RMT, Inc.
Suite 124
1406 East Washington Ave.
Madison, WI 53703-3009
Phone: 608-255-2134

GROUND WATER MONITORING SYSTEM INSTALLATION REPORT

GMC-CFD DANVILLE
DANVILLE, ILLINOIS

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Howard Evan Canfield
Hydrogeologist

Stephen D. Johannsen
Manager, Hydrogeology and
Applied Chemistry

John J. Reinhardt, P.E.
Senior Vice President

JOHN J. REINHARDT
REGISTERED PROFESSIONAL ENGINEER
ILLINOIS
3/5/87

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1. INTRODUCTION

1.1 Background

A nonhazardous foundry waste landfill is located on the Central Foundry-Danville (CFD-Danville) plant property on an upland adjacent to the Vermilion River. During March 1984, an application to operate this landfill was filed with the Illinois Environmental Protection Agency (IEPA). On January 10, 1985, CFD-Danville, the IEPA and RMT met to discuss permitting of the CFD landfill. At that time, the IEPA requested further documentation of the site's geology, ground water occurrence, and flow patterns. On March 18, 1985, the IEPA awarded the operating permit (IEPA Permit No. 1985-7-OP). Special condition #4 of that permit required that additional geologic data be gathered and that, based on that data, a ground water monitoring network for the landfill be developed and installed. A program to collect the geologic data and construct the monitoring network was submitted to the IEPA in July 1985 and subsequently approved. A subsurface investigation was conducted at the landfill and the ground water monitoring network was installed in two phases.

Phase I of the monitoring program was conducted during March 1986. During Phase I, nine soil borings were drilled in the landfill area. The borings were logged; soil samples were collected; and grain-size, Atterberg limit, and cation exchange capacity (CEC) tests were performed on samples that represented distinct geologic units. The testing results were submitted to the IEPA in a brief letter report on April 23, 1986. Upon IEPA review, a supplemental permit to construct the landfill ground water monitoring program (1985-163-SP) was granted on May 28, 1986.

During June 1986, RMT supervised the installation and development of 11 monitoring wells specified in the supplemental permit. In addition, as required by that permit, geologic cross sections, a well location diagram, and well construction diagrams were submitted to the IEPA on July 8, 1986.

1.2 Purpose

The purpose of this report is twofold:

- Document the methodology and describe the details used to install the monitoring network at the CFD-Danville plant during the investigation conducted June 16-20, 1986. The monitoring well network was proposed by RMT in the July 1985 and April 1986 submittals and was approved by the IEPA.
- Fulfill the IEPA request for more information on site geology, ground water occurrence, and flow patterns. This information will provide a more thorough understanding of the influence of the site geology on ground water flow and water quality.

1.3 Scope

This report presents the results of Phase II of the subsurface investigation. This phase of the investigation consisted of the following elements:

- Installation of 11 monitoring wells around the landfill area.
- In-field hydraulic conductivity testing at 11 wells.
- Measurement of ground water elevations from 12 monitoring wells and preparation of a water table map.
- Calculation of horizontal and vertical hydraulic gradients and ground water flow velocities.
- Construction of geologic cross sections.

Based on these data, the geologic and hydrogeologic settings have been characterized.

2. FINDINGS AND CONCLUSIONS

2.1 Geology

1. The CFD-Danville nonhazardous foundry waste landfill is located on a till-covered upland above the Vermilion River. The upland is dissected so that there are unnamed tributaries of the Vermilion River on the eastern and western edges of the landfill.

2. Data from previously installed borings show that the geologic materials covering the uplands consist of 10 to 20 feet of dense silty clay till. This till overlies shale bedrock. These native geologic materials are covered with foundry waste that is up to 50 feet thick at boring B-8.

3. Bedrock at the site is a silty gray shale that is probably fractured. It is encountered at all borings at depths from 11 feet at G-41 to 25 feet at G-30.

4. The Danville coal seam occurs within the shale and has been extensively mined beneath the southeast and northwest portions of the landfill. The mining activity left mine shafts and debris piles on the site.

5. Alluvium and reworked alluvium/foundry sand encountered at borings G-32 and G-42, respectively, indicate that these materials are present in the Vermilion River Valley and in the tributaries on the east and west side of the site.

2.2 Hydrogeology

1. A water table map constructed from water elevations at the site indicates that ground water flows north toward the upland in the center of the site. From the upland, the water flows in a radial pattern toward the Vermilion River on the north and to the tributaries on the east and west sides of the site.

2. Downward gradients between 0.4 foot/foot and 0.6 foot/foot at well nests G-41 and G-14 respectively are present on the slopes, while flat gradients were noted on the uplands at well nest G-30.

3. Hydraulic conductivities determined by single-well response tests at the site varied between 2×10^{-6} cm/sec for shale to 8×10^{-4} cm/sec for foundry sand/alluvium. Lab permeabilities using a falling head permeameter varied from 3×10^{-8} cm/sec for till to 2×10^{-7} for alluvium.

4. The two to three orders of magnitude difference between field permeabilities and lab permeabilities suggests that the till is fractured.

5. Locally, ground water movement appears to be influenced by the topography of the native materials beneath the fill. The water appears to flow along the contact between the till that has a lower permeability (geometric mean 2 x 10^{-5} cm/sec) and the overlying foundry sand which has a higher permeability (single test 8 x 10^{-4} cm/sec).

6. The water table is shallow within the unconsolidated materials in undisturbed areas such as G-14 and G-30, while it is deeper in areas disturbed by mining such as on the west side of the landfill at G-34 and on the east side of the landfill at G-129. This phenomenon seems to suggest that buried mine shafts and mining debris may allow more rapid ground water flow in these areas.

7. Flow velocities varied from 0.4 ft/day in foundry sand to 8 x 10^{-3} foot/day in shale for the same transect of 2,480 feet across the site from well nest G-30 to well G-32S. Based upon these velocities, it would take about 20 years for the water to flow through these two points in foundry sand and about 900 years to flow between the same two points in shale. Flow in the till from well nest G-30 to well G-32S is estimated to take 300 years.

2.3 Conclusions

1. Ground water flows north toward the upland in the center of the site. From the upland, the ground water flows toward and discharges to the Vermilion River to the north and to the unnamed tributaries to the east and west of the landfill.

2. Water tends to flow along the till/foundry sand interface, so the flow is strongly influenced by predisposal topography.

3. Ground water also appears to flow toward and in buried mining debris and buried mine shafts.

4. The existing monitoring well network is sufficient to monitor the overall ground water flow patterns at the site. The monitoring wells are located in the shallow soil layers downgradient of the landfill. Flow which may occur in old mine shafts is monitored at surface seeps around the perimeter of the site.

3. METHODS

3.1 Introduction

Methods were used to install a ground water monitoring system that would adequately monitor the site for contaminant migration. The two-phased approach of first installing borings and then installing wells was used. The objectives of this methodology are the following:

- To define the geologic environment of the site.
- To determine the vertical and horizontal components of flow.
- To identify possible contaminant migration pathways.
- To construct wells in such a way as not to influence water quality.
- To estimate velocities of possible contaminant migration.

3.2 Soil Borings

The number and locations of the nine soil borings were selected through negotiations with the Illinois Environmental Protection Agency (IEPA). The locations of the borings are shown on Figure 1. These borings were installed to a depth of 40 feet or auger refusal, whichever was shallowest. The borings were logged by a geologist, noting soil color, texture, structure, moisture, consistency, and any other distinguishing characteristics of the soil. The boring logs are presented in Appendix A.

The borings were installed using six-inch outside diameter hollow-stem augers. Continuous soil samples were collected using a two-foot long split-spoon sampler through the center of the augers. Samples were not collected when the spoon could no longer penetrate the materials. However, drilling was continued until either the auger could not be advanced or a depth of 40 feet was reached.

Water levels were recorded immediately after the boring was completed and at periodic intervals until the water level had stabilized. All borings were backfilled with a bentonite slurry that was pumped into the borehole from the bottom up, to reduce the potential for movement of ground water from one hydrostratigraphic unit to another. Soil samples were collected and stored in glass jars for transport to RMT. At RMT, samples representative of the lithologies encountered were selected for U.S.C.S. classification by analyzing their particle size distribution and Atterberg limits. The U.S.C.S. classification system is presented in Appendix B. All analyses were performed in accordance with ASTM specifications.

In addition to soil grain size analyses, selected samples were also analyzed for cation exchange capacity (CEC). The laboratory method for the CEC determinations is presented in Appendix C. The CEC measurements provide an estimate of the capacity of soils to sorb cations and are generally dependent on the mineralogy, particularly the clay mineralogy, of the soils. The organic matter content of the soil can also influence the CEC results.

3.3 Monitoring Wells

Twelve monitoring wells were constructed for monitoring the landfill (see Figure 1). Table 1 summarizes how construction of the monitoring program fit into the IEPA-approved plans. Construction details for each well are given in Appendix C. All of the wells were constructed using two-inch (inside diameter), threaded, flush joint, casing. One well (G-19D) was constructed in July 1981 and is

TABLE 1

SUMMARY OF MONITORING SYSTEM CONSTRUCTION

Elements of Monitoring Well Program	Adherence to IEPA-Approved Method
Well Construction Materials	Wells constructed of Teflon in the saturated zone as approved by the IEPA. One existing PVC well (G-19D) was incorporated into the plans submitted to the IEPA on April 23, 1986, and approved May 28, 1986.
Well Locations	All wells installed in IEPA-approved locations specified in the April 23, 1986, submittal except G-34S which was given verbal approval on June 16, 1986, by Steve Davis of the IEPA.
Number of Wells	Only 11 of the 12 IEPA-approved wells could be constructed. G34D could not be constructed because of access problems.
Depth of Wells	"S" wells were screened in the water table and "D" wells screened below the water table as proposed in the April 23, 1986, plan and approved in IEPA supplemental permit of May 28, 1986.

constructed entirely of PVC. The remaining eleven wells were constructed in June 1986. The well screens and the portions of casing beneath the water table in these wells are Teflon; the riser pipe above the water table is PVC. All of the well screens used were 0.010-inch slot size to reduce the potential for fine-grained sediment to enter the well. Teflon was chosen because of its inert nature and because it would not affect water quality.

The wells that were installed in fine-grained environments were developed in two stages (see Table 2). Under the two-stage well development process, the sand pack, bentonite seal, and the grouting were constructed between the first and second stages of development. In the first stage of development, the open borehole was flushed with clean water from the plant's supply to remove fine-grained material that may have become dislodged during drilling. In addition, flushing the open borehole with water dislodges fines that may become "plastered" onto the walls of the borehole by the augers during drilling. The well was developed by lowering the well screen and casing into the borehole and then pumping clean water through the screen and up the borehole annulus.

Following the first stage of development, the sand pack was completed with bagged silica sand, and the bentonite seals and cement grouts were installed. A steel protective casing with a locking cap was also installed on each monitoring well. The construction details for each monitoring well were recorded on a well construction diagram (see Appendix D).

TABLE 2

SUMMARY OF MONITORING WELL
CONSTRUCTION DETAILS
(All Units in Feet)

Well Number	Screen Length	Screen Interval (Below Ground Surface)	Sand Pack Interval (Below Ground Surface)	Seal Interval (Below Ground Surface)	Unit Finished In
G-14S	10	25.0 - 15.0	25.0 - 13.5	13.5 - 0	Shale
G-14D	5	35.0 - 30.0	35.0 - 27.0	27.0 - 0	Shale
G-19S	10	13.5 - 3.5	13.5 - 2.3	2.3 - 0	Till
G-19D[1]	10	25.0 - 15.0	25.0 - 14.0	14.0 - 0	Till
G-30S	10	12.0 - 2.0	12.0 - 1.5	1.5 - 0	Fill
G-30D	5	24.5 - 19.5	24.5 - 17.0	17.0 - 0	Till
G-32S	10	15.0 - 5.0	15.0 - 4.0	4.0 - 0	Alluvium
G-34S	5	12.3 - 7.3	12.3 - 6.0	6.0 - 0	Foundry Sand
G-41S	5	8.0 - 3.0	8.0 - 2.0	2.0 - 0	Foundry Sand/Till
G-41D	5	14.5 - 9.5	14.5 - 8.0	8.0 - 0	Till/Shale
G-42S	5	7.5 - 2.5	7.5 - 1.5	1.5 - 0	Alluvium/ Foundry Sand
G-42D	5	15.0 - 10.0	15.0 - 9.2	9.2 - 0	Alluvium

[1] - Denotes existing well.

After the wells were constructed, the second stage of development was implemented. The wells were either bailed or pumped to dislodge any fines that may have accumulated during the well construction. The details of the second stage of development are given on the well construction diagrams (see Appendix D).

Wells G-30S, G-32S, G34S, G-41S, and G-42S, which were installed in coarser-grained fill or alluvial sediments (see Table 2), were developed by alternately surging with a bailer (i.e., rapidly raising and lowering the bailer) and pumping with a guzzler pump. The details of development for these wells are also included in Appendix D.

The ground water flow patterns at the Danville plant were established using ground water elevation data. The depth to water was measured to the nearest 0.01 foot in each well until the water level stabilized. Horizontal flow directions were determined by plotting the ground water elevations recorded at the water table wells and contouring the values to form a water table map. Vertical flow directions were calculated using the elevations recorded at the nested water table wells and piezometers.

The hydraulic conductivities of the formations were estimated using data from single-well response tests. The single-well response test consists of withdrawing a given amount of water and recording the rate of recovery. The hydraulic conductivity at the water table observation wells was calculated using the Bouwer and Rice (1976) method. The hydraulic conductivity at the piezometers was calculated using formulas presented by Hvorslev (1951, p. 44).

In addition to field testing, vertical hydraulic conductivities of selected materials were tested in the laboratory using a falling head permeameter. Shelby tube samples were collected from the borings at monitoring well locations G-14S, G-32S, and G-19S. Undisturbed soil samples were cut from the Shelby tube and placed in the permeameter, and the permeability of the sample was determined.

The hydraulic conductivity values from the field and laboratory methods and the ground water elevations were used to estimate vertical and horizontal flow rates.

4. SUBSURFACE INVESTIGATION

4.1 Site Location and Setting

The CFD-Danville plant is located in Vermilion County, approximately one mile west of Danville, Illinois. The plant is situated immediately south of the Vermilion River and west of the Tilton municipal wastewater treatment plant.

The CFD-Danville plant property is located on a till-draped upland above the Vermilion River. The upland is dissected so that there are intermittent tributaries to the Vermilion River on the east and west sides of the plant property. The topography of the area is characterized as rolling to gently rolling in the upland areas with the drainageways providing very steep relief in certain areas. The landfill area itself is nearly flat with a graded slope. On the north and west sides of the landfill are irregular, steep slopes.

Locally, surface drainage is somewhat irregular following incised drainageways to the easterly flowing Vermilion River.

Figure 1 shows the site layout including buildings, roadways, the location of the foundry waste landfill, and well locations.

4.2 Site Geology

Site geology was evaluated by reviewing the existing published data for the region, data collected during the Phase I boring program conducted in March 1986, and data from previous subsurface investigations at the Danville plant property. The Phase I field investigation included drilling boreholes at nine locations, collecting split-spoon soil samples from the borings, visually classifying the samples in the

field, and testing selected soil samples in the laboratory. The locations of the borings are shown in Figure 1. The geologic logs for each boring are presented in Appendix A.

The boring locations and the locations of three geologic cross sections are shown in Figure 1. The three geologic cross sections are presented in Figure 2. The logs for each boring are presented in Appendix A.

4.2.1 Unconsolidated Deposits

The geologic cross sections (see Figure 2) show that the bedrock at the Danville plant is overlain by a combination of foundry waste and glacial deposits. The depth to the foundry waste varies considerably over the site, and, at its deepest point (B-8), the foundry waste is approximately 50 feet thick. The unconsolidated glacial deposits consist of 10 to 20 feet of dense silty clay till. Visual observations and laboratory grain size testing (see Table 3) show that these glacial tills consist of gray to light brown, dense, uniform, calcareous, silty clay. Generally, the till consists of between 35 to 40 percent silt and an approximately equal amount of sand (see Table 3). Results of Atterberg testing show that it is classified as a CL or ML under the Unified Soil Classification System. Although the till was generally very uniform, a single lens of sand was encountered in the till at location G-33 (see Figure 2).

In addition to the glacial deposits, on the north edge of the landfill area (see Figure 2) there are alluvial deposits in the Vermilion River valley. Three borings (G-32S, G-42S, and G-42D) were

TABLE 3

SUMMARY OF SOIL TESTING RESULTS

Material	Boring Number	Depth (feet)	% Gravel	% Sand	% Silt	% Clay	Atterberg Limits Liquid Limit	Atterberg Limits Plastic Limit	U.S.C.S. Classification
Till	G-14	11 - 12	1.3	35.8	38.0	24.9	18	7	CL - ML
	G-19	4.5 - 5.5	1.5	30.1	37.2	31.2	38	19	CL
	G-19	17 - 18	2.3	42.9	36.8	18	13	3	ML
	G-30	12 - 13	2.7	35.1	38.8	23.4	17	5	CL - ML
	G-30	21 - 22	.7	34.8	39.4	25.1	19	9	CL
Sand Lens in Till	G-33	13.5 - 14.5	15.9	69.9	11.3	2.9	--	--	SM
Weathered	G-14	13.5 - 14.5	4	16	52.5	27.5	36	16	CL
Shale	G-31	8 - 9	.2	4.6	59.1	36.1	40	21	CL
	G-34	19.5 - 20.5	0	5.8	58.1	36.1	40	16	CL
	G-41	8.5 - 9.5	4.9	18	18.1	59	--	--	CL
Alluvium	G-32	4 - 5	0	47.2	36.7	16.1	25	7	CL - ML
	G-32	15.5 - 16.5	16.6	46.7	19.5	17.2	38	12	SC
Alluvium/ Foundry Sand	G-42	7.5 - 8.5	6	71.7	15.4	6.9	--	--	SM
Foundry	G-34	2 - 3	3.3	86.7	7.5	2.5	--	--	SP - SM
Sand	G-41	2.5 - 3.5	2.8	87.6	6.8	2.8	--	--	SP - SM

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located in this area. The boring logs from these three locations show that the unconsolidated materials are predominantly alluvium. At location G-32S, the alluvium is a light brown silty sand (see Appendix A). However, at G-42S, the materials consist predominantly of foundry sand. The data in Table 3 show that samples from the alluvium are primarily a silty sand to a clayey silty sand.

Representative soil samples from each geologic unit and the foundry sand were tested for their Cation Exchange Capacity (CEC). The CEC testing results are presented in Table 4. In general, these results show that the till and the weathered shale materials have higher CEC values than either the foundry sand or the alluvium. These results reflect the higher percentages of silt and clay-sized particles found in these geologic units (see Table 3). One exception to this general trend is the high CEC value (22 me/100g dry weight) for the alluvium/foundry sand sample. The soil pH of this sample was not substantially different from the values recorded for either the till or weathered shale materials. Therefore, one possible explanation of the difference in CEC values is that the alluvium/foundry sand sample contained a higher amount of organic matter.

4.2.2 Bedrock

Bedrock was encountered at depths ranging from 11 to 25 feet below land surface during the site borings (see Appendix A). The bedrock is a gray shale of Pennsylvanian age that has thin, wavy bedding. An outcrop of the shale near the northeast corner of the landfill showed that the bedrock is extensively fractured with fractures oriented parallel to the

TABLE 4

SUMMARY OF CATION EXCHANGE CAPACITY (CEC) DATA

Material	Boring #	Depth (feet)	CEC me/100g dry wt.	Soil pH
Till	G-14	4 - 5'	12	6.7
	G-14	10 - 10.5'	21	6.6
	G-19	5.5 - 6.5'	15	6.2
	G-19	16 - 17'	20	6.6
	G-30	13 - 14'	20	5.5
	G-30	22 - 23'	21	6.0
	G-33	14.5 - 15.5'	15	6.0
Weathered Shale	G-31	8 - 9'	14	5.8
	G-34	6 - 7'	17	6.6
	G-41	2.5 - 4.5'	13	6.6
Alluvium	G-32	5 - 6'	10	5.3
Alluvium/ Foundry Sand	G-42	7 - 7.5'	22	6.6
Foundry Sand	G-34	18 - 19'	11	6.3
	G-41	9 - 10'	9	6.6

exposure face, as well as perpendicular to the exposure. The orientation of these fractures suggests that they are caused by stresses related to slope erosion. Generally, the upper two feet of the bedrock has weathered to silty clay. However, the weathered shale was up to 10 feet thick at locations on the northwest slope, particularly at boring G-31.

