

**South Cass Lake
Pumping Station
Remedial Investigation Report
(MPCA Spill # 54827)**

CASS LAKE, MINNESOTA

Prepared by:

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***ENBRIDGE™*
Enbridge Energy
Company**

October 2003

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I. INTRODUCTION

On behalf of Enbridge Energy, Limited Partnership (Enbridge), Natural Resources Engineering Company performed an investigation of shallow groundwater quality at Enbridge's South Cass Lake, Minnesota pumping station (from hereon referred to as the "Site"). Initial work was performed as part of Enbridge's voluntary Detection Monitoring Program. The location of the Site is shown on Figure 1. The objectives of the Detection Monitoring Program were as follows:

- Characterize the near surface geology and aquifer properties of the Site;
- Determine whether soil or groundwater contamination was present on the Site;
- Establish sampling frequency protocol based upon site specific fate and transport characteristics; and
- Provide an early warning system for a possible release.

The following is a chronology of events relative to this project:

- Shallow groundwater quality was first assessed via four monitoring wells (MW-1, -2, -3 and -4) which were installed in May 2001 and subsequently sampled in June 2001. Well locations are shown on Figure 2;
- Impacted soil and groundwater were discovered during the installation of MW-3 on May 23, 2001, and the Minnesota State Duty Officer was notified. The MPCA assigned Spill Number 54827 to the incident;
- Based upon the data gathered from monitoring wells MW-1 through MW-4, a network of push-probe borings (GP-1 to -16) were advanced across the Site in September 2001. The objectives of the push-probes were to define the magnitude and extent of impacted soil and groundwater. Findings from this phase of the investigation indicated that off-site monitoring wells would be required;
- In February 2002, a leaking flange was discovered approximately 75-feet upgradient of MW-3 (refer to Figure 2). The MPCA assigned Spill Number 56253 to this incident. This Spill Number was later (August 2003) retracted

because the weeping flange was found to be the source of oil for the initial incident (Spill Number 54827). Approximately 304 cubic yards of crude oil impacted soil were removed from the Site in association with the repair of the weeping flange. The excavation progressed laterally to clean soil on the sidewalls but due to concerns regarding pipeline integrity, impacted soil was still present in the base of the excavation at approximately 12 feet below ground surface. For details on the excavation and cleanup of Spill 56253, refer to the report titled "Remedial Action Report: February 13, 2002 Release South Cass Lake Station" submitted to the MPCA in June 2002.

- Upon gaining landowner permission to set permanent wells, four push-probe borings (GP-17, -18, -19 and -20) were advanced on August 13 and 14, 2002 to define off-site groundwater impacts, and as a pre-cursor for monitoring well installation. Four permanent monitoring wells (MW-6, -7, -8 and -9) were subsequently installed on November 19 and 20, 2002.

Monitoring well and push-probe boring locations associated with the Site are illustrated on Figure 2.

A. Purpose/Content

This report serves to detail investigation and monitoring activities conducted at the Site, document existing conditions, and set forth recommendations for future activities.

Including this section, this report is divided into seven parts: Section II summarizes the local topography, near surface geology, and hydraulic setting; Section III details the subsurface investigation; Section IV details the aquifer characterization results; Section V gives conclusions and recommendations for future activities at the Site; and references are given in Section VI.

II. PHYSICAL SETTING

A. Hydrology

The area surrounding the Site is characterized by rolling hills and heavy forestation. The topography is also pilled with many small, closed basins containing lakes or wetlands. Average annual precipitation is on the order of 24 inches per year, with approximately 15 inches per year runoff, and the remainder lost to evapotranspiration or seepage into the ground (Gerbert, 1987).

B. Hydrogeology

Regionally, the Cass Lake area is located in an outwash plain that is pitted and dissected by gravel-filled channels that are now partially occupied by kettle lakes. This unconsolidated glacial drift is horizontally and vertically extensive, with the saturated portion serving as the water supply for nearby municipalities and private wells (Oakes and Bidwell, 1968).

Local geology consists of Wisconsin-aged unconsolidated glacial deposits approximately 350 feet thick and underlain by Precambrian intrusive rocks. The glacial deposits near the surface are primarily composed of well-sorted fine sands (SW) and silts (ML). Near-surface geology at the Site consists of an unconsolidated, brown, medium-grained, moderately sorted sand and silt to a depth of greater than 40 feet.

The piezometric gradient in the near-surface aquifer is 0.1% to the southeast toward Fox Creek (part of the Pike Bay drainage). Flow in the aquifer occurs under unconfined conditions. Depth to groundwater varies in response to topographic and piezometric relief, but is on the order of 25-feet in the vicinity of the Site. The nearest surface water body is Spike Lake, located approximately ½-mile to the southwest of the Site.

C. Groundwater Receptor Survey

Sixteen residential wells were identified within a 1-mile radius of the Site. Of these wells, none were potentially downgradient and located within ½-mile of the Site. The wells range in depth from 42 to 218 feet below ground surface. Well logs were obtained from the Minnesota Geological Survey's County Well Index and are included as Appendix A. The residential well locations are shown on Figure 3.

III. SITE INVESTIGATION

To assess shallow groundwater quality, a network of four monitoring wells was initially installed in May 2001 as part of the Detection Monitoring Program. Wells were placed as follows:

- One well placed hydraulically upgradient as a background well (MW-1);
- Three wells downgradient of the main portion of the pumping station (MW-2, MW-3, MW-4).

Based upon the findings at MW-3, plans for an expanded investigation were laid. In general, these plans called for determining the extent and magnitude of crude oil impacts in the near surface aquifer via advancement of push-probes followed by placement of monitoring wells at select locations. To the degree feasible, these goals were achieved. However, the complexity of buried infrastructure and station construction activities prevented the installation of additional monitoring wells in the source area (the weeping flange). The following provides specifics of the investigation.

A. Investigation Procedures

- *Push-Probe Groundwater Sampling:*

Based on the analytical results of groundwater samples collected from the on-site monitoring wells, a network of sixteen push-probe borings was advanced across the Site. Using the presence of oil-stained soil as an indicator, boring locations were selected to define the extent and magnitude of impacted soil and assess shallow groundwater quality. This phase of the investigation indicated impacted groundwater migrated off-site to the southeast, and access from the adjacent landowner would be required to complete the investigation. In August 2002, landowner access was secured, and additional push-probes were advanced until the extent of impacted groundwater was defined. Information from these push-probes was also used as an aid for placement of the four off-site monitoring wells in November 2002. Push-probe boring logs are included in

Appendix B.

Water samples collected during the investigation were analyzed for concentrations of BTEX and ERDRO. Trip, temperature and field blanks were also submitted with the samples for analysis by EnChem, Inc. in Green Bay, WI.

- *Monitoring Well Installation:*

Monitoring wells were constructed in accordance with Minnesota Well Code and Chapter 4725. Wells were designed to have the screened interval bisect the water table. Boreholes for the monitoring wells were advanced with a nominal 4 ½-inch inner diameter hollow stem auger. One deep boring (adjacent to MW-1) was completed to a depth of approximately 46 feet and sampled continuously using two-foot split-spoons to characterize the near-surface geology at the Site. In the remainder of the monitoring well boreholes, split-spoon samples were collected on five-foot intervals. Boring logs with headspace screening results are included as Appendix B.

Wells were completed with 2-inch diameter, flush-threaded schedule 40 PVC risers and ten-foot, 0.01-inch slot screens. Risers extend to a height of approximately two feet above grade. The filter pack was completed to a depth of two feet above the top of the screen using Red Flint Sand (# 30) followed by bentonite chips and neat cement grout acting as the sealing material and surface seal, respectively. Lastly, protective tops were placed over the wells locked with padlocks. Bumper posts were also placed in a triangular configuration around wells located in high-traffic areas. Well construction detail is shown on forms in Appendix C.

- *Monitoring Well Development and Groundwater Sampling:*

Wells were developed using a vigorous pump and surge technique. The process was repeated until water bailed from the well was relatively clear of sediment and stable with respect to pH, specific conductivity and temperature.

Groundwater samples were collected following well development and stabilization. Samples were analyzed for benzene, toluene, ethylbenzene, xylenes (BTEX), and extended range DRO (ERDRO). Trip, temperature, and field blanks were also submitted with the samples for analysis by EnChem, Inc. in Green Bay, WI.

- *Surveying:*

Horizontal and vertical well locations were surveyed by LW Survey of Duluth, Minnesota. Horizontal locations are based on the NAD83 Minnesota North State Plane coordinate system and elevations are referenced to the NAVD 88 datum.

B. Groundwater Quality

- *Dissolved Phase:*

Analytical results from the water samples are summarized on Table 1, and complete analytical reports are included in Appendix D. In general, water samples were not collected at locations where there was evidence of free oil or a smear zone. These locations were: GP-1; GP-2; GP-7; GP-9; GP-12; GP-13; GP-14; and MW-3.

Benzene is the predominant compound of concern dissolved in the shallow groundwater at the Site (refer to Table 1). Concentrations of benzene above the Minnesota Department of Health's Health Risk Limits (HRLs) were present in three borings (GP-3, GP-4, and GP-16), and ranged from below detectable concentrations around the periphery of the Site, to a maximum of 1,300 µg/l at GP-4 along the axis of the plume approximately 180-feet downgradient from MW-3. The lateral extent of the impacted groundwater plume is depicted on Figure 4.

- *Non-Aqueous Liquid Phase:*

Excluding a petroleum sheen in MW-3, the initial monitoring event did not reveal a presence of free-oil in any of the monitoring wells. During the July 2003 event however, oil was present in MW-3 at a thickness of approximately 8-inches.

In an effort to determine product recovery rate in monitoring well MW-3, product thickness measurements were collected on six occasions. The following table summarizes these results.

Date	Time	Crude Oil Thickness (inches)
July 21, 2003	2:30 PM	8.4
July 22, 2003	9:45 AM	2.5
July 29, 2003	12:45 PM	5.0
July 31, 2003	1:30 PM	4.0
August 21, 2003	7:30 AM	8.4
September 4, 2003	9:49 AM	8.0

During each Site visit, product thickness was determined using an oil/water interface probe. Product present in the well was, and is continuing to be manually removed and placed in a 55-gallon drum on-site located adjacent to monitoring well MW-3. Figure 5 indicates the approximate lateral extent of residual product at the Site, and is based on the presence of a smear zone across the water table as observed in the push probes and oil measurements at MW-3. This footprint does not necessarily represent the extent of recoverable oil, but rather the area where the potential for recoverable oil exists.

IV. AQUIFER CHARACTERIZATION

A. Aquifer Characterization Procedures

- *Groundwater Levels:*

Water levels in the monitoring wells were measured electronically using a Solonist M-Scope resolved to 0.01 foot. Water level measurements in the monitoring wells were referenced to a mark on the top of the inner well casing.

- *Hydraulic Conductivity:*

Slug testing was completed in the monitoring wells to determine the hydraulic conductivity of the aquifer immediately about each monitoring well. A slug test consists of displacing a volume of water in a well by insertion or removal of a slug tool. The addition or removal of the slug tool from the water in the monitoring wells is equivalent to displacing an equal volume of water. By monitoring the transient water level in the well, it is possible to estimate the conductivity immediately surrounding the gravel pack of the well.

The slug used was constructed of 1-inch diameter PVC pipe, filled with sand, and sealed with silicone and PVC caps. The total length of the slug was 3.7 feet, which displaced approximately 0.2 cubic feet of water (or resulted in a change in head of approximately 0.9 feet). The time required for the well to dissipate the water and approach the initial static level was measured with a 20 psi In-Situ pressure transducer and recorded with a Hermit 3000 data logger at a very high frequency. Measurements were taken at 1-second intervals initially and 10-second intervals as the water level in the well approached steady state. Refer to Appendix C for well dimensions and construction specifics, and Appendix E for a discussion of the slug test analysis and for figures which graphically show the dissipation or recovery of the water displaced during the slug tests.

- ***Organic Carbon Content:***

A soil sample of the aquifer matrix was collected at the upgradient location (MW-1), and analyzed for Total Organic Carbon (TOC) content. The TOC sample was analyzed by En Chem, Inc. in Green Bay, Wisconsin. This aquifer characteristic is one of the key parameters for future fate and transport analysis of crude oil compounds dissolved in the shallow aquifer.

B. Aquifer Characteristics

- ***Groundwater Levels:***

Groundwater elevations in the monitoring wells are summarized in Table 2. Depth to groundwater across the Site varies from approximately 26 to nearly 28 feet below ground surface. Regionally, the groundwater flow gradient is expected to be to the southeast toward Fox Creek (part of the Pike Bay drainage) with a slope of approximately 0.1%. Locally, the distribution of compounds dissolved in the groundwater is consistent with the regional flow regime. However, survey elevations of the off-site wells should be checked prior to further analysis of the local flow regime.

- ***Hydraulic Conductivity and Mean Groundwater Velocity:***

Hydraulic conductivity and groundwater velocity calculations are detailed in Appendix E. Table 3 summarizes the hydraulic conductivity testing results. The hydraulic conductivity appears to be normally distributed about an arithmetic mean of 20 feet/day. This is in general agreement with reference values published for a fine to medium grained clean sand (Strack, 1989). Using the hydraulic gradient and assuming an effective porosity typical of a clean sand (0.25), the mean groundwater flow velocity was calculated at approximately 30 feet per year.

- ***Organic Carbon Content:***

The soil sample for TOC analysis was collected from the aquifer matrix at the upgradient well location (MW-1). The TOC concentration registered at 920 mg/kg (0.09%).

V. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have been drawn based on the findings of the investigation and monitoring activities at the Site.

A. CONCLUSIONS

- The near-surface geology at the Site is an unconsolidated, brown, medium-grained SW sand to a depth of greater than 40 feet below ground surface;
- Regionally, the groundwater flow regime appears to be to the southeast with a flow gradient of 0.1% toward Cass Lake. Locally, the distribution of crude oil related compounds in the groundwater is consistent with regional flow;
- Hydraulic conductivities across the Site appear to be normally distributed about an arithmetic mean of 20 ft/day;
- Mean groundwater velocity across the Site is approximately 30 feet/year;
- Sixteen residential wells were identified within 1-mile of the Site, with but none were located within ½-mile downgradient of the Site;
- Benzene concentrations dissolved in the groundwater ranged from below detection limit around the periphery of the Site, to a maximum of 1,300 ug/l at GP-4 along the axis of the plume downgradient of the source area (the weeping flange); and
- Crude oil was first observed in MW-3 during the July 2003 monitoring event at a thickness of 8.4 inches.

B. Recommendations

To adequately determine the lateral extent of crude oil on the watertable at the Site, two to four additional monitoring wells should be installed. The exact number of wells needed will be based on field observations during drilling activities. The proposed well locations are shown on Figure 6.

In addition to defining the magnitude of crude oil on the watertable, quarterly groundwater monitoring will continue at monitoring wells MW-1, -2, -4, -6, -7, -8 and -9 in order to evaluate BTEX and ERDRO trends and to document the natural attenuation process. The survey coordinates of these wells will also be checked in Fall 2003.

Following completion of the additional well installation and one round of sampling, a letter update will be submitted to the MPCA detailing the findings and recommendations for future activities.

VI. REFERENCES

Gerbert, W.H., Graczyk, D.J., and Krug, W.R. 1987. "Average annual runoff in the United States, 1951-80". U.S. Geological Survey Hydrologic Investigations Atlas. 730-J.

Strack, O.D.L., 1989, Groundwater Mechanics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 732p.

TABLES

Table 1: Groundwater Sampling Results
Enbridge Energy Company - South Cass Lake Station

Location	Date	Benzene (ug/l)	Ethylbenzene (ug/l)	Toluene (ug/l)	Xylenes, -m, -p (ug/L)	Xylenes, -o (ug/L)	ERDRO (ug/L)
MW-1	6-Jun-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-1	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-2	6-Jun-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-2	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-4	6-Jun-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-4	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-6	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-7	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-8	16-Jul-03	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 100
MW-9	16-Jul-03	0.51	< 1.0	< 1.0	< 2.0	< 1.0	< 100
GP-3	25-Sep-01	340	< 1.0	< 1.0	< 2.0	< 1.0	< 160
GP-4	25-Sep-01	1300	230	< 10	< 20	< 10	830
GP-5	25-Sep-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 180
GP-6	25-Sep-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 160
GP-10	26-Sep-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 160
GP-15	26-Sep-01	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	< 160
GP-16	26-Sep-01	19	< 1.0	< 1.0	< 2.0	< 1.0	< 160
GP-17	14-Aug-02						<230
GP-18	14-Aug-02	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0	<250
GP-19	14-Aug-02						<220
GP-20	13-Aug-02						<230
Trip Blank	16-Jul-03	<1.0	< 1.0	< 1.0	< 2.0	< 1.0	

Table 2: Groundwater Elevations
Enbridge Energy Company - South Cass Lake Station

Location	Date	Top of Casing Elevation (feet MSL)	Depth to Groundwater (feet MSL)	Groundwater Elevation (feet MSL)
MW-1	06-Jun-01	1339.94	26.29	1313.65
MW-1	10-May-02		27.57	1312.37
MW-1	14-May-02		27.60	1312.34
MW-1	21-Jul-03		28.07	1311.87
MW-2	06-Jun-01	1339.59	25.87	1313.72
MW-2	10-May-02		None Recorded	
MW-2	14-May-02		27.25	1312.34
MW-2	21-Jul-03		27.71	1311.88
MW-3	06-Jun-01	1339.63	25.92	1313.71
MW-3	10-May-02		27.19	1312.44
MW-3	14-May-02		27.22	1312.41
MW-3	21-Jul-03		28.30	1315.62
MW-4	06-Jun-01	1340.39	26.68	1313.71
MW-4	10-May-02		27.92	1312.47
MW-4	14-May-02		27.96	1312.43
MW-4	21-Jul-03		28.35	1312.04
MW-6	21-Jul-03	1338.67	28.75	1309.92
MW-7	21-Jul-03	1340.29	28.09	1312.20
MW-8	21-Jul-03	1338.97	29.37	1309.60
MW-9	21-Jul-03	1338.38	26.41	1311.97

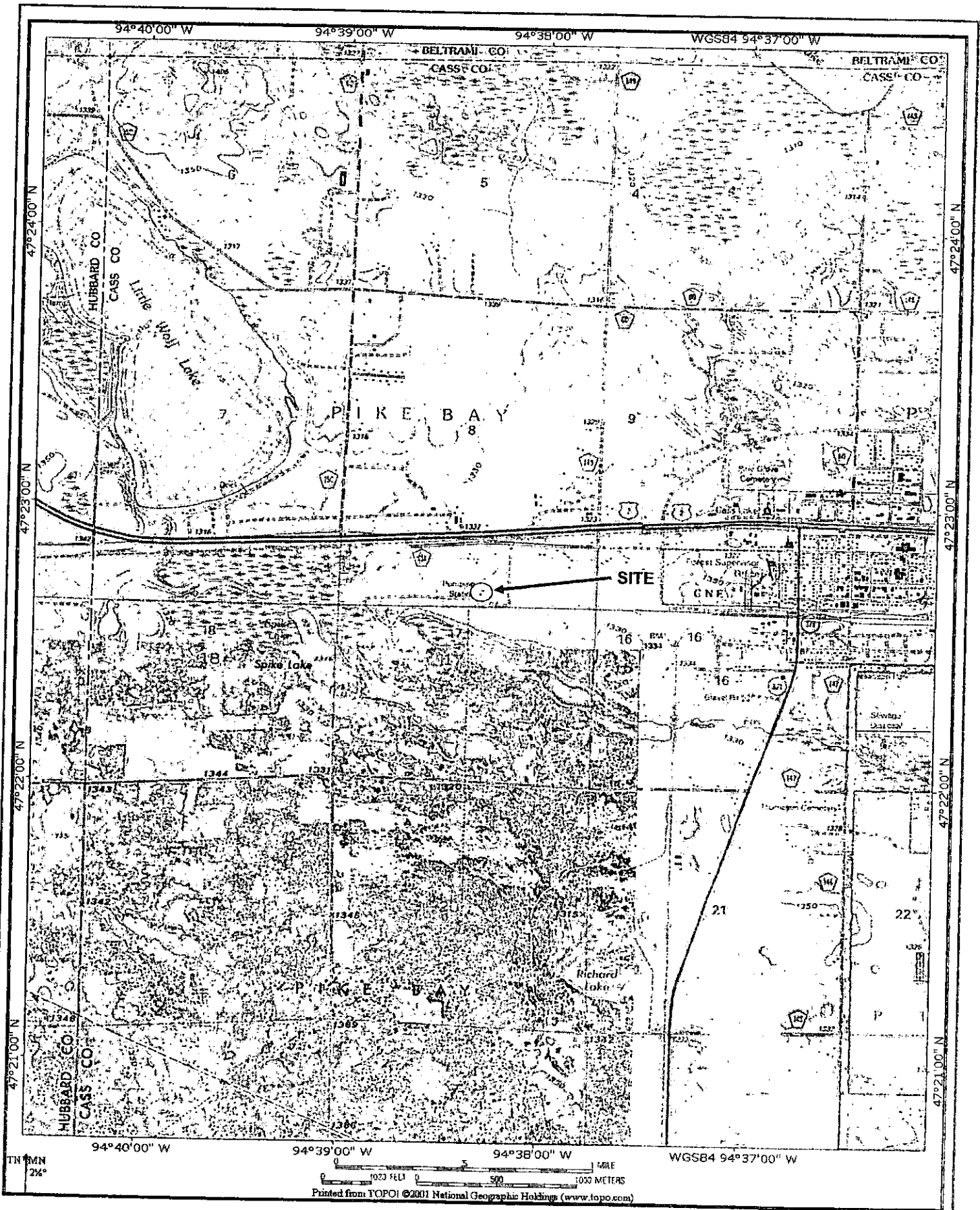
Table 3: Hydraulic Conductivity Values
Enbridge Energy Company - South Cass Lake Station

Well	Hydraulic Conductivity (feet/day)	Comments
MW-1	4.0	Dissipation
MW-1	13.2	Recovery
MW-2	19.8	Dissipation
MW-2	27.6	Recovery
MW-3	9.7	Dissipation
MW-3	27.6	Recovery
MW-4	17.4	Dissipation
MW-4	24.5	Recovery
MW-6	33.6	Recovery
MW-7	15.7	Dissipation
MW-7	15.4	Recovery
MW-8	27.4	Dissipation
MW-8	16.8	Recovery

Arithmetic Mean **19.4** **feet/day**

Geometric Mean **17.3** **feet/day**

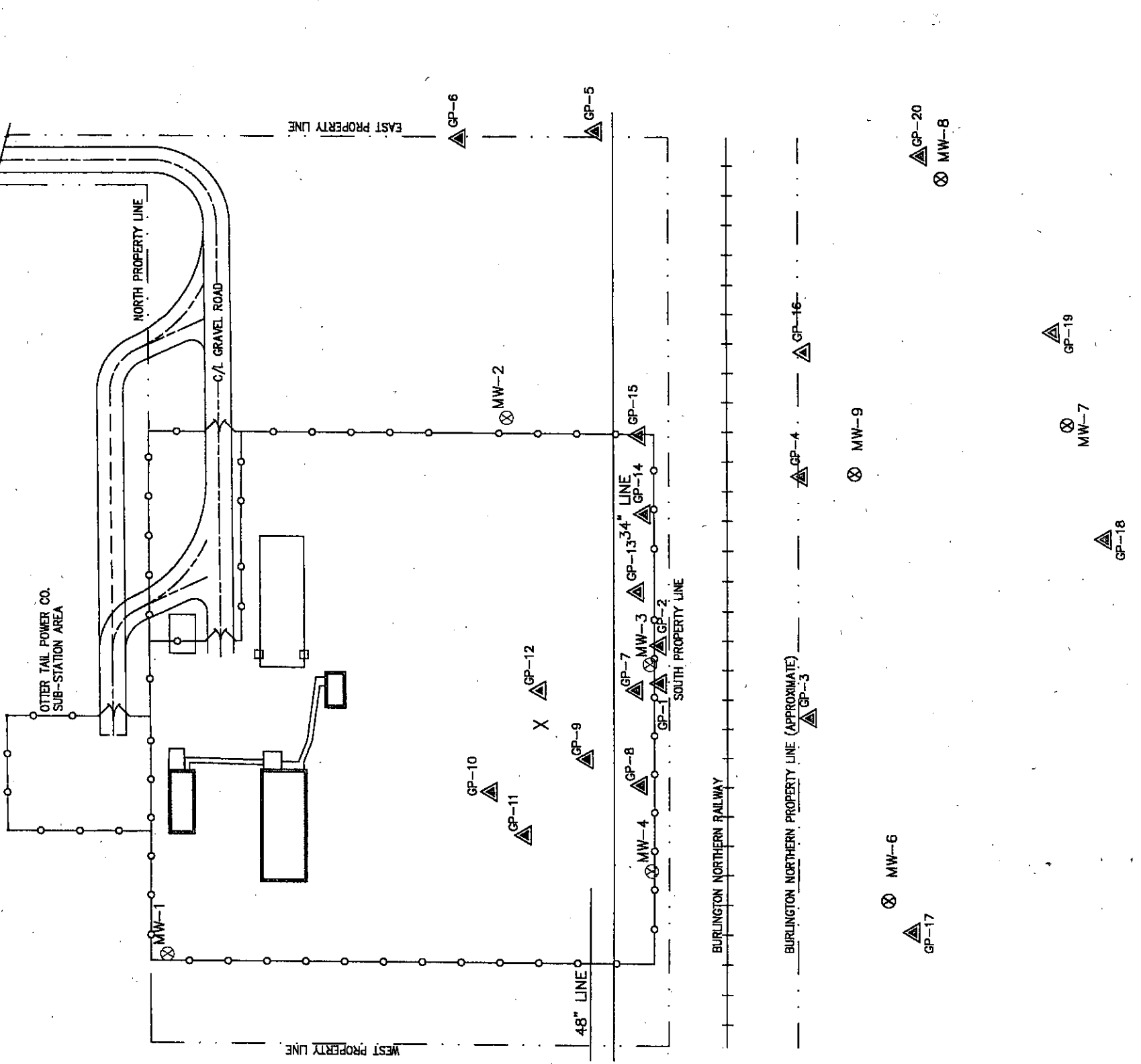
FIGURES



<p>Site Location Map</p>	<p>Enbridge Energy Company</p>	<p>enbridge</p>	<p>Oct-03</p>
<p>South Cass Lake Station</p>	<p>119 N 26th St. East, Superior, WI 54880</p>		<p>Figure 1</p>

