e., 5% slopes) are:

   - 2.62" = infiltraton from average annual precipitation rate

   - 10.72" = infiltration from highest 30-year precipitation period

2. Permeabilities and thicknesses for on-site soils used in final cover and liner construction are as follows:

LOCATION	ITEM	PERMEABILITY* (cm/second)	THICKNESS (feet)
Final Cover	Granular blanket over clay cap	1×10^{-4}	1.5
Final Cover	Clay cap	1×10^{-8}	2.0
Base of Site	Granular layer over primary layer	1×10^{-4}	1.0
Base of Site	Primary clay liner	1×10^{-8}	4.0
Base of Site	Granular layer over secondary layer	1×10^{-4}	2.0
Base of Site	Secondary clay liner	1×10^{-8}	2.0

*NOTE: Experience at the existing landfill has shown that these values are achievable using standard construction techniques.

3. Slopes used during analysis are:

   - 5% for final cover

   - 2.8% for liners

C. Summary of Results:

Since the integrity of the final cover configuration (i.e., due to settlements, etc.) is an important consideration for this analysis, two different cases were used. Case A assumes the final cover is 100% effective in diverting the infiltration (i.e., calculated efficiency). Case B assumes the final cover is 0% effective in diverting the infiltration. Both of these cases are shown on Figures 4 and 5 of the report, and are summarized as follows:

CASE A SUMMARY

ITEM	Average Precipitation (2.62 inches per year)		30-Yr Precipitation High (10.72 inches per year)	
	Exfiltration (inches)	Efficiency (%)	Exfiltration (inches)	Efficiency (%)
Final Cover	0.60	77.1	2.33	78.3
Primary Liner	0.12	79.7	0.34	85.4
		Net=88.3		Net=94.8
Secondary Liner	0.07*	41.9	0.12*	64.0
Net System Efficiency		97.3		98.9

* Amount leaving site after attenuation of 6' clay soils.

CASE B SUMMARY

ITEM	Average Precipitation (2.62 inches per year)		30-Yr Precipitation High (10.72 inches per year)	
	Exfiltration (inches)	Efficiency (%)	Exfiltration (inches)	Efficiency (%)
Final Cover	2.62	0	10.72	0
Primary Liner	0.38	85.6	1.41	86.9
		Net=95.0		Net=96.5
Secondary Liner	0.13*	65.7	0.37*	73.8
Net System Efficiency		95.0		96.5

* Amount leaving site after attenuation of 6' clay soils.

2038X-7300/D102/"Radandt8"

APPENDIX S

DNR Office of Endangered and
Non-game Species Letter

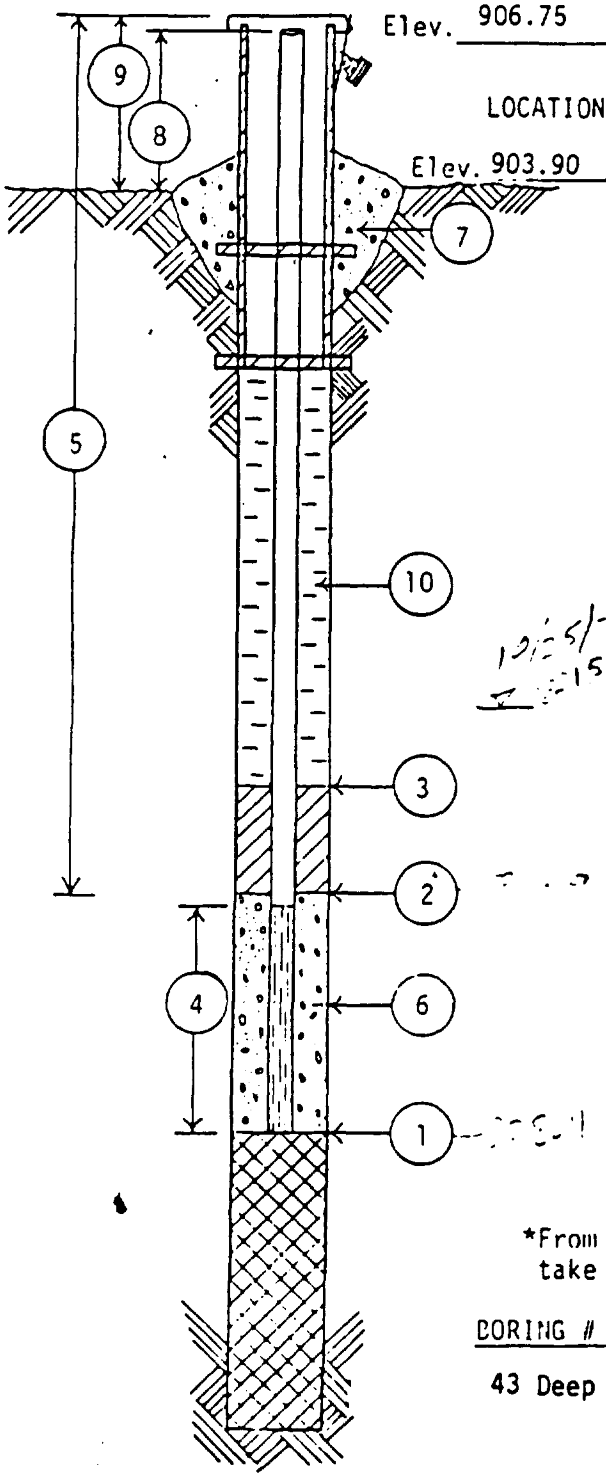
Lemberger Land Fill Tonnage Report Sept. 1980 thru Aug. 1981.