Within the shale is the Danville coal seam. Regional information and boring logs from previous investigations indicate that this coal seam dips slightly to the south and east (see Figure 2). A predisposal topographic map drawn in 1923 indicates that the area beneath the landfill has been extensively mined. The map indicates the presence of collapsed areas or "sinkholes" as well as mine shafts. It indicates that the areas in the northwest and along the eastern edge of the landfill have been extensively mined. These mining practices have resulted in disruption of the materials overlying the coal and the formation of potential conduits for ground water flow (see Figure 2).

4.3 Site Hydrogeology

The site hydrogeology was investigated during Phase II by installing a total of 12 monitoring wells, measuring ground water levels in all wells, and performing field permeability tests in 11 of the wells. A summary of well construction details is presented in Table 2. The locations of the monitoring wells are shown in Figure 1, the construction details of the monitoring wells are presented in Appendix D, and the relationship of the monitoring wells to site geology is illustrated in the geologic cross sections (see Figure 2).

4.3.1 Ground Water Elevations and Flow Directions

Water levels were measured at all twelve monitoring wells on July 10, 1986. Evaluation of these data showed that the water levels in all the wells in the till and shale, except G-19D, which was an existing well, had not stabilized. Therefore, a second round of water level measurements was collected from the eleven newly installed wells on July 31, 1986. The water levels were used to calculate ground water elevations at each well (see Table 5).

A water table map was constructed using the ground water elevations recorded in the water table observation wells on July 31, 1986 (see Figure 3). In general, the water table map shows that the water table occurs at a relatively shallow depth. The depth to ground water below surface ranged from 3 feet at well G-30S to 19 feet at well G-14S. The water table map also shows that ground water flows in a northerly direction and eventually discharges into the Vermilion River. The contrast in hydraulic conductivity between the more permeable foundry waste, which is composed primarily of sandy materials (see Table 3), and the much less permeable glacial tills results in ground water flowing horizontally along the contact between the foundry waste and the glacial till. Thus, predisposal topography influences the water table configuration. The map also shows that a ground water mound caused by a sand disposal pond influences the configuration of the water table locally.

Another localized influence on ground water movement at the site may be the presence of buried mine shafts and mining debris that may act

TABLE 5

WATER ELEVATIONS
JULY 1986

(All Elevations in Feet)

Well #	Top of PVC	Water Level	Bottom of Well
G-14S	631.03	609.91	603.99
G-14D	630.61	605.15	592.66
G-19S	630.79	623.71	614.08
G-19D*	630.68	627.98	604.09
G-30S	641.18	635.67	626.07
G-30D	641.19	635.3	616.69
G-32S	534.40	526.74	516.84
G-34S	600.29	590.4	585.29
G-41S	575.40	567.36	565.40
G-41D	576.06	564.40	559.10
G-42S	542.12	536.73	532.20
G-42D	542.32	536.35	523.92

*This elevation taken July 10, 1986. All other elevations taken July 31, 1986.

as zones of more rapid ground water flow. Discharge to these areas could result in dry borings in some areas with shallow ground water occurrence in adjacent areas. This relationship is illustrated in cross section A-A' (see Figure 2) where the water table is 6 feet below the surface at well G-127, while adjacent well G-129 is dry. The predisposal topographic map indicates that the area in the vicinity of G-129 had been mined. The water in this area may discharge into a mined-out area near well G-129.

Some of the ground water that flows into these mined-out areas may discharge as seep on the edge of the landfill. Sixteen seeps were identified during a site inspection in the fall of 1981. Many of these areas are being monitored.

In addition to the above-mentioned influences, secondary porosity, probably in the form of fractures within the shale, seems to affect ground water flow at the site. The water table was found to be within the shale at only 1 monitoring well (G-14S). The ability to auger through this material and install a well 20 feet into the shale at this location suggests that the shale was soft and probably fractured. This theory is further supported by the fact that G-14S and G-14D are located at the edge of a slope. As mentioned previously, fractured shale appears to be related to stresses caused by slope erosion.

A comparison between ground water elevations for water table observation wells and those for piezometers at nested locations (see Table 5) shows that on the uplands there is a very small, downward component of flow with a strong downward component on the slopes. For example, at wells G-30S and G-30D on the upland, there was a slight

0.02 ft/ft downward component of flow; while at wells G-14S and G-14D, there is a 0.4 ft/ft downward gradient and a 0.6 ft/ft downward gradient at wells G-41S and G-41D. The strong downward component of flow apparently dissipates in the Vermilion River Valley as wells G-42S and G-42D show nearly identical ground water elevations (see Table 5 and Figure 3). These concepts are illustrated in Figure 2.

Upward gradients were observed at Wells G-19S and G-19D. However, since the elevation at G-19S was recorded three weeks after the level at G-19D, the upward gradient at this location is not thought to be representative. Well G-19D was inadvertently omitted from the round of water levels taken on July 31, 1986.

In summary, ground water flow appears to be strongly influenced by the topography of the low permeability materials beneath the fill as well as by mine shafts and the mine debris beneath the fill.

The vertical gradients measured across the site show the following:

1. Ground water on the uplands flows horizontally.
2. There is a strong downward component of flow on the steep sideslopes.
3. Ground water flow in the Vermilion River Valley is again horizontal. Thus, ground water flows along the upland and down the steep sideslopes, and discharges to the Vermilion River.

4.3.2 Hydraulic Conductivities and Flow Velocities

In order to determine the approximate velocity of ground water movement, average linear velocities were determined for the major geologic units for a 2,480-foot-long transect across the site from well nest G-30 to well G-32S (see Figure 3). The first step in calculating

TABLE 6

HYDRAULIC CONDUCTIVITIES OF MATERIALS AT CFD DANVILLE

Field Permeabilities[1]

Material	Well #	Conductivity (cm/sec)
Till	G-19S	1.1×10^{-5}
	G-19D	6.8×10^{-5}
	G-30D	1.5×10^{-6}
	G-41S	4.1×10^{-5}
	G-41D	4.5×10^{-5}
	Geometric Mean	1.8×10^{-5}
Alluvium	G-32S	3.1×10^{-4}
	G-42S	8.2×10^{-4}
	G-42D	6.1×10^{-4}
	Geometric Mean	5.4×10^{-4}
Shale	G-14S	7.6×10^{-6}
	G-14D	1.2×10^{-6}
	Geometric Mean	3.0×10^{-6}
Foundry Sand/Alluvium	G-42S	8.2×10^{-4}
Fill	G-30S	2.3×10^{-5}

Lab Permeabilities[2]

Till	G-14S (8-10')	4.0×10^{-8}
	G-19 (8-10')	3.1×10^{-8}
	Geometric Mean	3.5×10^{-8}
Alluvium	G-32S (8-10')	1.9×10^{-7}

Notes:

1. Results assumed to be representative of horizontal hydraulic conductivity.

2. Results assumed to be representative of vertical hydraulic conductivity.

the flow velocities was to determine the hydraulic conductivity of the different geologic units.

Hydraulic conductivities for the different materials determined from single-well response tests varied from 1.2×10^{-6} cm/sec for shale to 8.2×10^{-4} cm/sec for foundry sand/alluvium (see Table 6). Conductivities determined at different wells in the same unit varied by a factor of ten. The calculations of hydraulic conductivities are presented in Appendix D. The geometric mean hydraulic conductivity is 3×10^{-6} cm/sec for the shale, 2×10^{-5} cm/sec for the till, and 5×10^{-4} cm/sec for the alluvium. These results are presented in Table 4, and calculations are presented in Appendix E. Results for a single test in a single material are also presented in Table 6.

Laboratory hydraulic conductivities were determined on undisturbed samples of till and alluvium and were conducted so that the results would reflect vertical permeabilities. Hydraulic conductivities determined with a falling head permeameter were found to be two to three orders of magnitude lower than results determined in the field for the same materials (see Table 6). This suggests that the till materials are fractured. These fractures give the glacial till a secondary permeability which is not reflected in the laboratory testing. The lower laboratory permeabilities for the alluvial materials suggest that this material is stratifield (i.e., layered). Since the laboratory procedure tests vertical permeability of the sample, small frequent layers of fine-grained material within the sandy alluvium would result in a lower permeability than an in-field hydraulic conductivity test. The in-field hydraulic conductivity test primarily measures horizontal

permeabilities, and, thus, these results would principally reflect the permeability of the sandy layers.

Hydraulic conductivity data were used to determine flow velocities for a transect across the landfill from well nest G-30 to well G-32S (see Figure 3). The flow velocities varied from 3.6×10^{-1} ft/day in foundry sand to 7.5×10^{-3} ft/day in shale and 2.3×10^{-2} ft/day in till. Calculations are presented in Appendix E.

Based on these flow velocities, it would take between 20 years and 900 years for water to flow the 2,480 feet from G30 to G32. As mentioned in the previous section, ground water at the site appears to flow along the foundry sand/till contact. It would take approximately 20 years for water to flow from G-30S to G-32S in the foundry sand. In contrast, it would take about 300 years for water to flow the same distance if the ground water flowed only through the till. This implies that water flowing along the till/foundry sand contact would take between 20 and 300 years to flow from well nest G-30 to well G-32S. However, because water flowing along this contact may discharge into conduits formed by mine shafts or mining debris, it may actually take less than 20 years for water to flow through the landfill area.

In summary, field hydraulic conductivities of the materials at the site vary between 1.2×10^{-6} cm/sec and 8.2×10^{-4} cm/sec. Conductivities determined from lab permeameter data are up to two orders of magnitude lower for the same material indicating that field conductivities could be influenced by secondary porosity in the till materials and the layering of the alluvial sediments. Furthermore, flow velocities and estimated time of flow across the landfill were highly variable for a representative flow path.

Generally, the twelve wells to be used in the ground water monitoring program should give an indication of whether ground water has been impacted by the landfill. The wells were constructed of materials that should not influence water quality and should, therefore, give an accurate indication of ground water quality at those monitoring wells. The wells were placed in the good locations, taking into account access problems, and were screened across appropriate units to give a good indication of vertical movement of ground water between units. The wells provide a good indication of general ground water flow direction including horizontal and vertical gradients.

APPENDIX A

BORING LOGS

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/25/86

JOB NO.: 105.26

BORING NO.: G- 14

SURFACE ELEV.:

SHEET NO.: 1 of 3

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
				1		Dark black silty clay (CL) moist, little medium to fine sand (topsoil).
1	SS			1		Light brown, silty clay (CL) moist, becoming mottled with gray and brown at about 2' and calcareous at about 5' (till)
				2		
				2	2	
2	SS			4		
				5		
				5		
				6	4	
3	SS			4		
				5		
				7		
				8	6	
4	SS			10		Reddish brown silty clay (CL) moist, compact, plastic, very calcareous, becoming dense at 9 feet (till).
				12		
				16		
				20	8	
5	SS			15		
				19		
				24		
				38	10	
6	SS			23		
				31		
				32		
				34	12	
7	SS			24		Mottled light brown silty clay (CL), dense, dry, iron mottles on horizontal bedding planes, noncalcareous (weathered shale).
				26		
				28		
				86	14	
				100		Gray silty clay grading into light gray silty shale, dry, 3 - 5 mm thick, wavy bedding, parting along bedding planes - spoon refused at 14.5 feet.
					16	

GENERAL NOTES

START: 10:30

COMPLETE: 12:15

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Dry

UPON COMPLETION: Dry upon completion

TIME AFTER DRILLING: 20 hours 70 hours

DEPTH OF WATER: 22 feet 19.5 feet

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville
LOCATION: Danville, Illinois
DRILLED BY: P.S.I.
LOGGED BY: HEC
DATE: 3/25/86

JOB NO.: 106.26
BORING NO.: G- 14
SURFACE ELEV.:
SHEET NO.: 2 of 3

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
					18	
9	SS			100		Sample at 18.5feet spoon refusal. Gray silty shale.
					20	
					22	
					24	
					26	
					28	
					30	
10	SS			>100		Sample at 30 feet spoon refusal. Gray silty shale.
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/ 25/86

JOB NO.: 106.26

BORING NO.: G- 14

SURFACE ELEV.:

SHEET NO.: 3 of 3

SAMPLE						VISUAL CLASSIFICATION and Remarks
Recovery		Moisture				
No.	Type			N	Depth	
						Gray shale as above to 40.5 feet.
					36	
					38	
						Boring dry on completion. SS Sample at 40 feet.
					40	
11	SS			>100		End of boring 40 feet.

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 19

SURFACE ELEV.:

SHEET NO.: 1 of 2

SAMPLE						VISUAL CLASSIFICATION and Remarks
Recovery		Moisture				
No.	Type			N	Depth	
1	SS			4 5 8 8	2	Road asphalt and black, medium to coarse grained foundry sand. Light gray silty clay (CL), moist, green and brown (iron) mottles, firm, noncalcareous (till)
2	SS			2 3 5 5	4	
3	SS			6 3 4 7	6	
4	SS			2 3 5 6	8	Light gray silty clay (CL) grading into light brown, silty clay (CL), wet, firm, calcareous, becoming mottled with gray mottles at about 11' (till).
5	SS			2 3 3 3	10	
6	SS			4 6 6 8	12	
7	SS			7 7 8 10	14	
8	SS			7 6 6 6	16	Light brown silty clay (CL) grading into light brown silty clay (CL) little to some fine sand, trace, coarse gravel, wet, firm.

GENERAL NOTES

START: 9:00

COMPLETE: 11:45

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: 23.6'

UPON COMPLETION: 13'

TIME AFTER DRILLING: 9.6 hours

DEPTH OF WATER: 4'

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 19

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
9	SS			4 4 5 6	18	
10	SS			3 6 9 12	20	
11	SS			9 16 20 22	22	Silty gray clay (CL), dry, firm, slightly plastic, noncalcareous, at 23 feet platy structure, 3 - 5 mm thick plates.
12	SS			18 28 40 60	24	
13	SS			35 55 100	26	Gray silty shale thinly bedded (3 - 5 mm thick) wavy bedding breaking along bedding planes. Very hard. End of boring 25.5 feet.
					28	
					30	
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/25/86

JOB NO.: 106.26

BORING NO.: G- 30

SURFACE ELEV.:

SHEET NO.: 1 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
No SS taken because can't penetrate gravel.					2	Limestone gravel fill Black medium to coarse grained foundry sand, moist.
1	SS			4 4 3 2	4	Mottled light gray silty clay (CL) wet, very plastic, few faint orange mottles, calcareous (fill). Black medium to coarse grained foundry sand
2	SS			2 4 6 8	6	Gray silty clay (CH) wet, almost fluid, plastic, noncalcareous (fill). * This appears to be a perched water table in the fill.
3	SS			5 5 5 7	8	Gravel with some sand (SM), well graded, rounded pebbles, pieces of wood (fill).
4	SS			6 8 10 22	10	Light brown, silty clay (CL) gray and orange mottling increasing at about 9 feet, moist, plastic, noncalcareous (till) becoming calcareous at about 10 feet, medium dense, becoming dense at about 14 feet.
5	SS			11 12 12 12	12	
6	SS			5 8 8 10	14	
7	SS			15 25 35 50	16	

GENERAL NOTES

START: 1:30

COMPLETE: 4:00

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Near surface

UPON COMPLETION: 13.6'

TIME AFTER DRILLING: 1 hour 24 hours

DEPTH OF WATER: ~~3 feet~~ ~~3 feet~~

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/25/86

JOB NO.: 106.26

BORING NO.: G- 30

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE						VISUAL CLASSIFICATION and Remarks
Recovery		Moisture				
No.	Type			N	Depth	
8	SS			25 22 18 14	18	Light brown silty clay till grading to mottled brown silty clay (CL) moist calcareous firm (till).
9	SS			15 17 35 50	20	Light gray sandy clay (CL) dense and dry calcareous, some pebbles of dolomite (till).
10	SS			35 45 76 100	22	Light gray sandy clay grading into red brown sandy clay (SC) dense and dry, calcareous (till)
11	SS			53 78 55 44	24	
12	SS			16 25 31 55	26	Light gray silty clay (CL), dense, slightly moist, noncalcareous, breaking along 3 - 5 mm thick bedding planes.
13	SS			58 123	28	Light gray silty clay grading into gray silty shale, breaking into plates 3 - 5 mm thick along bedding planes. End of boring at 28 feet.
					30	
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 31

SURFACE ELEV.:

SHEET NO.: 1 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
Auger through slag and gravel					2	Dark brown to black medium to coarse grained foundry sand (SM) little slag etc. * Put over site in construction of road.
1	SS			6 5 4 6	4	Light brown uniform silty clay (CL) moist calcareous, firm (till).
2	SS			6 6 9 12	6	Light brown silty clay (CH), slightly moist, noncalcareous.
3	SS			8 10 10 22	8	
4	SS			13 17 18 20	10	As above, becoming very dry with iron mottles.
5	SS			12 17 20 23	12	
6	SS			22 23 23 25	14	
7	SS			19 30 31 33	16	Becoming thinly bedded (3 - 5 mm), dense and dry with many iron mottles.

GENERAL NOTES

START: 2:30

COMPLETE: 4:15

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Dry

UPON COMPLETION: Dry

TIME AFTER DRILLING: Dry

DEPTH OF WATER:

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 31

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
8	SS			24 33 40 44	18	As above, becoming grayer with few iron mottles.
9	SS			15 35 55 82	20	
10	SS			35 55 58 91	22	Gray silty clay grading into gray silty shale, dry, with iron mottles along bedding planes, thinly bedded 3 - 5 mm.
11	SS			94 126	24	End of boring at 23 feet.
					26	
					28	
					30	
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 32

SURFACE ELEV.:

SHEET NO.: 1 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
1	SS			2 3 3 4	2	Dark brown silty clay (CL) trace coarse sand, moist, plastic, organic rich.
2	SS		Weight of spoon.		4	Light brown, fine silty sand (SM), wet, almost fluid, becoming more firm at about 12 feet, noncalcareous (alluvium).
3	SS			0 1 0 1	6	
4	SS		Weight of spoon.		8	
5	SS			1 2 2 1	10	
				0 1 2 1	12	
6	SS			0 2 1 2	14	
7	SS			2 1 2 1	16	As above, but becoming gray with few iron mottles. Black sandy gravel composed of angular fragments of shale and coal (GM).

GENERAL NOTES

START: 12:30

COMPLETE: about 1:30

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: 5 feet

UPON COMPLETION: 4.5 feet

TIME AFTER DRILLING: 96 hours

DEPTH OF WATER: 4.5 feet

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/24/86

JOB NO.: 106.26

BORING NO.: G- 32

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE						VISUAL CLASSIFICATION and Remarks
Recovery		Moisture				
No.	Type			N	Depth	
8	SS			4 >100	18	Light gray silty shale, iron stains on horizontal bedding planes, dry, hard.
					20	End of boring at 17 feet.
					22	
					24	
					26	
					28	
					30	
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/25/86

JOB NO.: 106.26

BORING NO.: G- 33

SURFACE ELEV.:

SHEET NO.: 1 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
				6 6 5 6	2	Light brown uniform sandy clay fill (CL) moist, plastic
1	SS					Black medium to coarse grained foundry sand (SM) slightly moist.
2	SS			3 3 3 2	4	
3	SS			4 3 3 2	6	
4	SS			2 2 2 1	8	Light brown sandy clay (SC) moist, slightly plastic, calcareous.
5	SS			6 7 8 8	10	
6	SS			6 7 7 8	12	
7	SS			10 14 13 11	14	Light brown sandy clay grades into light brown silty sand (SM), well graded, friable, very dry, calcareous, some pebbles.
8	SS			12 10 9 13	16	Becoming moist at 15'.

GENERAL NOTES

START: 8:45

COMPLETE: 10:00

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Dry

UPON COMPLETION: Dry

TIME AFTER DRILLING: Dry

DEPTH OF WATER:

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/25/86

JOB NO.: 106.26

BORING NO.: G- 33

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
9	SS			8 10 4 2	18	
10	SS			5 7 15 22	20	Very moist at approximately 19 feet. Light brown silty clay (CH), moist, dense, noncalcareous, common red iron mottles.
11	SS			26 22 30 34	22	Light brown silty clay grading into light gray silty clay (CH), slightly moist, bedded with mottled plates 3 - 5 mm thick.
12	SS			33 56 64 73	24	Iron mottles disappear at 23 feet. Dense and dry at 24 feet.
				62 73 112	26	Light gray silty clay grading into gray silty shale, dry, thinly bedded, dense.
					28	
					30	End of boring at 29 feet.
					32	
					34	

LOG OF TEST BORING
RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville
LOCATION: Danville, Illinois
DRILLED BY: P.S.I.
LOGGED BY: HEC
DATE: 3/27/86

JOB NO.: 106.26
BORING NO.: G- 34
SURFACE ELEV.:
SHEET NO.: 1 of 2

SAMPLE No.	Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
1	SS			3 4 4 4	2	Light brown silty clay (CL) moist, calcareous many carbonate pebbles (fill).
2	SS			5 5 4 4	4	Black medium to coarse grained foundry sand (SM), calcareous, moist, friable. Loose in upper part becoming more compact at 5 feet. Generally, well graded with few thin lenses of poorly graded medium sand.
3	SS			15 17 10 12	6	
4	SS			2 3 3 3	8	Wet above contact with underlying unit.
5	SS			1 1 2 3	10	Light brown silty clay (CH) very moist, plastic, noncalcareous
6	SS			4 4 4 4	12	Light reddish brown clay with some pebbles moist, noncalcareous matrix grading to brown silty sand with some pebbles (CL).
7	SS			5 5 7 8	14	Light brown silty clay (CH) with common light gray mottles, moist, noncalcareous
8	SS			5 6 7 8	16	Becoming drier and grayer at 15 feet.