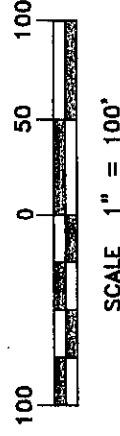
ENBRIDGE PUMPING STATION

CASS LAKE, MINNESOTA



LEGEND

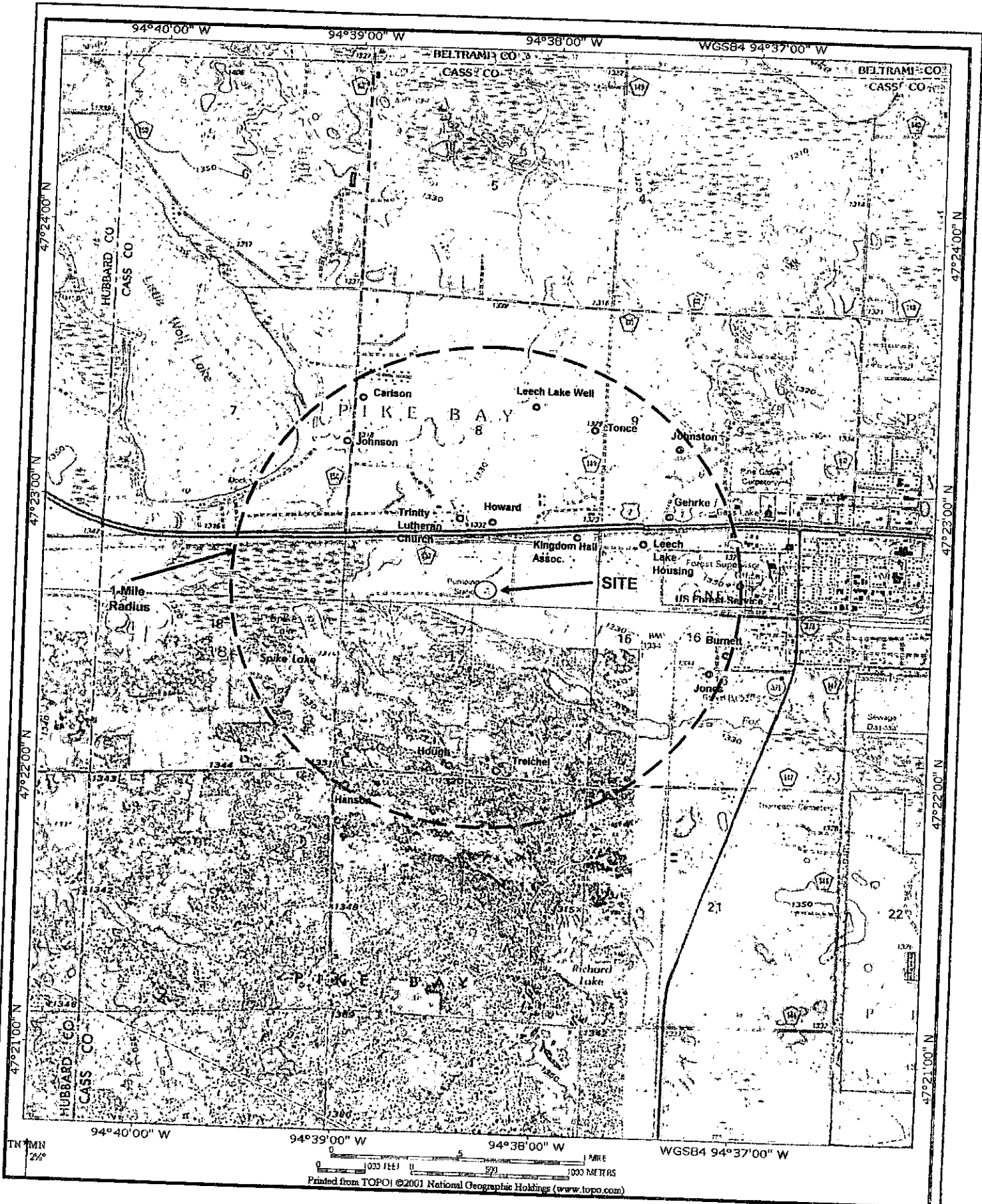
- ▲ PUSH PROBE BORING
- ⊗ MONITORING WELL
- X WEEPING FLANGE



LJB Engineers & Architects DULUTH, MINNESOTA 55802		Natural Resources Engineering Company DULUTH, MINNESOTA 55802	
NO.	REVISION	DATE	APPR.
1	ISSUED FOR REVIEW	11/27/01	HELDT
2	UPDATES BY NRE (BDH)	10/06/03	HELDT
3	UPDATES BY NRE (BDH)	10/10/03	BDH

DATE	DRAWN	APPROVED	LJB PROJ. NO.	DRAWING NO.
MAY 2002	HEB	DAH	01807.67	FIGURE 1

SITE LAY-OUT MAP
ENBRIDGE PUMPING STATION
CASS LAKE, MN

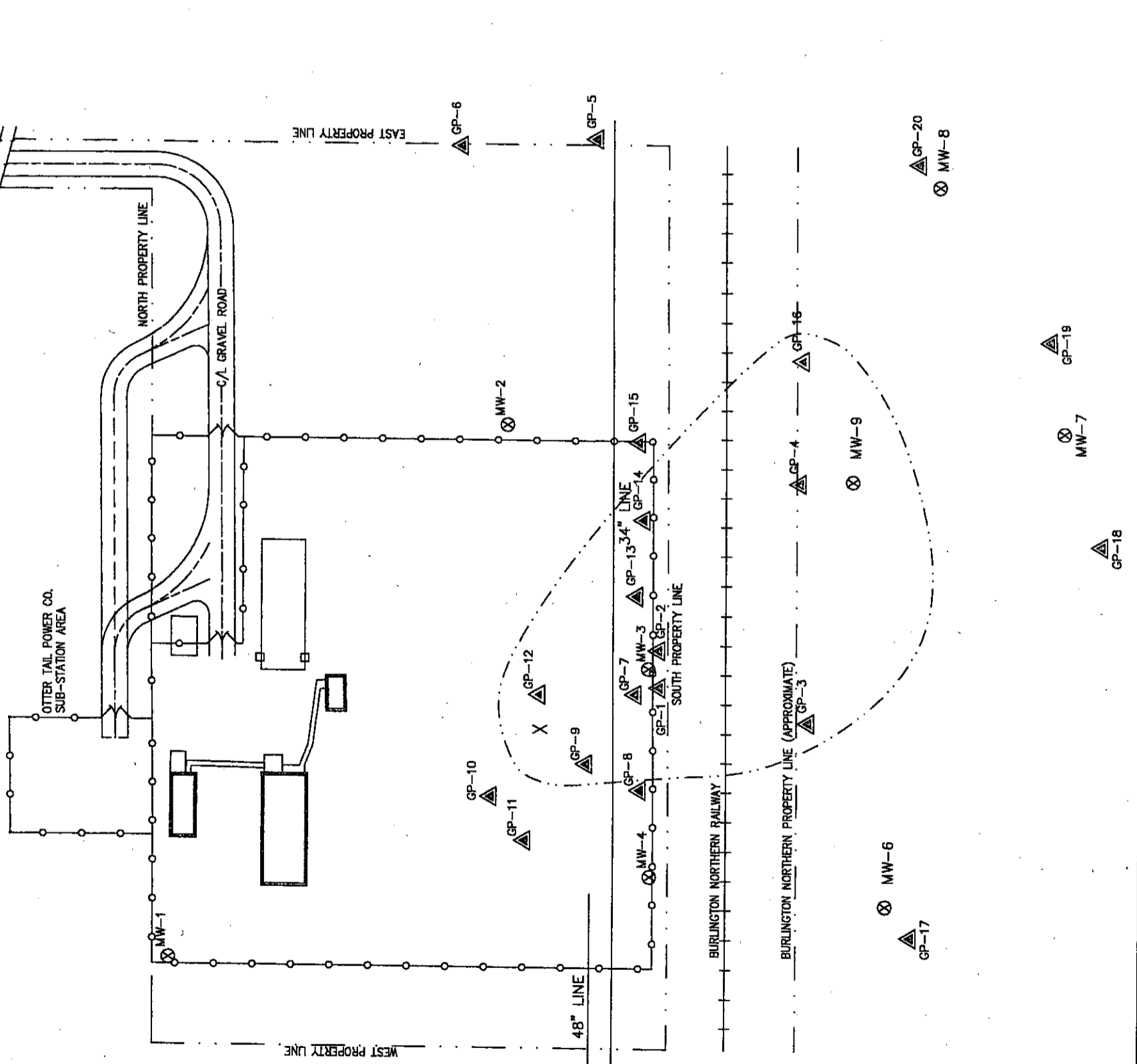


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Well Location Map South Cass Lake Station	Enbridge Energy Partners 119 N 25th St. East, Superior, WI 54880	Oct-03 Figure 3
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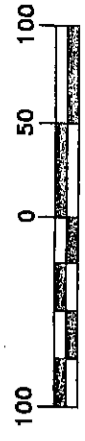
ENBRIDGE PUMPING STATION

CASS LAKE, MINNESOTA



LEGEND

- PUSH PROBE BORING
- MONITORING WELL
- WEEPING FLANGE
- APPROXIMATE EXTENT OF IMPACTED GROUNDWATER



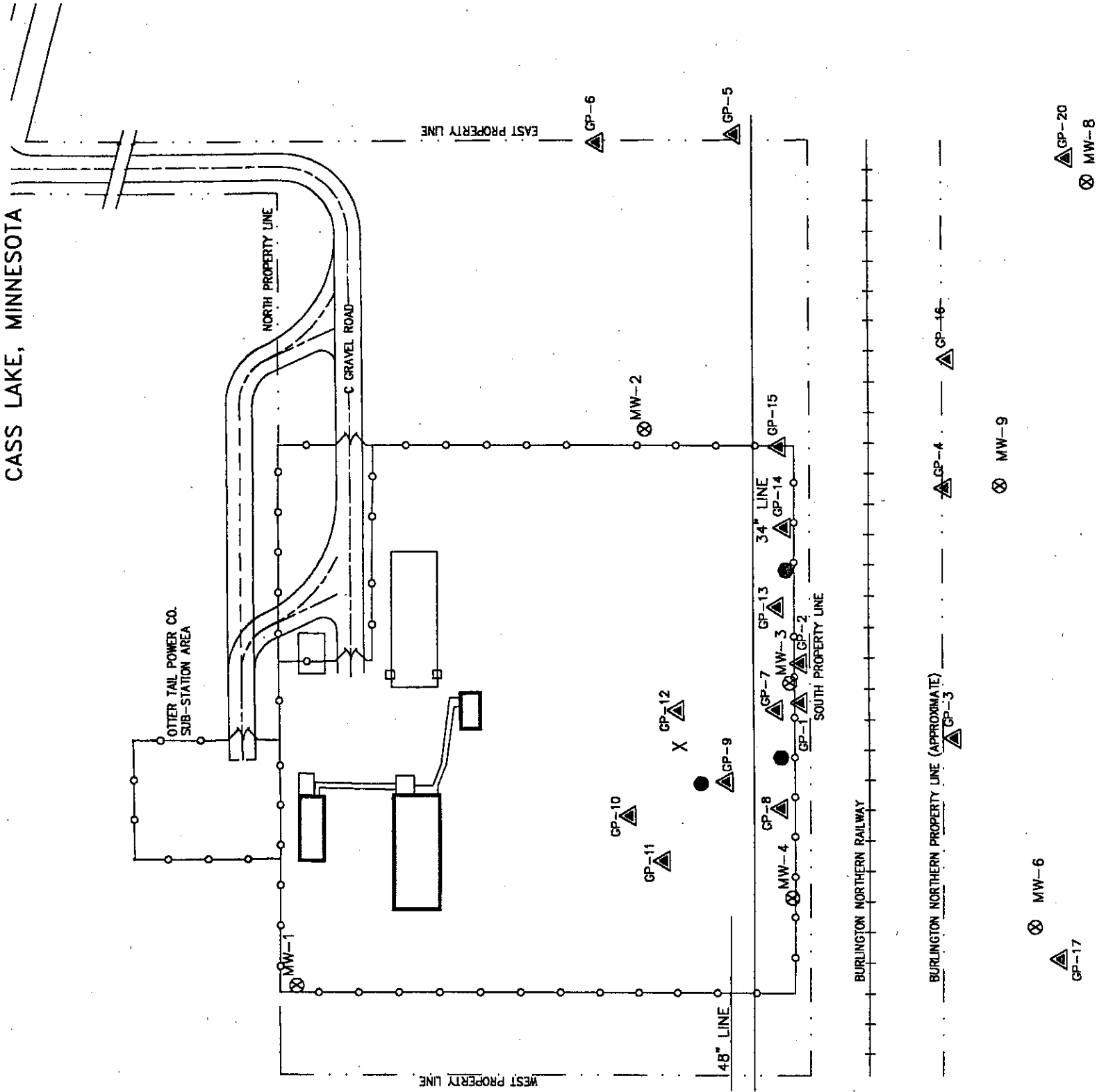
LHB Engineers & Architects		Natural Resources Engineering Company	
DULUTH, MINNESOTA 55802		DULUTH, MINNESOTA 55802	
NO.	REVISION	DATE	APPR. HELDT
1	ISSUED FOR REVIEW	05/21/02	HELDT
2	D.J.H. REDLINES	06/07/02	HELDT
3	NRE CHANGES	08/25/03	HELDT
4	UPDATES BY NRE (BDH)	10/06/03	HELDT
5	UPDATES BY NRE (GDH)	10/10/03	BDH

LATERAL EXTENT OF IMPACTED GROUNDWATER

DATE	DRAWN	APPROVED	LHB PROJ. NO.	DRAWING NO.
MAY 2002	HEB	DMH	01807.67	FIGURE 4

ENBRIDGE PUMPING STATION

CASS LAKE, MINNESOTA



LEGEND

- ▲ PUSH PROBE BORING
- ⊗ MONITORING WELL
- PROPOSED WELL LOCATIONS*
- X WEEPING FLANGE

* LOCATIONS MAY VARY BASED ON FIELD OBSERVATIONS



NO.	REVISION	DATE	APPL.
1	ISSUED FOR REVIEW	09/25/03	HELD
2	UPDATES BY NRE (BDH)	10/06/03	HELD
3	UPDATES BY NRE (BDH)	10/10/03	BDH

LHB Engineers & Architects DULUTH, MINNESOTA 55802		Natural Resources Engineering Company DULUTH, MINNESOTA 55802	
DATE	DRAWN	APPROVED	LIB. PROJ. NO.
SEPT 2003	HEB	DAH	01807.67
			DRAWING NO.
			FIGURE 6

PROPOSED WELL LOCATIONS
ENBRIDGE PUMPING STATION
CASS LAKE, MN

APPENDICES

APPENDIX A – RESIDENTIAL WELL LOGS

Unique No. 643007

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2000/06/06

Entry Date 2000/06/01

Township Name Township Range Dir Section Subsection
145 31 W 16 DBB

Well Depth 218 ft. Depth Completed 218 ft. Date Well Completed 2000/01/10

Well Name BURNETT, RANDELL

Drilling Method Non-specified Rotary

Drilling Fluid Bentonite Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter in. t 218 ft

Casing Diameter 4 in. t Weight(lbs/ft) 214 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
ABOVE GRADE			0	2
SAND	BROW	SOFT	2	40
CLAY AND SAND	GRAY	SOFT	40	126
SAND	GRAY	SOFT	126	127
CLAY AND SAND	GRAY	HARD	127	215
SAND	GRAY	SOFT	215	218

Screen Y Open Hole From ft. to ft.

Make JOHNSON Type O

Diameter Slot Length Set Fitting
4 7 4 214 ft. to 218 ft

Static Water Level 21 ft. from Land surface Date 2000/01/10

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 100 g.p.m.

Well Head Completion
Pitless adapter mf MAASS Model JC
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No
Material From To (ft.) Amount(yds/bags)
10 160 16 S

Nearest Known Source of Contamination
70 ft. direction SE type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed N
Mfr nam Mode HP Volts
Drop Pipe Length ft. Capacity g.p.m
Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 11064

License Business Name Freeman Well Co.

Name of Driller FREEMAN, J.

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00553311

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 1994/11/03

Entry Date 1994/11/03

Township Name Township Range Dir Section Subsection
145 31 W 16 CDB

Well Depth 55 ft. Depth Completed 55 ft. Date Well Completed 1994/08/30

Well Name JONES, RUSSELL

Drilling Method

Contact's Name JONES, RUSSELL
BOX 156
CASS LAKE MN 56633

Drilling Fluid Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter

Screen Open Hole From ft. to ft.
Make Type

Static Water Level 29 ft. from Land surface Date 1994/08/30

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No

Nearest Known Source of Contamination
89 ft. direction SW type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam HP Volts
Mode Drop Pipe Length ft. Capacity g.p.m.
Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 11064
License Business Name Freeman Well Co.
Name of Driller

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00497051

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 1991/12/20

Entry Date 1991/12/20

Township Name Township Range Dir Section Subsection
145 31 W 16

Well Depth Depth Completed Date Well Completed
113 ft. 113 ft. 1991/09/11

Well Name US FORESTRY SERVICES

Drilling Method

Contact's Name US FORESTRY SERVICES
200 ASH AV
MN

Drilling Fluid Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter

Screen Open Hole From ft. to ft.
Make Type

Static Water Level 32 ft. from Land surface Date 1991/09/11

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No

Nearest Known Source of Contamination
20 ft. direction S type O
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam HP Volts
Mode
Drop Pipe Length ft. Capacity g.p.m.
Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 29383

License Business Name Nevis & Elsner Well
Name of Driller

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00560998

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Update Date 1996/02/09

County Name Cass

Minnesota Statutes Chapter 1031

Entry Date 1996/02/09

Township Name Township Range Dir Section Subsection
145 31 W 9 CDD

Well Depth 51 ft. Depth Completed 51 ft. Date Well Completed 1995/06/07

Well Name GEHRKE, DAVID

Drilling Method Mud Rotary

Contact's Name GEHRKE, DAVID
RT 3 BOX 620
CASS LAKE MN 56633

Drilling Fluid Bentonite Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N

Hole Diameter
in. t 30 ft
in. t 51 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
SAND	YELLOW	SOFT	0	12
CLAY	YELLOW	SOFT	12	30
CLAY	BLUE	SOFT	30	45
SAND	BLUE	HARD	45	51

Casing Diameter 4 in. t Weight(lbs/ft) 47 ft

Screen Y Open Hole From ft. to ft.

Make JOHNSON Type L

Diameter Slot Length Set Fitting

2 10 4 47 ft. to 51 ft

Static Water Level 24 ft. from Land surface Date 1995/06/07

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf SNAPPY Model 8PL41U
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No
Material From To (ft.) Amount(yds/bags)
B 0 30 3 S

Nearest Known Source of Contamination
70 ft. direction N type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam MYERS
Mode HP 0.5 Volts 220
Drop Pipe Length 40 ft. Capacity 12 g.p.m
Type S

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 04121

License Business Name Nelson Well Drilling

Name of Driller REED, G

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00478284

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 1031

Update Date 1992/05/03

Entry Date 1992/03/24

Township Name Township Range Dir Section Subsection
145 31 W 9 DAC

Well Depth 55 ft. Depth Completed 55 ft. Date Well Completed 1991/10/11

Well Name JOHNSTON, PAULINE

Drilling Method

Contact's Name JOHNSTON, PAULINE
RT 3, BOX 100
CASS LAKE MN 56633

Drilling Fluid Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter

Screen Open Hole From ft. to ft.
Make Type

Static Water Level 35 ft. from Land surface Date 1991/10/11

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No

Nearest Known Source of Contamination
100 ft. direction type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam HP Volts
Mode Drop Pipe Length ft. Capacity g.p.m.
Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 49588
Licenise Business Name North Star Drilling
Name of Driller

USGS Quad Elevation
Aquifer: Alt Id:

Report Copy

Unique No. 00160276

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Update Date 1991/08/14

County Name Cass

Minnesota Statutes Chapter 1031

Entry Date 1989/03/02

Township Name Township Range Dir Section Subsection
145 31 W 8 ACA

Well Depth Depth Completed Date Well Completed
83 ft. 83 ft. 1979/07/06

Well Name LEECH LAKE WELL

Drilling Method

Drilling Fluid

Well Hydrofractured? Yes No
Fro ft. to ft.

Use Municipal

Casing Drive Shoe? Yes N Hole Diameter

Screen Open Hole From ft. to ft.
Make Type

Static Water Level 26 ft. from Land surface Date 1979/07/06

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No

Nearest Known Source of Contamination
75 ft. direction type
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam
Mode HP Volts
Drop Pipe Length ft. Capacity g.p.m
Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No.
License Business Name
Name of Driller

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00195009	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>	Update Date 1991/08/14
County Name Cass		Entry Date 1989/03/02
Township Name Township Range Dir Section Subsection 145 31 W 8 BCC	Well Depth 57 ft.	Depth Completed 57 ft.
Well Name ALBIN CARLSON	Date Well Completed 1982/09/16	
<div style="border: 1px solid black; height: 100%; width: 100%;"></div>	Drilling Method	
	Drilling Fluid	Well Hydrofractured? <input type="checkbox"/> Yes <input type="checkbox"/> No Fro ft. to ft.
	Use Domestic	
	Casing Drive Shoe? <input type="checkbox"/> Yes <input type="checkbox"/> N	Hole Diameter
	Screen	
	Make	Open Hole From ft. to ft. Type
	Static Water Level 23 ft. from Land surface Date 1982/09/16	
	PUMPING LEVEL (below land surface) ft. after hrs. pumping g.p.m.	
	Well Head Completion Pitless adapter mf Model Casing Protection <input type="checkbox"/> 12 in. above grade <input type="checkbox"/> At-grade (Environmental Wells and Borings ONLY)	
	Grouting Information Well grouted? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Nearest Known Source of Contamination 200 ft. direction type Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Pump <input type="checkbox"/> Not Installed Date Installed Mfr nam Mode HP Volts Drop Pipe Length ft. Capacity g.p.m. Type		
Any not in use and not sealed well(s) on property? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Was a variance granted from the MDH for this Well? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. License Business Name Name of Driller		

USGS Quad _____ Elevation _____
 Aquifer: _____ Alt Id: _____

Report Copy

Unique No. 00415148

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Update Date 1991/08/14

County Name Cass

Minnesota Statutes Chapter 1031

Entry Date 1988/04/07

Township Name Township Range Dir Section Subsection
145 31 W 8

Well Depth 74 ft. Depth Completed 72 ft. Date Well Completed 1986/06/17

Well Name TONCE, DELCIE

Drilling Method

Drilling Fluid

Well Hydrofractured? Yes No
Fro: ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter

Screen Open Hole From ft. to ft.
Make Type

Static Water Level 20 ft. from Land surface Date 1986/07/08

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No

Nearest Known Source of Contamination
100 ft. direction type
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam HP Volts
Mode Capacity g.p.m.
Drop Pipe Length ft. Type

REMARKS, ELEVATION, SOURCE OF DATA, etc.

LEECH LAKE INDIAN RES.

USGS Quad Elevation
Aquifer: Alt Id:

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No.

License Business Name

Name of Driller

Report Copy

Unique No. 657409

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2001/06/05

Entry Date 2001/01/10

Township Name Township Range Dir Section Subsection
145 31 W 8 DCB

Well Depth 88 ft. Depth Completed 88 ft. Date Well Completed 2000/11/01

Well Name HOWARD, SHERYL

Drilling Method Non-specified Rotary

Drilling Fluid Bentonite Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter in. t 88 ft

Casing Diameter Weight(lbs/ft)
4 in. t 84 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
ABOVE GRADE			0	2
SANDY LOAM	BROW	SOFT	2	7
SAND	BROW	SOFT	7	51
CLAY	GRAY	HARD	51	83
SAND	BROW	HARD	83	88

Screen Y Open Hole From ft. to ft.

Make JOHNSON Type O

Diameter Slot Length Set Fitting
4 7 4 84 ft. to 88 ft

Static Water Level 25 ft. from Land surface Date

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 50 g.p.m.

Well Head Completion
Pitless adapter mf MAASS Model JC
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No
Material From To (ft.) Amount(yds/bags)
B 10 60 6 S

Nearest Known Source of Contamination
80 ft. direction S type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed N
Mfr nam
Mode HP Volts
Drop Pipe Length ft. Capacity g.p.m
Type

REMARKS, ELEVATION, SOURCE OF DATA, etc.

TYPE: TELESCOPE

USGS Quad Elevation
Aquifer: Alt Id:

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 11064

License Business Name Freeman Well Co.

Name of Driller FREEMAN, J

Report Copy

Unique No. 604794
 County Name Cass
 MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
 Minnesota Statutes Chapter 1031
 Update Date 1999/12/17
 Entry Date 1999/05/10

Township Name Township Range Dir Section Subsection
 145 31 W 8
 Well Depth 42 ft. Depth Completed 42 ft. Date Well Completed 1998/04/09

Well Name TRINITY LUTHERAN CHURCH

Contact's Name TRINITY LUTHERAN CHURCH
 3RD & CENTRAL
 CASS LAKE MN 56633-

Well Owner's Name TRINITY LUTHERAN CHURCH
 HWY 2 W

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
SAND	BROW	MEDIUM	0	36
SAND	BROW	HARD	36	42

Drilling Method Non-specified Rotary

Drilling Fluid Bentonite
 Well Hydrofractured? Yes No
 Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter

Casing Diameter 4 in. t Weight(lbs/ft) 38 ft
 Hole Diameter in. t 30 ft
 in. t 42 ft

Screen Y Open Hole From ft. to ft.

Make JOHNSON Type B

Diameter Slot Length Set Fitting
 2 10 4 38 ft. to 42 ft

Static Water Level 9 ft. from Date 1998/09/04

PUMPING LEVEL (below land surface)
 14 ft. after 2 hrs. pumping 30 g.p.m.

Well Head Completion
 Pitless adapter mf SNAPPY Model 8PL41U
 Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No
 Material From To (ft.) Amount(yds/bags)
 B 7 30 3 S

Nearest Known Source of Contamination
 110 ft. direction NE type SDF
 Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
 Mfr nam MEYERS
 Mode 2N52 - 12 HP 0.5 Volts 220
 Drop Pipe Length 30 ft. Capacity 12 g.p.m.
 Type S

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 04121
 License Business Name Nelson Well Drilling
 Name of Driller REED, G.

USGS Quad Elevation
 Aquifer: Alt Id:

Report Copy

Unique No. 00437450	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>	Update Date 1991/08/14
County Name Cass		Entry Date 1991/03/30
Township Name Township Range Dir Section Subsection 145 31 W 7	Well Depth 58 ft.	Depth Completed 58 ft. Date Well Completed 1987/10/31
Well Name JOHNSON, KEN	Drilling Method	
Contact's Name JOHNSON, KEN RR 3 BOX 637 X CASS LAKE MN 56633	Drilling Fluid	Well Hydrofractured? <input type="checkbox"/> Yes <input type="checkbox"/> No Fro ft. to ft.
	Use Domestic	
	Casing Drive Shoe? <input type="checkbox"/> Yes <input type="checkbox"/> N	Hole Diameter
	Screen	
	Make	Open Hole From ft. to ft. Type
Static Water Level 26 ft. from Land surface Date 1987/10/31		
PUMPING LEVEL (below land surface) ft. after hrs. pumping g.p.m.		
Well Head Completion Pitless adapter mf Model Casing Protection <input type="checkbox"/> 12 in. above grade <input type="checkbox"/> At-grade(Environmental Wells and Borings ONLY)		
Grouting Information Well grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
Nearest Known Source of Contamination 100 ft. direction type Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Pump <input type="checkbox"/> Not Installed Date Installed Mfr nam Mode HP Volts Drop Pipe Length ft. Capacity g.p.m. Type		
Any not in use and not sealed well(s) on property? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Was a variance granted from the MDH for this Well? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 48038 License Business Name <u>North Star Drilling</u> Name of Driller		

USGS Quad _____ Elevation _____
 Aquifer: _____ Alt Id: _____

Report Copy

Unique No. 00555769

County Name Cass

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 1031

Update Date 1995/04/13

Entry Date 1995/04/13

Township Name Township Range Dir Section Subsection
145 31 W 17

Well Depth 60 ft. Depth Completed 59 ft. Date Well Completed 1994/02/20

Well Name TREICHEL, WALTER

Drilling Method

Contact's Name TREICHEL, WALTER
RR 2 BOX 407
CASS LAKE MN 56633

Drilling Fluid

Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N

Hole Diameter

Screen

Open Hole From ft. to ft.

Make

Type

Static Water Level 15 ft. from Land surface

Date 1995/02/20

PUMPING LEVEL (below land surface)

ft. after hrs. pumping g.p.m.

Well Head Completion

Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade (Environmental Wells and Borings ONLY)

Grouting Information

Well grouted? Yes No

Nearest Known Source of Contamination

50 ft. direction type SDF

Well disinfected upon completion? Yes No

Pump Not installed

Date Installed

Mfr nam

Mode

HP

Volts

Drop Pipe Length ft.

Capacity

g.p.m

Type

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 49588

License Business Name North Star Drilling

Name of Driller

USGS Quad
Aquifer:

Elevation
Alt Id:

Report Copy

Unique No. 00566263	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>	Update Date 1995/12/30
County Name Cass		Entry Date 1995/12/30

Township Name Township Range Dir Section Subsection 145 31 W 17 AAB	Well Depth 111 ft.	Depth Completed 111 ft.	Date Well Completed 1995/08/21
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Well Name KINGDOM HALL ASSOC.	Drilling Method Mud Rotary
-------------------------------	----------------------------

Contact's Name KINGDOM HALL ASSOC. RT 3 BOX 597 CASS LAKE MN 56633	Drilling Fluid Bentonite	Well Hydrofractured? <input type="checkbox"/> Yes <input type="checkbox"/> No Fro ft. to ft.
--	-----------------------------	---

Use Public Supply/non-comm.-transient

Casing	Drive Shoe? <input type="checkbox"/> Yes <input type="checkbox"/> N	Hole Diameter in. t 70 ft
--------	---	------------------------------

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
SAND	BROW	SOFT	0	44
CLAY/ROCK	GRAY	MEDIUM	44	98
SAND	GRAY	SOFT	98	111

Casing Diameter 4 in. t 66 ft	Weight(lbs/ft)
----------------------------------	----------------

Screen Y	Open Hole From ft. to ft.
----------	---------------------------

Make JOHNSON	Type L		
Diameter Slot	Length	Set	Fitting
2	12	4	66 ft. to 70 ft

Static Water Level 15 ft. from Land surface	Date 1995/08/21
---	-----------------

PUMPING LEVEL (below land surface)		
ft. after	hrs. pumping	g.p.m.