SOURCE	YEARLY CONTRACT TONNAGE	ACTUAL YEARLY TONNAGE
City of Manitowoc	30,000	25,242
Marinette	Variable	12,024*
Two Rivers	12,027	9,776
Valders	690	6141
Whitelaw	460	290
Town of Two Rivers	621	742
Kellnersville	217	87
St. Nazianz	554	359
Town of Manitowoc	807	165
Brillion	2800	2394
Demolition	Variable	1517
Foundry Sand	Variable	15,864
Misc.	Variable	567
Manitowoc Public Utilities	Variable	7,931
TOTALS		77,472

Monthly average for years of Sept. 1980 thru Aug. 1981 is 6456

*Not a full 12 months, average taken

WELL DETAIL INFORMATION SHEET



JOB NO. C 8327

BORING NO. 43A

DATE 9/20/79

CHIEF L. Smith

LOCATION Lemberger Site, Manitowoc County, Wisconsin

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 94'6" FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 90' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 87' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 3' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 97'6" FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES NO (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (Circle One)
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (Circle One)
    TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
43 Deep	9/20/79	10:00 am	44.5'	After Pumping Down

WARZYN

WELL DETAIL INFORMATION SHEET

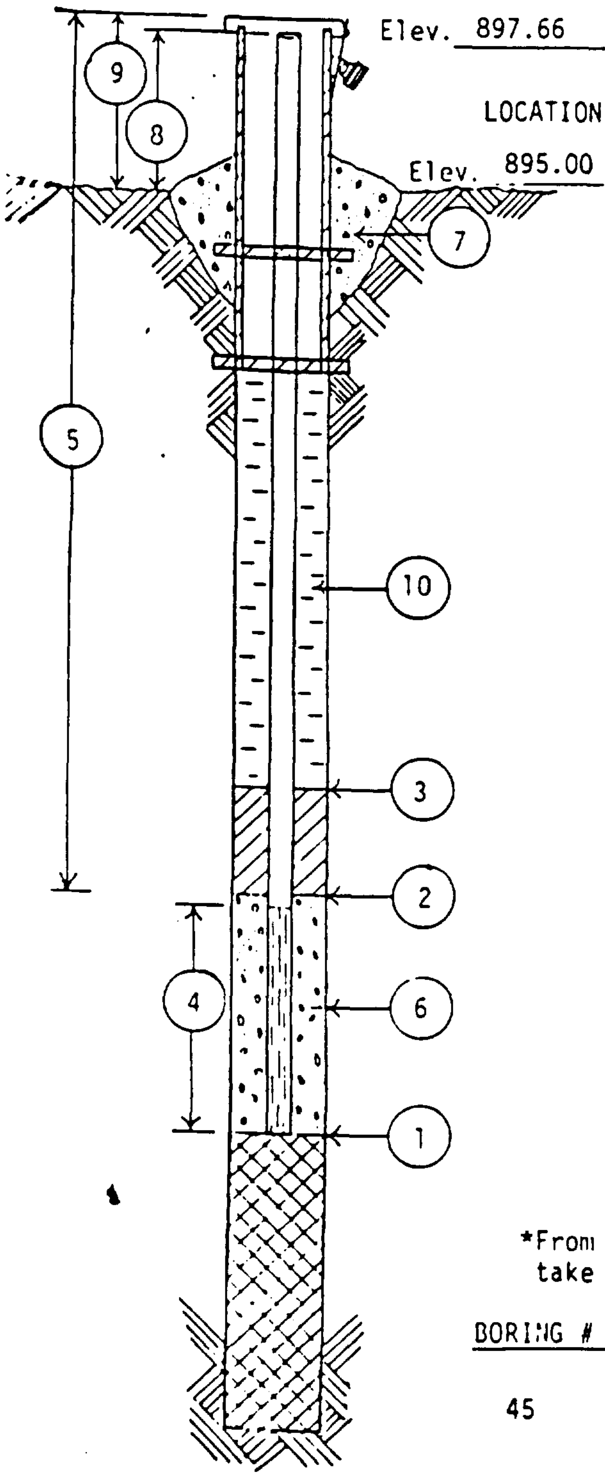
JOB NO. C 8327

BORING NO. 45

DATE 7/12/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 57' FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 40' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 30' FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 50 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils and Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
45	7/12/79	PM	50'	After Bail from top