GENERAL NOTES

START: 10:15
COMPLETE: 11:15
RIG: CME 55
CREW CHIEF:
DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Dry
UPON COMPLETION: Dry upon completion
TIME AFTER DRILLING: 24 hours Dry
DEPTH OF WATER:
DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/27/86

JOB NO.: 106.26

BORING NO.: G- 34

SURFACE ELEV.:

SHEET NO.: 2 of 2

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
9	SS			5 6 9 11	18	As above, light gray silty clay.
10	SS			9 11 18 23	20	
11	SS			13 15 15 17	22	
12	SS			12 18 15 16	24	Grading into light gray silty clay, thinly bedded (3 - 5 mm), dry, medium dense, grading to gray silty shale, thinly bedded, (3 - 5 mm) thick plates, dry, hard, noncalcareous.
13	SS			37 100	26	End of boring at 25 feet.
					28	
					30	
					32	
					34	

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/27/86

JOB NO.: 106.26

BORING NO.: G- 41

SURFACE ELEV.:

SHEET NO.: 1 of 1

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
1	SS			2 3 3 3	2	Black medium to coarse grained foundry sand (SM), friable, wet, little to trace amounts of slag. * Some of this was brought in during access road construction.
No SS, hit rock.					4	
2	SS			3 4 3 4	6	Light gray silty clay (CH) firm, few faint light brown mottles, wet, plastic, noncalcareous.
3	SS			5 10 9 7	8	
4	SS			4 3 3 3	10	Light gray silty clay grading into light gray silty clay, thinly bedded (3 - 5 mm) moist, plastic, many mottles, noncalcareous.
5	SS			1 8 48 43	12	Gray shale, poorly bedded, 3 - 5 mm plates, noncalcareous, dense. Black coal, dry, brittle. Gray shale, poorly, bedded 3 - 5 mm plates, noncalcareous.
6	SS			112	14	End of boring at 12.5 feet.
					16	

GENERAL NOTES

START: 8:40

COMPLETE: 9:45

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: Wet

UPON COMPLETION: Not available

TIME AFTER DRILLING: 2.5 hours 24 hours

DEPTH OF WATER: ~~5 feet~~ ~~3 feet~~

DEPTH OF CAVE-IN:

LOG OF TEST BORING

RESIDUALS MANAGEMENT TECHNOLOGY, INC.

PROJECT: CFD-Danville

LOCATION: Danville, Illinois

DRILLED BY: P.S.I.

LOGGED BY: HEC

DATE: 3/27/86

JOB NO.: 106.26

BORING NO.: G- 42

SURFACE ELEV.:

SHEET NO.: 1 of 1

SAMPLE No.	SAMPLE Type	Recovery	Moisture	N	Depth	VISUAL CLASSIFICATION and Remarks
1	SS			4 4 4 5	2	Light gray silty clay (CL) moist, plastic, calcareous, uniform (fill). Black to dark brown medium to coarse grained foundry sand (SM) well graded, friable, few organics, mottles.
2	SS			11 7 5 4	4	Wet at 3 feet.
3	SS			0 1 1 1	6	Little organic material at about 5 feet, including wood and roots.
4	SS			71 10 10 11	8	Silty black gravel (GM) composed of broken up angular fragments of coal and shale - hit rock.
5	SS			3 2 2 2	10	Black coal, fractured, brittle, friable.
6	SS			1 2 3 2	12	Gray silty clay (CH), plastic, orange iron mottling, noncalcareous.
7	SS			4 3 5 10	14	
8	SS			12 34 > 100	16	Black, fractured, friable shale. Gray compact shale, breaking along horizontal bedding plane. End of boring at 15.5 feet.

GENERAL NOTES

START: 2:00

COMPLETE: 3:30

RIG: CME 55

CREW CHIEF:

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATIONS

WHILE DRILLING: 2.5 feet

UPON COMPLETION: 2.5 feet

TIME AFTER DRILLING:

DEPTH OF WATER:

DEPTH OF CAVE-IN:

APPENDIX B

U.S.C.S. SOIL CLASSIFICATION SYSTEM

RMT, Inc.
Unified Soil Classification System
F- 245 (2-81)

COARSE-GRAINED SOILS

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

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

FINE-GRAINED SOILS

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

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

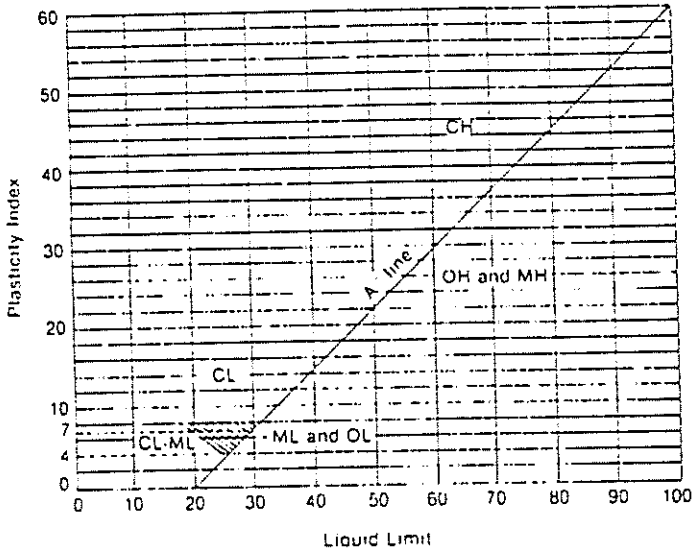
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 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; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 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

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)

APPENDIX C

CATION EXCHANGE CAPACITY (CEC) LAB METHOD

ESTIMATED CATION EXCHANGE CAPACITY

An estimation of the cation exchange capacity (CEC) is calculated for soil samples using the following equations:

$$\text{Sandy soils estimated CEC} = (0.75)\ \frac{\text{Ca(lbs/acre)}}{400} + \frac{\text{Mg(lbs/acre)}}{243} + \frac{\text{K(lbs/acre)}}{780}$$

$$\text{Silty or organic soils estimated CEC (Organic Matter less than 60 tons/acre)} = \frac{Ca}{400} + \frac{Mg}{243} + \frac{K}{780}$$

Silty or organic soils estimated CES (Organic Matter greater than 60 tons/acre) =

$$(2.00-0.05\ \text{Organic Matter} + 0.000556\ \text{O.M.}^2) = \frac{Ca}{400} + \frac{Mg}{243} + \frac{K}{780}$$

Estimated CEC gives a relative rating of the soil's ability to hold cation nutrients in an exchangeable form. CEC is also used to determine the loading rate of a given soil in terms of heavy metals from sludge.

AVAILABLE POTASSIUM[16]

This is determined on the remainder of the soil extract (after the phosphorus aliquot has been removed) with a Coleman Model 21[17] flame photometer. One drop of 1% Sterox solution [18] may be added to each tube of soil extract. The purpose of the Sterox is to keep the flame photometer atomizer free of minute particles that would otherwise obstruct it and give erroneous readings.

The flame photometer is set at zero with distilled water. Next, the instrument is set at 250 lbs K with a solution containing 12.5 ppm K in water. Then, a solution containing 25 ppm K should give a reading of 500 lbs K per acre (± 10 lbs). If the flame photometer cannot be standardized within these limits, it is necessary to alter the temperature of the flame by adjusting the amount of gas and oxygen supplied to the burner. (See Operator's Manual).

Standard K solutions: Standard K solutions for calibration purposes will be supplied to Wisconsin soil testing laboratories, upon request, by the State Soil and Plant Analysis Laboratory, Madison, or the State Soils and Forage Laboratory, Marshfield. The standard P solutions also contain K and can be used for calibration purposes.

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[16]Unpublished data, Soils Department, University of Wisconsin, Madison.

[17]Most laboratories currently use the Coleman Model 21 Flame Photometer with special adaptation for sample introduction. Coleman Instruments, Inc., Maywood, Illinois.

[18]Available from Monsanto Chemical Company. A similar product, Acationox, is available from Scientific Products, Chicago.

AVAILABLE PHOSPHORUS[12]

Special materials and reagents

Measuring spoon calibrated to hold 1.5 g of light-colored silt loam soil.[6]

Stock P-A solution (1.25 N HCl, 1.5 N NH_4F): Add 54 ml of 48% HF to 700 ml of water (makes 2 N HF). Neutralize to pH 7.0 with NH_4OH. Add 108 ml of concentrated HCl (11.6 N) and dilute to 1 liter.

Dilute P-A solution (0.025 N HCl, 0.03 N NH_4F): Dilute 20 ml of stock P-A solution to 1 liter.

P-B solution (0.87 N HCl, 0.38% ammonium molybdate, 0.5% H_3BO_3): Dissolve 3.8 g ammonium molybdate, $(NH_4)_6Mo_7O_{24} \cdot 4H_2O$, in 300 ml water at about 60°C. Cool. Dissolve 5.0 g boric acid, H_3BO_3, in 500 ml water and add 75 ml of concentrated HCl (11.6 N). Then, add the molybdate solution and dilute to 1 liter.

P-C solution: Dissolve 8 g of dry P-C powder in 50 ml of warm distilled water. Let stand overnight, if possible. A fresh reagent should be made every three weeks. (Upon long standing, some material may crystallize out, but this is still satisfactory.)

---

[12]Laverty, J.C. 1961. The Illinois Method for Determining Available Phosphorus in Soils. Department of Agronomy, Extension Service in Agriculture and Home Economics Bulletin,, University of Illinois College of Agriculture, Urbana, Illinois. This procedure is modified somewhat for use in Wisconsin soil testing labs.

The P-C powder is prepared by mixing thoroughly and grinding to a fine powder 2.5 g of 1-amino-2-napthol-4 sulfonic acid,[13] 5.0 g sodium sulfite (Na_2SO_3) and 146 g sodium metabisulfite ($Na_2S_2O_5$)[13].

Procedure

A measured volume of soil (equivalent to 1.5 g of light-colored silt loam) is placed in a 50-ml Erlyenmeyer flask. Fifteen ml of P-A solution is dispensed with a constant suction pipette apparatus. The suspension is shaken on an oscillating shaker at a speed of about 160 excursions per minute for five minutes. The samples are filtered through Whatman No. 2 (or equivalent) 9-cm filter paper into 15-ml funnel tubes.[14] A 3.0-ml aliquot of soil extract is taken with a constant suction pipette apparatus and dispensed into 20-ml colorimeter tubes. A 3.0 ml volume of P-B solution is added with the same pipette apparatus and mixed well. Five drops of P-C solution are added to each tube and mixed immediately. The color is read after 15 minutes and within 45 minutes with a Coleman Model 8 Photo-Electric colorimeter,[15] using filter 8-215 (645 mu). The instrument is calibrated from standard phosphorous solutions to read directly in pounds of available phosphorus per acre. The working range is from 0 to 400 lbs of phosphorus per acre in the soil. The calculations is lieu of direct calibration is ppm phosphorus in solution times 20 (i.e., ppm P in solution before adding P-B solution).

[13]Fisher Scientific Co., Fair Lawn, New Jersey.

[14]C & D Glass Co., Inc., P.O. Box 723, Millville, New Jersey 08332.

[15]Coleman Instruments, Inc., Maywood, Illinois.

106.28 239:RPT:danv0813A

Standard phosphorus solutions: Standard P solutions for calibration purposes will be supplied to Wisconsin soil testing labs, upon request, by the State Soil and Plant Analysis Laboratory, Madison, or the State Soils and Forage Laboratory, Marshfield.

A standard solution containing 250 ppm P (and 315 ppm K) is prepared by dissolving 1.0985 g of oven-dried (105°C) KH_2PO_4 in about 900 ml of distilled water. Next, 5 ml of concentrated H_2SO_4 is added as a preservative, and the solution is diluted to exactly 1000 ml. A dilute standard solution containing 25 ppm P (and 31.5 ppm K) is prepared by diluting 10 ml of the 250 ppm P standard to 100 ml with distilled water. These and other standards can be preserved by storing in a refrigerator and/or by adding one or two crystals of thymol.

The P in the working standards is equivalent to 0, 10, 25, 50, 100, 200, 300, and 400 lbs P per acre, respectively. (The K in these standards is equivalent to 0, 12.6, 31.5, 63, 126, 252, 378, and 504 lbs K per acre, respectively.) Working standards are prepared by diluting 0,1,5,10,20,40,60, and 80 ml of 25 ppm P (31.5 ppm K) to 100 ml with distilled water.

EXCHANGEABLE CALCIUM AND MAGNESIUM[16]

Special materials and reagents

Measuring spoon calibrated to hold 1.5 g of light-colored silt loam soil[6],

Extracting solution (1N NH_4OAc, pH 7.0): Add 57 ml glacial acetic acid to about 800 ml of distilled water in a 1-liter volumetric flask. Mix thoroughly. Add 67 ml concentrated NH_4OH slowly. Mix carefully; cool to room temperature. Adjusted the pH of the solution to 7.0 by adding acetic acid or NH_4OH. Dilute to 1 liter.

Procedure

A measured volume of soil (equivalent to 1.5 g of light-colored silt loam) is placed in a 50-ml Erlyenmeyer flask. Add 15 ml of extracting solution (1 N NH_4OAc, pH 7.0) by means of a constant suction pipette apparatus. Shake the suspension on an oscillating shaker at a speed of about 160 excursions per minute for five minutes. filter through Whatman No. 2, 9-cm filter paper into 15-ml funnel tubes. Add one drop of a 1% Sterox solution to each tube of soil extract. Determine Ca and Mg on the Coleman flame photometer, using the filters for Ca and Mg, respectively, and standard solutions made up in 1 N NH_4OAc. The instrument can be calibrated to read lbs exchangeable Ca and Mg per acre. The working range is from 0 to 8,000 lbs Ca and 0 to 2,000 lbs Mg. The calculation in lieu of calibration is ppm Ca or Mg. The calculation in lieu of calibration is ppm Ca or Mg in solution times 20.

It is recommended that atomic absorption spectrophotometry be used to determine Mg on soils where Mg deficiency is likely. In this range, atomic absorption will be considerably more accurate than flame photometry. Samples and standards will require a tenfold dilution to bring the Mg concentration into the working range of atomic absorption.

Preparation of Standard Solutions for Determining Ca, Mg and Na by Flame Photometry

Preparation of concentrated solutions from primary standards

Calcium: Prepare a stock solution containing 10,000 ppm Ca by adding 24.970 g of $CaCO_3$ (O.D., 105°C) in small increments to an equivalent amount of HCL (42 ml conc.) previously diluted to about 300 ml in a 500-ml flask. After the effervescence has ceased, boil for 5 minutes, cool, and dilute to

1 liter with water. Most reagent grade $CaCO_3$ contains some K and Na impurities. For precise work, use natural calcite crystals available in very pure form from geological supply houses.

Magnesium: Prepare a stock solution containing 5,000 ppm Mg as follows. Place 5,000 g of water-rinsed, oven-dried (105°C), pure metallic magnesium ribbon in a 500-ml flask and add about 300 ml of water. Add dilute HCL (1:4) in small increments until the effervescence ceases and the solution is clear. Acid should be added slowly to control the reaction and prevent a large excess after the Mg is dissolved. Evaporate to about 10 ml, cool, and then dilute to 1 liter with water.

Sodium: Prepare a stock solution containing 2,000 ppm Na by dissolving 5.084 g of NaCl (O.D. 105°C) in water and dilute to 1 liter.

Potassium: Prepare a stock solution of 5,000 ppm K by dissolving 9.535 g of KCl (O.D. 105°C) in water and dilute to 1 liter.

Preparation of standards for determining Ca, Mg and Na in soil extracts

These standards contain approximately the same ratio of the above cations as are present in the exchangeable form in the soil. This ratio is used to avoid unnecessary dilutions and improve accuracy. Sodium and K are added because they are present in the soil, and their presence affects the flame emission intensity of Ca.

Standard	ml of Conc. Stock Solution per Liter	Concentration of Cations in Final Standard			
		Ca	Mg	Na	K
		ppm			
A	0	0	0	0	0
B	20	80	20	2	5
C	40	160	40	4	10
D	60	240	60	6	15
E	80	320	80	8	20
F	100	400	100	10	25

Preparation of standard solution; Fungal growth in standard solutions can be prevented by adding 2 or 3 small crystals of thymol to each standard or by refrigerating the standards. The standards must be allowed to come to room temperature before use, however. Fungal mycellia in the solutions tend to plug the capillary of the flame photometer atomizer and give erratic readings.

APPENDIX D

WELL CONSTRUCTION DIAGRAMS

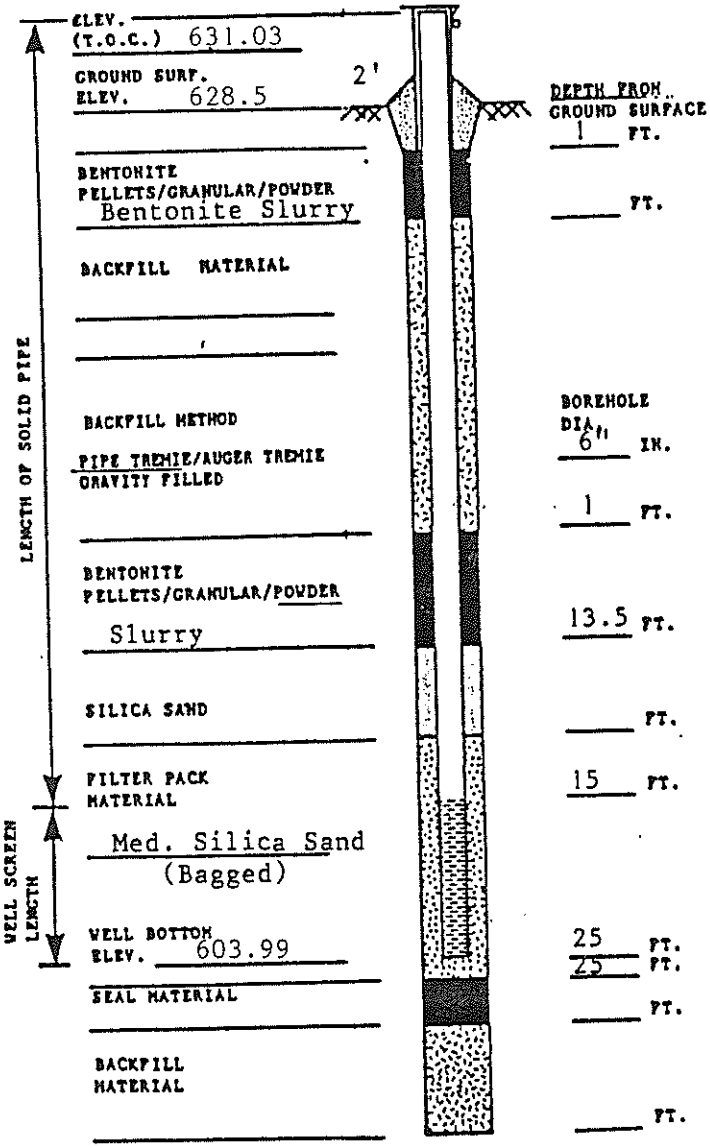
RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: Danville Landfill NO. 106.28

WELL NO. Monitoring G 14S

DATE INSTALLED 6/19/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 2' PVC Riser

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2" OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water/Bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 10 min. Circulate +

C) APPROXIMATE WATER VOLUME: REMOVED 3 gals

ADDED 100 gals (circulated)

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____ FT

DATE/TIME _____ FT

DATE/TIME _____ FT

ADDITIONAL COMMENTS: Circulate water down borehole leaving 10' of Auger in the borehole though screen is at 15-25'. All teflon except 2' of PVC Riser pipe. Circulate approximately 100 gallons. Rig clutch breaks down - can't tremie bentonite/cement slurry and Bentonite (Straight) so tremie Straight bentonite - no cement.