Well Head Completion	
Pitless adapter mf MONITOR	Model SNAPPY
Casing Protection	<input type="checkbox"/> 12 in. above grade
<input type="checkbox"/> At-grade(Environmental Wells and Borings ONLY)	

Grouting Information		Well grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Material	From	To (ft.)	Amount(yds/bags)
B	8	30	2 S

Nearest Known Source of Contamination			
100 ft.	direction W	type	SDF
Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No			

Pump	<input type="checkbox"/> Not Installed	Date Installed	
Mfr nam	GUNFOS	Mode	HP 0.5 Volts 230
Drop Pipe Length	70 ft.	Capacity	10 g.p.m
Type	S		

Any not in use and not sealed well(s) on property?	Yes <input type="checkbox"/> No <input type="checkbox"/>
--	--

Was a variance granted from the MDH for this Well?	Yes <input type="checkbox"/> No <input type="checkbox"/>
--	--

USGS Quad	Elevation
quifer:	Alt Id: 5111088S01

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 04463	
License Business Name	American Water Co.
Name of Driller	CESOLINI, C.

Report Copy

Unique No. 619870	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>	Update Date 1999/12/17
County Name Cass		Entry Date 1999/05/10
Township Name Township Range Dir Section Subsection 145 31 W 17	Well Depth 60 ft. Depth Completed 60 ft. Date Well Completed 1998/08/21	
Well Name HOUGH, JOE	Drilling Method Non-specified Rotary	
Well Owner's Name HOUGH, JOE	Drilling Fluid Bentonite	Well Hydrofractured? <input type="checkbox"/> Yes <input type="checkbox"/> No Fro ft. to ft.
CASS LAKE MN 56633-	Use Domestic	
	Casing Drive Shoe? <input type="checkbox"/> Yes <input type="checkbox"/> N	Hole Diameter in. t 60 ft
	Casing Diameter 4 in. t Weight(lbs/ft) ft	
GEOLOGICAL MATERIAL COLOR HARDNESS FROM TO	Screen Y	Open Hole From ft. to ft.
ABOVE GRADE 0 2	Make JOHNSON	Type L
SAND BRN SOFT 2 5	Diameter Slot 3	Length Set 4 56 ft. to 60 ft
SANDY LOAM BRN SOFT 5 8		Fitting
SAND BRN SOFT 8 18		
CLAY GRY SOFT 18 21	Static Water Level ft. from	Date
CLAY, SAND GRY SOFT 21 23	PUMPING LEVEL (below land surface) 9 ft. after 1 hrs. pumping 15 g.p.m.	
SAND GRY SOFT 23 47	Well Head Completion Pitless adapter mf Model Casing Protection <input type="checkbox"/> 12 in. above grade <input type="checkbox"/> At-grade(Environmental Wells and Borings ONLY)	
CLAY, SAND GRY SOFT 47 54	Grouting Information Well grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Material From To (ft.) Amount(yds/bags) B 10 50	
SAND GRY SOFT 54 60	Nearest Known Source of Contamination ft. direction type Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Pump <input checked="" type="checkbox"/> Not Installed Date Installed N Mfr nam Mode HP Volts Drop Pipe Length ft. Capacity g.p.m. Type	
	Any not in use and not sealed well(s) on property? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
	Was a variance granted from the MDH for this Well? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
USGS Quad Elevation	Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 11064	
Aquifer: Alt Id:	License Business Name Freeman Well Co. Name of Driller FREEMAN, J.	

Report Copy

Unique No. 659161

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD

Update Date 2001/08/08

County Name Cass

Minnesota Statutes Chapter 1031

Entry Date 2001/07/20

Township Name Township Range Dir Section Subsection
145 31 W 17 ABB

Well Depth 58 ft. Depth Completed 58 ft. Date Well Completed 2001/03/12

Well Name LEECH LAKE HOUSING AUTHO

Drilling Method Non-specified Rotary

Well Owner's Name LEECH LAKE HOUSING AUTHORITY
6677 160TH ST
CASS LAKE MN 56633-

Drilling Fluid Bentonite Well Hydrofractured? Yes No
Fro ft. to ft.

Use Domestic

Casing Drive Shoe? Yes N Hole Diameter
in. t 58 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
ABOVE GRADE			0	2
SAND	BROW	SOFT	2	46
CLAY	GRAY	HARD	46	48
SAND	GRAY	SOFT	48	58

Casing Diameter 4 in. t Weight(lbs/ft) 53 ft

Screen Y Open Hole From ft. to ft.

Make JOHNSON Type L
Diameter Slot Length Set Fitting
2 10 4 53 ft. to 58 ft

Static Water Level 26 ft. from Land surface Date 2001/03/12

PUMPING LEVEL (below land surface)
26 ft. after 2 hrs. pumping 25 g.p.m.

Well Head Completion
Pitless adapter mf Model
Casing Protection 12 in. above grade
 At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? Yes No
Material From To (ft.) Amount(yds/bags)
B 0 40

Nearest Known Source of Contamination
80 ft. direction S type SDF
Well disinfected upon completion? Yes No

Pump Not Installed Date Installed
Mfr nam STA-RITE
Mode HP 0.5 Volts 230
Drop Pipe Length ft. Capacity g.p.m
Type S

Any not in use and not sealed well(s) on property? Yes No

Was a variance granted from the MDH for this Well? Yes No

USGS Quad Elevation
Aquifer: Alt Id:

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 11064
License Business Name Freeman Well Co.
Name of Driller FREEMAN, J.

Report Copy

Unique No. 00519525	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>	Update Date 1993/03/15
County Name Cass		Entry Date 1993/03/15
Township Name Township Range Dir Section Subsection 145 31 W 20 BBB	Well Depth 135 ft.	Depth Completed 135 ft.
		Date Well Completed 1992/10/08
Well Name HANSON, DIANNE	Drilling Method	
	Drilling Fluid	Well Hydrofractured? <input type="checkbox"/> Yes <input type="checkbox"/> No Fro ft. to ft.
	Use Domestic	
	Casing Drive Shoe? <input type="checkbox"/> Yes <input type="checkbox"/> N	Hole Diameter
	Screen	Open Hole From ft. to ft.
	Make	Type
	Static Water Level 40 ft. from Land surface	Date 1992/10/08
	PUMPING LEVEL (below land surface)	
	ft. after	hrs. pumping g.p.m.
	Well Head Completion	
	Pitless adapter mf	Model
	Casing Protection	<input type="checkbox"/> 12 in. above grade
	<input type="checkbox"/> At-grade(Environmental Wells and Borings ONLY)	
	Grouting Information	Well grouted? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
	Nearest Known Source of Contamination	
	ft. direction	type
	Well disinfected upon completion? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Pump <input type="checkbox"/> Not Installed	Date Installed
	Mfr nam	
	Mode	HP Volts
	Drop Pipe Length ft.	Capacity g.p.m.
	Type	
	Any not in use and not sealed well(s) on property? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Was a variance granted from the MDH for this Well? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 49588	
	License Business Name	North Star Drilling
	Name of Driller	
REMARKS, ELEVATION, SOURCE OF DATA, etc.		
S. CASS LAKE		
USGS Quad	Elevation	
Aquifer:	Alt Id:	

Report Copy

APPENDIX B – BORING LOGS

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROBE LOG NO: **GP-1**

PROJECT NAME: EEC Detection Monitoring

PROJ. NO.

PROJECT LOCATION: South Cass Lake Station, MN

CHECKED BY: DJH

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Brown, medium grained, well-sorted, moist SP sand		< 5	None Collected	None Recorded
	SP			< 5		
	SP			< 5		
	SP			< 5		
4 to 8	SP	Same SP sand as above. Slightly coarser 7-8 feet		< 5		
	SP			< 5		
	SP			< 5		
8 to 12	SP	Same SP sand as above.		< 5		
	SP			< 5		
	SP			< 5		
12 to 16	SP	Same SP sand as above.		20.5		
	SP			25.7		
	SP			26.3		
16 to 20	SP	Same SP sand as above.		28.2		
	SP			42.4		
	SP			242		
20 to 24	SP	Same SP sand as above. Faint petro odor. Wet at 24 feet		497		
	SP					
	SP					
24 to 28	SW	Coarsens to a SW sand at 25 feet Oil saturated from 24 to 26 feet				
	SW					
	SW					
	SW					

TOTAL DEPTH: 28 feet

DRILLING METHOD: Push-Probe

DRILLING DATE: 9/25/2001

INSPECTOR: DJH

WATER LEVEL OBSERVATION: 24 feet

CONTRACTOR: Their Well Company

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROBE LOG NO: **GP-2**

PROJECT NAME: EEC Detection Monitoring

PROJ. NO.

PROJECT LOCATION: South Cass Lake Station, MN

CHECKED BY: **DJH**

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Brown, medium grained, well-sorted, moist SP sand		< 5	None Collected	None Recorded
	SP			< 5		
	SP			< 5		
	SP			< 5		
4 to 8	SP	Same SP sand as above. Lighter color at 6 feet		< 5		
	SP			< 5		
	SP			< 5		
8 to 12	SP	Same SP sand as above.		< 5		
	SP			< 5		
	SP			< 5		
12 to 16	SP	Same SP sand as above.		< 5		
	SP			< 5		
	SP			< 5		
16 to 20	SP	Same SP sand as above.		< 5		
	SP			11.5		
	SP			7.6		
20 to 24	SP	Same SP sand as above.		15.4		
	SP			1082		
	SP			1093		
24 to 28	SP	Same SP as above, but slightly coarser. Wet at 25 feet. Oil saturated from 24-26 feet	▼			
	SP					
	SP					

TOTAL DEPTH: 28 feet	DRILLING METHOD: Push-Probe
DRILLING DATE: 9/25/2001	
INSPECTOR: DJH	WATER LEVEL OBSERVATION: 25 feet
CONTRACTOR: Their Well Company	

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROBE LOG NO: **GP-3**

PROJECT NAME: EEC Detection Monitoring

PROJ. NO.

PROJECT LOCATION: South Cass Lake Station, MN

CHECKED BY: **DJH**

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Brown, medium grained, well-sorted, moist SP sand	▼	< 5	Water: BTEX, DRO collected from water table	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above. Light brown color at 6 feet		< 5		
8 to 12	SP SP SP SP	Same SP sand as above. Coarser grained at 10.5 feet		< 5		
12 to 16	SP SP SP SP	Same SP sand as above. Finer grained at 13 feet		< 5		
16 to 20	SP SP SP SP	Same SP sand as above.		< 5		
20 to 24	SP SP SP SP	Same SP sand as above.		< 5		
24 to 28	SP SP SP SP	Wet at 24 feet Grades to a coarse grained, poorly-sorted, SW sand at 26 feet		< 5		
				20.2		
				15.7		

TOTAL DEPTH: 28 feet	DRILLING METHOD: Push-Probe
DRILLING DATE: 9/25/2001	
INSPECTOR: DJH	WATER LEVEL OBSERVATION: 24 feet
CONTRACTOR: Thein Well Company	22.72 feet following development

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-4
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Brown, medium grained, well-sorted, moist SP sand		< 5		
	SP					
	SP					
	SP					
4 to 8	SP	Same SP sand as above. Light brown color at 7 feet		< 5	Water: BTEX, DRO collected from water table	None Recorded
	SP					
	SP					
	SP					
8 to 12	SP	Same SP sand as above. Coarser grained at 10.5 feet		< 5		
	SP					
	SP					
	SP					
12 to 16	SP	Same SP sand as above.		< 5		
	SP					
	SP					
	SP					
16 to 20	SP	Same SP sand as above.		< 5		
	SP					
	SP					
	SP					
20 to 24	SP	Same SP sand as above. Becomes more fine grained at 22 feet.		< 5		
	SP					
	SP					
	SP					
24 to 28	SP	Same SP as above to 25 feet, then grades to a SW sand. Wet at 25 feet	▼	8.2		
	SP					
	SP					
	SP					
				6.3		
				7.2		

TOTAL DEPTH: 28 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Their Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 25 feet
 22.55 feet following development

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-5
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	TPSL SP SP SP	Black, organic-rich topsoil to 1 foot. Brown, medium grained, well-sorted, moist SP sand	24	< 5	Water: BTEX, DRO collected from water table	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above. Light brown color at 7 feet		< 5		
8 to 12	SP SP SP SP	Same SP sand as above.		< 5		
12 to 16	SP SP SP SP	Same SP sand as above.		< 5		
16 to 20	SP SP SP SP	Same SP sand as above. 1-inch thick silt layer at 20 feet.		< 5		
20 to 24	SP SP SP SP	Same SP sand as above. Becomes more fine grained at 22 feet. Wet at 24 feet		< 5		
24 to 28	SP SP SP SP	Same SP sand as above.		< 5		
				< 5		

TOTAL DEPTH: 28 feet	DRILLING METHOD: Push-Probe
DRILLING DATE: 9/25/2001	
INSPECTOR: DJH	WATER LEVEL OBSERVATION: 24 feet
CONTRACTOR: Thein Well Company	23.40 feet following development

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-6
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Black, organic-rich topsoil to 1 foot. Brown, medium grained, well-sorted, moist SP sand	▼	< 5	Water: BTEX, DRO collected from water table	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above. Light brown color at 5.5 feet		< 5		
8 to 12	SP SP SP SP	Same SP sand as above.		< 5		
12 to 16	SP SP SP SP	Same SP sand as above.		< 5		
16 to 20	SP SP SP SP	Same SP sand as above. 1-inch thick silt layer at 20 feet.		< 5		
20 to 24	SP SP SP SP	Same SP sand as above. Becomes more fine grained at 22 feet.		< 5		
24 to 28	SP SP SP SP	Wet at 24 feet Same SP sand as above.		< 5		
				< 5		

TOTAL DEPTH: 28 feet DRILLING DATE: 9/25/2001 INSPECTOR: DJH CONTRACTOR: Thein Well Company	DRILLING METHOD: Push-Probe WATER LEVEL OBSERVATION: 24 feet 22.32 feet following development
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NATURAL RESOURCES ENGINEERING COMPANY
13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-7
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Brown, medium grained, well-sorted, moist SP sand		< 5	None Collected	None Recorded
	SP			7.1		
	SP			12.3		
	SP			21.7		
4 to 8	SP	Same SP sand as above.		6.3		
	SP			7.9		
	SP			< 5		
	SP			< 5		
8 to 12	SP	Same SP sand as above. Light brown to gray color at 9 feet. Faint petroleum odor.		28.3		
	SP			32.6		
	SP			107		
	SP			337		
12 to 16	SP	Same SP sand as above.				
	SP					
	SP					
	SP					
16 to 20	SP	Same SP sand as above.				
	SP					
	SP					
	SP					
20 to 24	SP	Same SP sand as above. Oil saturated from 23-24 feet Wet at 24 feet				
	SP					
	SP					
	SP					

TOTAL DEPTH: 24 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Their Well Company

DRILLING METHOD: Push-Probe
 WATER LEVEL OBSERVATION: 24 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-8
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Brown, medium grained, well-sorted, moist SP sand		< 5		None Recorded
4 to 8	SP SP SP SP	Same SP sand as above. Light brown color at 7.5 feet		< 5		
8 to 12	SP SP SP SP	Same SP sand as above.		< 5		
12 to 16	SP SP SP SP	Same SP sand as above.		< 5		
16 to 20	SP SP SP SP	Same SP sand as above.		< 5		
20 to 24	SP SP SW SW	Same SP sand as above to 22 feet Then becomes coarser grained, poorly-sorted SW		< 5		
24 to 28	SP SP SP SP	Same SP sand as above. Wet at 26 feet		< 5		
				< 5		

TOTAL DEPTH: 28 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 26 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

PROBE LOG NO: GP-9

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Brown, medium grained, well-sorted, moist SP sand	▼	< 5	None Collected	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above. Lighter color at 6 feet.		< 5		
8 to 12	SP SP SP SP	Same SP sand as above. Gray color at 11 feet.		< 5		
12 to 16	SP SP SP SP	Same SP sand as above.		7.3		
16 to 20	SP SP SP SP	Same SP sand as above.		14.6		
20 to 24	SP SP SP SP	Same SP sand as above.		17.9		
24 to 28	SP SP SP SP	Same SP as above to 26 feet, then coarsens to a SW sand. Oil saturated from 24-26 feet Wet at 25 feet		28.4		
				29.0		
			47.6			
			56.3			
			787			
			802			

TOTAL DEPTH: 28 feet

DRILLING DATE: 9/25/2001

INSPECTOR: DJH

CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-10
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE				SOIL SAMPLE DATA		
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4		Not Sampled		< 5	Analytical Samples: Water: BTEX, DRO collected from water table	None Recorded
4 to 8		Not Sampled				
8 to 12		Not Sampled				
12 to 16		Not Sampled				
16 to 20		Not Sampled				
20 to 24		Not Sampled				
24 to 26	SP SP	Brown, medium grained, well-sorted, moist SP sand				

TOTAL DEPTH: 26 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe
 WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

PROBE LOG NO: GP-11

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4		Not Sampled		12.8		None Recorded
4 to 8		Not Sampled				
8 to 12		Not Sampled				
12 to 16		Not Sampled				
16 to 20		Not Sampled				
20 to 24		Not Sampled				
24 to 26	SP SP	Brown, medium grained, well-sorted, moist SP sand				

TOTAL DEPTH: 26 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe
 WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-12
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Brown, medium grained, well-sorted, moist SP sand		< 5	None Collected	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above.		< 5		
8 to 12	SP	Same SP sand as above to 9 feet, then coarsens to a SW.		10.6		
	SW		13.2			
	SW		14.1			
12 to 16	SP	Grades back to a SP sand at 12 feet.		14.6		
	SP		14.8			
	SP		16.2			
	SP		20.3			
20 to 24	SP	Same SP sand as above.		29.5		
	SP		32.3			
	SP		34.1			
	SP		107			
24 to 28	SP	Same SP sand as above.		538		
	SP					
		Stained 1/2-inch thick at 27 feet. Wet at 27 feet				

TOTAL DEPTH: 28 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 27 feet

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-13
 PROJ. NO.
 CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Brown, medium grained, well-sorted, moist SP sand		< 5		
	SP					
	SP					
	SP					
4 to 8	SP	Same SP sand as above.		< 5	None Collected	None Recorded
	SP					
	SP					
8 to 12	SP	Same SP sand as above. Lighter brown color.		< 5		
	SP					
	SP					
	SP					
12 to 16	SP	Same SP sand as above.		5.7		
	SP					
	SP					
	SP					
16 to 20	SP	Same SP sand as above.		7.3		
	SP					
	SP					
	SP					
20 to 24	SP	Same SP sand as above.		20.7		
	SP					
	SP					
	SP					
		Oil stained 23-24 feet Wet at 24 feet		1630		
			▼	1198		

TOTAL DEPTH: 24 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Their Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 24 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

PROBE LOG NO: GP-14

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Brown, medium grained, well-sorted, moist SP sand		< 5	None Collected	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above.		< 5		
8 to 12	SW	Grades to a coarse grained, poorly-sorted, moist, SW sand.		< 5		
	SW			< 5		
	SW			< 5		
12 to 16	SP	Grades back to a SP sand at 12 feet.		< 5		
	SP			< 5		
	SP			< 5		
16 to 20	SP	Same SP sand as above.		< 5		
	SP			< 5		
	SP			< 5		
20 to 24	SP	Same SP sand as above.		< 5		
	SP		< 5			
	SP		< 5			
24 to 28	SP	Same SP sand as above to 27 feet, then grades to a SW sand. Oil stained from 26-27.5 Wet at 27.5 feet	< 5			
	SP		25.2			
	SP		954			

TOTAL DEPTH: 28 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 27.5 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

PROBE LOG NO: GP-15

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4		Not Sampled			Water: BTEX, DRO collected from water table	None Recorded
4 to 8		Not Sampled				
8 to 12		Not Sampled				
12 to 16		Not Sampled				
16 to 20		Not Sampled				
20 to 24		Not Sampled				
24 to 26	SP SP	Brown, medium grained, well-sorted, moist SP sand				
				< 5		

TOTAL DEPTH: 26 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROBE LOG NO: **GP-16**

PROJECT NAME: **EEC Detection Monitoring**

PROJ. NO.

PROJECT LOCATION: **South Cass Lake Station, MN**

CHECKED BY: **DJH**

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4		Not Sampled			Water: BTEX, DRO collected from water table	None Recorded
4 to 8		Not Sampled				
8 to 12		Not Sampled				
12 to 16		Not Sampled				
16 to 20		Not Sampled				
20 to 24		Not Sampled				
24 to 26	SP SP	Brown, medium grained, well-sorted, moist SP sand				

TOTAL DEPTH: 26 feet
 DRILLING DATE: 9/25/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-17
 PROJ. NO.
 CHECKED BY: BDH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Topsoil, with organic material to 6", then fine-grained, well sorted dry sand.			Water: BTEX and ERDRO at watertable.	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above to 6'. Then a 4" thick silt layer. Then SP again to the end of the interval.				
8 to 12	SP SP SP SP	Same SP sand as above.				
12 to 16	SP SP SP SP	Same SP sand as above.				
16 to 20	SP SP SP SP	Same SP sand as above.				
20 to 24	SP SP SP SP	Same SP sand as above.				
24 to 28	SP SP SP SP	Same SP sand as above. Fine-grained SP at 28'. Wet at 26 feet				

TOTAL DEPTH: 28 feet
 DRILLING DATE: 8/14/2002
 INSPECTOR: DJH
 CONTRACTOR: MESA

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 26 feet

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

PROBE LOG NO: GP-18

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: BDH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP	Organic rich topsoil with roots to 6". Then brown, fine-grained, well-sorted, dry SP sand.		<5.0		
	SP					
	SP					
	SP					
4 to 8	SP	Same SP sand as above. Slightly coarse grained sand.		<5.0	Water: BTEX and ERDRO at watertable.	None Recorded
	SP					
	SP					
	SP					
8 to 12	SP	Same SP sand as above. Alternates between fine and medium grained.		<5.0		
	SP					
	SP					
	SP					
12 to 16	SP	Same SP sand as above.		<5.0		
	SP					
	SP					
	SP					
16 to 20	SP	Same SP sand as above.		<5.0		
	SP					
	SP					
	SP					
20 to 24	SP	Same SP sand as above to 22', then becomes a medium grained SW.		<5.0		
	SP					
	SW					
	SW					
24 to 27	SW	Same SW as above. Fine-grained SP at 28'. Wet at 25 feet		<5.0		
	SW					
	SW					
	SW					

TOTAL DEPTH: 27 feet
 DRILLING DATE: 8/14/2002
 INSPECTOR: DJH
 CONTRACTOR: MESA

DRILLING METHOD: Push-Probe
 WATER LEVEL OBSERVATION: 25 feet

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring PROBE LOG NO: GP-19
 PROJECT LOCATION: South Cass Lake Station, MN PROJ. NO. _____
 CHECKED BY: BDH

SUBSURFACE PROFILE

Interval (feet)	USCS	Description	Depth (Ft.)	SOIL SAMPLE DATA			
				OVM (ppm)	Analytical Sample Analysis	Blows/6"	
0 to 4	SP SP SP SP	Organic rich topsoil with roots to 6". Then brown, fine-grained, well-sorted, dry SP sand.		<5.0	Water: BTEX and ERDRO at watertable.	None Recorded	
4 to 8	SP SW SW SW	Same SP sand as above to 5'. Then medium grained and poorly to moderately sorted SW sand.		<5.0 <5.0 <5.0			
8 to 12	SW SP SP SP	Same SW as above to 9'. Then back to well-sorted, fine-grained SP sand.		<5.0 <5.0			
12 to 16	SP SP SP SP	Same SP sand as above. Medium grained from 12-14', then fine grained SP sand.		<5.0 <5.0			
16 to 20	SP SP SP SP	Same SP sand as above.		<5.0 <5.0			
20 to 24	SP SP GP GP	Grades to a fine grained gravel or coarse sand at 23'.		<5.0 <5.0			
24 to 26	GP GP GP GP	Same GP as above. Fine-grained SP at 28'. Wet at 25.5 feet	▼	<5.0 <5.0			

TOTAL DEPTH: 26 feet DRILLING METHOD: Push-Probe
 DRILLING DATE: 8/14/2002
 INSPECTOR: DJH WATER LEVEL OBSERVATION: 25.5 feet
 CONTRACTOR: MESA

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring
 PROJECT LOCATION: South Cass Lake Station, MN

PROBE LOG NO: GP-20

PROJ. NO.
 CHECKED BY: BDH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Fl.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 4	SP SP SP SP	Light brown, fine grained, well sorted, dry SP sand.	▼	<5.0	Water: BTEX and ERDRO at watertable.	None Recorded
4 to 8	SP SP SP SP	Same SP sand as above (moist).		<5.0		
8 to 12	SP	Same SP as above.		<5.0		
	SP SP SP	Slightly coarser grained SP sand.		<5.0		
12 to 16	SP	Same SP sand as above.		<5.0		
	SP SP			<5.0		
	SP			<5.0		
16 to 20	SP	Same SP sand as above.		<5.0		
	SP SP			<5.0		
	SP			<5.0		
20 to 26	SW	Grades up to a coarser SW sand.	<5.0			
	SW SW		<5.0			
	SW	Same SW as above.	<5.0			
26 to 30	SW	Same SW as above to 28', then becomes a silty sand.	<5.0			
	SW		<5.0			
	SM	Wet at 26'.	<5.0			
	SM		<5.0			

TOTAL DEPTH: 30 feet
 DRILLING DATE: 8/13/2002
 INSPECTOR: DJH
 CONTRACTOR: MESA

DRILLING METHOD: Push-Probe

WATER LEVEL OBSERVATION: 26 feet

NATURAL RESOURCES ENGINEERING COMPANY
13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring BORING LOG NO: WW-1
PROJECT LOCATION: South Cass Lake Station, MN PROJ. NO.
CHECKED BY: DJH

SUBSURFACE PROFILE			SOIL SAMPLE DATA			
Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
1	TPSL/SP	Black, organic topsoil to 1/2-foot.				
2	SP	Then brown, medium-grained, well-sorted, dry sand. SP		< 5	None Collected	None
3	SP			< 5		
4	SP			< 5		
5	SW			< 5		
6	SW			< 5		
7	SW	Brown, medium grained, well-graded, SW sand		< 5		Recorded
8	SW			< 5		
9	SW			< 5		
10	SW			< 5		
11	SW			< 5		
12	SW	Same SW as above. Grades to SP at 11 feet		< 5		
13	SP			< 5		
14	SP			< 5		
15	SP			< 5		
16	SW			< 5		
17	SP	Grades back to SW from 15-16 feet Then same SP as above		< 5		
18	SP			< 5		
19	SP			< 5		
20	SP			< 5		
21	SP			< 5		
22	SP	Wet at 24.5 feet		< 5		
23	SP			< 5		
24	SP			< 5		
25	SP			< 5		
26	SP			< 5		
27	SP	Same SP as above		< 5		
28	SP			< 5		
29	SP			< 5		
30	SP			< 5		
31	SP			< 5		
32	SP	Same SP as above		< 5		
33	SW			< 5		
34	SW			< 5		
35	SW			< 5		
36	SW			< 5		
37	SW	Grades back to SW at 32 feet		< 5		
38	SW			< 5		
39	SW			< 5		
40	SW			< 5		
41	SW			< 5		
42	SW	Same SW as above		< 5		
43	SW			< 5		
44	SW			< 5		
45	SW			< 5		
46	SW			< 5		

TOTAL DEPTH: 46 feet DRILLING METHOD: Hollow Stem Auger
DRILLING DATE: 5/21/2001 WATER LEVEL OBSERVATION: 24.1 feet
INSPECTOR: DJH
CONTRACTOR: Their Well Company

NATURAL RESOURCES ENGINEERING COMPANY

13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

BORING LOG NO: MW-2

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SOIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
1 to 5	TPSL/SP	Black, organic topsoil to 1/2-foot.		< 5	None Collected	None Recorded
	SP	Then brown, medium-grained, well-sorted		< 5		
	SP	poorly-graded, SP sand. Dry.				
	SP					
8 to 10	SP	Same SP as above		< 5		
	SP					
13 to 15	SP	Same SP as above		< 5		
	SP					
18 to 20	SP	Same SP as above		< 5		
	SP					
24	SP	Same SP as above		< 5		
25	SP	Wet at 24 feet.	▼	< 5		
26	SP	Same wet SP as above		< 5		
27	SP					
28	SP					
29	SP					
30	SP					

TOTAL DEPTH: 30 feet

DRILLING DATE: 5/22/2001

INSPECTOR: DJH

CONTRACTOR: Thein Well Company

DRILLING METHOD: Hollow Stem Auger

WATER LEVEL OBSERVATION: 24 feet

NATURAL RESOURCES ENGINEERING COMPANY
 13 W. Superior St. Duluth, MN 55802

PROJECT NAME: EEC Detection Monitoring

BORING LOG NO: MW-4

PROJECT LOCATION: South Cass Lake Station, MN

PROJ. NO.

