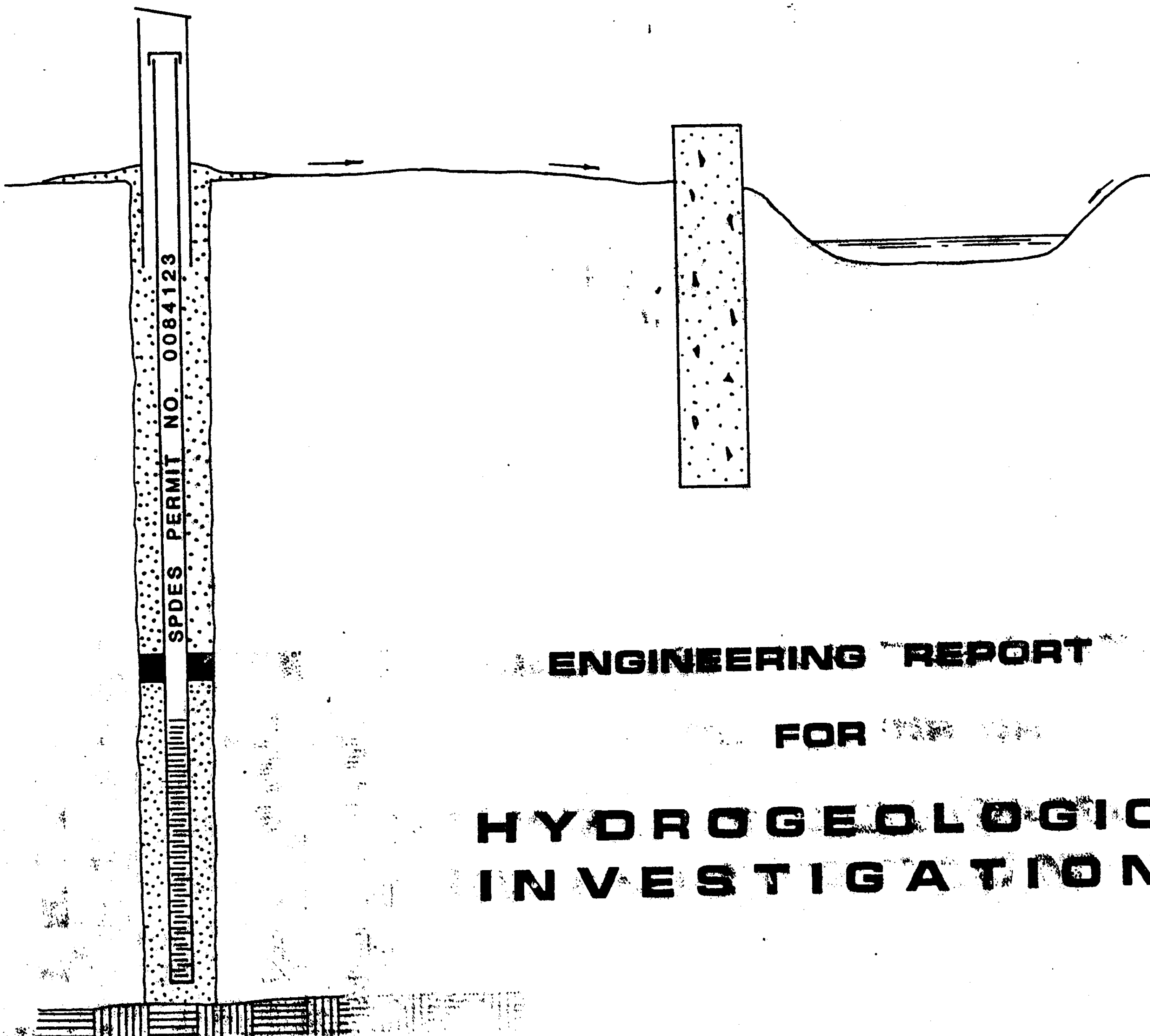
SITE. ID 915044

POLYMER APPLICATIONS INC.



ENGINEERING REPORT

FOR

HYDROGEOLOGIC INVESTIGATION

KREHBIEL ASSOCIATES INC.
1870 NIAGARA FALLS BLVD. • TONAWANDA, N.Y. 14150 • 716-693-9300

NOVEMBER 1983

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
REGION 9 OFFICE

APPROVED

DATE: 12/16/83

DESIGNATED REPRESENTATIVE: Gerard A. Palumbo, P.E.

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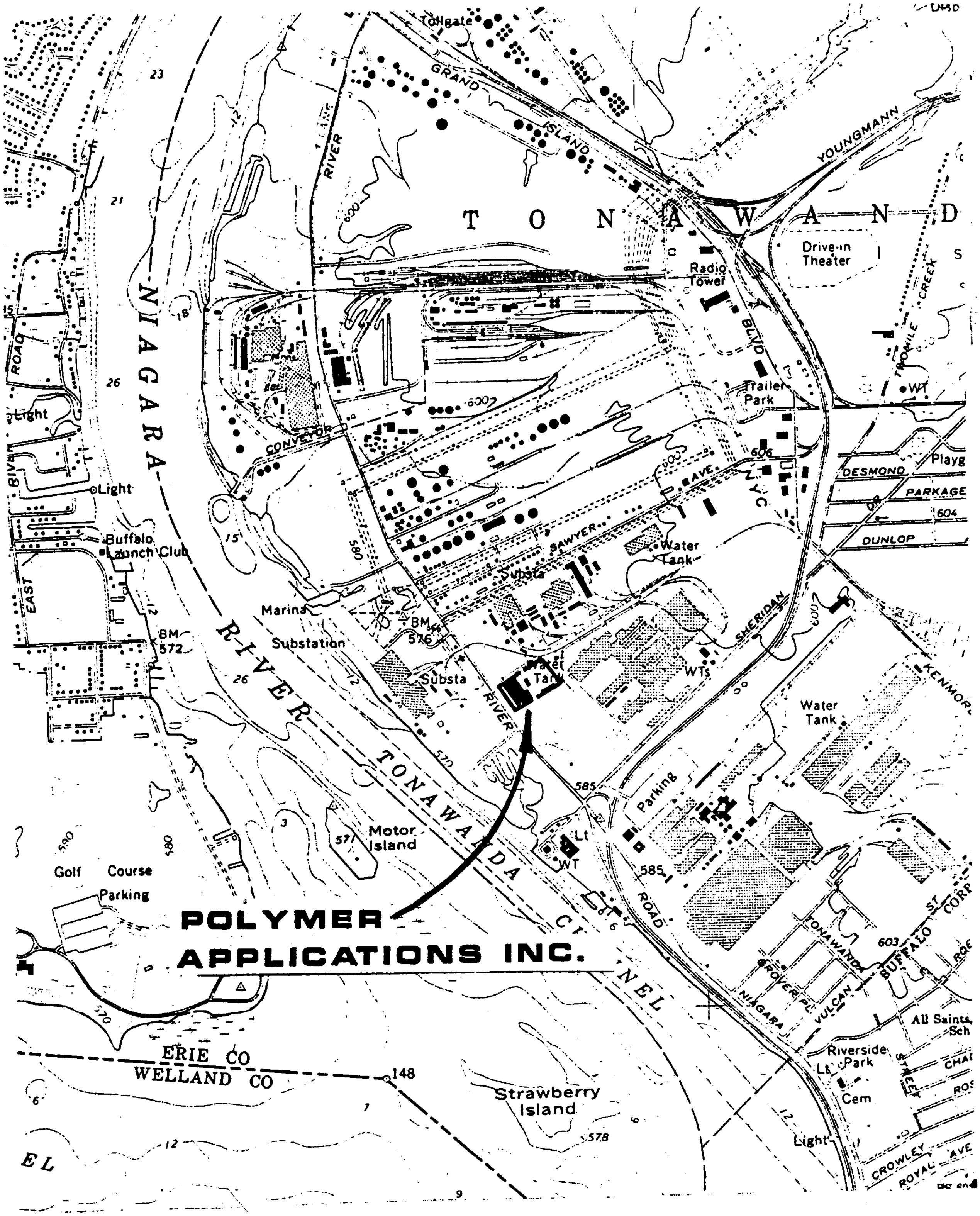
LIST OF EXHIBITS



LOCATION MAP

SCALE 1"=2000'

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EXHIBIT NO. 1

KREHBIEL ASSOCIATES INC.

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INTRODUCTION

Polymer Applications Inc. is located at 3445 River Road in the Town of Tonawanda, New York (See Exhibit 1). The 6.66 acre property is on the easterly side of River Road between Sawyer Road and Sheridan Drive. The site adjoins properties belonging to Niagara Mohawk Power Corp. and Dunlop Tire & Rubber Corp. The site was originally occupied by Allegheny Ludlum Steel Corp. and subsequently by Consolidated Steel Erectors, Inc., May Tool, & Die, Inc., Karl-Rothen & Meyer Inc., Stetter Machinery Co., and S. & H. Machine Co., Inc. At the present time, Polymer Applications Inc. is the sole occupant of the site.

Polymer Applications Inc. produces phenolic resins primarily used by the automotive industry. The company presently employs 64 full-time and up to 26 part-time people. Operation is continuous (7 days - 24 hours) except for planned 1-2 week shutdowns normally scheduled for each July.

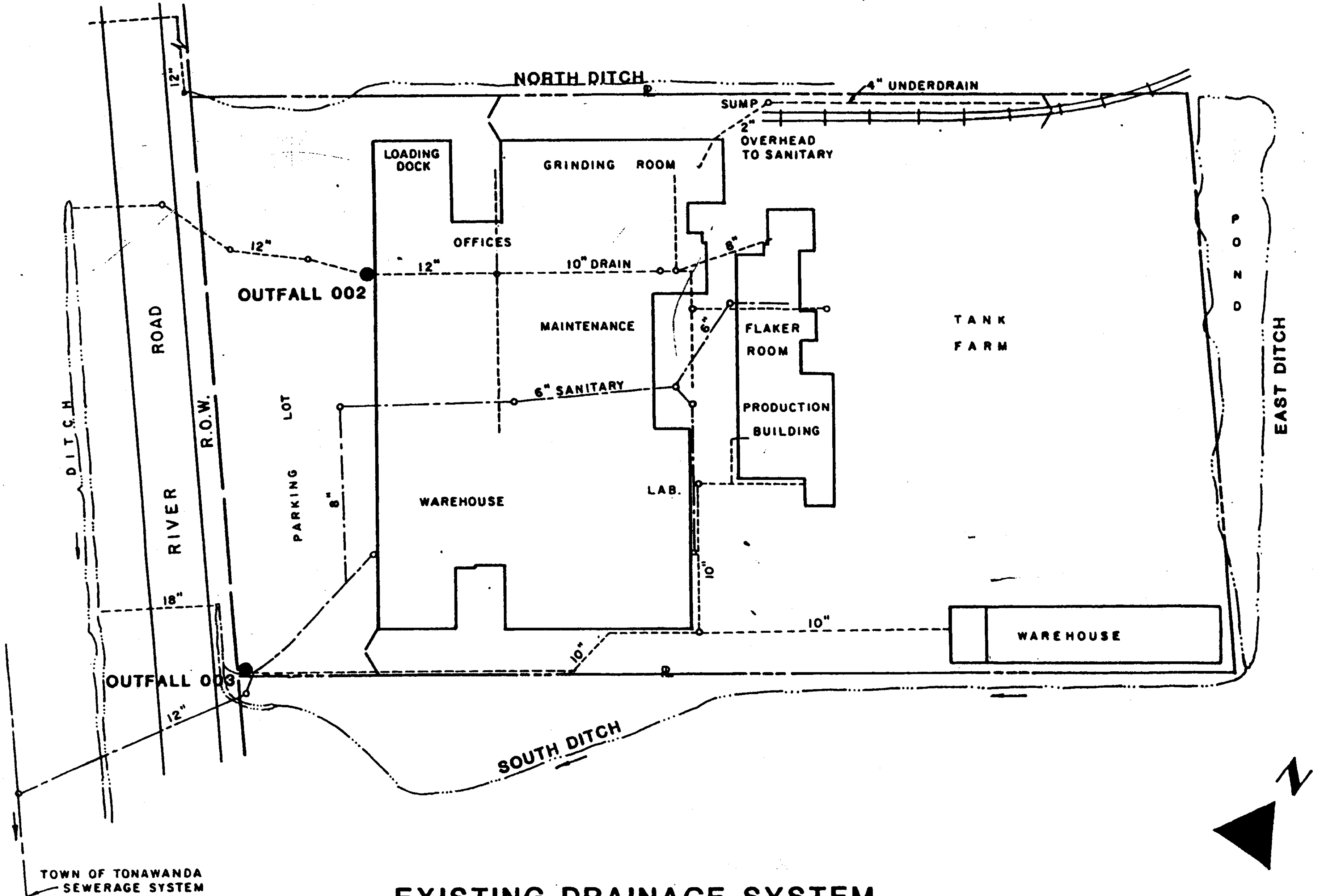
Self-monitoring sampling as required by State Pollutant Discharge Elimination System (SPDES) Permit No. NY0084123 revealed that phenol is draining from Polymer Applications' plant site. As a result of the sample findings, an Order on Consent (File No. 81-34) was issued by NYSDEC. This order required that an engineering report be prepared investigating the phenol discharge problem and the potential for groundwater contamination. The groundwater study was undertaken by Thomsen

Associates who provided the hydrogeological expertise for this project.

The intent of this document is to present investigative findings and alternative solutions for pollution abatement. This report contains conceptual designs and probable costs for handling contaminated water at this site and supersedes the document prepared in August 1982 which addressed surface water only.

The report partially fulfills BMP (Best Management Practices) plan requirements since it is designed to minimize the potential for release of phenolic pollutants into state waters. This document is not, however, intended to replace an SPCC plan.

The contamination problem at this site originated from spills, leaking drums, and a chemical waste lagoon. The rear area of the property (approximately 300' x 400') is the primary source of the problem and although not fully documented, past occupants of this site contributed to the contamination.



EXISTING DRAINAGE SYSTEM

EXHIBIT NO. 2

KREHBIEL ASSOCIATES INC.
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INVESTIGATION

This section contains background information and details with respect to the flow of water draining from this site. The purpose of the investigation was to determine the drainage system configuration and contamination sources.

WATER USE

Water is normally supplied to this company by two sources: a metered supply from the Town of Tonawanda and an unmetered private production well located at the rear of the property. The actual water consumption was determined from the Town meter while the well was not operating. The total average daily water consumption is presently 218,000 gpd which is used for non-contact cooling, production contact water, and sanitary purposes.

COOLING AND SURFACE WATER DRAINAGE SYSTEM

The existing drainage system is shown on Exhibit 2. Surface runoff is tributary to the internal piping system and to perimeter ditches boarding the site as described in this section.

North Ditch

This water channel is located mostly on Niagara Mohawk Power Corp. (NMPC) and receives Polymer's north driveway drainage, drainage from NMPC properties, and in the past, received runoff from the railroad siding. This channel was referred to as outfall 001, but has been discontinued since it no longer receives any cooling water. When the original SPDES Permit was issued in 1975, outfall 001 received most of the non-contact cooling water from the plant and drainage along the north property line. On July 23, 1981, cooling water from outfall 001 was combined with outfall 002.

Surface flow in this waterway during several wet weather obser vations amounts to 3-5 gpm maximum. These waters from the north ditch are piped under River Road to a 36" storm sewer which runs through NMPC's Huntley Station to the Niagara River. No dry weather flow was evident during this study.

A containment wall extended into clay on the north edge of the railroad siding now prevents the siding runoff from entering this ditch.

A sump manhole exists at the west end of the railroad siding and accommodates a 4" drain tile. This water collected is pumped to a separator near the machine shop before discharging into the industrial sewer.

Outfall 002

Outfall 002 receives roof drainage and non-contact cooling water from the production building. The pipe system for this outfall runs through the main warehouse and monitoring is accomplished at a manhole west of the wall of the building (See Exhibit 2). This water is tributary to a ditch on the west side of River Road.

In dry weather conditions, flow ranges from 100,000 gpd to 175,000 gpd and 2,500 gpd is estimated to be infiltration.

Runoff tributary to 002 is dependent on the severity of the wet weather event. The maximum wet weather flow rate observed in this 12" sewer was 2.6 mgd and the calculated capacity of the 12" line is 4.3 mgd.

Outfall 003

This drainage system receives roof and yard drainage and non-contact cooling water. A 10" pipe runs under the south drive and enters an oil skimmer located at the southwest property corner where monitoring is accomplished (See Exhibit 2).

Dry weather flow averages 30,000-40,000 gpd and 4,300 gpd is estimated to be infiltration. Peak wet weather flow has been measured to be 150,000 gpd; the calculated capacity of the 10" line is 1.1 mgd.

East Ditch

Site runoff into the east ditch is nil as a result of a 3'-4' high berm constructed inside the fence along the easterly properly line. This ditch is located on Dunlop Tire & Rubber Co. and primarily receives drainage from the east. During moderately wet periods, the area commonly has standing water. The outlet to this marshy area is located at the southeast property corner which flows into the south ditch.

South Ditch

The south ditch is located on Dunlop Tire and Rubber Co. property and receives waters from the east ditch and from a 30'-35' band along Polymer Applications' south lot line. The area in which the ditch is located is vacant to the south and is marshy. The south ditch joins outfall 003 near the southwest property corner. The water continues under River Road via an 18" storm sewer which discharges into another ditch on the west side of River Road. Eventually, these waters enter NMPC south slag pond before discharging to the Niagara River.

Roadside Drainage

Along the westerly property line (River Road), there is a 50' north-south stretch of open ditch at the southwest corner of the property. The remainder of the frontage has no defined channel, but the land slopes gently towards the north and combines with drainage from the north ditch (outfall 001) to the drainage system which discharges under River Road into the storm system in the Huntley Station (NMPC).

Roof and Yard Drainage

The roof area of the main warehouse is approximately 1-½ acres and does not act as a contaminant source. The roof of the production building is a potential source of contamination due to chemical pipelines and vessels.

The area in and around the production building is also a potential contaminant source. All tankage is or will be diked and precipitation pumped to a separator, thence to the industrial sewer. The rear property behind the production building is quite flat and precipitation tends to puddle in numerous depressions. Some runoff slowly reaches the drainage system described previously.

SEWER SYSTEM CONDITION

The exact age of the original sewer system is not known, but it is suspected to be at least 50 years. Many piping changes have occurred over the years and only the existing system of "live" sewers is shown on Exhibit 2. Physical inspection of the system reveals that the pipe material is vitrified clay and cast iron. Manholes visibly and freely leak at depths greater than 3-4'.

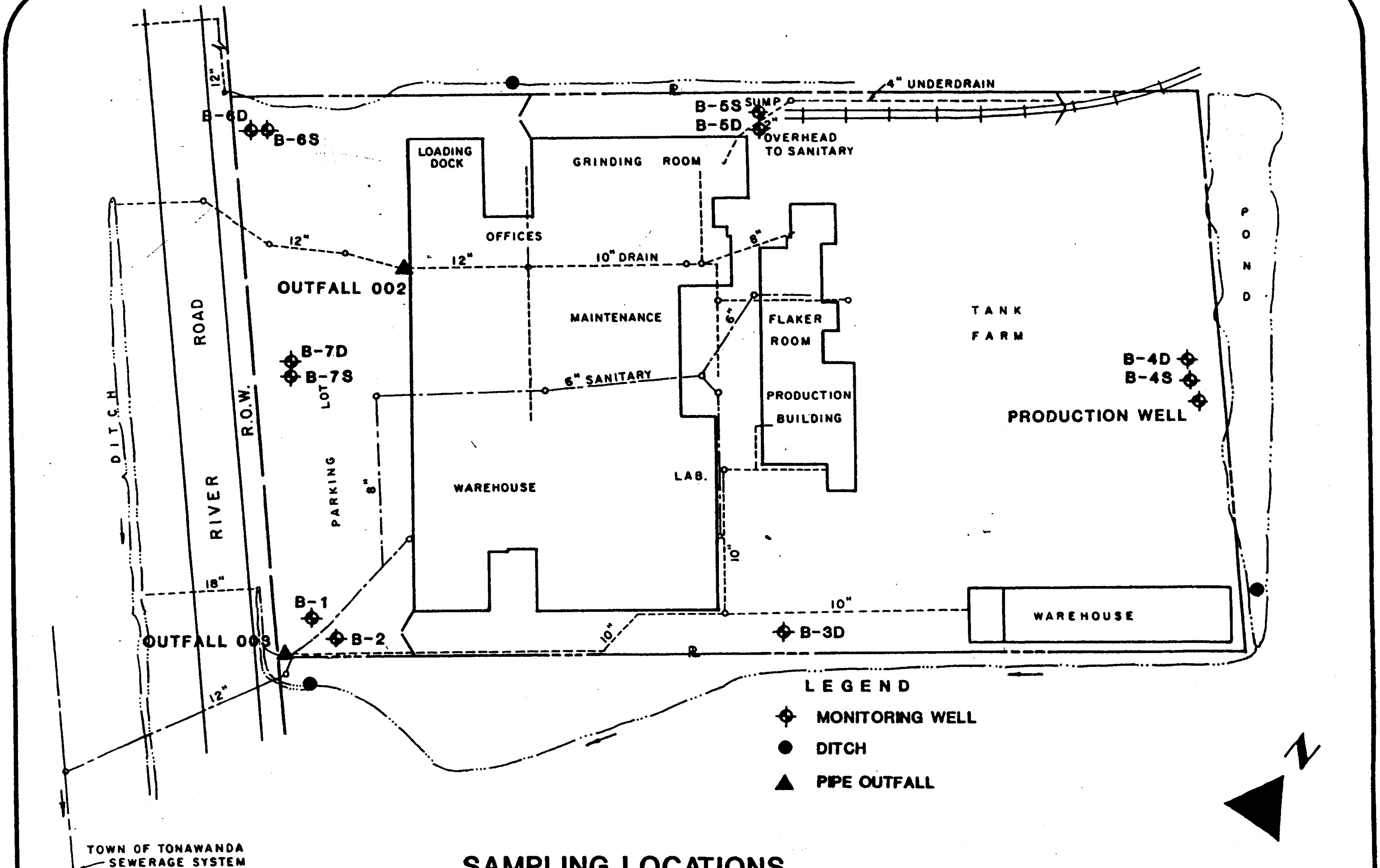
Infiltration into the sewer system is picking up contaminants from the soil since clean water can enter upstream in the system and become contaminated before leaving the site. For example, outfall 003 is a batch discharge during non-flow periods, phenol concentration is 80± ppm as a result of infiltration or pipe residue. During normal operation the discharge concentrations are much less. At 002, the water discharging from north end of flaker room measures no phenol until it enters the subsurface sewers.