WARZYN

WELL DETAIL INFORMATION SHEET

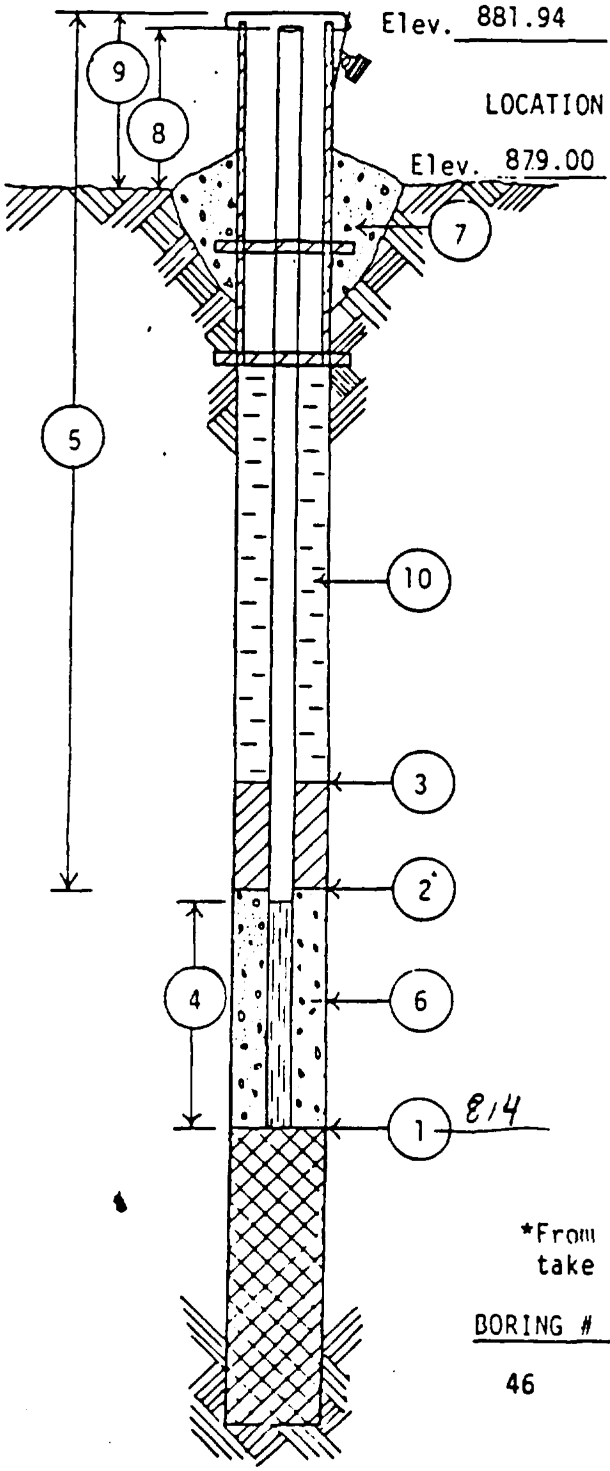
JOB NO. C 8327

BORING NO. 46

DATE 7/2/79

CHIEF James Rech

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 65' FEET.
2. DEPTH OF BOTTOM OF SEAL (if installed) 53' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 52' FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10 FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 58 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
46	7/2/79	1 Hr.	15' - 1"	

WARZYN ENGINEERING INC.