Danville Landfill

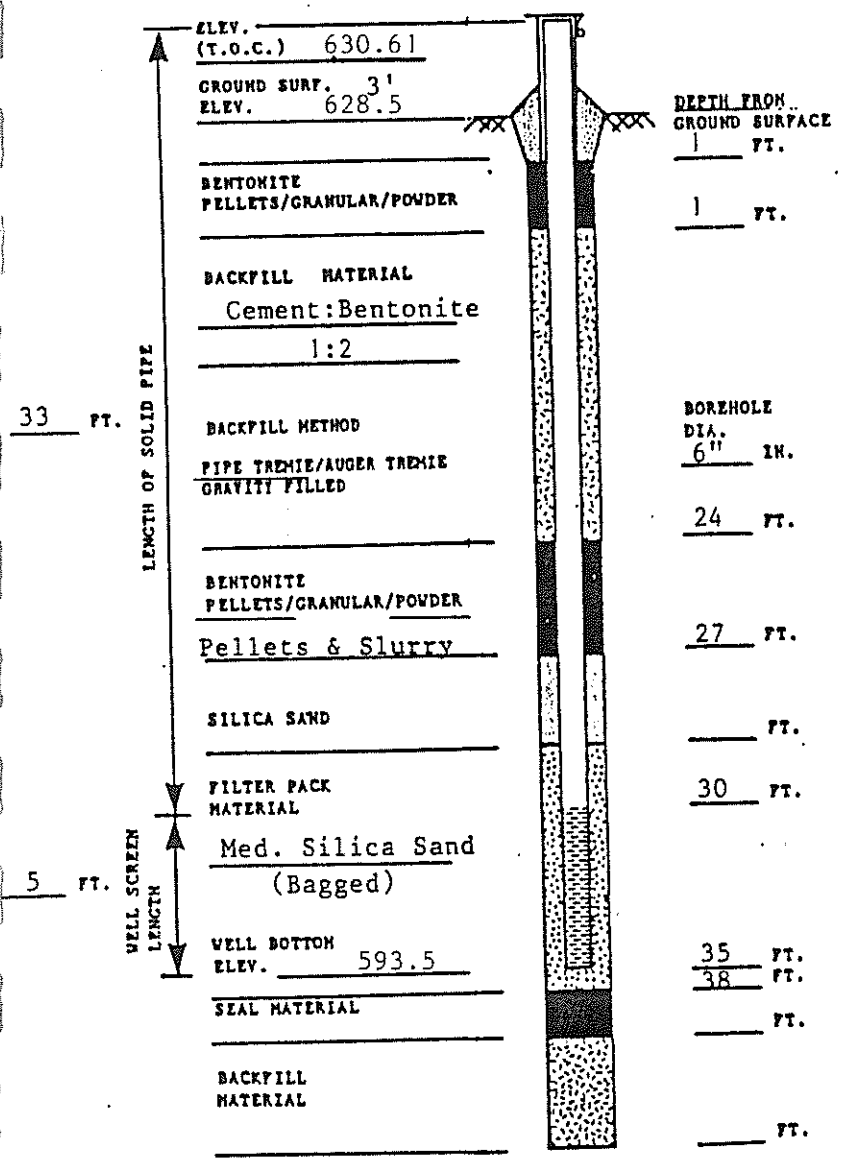
PROJECT NAME: Monitoring NO. 106.28

WELL NO. G 14D

DATE INSTALLED 6/19/86

RMT

Well Diagram
F-17 (R 11-85)



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 13' PVC Riser Pipe

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate water/bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 10 min pumping

C) APPROXIMATE WATER VOLUME: REMOVED 3 gallons
ADDED 100 gallons (circulated)

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Put in only 1/2 bag sand - must have knocked some of borehole down next to the screen effective sand pack may be 28'. Some material apparently fell down the borehole during washing. Use entire tank of water

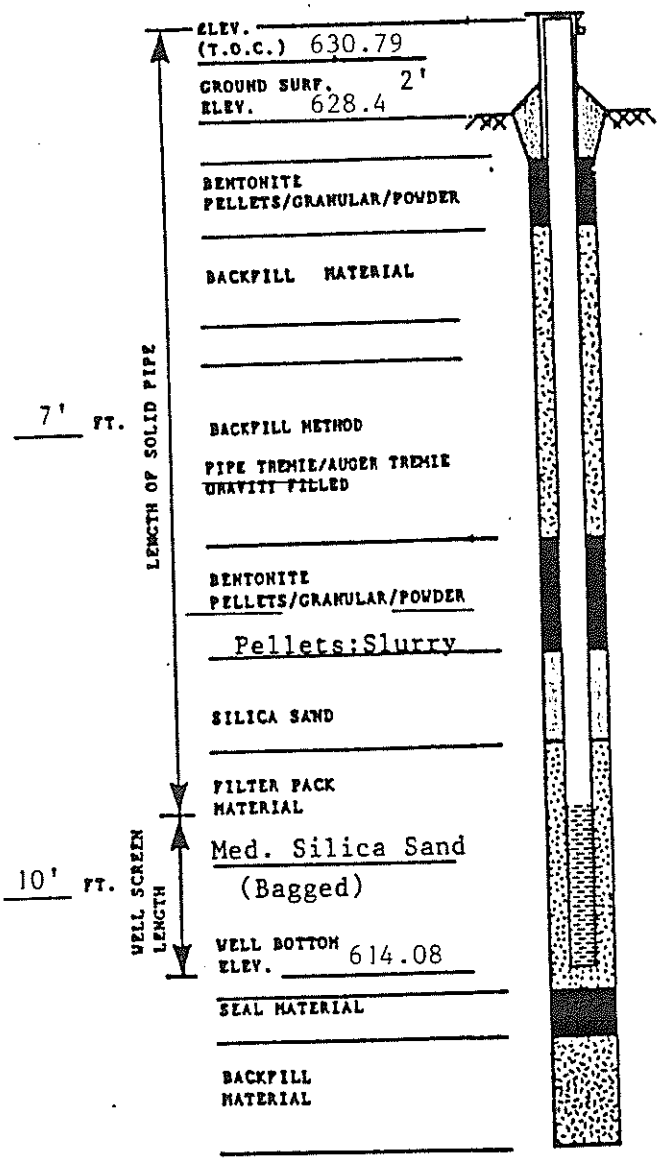
Bore down through shale heavy going

Well Diagram
F-17 (R 11-85)

PROJECT NAME: Danville Landfill Monitoring NO. 106.28

WELL NO G 19S

DATE INSTALLED 6/17/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 2' PVC Riser

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water/Bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 10 min

C) APPROXIMATE WATER VOLUME: REMOVED 10 gallo

ADDED 50 gallons (circulate

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, >OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

7.08 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Well constructed entirely of Teflon except for top 2' of Riser pipe. Take shelby tube 8-10'.

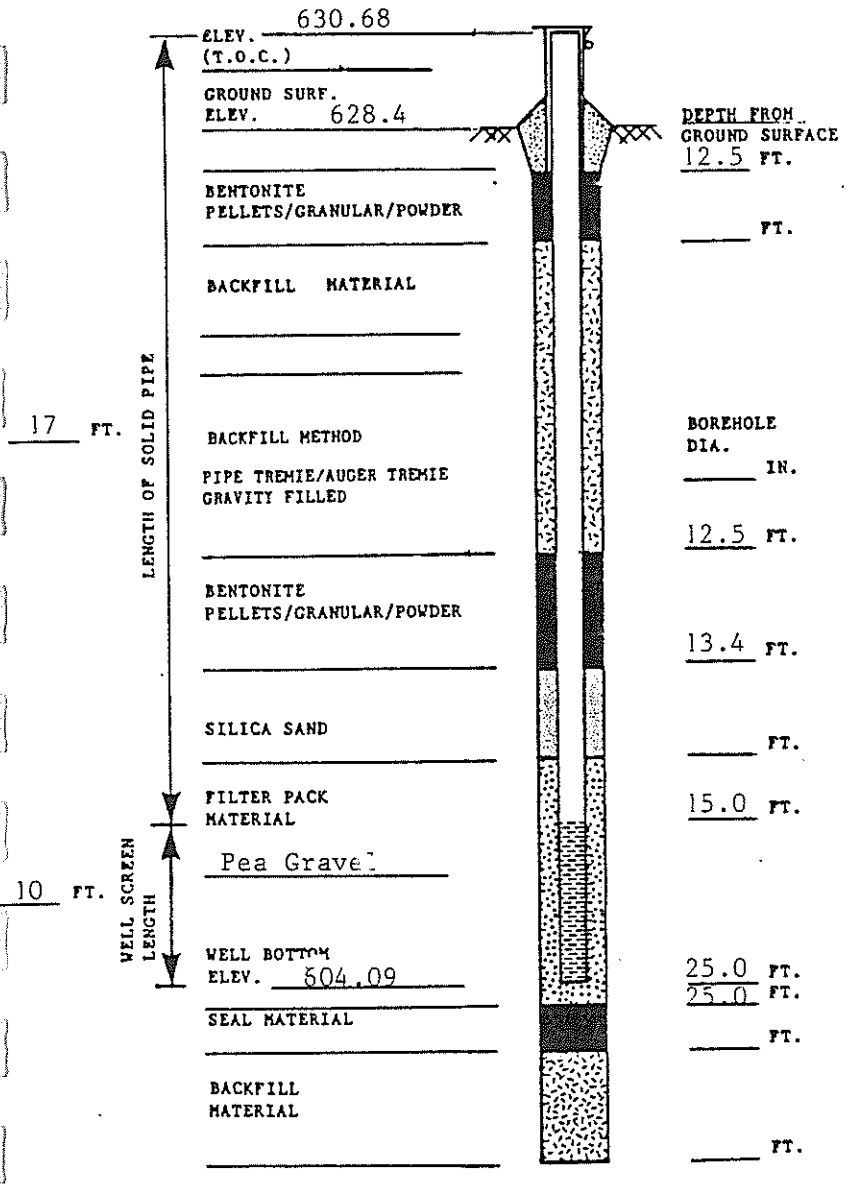
Well Diagram
F-17 (R 11-85)

Danville Landfill

PROJECT NAME: Monitoring NO. 106.28

WELL NO. G-19D

DATE INSTALLED 7/15/81



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER PVC

PIPE SCHEDULE 80

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER PVC

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. _____ OD IN. _____

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? _____

C) APPROXIMATE WATER VOLUME: REMOVED _____

ADDED _____

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____ F

DATE/TIME _____ F

DATE/TIME _____ F

ADDITIONAL COMMENTS: Well installed in 1981. Well development method unknown.

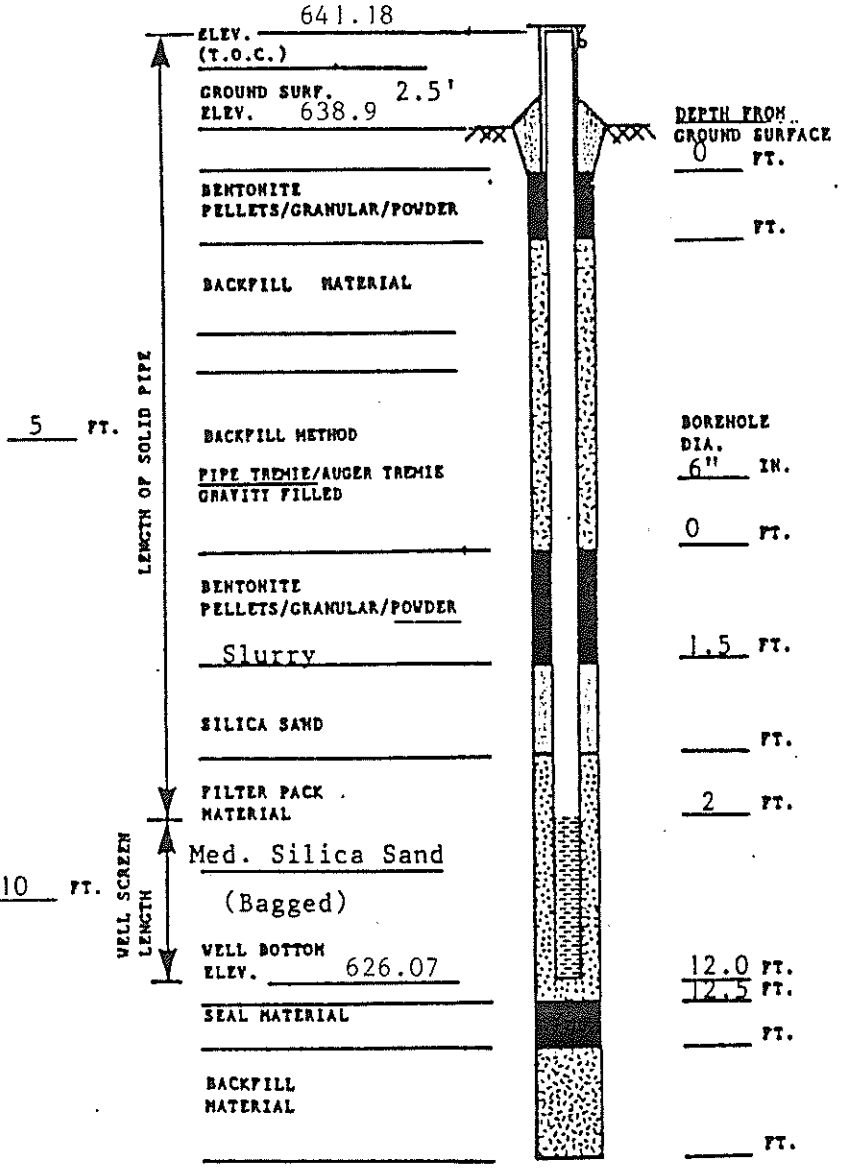
Well Diagram
F-17 (R 11-85)

Danville Landfill

PROJECT NAME: Monitoring NO. 106.28

WELL NO. G 30S

DATE INSTALLED 6/17/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 5' of PVC Riser Pipe

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water/Bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 15 minute

C) APPROXIMATE WATER VOLUME: REMOVED 5 gallons

ADDED 50 gallons (circulate

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

4.4 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Try to wash out hole by circulating water down the well and up Augers. Water comes up the borehole. Foundry sand falls down the borehole when pulling up the Augers. Well is screened in fill.

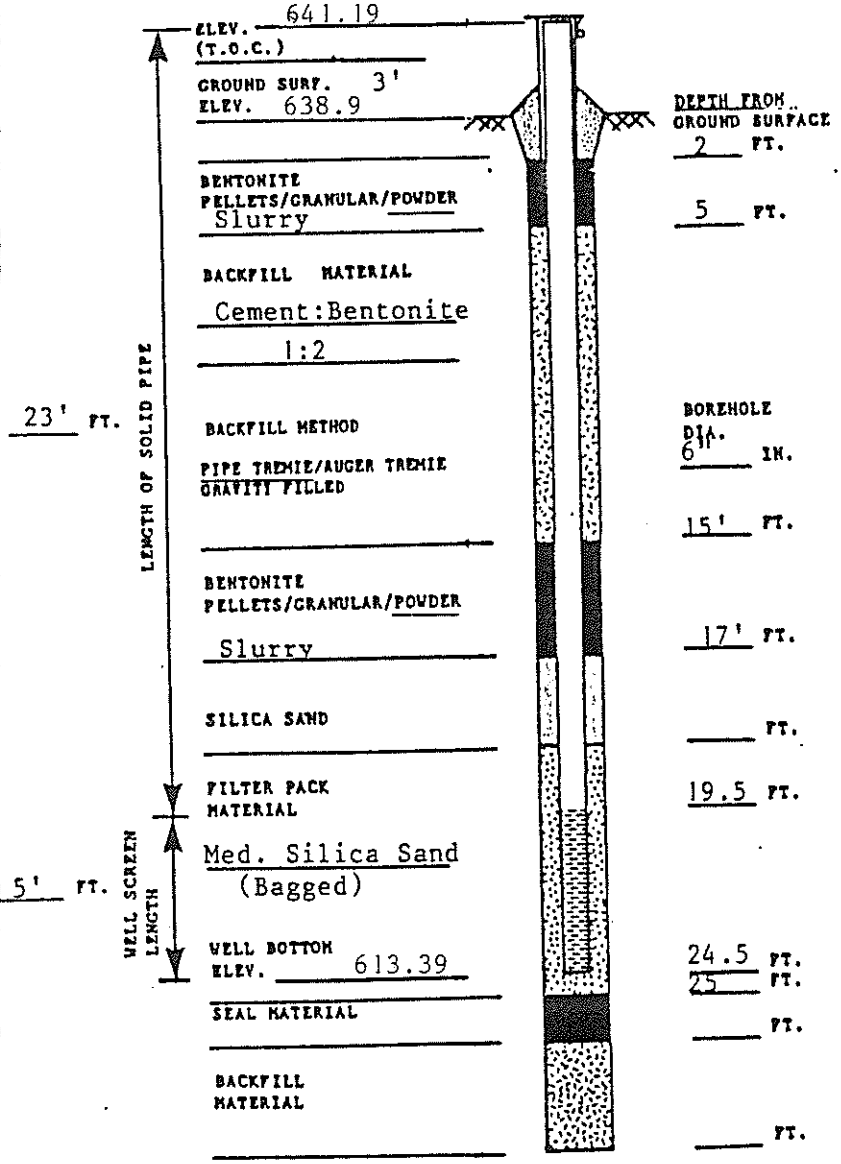
Danville Landfill

PROJECT NAME: Monitoring NO. 106.28

WELL NO. G 30D

DATE INSTALLED 6/17/86

Well Diagram
F-17 (R 11-85)



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 3' PVC Riser Pip

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water/Bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? _____

C) APPROXIMATE WATER VOLUME: REMOVED 5 gallons

ADDED 50 gallons (circulated)

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: 3' of PVC Riser pipe. The remaining pipe is teflon. Circulate water down hole to develop. Tremie clogs up. Cement:Bentonite Slurry partially gravity filled.