SURFACE AND COOLING WATER SAMPLING

Private laboratories and Polymer Applications tested grab samples at the outfalls and the ditches (See Exhibit 3). Various factors affected the sampling results including water usage and rainfall at the time of sampling and therefore, a range of values is presented.

The sampling method used is found in "Standard Methods for the Examination of Water and Wastewater" under 510B Chloroform Extraction Method. Polymer Applications used the Chemetric colormetric test kit.

Monitoring well results are discussed in Appendix 1.



SAMPLING LOCATIONS

EXHIBIT NO. 3

KREHBIEL ASSOCIATES INC.

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POLYMER APPLICATIONS INC.

SAMPLING RESULTS FOR
TOTAL PHENOL, PPM

SAMPLING LOCATION	DRY WEATHER	WET WEATHER
North Ditch	N.A.	65.3 (ARO) 8 - 90 (P.A.)
Outfall 002	2.65 (E & E) 2.5 - 15 (P.A.)	1.32 (ARO) 2.5 - 15 (P.A.)
Outfall 003	0.69 (E & E) 2 - 12 (P.A.)	5.30 (ARO) 0.4 - 1.5 (P.A.)
East Ditch	N.A.	< 0.1 (P.A.)
South Ditch	N.A.	2 - 8 (P.A.)

P.A. - Polymer Applications - lab

E & E - Ecology & Environment, Inc.

ARO - The ARO Corporation

Discussion of Sampling Results

The north ditch measured phenol concentrations of 30-90 ppm which could result from yard drainage or channel residue. Soil sampling and channel excavation may be necessary to remedy this situation. However, a recent surface water sample, after construction of the railroad siding wall, showed only 8 ppm which may be indicative of the wall's positive effect.

Phenol concentrations of up to 15 ppm at outfall 002 results from roof and yard drainage, and infiltration. Flow rerouting is needed to isolate the contaminant sources.

Outfall 003 indicates phenol concentrations up to 5 ppm. Sampling at times of no discharge from the flaker room results in concentrations around 50-80 ppm. The discharge during shut down is suspected as being contaminated infiltration from the sewer trench.

The surface water in the east ditch is no need for concern according to the sampling results.

The south ditch presently picks up some yard drainage which must be contained in order to prevent continued concentrations of up to 8 ppm from entering this channel.

Additional wet weather sampling is warranted to determine the actual effect of the remedial measures.

THE ARO CORPORATION
BUFFALO DIVISION
3695 BROADWAY, BUFFALO, N.Y. 14227

ARO

TELEPHONE 716-683-0440
TELEX 9-1250

ANALYTICAL RESULTS

Customer: KREHBIEL ASSOCIATES 1868 Niagara Falls Blvd, Tonawanda, N.Y. 141

DATE: COLLECTED: 7/28/82 RECEIVED: 7/28/82 COMPLETED: 8/5/

P.O. NO. ARO W.O. 20,531W-5362-64

TEST	Polymer Applications 001	Polymer Applications 002	Polymer Applications 003		
BOD mg/L	23.2	13.0	120.0		
COD ppm	4328. ppm	75.	473.		
Phenols ppm	65.3	1.32	5.30		

Bernard J. Gruczа

Bernard J. Gruczа, Ph.D.
Director, Environmental Laborator

ecology and environment, inc.
International Specialists in the Environmental Sciences

LABORATORY REPORT

FOR

KREHBIEL ASSOCIATES

Job No.: KA-196

Sample Date: 10/3/83 Job Site: Polymer Applications, Inc.

Sample Type: Grab Sampled By: G. Jones, N. Augnst (E & E)

E & E Lab Number 83-	3651	3652	3653	3654	3655	3656	3657	3658	3659	3660	36
Well Number	--	B3	B1	B2	B4	B4	B5	B5	B6	B7	E
Sample Identity	Out Fall 1&2	--	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Deep	Sh
Phenol, mg/L	2.65	0.062	0.271	0.044	17.1	30.0	2.10	4250	1.70	<0.004	0.
Depth from top of casing to water	NA		42'8"	14'	13'1"	4'3"	20'	4'2"	20'7"	16'2"	5'

Quality Control

Spike Recovery, Sample 3659 - 98.6%

Replicate Analysis, Sample 3659 - 9.0% Difference

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst ____________

Date: 10-10-83

recycled paper

ecology and environment, inc.

International Specialists in the Environmental Sciences

LABORATORY REPORT

FOR

KREHBIEL ASSOCIATES

Job No.: KA-196

Sample Date: 10/17/83

Sample Type: Grab

Job Site: Polymer Applications, Inc.

Sampled By: G. Jones (E & E)

E & E Lab Number 83-	3836	3837	3838	3839	3840	3841	3842	3843	3844	3845	3
Well Number	B1	B2	B3	B4	B4	B5	B5	#3	B6	B7	
Sample Identity	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Out Fall	Deep	Shallow	D
Phenol, mg/L	0.066	0.023	0.028	1.04	5.30	2400	0.12	0.69	2.47	10.5	[illegible]
Depth from top of casing to water	45'11"	14'3"	4'7"	4'1"	5'8"	3'10"	19'	NA	19'7"	5'2"	1

Quality Control

Spike Recovery, Sample 3846 - 117%

Replicate Analysis - 6.6% difference

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst [signature]

Date: 10-25-83

recycled paper

POLLUTION ABATEMENT

This section addresses existing improvements, proposed actions, and estimated costs in order to comply with New York State water quality requirements. In Polymer Applications' 1975 SPDES Permit, outfall 001, a cooling water discharge, had discharge limitations for phenol as follows: daily average 0.5 mg/l and daily maximum 1.0 mg/l.

The 1980 SPDES Permit had no discharge limitation for phenol, only oil and grease (15 mg/l). The permit did require dry and wet weather sampling at the outfalls.

Discharge limitations may be set on the basis of technological standards for a specific industrial category or on water quality limitations of the Niagara River. Actual effluent limits were not established at the completion time of this report. The final phenol discharge allocation into the Niagara River will be established for the modified SPDES permit after this report has been reviewed by NYSDEC.

EXISTING MEASURES

In the past several years, Polymer Applications Inc. has instituted several major improvements for the reduction of pollutants leaving the site.

Block and mortar containment walls have been constructed around all liquid storage tanks (see Exhibit 4). The walls are coated with epoxy to make them leakproof and the bottom of the containment areas are constructed of concrete and sloped towards manually operated sumps. In this manner, any spillage can be recovered and precipitation can be discharged in a controlled manner.

A containment wall has been partially constructed (July 1983) around the railroad siding on the northeast part of this property. The 8" concrete wall was designed to prevent any spillage from entering the north ditch. Drain tile within this area collects any contaminated water and enters a sump manhole with a permanent pump set up to transport this water to a phenol separator tank.

As part of this project, it is proposed to continue the same type of wall along the south side of the railroad siding and create a containment area for potential spills from tank cars. The bottom of this containment area will be constructed of fiberglass, concrete, or steel plating.

A drum storage plan was prepared and approved by New York State Department of Environmental Conservation to control the number, contained substance, routing, and disposal of drums on the site. Four specific drum storage areas were designated as part of this plan. This significant housekeeping improvement has added to the effectiveness of the reducing contaminants.

PROPOSED MEASURES

The investigation indicates a drainage and soil contamination problem exists warranting remedial work at this site. The proposed alternatives for reducing the phenol discharge involves a combination of site containment, flow re-routing, and water treatment in conjunction with supplementary sampling.

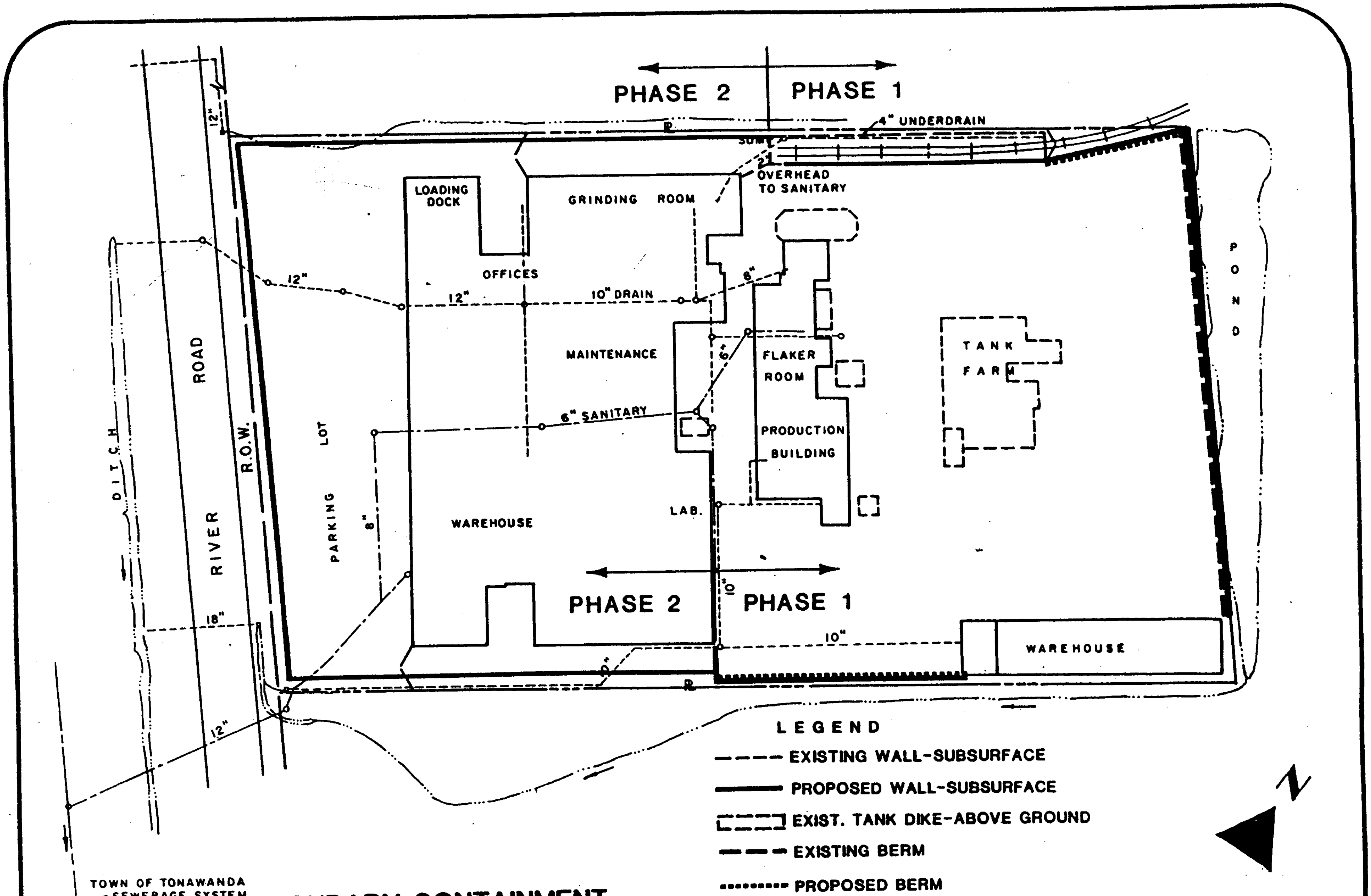
1. Containment

It is proposed to construct a containment wall and berm (see Exhibit 4) to prevent water on the surface and in the soil above the clay from leaving the site. This plan uses the warehouses foundations as part of the wall.

Two methods were considered for containment wall construction:

a. Slurry trench cut-off wall

b. Concrete cut-off wall



SECONDARY CONTAINMENT

EXHIBIT NO. 4

KREHBIEL ASSOCIATES INC.
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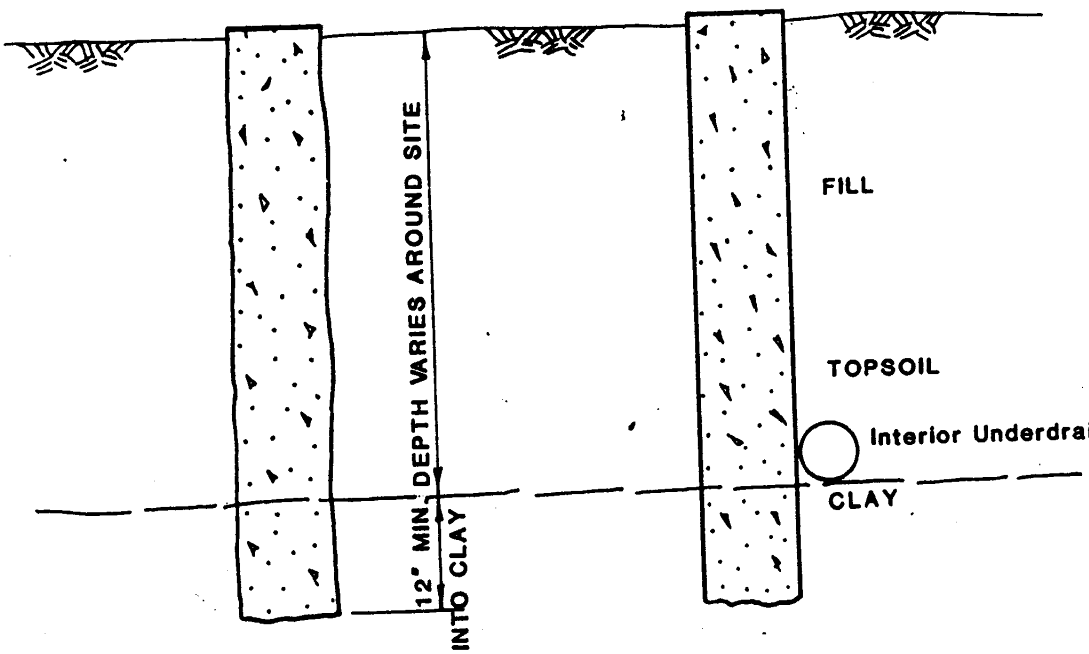
Polymer Applications' previous experience is that construction of a concrete wall using their own forces will be less expensive than having a contractor construct the slurry wall. Construction of the concrete wall can be accomplished using one of the methods shown on Exhibit 5. A properly constructed cut-off wall which penetrates and is keyed into the clay will provide on effective barrier against migration of perched groundwater above the clay.

For complete containment of surface water on the rear property, an earthen berm is necessary between the railroad siding gate and the rear property line. A berm must also be extended along the south fence between the rear warehouse and the main warehouse (see Exhibit 4). The berm height should be a minimum of 1.5'-2'.

This containment wall is proposed to be constructed in two phases as shown on Exhibit 4. Additional samples need to be taken to determine the necessity for a wall around the front portion of the site.



METHOD NO. 1

POUR CONCRETE DIRECTLY INTO TRENCH.

METHOD NO. 2

FORMED REINFORCED CONCRETE (6"-8" WIDE)

NOTES:

1. DO NOT USE STONE BEDDING OR GRANULAR MATERIAL UNDER WALL.
2. USE CLASS B CONCRETE WITH MESH.
3. INSTALL UNDERDRAINS DOWNSLOPE.

CONTAINMENT WALL DETAIL

KREHBIEL ASSOCIATES INC.
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EXHIBIT NO. 5

2. <u>Treatment</u>

Two alternatives were evaluated for on-site treatment of process water and precipitation falling on the containment area. A treatment system could be installed and operated by Polymer Aplications Inc. The alternative would discharge water into the Town of Tonawanda sanitary sewerage system which would eliminate the expense of a sophisticated treatment system.

Treatment with activated carbon filters or a plastic roughing (trickling) filter in a biotower are two likely methods for removing the contaminants from Polymer's water at the source (Alternative 1). A pilot plant study would be needed to assure proper treatment before installing a full-scale system and this would cause some time delays. In all likelihood, activated carbon would be the more efficient system.

A disadvantage to activated carbon is that the carbon must periodically be replaced or regenerated. Cost estimates were made for a plant sized to handle 300,000 gallons per day. In addition, a sealed pipeline across River Road and through Niagara Mohawk's property would need to be constructed.

Alternative 1 Costs

Activated carbon plant (0.3 mgd)	$375,000
Pipeline - Bore River Road and install 8" pipeline to River	70,000
Capital Cost	$445,000

Operating costs for replenishing charcoal and an operator would cost roughly $125,000/year.

As an alternative to on-site treatment, Polymer Applications Inc. can pay the Town of Tonawanda to accept additional water into their sewage system (Alternative 2). Treatment would then take place at the Town's plant and the cost would be charged at the rate of $0.35 per 1000 gallons. In addition to the current sewer charges, the added annual charge would be as follows:

Alternative 2 Costs

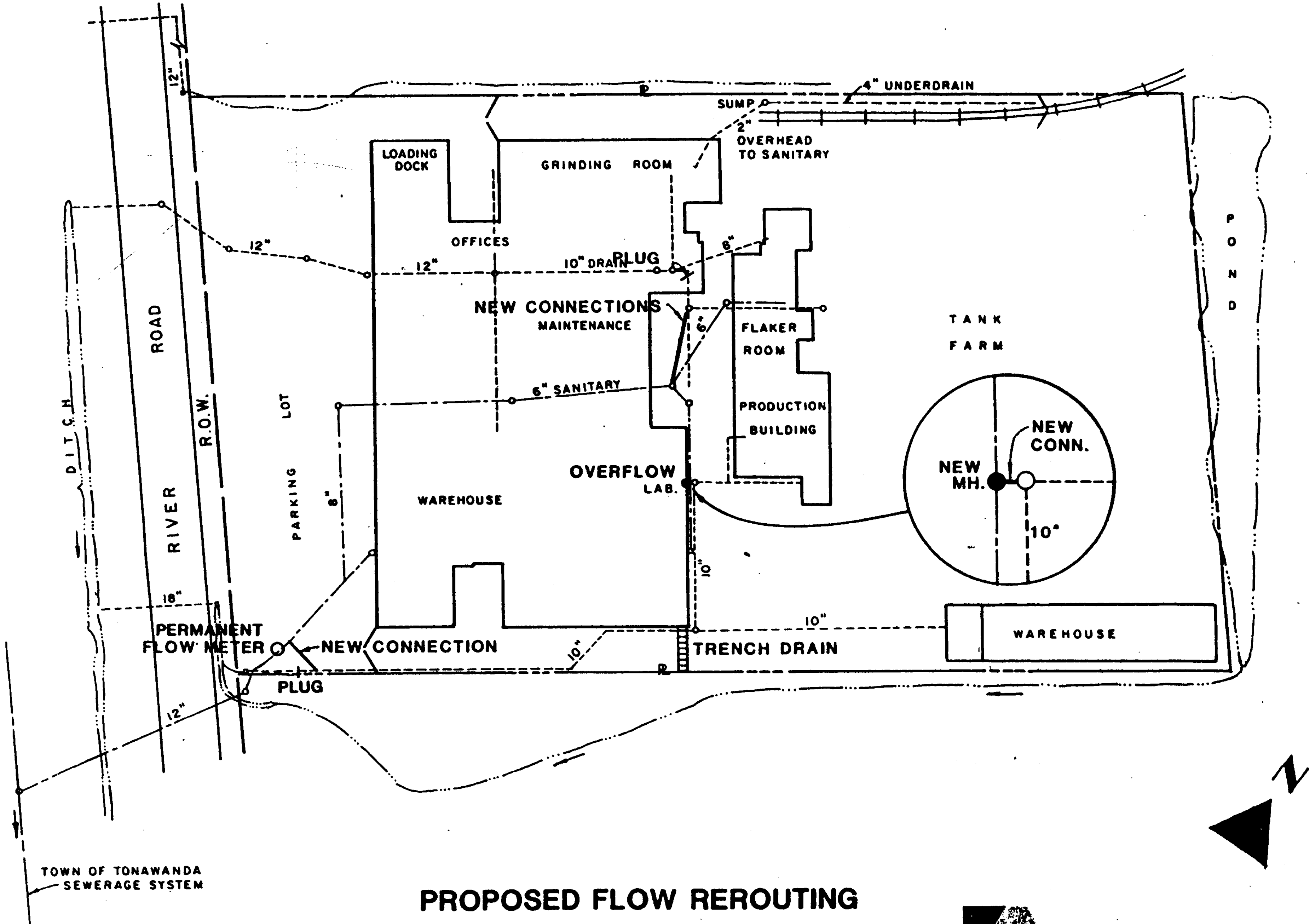
Non-contact cooling water (based on 200,000 gpd)

$$73{,}000{,}000 \text{ gal./yr.} \times \frac{\$0.35}{1000 \text{ gal.}} = \$25{,}550$$

Storm Water (based on 36" precipitation)

$$3{,}000{,}000 \text{ gal./yr.} \times \frac{\$0.35}{1000 \text{ gal.}} = \$1{,}050$$

TOTAL $26,600



PROPOSED FLOW REROUTING

EXHIBIT NO. 6

KREHBIEL ASSOCIATES INC.