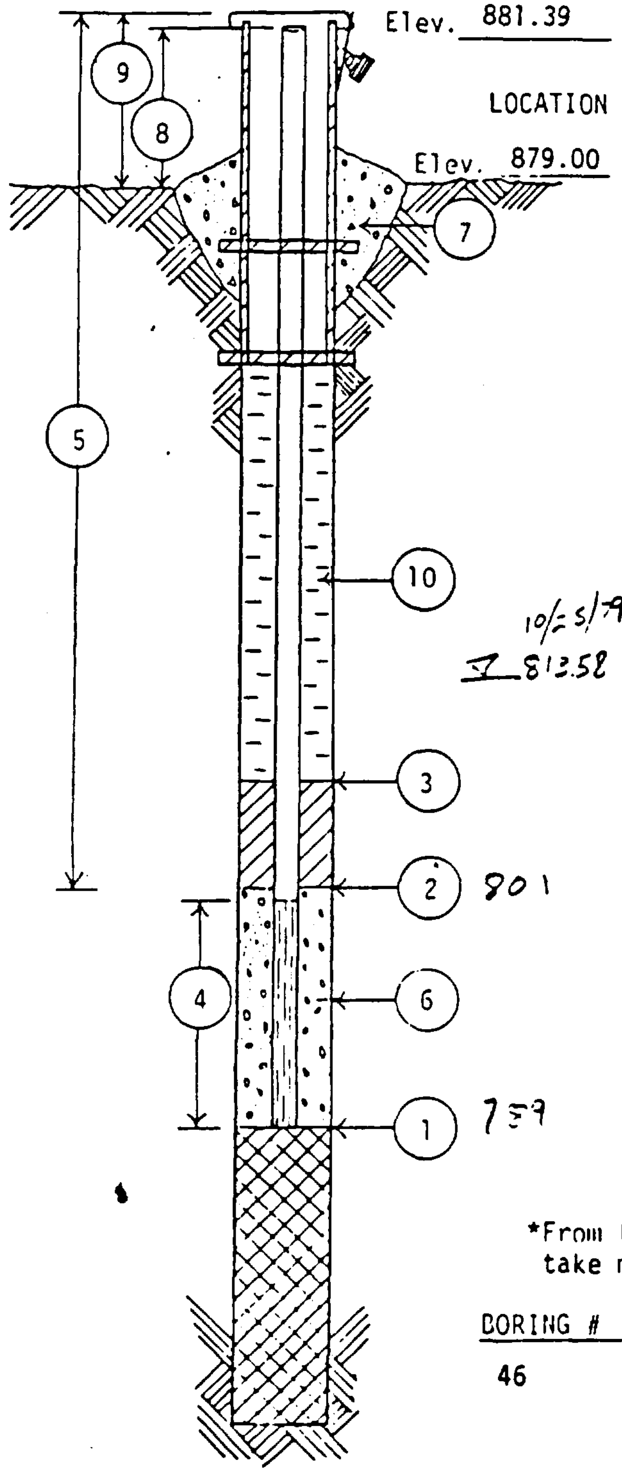
WELL DETAIL INFORMATION SHEET

JOB NO. C 8327

BORING NO. 46A

DATE 9/18/79

CHIEF L. Smith



LOCATION Lemberger Site, Manitowoc County, Wisconsin

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 90 FEET.
3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 78' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 76' FEET.
4. LENGTH OF WELL POINT, PVC WELL SCREEN, OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 89' FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES NO (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES NO (Circle One) HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES NO (Circle One) TYPE OF BACKFILL: Clay & Sand

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
46	9/18/79	11:30 am	36.5'	From Ground

