THOMSEN ASSOCIATES

FRONTIER CHEMICAL
HYDROGEOLOGIC INVESTIGATION
EVALUATION OF
GROUNDWATER QUALITY

EMPIRE
SOILS INVESTIGATIONS INC.

Entered

FRONTIER CHEMICAL
HYDROGEOLOGIC INVESTIGATION
EVALUATION OF
GROUNDWATER QUALITY

FOR

Frontier Chemicl Waste Process, Inc.

Job No. BD-84-142

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105 CORONA AVENUE, GROTON, NY 13073, 607-898-5881

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1.0 INTRODUCTION

1.1 Project Background

Empire Soils Investigations, Inc. was retained by Frontier Chemical Waste Process, Inc. in November, 1984 to 1) install monitoring wells around their facility in Niagara Falls, New York, 2) prepare a hydrogeologic report describing the direction of groundwater flow and conditions encountered during the investigation, and 3) analyze water quality data from the monitoring wells and prepare a groundwater quality assessment report. The hydrogeologic report describing groundwater flow conditions beneath the facility was presented to Frontier Chemicals in February, 1985 and is included in Appendix A. This report presents the findings and conclusions from the final task of our investigation, evaluation of ground water quality based on results from the water samples taken from the monitoring wells installed around the facility.

1.2 Purpose and Scope

The purposes of the ground water quality assessment is to evaluate the impact of the Frontier Chemical Waste Process, Inc. facility on ground water quality beneath the site. This work was performed to comply with the requirements of the New York Department of Environmental Conservation for a groundwater monitoring program at the facility. Specifically, the purpose of our work was to:

- Analyze results form 3 months of monitoring data obtained from 9 wells.
- Analyze results from volatile organic analyses on two sets of water samples from 9 wells.
- Evaluate the impact of the sludge settler on downgradient water quality.

The scope of our work was limited to analyzing results from the chemical analysis of water samples. Water samples from the wells were taken by Frontier Chemical Waste Process and analyzed by Frontier Chemical Waste Process, Ecology and Environment, and Zenon Environmental.

This report has been prepared for the exclusive use of Frontier Chemicals for specific application to groundwater monitoring at their facility in Niagara Falls, New York. No other warranty, expressed or implied is made.

2.0 FINDINGS OF INVESTIGATION

2.1 Groundwater Flow

The water table map developed for the initial hydrogeologic investigation (see Appendix A, Drawing No. 2) indicates the groundwater flow is from the northwest corner of the property toward the south, southeast, and east. Monitoring wells MW-9, MW-11, MW-12 and MW-13 are downgradient of the facility. Monitoring wells MW-9, MW-10 and MW-11 are downgradient of the sludge settler. Monitoring wells MW-14 and MW-17 are upgradient of the facility. Monitoring wells MW-15 and MW-16 are within the facility and are

described in subsequent sections as downgradient wells because water quality results from these wells could reflect an influence by the facility. Although water elevation data suggest flow patterns as indicated above, the regional bedrock groundwater flow pattern in the Niagra Falls area is towards the Niagara River Gorge below the falls, i.e., in a northwest direction. It is possible that the deep city sewers, laid in bedrock along Royal Avenue and 47th Street could account for the observed flow direction beneath the site.

Water level elevations measured during the 12 week sampling period show the same groundwater flow pattern as that shown in Drawing No. 2, Appendix A.

An estimate of the rate of groundwater flow was obtained by performing a field permeability test at well MW-15. Fourteen gallons of water were pumped out of well MW-15 and the recovery of the well was measured. The data obtained were analyzed according to the methodology of Bouwer and Rice (1976). Results of the field test indicate a hydraulic conductivity of 8×10^{-4} cm/sec for well MW-15. Using a value of 8×10^{-4} cm/sec for hydraulic conductivity, 0.06 ft/ft for the hydraulic gradient, and assuming a value of 0.2 for specific yield, the average linear velocity of groundwater flow ($\bar{v}$) is 0.2 m/day (0.6 ft/day). Assuming a velocity of 0.2 m /day, the distance groundwater would travel during the 3 month monitoring period (90 days) would be about 18 meters (55 feet).

However, in areas with less fracturing in bedrock than encountered at Well MW-15, ground water flow rates could be substantially lower than indicated above. The data from groundwater quality parameters in MW-2 (phenol, TOC, conductivity) have remained essentially similar since sampling begain in May 1982, which suggests a much lower groundwater flow velocity than 0.6 ft/day.

2.2 Groundwater Quality

Water samples were taken weekly for one month, then monthly for two months at the nine monitoring wells installed into bedrock (MW-9 through MW-17). These samples were analyzed for pH, specific conductance, total organic carbon (TOC) and phenol. The samples taken at the end of each month were also analyzed for iron, nickel, chromium, cadmium, copper and zinc. Water samples were also taken monthly from four shallow wells installed in the unconsolidated deposits (MW-5, MW-6, MW-7 and MW-8) and three wells installed at the soil-rock interface (MW-2, MW-3 and MW-4) and analyzed for total organic halogens, cyanide, thiocyanate, chloride, sulfate, iron, manganese, nickel and sodium in addition to pH, specific conductance, TOC and phenol. In addition, water samples were taken twice from the bedrock wells (MW-9 through MW-17) and analyzed for volatile organic priority pollutants. (See drawing No. 1 for the location of the monitoring wells).