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This plan eliminates outfall 003 by diverting it to the sanitary system. A flow meter is proposed to be installed on the existing 8" sewer prior to entering the public sewerage system.

To prevent runoff from passing over the cut-off wall at the south drive, a drainage trench with frame and grate is proposed. The north drive will have an asphalt speed bump between the railroad siding dike and the warehouse to prevent water from escaping from the rear yard to the north ditch.

4. Supplemental Sampling

It is recommended that additional samples be analysed at the perimeter ditches and outfall 002 in mid-November and mid-December and quarterly, thereafter. Pre-construction and post-construction samples will indicate the effectivensss of the remedial measures described previously.

The monitoring wells and the railroad siding sump will also be re-sampled similarly as described in Appendix 1.

APPENDIX 1

HYDROGEOLOGIC INVESTIGATION

THOMSEN ASSOCIATES

HYDROGEOLOGIC INVESTIGATION
FOR POLYMER APPLICATIONS, INC.
TONAWANDA, NEW YORK

FOR

Polymer Applications, Inc.

Job No. GTA-83-76

October 1983

Geotechnical & Materials Engineering, Geologic & Environmental Geoscience Services

635 JAMES ST., SYRACUSE, NY 13203 (315) 472-9333

THOMSEN ASSOCIATES

HYDROGEOLOGIC INVESTIGATION FOR POLYMER APPLICATIONS, INC. TONAWANDA, NEW YORK

1.0 INTRODUCTION

Thomsen Associates was retained by Polymer Applications, Inc. to perform a hydrogeologic investigation at their River Road facility in the Town of Tonawanda. This report presents our findings, conclusions and recommendations from our analysis of data obtained during our investigation at the site. This report is presented to Polymer Applications, Inc. in accordance with P. O. 17812 issued September 14, 1983 by Polymer Application and completes our contract to Polymer Application for P. O. 17812.

Assistance during the project was provided by Harold Marshall from Polymer Applications, Inc., Roy Svensson and Theodore Krehbiel of Krehbiel Associtès, Inc., and Andrew Kucerik and John Danzer of Thomsen Associates-Buffalo.

Data obtained from two observation wells installed for the Town of Tonawanda on Polymer Applications property was used in our analysis. The short report prepared for the Town of Tonawanda describing hydrogeologic conditions encountered at the two observation wells is included as an appendix to this report (Appendix E).

1.1 Purpose and Scope

The purpose of our study was to investigate the presence of and/or migration of phenols in groundwater in the area around the Polymer manufacturing plant. The specific issues addressed, to satisfy concerns of the New York State Department of Environmental Conservation, include:

- Percolation of phenols from behind the building (east) to the front of the building (west) along River Road
- Migration of phenols into the natural clay soils
- Rate of penetration of phenols into the natural clay soils

The scope of this report was limited to:

- Review of available geologic information on the area.
- Analysis of data obtained from soil borings and monitoring wells installed by Empire Soils Investigations, Inc. under the supervision of a geologist from Thomsen Associates for this study.
- Analysis of data obtained from soil borings and monitoring wells installed by Empire Soils Investigations, Inc. under the supervision of a geologist from Thomsen Associates on Polymer Applications, Inc. property for the Town of Tonawanda.
- Analysis of chemical data provided by Ecology and Environment, Inc.

This report has been prepared for the exclusive use of Polymer Applications for specific application to their River Road facility in accordance with generally accepted hydrogeologic practices.

1.2 Methodology

1.2.1 Borings

Nine borings were drilled during the investigation. Five of the borings were drilled to a depth of 20 to 21 feet (B-3, B-4d, B-5d, B-6d, B-7d). Adjacent to four of these borings, four shallow borings were drilled to a depth of 5 to 6 feet (B-4s, B-5s, B-6s, B-7s). All borings were advanced using a 3-3/4 inch ID hollow stem auger casing. The location of the borings is shown on Figure 2 and the boring logs are found in Appendix A. The methodology used to drill borings B-1 and B-2, advanced for for the Town of Tonawanda is contained in Appendix E.

1.2.2 Soil Sampling

Continuous split-spoon soil samples were taken in the four deeper borings (B-3, B-4d, B-5d, B-6d) using a two-foot sampling spoon. At boring B-7d continuous split-spoon samples were taken to a depth of eight feet. Standard split-spoon samples (a 1.5 foot sample spoon advanced every five feet) were taken in boring B-7d below eight feet. All split spoon samples were taken in accordance with ASTM Method D-1586. The depth where the samples were taken is shown on each boring log in Appendix A. To avoid potential contamination of deeper soil samples while drilling, the split spoon samplers were rinsed with acetone before taking each sample. The methodology used to obtain soil samples from B-1 and B-2 is contained in Appendix E.

1.2.3 Soil Classification

All soil samples were visually classified in the field by a geologist. Three samples were chosen for laboratory testing to refine the visual classification. These samples were analyzed for particle size distribution in general accordance with ASTM Method D-422. The results of the laboratory tests are contained in Appendix C.

1.2.4 Monitoring Wells

Nine monitoring wells were installed in the borings around the facility. The observation wells were constructed of threaded flush-joint, two-inch diameter PVC pipe with a machine slotted well screen having 0.01 inch slots. All joints were sealed with teflon tape. The observation wells were installed inside the hollow stem auger to allow for placement of clean sand around the well screen and a bentonite seal above the sand. A ten-foot well screen was installed at the bottom of the deeper borings (B-3, B-4d, B-5d, B-6d, B-7d). A sand pack was placed around the well screen from the bottom of the boring to one foot above the well screen. A one-foot bentonite pellet seal was placed above the sand pack. Bentonite/cement slurry was placed in the annular space above the bentonite pellets to 1.5 feet to 2 feet below the ground surface. A 1.5 to 2 foot plug of cement was placed at the top of the boring to cement a guard pipe in place.

The shallow observation wells (B-4s, B-5s, B-6s, B-7s) were placed in holes drilled to the fill/natural soil interface and are between 5 and 6 feet deep. The well screens in the shallow wells are 1.5 to 2.5 feet long. A clean sand pack was placed around the well screens from the bottom of the boring to 0.5 to 1.0 feet above the well screen. A one-foot bentonite pellet seal was placed above the well screen. The remaining annular space was filled with concrete to hold the guard pipe.

A locking metal protector (guard) pipe or water box was installed over the PVC pipes at all wells to minimize vandalism of the wells. The location of the observation wells is shown on Figure 2. Well construction details are shown on the boring logs in Appendix A.

Well construction techniques used for B-1 and B-2 are contained in Appendix E.

1.2.5 Field Hydraulic Conductivity Tests

Field tests were performed on three observation wells to assess the horizontal hydraulic conductivity of the soils adjacent to the well screen. The methodology of Bouwer and Rice (1976) was used to perform the field tests and analyze the data. Results from the field tests are found in Appendix B.

1.2.6 Water Elevations

All wells were developed by bailing following their installation. Water levels were taken over a period of 5 weeks. Water level readings were taken by personnel from Thomsen Associates and converted to elevations based on data supplied by Krehbiel Associates. Water level readings taken on October 21, 1983 were used to draw the water table map (Figure 2).

1.2.7 Water Quality

Water samples were taken from wells on October 3, October 17, and October 27, 1983 by Ecology and Environment, Inc. for phenols analysis. Prior to taking the water samples, stagnant water in the wells was removed by bailing by personnel from Thomsen Associates on September 29 and October 26, 1983 and by Polymer

Applications on October 13 and 14, 1983. Results from the chemical analysis on water samples are contained in Appendix D.

2.0 GEOLOGY

2.1 Geologic Setting

The Polymer Applications, Inc. facility is located in the Town of Tonawanda, Erie County, New York (Figure 1). This area is within the Erie-Ontario Lowlands Physiographic Province which is characterized by relatively low lying topography. (University of New York, 1966). Bedrock in the area is Camillus Shale of Silurian Age and was deposited about 400 million years ago. The Camillus Shale is a dolomitic shale and contains layers and seams of gypsum. (Goldberg-Zoino, 1978).

Topography in the area has been greatly influenced by glacial events 10,000 years ago. A large lake, Glacial Lake Tonawanda, covered the area at the close of the last glaciation. Lacustrine deposits consisting of silt, fine sand and clay are found in the area. Glacial till, deposited by glacial advances both before and after the lake covered the area are also found in the area.

2.2 Unconsolidated Deposits

2.2.1 Fill

The borings around the Polymer Applications, Inc. facility encountered varying depths of fill over natural soils. Fill depth ranged from 3 to 6 feet. Fill depth was the shallowest at B-3 and B-5 in the center of both the northern and southern property boundaries and deepest at the eastern and western edges of the property (B-1, B-5, B-6, B-7).

Fill consisted of crushed stone, foundry sand, cinders, sand, wood, slag, and clayey silt. The grain size distribution of two samples of fill from B-4 and B-7 was determined to compare the grain size distribution of fill with that of the underlying natural soils and help in evaluating results from field hydraulic conductivity tests in the fill. The grain size distribution of the sand and wood fill sample from 4 to 6 feet in B-4 was 1% gravel size material, 42% sand size material and 57% silt and clay size material. The grain size distribution of the foundry sand fill sample from 4 to 6 feet in B-7 was 18% gravel size material, 23% sand size material and 59% silt and clay size material.

Field permeability tests were performed at B-4s and B-7s to assess the hydraulic conductivity of the fill (Appendix B). The result of these tests indicate the hydraulic conductivity of the fill varies from $9x10^{-4}$cm/sec at B-4s to $6x10^{-4}$cm/sec at B-7s.

2.2.2 Natural Soil

The five deeper borings (20 to 21 feet deep) encountered a red-brown silty clay glacial till beneath the fill. The bottom of all the borings terminated in glacial till. The glacial till consists of silt and clay with little sand and inclusion of embedded fine to coarse gravel. Results from mechanical analysis of a soil sample from the glacial till (B-4, S-8) show a grain size distribution of 2% gravel, 9% sand, and 89% silt and clay size material.

Boring B-1 drilled for the Town of Tonawanda encountered lacustrine silts and clays beneath the glacial till at about 23 feet. None of the borings for this study were drilled deep enough to encounter the lacustrine deposits. The lacustrine deposits at B-1 were 20 feet thick. A sample from these deposits was classified as a CL soil under the Unified Soil Classification System and had 98.7% silt and clay size material. A laboratory permeability test on a soil sample from this unit indicates the vertical hydraulic conductivity is very low ($2x10^{-8}$cm/sec).

Below the lacustrine silts and clays approximately 14 feet of glacial till and 3½ feet of gravelly sand was found above bedrock. The glacial till below the lacustrine silts and clays consists of silty clay with some sand and gravel. The fill becomes coarser with depth and very compact; the bottom 8 feet of the till consisted of silty sand and gravel. The thin layer of gravelly sand encountered above bedrock at B-1 was also found when the production well was drilled (Figure 2). The driller's log for the production well reports two feet of sand and gravel above bedrock.

Bedrock was encountered at elevation 525 in both boring B-1 and the production well for Polymer Applications. The driller's log for the production well called the bedrock Niagara Limestone and "limestone" fragments were noted coming out of the bottom of B-1 (Appendix A). The "limestone" noted in the logs is from dolomitic layers within the Camillus Shale formation.

Unconsolidated deposits above bedrock in both the production well and B-1 were similar. A thin layer of permeable sand (2 feet thick at the production well and 3½ feet thick at B-1) was found on top of bedrock. Predominantly silt and clay soils were found above the sand to the ground surface. At least 40 feet of silt and clay were found at boring B-1. The driller's log for the production well reports 65 feet of silt and clay. The boring logs show that extensive silt and clay soils are found beneath the Polymer facility.

3.0 GROUNDWATER

3.1 Groundwater Flow

Monitoring wells were installed around the Polymer facility to investigate groundwater movement in the fill, natural silt and clay soils below the fill and deeper sand and gravel above bedrock. The production well provides an additional monitoring point for the sand and gravel aquifer above bedrock. Wells B-4s, B-5s, B-6s and B-7s monitor water in the fill. Groundwater in the silt and clay soils is monitored by wells B-2, B-3, B-4d, B-5d, B-6d and B-7d. Well B-1 and the production well monitor groundwater in the sand and gravel unit above bedrock.

Water levels in the wells were monitored over a five week period. A water table map was prepared based on stabilized water levels taken on October 21, 1983 (Figure 2). As shown on Figure 2, groundwater in the silt and clay soils is flowing westward, toward the

Niagara River. The water table is closest to the ground surface at B-4 where it is within 5 feet of the ground surface. As the water table slopes to the west it gets deeper, and drops to about 18 feet below ground surface at B-6. The average horizontal gradient of the water table is about 0.06 ft/ft.

Field tests were performed on two wells in the silt and clay soils (B-2 and B-4d) following the methodology of Bouwer and Rice (1976) to assess the horizontal hydraulic conductivity of the silt and clay deposits (Appendix C). Results from the two tests indicate the horizontal hydraulic conductivity of the silt and clay soils is $1\text{-}2 \times 10^{-6}$ cm/sec.

The rate of groundwater flow horizontally through the silt and clay soils can be estimated using Darcy's Law, $\bar{v} = Ki/n$ where $\bar{v}$ is the average linear velocity of groundwater flow, K is hydraulic conductivity, i is hydraulic gradient and n is effective porosity. Using values of K and i obtained from the field study ($K = 2 \times 10^{-6}$ cm/sec $i = 0.06$ ft/ft) and assuming an effective porosity of 0.06 (Todd, 1980), the average linear velocity of flow is only about 2 ft/year.

Water level measurements at wells B-1 and B-2 show that there is a vertical gradient downward through the silt and clay soils. On October 17, 1983 the vertical gradient was 0.77 ft/ft. Although the vertical gradient is higher than the horizontal gradient (0.06 ft/ft), the vertical hydraulic conductivity of the silt and clay soils is lower than the horizontal hydraulic conductivity by about 2 orders of magnitude. Based on results from a laboratory permeability test on a soil sample from B-1 (Appendix C), the vertical hydraulic conductivity of the silt and clay soils is expected to be only $2x10^{-8}$cm/sec. Thus despite the increased gradient in the vertical direction, groundwater movment downward is only about 0.3 ft/year. Thus, the silt and clay soils function as an aquitard, restricting the downward flow of water into the underlying sand and gravel.

Four wells were installed in the fill to measure water movement in this layer (B-4s, B-5s, B-6s and B-7s). No water was encountered during the study period in B-6s. However, the remaining wells did have water in them during the study period. Water table elevations from the wells in the silt and clay soils indicate that the water found in two of the wells in fill (B-5s and B-7s) is "perched"

"Perched" water is found in the fill because the fill has a higher hydraulic conductivity than the underlying silt and clay soils. Results from field tests at B-4s and B-7s (see Appendix B) indicate the horizontal hydraulic conductivity of the fill is approximately $8x10^{-4}$cm/sec, almost three orders of magnitude greater than the horizontal hydraulic conductivity of the silt and clay soils, and four orders of magnitude greater than the vertical hydraulic conductivity of the silt and clay soils. Thus, water percolating into the fill during rainy periods will pond above the silt and clay soils resulting in seasonal perched water. Water in the fill either drains out into ditches or slowly percolates through the silt and clay soils to the underlying water table.

Both the production well and B-1 encountered a thin (2-3.5 feet) layer of sand and gravel over bedrock. Water level measurements in B-1 and the production well show that the potentiometric surface in this layer is at least 30 feet below the water table. Groundwater flow in the sand and gravel layer is not hydraulically connected to groundwater movement in the overlying silts and clays (Thomsen Associates, 1983).

Water level measurements at B-1 show large rapid fluctuations in water level. Between September 21 and September 29 there was an eight foot drop in the water level and between October 17 and October 21 the water level dropped almost six feet. This fluctuation in the potentiometric surface would not be expected from natural seasonal variations in water levels. These rapid fluctuations in the potentiometric surface indicate that water levels in B-1 are responding to pumping from some production well(s) which is used intermittently. Since the production well on the Polymer Applications property was not used during the study period, the production well(s) causing the water level fluctuations at B-1 must be located off-site.

3.2 Water Quality

The monitoring wells allow sampling and water quality tesing of the perched water in the fill, groundwater in silt and clay soils, and groundwater in the deep sand and gravel aquifer. Water samples were taken from the wells three times to evaluate phenols concentrations in these geologic units. Results from the analyses are contained in Appendix D and summarized in Table I.

TABLE I

SUMMARY OF WATER QUALITY RESULTS

Geologic Unit	Well	Phenols Concentrations (mg/l) 9-23-83	10-3-83	10-17-83	10-29-83
Sand & Gravel	Production Well	0.03			0.014
	B-1		0.271	0.07	0.056
Silt and Clay	B-2		0.044	0.023	-
	B-3		0.062	0.028	-
	B-4d		17.1	5.3	3.20
	B-5d		2.10	0.12	0.012
	B-6d		1.70	2.47	< 0.004
	B-7d		< 0.004	0.78	0.066
Fill	B-4s		30.0	1.04	10.0
	B-5s		4250	2400	-
	B-7s		0.440	10.5	-

Note: Except for the water sample from the production well taken on 9-23-83, all water samples were taken and analyzed by Ecology and Environment, Inc. The water sample from the production well taken on 9-23-83 was taken and analyzed by Acts Testing Laboratory.

The water table map shows that groundwater flow in the silt and clay soils is toward the west. Well B-3 is upgradient of the facility, while wells B-5d, B-6d and B-7d are downgradient. Well 2 is downgradient of Well 3 but should not be strongly influenced by operations at the facility. Well B-4d is in an area where past spills have occurred.

Water quality results reflect the location of the monitoring wells in the groundwater system in relation to past spills at the facility. The highest concentrations of phenols were found in B-5s, the shallow well monitoring "perched" water next to the railroad siding. Spills of phenols have occurred in this area during unloading of tank cars. Concentrations above the proposed EPA water quality criteria of 3.4 mg/l were also found in water samples taken from the fill at B-4s and B-7s (Federal Register, 1979). B-4s is in an area where past spills have occurred. B-7s is close to a loading dock where spills could have occurred. Phenols concentrations found at B-7s could have been the result of past spills in this area or from recent construction activity. B-7s is in a parking lot, and the top of the well is flush with the ground surface. During the study period, equipment used to excavate the cut-off wall behind the facility was passing close to B-7s. The trucks and equipment used during the construction could have carried contaminated soil from behind the facility to the area around B-7s, resulting in the high concentration of phenols found in the water sample from B-7s on October 17, 1983.

Water quality results from B-3 and B-2 and groundwater flow direction indicate these wells will provide reasonable upgradient points for monitoring water quality in the silt and clay soils. Comparison of water quality results from B-5d, B-6d, and B-7d on October 29, 1983 with concentration of phenols in B-2 and B-3 taken on previous dates indicate phenols are not penetrating the silt and clay soils in these locations.

The higher concentrations of phenols found in B-5d, B-6d and B-7d on previous sampling dates are attributed to two causes: (1) possible contamination of the water sample before sampling due to inadequate cleaning of the bailor used to purge wells and (2) possible introduction of low levels of phenols into the borehole during drilling. Special precautions were taken when the wells were purged prior to sampling and during water sampling on October 29, 1983 to prevent the suspected contamination problems of the previous sampling dates. Therefore, the results from this sampling date are believed to be more representative of groundwater quality than previous results.

The only water quality results which indicate phenols are penetrating the silt and clay soils are those from B-4d. This could be because spills in this area are older than spills which occurred in the area of B-5 and B-7 (resulting in a longer time period during which contaminated water in the fill was in contact with the underlying silt and clay soils) and/or more rapid penetration of contaminated water into the silty clay soils in this area due to the hydrologic continuity between the fill and the silty clay soils. Well B-4d was the only location where the water table was in the fill. In the other areas where the fill was saturated the water table was in the underlying silt and clay soils (B-5d, B-7d, B-2). Contaminants can move more quickly into the silt and clay soils when the water table is in the fill because the hydraulic conductivity of the silt and clay soils is higher when the soils are completely saturated.

The decrease in phenols concentrations between the shallow and deep wells at B-4, B-5, and B-7 indicates phenols are rapidly attenuated in the silty clay soils. The concentration of phenols in B-5d was less than 0.05% of that found in the "perched" water at B-4s. A recent study by the Groundwater Research Branch of the U. S. Environmental Protection Agency predicts phenols will be rapidly attenuated in groundwater (Wilson and McNabb, 1983). Their study shows probable biotransformation of phenols under both aerobic and anaerobic water table conditions. The lower concentrations of phenols in all the wells sampling the silt and clay layer relative to the wells sampling the fill in these areas corroborates this prediction of rapid attenuation of phenols in groundwater.

Phenols concentrations were also analyzed from water samples taken from well B-1 and the production well to investigate migration of phenols through the silty clay soils into the underlying sand and gravel aquifer. Results indicate phenols have not migrated into the sand and gravel aquifer (Table I).

wrong!

Groundwater flow calculations indicate that during the 13 years the plant has been in operation, groundwater should only have moved about 26 feet in the silty clay soils (2 ft/year). Therefore, phenols should not migrate readily through the silty clay soils. Since the hydraulic conductivity of the fill is almost three orders of magnitude higher than the underlying silty clay soils, the primary route of migration of phenols will be through the fill on top of the silty clay soils. Water quality samples seem to confirm hydrogeologic data which predict phenols will only migrate very slowly through the silty clay soils. Concentrations of phenols above 1 mg/l in the silty clay soils were only found at well B-4d on October 29, 1983. Water quality results from October 29, 1983 indicate phenols are not penetrating the silty clay soils at B-5d, B-6d or B-7d.