WARZYN

WELL DETAIL INFORMATION SHEET

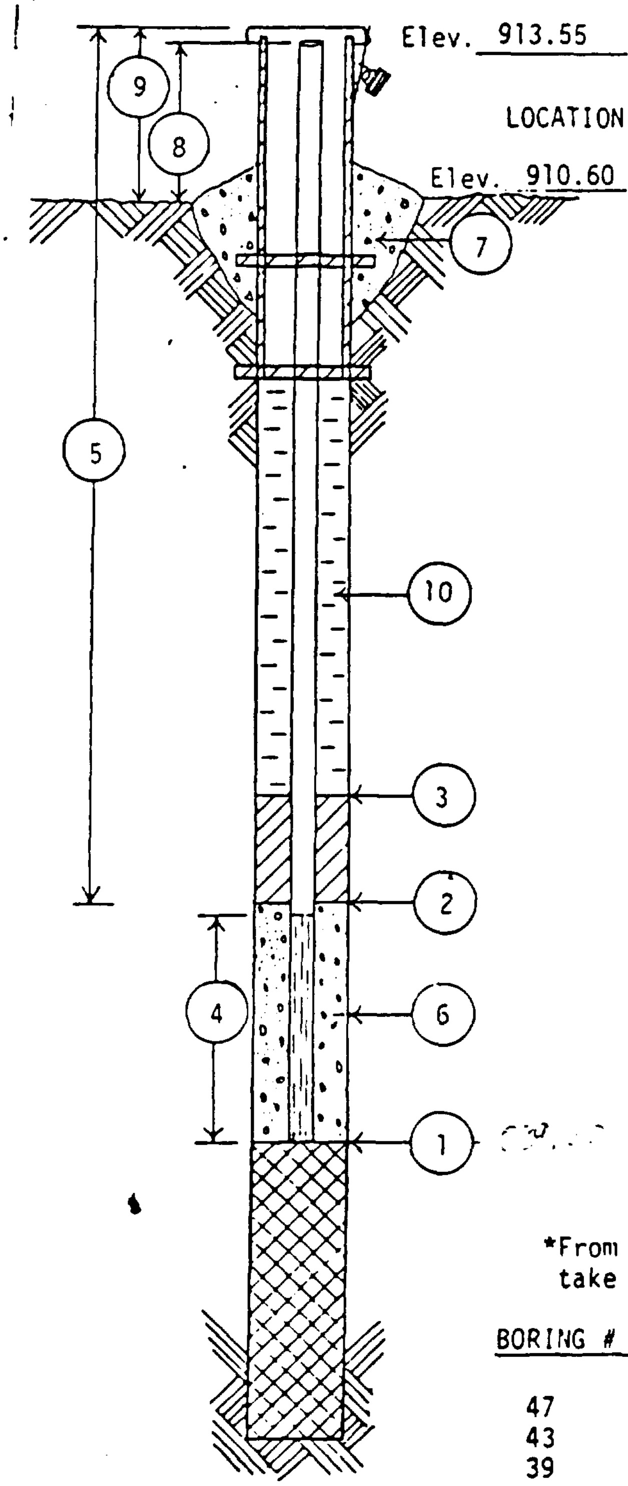
JOB NO. C 8327

BORING NO. 47

DATE 6/19/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

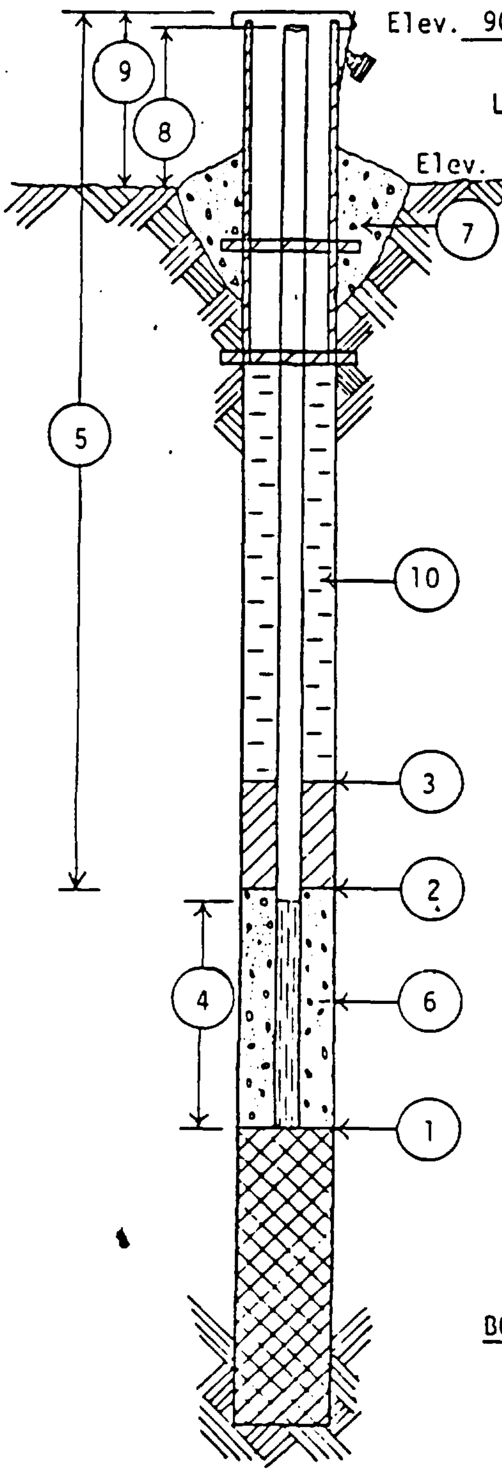
1. DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 71 FEET.
   3' Blank Under Well Screen
2. DEPTH OF BOTTOM OF SEAL (if installed) 60' FEET.
3. DEPTH TO TOP OF SEAL (if installed) 55' FEET.
4. LENGTH OF WELL POINT, (PVC WELL SCREEN), OR SLOTTED PIPE 10' FEET. (Circle One)
5. TOTAL LENGTH OF PIPE 67 FEET @ 2" IN. DIAMETER.
6. TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.
7. CONCRETE CAP, YES (NO) (Circle One)
8. HEIGHT OF WELL CASING ABOVE GROUND 3' FEET.
9. PROTECTIVE CASING? YES (NO) (Circle One)
   HEIGHT ABOVE GROUND ______.
10. LOCKING CAP? YES (NO) (Circle One)
    TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
47	6/19/79		49'	After Bail from top
43	4/20/79		13.2	
39	4/20/79		72.2	
47	4/20/79		37.5	

WARZYN



JOB NO. 8327

BORING NO. 51

DATE 8/15/79

CHIEF Jim Grieger

LOCATION Lemberger Site Manitowoc Co, WI

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

(1) DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 51 FEET.

(2) DEPTH OF BOTTOM OF SEAL (if installed) 40 FEET.