CHECKED BY: DJH

SUBSURFACE PROFILE

SCIL SAMPLE DATA

Interval (feet)	USCS	Description	Depth (Ft.)	OVM (ppm)	Analytical Sample Analysis	Blows/6"
0 to 5	TPSL/SP SP SP SP	Black, organic topsoil to 1/2-foot. Then brown, medium-grained, well-sorted poorly-graded, SP sand. Dry.		< 5 < 5	None Collected	None Recorded
8 to 10	SW SW	Light brown, medium to coarse grained, poorly-sorted, moist sand.		< 5		
13 to 15	SP SP	Grades back to a SP sand		< 5		
18 to 20	SP SP	Same SP as above		< 5		
24	SP	Same SP as above		< 5		
25	SP	Wet at 25 feet.		< 5		
26	SP			< 5		
27	SP			< 5		
28	SP			< 5		
29	SP	Same wet SP as above		< 5		
30	SP			< 5		

TOTAL DEPTH: 30 feet
 DRILLING DATE: 5/21/2001
 INSPECTOR: DJH
 CONTRACTOR: Thein Well Company

DRILLING METHOD: Hollow Stem Auger
 WATER LEVEL OBSERVATION: 25 feet

APPENDIX C – MONITORING WELL CONSTRUCTION LOGS

Monitoring Well Construction Information

WELL DESIGNATION MW-3

PROJECT EEC - South Cass Lake

DRILLER Thein Well Company

COMPLETION DATE 5/22/2001

Elev.(± 0.01')
(Grade Elevation)

CONCRETE SURFACE SEAL:

Y/N Y

Elev.(± 0.01') 1337.27
(Top of Inner Casing w/o Cover)

OUTER CASING:

Type Carbon Steel
Diameter 4 inches
Total Length 5 feet
Lock Yes

State Plane N 651936.1793
Coord.: E 2243713.883

INNER CASING:

Type PVC
Diameter 2-inch
Total Length 19 feet
Sections Used 2
Joints 1

Method of Advance:
 Hollow Stem Auger

Borehole Diameter: 8 inches

Drilling Fluid: None

GROUT ABOVE SEAL:
 Neat Cement Grout

SEALING MATERIAL:
 Bentonite Chips

FILTER MATERIAL:
 # 30 Red Flint Sand

Depth to Bottom
of Grout : 15 feet

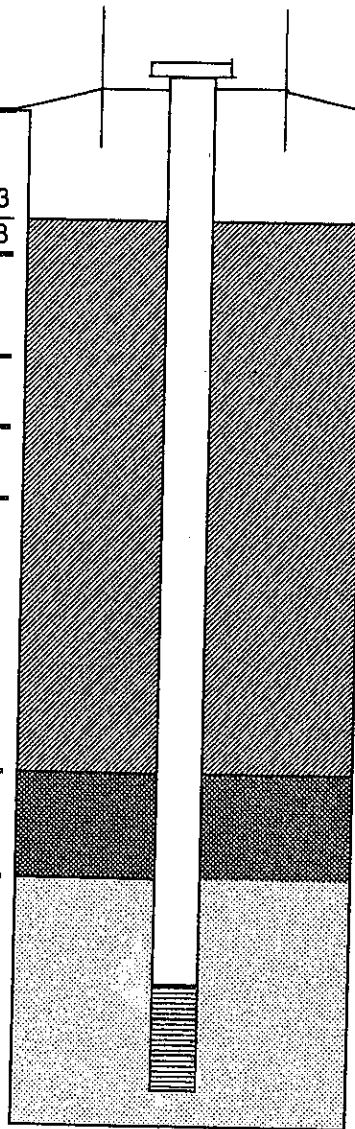
Depth to Bottom
of Seal : 17 feet

Depth to top of
Screen : 19 feet

Depth to Bottom
of Boring : 29 feet

Depth to First
Water Encountered
during Drilling : 24 feet

Depth to Water Level
before Installation : 24 feet



**Note: All depths are from
Ground Level

SCREEN:
Type PVC
Length 10 feet
Diameter 2-inch
Slot Size 0.01-inch

PUMP:
Type N/A
Length N/A
Diameter N/A

METHOD OF DEVELOPMENT: Surge with weighted bailer and dewater with Brainard-Kilman Pump

CONSTRUCTION NOTES:

Monitoring Well Construction Information

WELL DESIGNATION MW-6

PROJECT EEC - South Cass Lake

DRILLER Thein Well Company

COMPLETION DATE 11/19/2002

Elev.(± 0.01') 1321.60
(Grade Elevation)

Elev.(± 0.01') 1323.55
(Top of Inner Casing w/o Cover)

State Plane N 651762.4858
Coord.: E 2243525.5902

Method of Advance:
 Hollow Stem Auger

Borehole Diameter: 8 inches

Drilling Fluid: None

Depth to Bottom of Grout : 20 feet

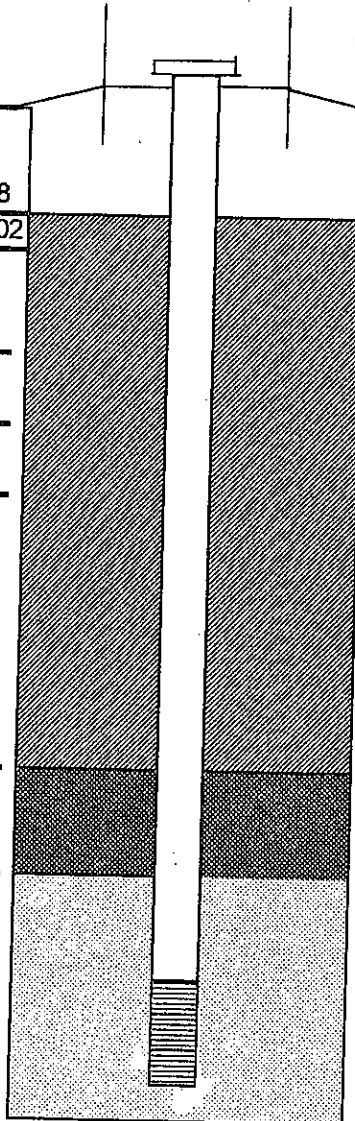
Depth to Bottom of Seal : 22 feet

Depth to top of Screen : 24 feet

Depth to Bottom of Boring : 36 feet

Depth to First Water Encountered during Drilling :

Depth to Water Level before Installation :



**Note: All depths are from Ground Level

CONCRETE SURFACE SEAL:

Y/N Y

OUTER CASING:

Type Carbon Steel
Diameter 4 inches
Total Length 5 feet
Lock Yes

INNER CASING:

Type PVC
Diameter 2-inch
Total Length 24 feet
Sections Used 3
Joints 2

GROUT ABOVE SEAL:
 Neat Cement Grout

SEALING MATERIAL:
 Bentonite Chips

FILTER MATERIAL:
 # 30 Red Flint Sand

SCREEN:

Type PVC
Length 10 feet
Diameter 2-inch
Slot Size 0.01-inch

PUMP:

Type N/A
Length N/A
Diameter N/A

METHOD OF DEVELOPMENT: Surge with weighted bailer and dewater with Brainard-Kilman Pump

CONSTRUCTION NOTES:

Monitoring Well Construction Information

WELL DESIGNATION MW-8

PROJECT EEC - South Cass Lake

DRILLER Thein Well Company

COMPLETION DATE 11/20/2002

Elev.(± 0.01') 1321.80
(Grade Elevation)

CONCRETE SURFACE SEAL:

Y/N Y

Elev.(± 0.01') 1323.85
(Top of Inner Casing w/o Cover)

OUTER CASING:

Type Carbon Steel
Diameter 4 inches
Total Length 5 feet
Lock Yes

State Plane N 651721.0749
Coord.: E 2244083.1014

INNER CASING:

Type PVC
Diameter 2-inch
Total Length 24 feet
Sections Used 3
Joints 2

Method of Advance:
Hollow Stem Auger

Borehole Diameter: 8 inches

Drilling Fluid: None

GROUT ABOVE SEAL:
Neat Cement Grout

Depth to Bottom of Grout : 19 feet

SEALING MATERIAL:
Bentonite Chips

Depth to Bottom of Seal : 21 feet

FILTER MATERIAL:
30 Red Flint Sand

Depth to top of Screen : 24 feet

SCREEN:
Type PVC
Length 10 feet
Diameter 2-inch
Slot Size 0.01-inch

Depth to Bottom of Boring : 34 feet

PUMP:
Type N/A
Length N/A
Diameter N/A

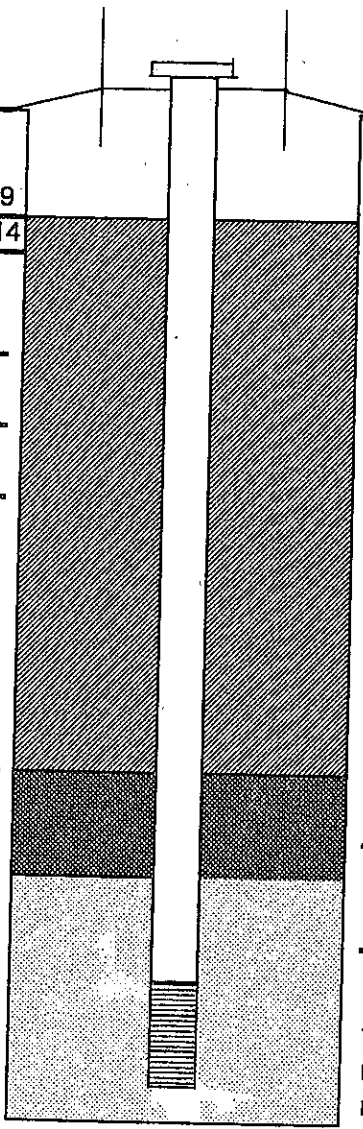
Depth to First Water Encountered during Drilling :

**Note: All depths are from Ground Level

Depth to Water Level before Installation :

METHOD OF DEVELOPMENT: Surge with weighted bailer and dewater with Brainard-Kilman Pump

CONSTRUCTION NOTES:



Monitoring Well Construction Information

WELL DESIGNATION MW-9

PROJECT EEC - South Cass Lake

DRILLER Thein Well Company

COMPLETION DATE 11/19/2002

Elev.(± 0.01') 1319.03
(Grade Elevation)

CONCRETE SURFACE SEAL:

Y/N Y

Elev.(± 0.01') 1321.10
(Top of Inner Casing w/o Cover)

OUTER CASING:

Type Carbon Steel
Diameter 4 inches
Total Length 5 feet
Lock Yes

State Plane N 651788.2945
Coord.: E #####

INNER CASING:

Type PVC
Diameter 2-inch
Total Length 22 feet
Sections Used 3
Joints 2

Method of Advance:
 Hollow Stem Auger

Borehole Diameter: 8 inches

Drilling Fluid: None

GROUT ABOVE SEAL:
 Neat Cement Grout

Depth to Bottom
of Grout : 17 feet

SEALING MATERIAL:
 Bentonite Chips

Depth to Bottom
of Seal : 19 feet

FILTER MATERIAL:
 # 30 Red Flint Sand

Depth to top of
Screen : 22 feet

SCREEN:
Type PVC
Length 10 feet
Diameter 2-inch
Slot Size 0.01-inch

Depth to Bottom
of Boring : 32 feet

PUMP:
Type N/A
Length N/A
Diameter N/A

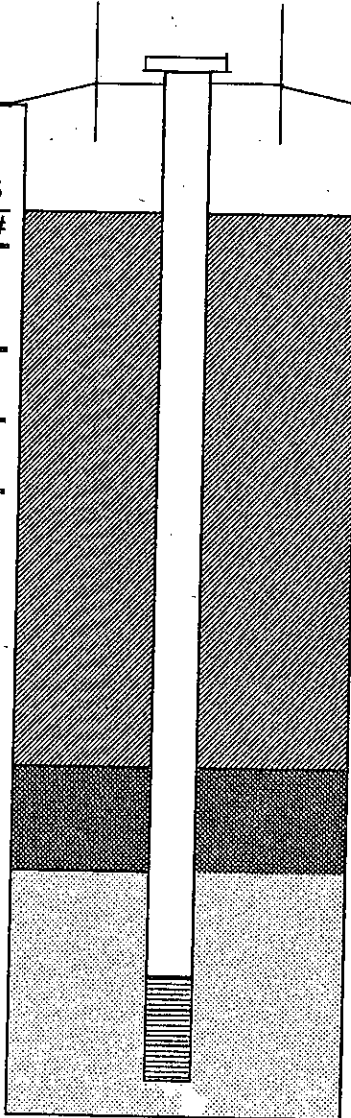
Depth to First
Water Encountered
during Drilling :

**Note: All depths are from
Ground Level

Depth to Water Level
before Installation :

METHOD OF DEVELOPMENT: Surge with weighted bailer and dewater with Brainard-Kilman Pump

CONSTRUCTION NOTES:



APPENDIX D – LABORATORY ANALYTICAL REPORTS

Analytical Report Number: 836821

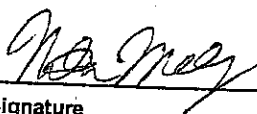
Client : NREC

Project Name : SOUTH CASS LAKE

Project Number :

Lab Sample Number	Field ID	Matrix	Collection Date
836821-001	MW-1	WATER	07/16/03
836821-002	MW-2	WATER	07/16/03
836821-003	MW-4	WATER	07/16/03
836821-004	MW-6	WATER	07/16/03
836821-005	MW-7	WATER	07/16/03
836821-006	MW-8	WATER	07/16/03
836821-007	MW-9	WATER	07/16/03
836821-008	TRIP BLANK	WATER	07/16/03

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.


Approval Signature

8/06/03
Date

Analytical Report Number: 836821

Client : NREC
Project Name : SOUTH CASS LAKE
Project Number :
Field ID : MW-1

Matrix Type : WATER
Collection Date : 07/16/03
Report Date : 08/06/03
Lab Sample Number : 836821-001

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	107	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-32		1					

Analytical Report Number: 836821

Client : NREC
 Project Name : SOUTH CASS LAKE
 Project Number :
 Field ID : MW-2

Matrix Type : WATER
 Collection Date : 07/16/03
 Report Date : 08/06/03
 Lab Sample Number : 836821-002

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	107	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-32		1					

Analytical Report Number: 836821

Client : NREC
 Project Name : SOUTH CASS LAKE
 Project Number :
 Field ID : MW-4

Matrix Type : WATER
 Collection Date : 07/16/03
 Report Date : 08/06/03
 Lab Sample Number : 836821-003

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	108	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-32		1					

Analytical Report Number: 836821

Client : NREC
 Project Name : SOUTH CASS LAKE
 Project Number :
 Field ID : MW-6

Matrix Type : WATER
 Collection Date : 07/16/03
 Report Date : 08/06/03
 Lab Sample Number : 836821-004

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	99	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-33		1					

Analytical Report Number: 836821

Client : NREC
Project Name : SOUTH CASS LAKE
Project Number :
Field ID : MW-7

Matrix Type : WATER
Collection Date : 07/16/03
Report Date : 08/06/03
Lab Sample Number : 836821-005

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	98	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-33		1					

Analytical Report Number: 836821

Client : NREC

Project Name : SOUTH CASS LAKE

Project Number :

Field ID : MW-8

Matrix Type : WATER

Collection Date : 07/16/03

Report Date : 08/06/03

Lab Sample Number : 836821-006

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	99	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-33		1					

Analytical Report Number: 836821

Client : NREC
 Project Name : SOUTH CASS LAKE
 Project Number :
 Field ID : MW-9

Matrix Type : WATER
 Collection Date : 07/16/03
 Report Date : 08/06/03
 Lab Sample Number : 836821-007

DRO Extended Range C10-C40

Prep Date: 07/22/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
DRO Ext. Range C10 - C40	< 100	100	1	ug/L		07/31/03	WI MOD DRO	WI MOD DRO

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	0.51	J 1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	98	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-33		1					

Analytical Report Number: 836821

Client : NREC

Project Name : SOUTH CASS LAKE

Project Number :

Field ID : TRIP BLANK

Matrix Type : WATER

Collection Date : 07/16/03

Report Date : 08/06/03

Lab Sample Number : 836821-008

BTEX

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
Benzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Ethylbenzene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Toluene	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylene, o	< 1.0	1.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
Xylenes, m + p	< 2.0	2.0	1	ug/l		07/23/03	SW846 5030B	SW846 M8021B
a,a,a-Trifluorotoluene	98	—	1	%Recov		07/23/03	SW846 5030B	SW846 M8021B

BTEX BLANK

Prep Date: 07/23/03

Analyte	Result	EQL	Dilution	Units	Code	Analysis Date	Prep Method	Analysis Method
BTEX Blank ID	1275-33		1					

Qualifier Codes

Flag	Applies To	Explanation
A	Inorganic	Analyte is detected in the method blank. Method blank criteria is evaluated to the laboratory method detection limit. Additionally, method blank acceptance may be based on project specific criteria or determined from analyte concentrations in the sample and are evaluated on a sample by sample basis.
B	Inorganic	The analyte has been detected between the method detection limit and the reporting limit.
B	Organic	Analyte is present in the method blank. Method blank criteria is evaluated to the laboratory method detection limit. Additionally, method blank acceptance may be based on project specific criteria or determined from analyte concentrations in the sample and are evaluated on a sample by sample basis.
C	All	Elevated detection limit.
D	All	Analyte value from diluted analysis or surrogate result not applicable due to sample dilution.
E	Inorganic	Estimated concentration due to matrix interferences. During the metals analysis using the inductively coupled plasma (ICP), the serial dilution failed to meet the established control limits of 0-10% and the sample concentration is greater than 50 times the IDL (100 times the IDL for analysis done on the ICP-MS). The result was flagged with the E qualifier to indicate that a physical interference was observed.
E	Organic	Analyte concentration exceeds calibration range.
F	Inorganic	Due to potential interferences for this analysis by Inductively Coupled Plasma techniques (SW-846 Method 6010), this analyte has been confirmed by and reported from an alternate method.
F	Organic	Surrogate results outside control criteria.
H	All	Preservation, extraction or analysis performed past holding time.
J	Inorganic	The analyte has been detected between the method detection limit and the reporting limit.
J	Organic	Concentration detected is greater than the method detection limit but less than the reporting limit.
K	Inorganic	Sample received unpreserved. Sample was either preserved at the time of receipt or at the time of sample preparation.
K	Organic	Detection limit may be elevated due to the presence of an unrequested analyte.
L	All	Elevated detection limit due to low sample volume.
N	All	Spiked sample recovery not within control limits.
P	Organic	The relative percent difference between the two columns for detected concentrations was greater than 40%.
Q	All	The analyte has been detected between the limit of detection (LOD) and limit of quantitation (LOQ). The results are qualified due to the uncertainty of analyte concentrations within this range.
S	Organic	The relative percent difference between quantitation and confirmation columns exceeds internal quality control criteria. Because the result is unconfirmed, it has been reported as a non-detect with an elevated detection limit.
U	All	The analyte was not detected at or above the reporting limit.
V	All	Sample received with headspace.
W	All	A second aliquot of sample was analyzed from a container with headspace.
X	All	See Sample Narrative.
&	All	Laboratory Control Spike recovery not within control limits.
*	All	Precision not within control limits.
<	All	The analyte was not detected at or above the reporting limit.
1	Inorganic	Dissolved analyte or filtered analyte greater than total analyte; analyses passed QC based on precision criteria.
2	Inorganic	Dissolved analyte or filtered analyte greater than total analyte; analyses failed QC based on precision criteria.
3	Inorganic	BOD result is estimated due to the BOD blank exceeding the allowable oxygen depletion.
4	Inorganic	BOD duplicate precision not within control limits. Due to the 48 hour holding time for this test, it is not practical to reanalyze and try to correct the deficiency.
5	Inorganic	BOD result is estimated due to insufficient oxygen depletion. Due to the 48 hour holding time for this test, it is not practical to reanalyze and try to correct the deficiency.
6	Inorganic	BOD laboratory control sample not within control limits. Due to the 48 hour holding time for this test, it is not practical to reanalyze and try to correct the deficiency.
7	Inorganic	BOD result is estimated due to complete oxygen depletion. Due to the 48 hour holding time for this test, it is not practical to reanalyze and try to correct the deficiency.

En Chem Inc.

Analysis Summary by Laboratory

1241 Bellevue Street
Green Bay, WI 54302

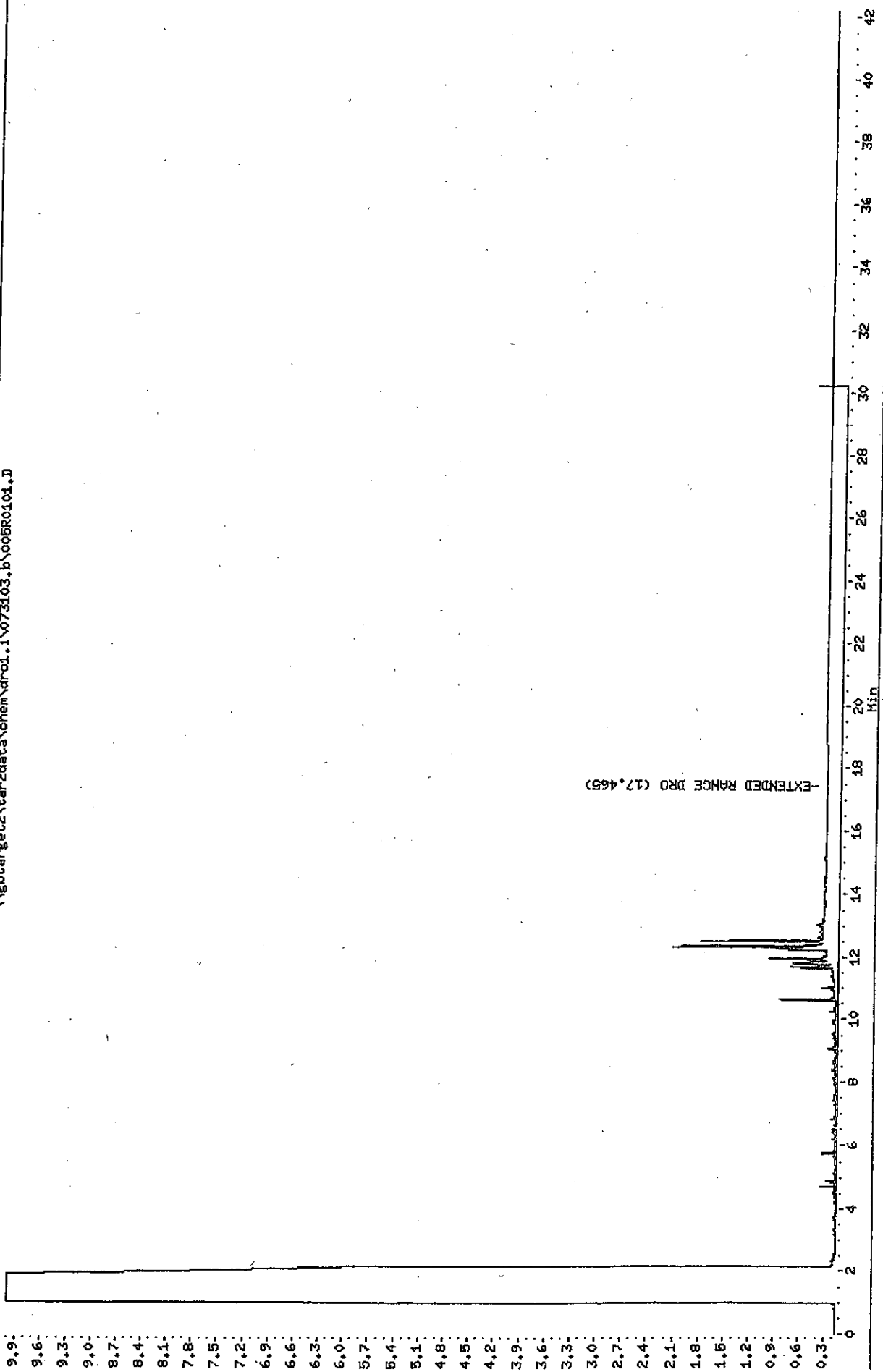
1090 Kennedy Avenue
Kimberly, WI 54136

Test Group Name	836821-001	836821-002	836821-003	836821-004	836821-005	836821-006	836821-007	836821-008
BTEX	G	G	G	G	G	G	G	G
BTEX BLANK	G	G	G	G	G	G	G	G
DRO Extended Range C10-C40	G	G	G	G	G	G	G	G

Minnesota Certification	
G = En Chem Green Bay	055-999-334
K = En Chem Kimberly	055-999-107
S = Subcontracted Analysis	

Client ID: 836821-001
Sample Info: 36821E001MUK1
Volume Injected (ul): 2.0
Column phase: RTX-5/1.G.
Instrument: drof.i
Operator: KEG
Column diameter: 0.53

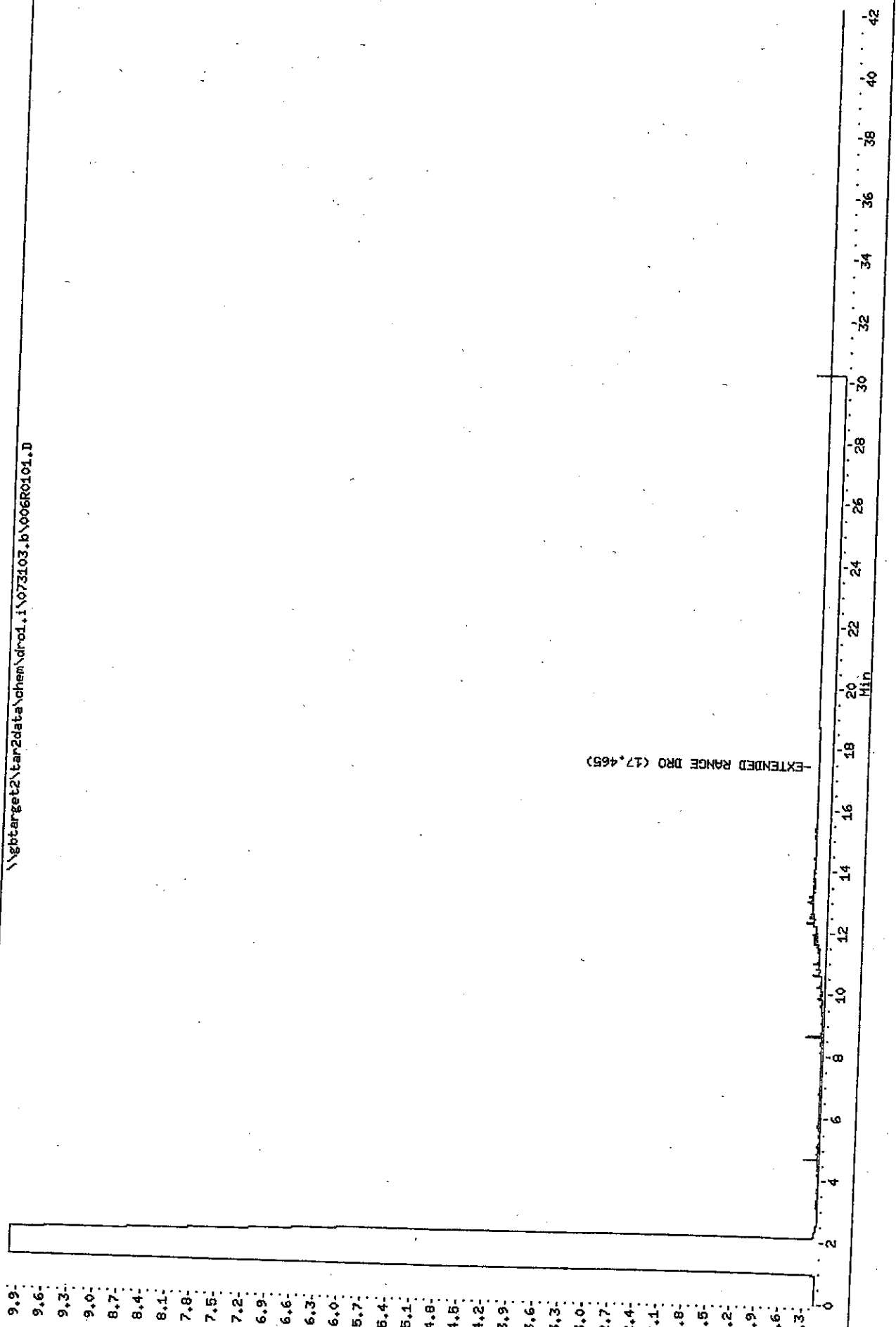
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file: \\gbtarget2\bar2data\chem\dro1.1\073103.b\006R0101.D
Date: 31-JUL-2003 15:10
Client ID: 836821-002
Sample Info: 36821E002MUX1
Volume Injected (ul): 2.0
Column phase: RTX-B/1.G.