4.0 CONCLUSIONS

Borings placed around the site indicate at least 40 feet of silt and clay deposits with a low hydraulic conductivity are found beneath the Polymer Applications facility. The rate of groundwater flow through the silts and clays horizontally is estimated to be about 2 ft/year. Groundwater is flowing westward through the silts and clays toward the northwestern corner of the Polymer Applications property.

Three to six feet of fill was found above the natural silts and clays. The fill is more permeable than the underlying silts and clays. Water was found in the fill in some areas (B-4s, B-5s and B-7s), while at other locations the fill was unsaturated (B-6). The water in the fill at B-5 and B-7 is "perched" and not hydraulically connected to the underlying water table in the silts and clays.

The silt and clay deposits are an aquitard, restricting the downward migration of groundwater into the underlying sand and gravel and Camillus Shale aquifers. The rate of groundwater flow downward through the silt and clay deposits is estimated to be only about 0.3 ft/year. Rapid fluctuations of water levels during the study period (10 feet in 1 week) in the well screened in the sand and gravel aquifer indicate pumping from an unknown source influences ground water flow in the sand and gravel aquifer.

Water quality results show the highest concentrations of phenols are found in water samples taken from the fill. The highest phenol concentrations were found in the "perched" water at B-5s, close to the railroad siding. Phenols were also found in monitoring wells sampling the fill at B-4s and B-7s. However, water quality results also indicate phenols are rapidly attenuated in the silty clay soils. Concentrations of phenols in the silty clay soils below where the highest concentrations of phenols were found in "perched" water show a decrease in concentration in the silty clay soils to less than 0.05% of the phenols concentrations in the overlying "perched" water. The large decrease in phenols concentrations from water samples taken in the fill to water samples taken in the underlying silty clay soils corroborates recent research indicating probable biotransformation of phenols in water table aquifers which would result in decreasing phenols concentrations. Water quality results also indicate the silty clay soils are an effective aquitard, protecting groundwater quality in the underlying sand and gravel aquifer by restricting downward migration of phenols. Concentrations of phenols in the water samples from the wells screened in the sand and gravel aquifer were similar to background water quality in the silty clay soils.

Water quality results and groundwater flow estimates indicate phenols move very slowly through the silts and clays and are rapidly attenuated. The primary route of migration of phenols from the facility is through the fill overlying the silts and clays. Restricting phenols migration in the fill by placing cutoff walls through the fill into the underlying silts and clays should reduce migration of phenols off-site. However, to be effective, the cut-off wall must surround all areas where perched water containing phenols is found. In addition, the cut-off wall must be keyed into the underlying silty clay soils in all areas. Any break in the cut-off wall (either horizontally or through inadequate penetration into the underlying clay soils) would negate its usefulness in restricting phenols migration.

Since high concentrations of phenols were found at B-5s, it may be necessary to extend the cut-off wall to include this area. However, preliminary results indicate concentrations of phenols are rapidly decreasing at B-5s (46% reduction in 2 weeks).

Additional samples from wells for phenols concentrations are needed to (1) corroborate water quality results of October 29, 1983, (2) assess the effectiveness of the cut-off wall in restricting movement of phenols off-site in the fill, (3) evaluate the effect of construction activities of water quality results in the shallow wells in the fill, and (4) determine the extent of the area which should be surrounded by a cut-off wall. We recommend additional samples are taken from each well in mid-November and mid-December and a supplemental report prepared with an analysis of all water quality data.

Respectfully submitted,

THOMSEN ASSOCIATES

Marjory Rinaldo-Lee, C.P.G.S.

Charles T. Gaynor, II, P. E.

REFERENCES

1. Bouwer, H. and R. C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, V. 12, No. 3, pp. 423-427.

2. Federal Register, July 25, 1979, p. 43660.

3. Goldberg-Zoino Associates, 1978, Buffalo Light Rail Rapid Transit Project, Buffalo, New York, Geotechnical Interpretive Report Tunnel Section Sta 2190+00 to Sta 2375+00, for Niagara Frontier Transportation Authority, Metro Construction Division, Buffalo, N.Y.

4. Muller, Ernest H., 1977, Quatenary Geology of New York, Niagara Sheet, New York State Museum and Science Service Map and Chart Series No. 28.

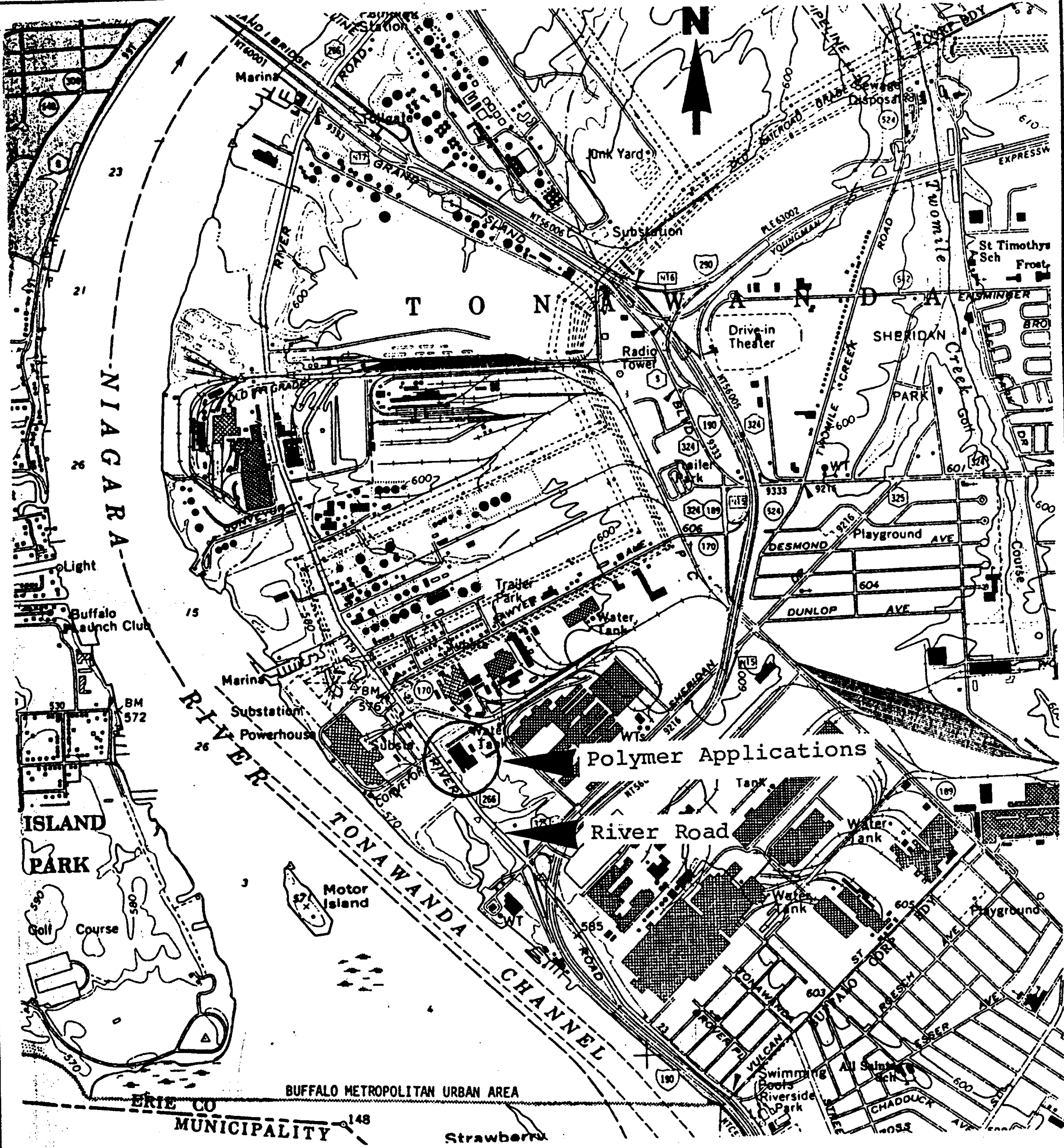
5. Richard, Lawrence V. and Donald Fisher, 1970, Geologic Map of New York, 1970, Niagara Sheet, New York State Museum and Science Service Map and Chart Series No. 15.

6. Thomsen Associates, 1983, Hydrogeologic Investigation, 50 Acre Solid Waste Landfill and Potential Expansion Area, Town of Tonawanda, N. Y.

7. Todd, David Keith, 1980, Groundwater Hydrology, John Wiley and Sons, New York, New York.

8. University of the State of New York, 1966, Geology of New York: A Short Account, Education Leaflet No. 20, New York State Museum and Science Service.

9. Wilson, John T. and James F. McNabb, 1983, EOS, Transactions of the American Geophysical Union, Vol. 64, No. 33, August 16, 1983.



Base Map from USGS
Buffalo NW Quadrangle,
1975

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

Groton • Buffalo • Rochester • Syracuse • Albany
New York • Woodbridge • Harrisburg • Washington

GENERAL LOCATION MAP
POLYMER APPLICATIONS
TONAWANDA, NY

DR.BY: MR-L	SCALE: 1"=2000'	PROJ. NO GTA-83-76
CK'D.BY: MR-L	DATE: 9-29-83	DRWG.NO. 1

APPENDIX A

BORING LOGS

DATE STARTED 8-15-83
FINISHED 8-16-83
SHEET 1 OF 2

EMPIRE SOILS INVESTIGATIONS INC. SUBSURFACE LOG

HOLE NO. B-1
SURF. ELEV. 580.81
G. W. DEPTH 38.9'

PROJECT Monitoring Wells
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

DEPTH	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0	1	13	50	30	80		Brown-Black firm fine-coarse SAND, Some fine-coarse Gravel, Some Clayey Silt (FILL) (Moist-Very Compact)	
5	2	4	1	2	3		Gray fine-coarse SAND & fine-coarse GRAVEL size SLAG (FILL) (Moist)	
							Black fine-coarse SAND-FLYASH FOUNDRY SAND (FILL) (Moist-Loose)	
10	3	3	3	5	8		Moist Gray-Brown soft silty CLAY (Possible FILL) (Moist-Soft)	
							Red Brown medium SILT w/occasional embedded fine-coarse GRAVEL, little clay, fine sand partings (TILL) (Moist-Medium)	
15	4	14	17	22	39		grades Hard	
20	5	7	8	9	17		grades Stiff	
25	6	6	6	6	12		Red-Brown CLAY, Some Silt (Lacustrine) (Wet-Medium)	
30	7	3	5	5	10			
	T-1	PUSHED TUBE						1) Pushed 3" ø Shelby tube, 31'-33' Recovered 2.0'
35	8	3	3	4	7			
40	9	2	2	3	5			

N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 "per blow.
CLASSIFICATION Visual by Geotechnical Engineer

C = No. blows to drive ____ " casing ____ " with ____ lb. weight falling ____ "per blow.

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Auger

DATE			
STARTED 8-15-83	**EMPIRE** SOILS INVESTIGATIONS INC. SUBSURFACE LOG	HOLE NO. B-1	
FINISHED 8-16-83		SURF. ELEV. 580.81	
SHEET 2 OF 2		G. W. DEPTH 38.9	

PROJECT Monitoring Wells
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

DEPTH	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
40									
45		10	3	3	3	6		Red-Brown CLAY & SILT, Some fine-coarse Sand, Some fine-coarse Gravel (TILL) (Wet-Medium)	
50		11	22	25	27	52		grades to Gray Brown fine-coarse SAND, Some fine-coarse Gravel, Some Clayey Silt (Moist-Very Compact),	
55		12	42	47	100/.3			grades to Gray Brown fine-coarse GRAVEL size ROCK FRAGMENTS & fine-coarse SAND, Some little Silt (Wet-Very Compact)	2) Approximately 35' of running sand & gravel @ 56.0'
								Boring Complete @ 56.4' with Casing Refusal at 56.0'	3) Water at 44.7' @ 5:00 P.M.,8-15-83 Casing @ 56.0'
60									4) Water at 43.7'@ 8:30 A.M.,8-16-83 Casing @ 56.0'
									5) Driller washed hole w/roller bit, drilled approx. 0.4' into refusal material w/roller bit-fractured limestone fragments noted coming to surface in wash water.
									6) Water at 44.5' @ 8:00 A.M.,8-17-83
									7) 2" PVC well installed in boring, see diagram for well construction details

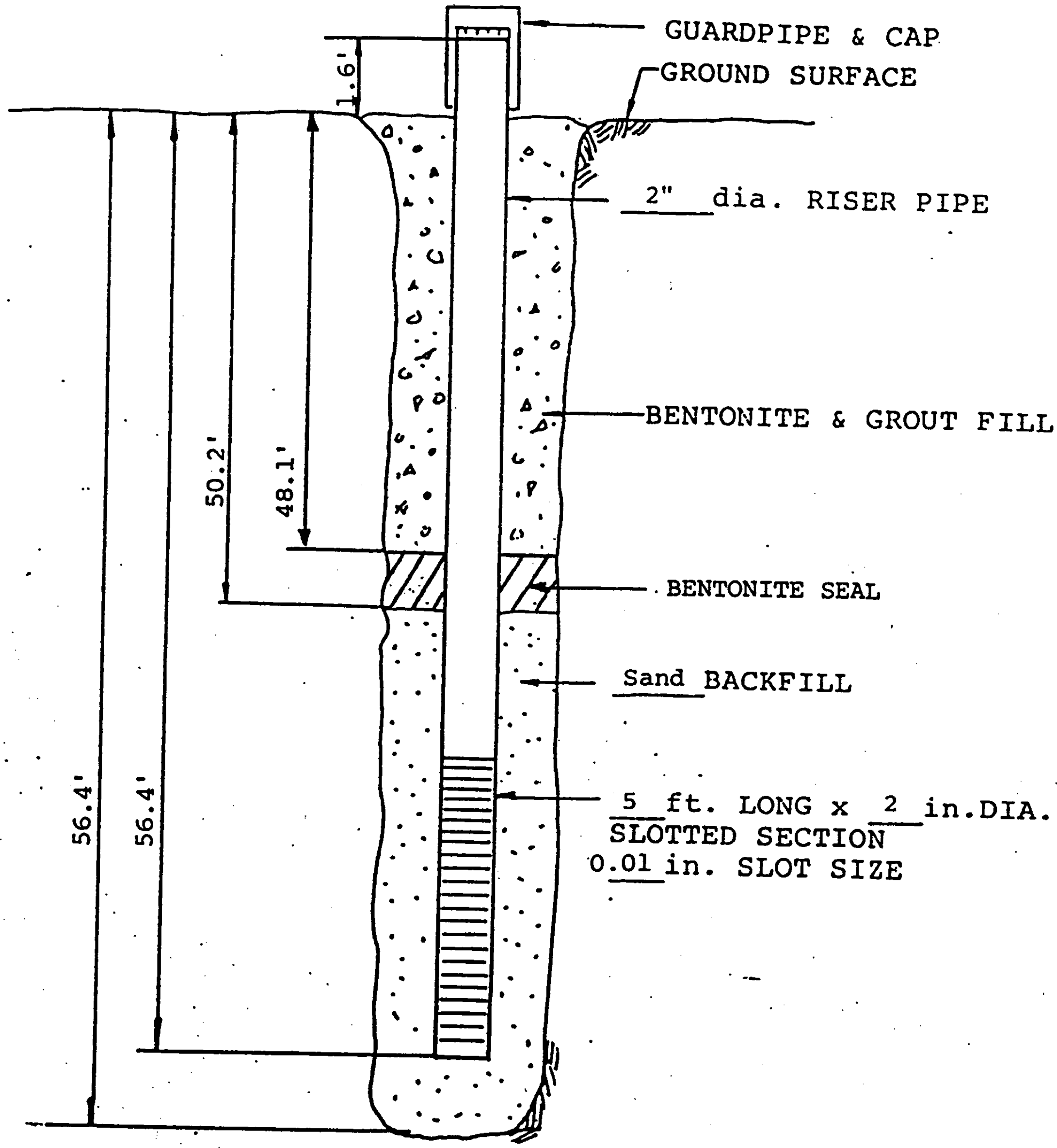
N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 "per blow.

C = No. blows to drive ______ " casing ______ " with ______ lb. weight falling ______ "per blow.

CLASSIFICATION Visual by Geotechnical Engineer

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Auger

PIEZOMETER NO. B-1



PROJECT Town of Tonawanda

LOCATION River Road

EMPIRE SOILS INVESTIGATIONS INC.

DATE

STARTED 8-16-83

FINISHED 8-17-83

SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

HOLE NO. B-2

SURF. ELEV. 581.80

G. W. DEPTH 5.3'

PROJECT Monitoring Well Installation
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

DEPTH	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0								OVERBURDEN SOIL	1) Driller augered hole to 23.7' through overburden soil. No samples were taken. Surficial fill materials were brought up on auger flights initially then changing to red-brown silty clay natural soil.
5									
10									2) No water in hole at boring completion prior to well installation 4:00 P.M., 8-16-83
15									3) Well installation started 8-16-83
									4) Well installation continued with placement of pellet seal at 8:00 A.M. 8-17-83
20									5) See diagram for well installation details
25								Boring Complete @ 23.7'	

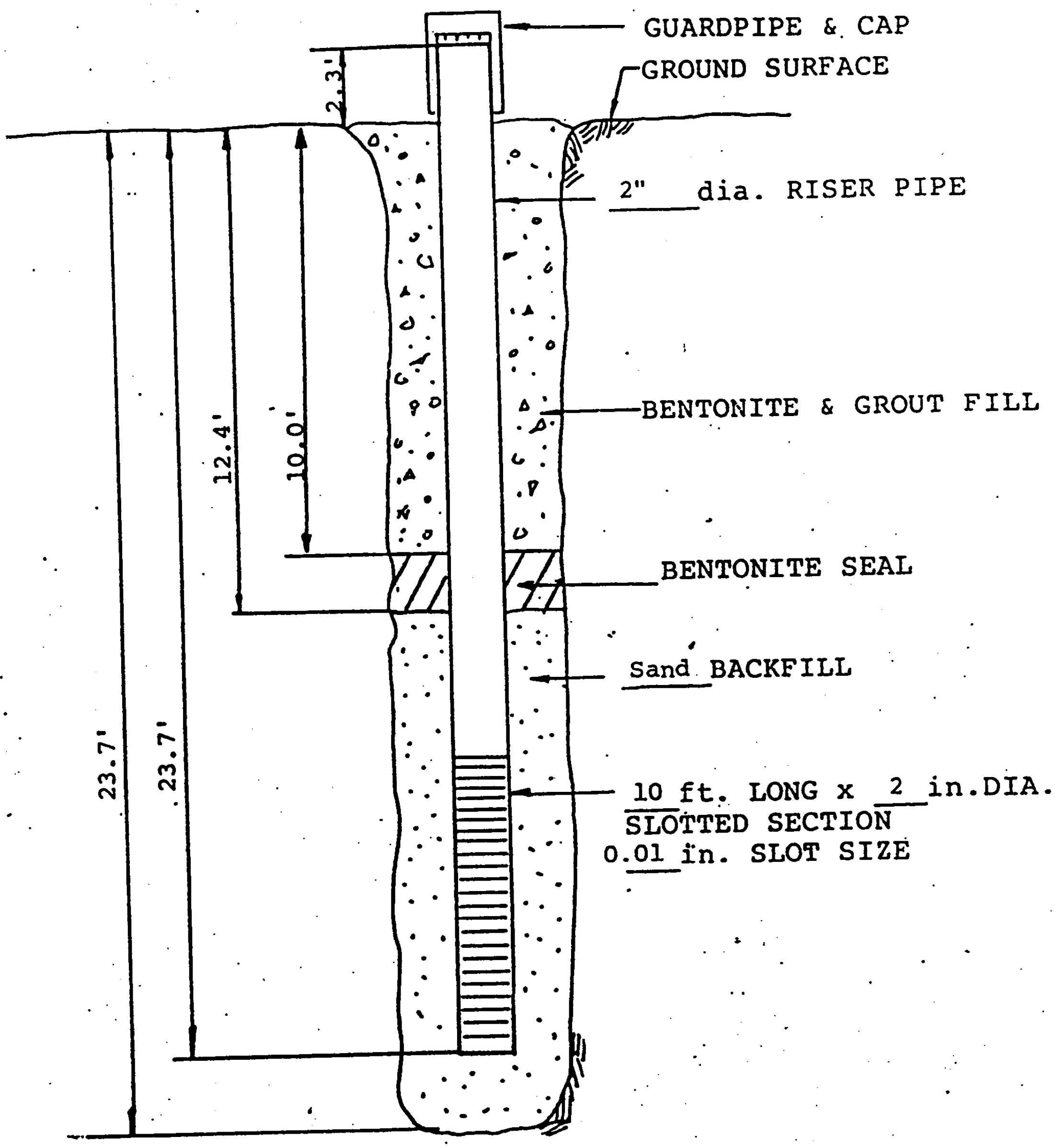
N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 "per blow.

C = No. blows to drive ____ " casing ____ " with ____ lb. weight falling ____ "per blow.

CLASSIFICATION Visual by Geotechnical Engineer

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Au

PIEZOMETER NO: B-2



PROJECT Town of Tonawanda

LOCATION River Road

EMPIRE SOILS INVESTIGATIONS INC.