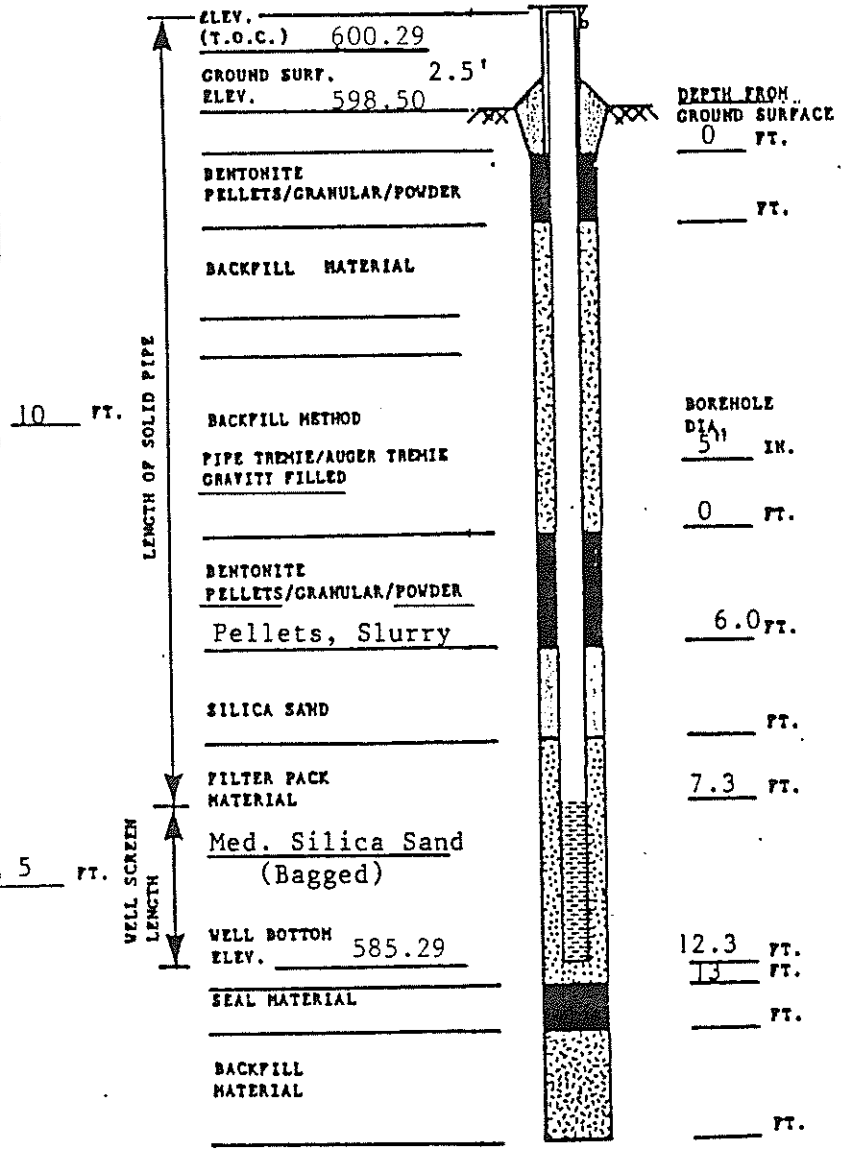
RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: Danville Landfill Monitoring NO. 106.28

WELL NO. G 34S

DATE INSTALLED 6/20/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 4' PVC Riser

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 15 minutes

C) APPROXIMATE WATER VOLUME: REMOVED 10 gals
ADDED 3 gallons

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

10.5 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

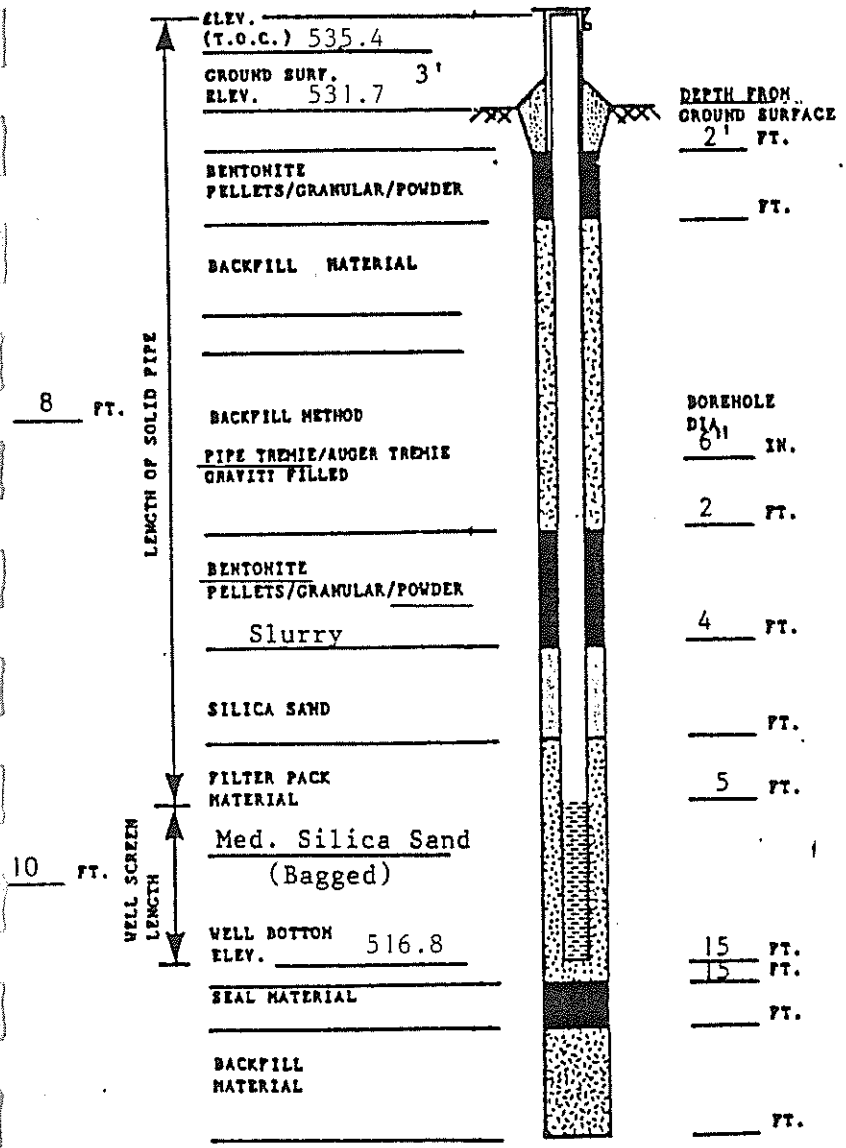
ADDITIONAL COMMENTS: Boring is hand augered in. We stop when we reach non-penetration. We build well. Borehole is smaller than others. Put in pellets over sand park to ensure seal because we can't pipe tremie. There is some foundry sand that falls down the hole.

Well Diagram
P-17 (R 11-85)

PROJECT NAME: Danville Landfill Monitoring NO. 106.28

WELL NO. G 32S

DATE INSTALLED 6/18/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 3' PVC Riser Pip

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 20 minutes

C) APPROXIMATE WATER VOLUME: REMOVED 20 gallons

ADDED _____

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

7.46 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Take shelby tube 8-10'. Well is constructed entirely of Teflon except for 3' of PVC riser pipe.

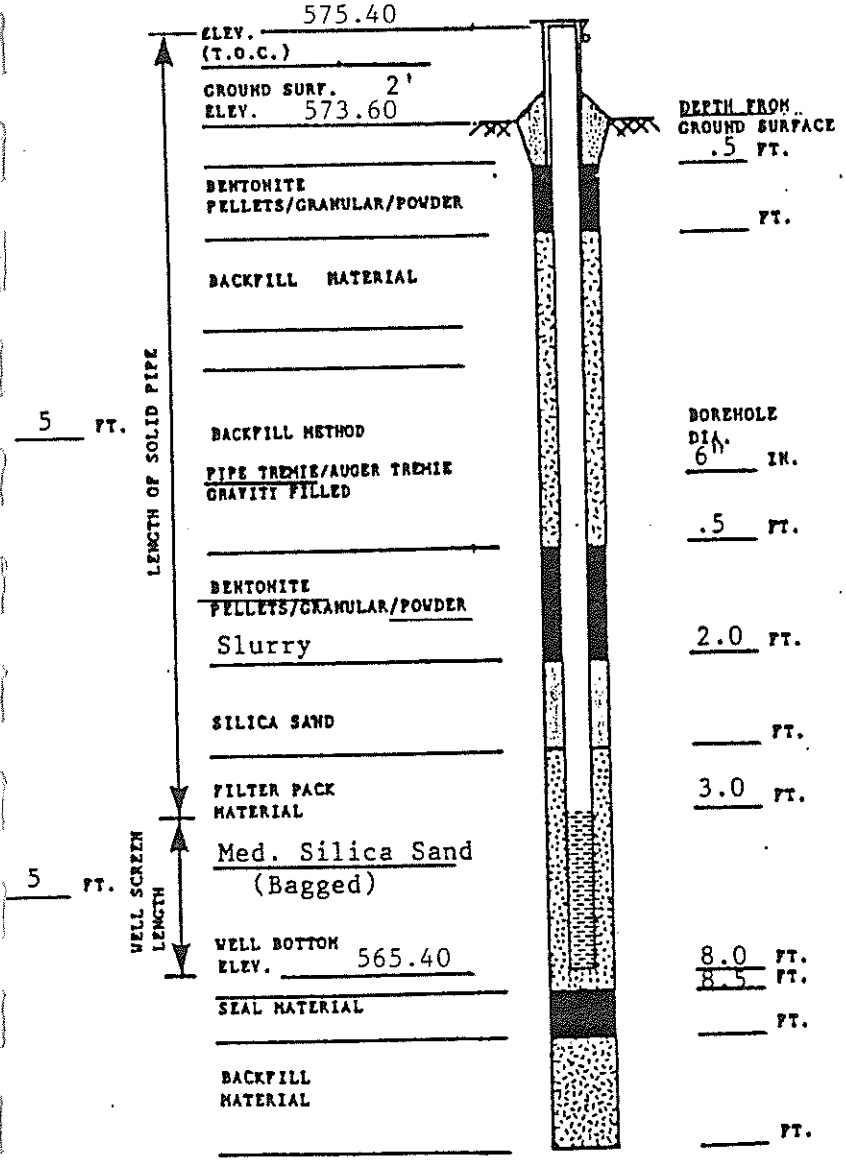
Well Diagram
F-17 (R 11-85)

Danville Landfill

PROJECT NAME: Monitoring NO. 106.28

WELL NO. G 41S

DATE INSTALLED 6/18/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER _____

PIPE SCHEDULE _____

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 30 min

C) APPROXIMATE WATER VOLUME: REMOVED 8 gallons

ADDED _____

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Screen length overlaps slightly with Deep well.
Well may not have been developed adequately.

FMT

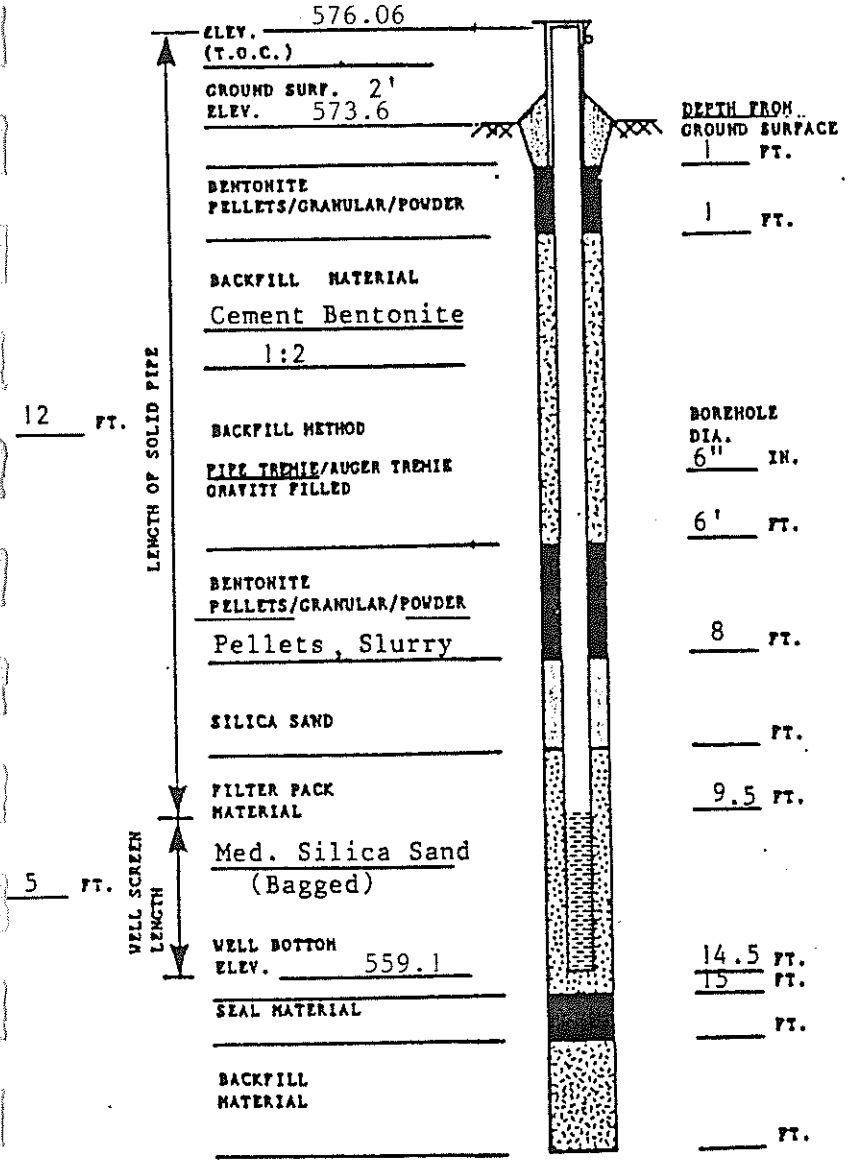
Well Diagram
F-17 (R 11-85)

Danville Landfill

PROJECT NAME: Monitoring NO. 106.28

WELL NO. G 41D

DATE INSTALLED 6/18/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER 2' PVC Riser Pipe

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water/Bail

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 10 min Circulate
10 min Bail

C) APPROXIMATE WATER VOLUME: REMOVED 5 gals
ADDED 100 gals (circulated

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

13.5 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Put in Bentonite pellets after Circulating water so that well is sealed against Foundry Sand falling down hole. Then put in Bentonite Slurry and Bentonite:Cement Slurry

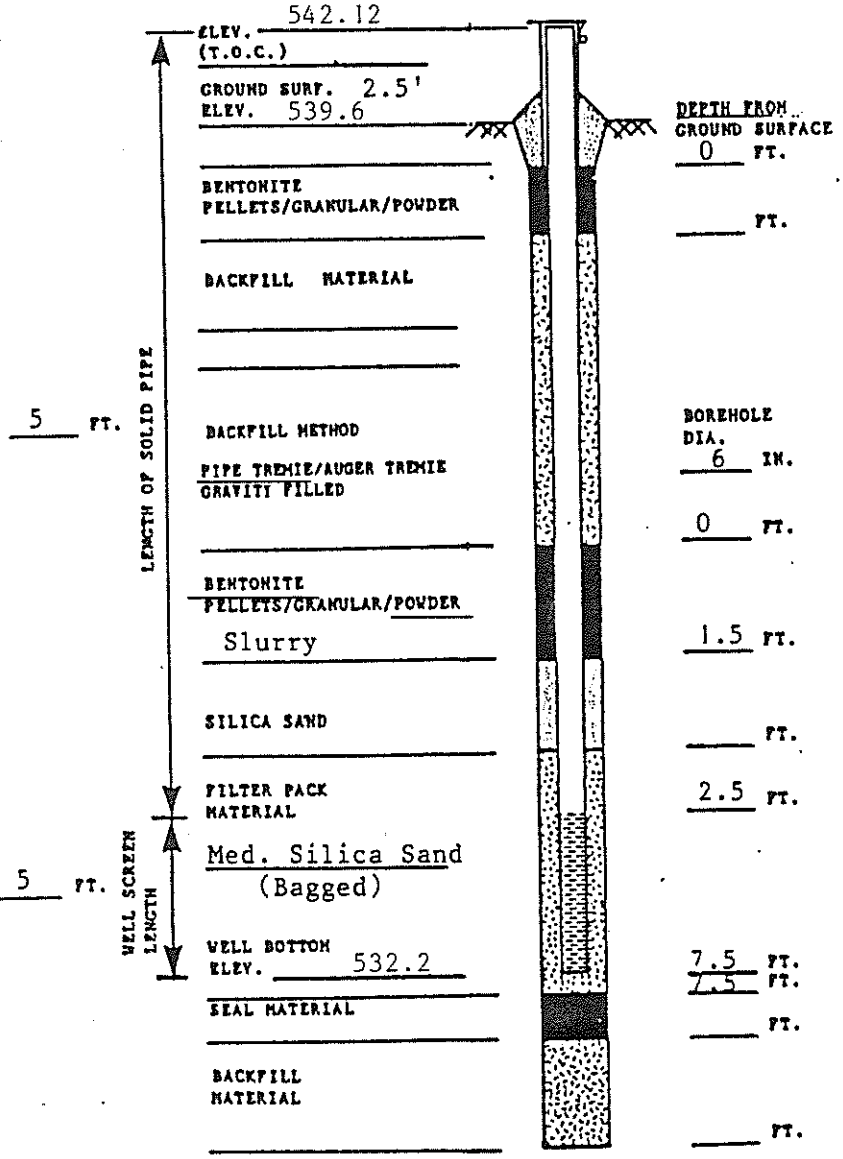
*Pellets for sealing well while they are mixing up slurry.

Well Diagram
F-17 (R 11-85)

PROJECT NAME: Danville Landfill Monitoring NO. 106.28

WELL NO. G 42S

DATE INSTALLED 6/18/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER _____

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 30 min

C) APPROXIMATE WATER VOLUME: REMOVED 20 gallons

ADDED _____

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

5.5 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

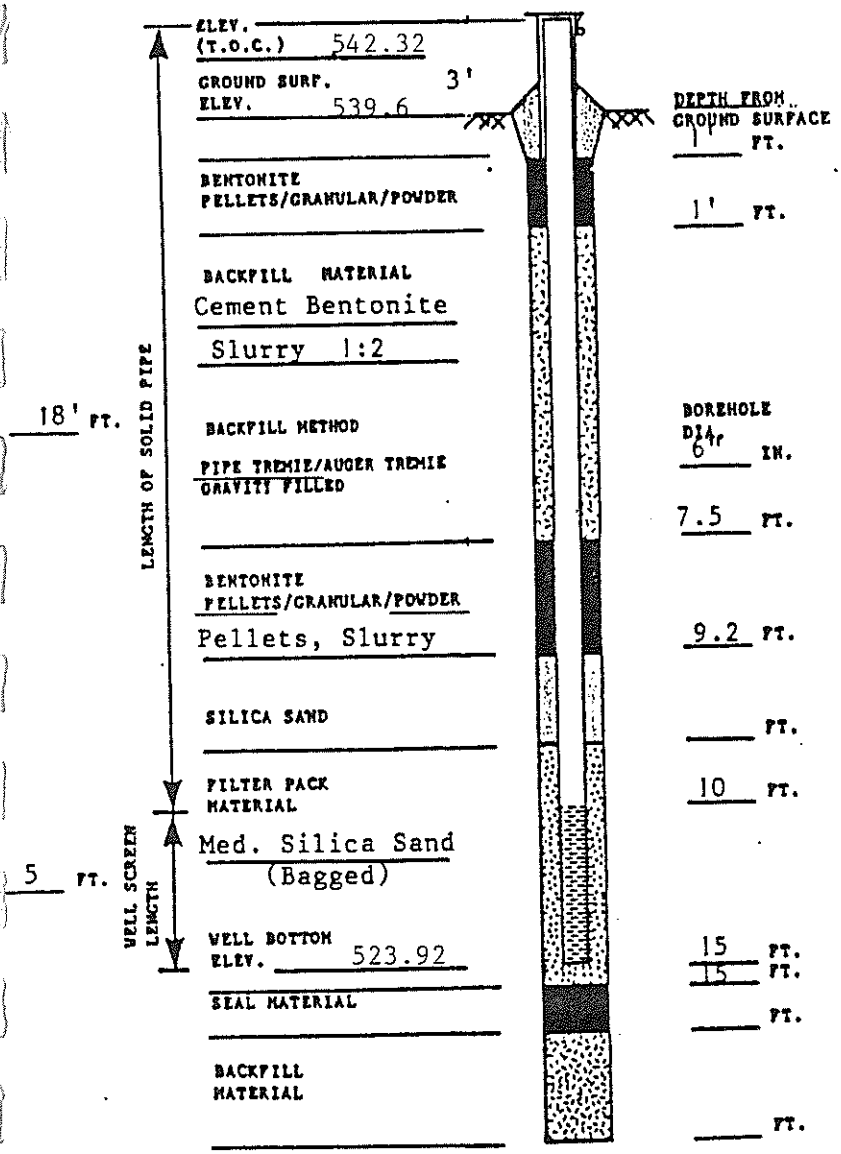
ADDITIONAL COMMENTS: Well is screen in foundry sand at the base of a hill that has been mined. Seeps have iron and water smells swampy and sulfery. (East well at Base of Rip Rap Spillway)

Well Diagram
F-17 (R 11-85)

PROJECT NAME: Danville Landfill Monitoring NO. 106.28

WELL NO. G 42D

DATE INSTALLED 6/18/86



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER (3' PVC Riser Pip

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS:

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE .010

F) PIPE DIA: ID IN. 2 OD IN. 2 3/8

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 4 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER Circulate Water down borehole/Ba

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 15 min.

C) APPROXIMATE WATER VOLUME: REMOVED 20 gallons

ADDED 50 gallons

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

6.03 FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____

DATE/TIME _____

DATE/TIME _____

ADDITIONAL COMMENTS: Pour pellets in after putting in sand pack to get some seal between sand pack and any foundry sand that might fall down the hole. All teflon except 3' of Riser pipe - Teflon up to surface.