(3) DEPTH TO TOP OF SEAL (if installed) 37 FEET.

(4) LENGTH OF WELL POINT, (PVC WELL SCREEN,) OR SLOTTED PIPE 10 FEET. (Circle One)

(5) TOTAL LENGTH OF PIPE 44⅓ FEET @ 2 IN. DIAMETER.

(6) TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Sand.

(7) CONCRETE CAP, YES (NO) (Circle One)

(8) HEIGHT OF WELL CASING ABOVE GROUND 3½ FEET.

(9) PROTECTIVE CASING? YES (NO) (Circle One)
HEIGHT ABOVE GROUND ______.
LOCKING CAP? YES (NO) (Circle One)

(10) TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS

WARZYN ENGINEERING INC

WELL DETAIL INFORMATION SHEET

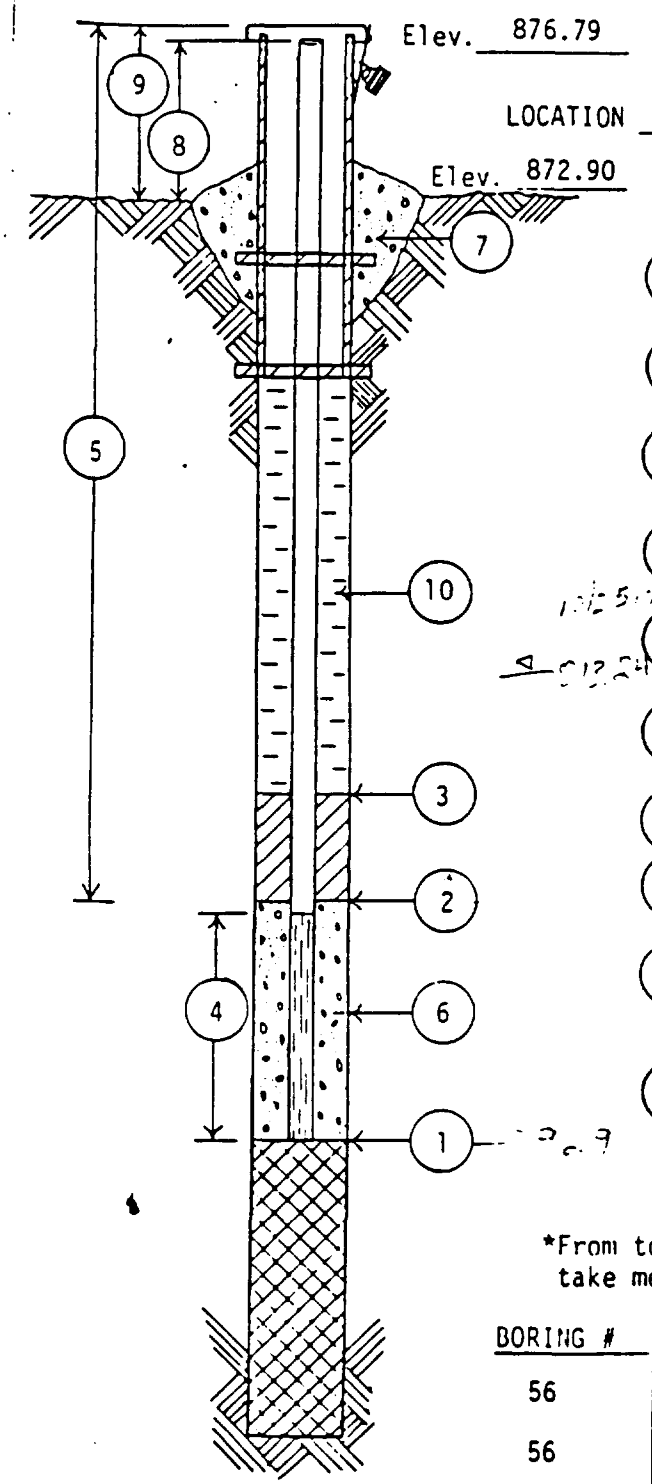
JOB NO. C 8327

BORING NO. 56

DATE 8/30/79

CHIEF Jim Grieger

LOCATION Lemberger Site, Manitowoc Co., WI



All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.

(1) DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE 76 FEET.

(2) 3' Blank Under Well Screen
DEPTH OF BOTTOM OF SEAL (if installed) 10' FEET.

(3) DEPTH TO TOP OF SEAL (if installed) 0 FEET.

(4) LENGTH OF WELL POINT, (PVC WELL SCREEN,) OR SLOTTED PIPE 10 FEET. (Circle One)

(5) TOTAL LENGTH OF PIPE 73 FEET @ 2" IN. DIAMETER.

(6) TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand.

(7) CONCRETE CAP, YES NO (Circle One)

(8) HEIGHT OF WELL CASING ABOVE GROUND 4 FEET.