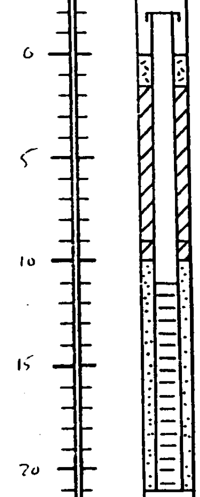
HYDROGEOLOGIC LOG

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0											
			1		24	9	Black FILL, Crushed Stone and Foundry Sand (Moist-Loose) 3.5'				
			2		24	18	Red-Brown SILT & CLAY, little sand, inclusions of embedded fine-coarse gravel (TILL)				
5			3		24	54					
			4		24	61	(Moist-Hard)				
			5		24	55					
10			6		24	56					
			7		24	27					
15			8		24	26					
			9		24	24					
20			10		24	18					
							Boring Terminated @ 21.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS

B-3d

W.L.*



WATER PROBE READINGS

Temp. (°C)	Cond. (µmho/cm)	Eh (mV)	pH

NOTES

*Water Level Measured on

Well Materials:
Screen - 2" I.D. PVC
0.01" machine slots
Riser - 2" I.D. PVC

Stick up: 2.0'

Bore Hole Diameter: 7.5"

No free standing water in boring when well installed

NOTE: See reverse side for key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 589.55
Date Started 9-15-83
Date Completed 9-16-83
Number of Installations in Boring 1
Method of Installation Hollow Stem Auger

Project No. GTA-83-76
Project Title Polymer Applications
Location Tonawanda, NY
Classified By AK Checked MR-L

THOMSEN ASSOCIATES

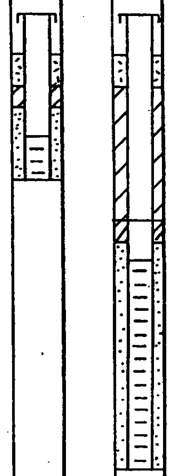
MONITOR NO. B-3

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0		/	1		24	17	Brown FILL, Crushed Stone and Sand (Moist-Firm)				
		/	2		24	24	Brown FILL, Sand and Wood (Moist-Firm)				
5		/	3		24	26	5.8'				
		/	4		24	59	Red-Brown SILT & CLAY, little sand, trace gravel (TILL) (Moist-Hard)				
		/	5		24	67					
10		/	6		24	73					
		/	7		24	49					
15		/	8		24	44					
		/	9		24	48					
		/	10		24	34					
20							Boring Terminated @ 20.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS

B-4s		B-4d			
W.L.*		W.L.*			



WATER PROBE READINGS

Temp. (°C)	Cond. (µmho/cm)	Eh (mV)	pH

NOTES

*Water level measured on

Well Materials:
Screen - 2" I.D. PVC
0.01" machine slots
Riser - 2" I.D. PVC

Stick Up: 2.0'

Bore Hole Diameter: 7.5"

No free standing water in borin when well installed

Well B-4s installed in separate boring next to B-4d

NOTE: See reverse side for key and explanation to log.

RUN NO. | RECOVERY (Percent) | RQD

Surface Elevation 592.29
Date Started 9-15-83
Date Completed 9-15-83
Number of Installations in Boring 1
Method of Installation Hollow Stem Auger

Project No. GTA-83-76
Project Title Polymer Applications
Location Tonawanda, NY
Classified By AK Checked MR-L

HYDROGEOLOGIC LOG

THOMSEN ASSOCIATES

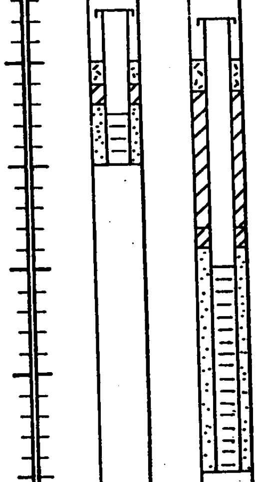
MONITOR NO. B-4

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0			1		24	6	Black FILL, fine-coarse Foundry Sand, layer of silty clay, cinders (Wet-Loose) 3.0'				
			2		24	13					
			3		24	33	Red-Brown SILT & CLAY, embedded fine-coarse sand and gravel (TILL) (Moist-Hard)				
5			4		24	50					
			5		24	43					
10			6		24	26					
			7		24	52					
15			8		24	32					
			9		24	23					
			10		24	24					
20							Boring Terminated @ 20.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS

B-5s		B-5d		
W.L.*		W.L.*		



WATER PROBE READINGS

Temp. (°C)	Cond. (µmho/cm)	Eh (mV)	pH

NOTES

*Water level measured on

Well Materials:
Screen - 2" I.D. PVC
0.0" machine slots
Riser - 2" I.D. PVC

Stick Up:
5s - 2.5'
5d - 2.0'

Bore Hole Diameter: 7.5"

No free standing water in bori[ng] when well B-5d installed

Well B-5s installed in separat[e] boring next to B-5d

NOTE:	RUN NO.	RECOVERY (Percent)	RQD
See reverse side for key and explanation to log.			

Surface Elevation 589.48
Date Started 9-16-83
Date Completed 9-16-83
Number of Installations in Boring 1
Method of Installation Hollow Stem Auger

Project No. GTA-83-76
Project Title Polymer Applications
Location Tonawanda, NY
Classified By AK Checked MR-L

HYDROGEOLOGIC LOG

THOMSEN ASSOCIATES

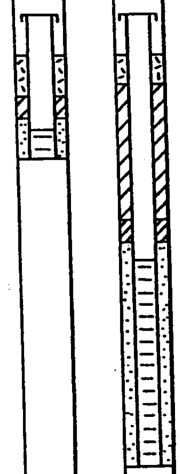
MONITOR NO. B-5
Sheet 1 of 1

HYDROGEOLOGIC LOG

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0		/	1		24	20	Black FILL, fine-coarse SAND, Some Silt, trace foundry sand, trace gravel				
		/	2		24	16					
		/	3		24	18	(Moist-Firm) 5.0'				
5		/	4		24	42	Red-Brown SILT & CLAY, little fine-coarse sand, trace gravel. (TILL) (Moist-Hard)				
		/	5		24	38					
10		/	6		24	53					
		/	7		24	49					
15		/	8		24	29					
		/	9		24	15					
		/	10		24	11					
20							Boring Terminated @ 20.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS

B-6s	B-6d
W.L.*	W.L.*



WATER PROBE READINGS

Temp. (°C)	Cond. (µmho/cm)	Eh (mV)	pH

NOTES

*Water level measured on

Well Materials:
Screen: 2" I.D. PVC
0.01" machine slots
Riser: 2" I.D. PVC
Stick Up: 2.[illegible]
Bore Hole Diameter: 7.5"

No free standing water in boring when wells installed

Well B-6s installed in separate boring next to B-6d

NOTE: See reverse side for key and explanation to log.	RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation B-6s:580.04;B-6d:579.94
Date Started 9-17-83
Date Completed 9-17-83
Number of Installations in Boring 1
Method of Installation Hollow Stem Auger

Project No. GTA-83-76
Project Title Polymer Applications
Location Tonawanda, NY
Classified By AK Checked MR-L

THOMSEN ASSOCIATES

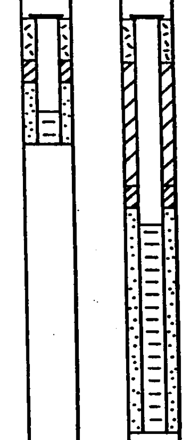
MONITOR NO. B-6

Sheet 1 of 1

Depth	Elevation	Sample No.	Chem. Smpl	Recovery (Inches)	N	Soil or Rock Classification	Unified Soil Classif.	Density (PCF)	Water Content (Percent)	Permeability (cm/sec)
0		1		24	82	Black FILL, Slag and Foundry Sand (Moist-Firm)				
		2		24	8	Black FILL, Clayey Silt and Foundry Sand				
5		3		24	14	(Moist-Firm) 5.8'				
		4		24	63	Red-Brown SILT & CLAY, little sand, trace gravel (TILL) (Moist-Stiff)				
10		5		18	40					
15		6		18	21					
20		7		18	18	Boring Terminated @ 20.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS

B-7s W.L.* | B-7d W.L.*



WATER PROBE READINGS: Temp. (°C) | Cond. (µmho/cm) | Eh (mV) | pH

NOTES

*Water level measured on

Well Materials:
Screen - 2" I.D. PVC
[illegible] 0.01" machine slots
Riser - 2" I.D. PVC

Stick-Up [illegible] 0' (water box)

Bore Hole Diameter: 7.5"

No free standing water in boring when wells installed

Well B-7s installed in separate boring next to B-7d

NOTE: See reverse side for key and explanation to log.

RUN NO. | RECOVERY (Percent) | RQD

Surface Elevation B-7s:578.53;B-7d:578.59
Date Started 9-17-83
Date Completed 9-17-83
Number of Installations in Boring 1
Method of Installation Hollow Stem Auger

Project No. GTA-83-76
Project Title Polymer Applications
Location Tonawanda, NY
Classified By AK Checked MR-L

HYDROGEOLOGIC LOG

THOMSEN ASSOCIATES

MONITOR NO. B-7

Sheet 1 of 1

TEST WELL # 2

[To rear of property along fence line]

POLYMER APPLICATIONS INC.
3445 River Road
Tonawanda, New York 14150

Driller: Robert Eacker

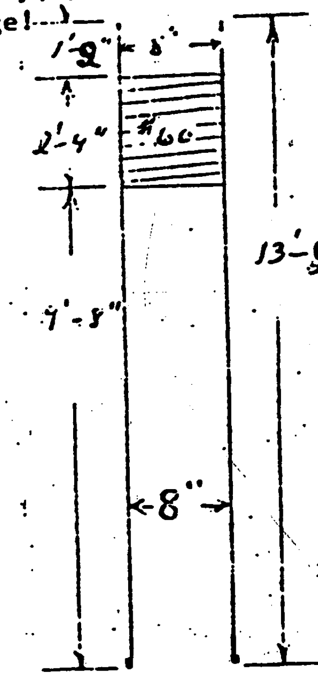
Completed: 10-15-76

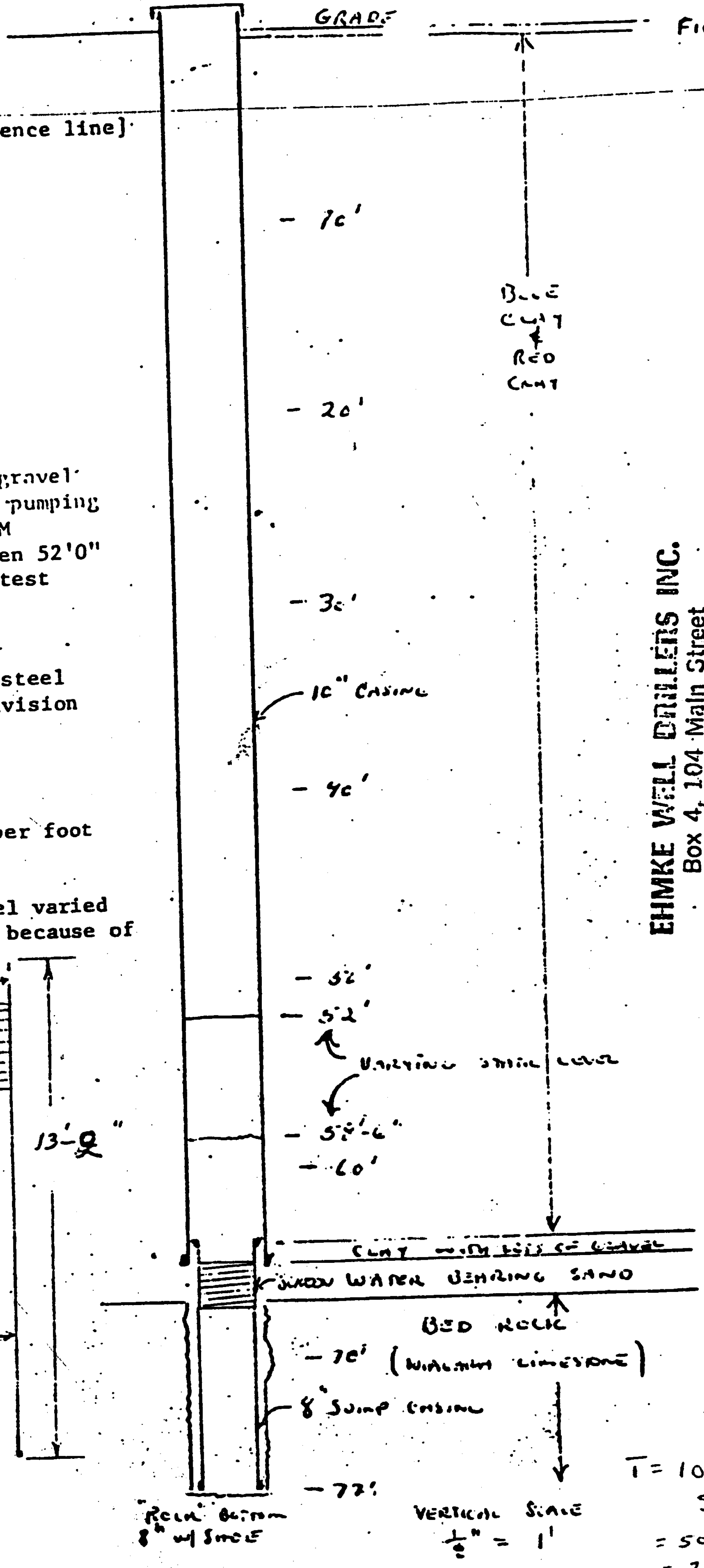
Depth: 77'0"
Bed Rock: 67'0"
Casing: 66'0" of new 10" ID
Vein: 65' to 67' in sand & gravel
Flow: 270 GPM after 24 hrs. pumping at average rate of 290 GPM
* Static Level: Varying between 52'0" and 58'6" on day of pump test
Pumping level: 64'3"

Well Screen: 8" pipe size -
304 stainless steel
UOP Johnson Division
24" long
Set 65' to 67'
[Detail below]

Specific capacity: 46 GPM per foot of drawdown

* Note: The static water level varied from day to day, probably because of Dunlop pumpage!





EHMKE WELL DRILLERS INC.
Box 4, 104 Main Street
Silver Creek, N.Y. 14136
934-2658

T = 100,000 gpd/ft
= 50,000 gpd/ft²
= 2.3 cm/sec

HYDROGEOLOGIC DATA

Water Level Information, Boring Logs, Well Construction Details, Permeability Test Results

DATE
STARTED 8-15-83
FINISHED 8-16-83
SHEET 1 OF 2

EMPIRE SOILS INVESTIGATIONS INC. **SUBSURFACE LOG**

HOLE NO. B-1
SURF. ELEV. 580.81
G. W. DEPTH 38.9'

PROJECT Monitoring Wells
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

DEPTH-FT.	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	13	50	30	70		Brown-Black firm fine-coarse SAND, Some fine-coarse Gravel, Some Clayey Silt (FILL) (Moist-Very Compact)	
5		2	4	1	2	3		Gray fine-coarse SAND & fine-coarse GRAVEL size SLAG (FILL) (Moist)	
								Black fine-coarse SAND-FLYASH FOUNDRY SAND (FILL) (Moist-Loose)	
10		3	3	3	5	8		Moist Gray-Brown soft silty CLAY (Possible FILL) (Moist-Soft)	
								Red Brown medium SILT w/occasional embedded fine-coarse GRAVEL, little clay, fine sand partings (TILL) (Moist-Medium)	
15		4	14	17	22	39		grades Hard	
20		5	7	8	9	17		grades Stiff	
25		6	6	6	6	12		Red-Brown CLAY, Some Silt (Lacustrine) (Wet-Medium)	
30		7	3	5	5	10			
		T-1	PUSHED TUBE						1) Pushed 3" ø Shelby tube, 31'-33' Recovered 2.0'
35		8	3	3	4	7			
40		9	2	2	3	5			

N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 "per blow.

CLASSIFICATION Visual by Geotechnical Engineer

C = No. blows to drive ____ " casing ____ " with ____ lb. weight falling ____ "per blow.

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Auger

R/T Form H

EMPIRE SOILS INVESTIGATIONS INC. SUBSURFACE LOG

DATE STARTED 8-15-83
FINISHED 8-16-83
SHEET 2 OF 2

HOLE NO. B-1
SURF. ELEV. 580.81
G. W. DEPTH 38.9

PROJECT Monitoring Wells
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

Depth	Samples	Sample No	Blows on Sampler 0-6	6-12	12-18	18-	Blow on Casing C	Soil or Rock Classification
40								
								Red-Brown CLAY & SILT, Some fine-coarse Sand, Some fine-coarse Gravel (TILL) (Wet-Medium)
45	/	10	3	3	3	6		
50	/	11	22	25	27	52		grades to Gray Brown fine-coarse SAND, Some fine-coarse Gravel, Some Clayey Silt (Moist-Very Compact)
55	/	12	42	47	100/.3'			grades to Gray Brown fine-coarse GRAVEL size ROCK FRAGMENTS & fine-coarse SAND, Some little Silt (Wet-Very Compact)
								Boring Complete @ 56.4' with Casing Refusal at 56.0'
60								

NOTES

2) Approximately 35' of running sand & gravel @ 56.0'

3) Water at 44.7' @ 5:00 P.M., 8-15-83 Casing @ 56.0'

4) Water at 43.7' @ 8:30 A.M., 8-16-83 Casing @ 56.0'

5) Driller washed hole w/roller bit, drilled approx. 0.4' into refusal material w/roller bit-fractured limestone fragments noted coming to surface in wash water.

6) Water at 44.5' @ 8:00 A.M., 8-17-83

7) 2" PVC well installed in boring, see diagram for well construction details

N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 " per blow.

C = No blows to drive ____ " casing ____ " with ____ lb. weight falling ____ " per blow.

CLASSIFICATION Visual by Geotechnical Engineer

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Auger

EMPIRE SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

DATE
STARTED 8-16-83
FINISHED 8-17-83
SHEET 1 OF 1

HOLE NO. B-2
SURF. ELEV. 581.80
G. W. DEPTH 5.3'

PROJECT Monitoring Well Installation
Town of Tonawanda

LOCATION River Road
Tonawanda, New York

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0								OVERBURDEN SOIL	1) Driller augered hole to 23.7' through overburden soil. No samples were taken. Surficial fill materials were brought up on auger flights initially then changing to red-brown silty clay natural soil.
5									
10									2) No water in hole at boring completion prior to well installation 4:00 P.M.,8-16-83
15									3) Well installation started 8-16-83
									4) Well installation continued with placement of pellet seal at 8:00 A.M. 8-17-83
20									5) See diagram for well installation details
23.7								Boring Complete @ 23.7'	
25									

N = No. blows to drive 2 " spoon 12 " with 140 lb. pin wt. falling 30 "per blow.

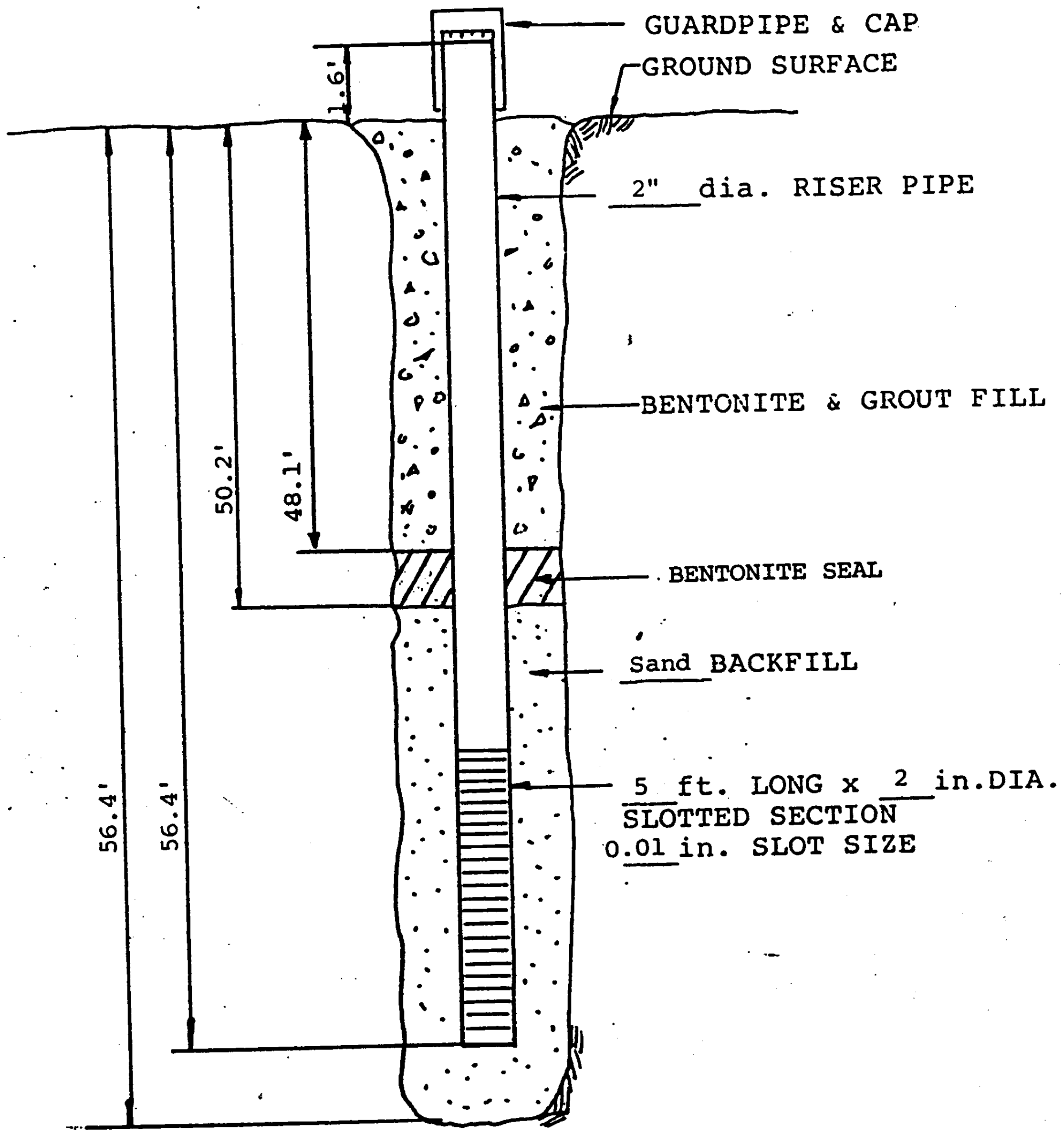
C = No. blows to drive ____ " casing ____ " with ____ lb. weight falling ____ "per blow.