APPENDIX E

HYDRAULIC CONDUCTIVITY DETERMINATION

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: G114s

PROJECT NAME: Danville Landvill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 7.01
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 80
STATIC WATER LEVEL READING (FT): 20.03

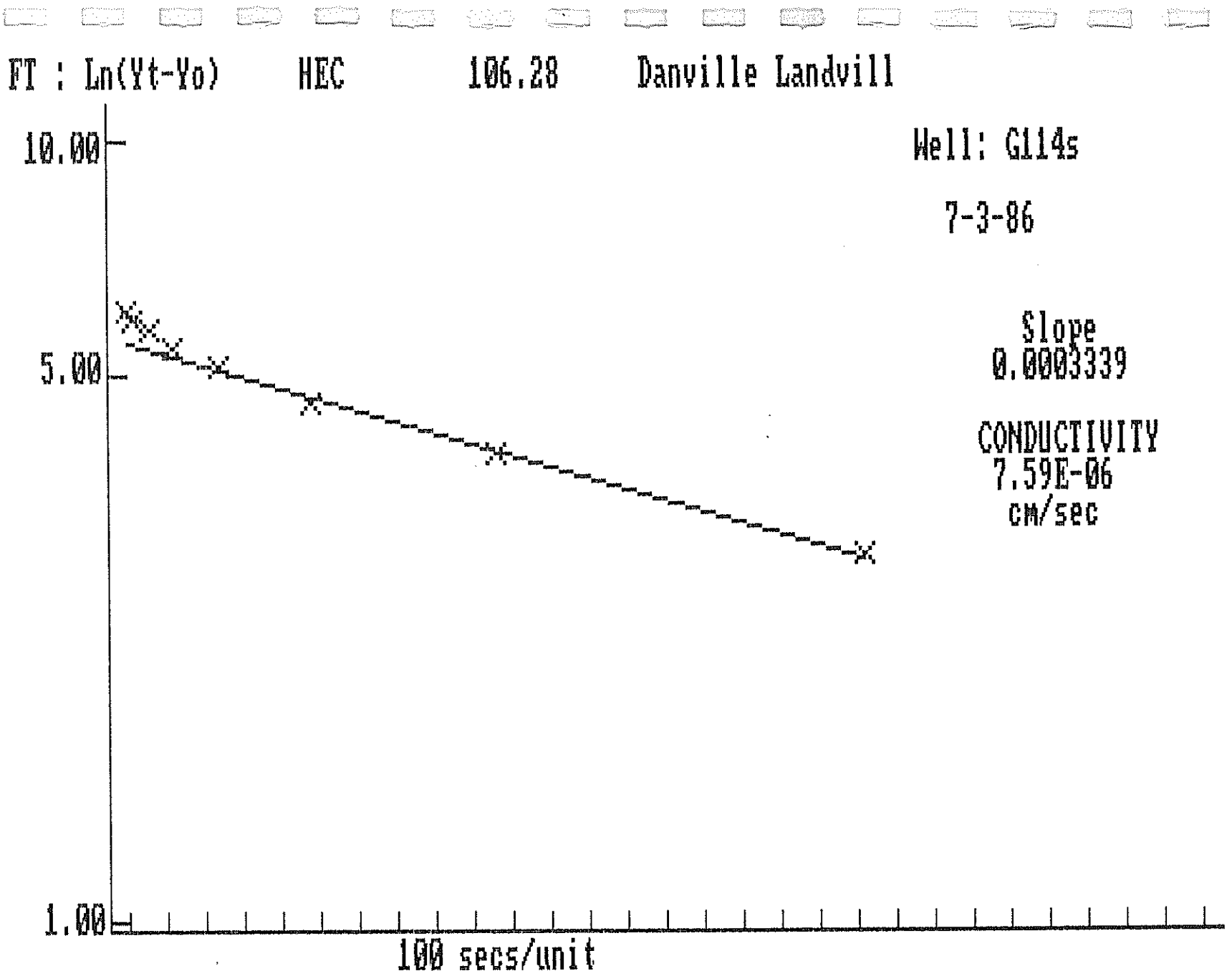
TIME (H,M,S)	DEPTH (FT)
0,0,0	26.06
0,0,15	25.94
0,1,0	25.78
0,2,0	25.5
0,4,0	25.2
0,8,0	24.67
0,16,0	24.01
0,32,0	22.99

(1/t) (ln(Yo/Yt))= 0.0003339

PARTIALLY PENETRATING: A= 2.75 B= 0.47

HYDRAULIC CONDUCTIVITY: 2.49E-07 ft/sec
7.59E-06 cm/sec

✓ JAW
8/11/86


FT : Ln(Yt-Yo)
HEC
106.28
Danville Landvill
10.00
5.00
1.00
Well: G114s
7-3-86
Slope
0.0003339
CONDUCTIVITY
7.59E-06
cm/sec
100 secs/unit

COMPUTATION SHEET

RMT INC.

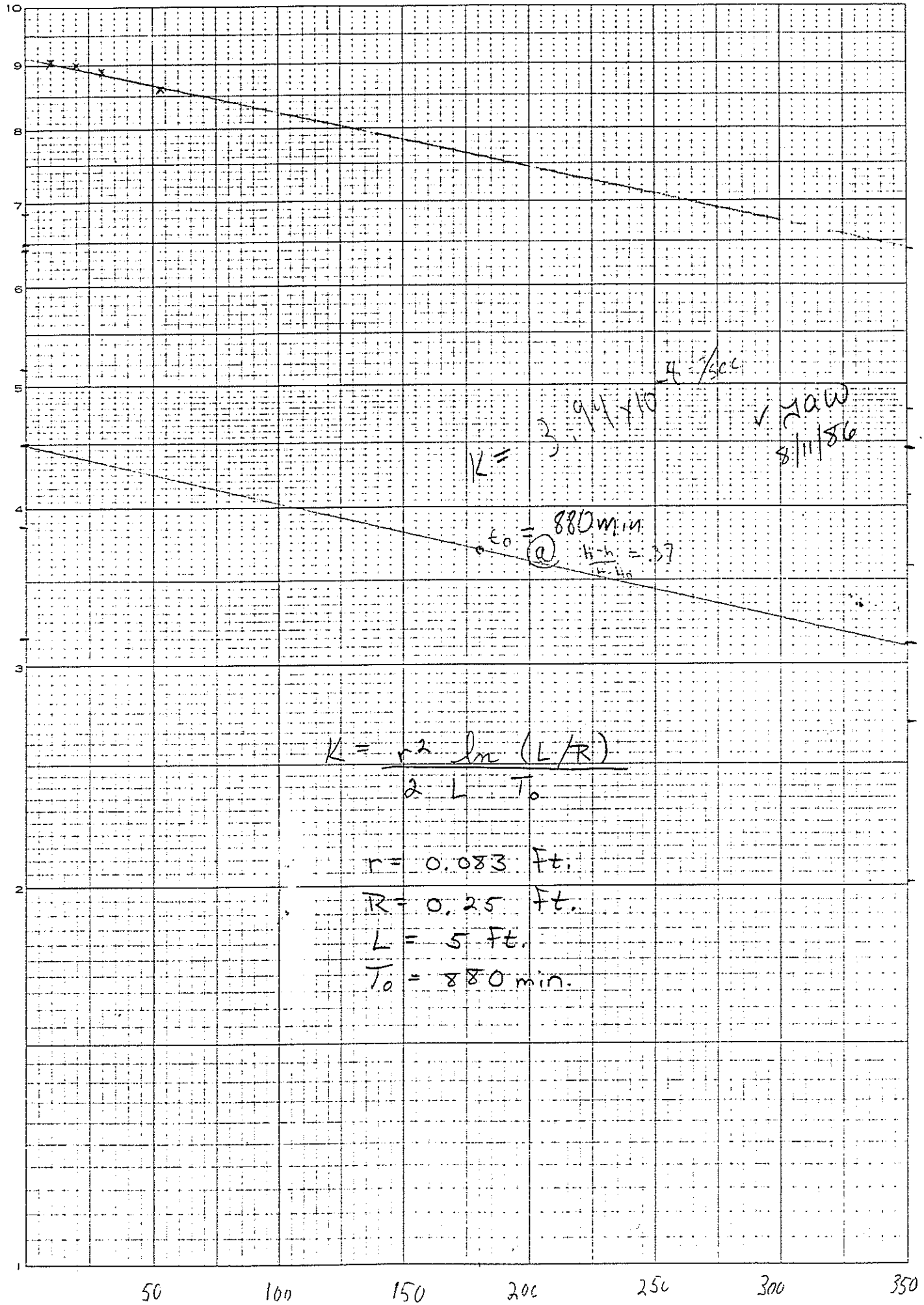
1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
6,140			TAW	8/11/86	

$H = 31'$ $H_o = 37.95$ 5'

$\frac{1}{(min)}$	h	$\frac{H-h}{H-H_o}$
0	37.95	1
10	37.28	.90
20	37.26	.90 .901
30	37.18	.89 .71
53	36.99	.86


10
9
8
7
6
5
4
3
2
1
50
100
150
200
250
300
350
$K = \frac{r^2 \ln(L/R)}{2 L T_o}$
r = 0.083 Ft.
R = 0.25 Ft.
L = 5 Ft.
T_o = 880 min.
t_o = 880 min @ h-h / h-hn = .37
K = 3.9/4 x 10
4 1/sec
Saw 8-11-86
DIETZGEN CORPORATION
NO. 357-110 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
1 CYCLE X 10 DIVISIONS PER INCH

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: G119s

PROJECT NAME: Danville Landfill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 10.67
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 21
STATIC WATER LEVEL READING (FT): 6.04

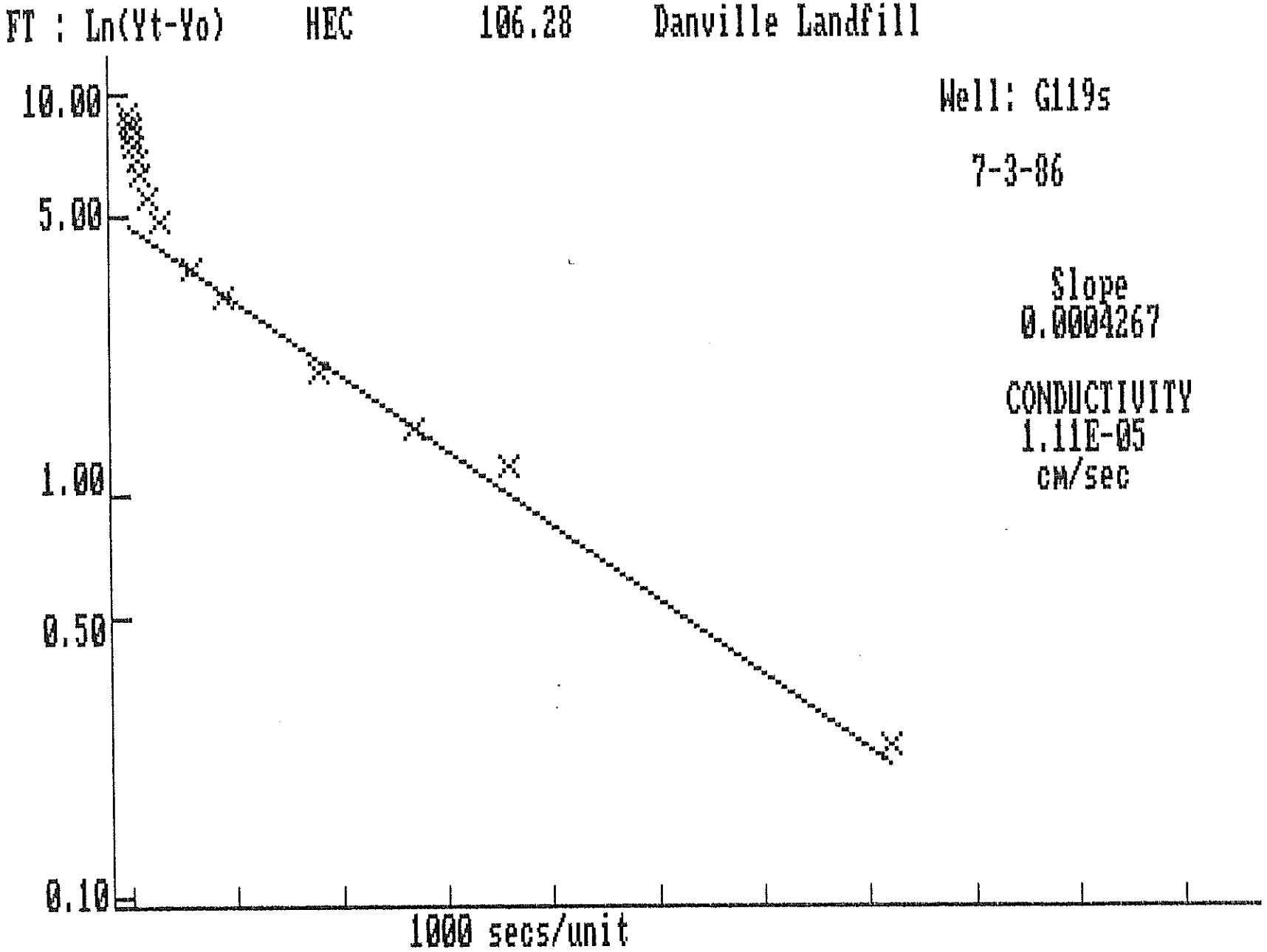
TIME (H,M,S)	DEPTH (FT)
0,0,0	14.98
0,0,15	14.57
0,0,30	14.22
0,0,45	13.86
0,1,0	13.56
0,1,30	12.84
0,2,0	12.29
0,3,0	11.57
0,5,0	10.83
0,10,0	9.71
0,15,0	9.15
0,30,0	8.04
0,45,0	7.52
1,0,0	7.22
2,0,0	6.28

(1/t) (ln(Yo/Yt))= 0.0004267

PARTIALLY PENETRATING: A= 2.75 B= 0.47

HYDRAULIC CONDUCTIVITY: 3.65E-07 ft/sec
1.11E-05 cm/sec

~ 20.0
8/11/86


FT : Ln(Yt-Yo)
HEC
106.28
Danville Landfill
10.00
5.00
1.00
0.50
0.10
1000 secs/unit
Well: G119s
7-3-86
Slope
0.0004267
CONDUCTIVITY
1.11E-05
cm/sec

COMPUTATION SHEET

RMT INC.

1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

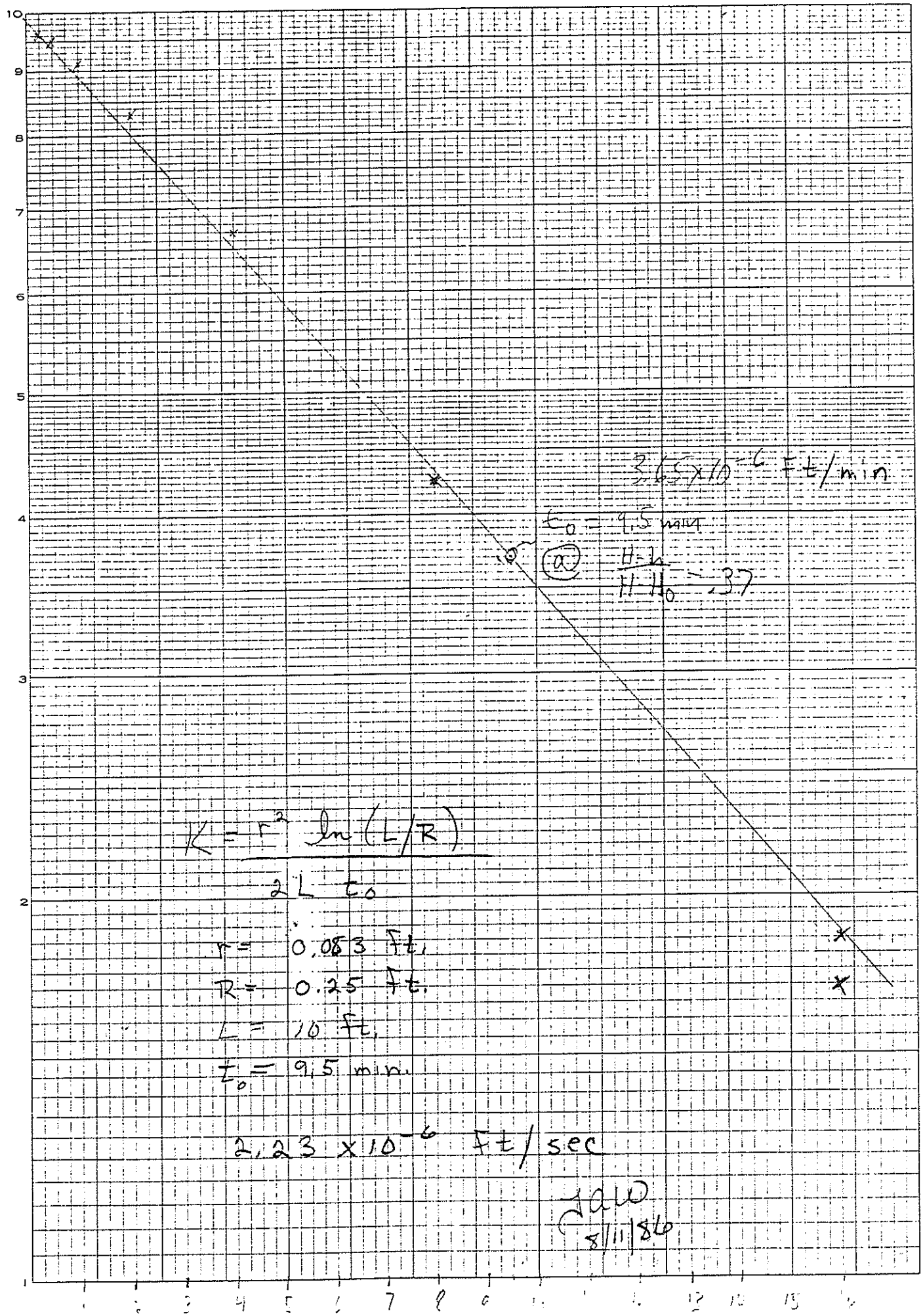
SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Danville-Clover C-1140			JAW	8/11/86	

Hvorslev

$H = 6.22$ $H_0 = 24.26$ 15'

t (min)	h	$\frac{H-h}{H-H_0}$
0	24.26	1
.25	23.64	.965
.5	23.29	.95
1.0	22.56	.91
2.0	21.16	.83
4.0	18.37	.67
8.0	13.81	.42
16.0	9.22	.18 .17
32.0	7.0	.04
64.0	6.49	.015


2.65×10^{-6} Ft/min
$t_0 = 9.5$ min
(a) $\frac{H-h}{H-H_0} = .37$
$K = \frac{r^2 \ln(L/R)}{2L\, t_0}$
r = 0.083 ft.
R = 0.25 ft.
L = 10 ft.
t_0 = 9.5 min.
2.23×10^{-6} ft/sec
JAW
8/11/86

COMPUTATION SHEET

RMT INC.