(9) PROTECTIVE CASING? YES (NO) (Circle One)
HEIGHT ABOVE GROUND ______.

(10) LOCKING CAP? YES (NO) (Circle One)
TYPE OF BACKFILL: Spoils & Bentonite

WATER LEVEL CHECKS

*From top of casing, if protective casing higher, take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
56	8/30/79	AM	79'	After Bail
56	8/31/79	AM	62.2	From top of Stickup

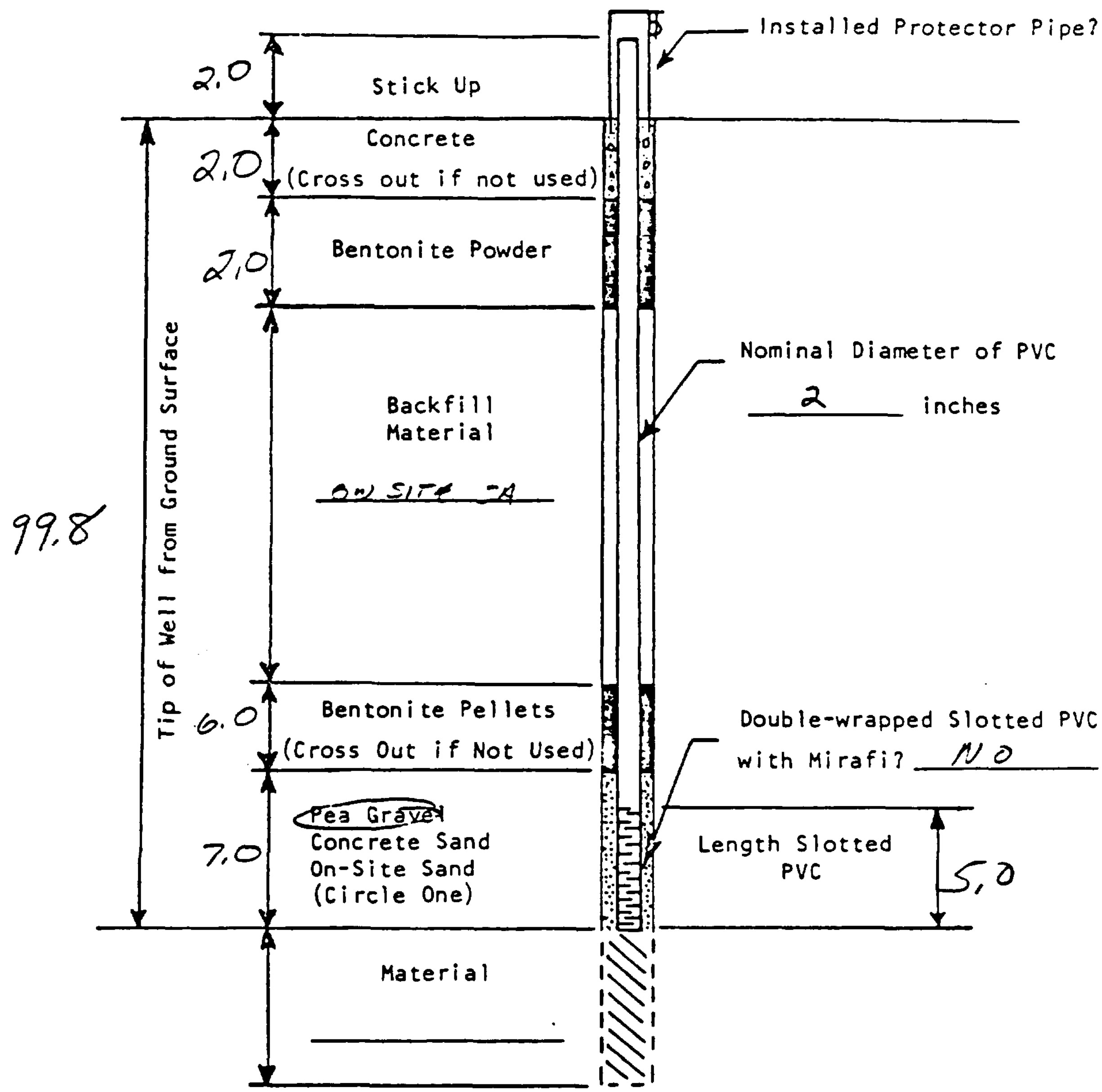
WARZYN

FIELD WELL INSTALLATION DIAGRAM - AS INSTALLED

STS JOB NO. 11086 JOB ______

CLIENT LEMBERGER LANDFILL

WELL NO. MW-57 DATE INSTALLED 7-15-81



INSTALLATION

1. Did the bentonite pellets hang up? NO
2. Did you have to drive the protector pipe? NO
3. Did you install a lock on the protector pipe? YES
   If so, who has the keys? CLIENT
4. Did the PVC come up when you removed the casing? /
5. Was the well bailed? NO
6. Were water level readings taken after the well was installed? YES 53.5
7. Was a PVC cap installed on bottom of well? YES