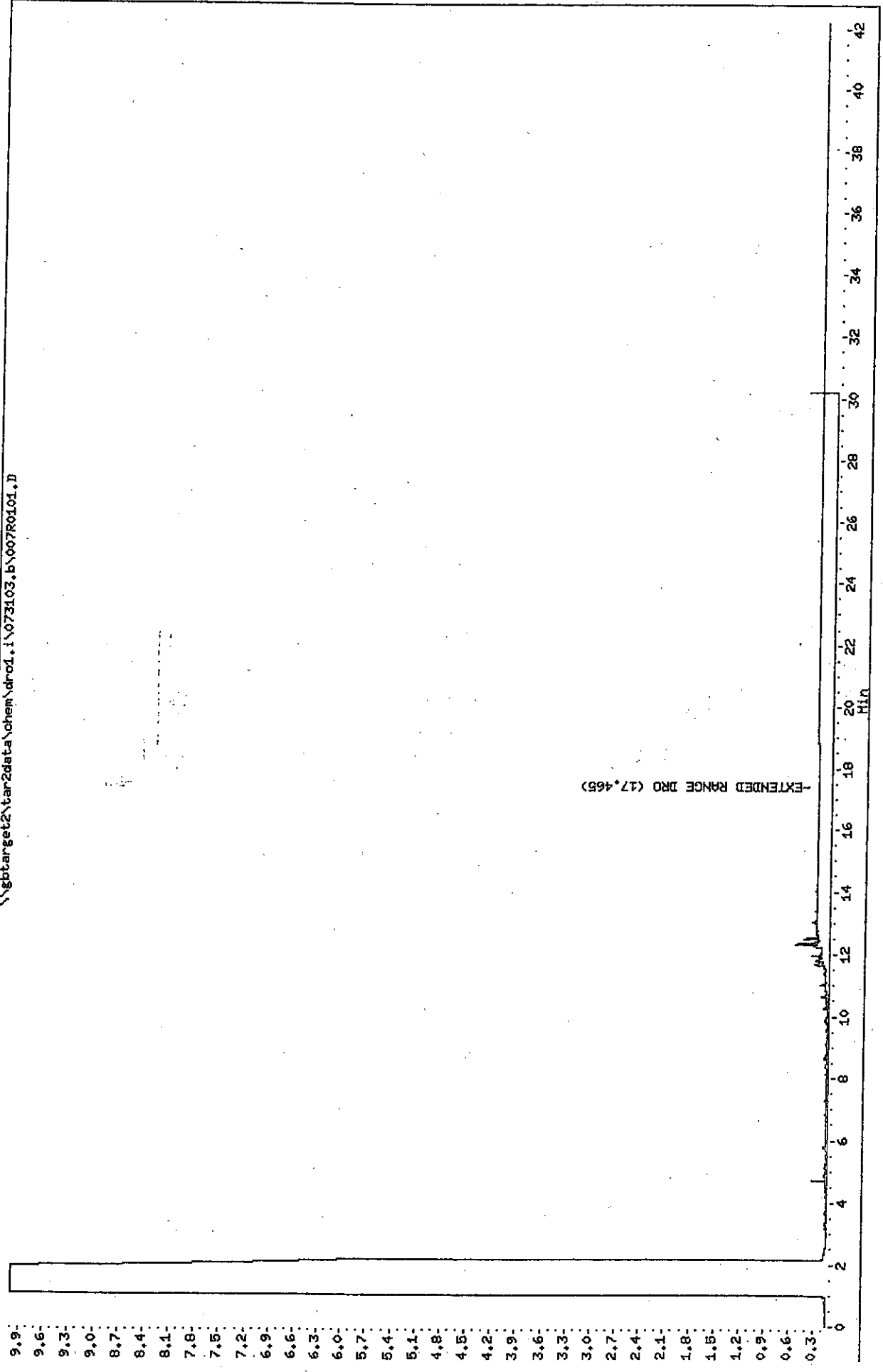
Instrument: dro1.f
Operator: KEG
Column diameter: 0.53

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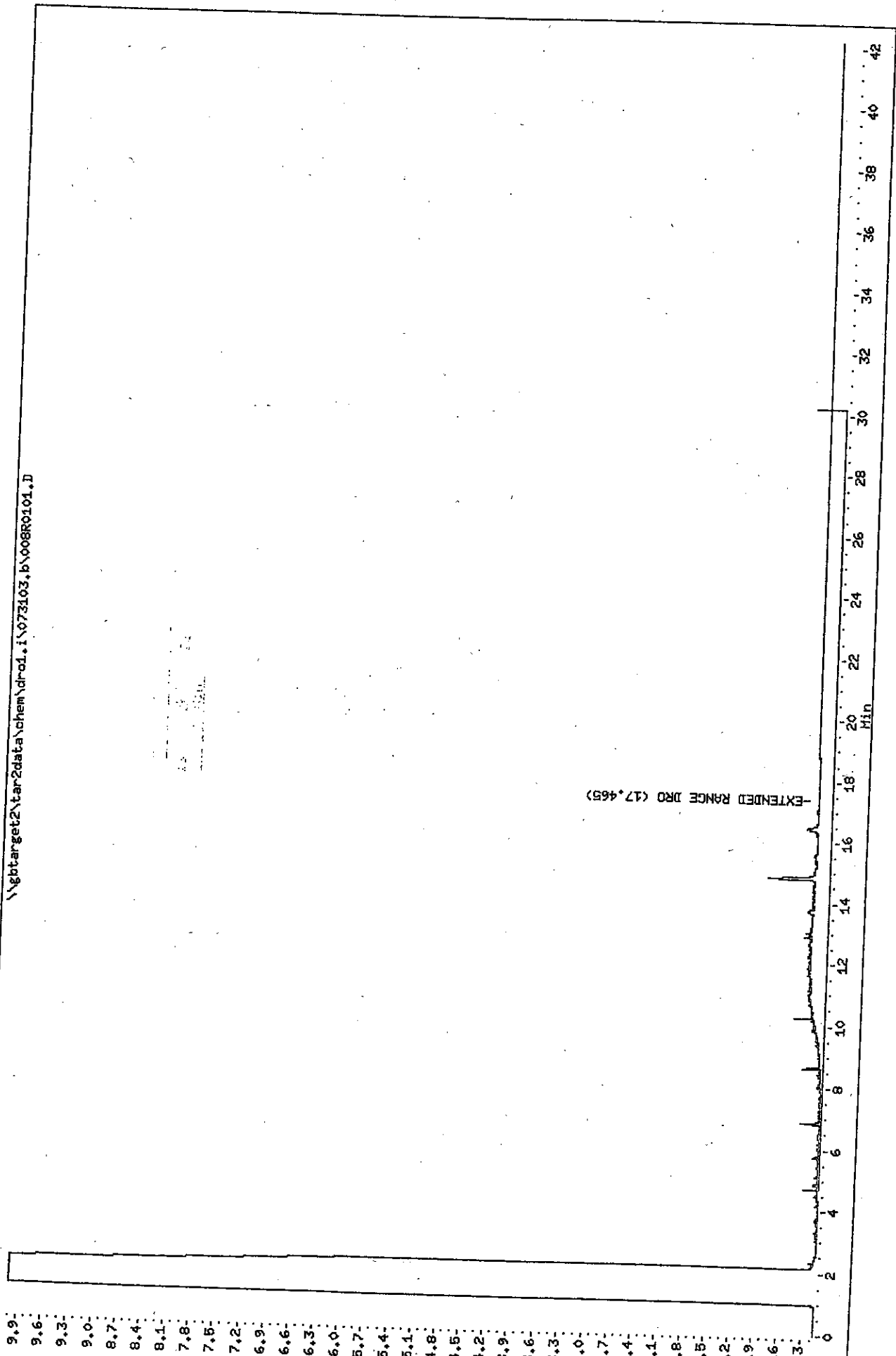
\\gwserver\get2\data\chem\drof.i\073103.b\007R0101.D
Date: 31-JUL-2003 15:57
Client ID: 836824-003
Sample Info: 36821E003MUK1
Volume Injected (uL): 2.0
Column phase: RTX-5/1.G.

Instrument: drof.i
Operator: KEG
Column diameter: 0.53
\\gbtarget2\tar2\data\chem\drof.i\073103.b\007R0101.D



Save file: \\gbtarget2\far2data\chen\dro1.i\073103.b\008R0101.D
Date: 31-JUL-2003 16:45
Client ID: 836821-004
Sample Info: 36821E004HUX1
Volume Injected (uL): 2.0
Column phase: RTX-S/1.0.

Instrument: dro1.i
Operator: KEG
Column diameter: 0.53

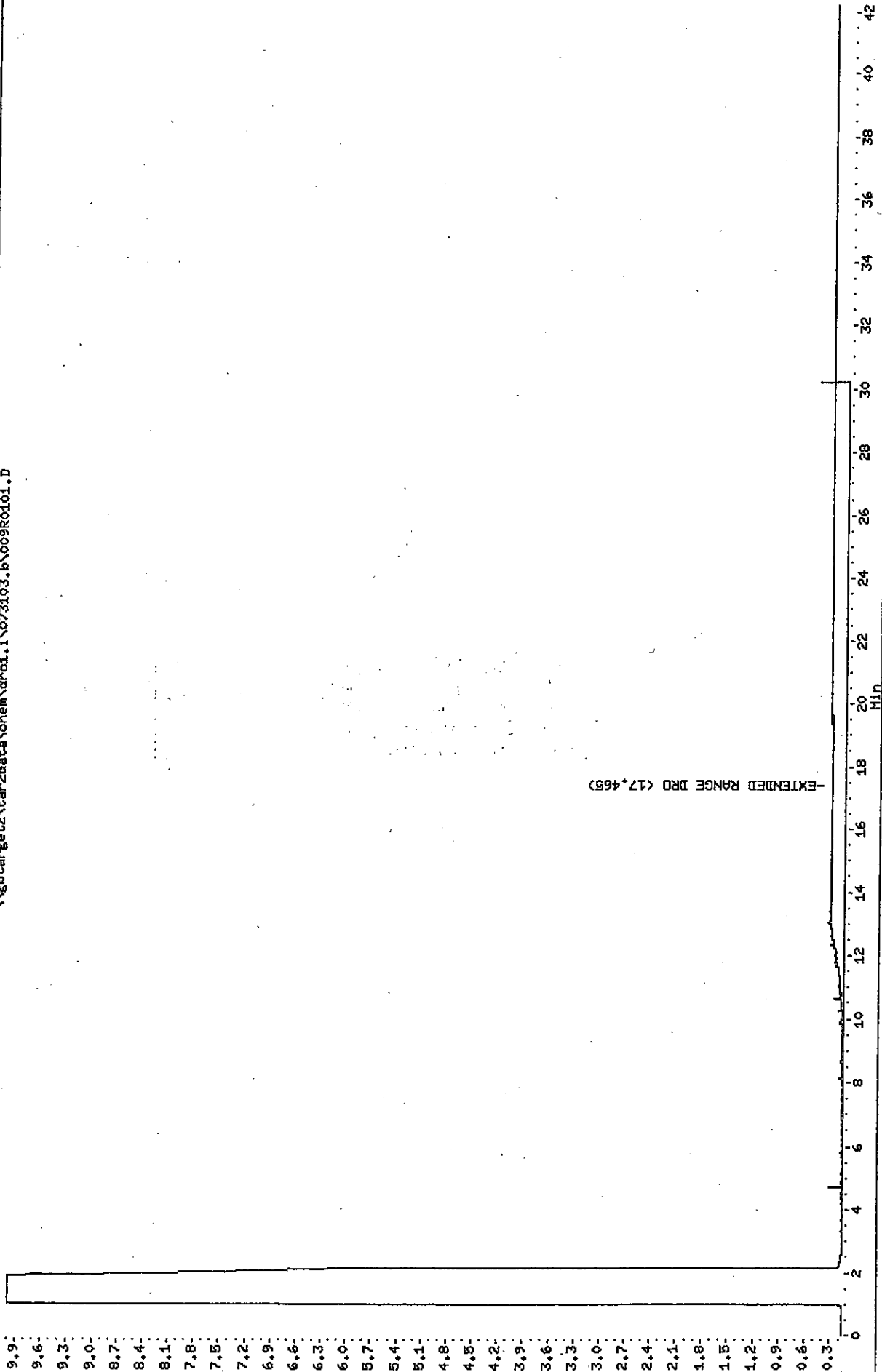


\\server\erg\2\erg\2\data\chem\drof.1\073103.b\009R0101.D

Date : 31-JUL-2003 17:32
Client ID: 836821-005
Sample Info: 36821E005MUK1
Volume Injected (uL): 2.0
Column phase: RTX-5/1.G.

Instrument: drof.i
Operator: KEG
Column diameter: 0.53

\\gbtarget2\tar2\data\chem\drof.1\073103.b\009R0101.D



9.9
9.6
9.3
9.0
8.7
8.4
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7.8
7.5
7.2
6.9
6.6
6.3
6.0
5.7
5.4
5.1
4.8
4.5
4.2
3.9
3.6
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3

42
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MIN

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

Lab Name: ENCHEM INC. - GREEN BAY Contract:

BLKZ 1083-71

Lab Code: ENCHEMGB Case No.: SAS No.:

SDG No.: GRO2-082102

Matrix: (soil/water) WATER

Lab Sample ID: BLKZ 1083-71

Sample wt/vol: _____ (g/mL) ML

Lab File ID: 002F0101

Level: (low/med) LOW

Date Received: _____

% Moisture: not dec. _____

Date Analyzed: 08/21/02

GC Column: DB-624 ID: 0.32 (mm)

Dilution Factor: 1.0

Soil Extract Volume: _____ (uL)

Soil Aliquot Volume: _____ (uL)

CAS NO.

COMPOUND

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

Q

1634-04-4	Methyl tert-butyl ether	0.7700	U
71-43-2	Benzene	0.3300	U
108-88-3	Toluene	0.7300	U
100-41-4	Ethylbenzene	0.7200	U
108-38-3	m/p-Xylene	1.500	U
95-47-6	o-Xylene	0.7400	U
108-67-8	1,3,5-Trimethylbenzene	0.7200	U
95-63-6	1,2,4-Trimethylbenzene	0.7100	U
91-20-3	Naphthalene	0.6900	U
	Total Xylenes	2.200	U

Data File: \\gbtarget2\ar2data\chem\dro1.i\073103.b\010R0101.D

Date : 31-JUL-2003 18:20

Client ID: 836821-006

Sample Info: 36821E006MUX1

Volume Injected (uL): 2.0

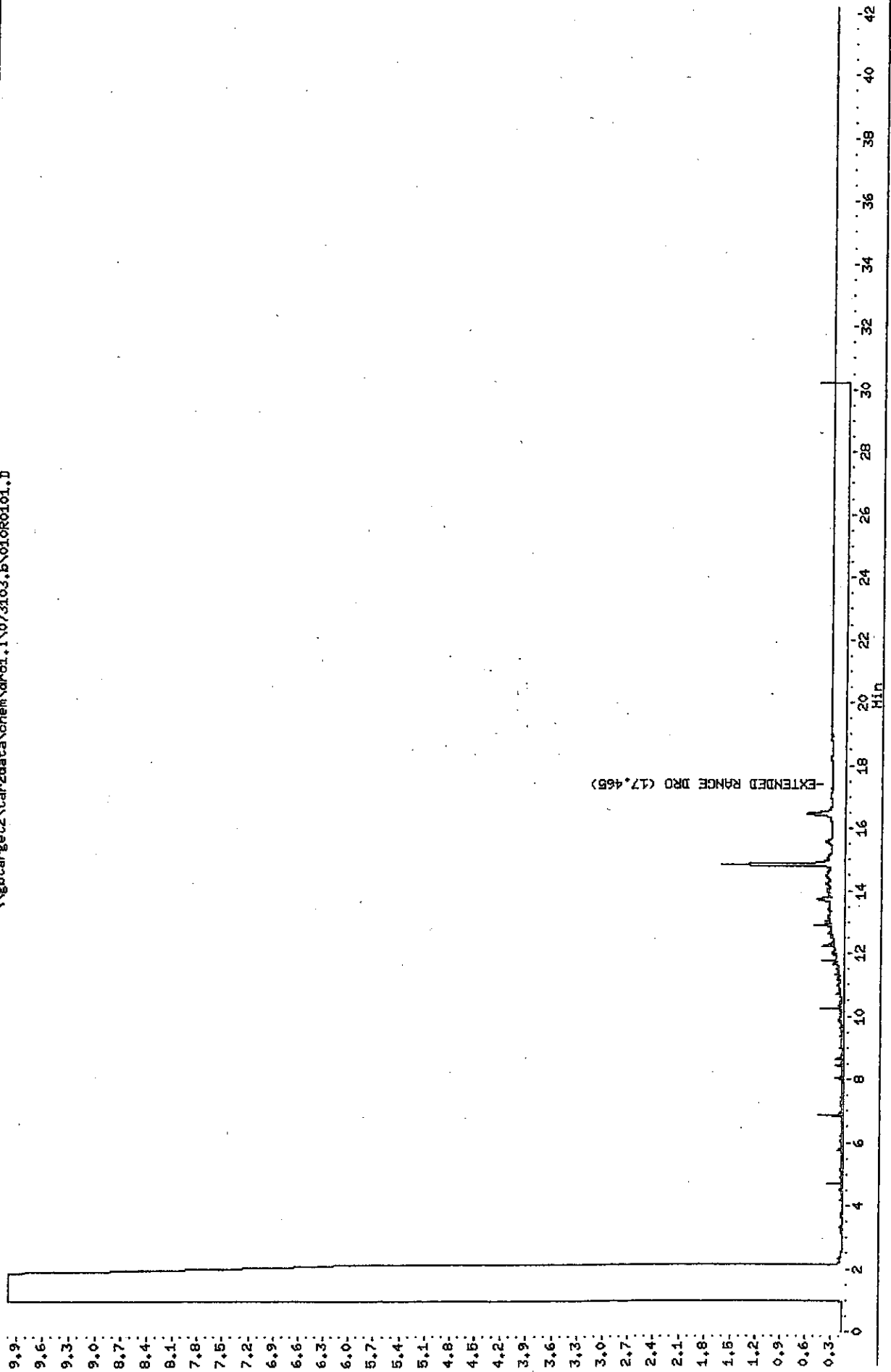
Column phase: RTX-5/1.G.

Instrument: dro1.i

Operator: KEG

Column diameter: 0.53

\\gbtarget2\ar2data\chem\dro1.i\073103.b\010R0101.D



FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

BLKC 1275-33

Lab Name: ENCHEM INC. - GREEN BAY Contract:

Lab Code: ENCHEMGB Case No.: SAS No.: SDG No.: GRO1-072303

Matrix: (soil/water) WATER Lab Sample ID: BLKC 1275-33

Sample wt/vol: _____ (g/mL) ML Lab File ID: 002F0101

Level: (low/med) LOW Date Received: _____

% Moisture: not dec. _____ Date Analyzed: 07/23/03

GC Column: DB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO. COMPOUND CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L Q

1634-04-4	Methyl tert-butyl ether	1.00	U
71-43-2	Benzene	1.00	U
108-88-3	Toluene	1.00	U
100-41-4	Ethylbenzene	1.00	U
108-38-3	m/p-Xylene	1.00	U
95-47-6	o-Xylene	2.00	U
108-67-8	1,3,5-Trimethylbenzene	1.00	U
95-63-6	1,2,4-Trimethylbenzene	1.00	U
91-20-3	Naphthalene	1.00	U
	Total Xylenes	3.00	U

FORM 3
WATER VOLATILE BLANK SPIKE RECOVERY

Lab Name: ENCHEM INC. - GREEN BAY Contract:
 Lab Code: ENCHEMGB Case No.: SAS No.: SDG No.: GRO1-072303
 Matrix Spike - Sample No.: BLKC 1275-33

COMPOUND	SPIKE ADDED (ug/L)	BLANK CONCENTRATION (ug/L)	BS CONCENTRATION (ug/L)	BS % REC #	QC LIMITS REC.
Methyl tert-butyl ether	20.00	0.00	19.83	99	80-120
Benzene	20.00	0.00	19.68	98	80-120
Toluene	20.00	0.00	19.21	96	80-120
Ethylbenzene	20.00	0.00	18.48	92	80-120
m/p-Xylene	40.00	0.00	36.52	91	80-120
o-Xylene	20.00	0.00	18.51	92	80-120
1,3,5-Trimethylbenzene	20.00	0.00	17.89	89	80-120
1,2,4-Trimethylbenzene	20.00	0.00	17.48	87	80-120
Naphthalene	20.00	0.00	16.99	85	80-120
Total Xylenes	60.00	0.00	55.03	92	80-120

COMPOUND	SPIKE ADDED (ug/L)	BSD CONCENTRATION (ug/L)	BSD % REC #	% RPD #	QC LIMITS RPD	REC.
Methyl tert-butyl ether	20.00	20.14	101	2	20	80-120
Benzene	20.00	19.07	95	3	20	80-120
Toluene	20.00	18.65	93	3	20	80-120
Ethylbenzene	20.00	17.92	90	3	20	80-120
m/p-Xylene	40.00	35.43	88	3	20	80-120
o-Xylene	20.00	18.07	90	2	20	80-120
1,3,5-Trimethylbenzene	20.00	17.39	87	3	20	80-120
1,2,4-Trimethylbenzene	20.00	17.20	86	2	20	80-120
Naphthalene	20.00	17.81	89	5	20	80-120
Total Xylenes	60.00	53.50	89	3	20	80-120

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 10 outside limits

Spike Recovery: 0 out of 20 outside limits

COMMENTS:

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

Name: Superior
 Project Contact: Tim Jefferson
 Telephone: 715-395-5680
 Project Name: South Cass Lake
 Project State: MI
 Sampled By (Print): Tim Jefferson

CHAIN OF CUSTODY

Quota #: 1 of 1
 Mail Report To: Tim Jefferson
 Company: NRCS
 Address: 60N. 28th St. Suite 27
Superior, WI 54880
 Invoice To: Barry Power
 Company: Embroidery Services
 Address: 119 N. 25th St. 2nd
Superior, WI 54880
 Mail Invoice To: Tim Jefferson

*Preservation Codes
 D-HNO3 E-Encore
 L-Sodium Disulfate J-Other

A=None B-HCL C-H2SO4
 H = Sodium Bisulfate Solution
 FILTERED? (YES/NO) J

PRESERVATION (CODE):

ANALYSES REQUESTED
 FR ORO
 BTEX
 TOTAL # OF BOTTLES SENT

LABORATORY ID (Lab Use Only)	FIELD ID	Regulatory Program	Matrix Codes W=Water S=Soil A=Air C=Charcoal B=Biota Sl=Sludge	COLLECTION		DATE	TIME
				DATE	TIME		
001	MW-1	UST	W	7/16	11:40	7/16	11:40
002	MW-2	RCRA	S	7/16	12:48	7/16	12:48
003	MW-4	SDWA	A	7/16	12:45	7/16	12:45
004	MW-6	NPDES	C	7/16	13:24	7/16	13:24
005	MW-7	CECCLA	B	7/16	12:20	7/16	12:20
006	MW-8		Sl	7/16	13:10	7/16	13:10
007	MW-9						
008	Tap Blank						
009							

CLIENT COMMENTS

LAB COMMENTS
(Lab Use Only)

1-1 Lab 3-40 ml B

2.40 ml B

Turnaround Time Requested (TAT) - Prelim	Relinquished By:	Date/Time:	Received By:	Date/Time:	En Chem Project No.
TAT subject to approval/surcharge	<u>Tim Jefferson</u>	<u>7/16/03 8:28</u>	<u>Barry Power</u>	<u>7-18-03 8:28</u>	<u>836821</u>
Needed:	<u>Tim Jefferson</u>	<u>7/16/03 17:00</u>	<u>Barry Power</u>	<u>7/22/03 8:15</u>	Sample Receipt Temp: <u>3.0°C</u>
with Prelim Rush Results by (circle):	<u>Dunham</u>	<u>7/22/03 08:15</u>	<u>Kathy Dunham</u>	<u>7/22/03 08:15</u>	Sample Receipt pH (Weather): <u>N/A</u>
Phone Fax E-Mail					Cooler Custody Seal
Address:					Present / Not Present: <u>Not Present</u>
Samples on HOLD are subject to special pricing and release of liability					Intact / Not Intact

En Chem, Inc. Cooler Receipt Log

Batch No. 836821

Project Name or ID South Cass Lake No. of Coolers: 1 Temps: 3.0°C

A. Receipt Phase: Date cooler was opened: 7/22/03 By: KOP

- 1: Were samples received on ice? (Must be ≤ 6 C)..... YES NO²
- 2: Was there a Temperature Blank?..... YES NO
- 3: Were custody seals present and intact? (Record on COC)..... YES NO
- 4: Are COC documents present?..... YES NO²
- 5: Does this Project require quick turn around analysis?..... YES NO
- 6: Is there any sub-work?..... YES NO
- 7: Are there any short hold time tests?..... YES NO
- 8: Are any samples nearing expiration of hold-time? (Within 2 days)..... YES NO Contacted by/Who S.M.
- 9: Do any samples need to be Filtered or Preserved in the lab?..... YES¹ NO Contacted by/Who _____

B. Check-In Phase: Date samples were Checked-in: 7/22/03 By: KOP

- 1: Were all sample containers listed on the COC received and intact?..... YES NO² NA
- 2: Sign the COC as received by En Chem. Completed..... YES NO
- 3: Do sample labels match the COC? YES NO²
- 4: Completed pH check on preserved samples..... YES NO NA
(This statement does not apply to water: VOC, O&G, TOC, DRO, Total Rec. Phenolics)
- 5: Do samples have correct chemical preservation?..... YES NO² NA
(This statement does not apply to water: VOC, O&G, TOC, DRO, Total Rec. Phenolics)
- 6: Are dissolved parameters field filtered?..... YES NO² NA
- 7: Are sample volumes adequate for tests requested? YES NO²
- 8: Are VOC samples free of bubbles >6mm YES NO² NA
- 9: Enter samples into logbook. Completed..... YES NO
- 10: Place laboratory sample number on all containers and COC. Completed..... YES NO
- 11: Complete Laboratory Tracking Sheet (LTS). Completed..... YES NO NA
- 12: Start Nonconformance form. YES NO NA
- 13: Initiate Subcontracting procedure. Completed..... YES NO NA
- 14: Check laboratory sample number on all containers and COC. S.M. YES NO NA

Short Hold-time tests:

48 Hours or less Coliform (6 hrs) Hexavalent Chromium (24 Hrs) BOD Nitrite or Nitrate Low Level Mercury Ortho Phosphorus Turbidity Surfactants Sulfite En Core Preservation Color	7 days Flashpoint TSS Total Solids TDS Sulfide Free Liquids Total Volatile Solids <u>Aqueous Extractable Organics- ALL</u> Unpreserved VOC's Ash	Footnotes 1 Notify proper lab group immediately. 2 Complete nonconformance memo.
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Rev. 4/11/03, Attachment to 1-REC-5.
 Subject to QA Audit.