1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

SHEET 1 OF

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Danville 61300	JAW	8/11/86			

$H = 18.27$ $H_o = 25.30$ 5'

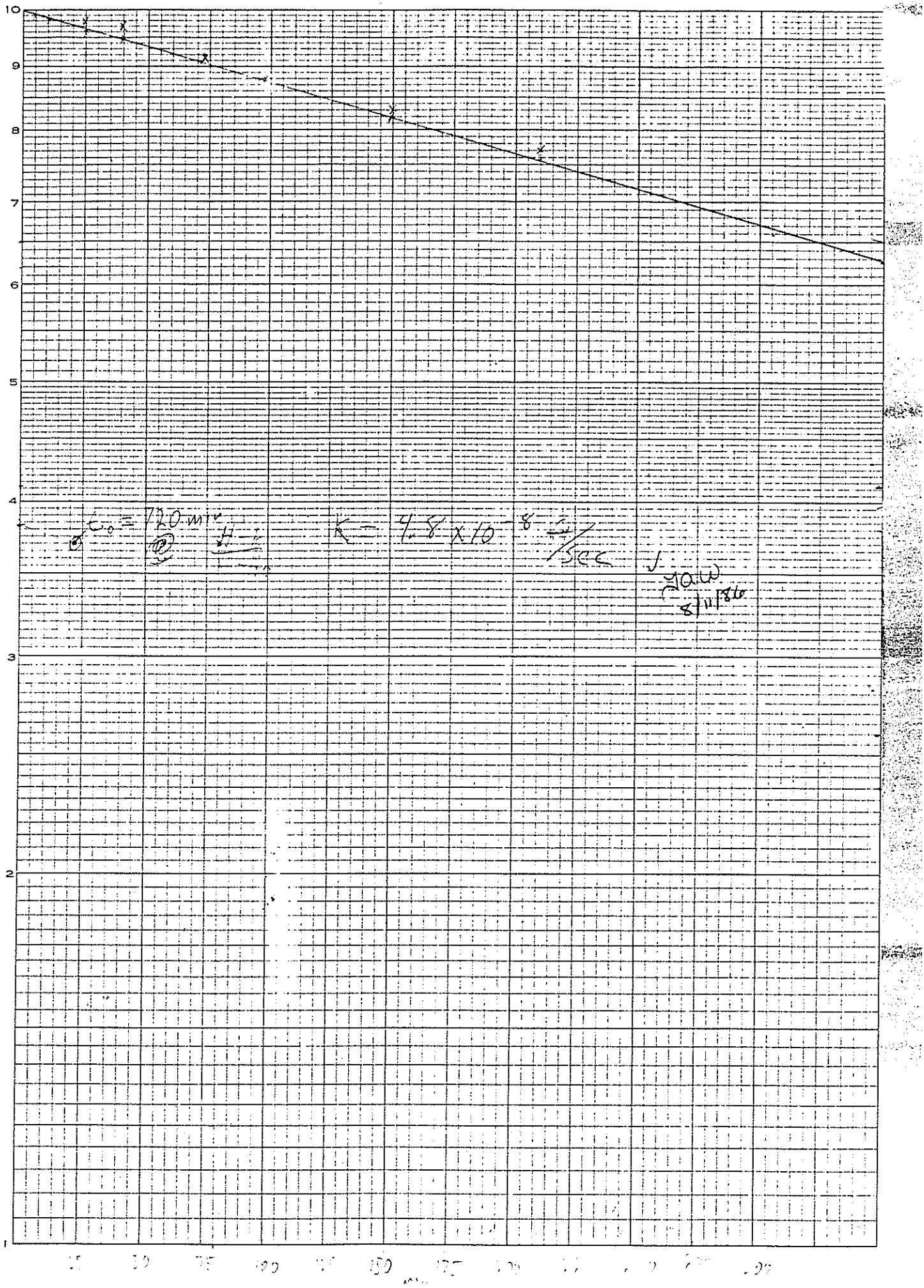
	t minutes	$\frac{H-h}{H-H_o}$
25.30	0	1
25.24	5	.99
25.19	10	.985
25.14	25	~~.96~~ .98 JAW
25.06	40	.95 .97
24.75	72	.915
24.47	97	.875
24.11	150	.82 .83
23.67	210	~~.76~~ .77

From Graph $T_o = 720$ min

$$K = \frac{r^2}{2} \frac{\ln (L/P)}{L} \frac{t}{T_o}$$

$$= \frac{(.083)^2}{2} \frac{\ln (5/.25)}{5} \frac{}{(720 \text{ min} \times 60 \text{ sec})}$$

=



DIETZGEN CORPORATION MADE IN U.S.A.
NO. 340-110 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
1 CYCLE X 10 DIVISIONS PER INCH

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: g130s

PROJECT NAME: Danville Landvill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 10.71
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 26.5
STATIC WATER LEVEL READING (FT): 4.4

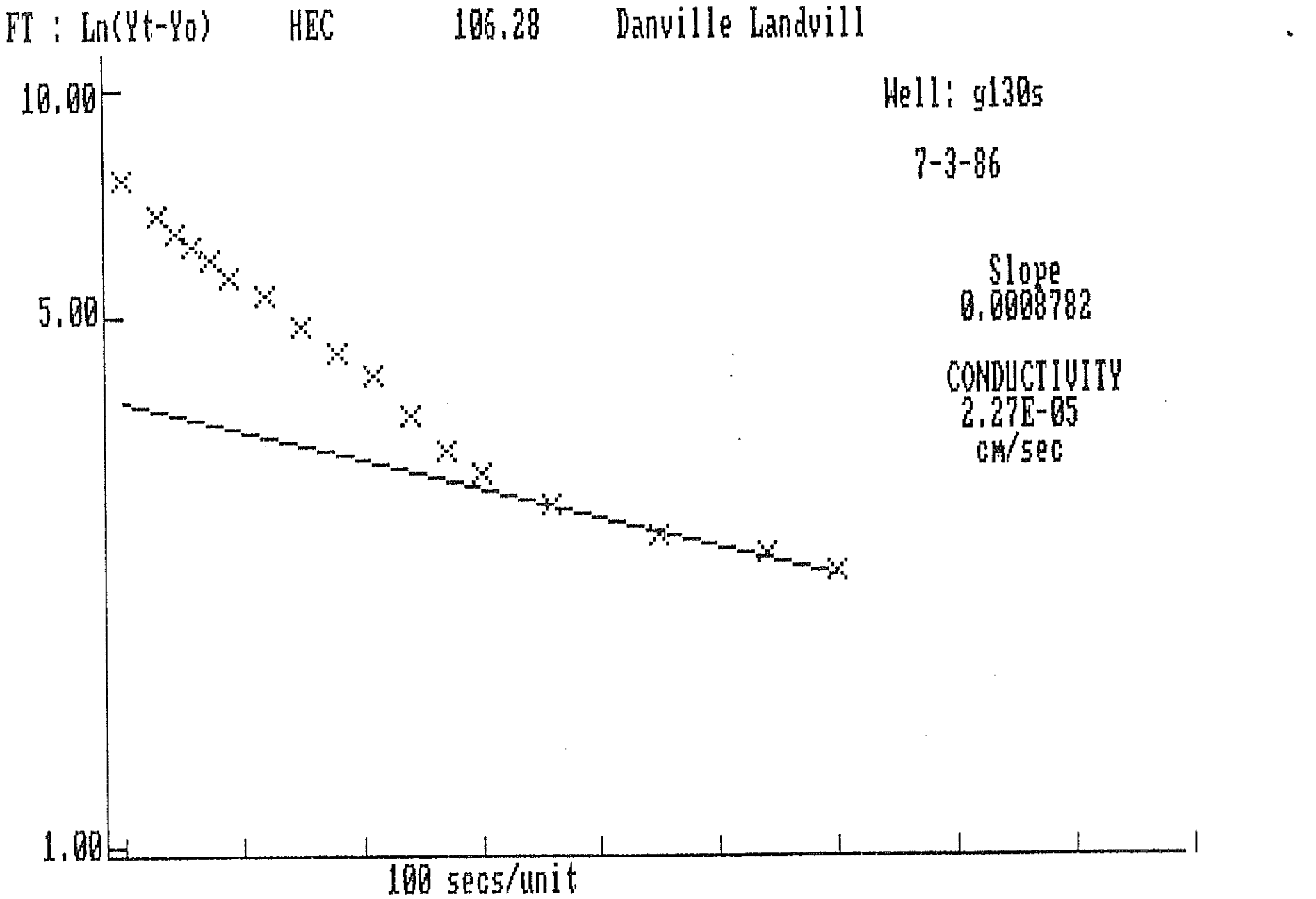
✓ AO : 8/11/86

TIME (H,M,S)	DEPTH (FT)
0,0,0	12
0,0,30	11.24
0,0,45	10.9
0,1,0	10.63
0,1,15	10.34
0,1,30	10.08
0,2,0	9.770001
0,2,30	9.29
0,3,0	8.89
0,3,30	8.6
0,4,0	8.12
0,4,30	7.76
0,5,0	7.5
0,6,0	7.25
0,7,30	6.98
0,9,0	6.84
0,10,0	6.72

(1/t) (ln(Yo/Yt))= 0.0008782

PARTIALLY PENETRATING: A= 2.75 B= 0.47

HYDRAULIC CONDUCTIVITY: 7.43E-07 ft/sec
2.27E-05 cm/sec


FT : Ln(Yt-Yo)
HEC
106.28
Danville Landvill
10.00
5.00
1.00
Well: g130s
7-3-86
Slope
0.0008782
CONDUCTIVITY
2.27E-05
cm/sec
100 secs/unit

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: G132S

PROJECT NAME: Danville Landfill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 10.1
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 12.5
STATIC WATER LEVEL READING (FT): 7.46

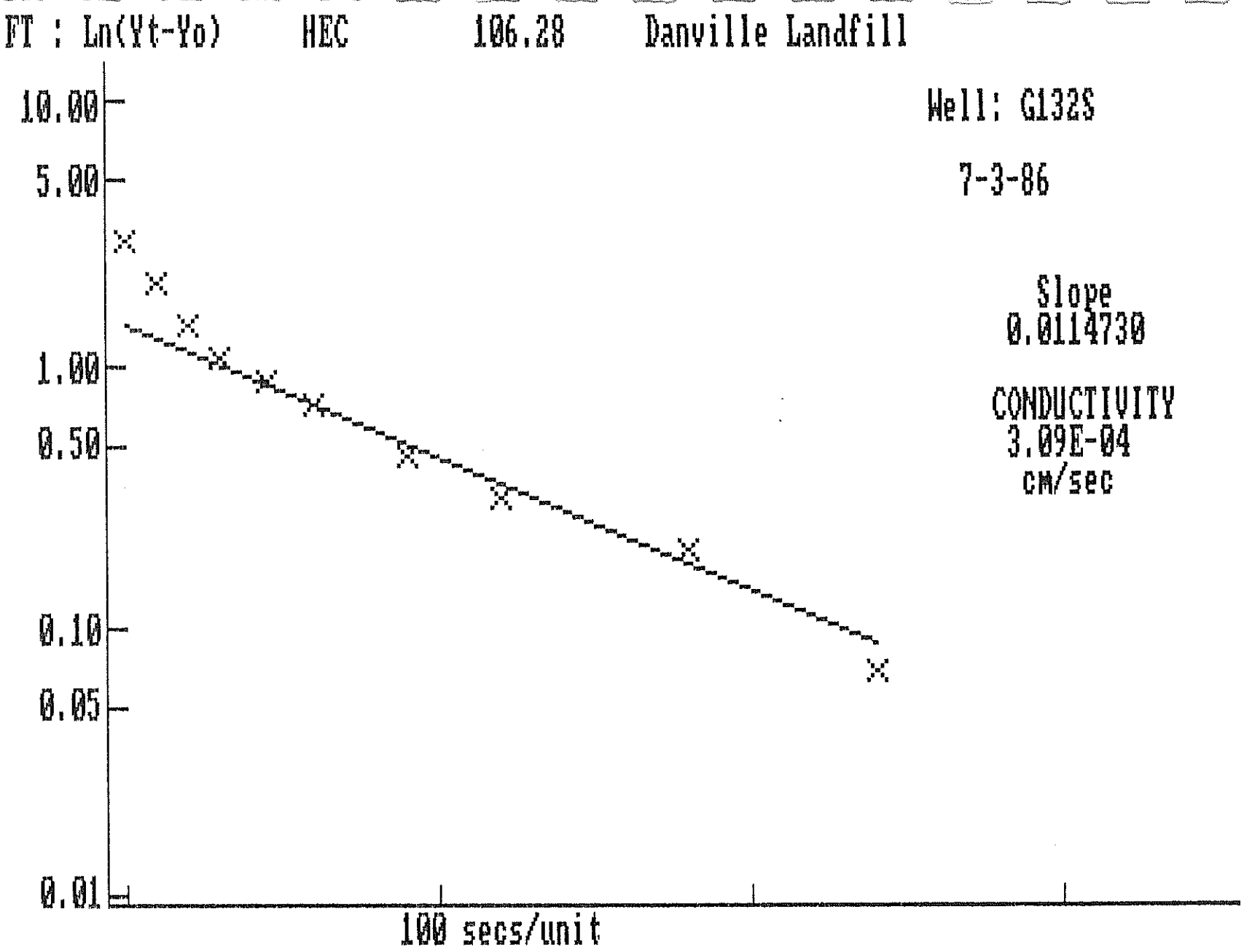
TIME (H,M,S)	DEPTH (FT)
0,0,0	10.39
0,0,10	9.55
0,0,20	8.89
0,0,30	8.55
0,0,45	8.33
0,1,0	8.16
0,1,30	7.91
0,2,0	7.78
0,3,0	7.66
0,4,0	7.53

(1/t) (ln(Yo/Yt))= 0.0114730

PARTIALLY PENETRATING: A= 2.75 B= 0.47

HYDRAULIC CONDUCTIVITY: 1.01E-05 ft/sec
3.09E-04 cm/sec

✓ JDW
8/11/86


FT : Ln(Yt-Yo)
HEC
106.28
Danville Landfill
10.00
5.00
1.00
0.50
0.10
0.05
0.01
Well: G132S
7-3-86
Slope
0.0114730
CONDUCTIVITY
3.09E-04
cm/sec
100 secs/unit

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: G141s

PROJECT NAME: Danville Landvill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 5
H - SCREEN BASE TO WATER TABLE (FT): 1.9
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 6
STATIC WATER LEVEL READING (FT): 8.1

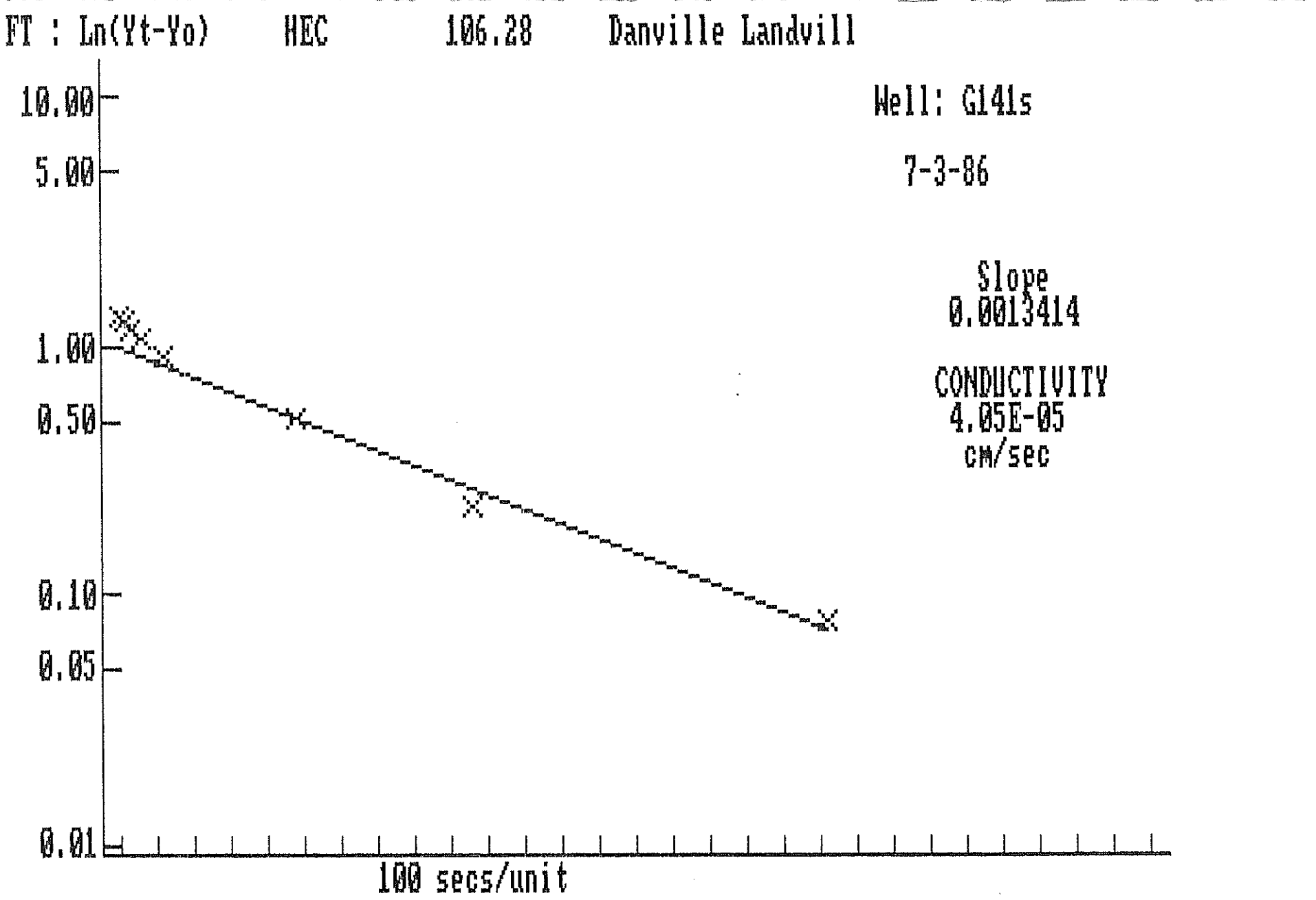
TIME (H,M,S)	DEPTH (FT)
0,0,0	9.39
0,0,15	9.34
0,0,30	9.25
0,1,0	9.16
0,2,0	9
0,8,0	8.62
0,16,0	8.33
0,32,0	8.18

(1/t) (ln(Yo/Yt))= 0.0013414

PARTIALLY PENETRATING: A= 2.20 B= 0.35

HYDRAULIC CONDUCTIVITY: 1.33E-06 ft/sec
4.05E-05 cm/sec

✓ ZAW
8/11/86


FT : Ln(Yt-Yo) HEC 106.28 Danville Landvill
10.00
5.00
1.00
0.50
0.10
0.05
0.01
Well: G141s
7-3-86
Slope
0.0013414
CONDUCTIVITY
4.05E-05
cm/sec
100 secs/unit

COMPUTATION SHEET

RMT INC.

1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
Danville Control Lot 6141 D	By: HFC	Date:	By: JAW	Date: 8/11/86	

$H = 10.30$ $H_o = 15.25$ Hvorslav 5'

t (minutes)	h	$\frac{H-h}{H-H_o}$
0	15.25	1
.25	15.18	.985
.5	14.97	.94
1	14.75	.90
2	14.36	.82
4	14.05	.76
8	13.78	.70
16	13.14	.57
32	11.24	.19
58	10.32	.004

$$K = \frac{r^2}{2} \frac{\ln(L/R)}{L \cdot T_o}$$

r = well radius (ft) = .083
L = Screen length (ft) = 5.0'
T_o = time at $\frac{H-h}{H-H_o} = .37$

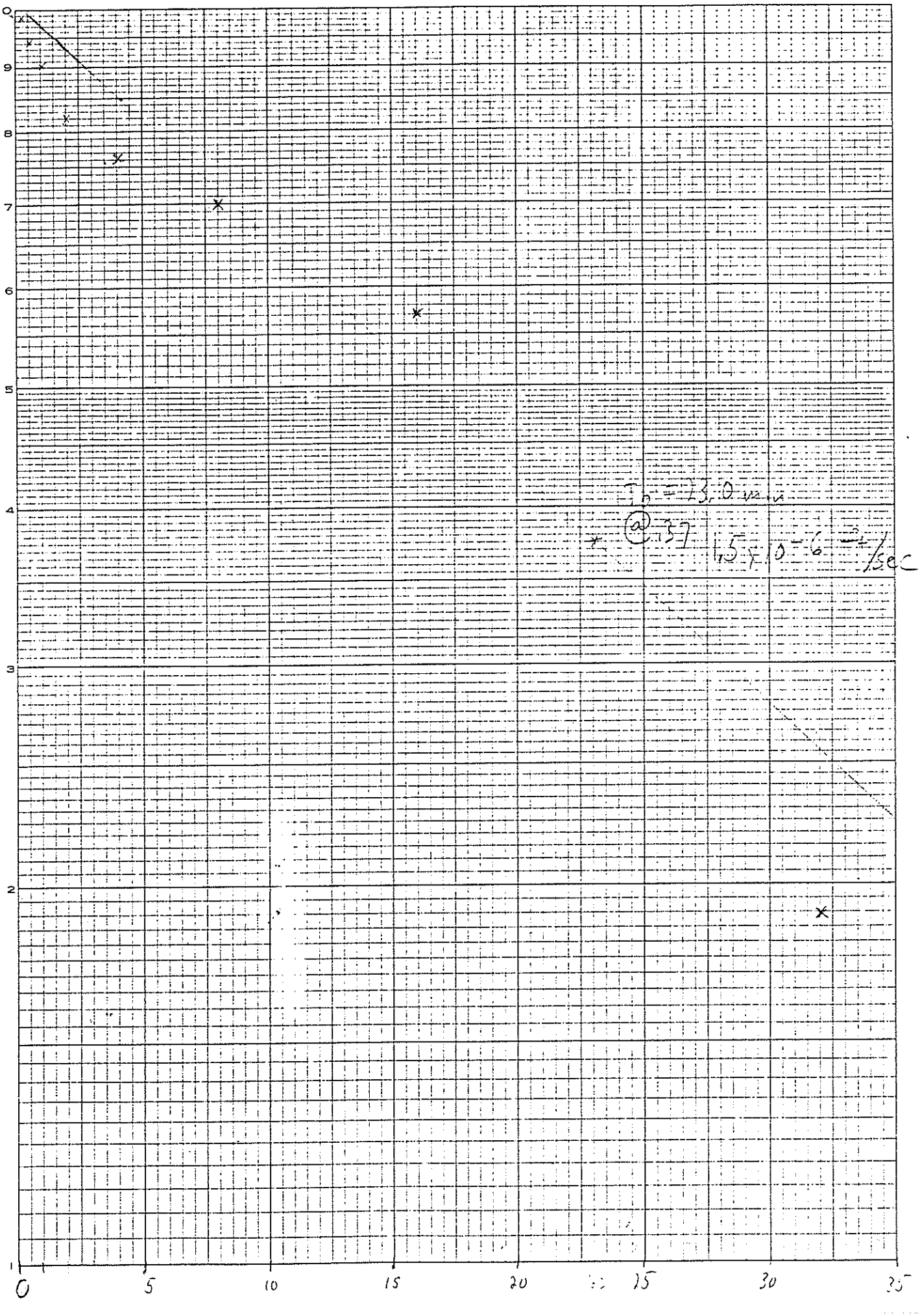
H_o = initial water level instant after drawdown