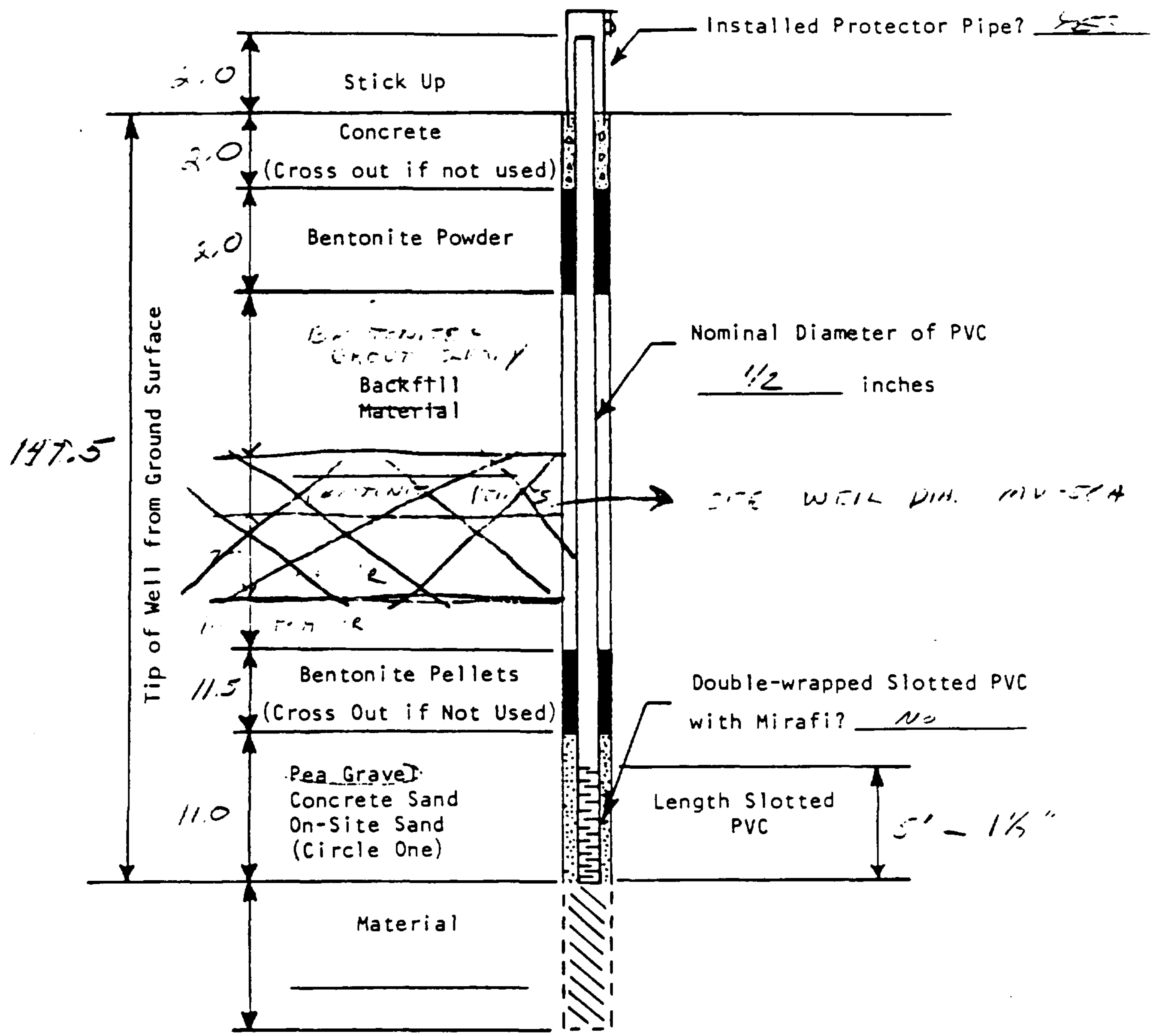
BBS101978

FIELD WELL INSTALLATION DIAGRAM - AS INSTALLED

STS JOB NO. 11X5 JOB

CLIENT

WELL NO. DATE INSTALLED 7-7-91



INSTALLATION

1. Did the bentonite pellets hang up? Some
2. Did you have to drive the protector pipe? No
3 Did you install a lock on the protector pipe? YES
   If so, who has the keys? CLIENT
4. Did the PVC come up when you removed the casing? NO
5. Was the well bailed? NO
6. Were water level readings taken after the well was installed? NO
7. Was a PVC cap installed on bottom of well? YES

98S101979