CLASSIFICATION Visual by Geotechnical Engineer

METHOD OF INVESTIGATION: 3 3/4" I.D. Hollow Stem Auger

B/T Form H

PIEZOMETER NO. B-1

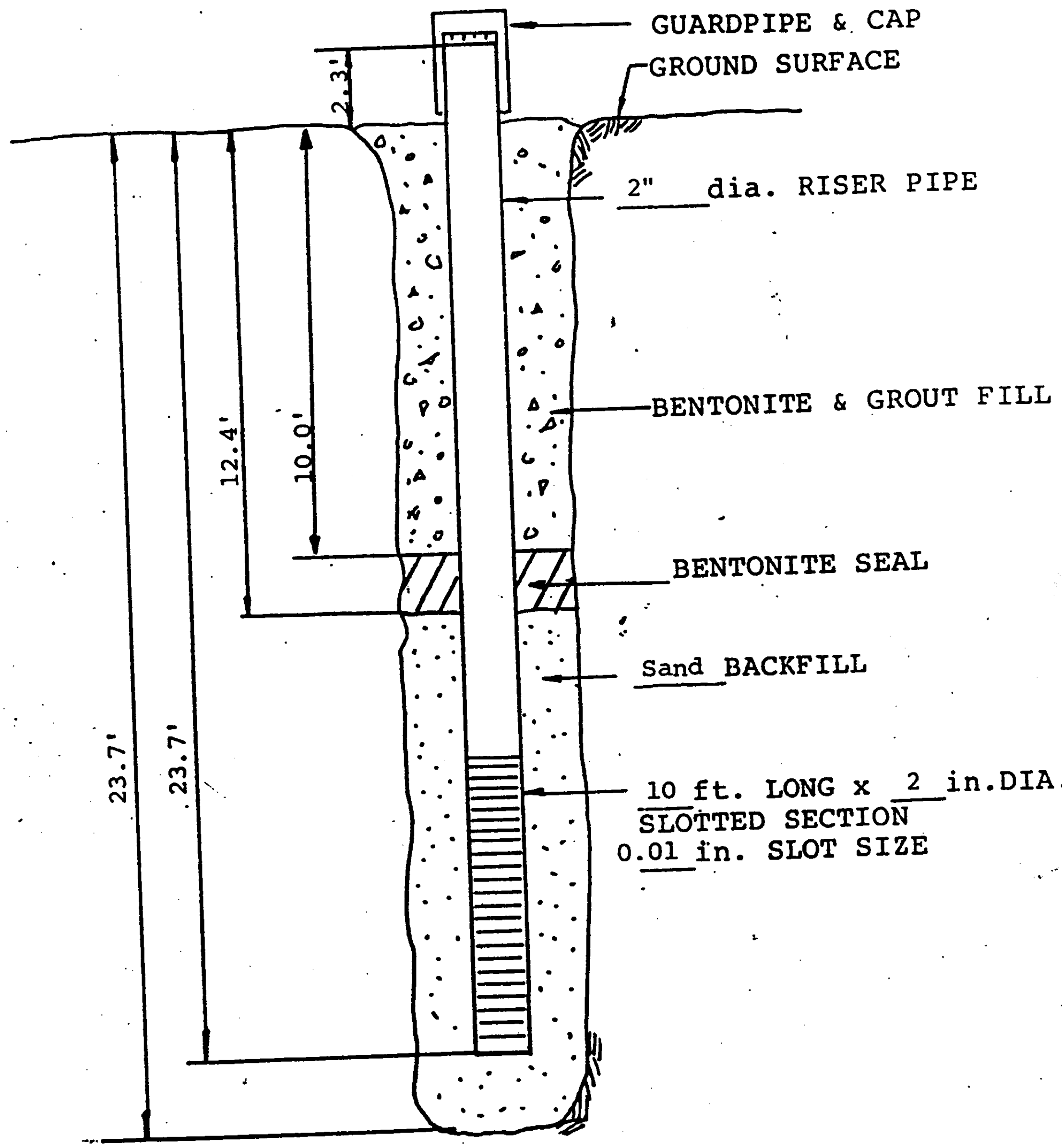


PROJECT Town of Tonawanda

LOCATION River Road

EMPIRE SOILS INVESTIGATIONS INC.

PIEZOMETER NO. B-2



PROJECT Town of Tonawanda

LOCATION River Road

EMPIRE SOILS INVESTIGATIONS INC.

APPENDIX B

WELL DATA

POLYMER APPLICATIONS, INC.

MONITORING WELL ELEVATIONS

WELL NO.	GROUND	TOP P.V.C. PIPE	TOP CASING PIPE
B-1	580.81	582.50	582.67
B-2	581.80	584.07	584.25
B-3	589.55	591.48	591.66
B-4S	592.29	594.58	594.91
B-4D	592.29	594.49	594.69
B-5S	589.48	591.71	591.91
B-5D	589.48	591.56	591.73
B-6S	580.04	582.33	582.69
B-6D	579.94	582.17	582.35
B-7S	578.53(valve Box)	578.39	-
B-7D	578.59(valve box)	578.32	-
Production	592.37 592.68(floor)	-	594.43

Bench Mark 579.70
Sanitary manhole rim (north edge) at southwest property corner

WATER LEVEL ELEVATIONS

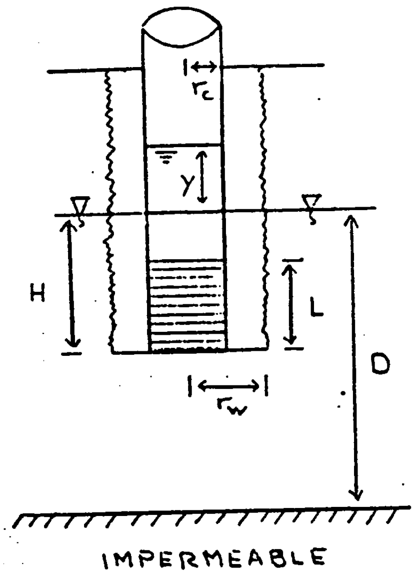
Observation Well	Reference Elevation*	DATES									
		8-30-83	9-15-83	9-17-83	9-21-83	9-29-83	10-4-83	10-6-83	10-12-83	10-21-83	10-26-83
B-1	582.50	542.50	542.23	542.57	542.60	534.05	540.2	534.63	533.62	530.86	532.07
B-2	584.07	576.47	572.55	572.67	573.31	573.85	569.57	569.77	571.99	569.79	571.86
B-3d	591.48			576.48	587.00	586.48	586.43	586.68	587.03	586.83	587.44
B-4s	594.58			589.68	590.83	590.41	590.31	590.88	590.73	590.29	590.73
B-4d	594.49			582.64	582.39	584.76	582.39	581.56	583.54	589.87	590.09
B-5s	591.71			587.91	588.21	587.93	587.86	588.16	588.03	587.88	587.86
B-5d	591.56			dry	dry	571.09	569.31	571.81	573.11	572.71	573.69
B-6s	582.33			-	dry	dry	dry	dry	dry	dry	dry
B-6d	582.17			-	dry	560.82	561.57	561.64	562.42	561.17	564.62
B-7s	578.39			-	573.09	573.49	573.46	573.59	574.44	573.49	573.51
B-7d	578.32			-	558.67	562.44	563.99	563.10	564.77	565.34	566.71
Production Well	594.43		541.60	544.93	-	-	-	-	-	-	-

*Top of PVC

THOMSEN ASSOCIATES CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

SUBJECT FIELD PERMEABILITY TESTS PROJECT NUMBER

BY DATE CHECKED BY DATE SHEET NUMBER OF



$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln\left(\frac{y_o}{y_t}\right)$$

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ln[(D-H)/r_w]}{L/r_w}\right]^{-1}$$

K = hydraulic conductivity

y_o = change in water level at time t = 0

y_t = change in water level at time t

t = time between water level measurements y_o and y_t

A = empirical coefficient

B = empirical coefficient

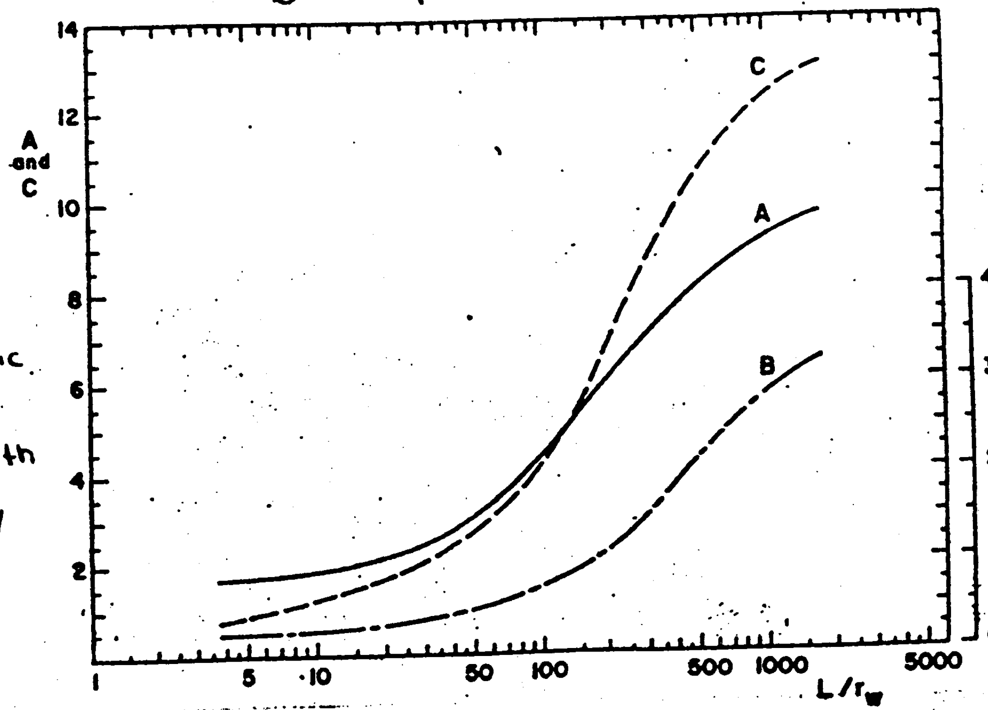


Fig. 3. Curves relating coefficients A, B, and C to L/r_w.

From: Bouwer & Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, Water Resources Research, V. 12 pp. 423-428

SLUG TESTS FOR
HYDRAULIC CONDUCTIVITY

Well	H (ft)	D (ft)	r_w (ft)	r_c (ft)	L (ft)	t (sec)	Y_o (ft)	Y_t (ft)	ln (Re/rw)	k (ft/sec)	k (cm/sec)	Comments
B-1	17.7	17.7	0.3125	0.0833	6.2	270	0.15	0.10	2.84	2.4×10^{-6}	7.2×10^{-5}	Sand & Gravel
B-2	15.8	48.1	0.3125	0.0833	11.3	720	6.3	6.1	2.44	3.4×10^{-8}	1.0×10^{-6}	Till
*B-4s	4.12	4.12	0.3125	0.0833	2.0	120	3.27	1.05	1.72	2.8×10^{-5}	8.6×10^{-4}	Fill
B-4d	12.47	57.5	0.3125	0.0833	11.0	240	5.70	5.57	2.35	7.1×10^{-8}	2.2×10^{-6}	Till
*B-7s	1.1	1.1	0.3125	0.0833	1.1	180	1.06	0.31	0.98	2.1×10^{-6}	6.4×10^{-4}	Fill

*Note: Some of the assumptions for the equation used to evaluate slug test results for the two shallow wells in the "perched" water are violated because the test is being run on "perched" water rather than an aquifer. However, results do provide an indication of the relative hydraulic conductivity of the fill.

WATER LEVEL AND WELL TEST INFORMATION

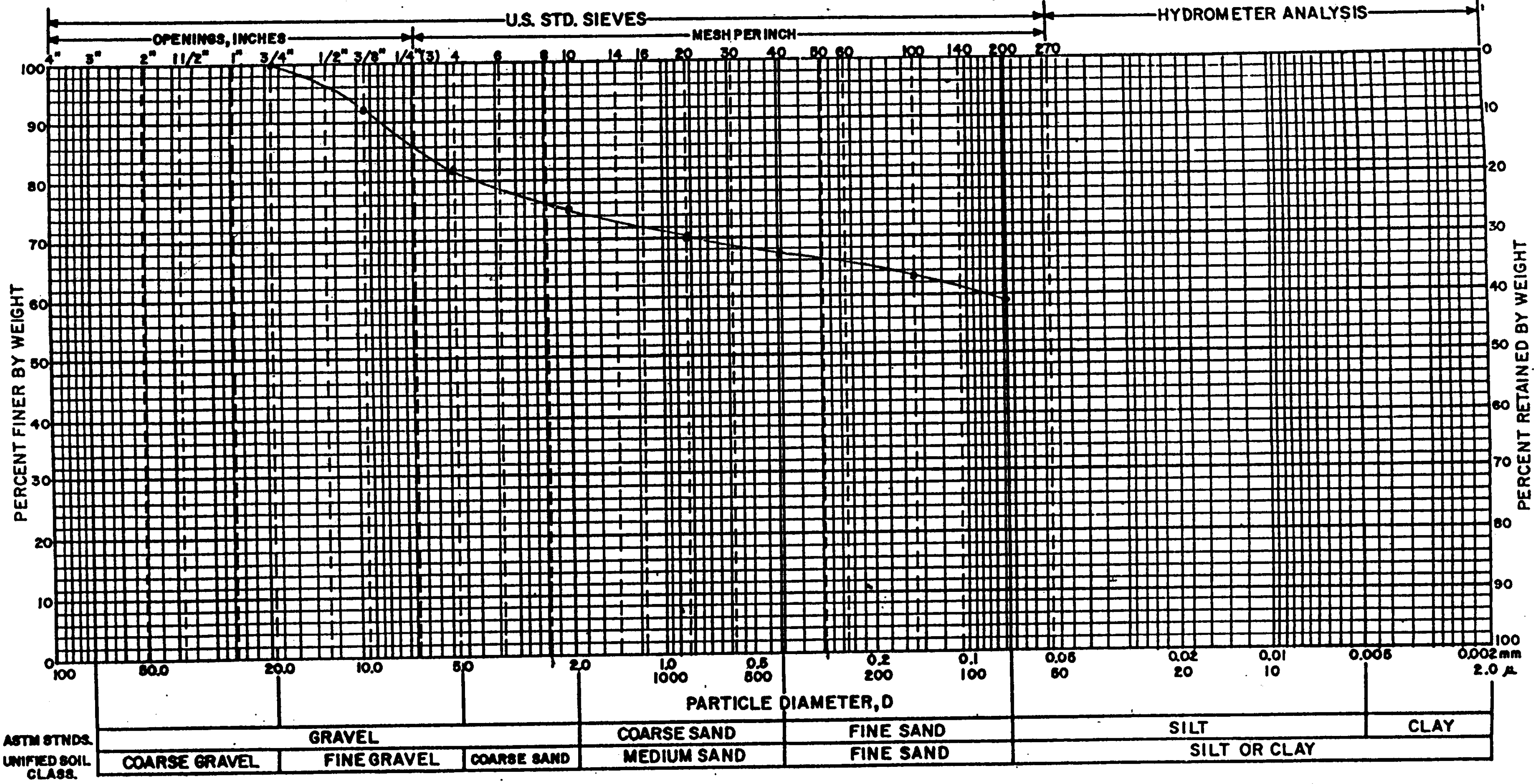
Well	*Reference Elevation	Water Level			Hydraulic Conductivity Test Result
		8-30-83	9-15-83	9-21-83	
B-1	582.50'	542.2'	542.4'	542.8'	$7.2x10^{-5}$cm/sec
B-2	584.07'	576.6'	572.7'	573.5'	$1.0x10^{-6}$cm/sec

*Top of PVC

APPENDIX C

SOIL TESTS

GRAIN SIZE DISTRIBUTION CURVE



SAMPLE INFORMATION:

B-7d
S-3
4'-6'
(Fill)

Gravel = 18%
Sand = 23%
Silt & Clay = 59%

EMPIRE SOILS INVESTIGATIONS, INC.

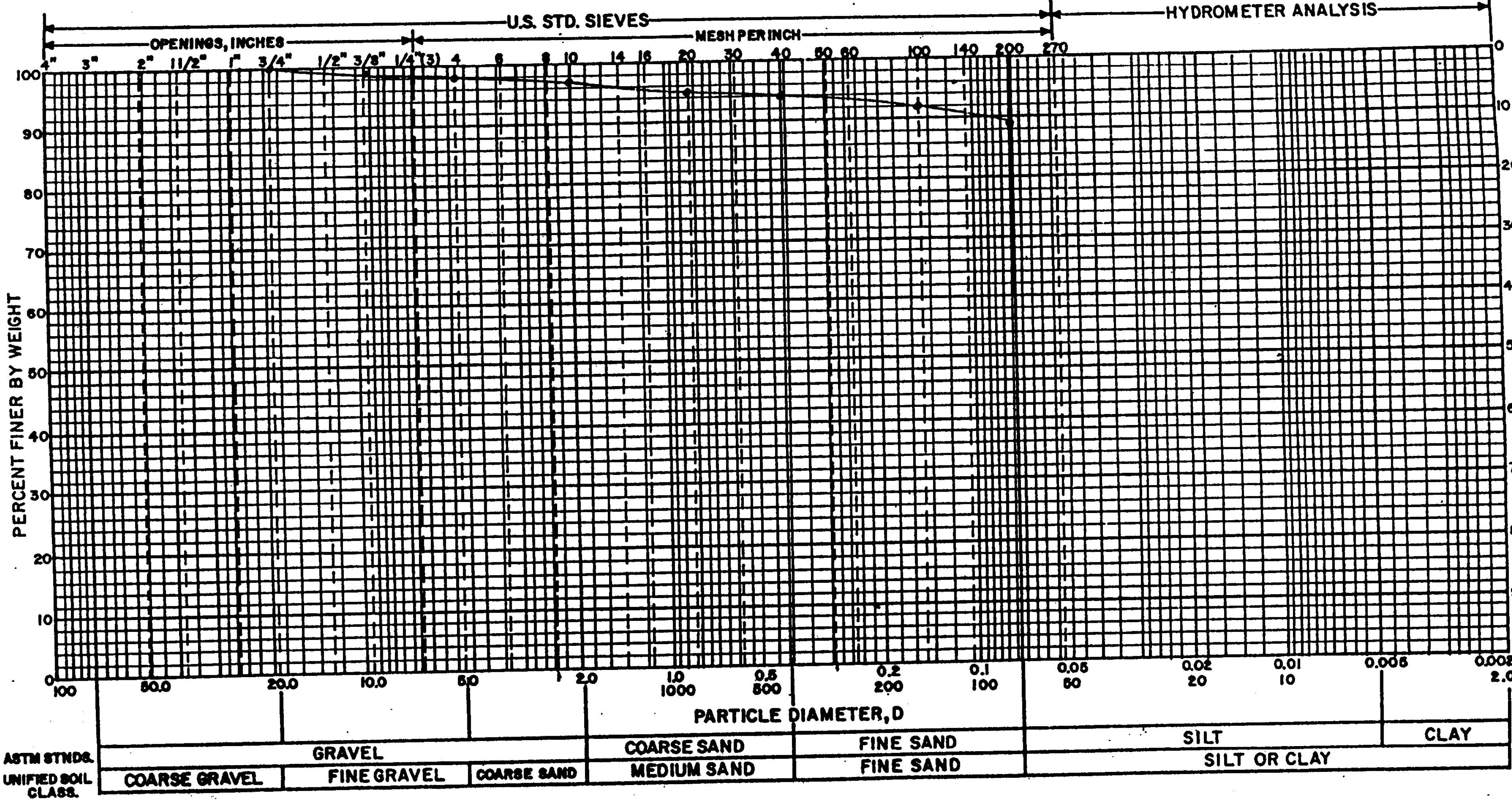
MECHANICAL ANALYSIS

POLYMER APPLICATIONS

DR. BY: AK	CK'D: MR-L	DATE: 10-20-83	PROJ. NO. GTA-83-76

NOTE: VISUAL SOIL CLASSIFICATIONS ON E.S.I. SUBSURFACE LOGS ARE BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.

GRAIN SIZE DISTRIBUTION CURVE



SAMPLE INFORMATION:

B-4d	Gravel	= 2%
S-8	Sand	= 9%
14'-16'	Silt & Clay	= 89%
(Till)		

EMPIRE SOILS INVESTIGATIONS, INC.