H = initial water level

h = water level at time t

$K = 1.5 \times 10^{-6}$ ft/sec

6171 D



DIETZGEN CORPORATION
NO. 340-110 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
1 CYCLE X 10 DIVISIONS PER INCH

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: G142s

PROJECT NAME: Danville Landvill
PROJECT NUMBER: 106.28
FIELD WORK DATE(S): 6/17-6/20-86

USER NAME: HEC
DATE: 7-3-86

Rw - BORING RADIUS (IN): 3
L - SCREEN LENGTH (FT): 5
H - SCREEN BASE TO WATER TABLE (FT): 4.63
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 5.1
STATIC WATER LEVEL READING (FT): 5.33

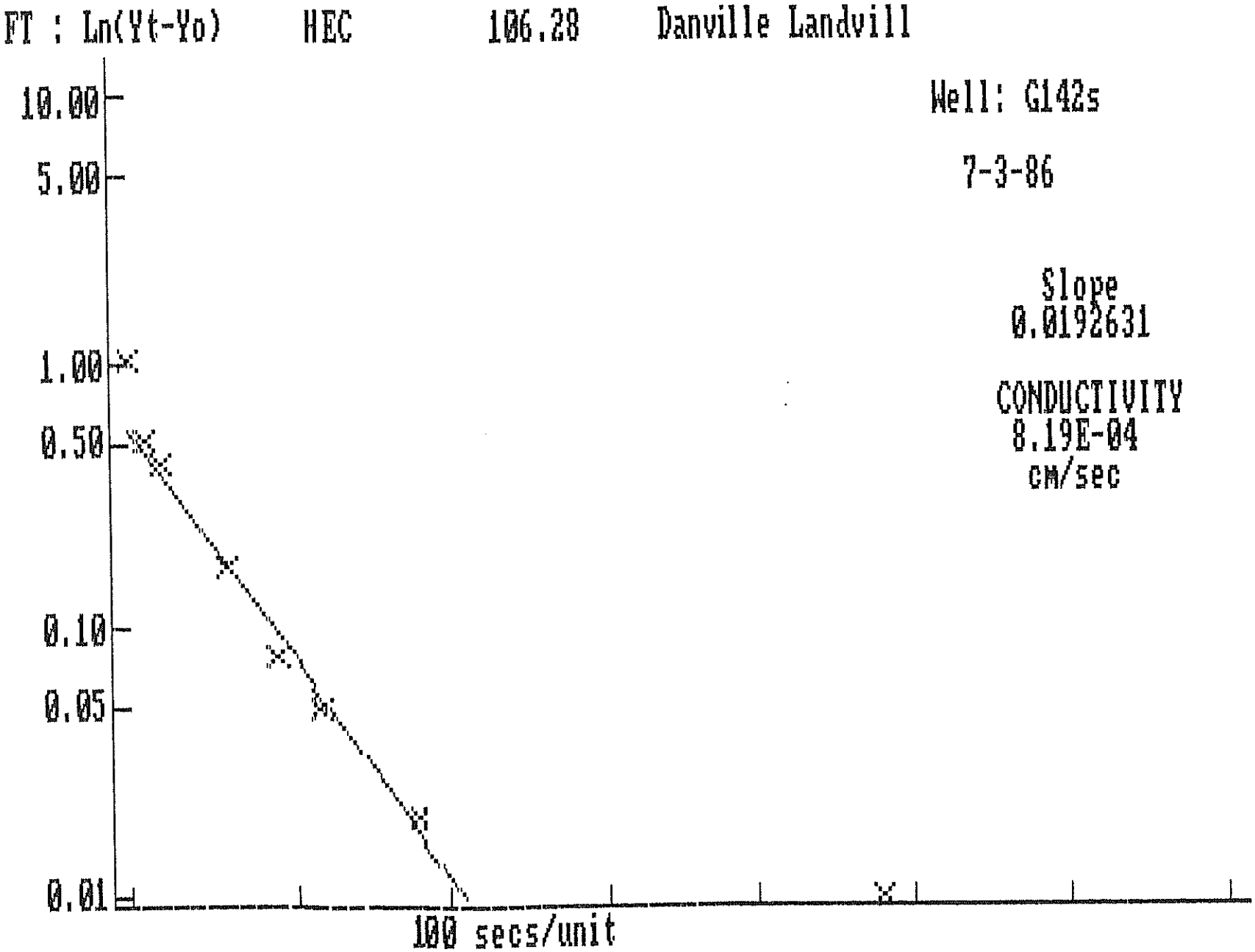
TIME (H,M,S)	DEPTH (FT)
0,0,0	6.34
0,0,10	5.85
0,0,20	5.75
0,1,0	5.5
0,1,30	5.41
0,2,0	5.38
0,3,0	5.35
0,8,0	5.34

(1/t) (ln(Yo/Yt))= 0.0192631

PARTIALLY PENETRATING: A= 2.20 B= 0.35

HYDRAULIC CONDUCTIVITY: 2.69E-05 ft/sec
8.19E-04 cm/sec

J Jaw
8/11/86


FT : Ln(Yt-Yo)
HEC
106.28
Danville Landvill
Well: G142s
7-3-86
Slope
0.0192631
CONDUCTIVITY
8.19E-04
cm/sec
10.00
5.00
1.00
0.50
0.10
0.05
0.01
100 secs/unit

COMPUTATION SHEET

RMT INC.

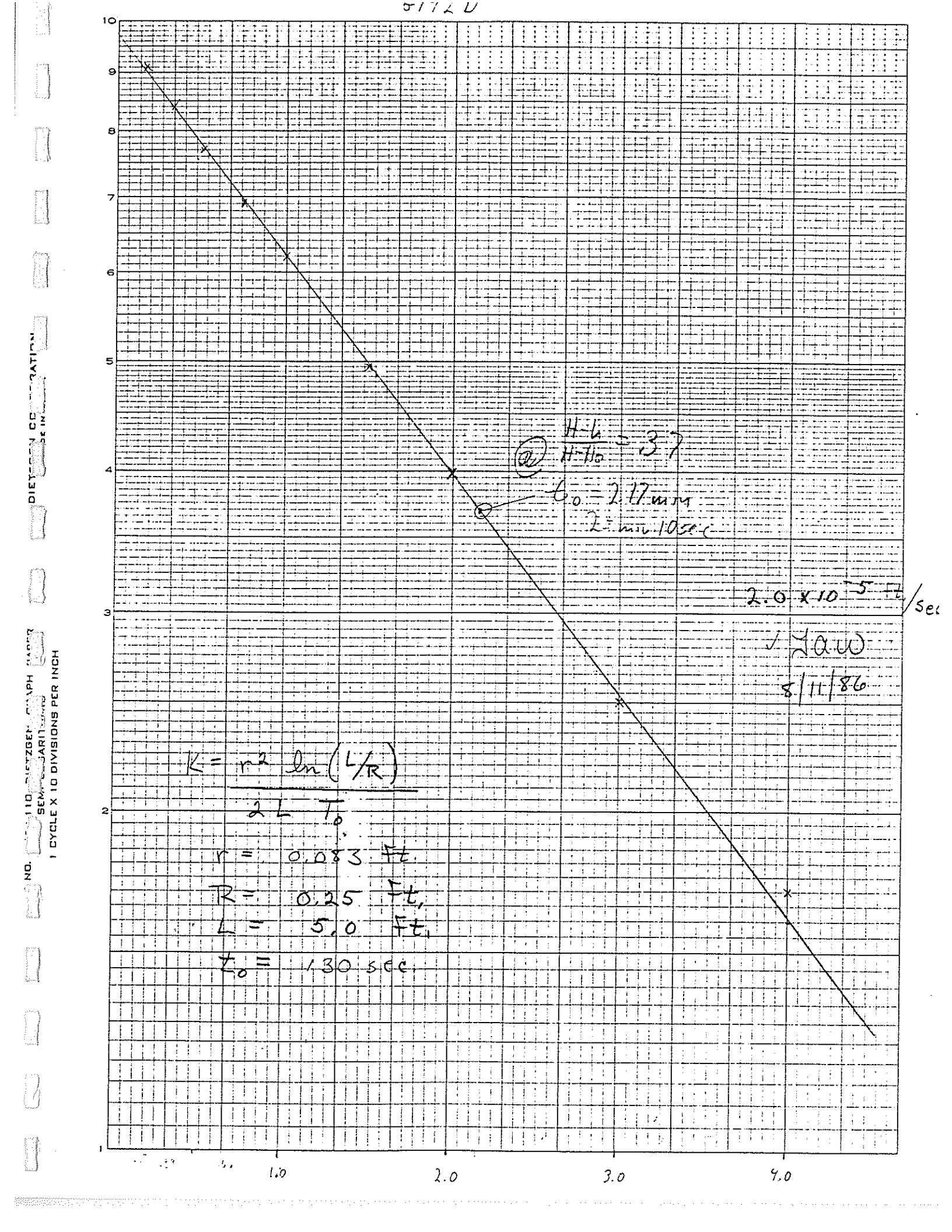
1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
6-42-01 [illegible]			Jaw	8/11/86	

H = 6.03 Ho 13.44 5'

t (minutes)	h	$\frac{H-h}{H-Ho}$
0	13.44	1.
.17	12.75	.91
.33	12.29	.799
.5	11.74	.77
.75	11.11	.68
1.0	10.60	.62
1.5	9.67	.49
2	9.03	.40
3	7.91	.25
4	7.30	.17
14	6.19	.02


5172 D
10
9
8
7
6
5
4
3
2
1
1.0
2.0
3.0
4.0
@ H-h / H-H0 = .37
t0 = 2.17 min
2 min 10 sec
2.0 x 10^-5 Ft/sec
1200
8/11/86
K = r^2 ln(L/R) / 2L t0
r = 0.083 Ft.
R = 0.25 Ft.
L = 5.0 Ft.
t0 = 130 sec
DIETZGEN CO
1 CYCLE X 10 DIVISIONS PER INCH

WARZYN ENGINEERING INC

FALLING HEAD PERMEABILITY TEST RESULTS

PROJECT: Residuals Management Technology
Madison, Wisconsin
LOCATION: Job No. 106.28

Test No. 1
Job No. C 9643
Date 6/27/86
Sheet 1 of 1

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

SAMPLE (a)	G1145		G1325		G1195	
DEPTH	-		-		-	
SOIL DESCRIPTION (b)	Red-Brown Lean Clay, Little Fine Sand (CL)		Brown Sandy Silt, Some Clay (ML)		Brown Lean Clay, Little Fine Sand (CL)	
SAMPLE DIAMETER (cm)	7.4		7.4		7.4	
SAMPLE AREA, A (cm^2)	42.6		42.6		42.6	
SAMPLE LENGTH, L (cm) (c)	17.5		15.0		19.0	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
MOISTURE CONTENT, %	12.2	12.5	24.6	25.3	13.7	13.5
DRY DENSITY (PCF)	124.2	124.2	98.7	98.7	122.5	122.5

COEFFICIENT OF PERMEABILITY, k (cm/sec)			
RUN NO. 1	4.3×10^{-8}	3.6×10^{-7}	3.4×10^{-8}
2	4.0×10^{-8}	3.5×10^{-7}	3.2×10^{-8}
3	3.9×10^{-8}	3.5×10^{-7}	3.2×10^{-8}
4	4.2×10^{-8}	3.5×10^{-7}	3.3×10^{-8}
5	4.2×10^{-8}	3.9×10^{-7}	3.5×10^{-8}
6	3.9×10^{-8}	2.3×10^{-7}	3.2×10^{-8}
7	4.0×10^{-8}	2.0×10^{-7}	3.2×10^{-8}
8	4.0×10^{-8}	1.8×10^{-7}	3.0×10^{-8}
9	4.1×10^{-8}	1.9×10^{-7}	3.3×10^{-8}
10	3.8×10^{-8}	2.0×10^{-7}	3.1×10^{-8}
AVERAGE k, (cm/sec) (d)	4.0×10^{-8}	1.9×10^{-7}	3.1×10^{-8}

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

REMARKS:

(a) Each permeability test was performed on a 3" diameter shelby tube sample delivered to our laboratory by RMT.

(b) Soil description based on visual classification only.

(c) Each test specimen was taken near the center of the 3" shelby tube samples.

(d) Average of last three runs.

Checked By DLN Approved By: DWA Date 7/16/86

FORM NO. 30-05

APPENDIX F

FLOW VELOCITY, VERTICAL GRADIENTS, AND AVERAGE HYDRAULIC CONDUCTIVITY CALCULATIONS

COMPUTATION SHEET

RMT INC.

1406 East Washington Avenue Suite 124 Madison, Wisconsin 53703 (608) 255-2134

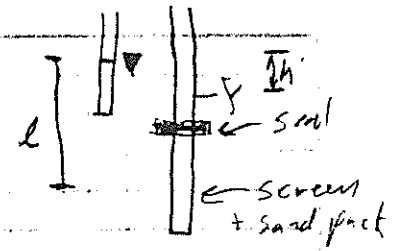
SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Landfill					

Vertical Gradients

Well nest 6-14

Water elevation $\frac{\Delta h}{\Delta l}$



6145 609.91

$dh =$

6140 605.15

center of Screen length + Sand Pack

597.5

Vertical Separation

$dl = 609.91' - 597.5 = 12.41'$

$\frac{dh}{dl} = 0.3836\ ft/ft$

6-19

- well elevations taken on different days
- gradients not valid

6-30

GW elevations

6305 635.67

$dh = 635.67 - 635.3 = .37$

6-30D 635.3

6-30D center of screen length + sand pack = 620.4

6305 water elevation = 635.67

$\frac{dh}{dl} = \frac{.37}{15.27} = .0242\ ft/ft$

COMPUTATION SHEET

RMT INC.

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SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.

G 41

GW elevation

G 41 S 567.36'

G 41 D 564.4'

$dh = 567.36 - 564.4 = 2.96'$

G 41 D center of Screen + Sand Pack = 562.35'

G 41 w.l. elevation = 567.36

$dl = 567.36 - 562.35$

$= 5.01$

$\frac{dh}{dl} = \frac{2.96'}{5.01} = .60$ ft/ft.

G 42

dh

G.W. elevation

G 42 S 536.73

G 42 D 536.35

$dh = 536.73 - 536.35 = .38$

dl

G 42 D center of Screen + Sand pack = 526.82

G 42 S w.l. elevation = 536.73

$dl = 536.73 - 526.82 = 9.91'$

$\frac{dh}{dl} = \frac{.38'}{9.91'} = .038$ ft/ft.

COMPUTATION SHEET

RMT INC.

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SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT/PROPOSAL NO.
Dunn Co. Landfill Monitoring	By: HEC Date: 8/13	By: JAW Date: 8/15/18	106.28

Average Hydraulic Conductivity of Materials

Well in Till	k cm/sec
G 19S	1.11×10^{-5}
G 41S	4.05×10^{-5}
G 30D	1.46×10^{-6}
G 41D	4.5×10^{-5}
G 19D	6.8×10^{-5}

$\bar{K} = e^{x} = \frac{\ln k_x^n}{n}$

$n = 1.8$

$\bar{K} = 1.82 \times 10^{-5}$ cm/sec

cm/sec · 2835 = ft/day

$= 5.2 \times 10^{-2}$ ft/day ✓ JAW 8/15/18

Well in Shale	
G 14S	7.6×10^{-6}
G 14D	1.2×10^{-6}

$\bar{K} = e^{x} = \frac{\ln k_x^n}{n}$

$\bar{K} = 3.02 \times 10^{-6}$ cm/sec

$= 8.6 \times 10^{-3}$ ft/day ✓ JAW 8/15

Well in Alluvium	
G 32S	3.09×10^{-4}
G 42S/Foundry Sand	8.19×10^{-4}
G 42D	6.1×10^{-4}

$\bar{K} = e^{x} = \frac{\ln k_x^n}{n}$

$\bar{K} = 5.36 \times 10^{-4}$ cm/sec

$= 1.52$ ft/day ✓ JAW 8/13/18

Foundry Sand	
G 42S Foundry Sand	8.19×10^{-4}

8.19×10^{-4} cm/sec

$= 2.32$ ft/day ✓ JAW 8/15

COMPUTATION SHEET

RMT INC.

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SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED By: MEC Date: 8-13	CHECKED By: JDW Date: 8/13/86	PROJECT/PROPOSAL NO. 106.28

Flow through till

gradient $\frac{dh}{dl} = \frac{635.30 - 526.74}{2,480} = .0437$ ✓

(630D to 632D; distance 630 to 632)

ne Silty till = .10

average velocity for till $= \frac{\bar{K}_{till}}{ne} \frac{dh}{dl}$

$= \frac{5.2 \times 10^{-2} \text{ ft/day}}{.10} \cdot .0437$

$= 2.27 \times 10^{-2} \text{ ft/day}$ ✓

average velocity for Alluvium

$= \frac{\bar{K}_{Alluvium}}{ne} \frac{dh}{dl}$

$= \frac{1.52 \text{ ft/day}}{.23} .0437$

$= 2.89 \times 10^{-1} \text{ ft/day}$ ✓

time to flow from 630 to 632 through foundry Sand + Alluvium = time in foundry Sand + time in Alluvium

through foundry Sand distance = 2400 ft

$\text{days} = \frac{\text{distance}}{\text{velocity}}$

$= \frac{2400 \text{ ft}}{.364 \text{ ft/day}} = 6,593 \text{ days}$ ✓

through Alluvium distance = 80 ft

$= \frac{80 \text{ ft}}{.29 \text{ ft/day}} = 275 \text{ days}$ ✓

time to move from 630 to 632 through Sand

$= 6,593 \text{ days} + 275 \text{ days} = 6,868 \text{ days}$

$= 18.8 \text{ years}$ ✓

COMPUTATION SHEET

RMT INC.

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SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED By: HEC Date: 8-12	CHECKED By: JAW Date: 8/13/86	PROJECT/PROPOSAL NO. 106.28

Average Velocities

- use average K from log Average of K
- distance across landfill
  from 6 30
  to 6 32
  = 2,480 feet

2,400 feet in Foundry Sand or till
80 feet in Alluvium

Flow through foundry Sand

- assume same gradient for Sand and Alluvium

$$\text{Gradient} = \frac{dh}{dl} = \frac{635.67 - 526.74}{2480} = .0439 \text{ ft/ft}$$

(distance 630 to 632)

So

$$\text{average velocity in foundry Sand} = \frac{K_{sand}}{n_e} \cdot \frac{dh}{dl}$$

n_e med Sand = .28

$$= \frac{2.32 \text{ ft/day}}{.28} \cdot .0439 \text{ ft/ft}$$

$$= .364 \text{ ft/day}$$

$$\text{average velocity in Alluvium} = \frac{1.52 \text{ ft/day}}{.23} \cdot .0439$$

n_e fine Sand = .23

$$= .290 \text{ ft/day}$$

PROJECT / PROPOSAL NAME	PREPARED By: HFC Date: 8-13	CHECKED By: JAW Date: 9/13/86	PROJECT/PROPOSAL NO. 166.28

Flow time through till and Alluvium from 630 to 632

distance in till = 2400 ft.

time = $\frac{\text{distance}}{\text{velocity}}$ = $\frac{2400 \text{ ft}}{2.27 \times 10^{-2} \text{ ft/day}}$

= 105,726 days ✓

distance in Alluvium = 80 ft

time = $\frac{\text{distance}}{\text{velocity}}$ = $\frac{80}{.28}$ = 285 days ✓

time to flow from 630 to 632 through till + Alluvium

= time through till + time through Alluvium

= 105,726 days + 285 days

= 290 years ✓

Assuming same gradient flow through Shale

Velocity = $\frac{K_{shale}}{n_e} \frac{dh}{dl}$

= $\frac{8.6 \times 10^{-3} \text{ ft/day}}{.05}$ .0437 ft/ft ✓

n_e Shale = .05

= 7.5×10^{-3} ft/day

time = $\frac{\text{distance}}{\text{velocity}}$ = $\frac{2400 \text{ ft}}{7.5 \times 10^{-3} \text{ ft/d}}$ = 319,301 days ✓

= 874 years