The results of the water sample analyses are summarized in Tables 2 and 3. Table 2 contains a summary of all analytical results for the three months of sampling except for the volatile organic results and Table 3 has a summary of the parameters detected in the analyses for volatile organics.

A comparison of data in Table 2 and the direction of groundwater flow indicates that the settler is not the source of the elevated concentrations of many parameters in downgradient wells. Wells MW-15, MW-16 and MW-2 are upgradient of the settler. Well MW-12 is cross gradient to the settler. Thus the elevated concentrations of phenols, TOC and specific conductance (compared to background concentrations at MW-14 and MW-17 of these parameters) does not appear to be related to the settler. The pH is another indication that the settler is not the source of elevated concentrations of parameters in wells MW-9, MW-15 and MW-16. The pH in these wells was between 11.1 and 11.7 while the pH in well MW-10 (directly downgradient of the settler) was 9.3 to 9.7. The high pH in wells MW-9, MW-15 and MW-16 is thus not attributable to the settler.

During the sampling period (3 months), there was little change in concentration of most parameters. Except for the increase in pH, TOC, phenols and specific conductance at well MW-11 between weeks 2 and 3, concentrations of parameters in the other wells remained fairly constant. Given the short time span and estimated

groundwater flow velocity, (0.6 ft/day), one would not expect much change in concentration during the sampling period. A longer time period for sampling is needed to evaluate the source causing the increased concentrations in downgradient wells.

The increased concentration of parameters in well MW-11 after week 2 may be attributed to either: 1)dilution of aquifer water in the immediate vicinity of the well by water introduced during drilling, which results in low concentrations for the first two weeks of sampling until this water is completely purged from the system and/or 2) movement of a "slug" of contaminated groundwater through well MW-11. Further monitoring at well MW-11 is needed to assess the reason for the increased concentrations in this well and whether the concentrations will remain at the values measured in weeks 3, 4 and 8 or return to early concentrations.

Table 3 summarizes the results from the volatile organic analyses. Only those parameters detected by the laboratories are included in the table. Water samples were analyzed twice by two different laboratories because of the discrepancies found in the data from the first analyses by Ecology and Environment. The high concentrations of toluene and chlorotoluene in well MW-17 did not seem reasonable. In addition concentrations of other parameters in two upgradient wells (MW-14 and MW-17) did not seem reasonable (benzene, trichloroethane, chloroform, and

trichloroethene). In order to check these results a second set of samples were taken and analyzed by Zenon Environmental.

A subsequent report to Ecology and Environment's initial analysis of the volatiles dated May 31, 1985 and included in Appendix B points to some errors in the quantitation of chlorotoluene for all the wells and toluene for MW-17. The concentration of chlorotoluene is 4.6 times lower for all the wells with the exception of MW-10 which is 22 times higher. Toluene is reported at over 1000 times lower from the previous work. This substantiates Frontier's original concerns over the validity of Ecology and Environment's data. The corrected concentrations are shown in Table 3.

A comparison of results from the two laboratories indicates many discrepancies in the data. Of the 12 parameters which both laboratories analyzed, results from only 3 parameters showed similar concentrations in the two samples analyzed, 1-1 dichloroethene, chloroform and tetrachloroethene. Concentrations of 6 parameters analyzed by Ecology and Environment were 2 to 3000 times higher than concentrations of the same parameters analyzed by Zenon Environmental (benzene, chlorobenzene, methylene chloride, toluene, trichloroethene, and chlorotoluene). Three parameters analyzed by both laboratories were not detected by Ecology and Environment while Zenon Environmental detected these same parameters in concentrations well above Ecology

and Environment's detection limit of 50 ug/l (carbon tetrachloride, 1-2 dichloroethane, and 1-1 dichloroethene). (Zenon's reported detection limit is 0.1 ug/l.) In addition to these discrepancies, the concentrations of several parameters reported by Zenon Environmental for the upgradient wells (MW-14 and MW-17) appear high. Reported concentrations for carbon tetrochloride, chlorobenzene, and toluene in at least one upgradient seem high. The discrepancies in concentrations of parameters analyzed by the two laboratories indicates that the concentrations shown on Table 3 for the parameters are not exact numbers. Rather, the numbers should be used to evaluate which wells had the highest concentrations of parameters compared to the background concentrations, and a general order of magnitude concentration of the parameter (i.e. 10 ug/l, 100 ug/l or 1000 ug/l).