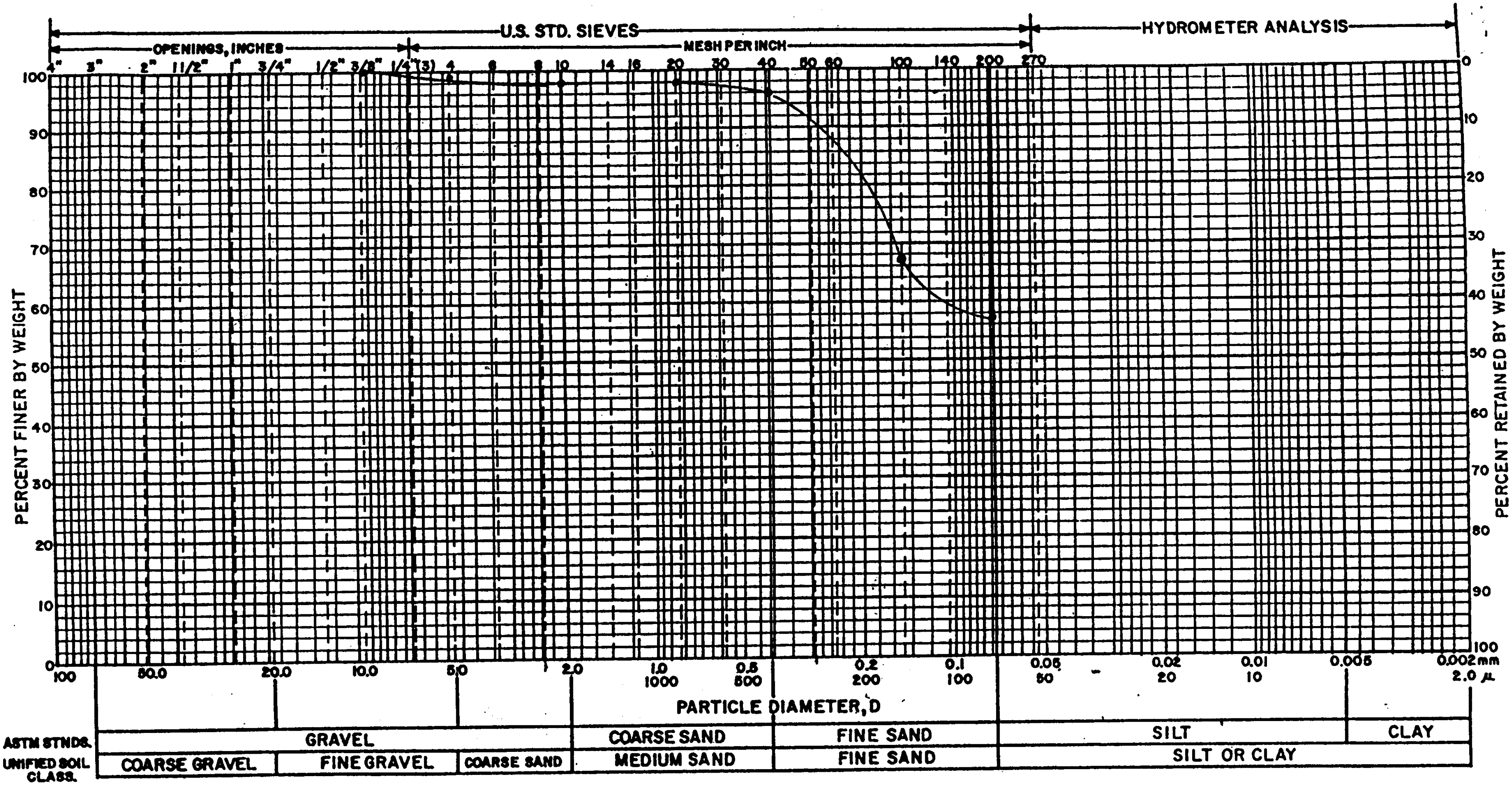
MECHANICAL ANALYSIS

POLYMER APPLICATIONS

DR. BY: AK	CK'D. MR-L	DATE: 10-20-83	PROJ. NO. GTA-83-76

NOTE: VISUAL SOIL CLASSIFICATIONS ON E.S.I. SUBSURFACE LOGS ARE BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.

GRAIN SIZE DISTRIBUTION CURVE



SAMPLE INFORMATION:

B-4d	Gravel = 1%
S-3	Sand = 42%
4'-6'	Silt & Clay = 57%
(Fill)	

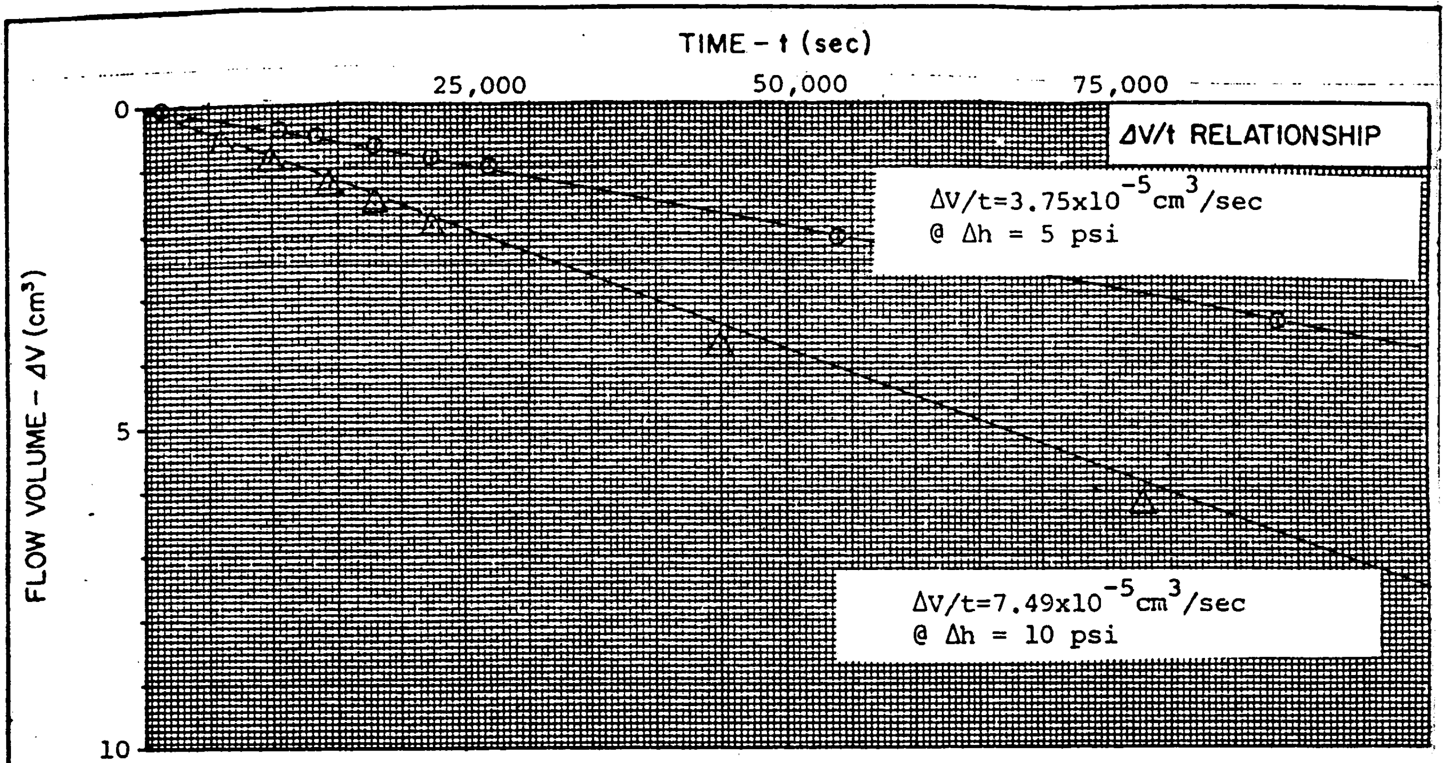
EMPIRE SOILS INVESTIGATIONS, INC.

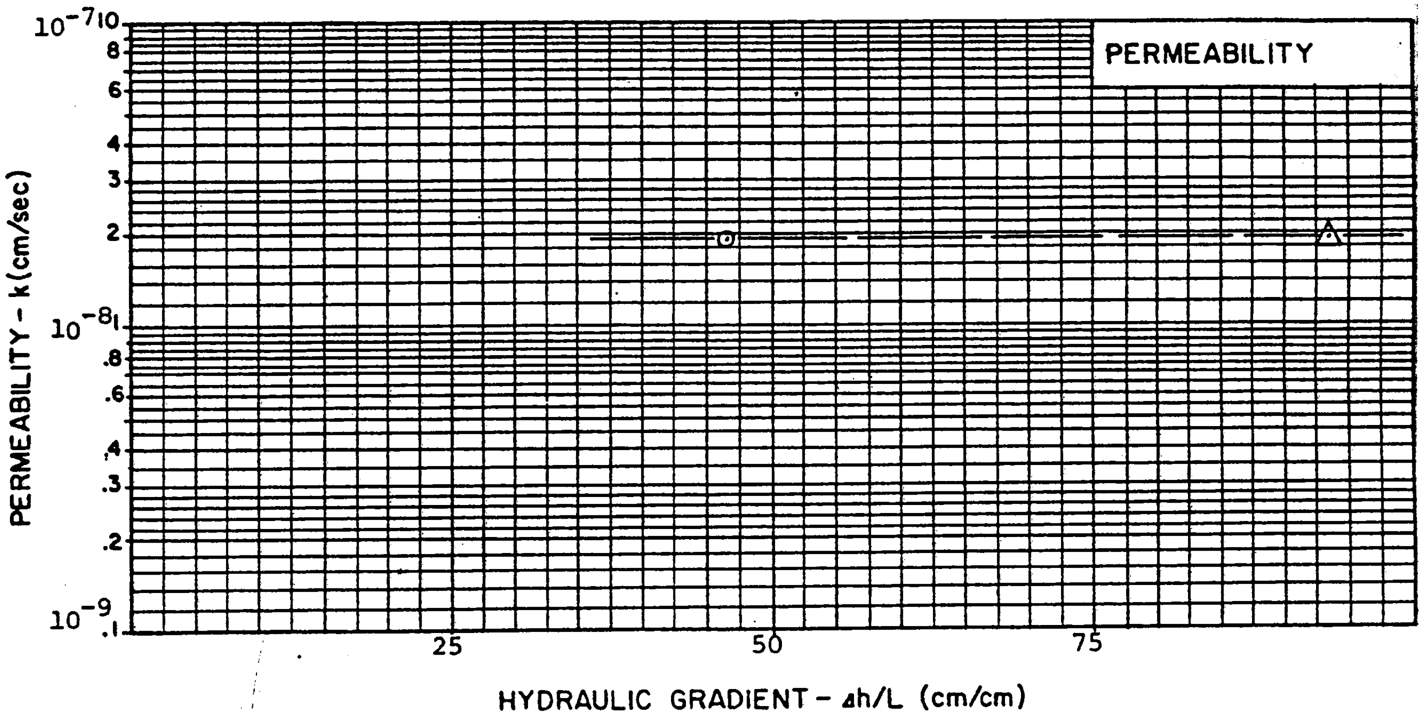
MECHANICAL ANALYSIS

POLYMER APPLICATIONS

DR. BY: AK	CK'D. MR-L	DATE: 10-20-83	PROJ. NO. GTA-83-76

NOTE: VISUAL SOIL CLASSIFICATIONS ON E.S.I. SUBSURFACE LOGS ARE BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.





TEST DATA:

TYPE OF PERMEAMETER: Constant Head Triaxial

SPECIMEN HEIGHT (cm): 7.528

SPECIMEN DIAMETER (cm): 7.264

DRY UNIT WEIGHT (pcf): 89.7

MOISTURE CONTENT BEFORE TEST (%): 33.8

MOISTURE CONTENT AFTER TEST (%): 33.5

MAXIMUM DRY DENSITY (ASTM D ______) (pcf): ______

OPTIMUM MOISTURE CONTENT (%): ______

CELL CONFINING PRESSURE (psi)	95.0	95.0
TEST PRESSURE (psi)	85.0	90.0
BACK PRESSURE (psi)	80.0	80.0
DIFFERENTIAL HEAD (psi)	5.0	10.0
PERMEABILITY (cm/sec)	1.94×10^{-8}	1.94×10^{-8}

SAMPLE IDENTIFICATION: B-1, 31.0'-33.0'

VISUAL DESCRIPTION: Red-Brown CLAY

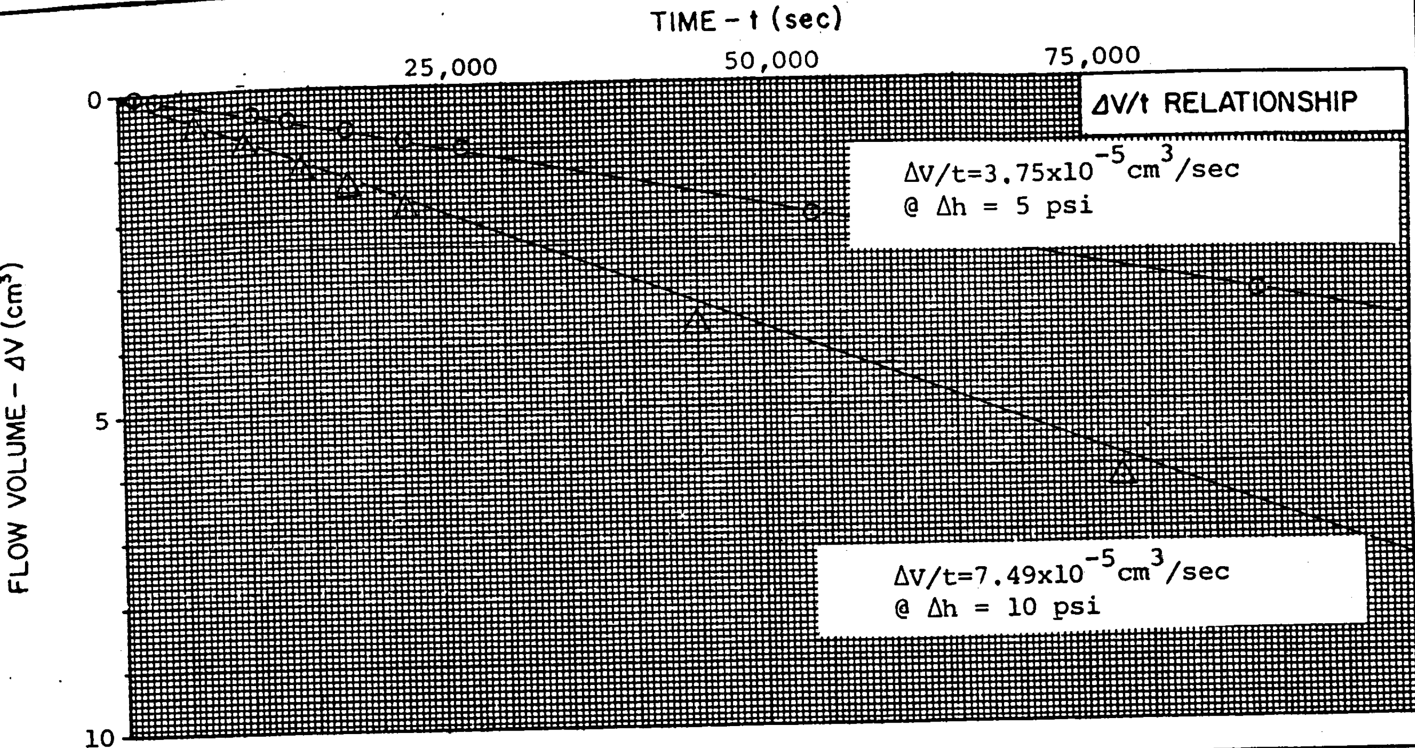
EMPIRE SOILS INVESTIGATIONS, INC.

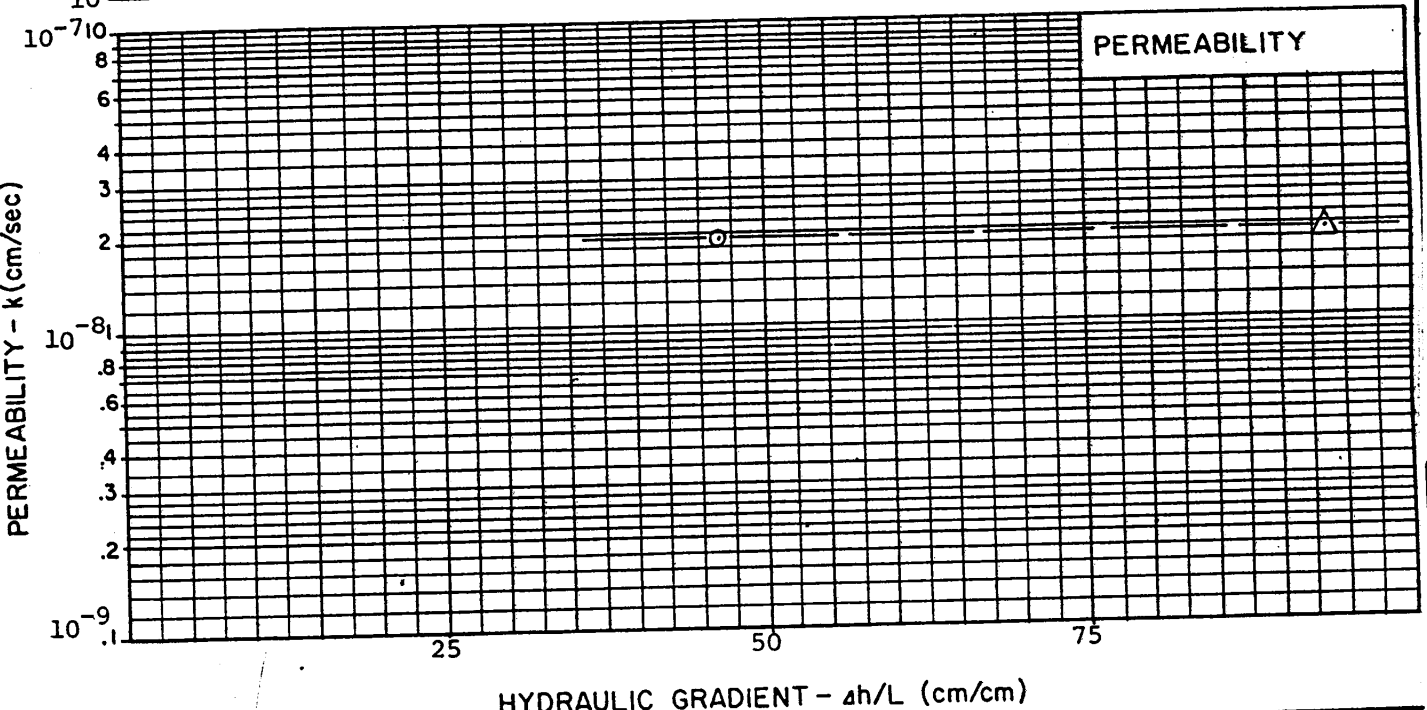
PERMEABILITY TEST REPORT

Town of Tonawanda-Polymer Wells

DATE: August 1983

PROJ. NO.: GTA-83-18





TEST DATA:

TYPE OF PERMEAMETER	Constant Head Triaxial	
SPECIMEN HEIGHT (cm)	7.528	
SPECIMEN DIAMETER (cm)	7.264	
DRY UNIT WEIGHT (pcf)	89.7	
MOISTURE CONTENT BEFORE TEST (%)	33.8	
MOISTURE CONTENT AFTER TEST (%)	33.5	
MAXIMUM DRY DENSITY (ASTM D_____) (pcf)		
OPTIMUM MOISTURE CONTENT (%)		
CELL CONFINING PRESSURE (psi)	95.0	95.0
TEST PRESSURE (psi)	85.0	90.0
BACK PRESSURE (psi)	80.0	80.0
DIFFERENTIAL HEAD (psi)	5.0	10.0
PERMEABILITY (cm/sec)	1.94×10^{-8}	1.94×10^{-8}

SAMPLE IDENTIFICATION:
B-1, 31.0'-33.0'

VISUAL DESCRIPTION: Red-Brown CLAY

EMPIRE SOILS INVESTIGATIONS, INC.

PERMEABILITY TEST REPORT

Town of Tonawanda-Polymer Wells

DATE: August 1983 | PROJ. NO.: GTA-83-18

APPENDIX D

CHEMICAL ANALYSES

Job Site: [illegible]

Grab

Sampled By: [illegible]

[illegible] Number 83-	3651	3652	3653	3654	3655	3656	3657	3658	3659	3660	3661
Well Number	--	D3	B1	B2	B4	B4	D5	B5	B6	B7	B7
Sample Identity	Out Fall 112	[illegible]	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Deep	Shallow
Phenol, mg/L	2.65	0.062	[illegible]	[illegible]	[illegible]	20.0	2.10	4250	1.70	<0.004	0.440
Depth from top of casing to water	NA		42'8"	14'	13'1"	4'3"	20'	4'2"	20'7"	15'2"	5'2"

Quality Control [illegible]

Spike Recovery, Sample 3659 - 96.6%

Duplicate Analysis, Sample 3659 - 4.0% Difference [illegible]

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst [signature]

Date: 10-10-83

ecology and environment, inc.
International Specialists in the Environmental Sciences

LABORATORY REPORT

FOR

KREHBIEL ASSOCIATES

Job No.: KA-196

Sample Date: 10/3/83 Job Site: Polymer Applications, Inc.

Sample Type: Grab Sampled By: G. Jones, N. Augnst (E & E)

E & E Lab Number 83-	3651	3652	3653	3654	3655	3656	3657	3658	3659	3660	3661
Well Number	--	D3	B1	B2	B4	B4	D5	B5	B6	B7	B7
Sample Identity	Out Fall 1&2	--	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Deep	Shal
Phenol, mg/L	2.65	0.062	0.271	0.044	17.1	30.0	2.10	4250	1.70	<0.004	0.44
Depth from top of casing to water	NA		42'8"	14'	13'1"	4'3"	20'	4'2"	20'7"	16'2"	5'2"

Quality Control

Spike Recovery, Sample 3659 - 98.6%

Replicate Analysis, Sample 3659 - 9.0% Difference

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst [signature]

Date: 10-10-83

recycled paper

ecology and environment, inc.