Reviewed by/date EB 7/23/03

Batch No. 824906

En Chem, Inc. Cooler Receipt Log

Project Name or ID NRE

No. of Coolers: 1

Temps: 1.4°

A. Receipt Phase: Date cooler was opened: 8/20/02 By: JR

- 1: Were samples received on ice? (Must be ≤ 6 C) YES NO²
- 2: Was there a Temperature Blank? YES NO
- 3: Were custody seals present and intact? (Record on COC) YES NO
- 4: Are COC documents present? YES NO²
- 5: Does this Project require quick turn around analysis? YES NO
- 6: Is there any sub-work? YES NO
- 7: Are there any short hold time tests? YES NO
- 8: Are any samples nearing expiration of hold-time? (Within 2 days) YES¹ NO Contacted by/Who Randy
- 9: Do any samples need to be Filtered or Preserved in the lab? YES¹ NO Contacted by/Who _____

B. Check-in Phase: Date samples were Checked-In: 8/20/02 By: JR

- 1: Were all sample containers listed on the COC received and intact? YES NO² NA
- 2: Sign the COC as received by En Chem. Completed YES NO
- 3: Do sample labels match the COC? YES NO²
- 4: Check sample pH of preserved samples. (Not VOCs) Completed YES NO NA
- 5: Do samples have correct chemical preservation? YES NO² NA
- 6: Are dissolved parameters field filtered? YES NO² NA
- 7: Are sample volumes adequate for tests requested? YES NO²
- 8: Are VOC samples free of bubbles >6mm YES NO² NA
- 9: Enter samples into logbook. Completed YES NO
- 10: Place laboratory sample number on all containers and COC. Completed YES NO
- 11: Complete Laboratory Tracking Sheet (LTS). Completed YES NO NA
- 12: Start Nonconformance form. YES NO NA
- 13: Initiate Subcontracting procedure. Completed YES NO NA
- 14: Check laboratory sample number on all containers and COC. YES NO NA

Short Hold-time tests:

48 Hours or less	<input checked="" type="radio"/> 7 days	Footnotes
Coliform (6 hrs)	Flashpoint	1 Notify proper lab group immediately.
Hexavalent Chromium (24 Hrs)	TSS	2 Complete nonconformance memo.
BOD	Total Solids	
Nitrite or Nitrate	TDS	
Low Level Mercury	Sulfide	
Ortho Phosphorus	Free Liquids	
Turbidity	Total Volatile Solids	
Surfactants	<input checked="" type="radio"/> Aqueous Extractable Organics- ALL	
Sulfite	Unpreserved VOC's	
En Core Preservation	Ash	
Color		

Rev. 9/5/2001, Attachment to 1-REC-5.
Subject to QA Audit.

Reviewed by/date EDS/2/02

- Analytical Report -

Project Name : SOUTH CASS LAKE

Project Number :

Client : NRE

Field ID : GP-18

Report Date : 8/29/02

Lab Sample Number : 824906-002

Collection Date : 8/14/02

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 8/21/02 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	101	—	%Recov		8/21/02	WI MOD GRO
Benzene	< 1.0	1.0	ug/l		8/21/02	WI MOD GRO
Ethylbenzene	< 1.0	1.0	ug/l		8/21/02	WI MOD GRO
Toluene	< 1.0	1.0	ug/l		8/21/02	WI MOD GRO
Xylenes, -m, -p	< 2.0	2.0	ug/l		8/21/02	WI MOD GRO
Xylene, -o	< 1.0	1.0	ug/l		8/21/02	WI MOD GRO

Organic Results

BTEX BLANK

Prep Method: Prep Date: 8/21/02 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	1083-71					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 8/20/02 Analyst: KEG

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 250	250	ug/L		8/23/02	WI MOD DRO
Blank spike	91.0	—	%recov		8/23/02	WI MOD DRO
Blank spike duplicate	88.0	—	% recov		8/23/02	WI MOD DRO
Blank	< 200	200	ug/L		8/23/02	WI MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE

Project Number :

Field ID : GP-20

Lab Sample Number : 824906-004

MDH LAB ID : 055-999-334

Client : NRE

Report Date : 8/29/02

Collection Date : 8/13/02

Matrix Type : WATER

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 8/20/02 Analyst: KEG

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 230	230	ug/L		8/23/02	WI MOD DRO
Blank spike	91.0	---	%recov		8/23/02	WI MOD DRO
Blank spike duplicate	88.0	---	% recov		8/23/02	WI MOD DRO
Blank	< 200	200	ug/L		8/23/02	WI MOD DRO

FORM 3
WATER VOLATILE BLANK SPIKE RECOVERY

Lab Name: ENCHEM INC. - GREEN BAY Contract:
 Lab Code: ENCHEMGB Case No.: SAS No.: SDG No.: GRO2-082102
 Matrix Spike - Sample No.: BLKZ 1083-71

COMPOUND	SPIKE ADDED (ug/L)	BLANK CONCENTRATION (ug/L)	BS CONCENTRATION (ug/L)	BS % REC #	QC LIMITS REC.
Methyl tert-butyl ether	20.000	0.0000	19.418	97	85-115
Benzene	20.000	0.0000	19.364	97	85-115
Toluene	20.000	0.0000	19.741	99	85-115
Ethylbenzene	20.000	0.0000	19.634	98	85-115
m/p-Xylene	40.000	0.0000	39.491	99	85-115
o-Xylene	20.000	0.0000	19.837	99	85-115
1,3,5-Trimethylbenzene	20.000	0.0000	19.364	97	85-115
1,2,4-Trimethylbenzene	20.000	0.0000	19.137	96	85-115
Naphthalene	20.000	0.0000	19.441	97	85-115
Total Xylenes	60.000	0.0000	59.329	99	85-115

COMPOUND	SPIKE ADDED (ug/L)	BSD CONCENTRATION (ug/L)	BSD % REC #	% RPD #	QC LIMITS	
					RPD	REC.
Methyl tert-butyl ether	20.000	19.660	98	1	20	85-115
Benzene	20.000	19.587	98	1	20	85-115
Toluene	20.000	19.815	99	0	20	85-115
Ethylbenzene	20.000	19.766	99	1	20	85-115
m/p-Xylene	40.000	39.737	99	0	20	85-115
o-Xylene	20.000	19.933	100	1	20	85-115
1,3,5-Trimethylbenzene	20.000	19.651	98	1	20	85-115
1,2,4-Trimethylbenzene	20.000	19.410	97	1	20	85-115
Naphthalene	20.000	20.633	103	6	20	85-115
Total Xylenes	60.000	59.670	99	0	20	85-115

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 10 outside limits
 Spike Recovery: 0 out of 20 outside limits

COMMENTS: _____

Corporate Office & Laboratory
1241 Bellevue Street
Green Bay, WI 54302
920-469-2436 • FAX: 920-469-8827
800-7-ENCHEM



Madison Office & Laboratory
525 Science Drive
Madison, WI 53711
608-232-3300 • FAX: 608-233-0502
888-5-ENCHEM

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client: NRE

MDH LAB ID : 055-999-334

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
814647-001	GP-4	9/25/01			
814647-002	GP-3	9/25/01			
814647-003	GP-5	9/25/01			
814647-004	GP-6	9/25/01			
814647-005	GP-10	9/26/01			
814647-006	GP-15	9/26/01			
814647-007	GP-16	9/26/01			
814647-008	TRIP BLANK	9/26/01			

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Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.


Approval Signature


Date

En Chem, Inc. Cooler Receipt Log

Batch No. 814647

Project Name or ID SOUTH CASS LAKE STATION No. of Coolers: 1 Temps: 4.0°C

A. Receipt Phase: Date cooler was opened: 9/28/01 By: GD

- 1: Were samples received on ice? (Must be $\leq 6\text{ C}$)..... YES NO²
- 2: Was there a Temperature Blank?..... YES NO
- 3: Were custody seals present and intact? (Record on COC)..... YES NO
- 4: Are COC documents present?..... YES NO²
- 5: Does this Project require quick turn around analysis?..... YES NO
- 6: Is there any sub-work?..... YES NO
- 7: Are there any short hold time tests?..... YES NO
- 8: Are any samples nearing expiration of hold-time? (Within 2 days)..... YES¹ NO Contacted by/Who _____
- 9: Do any samples need to be Filtered or Preserved in the lab?..... YES¹ NO Contacted by/Who _____

B. Check-in Phase: Date samples were Checked-in: 9-28-01 By: GD

- 1: Were all sample containers listed on the COC received and intact? GD 9/28/01 YES NO² NA See E-mail attached
- 2: Sign the COC as received by En Chem. Completed..... YES NO
- 3: Do sample labels match the COC? YES NO²
- 4: Check sample pH of preserved samples. (Not VOCs) Completed..... YES NO NA
- 5: Do samples have correct chemical preservation?..... YES NO² NA
- 6: Are dissolved parameters field filtered?..... YES NO² NA
- 7: Are sample volumes adequate for tests requested? YES NO²
- 8: Are VOC samples free of bubbles >6mm YES NO² NA
- 9: Enter samples into logbook. Completed..... YES NO
- 10: Place laboratory sample number on all containers and COC. Completed..... YES NO
- 11: Complete Laboratory Tracking Sheet (LTS). Completed..... YES NO NA
- 12: Start Nonconformance form. YES NO NA
- 13: Initiate Subcontracting procedure. Completed..... YES NO NA
- 14: Check laboratory sample number on all containers and COC. JJ YES NO NA

Short Hold-time tests:

48 Hours or less Coliform (6 hrs) Hexavalent Chromium (24 Hrs) BOD Nitrite or Nitrate Low Level Mercury Ortho Phosphorus Turbidity Surfactants Sulfite En Core Preservation Color	7 days Flashpoint TSS Total Solids TDS Sulfide Free Liquids Total Volatile Solids Aqueous Extractable Organics- ALL Unpreserved VOC's Ash	Footnotes 1 Notify proper lab group immediately. 2 Complete nonconformance memo.
--	---	--

Rev. 9/5/2001, Attachment to 1-REC-5.
 Subject to QA Audit.

Reviewed by/date EB 10/1/01

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION
Project Number :
Field ID : GP-4
Lab Sample Number : 814647-001
MDH LAB ID : 055-999-334

Client : NRE
Report Date : 10/5/2001
Collection Date : 9/25/2001
Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	96	—	%Recov		10/4/2001	MOD 8021B
Benzene	1300	10	ug/l		10/4/2001	MOD 8021B
Ethylbenzene	230	10	ug/l		10/4/2001	MOD 8021B
Toluene	< 10	10	ug/l		10/4/2001	MOD 8021B
Xylenes, -m, -p	< 20	20	ug/l		10/4/2001	MOD 8021B
Xylene, -o	< 10	10	ug/l		10/4/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: Wi MOD DRO Prep Date: 9/28/1901 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	830	160	ug/l		9/28/2001	Wi MOD DRO
Blank spike	79	—	%Recov		9/28/2001	Wi MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	Wi MOD DRO
Blank	< 160	160	ug/l		9/28/2001	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : GP-3

Report Date : 10/5/2001

Lab Sample Number : 814647-002

Collection Date : 9/25/2001

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	86	---	%Recov		10/2/2001	MOD 8021B
Benzene	340	1.0	ug/l		10/2/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: Wi MOD DRO Prep Date: 9/28/2001 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 160	160	ug/l		9/28/2001	Wi MOD DRO
Blank spike	79	---	%Recov		9/28/2001	Wi MOD DRO
Blank spike duplicate	87	---	%Recov		9/28/2001	Wi MOD DRO
Blank	< 160	160	ug/l		9/28/2001	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Field ID : GP-5

Lab Sample Number : 814647-003

MDH LAB ID : 055-999-334

Client : NRE

Report Date : 10/5/2001

Collection Date : 9/25/2001

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	108	—	%Recov		10/2/2001	MOD 8021B
Benzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 9/28/1901 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 180	180	ug/l		9/28/2001	WI MOD DRO
Blank spike	79	—	%Recov		9/28/2001	WI MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	WI MOD DRO
Blank	< 160	160	ug/l		9/28/2001	WI MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION
Project Number :
Field ID : GP-6
Lab Sample Number : 814647-004
MDH LAB ID : 055-999-334

Client : NRE
Report Date : 10/5/2001
Collection Date : 9/25/2001
Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	107	—	%Recov		10/2/2001	MOD 8021B
Benzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 9/28/2001 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 160	160	ug/l		9/28/2001	WI MOD DRO
Blank spike	79	—	%Recov		9/28/2001	WI MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	WI MOD DRO
Blank	< 160	160	ug/l		9/28/2001	WI MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : GP-10

Report Date : 10/5/2001

Lab Sample Number : 814647-005

Collection Date : 9/26/2001

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	108	—	%Recov		10/2/2001	MOD 8021B
Benzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 9/28/1901 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 160	160	ug/l		9/28/2001	Wi MOD DRO
Blank spike	79	—	%Recov		9/28/2001	Wi MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	Wi MOD DRO
Blank	< 160	160	ug/l		9/28/2001	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION
 Project Number : Client : NRE
 Field ID : GP-15 Report Date : 10/5/2001
 Lab Sample Number : 814647-006 Collection Date : 9/26/2001
 MDH LAB ID : 055-999-334 Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/2001 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	108	—	%Recov		10/2/2001	MOD 8021B
Benzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: Wi MOD DRO Prep Date: 9/28/1901 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 160	160	ug/l		9/28/2001	Wi MOD DRO
Blank spike	79	—	%Recov		9/28/2001	Wi MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	Wi MOD DRO
Blank	< 160	160	ug/l		9/28/2001	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Field ID : GP-16

Lab Sample Number : 814647-007

MDH LAB ID : 055-999-334

Client : NRE

Report Date : 10/5/2001

Collection Date : 9/26/2001

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/3/2001 Analyst: SMT

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	102	—	%Recov		10/3/2001	MOD 8021B
Benzene	19	1.0	ug/l		10/3/2001	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/3/2001	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/3/2001	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/3/2001	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/3/2001	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/3/2001 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-73					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 9/28/1901 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
EXTENDED RANGE	< 160	160	ug/l		9/28/2001	WI MOD DRO
Blank spike	79	—	%Recov		9/28/2001	WI MOD DRO
Blank spike duplicate	87	—	%Recov		9/28/2001	WI MOD DRO
Blank	< 160	160	ug/l		9/28/2001	WI MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : TRIP BLANK

Report Date : 10/5/01

Lab Sample Number : 814647-008

Collection Date : 9/26/01

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 10/1/01 Analyst: PMS

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	107	--	%Recov		10/2/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		10/2/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		10/2/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		10/2/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		10/2/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		10/2/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 10/1/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	968-69					



1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

CHAIN OF CUSTODY

A-Ions B-HCL C-H2SO4
H - Sodium Bisulfate Solution
L - Other
F-Fluoride E-Encore
G-NaOH

Page 1 of 1
R.O. # Quote #
Mail Report To: DAVE HODER
Company:
Address:
Invoice To:
Company:
Address:
Mail Invoice To:

ANALYSES REQUESTED
TOTAL # OF BOTTLES SENT

LABORATORY ID (Lab Use Only)	FIELD ID	Regulatory Program	Matrix Codes	COLLECTION		LAB COMMENTS	CLIENT COMMENTS
				DATE	TIME		
GP-1	GP-1	UST	W-Water	9/12	1030		
GP-3	GP-3	RCRA	S-Soil	9/25	1120		
GP-5	GP-5	SDWA	A-Air	9/26	1435		
GP-6	GP-6	NPDES	C-Charcoal	9/26	1435		
GP-10	GP-10	CERCLA	B-Biota	9/26	1230		
GP-15	GP-15		SI-Sludge	9/26	1520		
GP-16	GP-16			9/26	1530		

Received By:	Date/Time:	En Chem Project No.
DAVE HODER	9/26/00 1030	
DAVE HODER	9/25/00 1120	
DAVE HODER	9/26/00 1435	
DAVE HODER	9/26/00 1435	
DAVE HODER	9/26/00 1230	
DAVE HODER	9/26/00 1520	
DAVE HODER	9/26/00 1530	

Project Location: DULUTH MA
Project Contact: DAVE HODER
Phone: (208) 727-7554
Project Number:
Project Name: South Cass Lake Station
Project State: Minnesota
Ordered By (Print): Dave Hoder

Package Options
Please circle if requested
Ils Only
Item Level III (Subject to Surcharge)
Item Level IV (Subject to Surcharge)

turnaround Time Requested (TAT) - Prelim
 subject to approval/surcharge
 Prelim Rush Results by (circle):
 Fax E-Mail
 Samples on HOLD are subject to special pricing and release of liability

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client: NRE

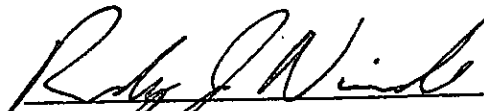
MDH LAB ID : 055-999-334

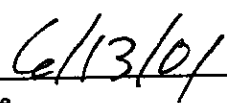
Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
812488-001	MW-1	6/6/2001			
812488-002	MW-2	6/6/2001			
812488-003	MW-4	6/6/2001			
812488-004	FIELD BLANK	6/6/2001			
812488-005	TRIP BLANK	6/6/2001			

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Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.


Approval Signature


Date

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : MW-1

Report Date : 6/12/01

Lab Sample Number : 812488-001

Collection Date : 6/6/01

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 6/11/01 Analyst: MSB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	104	---	%Recov		6/11/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		6/11/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		6/11/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 6/11/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	939-19					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: Wi MOD DRO Prep Date: 6/8/01 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 100	100	ug/l		6/8/01	Wi MOD DRO
Blank spike	86	---	%Recov		6/8/01	Wi MOD DRO
Blank spike duplicate	88	---	%Recov		6/8/01	Wi MOD DRO
Blank	< 50	50	ug/l		6/8/01	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION
Project Number :
Field ID : MW-2
Lab Sample Number : 812488-002
MDH LAB ID : 055-999-334

Client : NRE
Report Date : 6/12/01
Collection Date : 6/6/01
Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 6/11/01 Analyst: MSB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	104	—	%Recov		6/11/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		6/11/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		6/11/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 6/11/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	939-19					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: WI MOD DRO Prep Date: 6/8/01 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 100	100	ug/l		6/8/01	WI MOD DRO
Blank spike	86	—	%Recov		6/8/01	WI MOD DRO
Blank spike duplicate	88	—	%Recov		6/8/01	WI MOD DRO
Blank	< 50	50	ug/l		6/8/01	WI MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : MW-4

Report Date : 6/12/01

Lab Sample Number : 812488-003

Collection Date : 6/6/01

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 6/11/01 Analyst: MSB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103	—	%Recov		6/11/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		6/11/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		6/11/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 6/11/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	939-19					

Organic Results

DIESEL RANGE ORGANICS - WATER

Prep Method: Wi MOD DRO Prep Date: 6/8/01 Analyst: DJB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
DIESEL RANGE ORGANICS	< 100	100	ug/l		6/8/01	Wi MOD DRO
Blank spike	86	—	%Recov		6/8/01	Wi MOD DRO
Blank spike duplicate	88	—	%Recov		6/8/01	Wi MOD DRO
Blank	< 50	50	ug/l		6/8/01	Wi MOD DRO

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Field ID : FIELD BLANK

Lab Sample Number : 812488-004

MDH LAB ID : 055-999-334

Client : NRE

Report Date : 6/12/01

Collection Date : 6/6/01

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 6/11/01 Analyst: MSB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	104	—	%Recov		6/11/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		6/11/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		6/11/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 6/11/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	939-19					

- Analytical Report -

Project Name : SOUTH CASS LAKE STATION

Project Number :

Client : NRE

Field ID : TRIP BLANK

Report Date : 6/12/01

Lab Sample Number : 812488-005

Collection Date : 6/6/01

MDH LAB ID : 055-999-334

Matrix Type : WATER

Organic Results

BTEX - WATER

Prep Method: SW846 5030B Prep Date: 6/11/01 Analyst: MSB

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
a,a,a-Trifluorotoluene	103	—	%Recov		6/11/01	MOD 8021B
Benzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Ethylbenzene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Toluene	< 1.0	1.0	ug/l		6/11/01	MOD 8021B
Xylenes, -m, -p	< 2.0	2.0	ug/l		6/11/01	MOD 8021B
Xylene, -o	< 1.0	1.0	ug/l		6/11/01	MOD 8021B

Organic Results

BTEX BLANK

Prep Method: Prep Date: 6/11/01 Analyst:

Analyte	Result	EQL	Units	Code	Analysis Date	Analysis Method
BTEX - Blank	939-19					

Form I
Extraction Blank

Anal by: MSB
Anal date: 6/11/01
Blank #: 939-19

	LOD	LOQ	REPORTED RESULT	UNITS	Q ₁
Benzene	0.45	1.5	ND	ug/L	
Toluene	0.68	2.27	ND	ug/L	
Ethylbenzene	0.82	2.73	ND	ug/L	
m/p-Xylene	1.70	5.7	ND	ug/L	
o-Xylene	0.77	2.6	ND	ug/L	
Methyl tert-butyl ether	0.43	1.43	ND	ug/L	
a,a,a-Trifluorotoluene			103	% recov	

B Analyte present in blank. Value in sample(s)
may be suspect.
ND Not Detected

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-9827

EN CHEM
INC.

Branch or Location: DULUTH, MN
Project Contact: DAVE HOEK
Telephone: (218) 722-9554
Project Number: _____

Project Name: South Cass Lake Station
Project State: MN
Sampled By (Print): DAVE HOEK

Data Package Options
Please circle if requested:
 Results Only
 nChem Level III (Subject to Surcharge)
 nChem Level IV (Subject to Surcharge)

LABORATORY ID (Lab Use Only)	FIELD ID	REGULATORY PROVISION		COLLECTION DATE	TIME	MATRIX
		LIST	RCRA			
001	MW-1	✓	✓	6/7/01	915	W
002	MW-2	✓	✓	1105		W
003	MW-4	✓	✓	1210		W
004	Field Blank	✓	✓	218		W
005	TECH BLANK *					
	* Added by Lab 6/8/01 GD					

Relinquished By: _____ Date/Time: _____
 Relinquished By: _____ Date/Time: _____
 Relinquished By: _____ Date/Time: _____
 Relinquished By: _____ Date/Time: _____
 Relinquished By: _____ Date/Time: _____
 Relinquished By: _____ Date/Time: _____

Phone # _____ Fax _____ E-Mail _____

Mail Address: _____

Samples on HOLD are subject to special pricing and release of liability

CHAIN OF CUSTODY

*Preservation Codes
 A=None B=HCL C-H2SO4 D=HNO3 E=EnCore F=Methanol G=NaOH
 H = Sodium Bisulfate Solution I = Other
 FILTERED? (YES/NO) N
 PRESERVATION (CODE)* N

Page 1 of 1
 P.O. # _____ Quote # _____
 Mail Report To: DAVE HOEK
 Company: NRE
 Address: 13 W. SUPERIOR ST
DULUTH, MN 55802
 Invoice To: GARRY POWER
 Company: LAKEHEAD PIPE LINE CO.
 Address: 21 W. SUPERIOR ST
DULUTH, MN 55802
 Mail Invoice To: DAVE HOEK

ANALYSES REQUESTED DTE X
020
 TOTAL # OF BOTTLES SENT _____

CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)
4	60
4	
4	
3	

En Chem Protect No.	Sample Receipt Temp	Sample Receipt pH (Wet/Mealy)	Cooler Custody Seal	Present / Not Present	Intact / Not Intact
	3.6°C / 31.2°C				

Received By: M. G. Power Date/Time: 6-7-01 9:00
 Received By: M. G. Power Date/Time: 6-7-01 9:00
 Received By: M. G. Power Date/Time: 6-7-01 14:00
 Received By: M. G. Power Date/Time: 6-7-01 14:00
 Received By: M. G. Power Date/Time: _____
 Received By: M. G. Power Date/Time: _____

330 SO. CLEVELAND ST.
CAMBRIDGE, MN 55008
LAB (612) 689-2175
METRO (612) 444-9270
FAX (612) 689-3660



LAKE SUPERIOR LABORATORIES

MIDWEST ANALYTICAL SERVICES

MINNESOTA CERTIFIED LABORATORY
NUMBER 027-059-156



205 WEST 2ND STREET
SUITE 105
DULUTH, MN 55802
LAB (218) 722-9884
FAX (218) 722-9964

14-Jun-01

Natural Resources Engineering

13 W. Superior Street
Duluth, MN 55802

Report of Analysis

Chain of Custody: 32473
Project Description: Cass Lake Station
Received: 05/30/2001 1:52:04 PM by Lori A. Baillargeon
Date Required: 06/13/2001

ID: 22696

Matrix: Soil

	Desc:	SB - 1	
	Date Sampled:	05/22/2001	
Analyte	Units	#71660	Analyzed
Total Organic Carbon	mg/Kg	920	06/11/01

Results reported on as received basis. TOC analysis performed by an outside laboratory.

Reviewed by

Anne Hoppentrath 6/14/01

Anne Hoppentrath
Organic Chemist



330 SO. CLEVELAND ST.
 P.O. BOX 349
 CAMBRIDGE, MN 55008
 LAB (612) 689-2175
 FAX (612) 689-3660

CHAIN OF CUSTODY RECORD

ANL

REQUEST FOR ANALYSIS

(Instructions on Back of Form)

NO 32473

UTH OFFICE:

205 WEST 2ND STREET
 DULUTH, MN 55802
 PHONE (218) 722-9884
 FAX (218) 722-9984

CLIENT:		PROJECT I.D.:		SAMPLER NAME:		SAMPLER SIGNATURE:		REMARKS:	
NRE		CASS LAKE STATION		DAVE HOEKE		<i>[Signature]</i>		Dave Hoek - NRE	
NO OF CONTAINERS	COMP	DATE	TIME	MATRIX			SAMPLE IDENTIFICATION		
				WATER	SOIL	OTHER	SAMPLE NO.	LABORATORY I.D. NO.	LABORATORY I.D. NO.
1	X	5/22/01	935	X			SB-1	71660	

SHADED AREAS FOR LABORATORY USE ONLY	
GRO (Includes BTEX)	
DRO	
BTEX	
VOC (MNA65)	
PH	
Pb (Diss. or Total)	
PCRA & METALS	
BOD OR CBOD	
TSS	
FCOL OR TCOL	X
Total Chlorine	
HCl	
HNO ₃	
H ₂ SO ₄	
ICE	X
OTHER	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
<i>[Signature]</i>	5/29/01 1130	<i>[Signature]</i>	5/31/01
<i>[Signature]</i>		<i>[Signature]</i>	
<i>[Signature]</i>		<i>[Signature]</i>	

Relinquished by: (Signature)	Date / Time	Contents Temperature:
<i>[Signature]</i>	5/29/01 1130	71.660
<i>[Signature]</i>		
<i>[Signature]</i>		

CHECK HERE FOR DRINKING WATER DETECTION LIMITS

TURNAROUND TIME REQUIRED: NORMAL RUSH *1 hr*

APPENDIX E – AQUIFIER CHARACTERIZATION

AQUIFER CHARACTERIZATION

A. Hydraulic Conductivity Calculation

Slug test data was analyzed using a Bouwer-Rice unconfined aquifer analysis. This method of analysis is valid for fully or partially penetrating wells in unconfined aquifers. It is a semi-empirical relationship based upon the conservation of mass. It incorporates empirical relationships between the well geometry and groundwater flow using electric analog models.