International Specialists in the Environmental Sciences

LABORATORY REPORT

FOR

KREHBIEL ASSOCIATES

Job No.: KA-196

Sample Date: 10/17/83 — Job Site: Polymer Applications, Inc.

Sample Type: Grab — Sampled By: G. Jones (E & E)

E & E Lab Number 83-	3836	3837	3838	3839	3840	3841	3842	3843	3844	3845	38
Well Number	B1	B2	B3	B4	B4	B5	B5	#3	B6	B7	E
Sample Identity	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Out Fall	Deep	Shallow	De
Phenol, mg/L	0.066	0.023	0.028	1.04	5.30	2400	0.12	0.69	2.47	10.5	0
Depth from top of casing to water	45'11"	14'3"	4'7"	4'1"	5'8"	3'10"	19'	NA	19'7"	5'2"	1

Quality Control

Spike Recovery, Sample 3846 - 117%

Replicate Analysis - 6.6% difference

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst [signature]

Date: 10-25-83

recycled paper

ACTS TESTING LABS, INC.

3900 Broadway • Buffalo, N.Y. 14227-1192 • (716) 684-3300

TECHNICAL REPORT 3-4353

October 11, 1983

Mr. Harold Marshall
POLYMER APPLICATIONS

OBJECT:

Analysis of one water sample for various parameters. The sample was received on September 22, 1983.

RESULTS:

	Prod Well 9/22/83-7:30AM
pH Units	6.70
Total Suspended Solids	124
Nitrite Nitrogen	0.021
Nitrate Nitrogen	1.2
Chloride	458
Sulfide	1.8
Sulfate	972
Phosphate	LT 0.6

ecology and environment, inc.
International Specialists in the Environmental Sciences

LABORATORY REPORT

FOR

KREHBIEL ASSOCIATES, INC.

Job No.: KA-196

Sample Date: 10/27/83 Sampled By: G. Jones (E & E)

Date Received: 10/27/83 Picked Up By: Ecology and Environment, Inc.

Sample Type: Grab

E & E Lab Number	83-	4000	4001	4002	4003	4004	4005	4006
Well Number			B-1	B-4	B-4	B-5	B-6	B-7
Sample Identity		Prod. Well	Deep	Shallow	Deep	Deep	Deep	Deep
Phenols, mg/L		0.014	0.056	10.0	3.20	0.012	<.004	0.066
Depth from top of casing to water		--	51'11"	4'1½"	17'4½"	20'1"	20'10¼"	17'2½"

Quality Control

Spike Recovery, Sample 4003 - 96.0% Recovery

Replicate Analysis, Sample 4003 - 0.0% Difference

Analytical References: "Standard Methods for the Examination of Water and Wastewater", 15th edition, 1980.

Supervising Analyst [signature]

Date: 11-4-83

recycled paper

026129

ACTS TESTING LABS, INC.

Mr. Harold Marshall
POLYMER APPLICATIONS

October 11, 1983
Page Two

RESULTS: (continued)

	Prod Well 9/22/83 - 7:30AM
Carbonate	None present at a pH of 6.70
Phenols	0.03
Iron	53.0
Manganese	0.53
Hardness *	1,300

LT = Less Than

The above results are reported as milligrams per liter, except where otherwise noted.

* Hardness is reported as milligrams per liter of calcium carbonate via calculations.

EXPERIMENTAL:

All analyses were conducted according to procedures listed in "Standard Methods for the Examination of Water and Wastewater", 15th Edition, 1980.

ACTS TESTING LABS, ICN.

Thomas Knickerbocker
Thomas Knickerbocker
Environmental Laboratory
Coordinator

ACTS TESTING LABS, INC.

Daniel P. Murtha
Daniel P. Murtha, Ph.D.
Laboratory Director

kb

APPENDIX E

REPORT PREPARED FOR TOWN OF TONAWANDA

TOWN OF TONAWANDA - POLYMER WELLS

FOR

Town of Tonawanda
Tonawanda, New York

Job No. GTA-83-18
September 1983

September 30, 1983

Mr. Theodore Krehbiel
Krehbiel Associates
1868 Niagara Falls Boulevard
Tonawanda, New York 14150

Dear Mr. Krehbiel:

The purpose of this letter is to summarize our findings from the two monitoring wells installed on the Polymer Applications property (Drawings 1 & 2). Hydrogeologic conditions encountered in the two borings were very similar to those found at the Town of Tonawanda landfill. Fifty-nine feet of unconsolidated deposits were found above bedrock. These deposits included 7½ feet of fill on top of about 40 feet of silty clay, of glacial origin, overlying about 8 feet of silty sand and gravel and 3½ feet of gravelly sand. The piezometric surface of the deep silty sand and gravel and gravelly sand units is not hydraulically connected to the water table in the overlying silt and clay deposits. The water table in the silt and clay deposits is within ten feet of the ground surface, while the piezometric surface of the lower sands and gravels is 39 feet below the ground surface. The silt and clay acts as a confining layer over the sands and gravels and bedrock.

The data collected during our investigation are attached to the end of this letter. These data include boring logs, well construction details, field hydraulic conductivity test results, laboratory permeability test results and water level measurements. A more detailed explanation of our findings and conclusions follows.

INTRODUCTION

The purpose of our investigation was to compare hydrogeologic conditions at the Polymer Applications property with the hydrogeology of the Town of Tonawanda Landfill based on two wells installed on the Polymer Applications property and our hydrogeologic study at the Town of Tonawanda Landfill. A more complete discussion of regional geology and hydrogeology at the Town of Tonawanda Landfill is found in our report of September, 1983 "Hydrogeologic Investigation, 50 Acre Solid Waste Landfill and Potential Expansion Area, Town of Tonawanda, N. Y.". This document with the boring logs from the Town of Tonawanda landfill should be referred to when reading this report.

The location of Polymer Applications in relation to the Town of Tonawanda landfill is shown on Drawing 1. The Polymer Applications property is within the same physiographic province as the Town of Tonawanda landfill, the Erie-Ontario Lowlands (University of New York, 1966). Glacial Lake Tonawanda covered the area at the close of the last glaciation (Muller, 1977). Both DW-1 at the Town of Tonawanda landfill and B-1 on the Polymer Applications property are within the area covered by the glacial lake, so unconsolidated deposits encountered at these borings should be similar.

Results from the hydrogeologic study at the Town of Tonawanda landfill were used in interpreting groundwater conditions at the Polymer Applications property. Conclusions on groundwater flow at the Town of Tonawanda landfill should be referred to when reading the secton on groundwater.

FINDINGS

The borings on the Polymer property encountered 7½ feet of fill on top of 52½ feet of natural unconsolidated deposits. The natural soils consisted of approximately 15 feet of a silty clay glacial till overlying 20 feet of clayey lacustrine deposits.

Approximately 14 feet of glacial till was found below the lacustrine deposits. The deeper glacial till becomes more coarse with depth and very compact. The bottom 8 feet of the till consisted of silty sand and gravel. A thin layer of gravelly sand (3½ feet thick) was found between the bottom of the glacial till and bedrock. These deposits are similar to those encountered at the Town of Tonawanda landfill. The silty clay glacial till overlying lacustrine deposits was found at boring DW-1 at the Town of Tonawanda landfill. The deeper glacial till deposit beneath the lacustrine silt and clay was not found at DW-1. However, silty sand and gravel was found between the bottom of the till and bedrock at two of the borings around the Town of Tonawanda landfill.

Both field and laboratory tests were performed to evaluate the horizontal and vertical hydraulic conductivity of the unconsolidated deposits. A laboratory permeability test was performed on a thin wall shelby tube sample from the lacustrine clay and silt deposit. The permeability test was run using a triaxial cell with confining pressure and backpressure saturation according to the method described in Appendix VII of the United States Army Corps of Engineers publication on Laboratory Soils Testing (1970). Field tests were performed on both monitoring wells to evaluate the horizontal hydraulic conductivity of the unconsolidated deposits. Field hydraulic conductivity tests were run according to the method of Bouwer and Rice (1976).

The results from the permeability tests were similar to results from tests performed at the Town of Tonawanda landfill.

The result of the laboratory permeability test on the lacustrine sample indicates a hydraulic conductivity of $2x10^{-8}$cm/sec, which is the same result obtained for a similar sample from the lacustrine deposits at the Town of Tonawanda landfill site. According to results of additional laboratory tests on the sample, the soil is classified as a CL under the Unified Soil Classification System. The grain size distribution test showed that 98.7% of the sample was silt and clay size material. The liquid limit of the sample was 39.8% and the plasticity index was 18.0%.

The field test results indicate the upper silty clay glacial till has a horizontal hydraulic conductivity of $1x10^{-6}$cm/sec. This result is slightly lower than results from the silty clay glacial till found at the Town of Tonawanda landfill which ranged from $2x10^{-6}$cm/sec to $1x10^{-5}$cm/sec. The field test results from the deep well indicate a horizontal hydraulic conductivity of $7x10^{-5}$cm/sec for the sandy glacial till, which is similar to results from DW-1 at the Town of Tonawanda landfill site where the field test showed a hydraulic conductivity of $3x10^{-5}$cm/sec.

Well B-1 was installed to measure the piezometric surface in the deep sandy glacial till and sand and gravel deposits, while B-2 was installed as a water table well in the silt and clay unit. Water level measurements at B-2 show that the water table is within 10 feet of the ground surface. The water level in the shallow well was 9.2 feet below the ground surface on September 15, 1983. The piezometric surface of the deep silty sand and gravel deposit was 38.7 feet below the ground surface on September 15, 1983.

Groundwater conditions at the Polymer Applications property are similar to those at the Town of Tonawanda landfill. The silt and clay deposits act as an aquitard over the underlying more permeable silty sand and gravel deposits; resulting in large downward vertical gradients. The vertical gradient between B-1 and B-2 was 0.84 ft/ft on September 15, 1983. The rate of groundwater flow moving vertically downward through the silt and clay deposits underlying the area can be estimated using Darcy's law $\overline{v} = KI/n$ where $\overline{v}$ = average linear velocity of flow, k = vertical hydraulic conductivity, i = vertical hydraulic gradient, and n = effective porosity. Using results from field and laboratory tests ($K = 2x10^{-8}$ cm/sec, i = 0.84 ft/ft) and assuming an effective porosity of 0.06 (Todd, 1980), the average linear velocity of groundwater flow downward through the silt and clay unit is only 0.3 ft/year.

CONCLUSIONS

The boring installed on the Polymer Applications property encountered 7½ feet of fill overlying 51½ feet of unconsolidated deposits. The top 40 feet of unconsolidated deposits were primarily silt and clay, beneath which was 8 feet of sandy glacial till overlying 3½ feet of sand. The upper 40 feet of unconsolidated deposits beneath the fill have a low vertical and horizontal hydraulic conductivity and act as a aquitard over the underlying sand and gravel. Vertical groundwater movement through these deposits toward the underlying bedrock is only 0.3 ft/year. Due to the low vertical hydraulic conductivity of the silt and clay deposits, these deposits will restrict downward movement of groundwater.

Respectfully submitted,

THOMSEN ASSOCIATES

Marjory B. Rinaldo-Lee

Marjory Rinaldo-Lee, C. P. G. S.

References

1. Bouwer, H. C. and Rice, R. D., 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, v. 12, No. 3, pp 423-427.

2. Muller, Ernest H., 1977, Quaternary Geology of New York, Niagara Sheet, New York State Museum and Science Service Map and Chart Series No. 28.

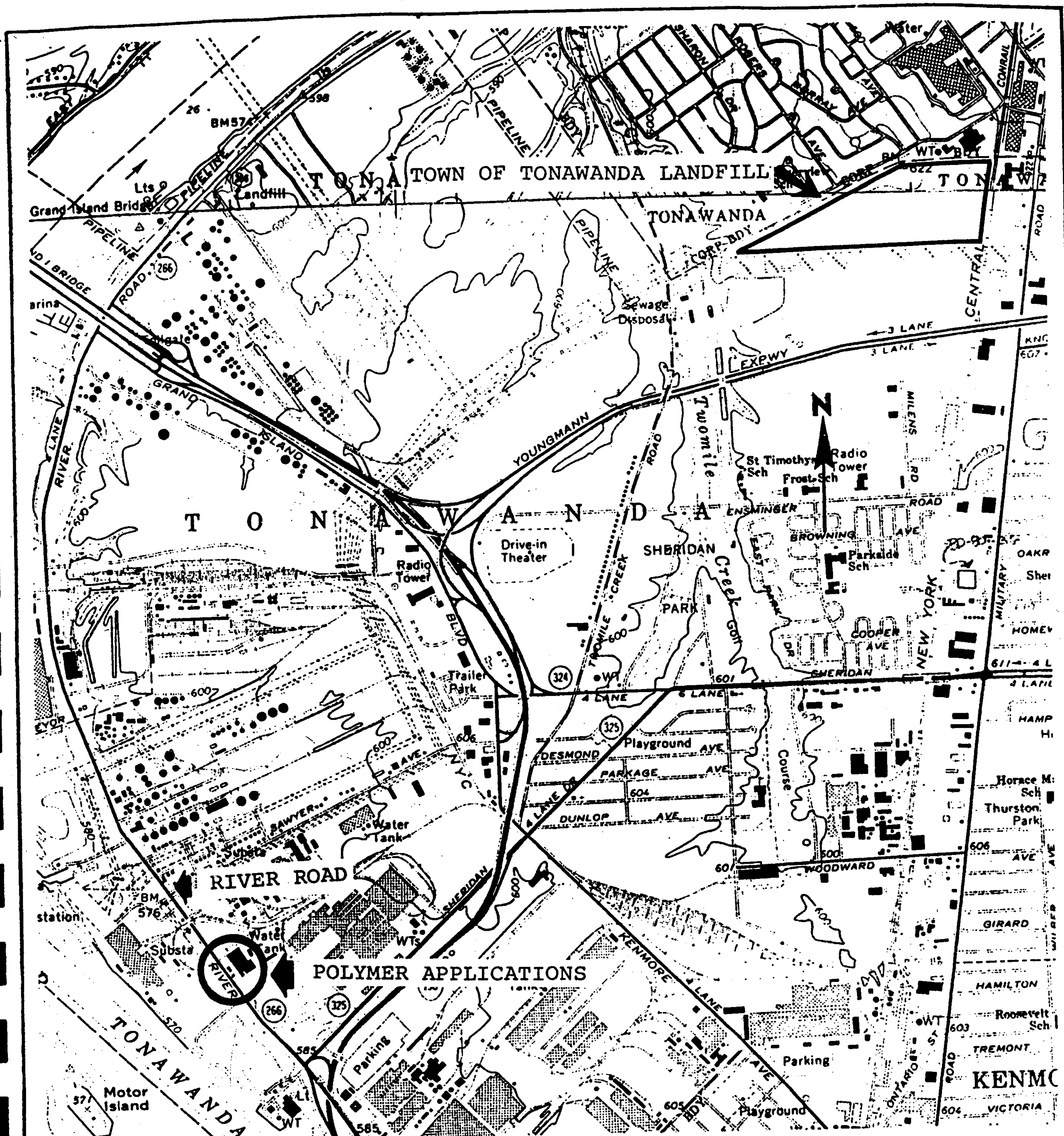
3. Thomsen Associates, 1983, Hydrogeologic Investigation, 50 Acre Solid Waste Landfill and Potential Expansion Area, Town of Tonawanda, N. Y.

4. Todd, David Keith, 1980, Groundwater Hydrology, John Wiley and Sons, New York, New York.

5. United States Army Corps, 1970, Laboratory Soils Testing, EM-1110-2-1906, Appendix VII, No. 7.

6. University of the State of New York, 1966, Geology of New York: A Short Account, Educational Leaflet No. 20, New York State Museum and Science Service.

DRAWINGS



Map Compiled From:
USGS Tonawanda West Quadrangle, 1976
USGS Buffalo NW Quadrangle, 1965

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

Groton • Buffalo • Rochester • Syracuse • Albany New York • Woodbridge • Harrisburg • Washington

SITE LOCATION

Town of Tonawanda - Polymer Wells

DR.BY: MR-L	SCALE: 1" = 2000'	PROJ. NO. GTA-83-18
CK'D.BY: MR-L	DATE: 9-29-83	DRWG.NO. 1

APPENDIX F

REFERENCES

REFERENCES

1. Bouwer, H. and R. C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, Water Resources Research, V. 12, No. 3, pp. 423-427.

2. Goldberg-Zoino Associates, 1978, Buffalo Light Rail Rapid Transit Project, Buffalo, New York, Geotechnical Interpretive Report Tunnel Section Sta 1190+00 to Sta 2375+00, for Niagara Frontier Transportation Authority, Metro Construction Division, Buffalo, New York.

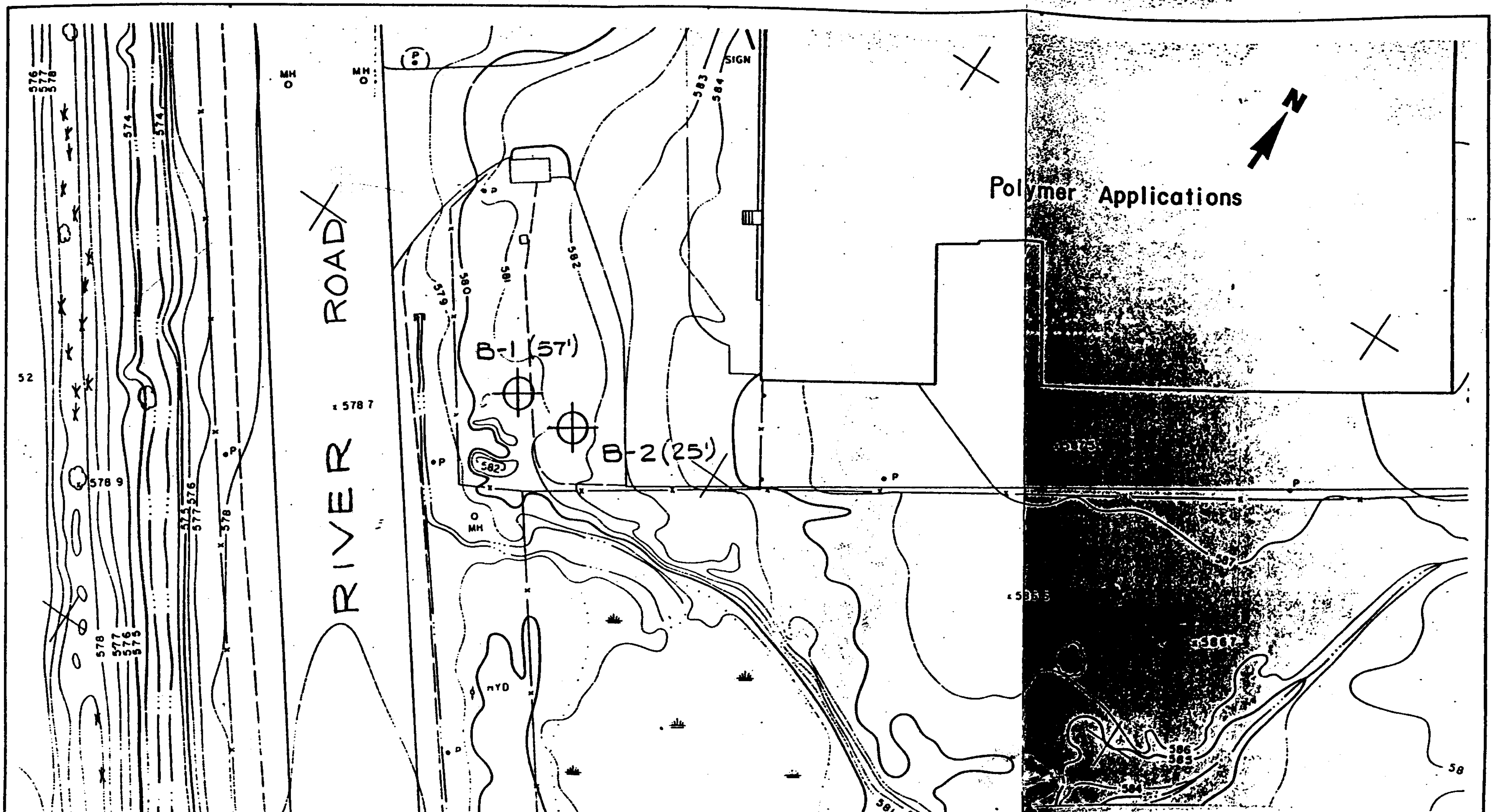
3. Muller, Ernest H., 1977, Quatenary Geology of New York, Niagara Sheet, New York State Museum and Science Service Map and Chart Series No. 28.

4. Richard, Lawrence V. and Donald Fisher, 1970, Geologic Map of New York, 1970, Niagara Sheet, New York State Museum and Science Service Map and Chart Series No. 15.

5. Thomsen Associates, 1983, Hydrogeologic Investigation, 50 Acre Solid Waste Landfill and Potential Expansion Area, Town of Tonawanda, N. Y.

6. Todd, David Keith, 1980, Groundwater Hydrology, John Wiley and Sons, New York, New York.

7. University of the State of New York, 1966, Geology of New York: A Short Account, Education Leaflet No. 20, New York State Museum and Science Service.



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WELL LOCATIONS
TOWN OF TONAWANDA - POLYMER WELLS

DR.BY: SC	SCALE: 1" = 30'	PROJ. NO. GTA-83-18
CK'D.BY: MR-L	DATE: 9-29	DRWG.NO. 2