The method assumes that the aquifer is locally homogeneous and isotropic with respect to conductivity, the groundwater flow is laminar, and there is no resistance to flow in the vertical direction. It also assumes that the change in head due to the slug is much less than the saturated thickness of the aquifer. Hydraulic conductivity is calculated with the use of equation (1).

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L} \frac{1}{t} \ln\left(\frac{Y_o}{Y_t}\right) \quad (1)$$

Where:

- K = mean hydraulic conductivity (l/t)
- r_c = radius of casing (l)
- r_w = radius of screened section plus gravel pack (l)
- Y_o = static head (l)
- Y_t = head at time t (l)
- R_e = effective distance over which Y is dissipated (l)
- L = length of screened section (l)

The term $1/t * \ln(Y_o/Y_t)$ in equation (1) is the slope of a line regressed on the straight portion of the data as plotted on semi-logarithmic paper. These plots can be found following the text in this appendix.

From the data for recovery and dissipation, both a geometric mean and an arithmetic mean were calculated. These values were 20.0 ft/day and 17.2 ft/day, respectively. Table 4 is a summary of calculated hydraulic conductivities from the slug test data. Distribution plots for both hydraulic conductivity values and their natural logarithms are included in this appendix. These plots show that a normal distribution of hydraulic conductivity values is appropriate for the Site. Thus, a normal distribution for hydraulic conductivity values with a mean hydraulic conductivity of 20.0 ft/day will be used for any calculations and further references.

B. Groundwater Velocity Calculations

For the purpose of this report, the x direction or axis will be aligned with the direction of groundwater flow and mean groundwater velocity can be expressed as:

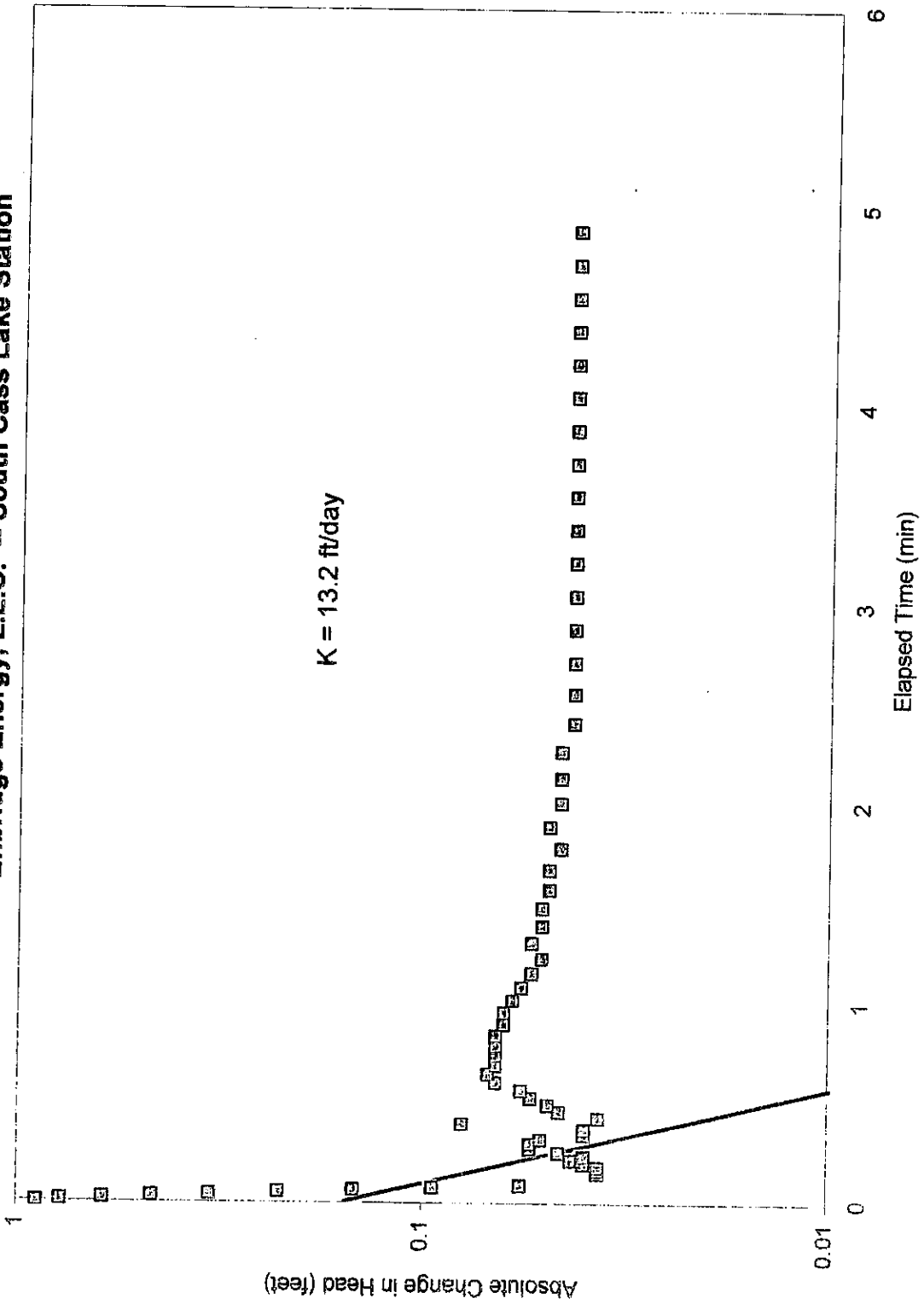
$$\bar{V}_x = \frac{K}{n_e} \frac{dh}{dx} \quad (2)$$

Where:

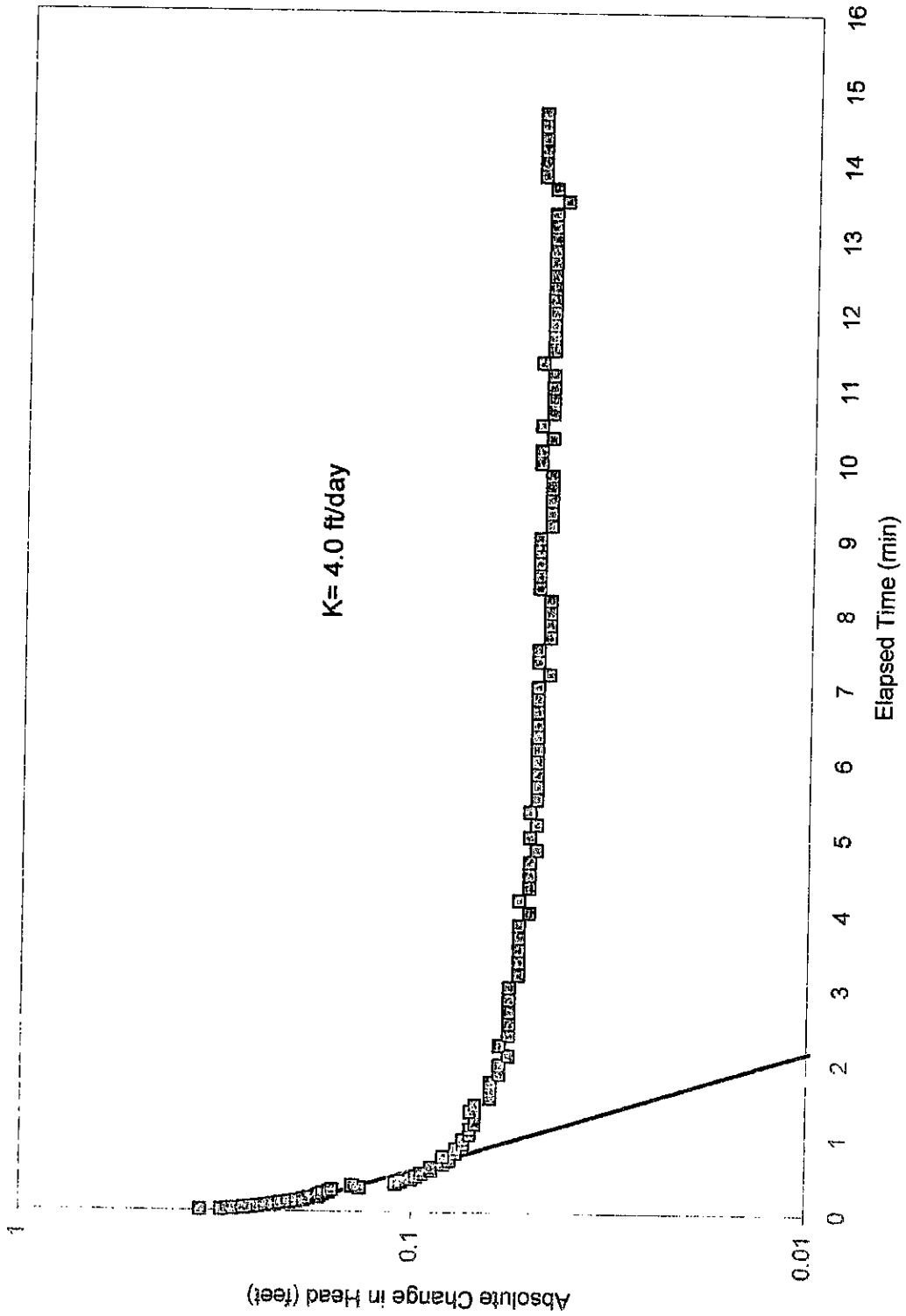
- K = mean hydraulic conductivity from slug test data (l/t)
- V_x = mean groundwater flow velocity in the x direction (l/t)
- n_e = effective porosity (dimensionless)
- dh/dx = hydraulic gradient or i (dimensionless)

Using a typical value of 0.30 for the effective porosity of clean sand, the hydraulic gradient of 0.03% from the Site, and a hydraulic conductivity of 20.0 ft/day from the slug test data; the mean groundwater velocity calculated for the Site is approximately 0.02 feet/day or 7 feet/year.

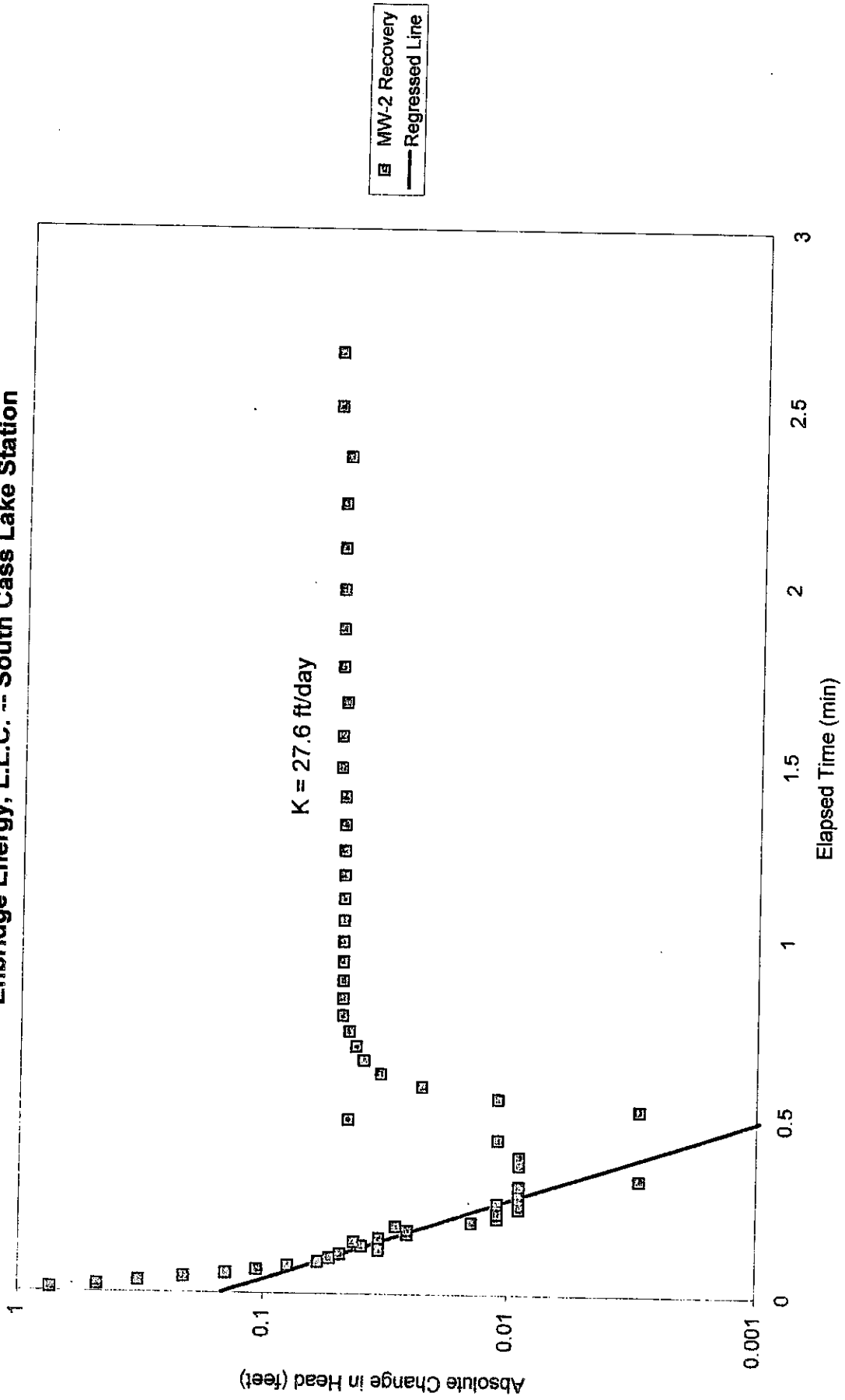
MW-1 Recovery Data
Enbridge Energy, L.L.C. - South Cass Lake Station



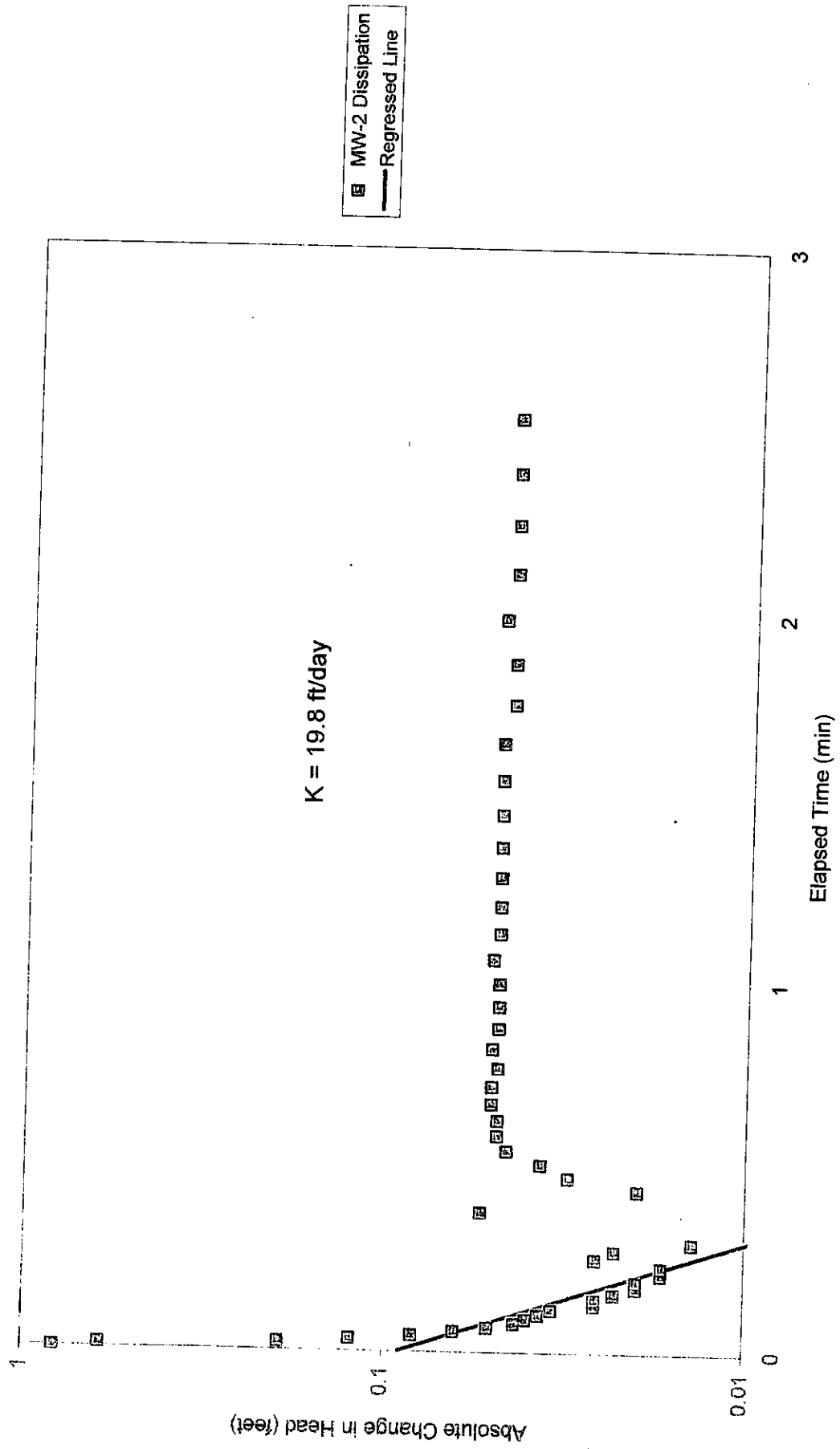
MW-1 Dissipation Data
Enbridge Energy, L.L.C. -- South Cass Lake Station



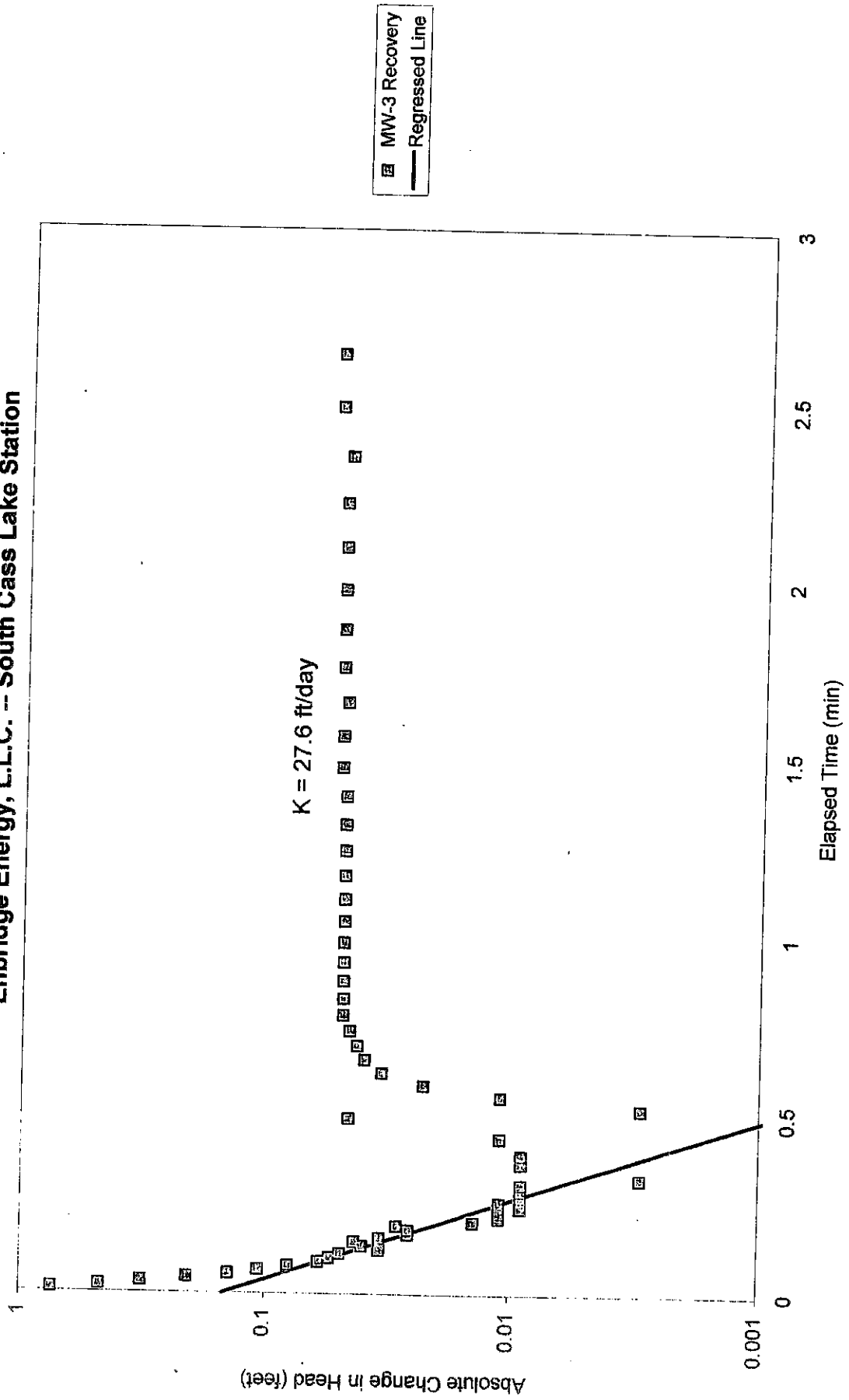
MW-2 Recovery Data
Enbridge Energy, L.L.C. -- South Cass Lake Station



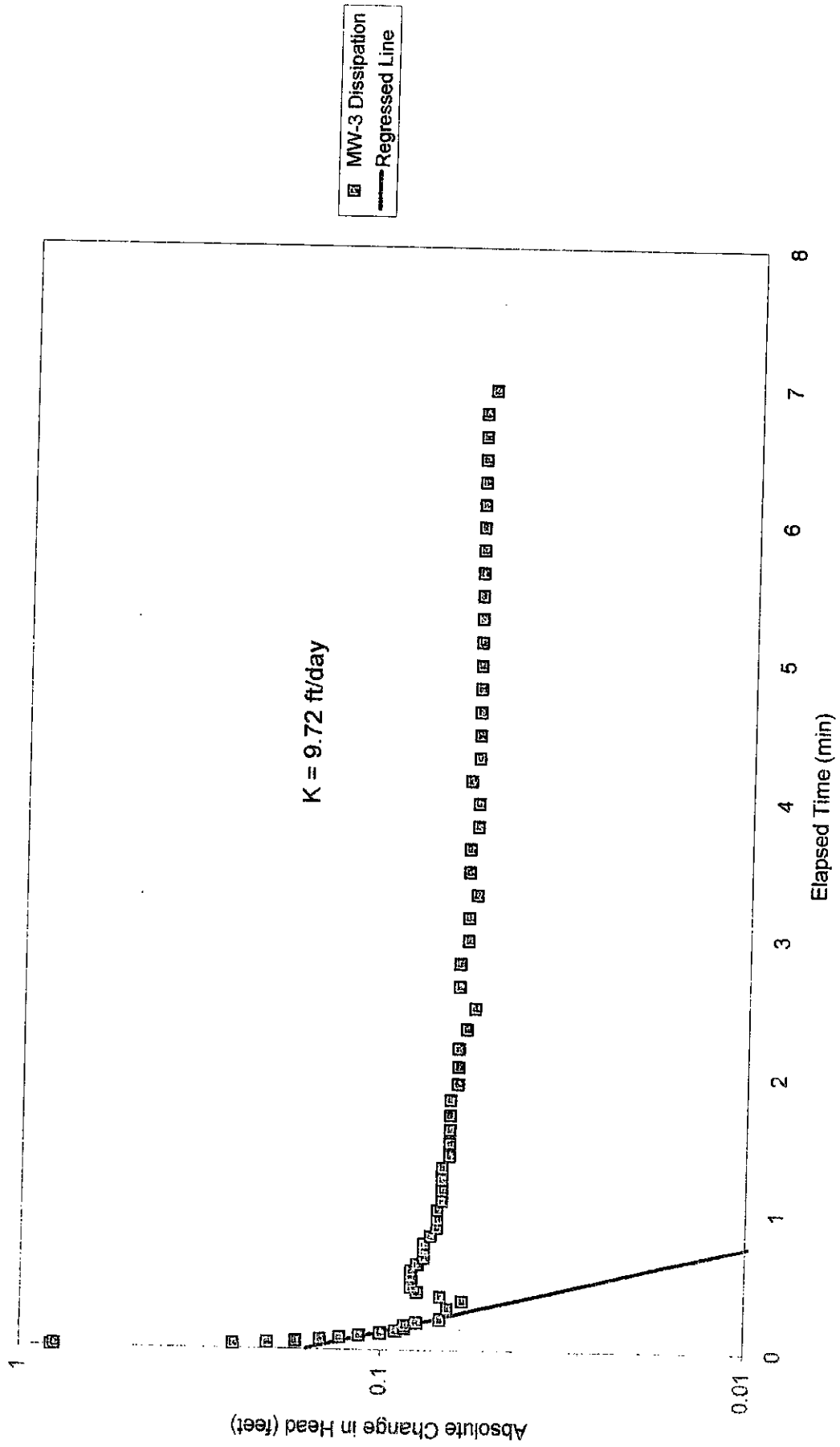
MW-2 Dissipation Data
 Enbridge Energy, L.L.C. -- South Cass Lake Station



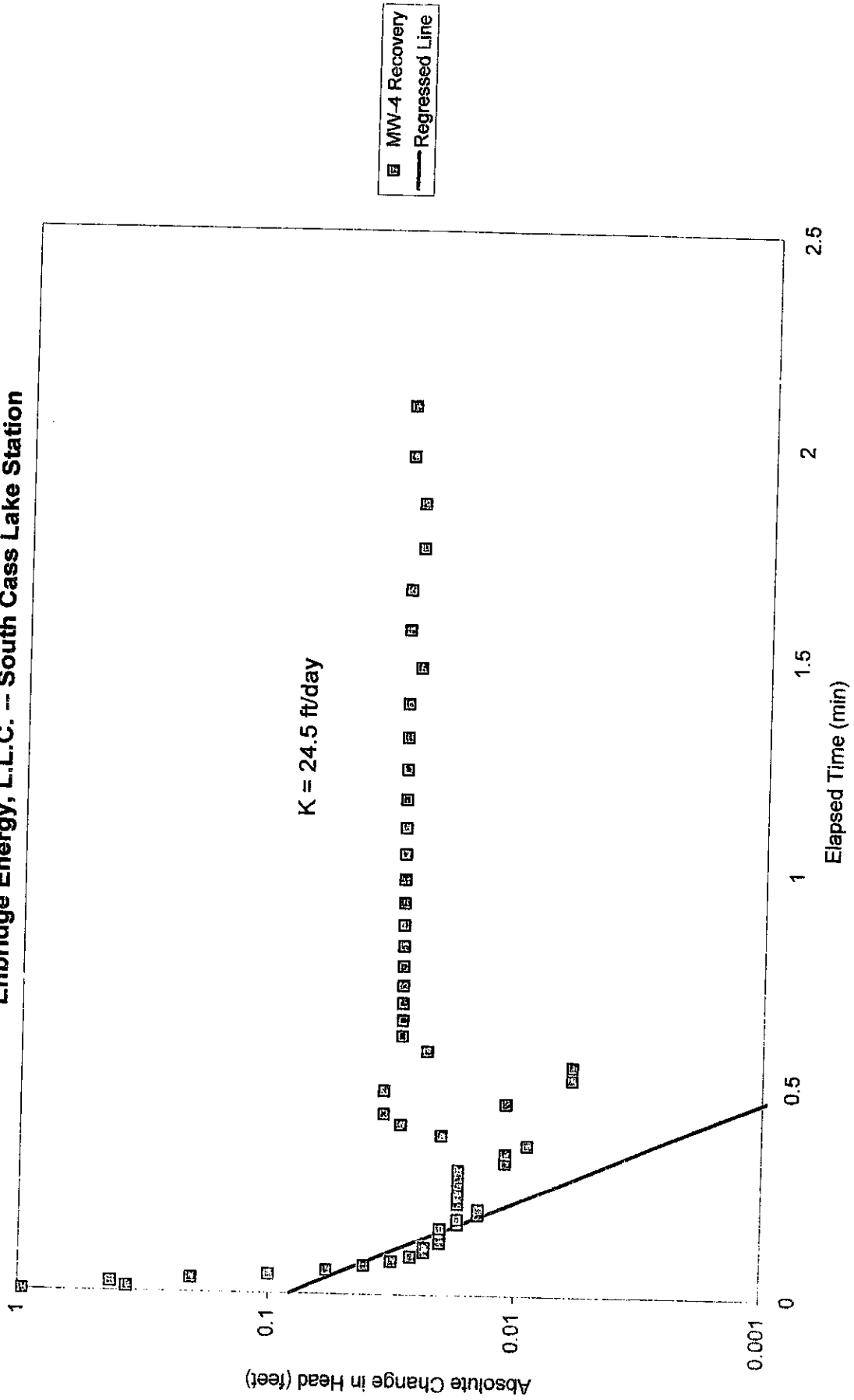
MW-3 Recovery Data
Enbridge Energy, L.L.C. -- South Cass Lake Station



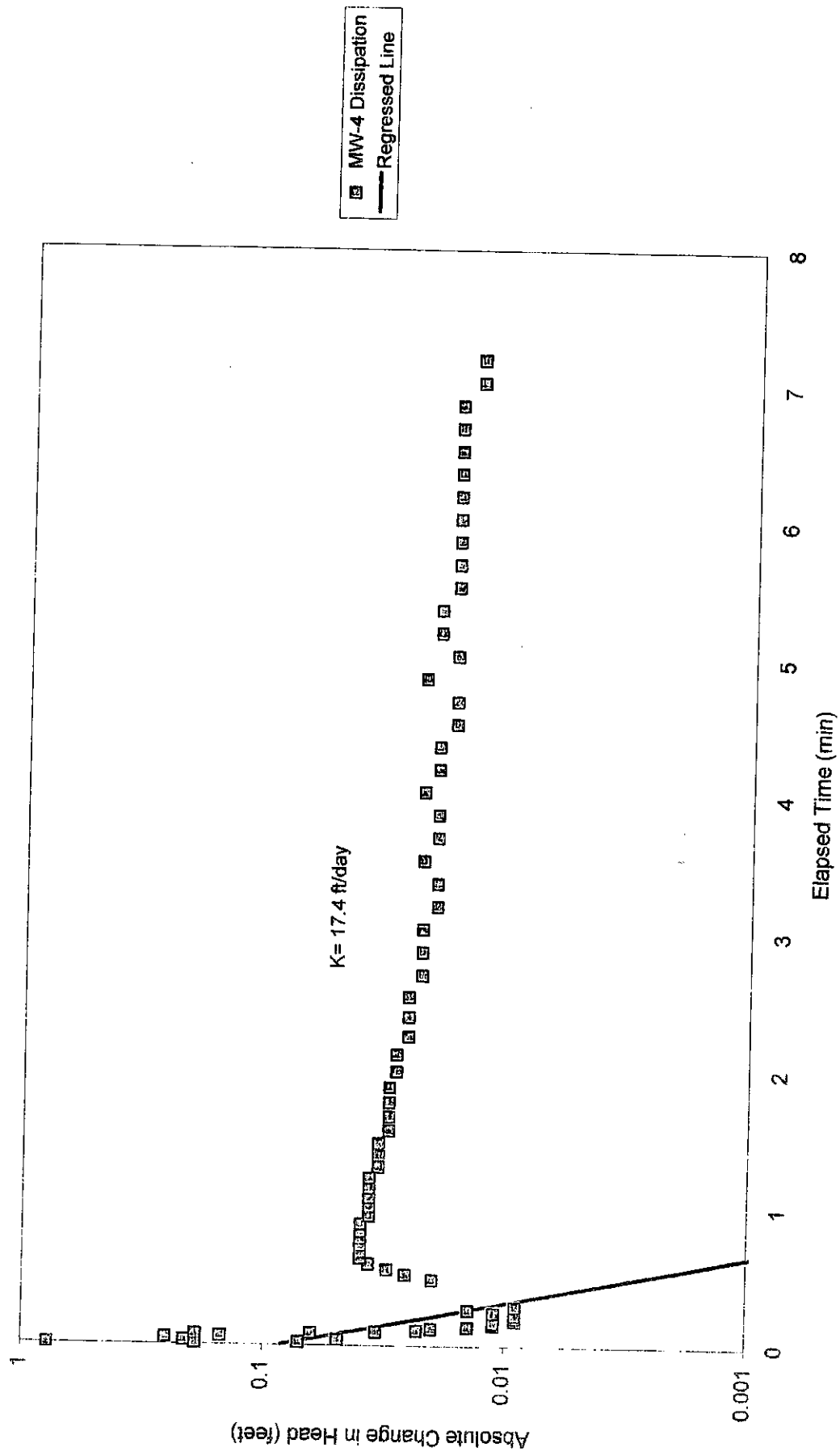
MW-3 Dissipation Data
Enbridge Energy, L.L.C. -- South Cass Lake Station



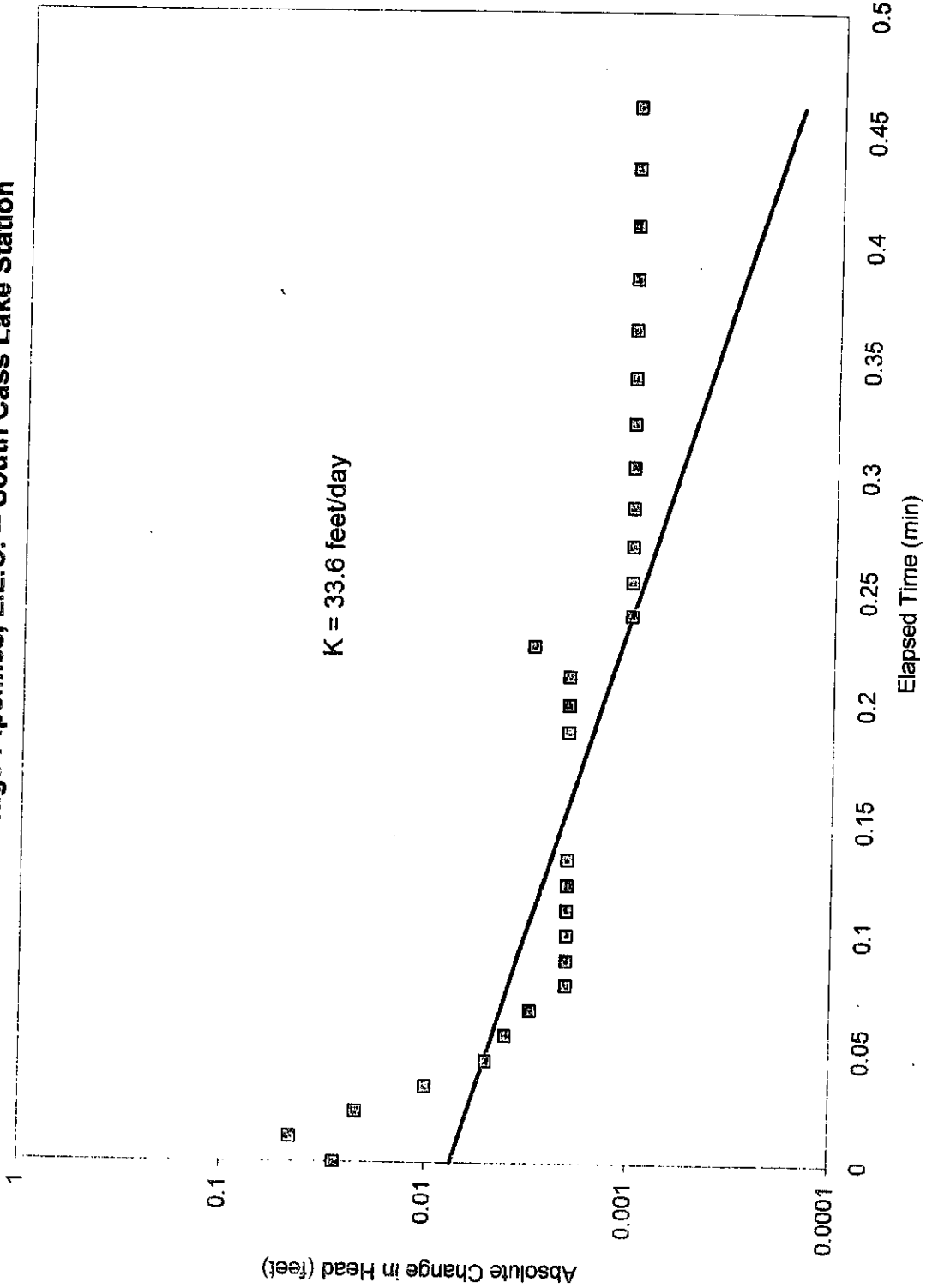
MW- 4 Recovery Data
 Enbridge Energy, L.L.C. -- South Cass Lake Station



MW-4 Dissipation Data Enbridge Energy, L.L.C. -- South Cass Lake Station

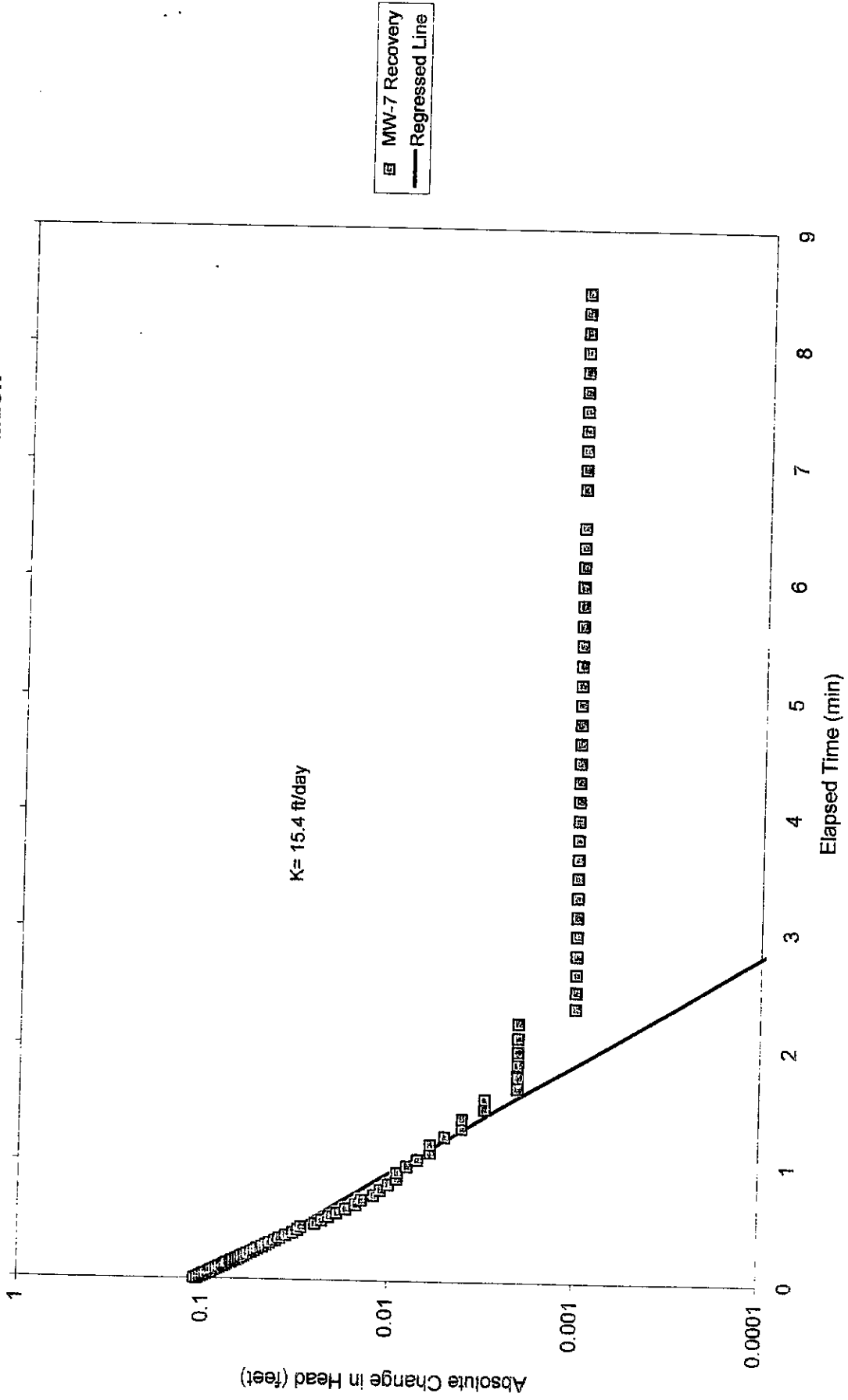


MW-6 Recovery Data
Enbridge Pipelines, L.L.C. -- South Cass Lake Station

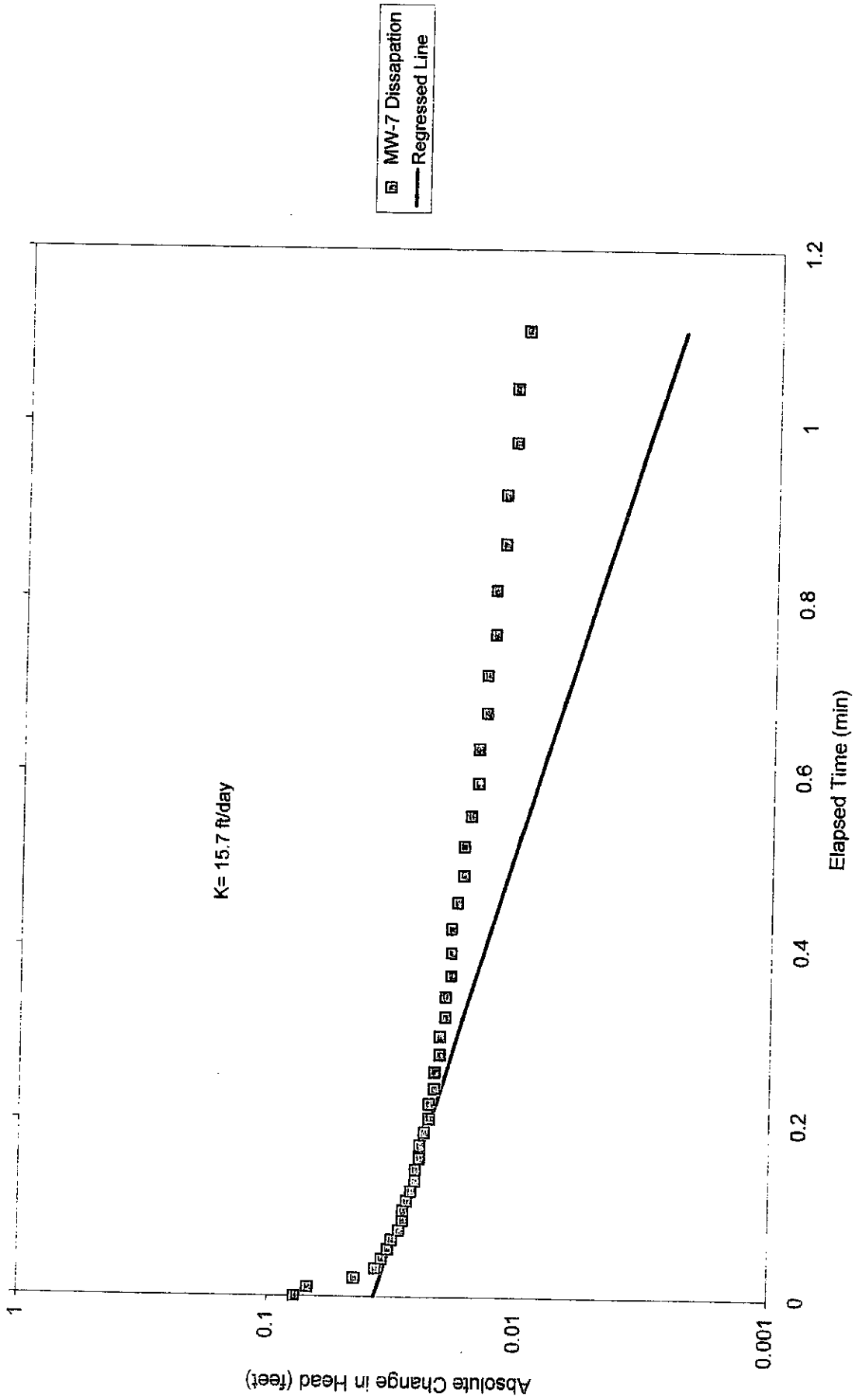


□ MW-6 Recovery
 — Regressed Line

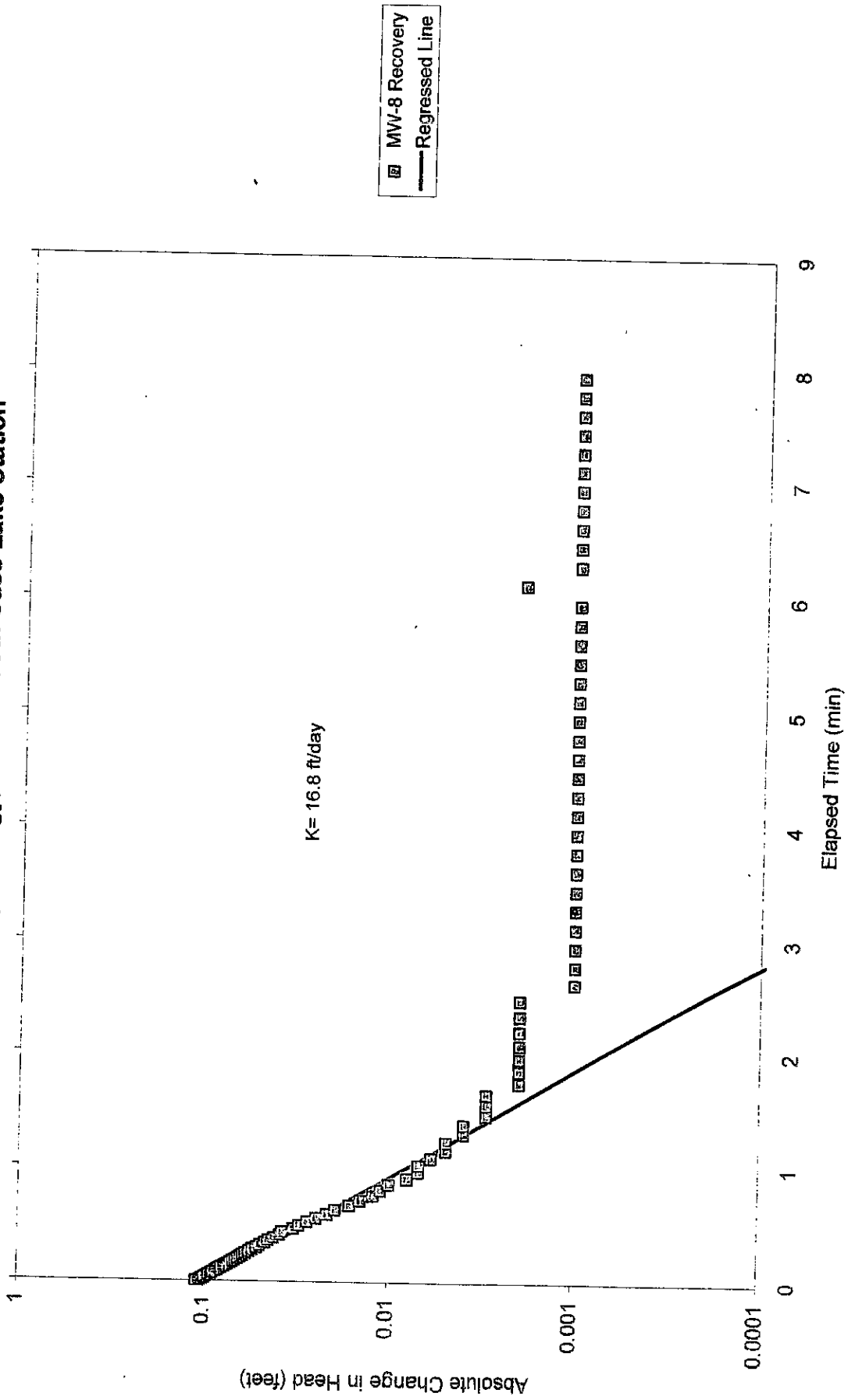
MW-7 Recovery Data
Enbridge Pipelines, L.L.C. -- South Cass Lake Station



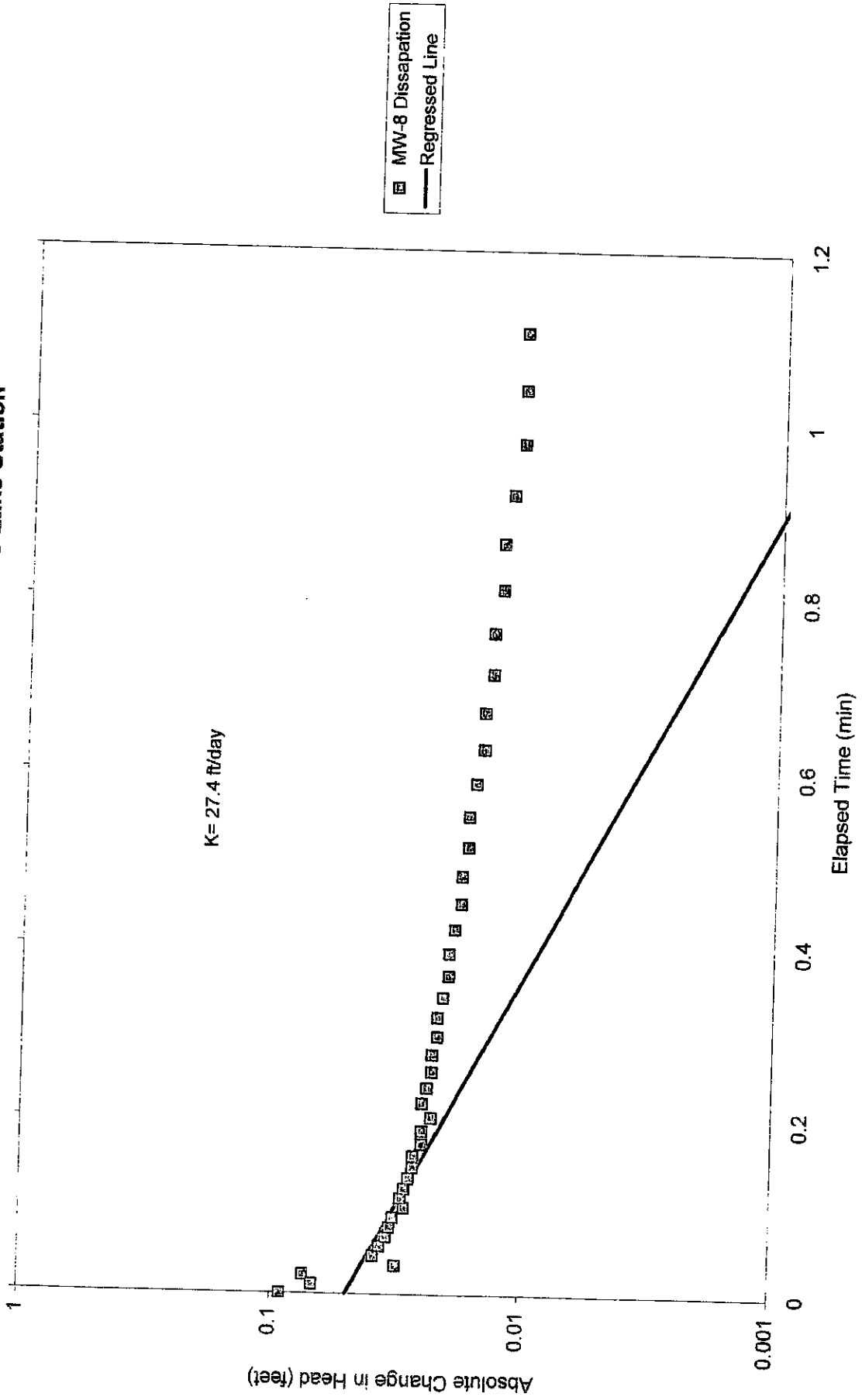
MW-7 Dissipation Data Enbridge Energy, L.L.C. -- South Cass Lake Station



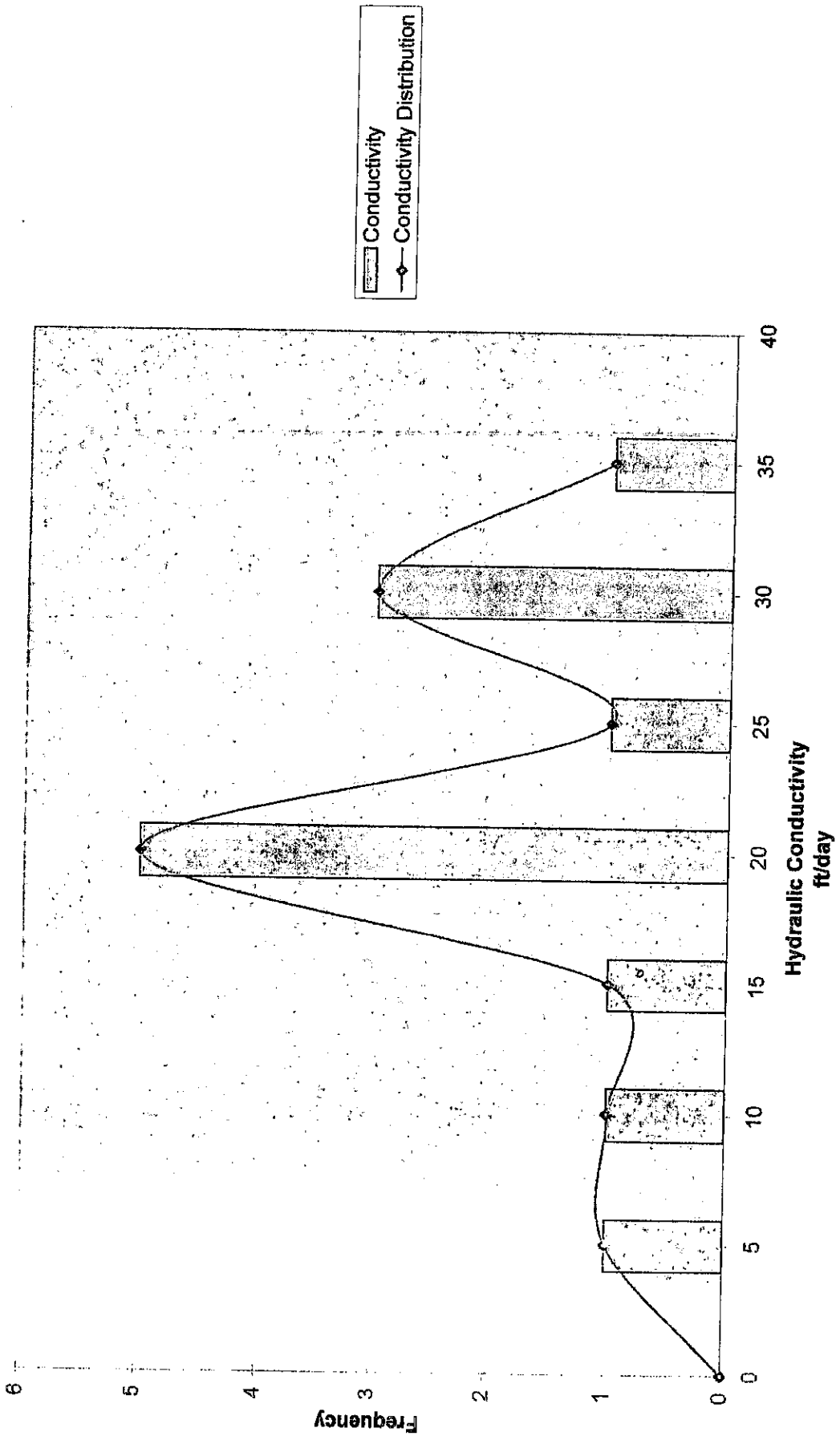
MW-8 Recovery Data
Enbridge Energy, L.L.C. - Soth Cass Lake Station



MW-8 Dissipation Data
Enbridge Energy, L.L.C. -- South Cass Lake Station



Hydraulic Conductivity, Normal Distribution
 Enbridge Energy, L.L.C. -- South Cass Lake



Hydraulic Conductivity, Log-Normal Distribution
 Enbridge Energy, L.L.C. - South Cass Lake