Despite the discrepancies in the data, the results from both laboratories indicate the same trends. When the data is ranked, concentrations of volatile organics at well MW-11 were generally the highest, followed by concentrations of parameters in wells MW-16, MW-9, then MW-12. The rank for wells MW-10 and MW-15 was similar, with concentrations of volatile organics generally below those found in wells MW-11, MW-16, MW-9 and MW-12. These results also indicate that the sludge settler is not the source for the elevated concentrations of the organics in the downgradient wells since concentrations of most parameters were higher in wells MW-9, MW-11, MW-12 and MW-16 than in well MW-10.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Water quality sampling results indicate that concentrations of many parameters are elevated in the downgradient wells compared to the upgradient wells (MW-14 and MW-17). In addition to elevated concentrations of many volatile organics, downgradient wells show a higher pH, increased specific conductance, and higher concentrations of phenols and total organic carbon. However, the sludge settler does not appear to be the source of the elevated concentrations of most parameters in the downgradient wells. Probably only the elevated concentrations of phenol in well MW-10 should be attributed to the settler. Analysis of the data and groundwater flow direction indicates the elevated concentrations of parameters found in other downgradient wells (MW-7, MW-11, MW-12, MW-15 and MW-16) are probably not attributable to the sludge settler.

Frontier Chemical plans to construct a concrete containment area in the vicinity of the sludge settler within the next two years. At that time the soil underneath the settler will be evaluated for possible contamination and disposed in accordance with accepted practices. This should resolve problems associated with the settler and mitigate the need for MW-2, MW-7 and MW-10. Consequently, Frontier recommends that these wells be properly abandoned at the time of construction as their existence would hinder the construction process.

The many discrepancies in the analytical results from the two laboratories indicates that the reported concentrations are probably not exact numbers, but rather should be interpreted as order of magnitude indications of concentrations.

Due to the relatively short time period for sampling (3 months) and estimated groundwater flow velocity (0.6 ft/day) not enough data is available to draw any meaningful conclusions as to the causes of the organic contaminations in the groundwater.

We recommend continued monitoring of the downgradient wells every two months for one year. Additional results from water quality sampling over a longer time period will provide information on 1) seasonal fluctuations in concentrations and 2) the possible source(s) of groundwater contamination. We recommend that the nine bedrock wells (MW-9 through MW-17) and bedrock well (MW-2) until abandoned, are sampled. Since results from the remaining shallow wells (MW-3, MW-4, MW-5, MW-6, MW-7 and MW-8 did not indicate any significant contamination, we further recommend sampling these wells only semiannually.

The parameters which should be analyzed at the wells include pH, specific conductance, total organic carbon, phenol, cyanide, iron, chromium, nickel, benzene and tetrachloroethene. Analytical results indicated increased concentrations of all of the above parameters in the downgradient wells. Concentrations of other parameters previously monitored (cadmium, arsenic, copper, and zinc) were low in downgradient wells so will not be analyzed. Since specific conductance reflects increased concentrations of chloride, sulfate and sodium, these specific parameters will not be analyzed. Benzene and tetrachloroethene were chosen for analysis rather than total halogenated organics because both laboratories reported relatively high concentrations for these parameters in downgradient wells,

and results from these two parameters will provide an indication of differences in migration of halogenated hydrocarbons (tetrachloroethene) versus non-halogenated hydrocarbons (benzene).

4.0 REFERENCES

Bouwer, H. and R. C. Rice, 1976, "A Slug Test for Determining Hydraulic conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells" Water Resource Research, Vol. 12, No. 3, pp 423-428.

Respectfully submitted,

EMPIRE-THOMSEN

Marjory B. Rinaldo-Lee

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TABLES

TABLE 1

WATER LEVEL ELEVATIONS

Measuring Date	WELL								
REFERENCE[1] ELEVATION	MW-9[2] 573.9	MW-10 575.7	MW-11[2] 573.7	MW-12[2] 573.5	MW-13[2] 574.0	MW-14 573.5	MW-15 572.4	MW-16 573.4	MW-17 573.0
1-4-85[3]	dry	554.4	550.6	557.7	574.0	559.9	556.8	553.9	558.2
1-11-85	dry	554.0	dry	549.9	dry	558.8	557.0	556.7	557.9
1-15-85	dry	554.2	dry	550.0	dry	558.5	557.0	556.8	557.9
1-29-85	dry	554.0	dry	549.7	dry	558.2	556.4	556.8	557.6
1-31-85	dry	554.1	544.0	544.1[4]	dry	558.3	556.5	556.5	557.6
2-1-85	545.9	554.1	543.8	543.8	dry	558.0	556.2	556.6	557.6
2-8-85	546.1	553.8	544.0	544.0	544.6	558.1	556.2	554.9	557.6
2-14-85	546.3	554.3	544.3	544.3	545.0	558.3	556.2	556.8	557.7
2-21-85	546.4	554.3	544.3	544.4	545.0	558.6	556.4	556.8	557.7
2-27-85	547.0	554.3	544.5	544.6	545.6	560.4	557.8	556.8	558.7
3-27-85	546.8	554.4	544.4	544.4	545.5	559.3	557.5	556.7	557.8
4-24-85	546.5	554.4	544.3	544.3	545.9	558.9	556.5	555.5	557.6

[1]Reference Point is Top of PVC

[2]Wells MW-9, MW-11, MW-12 and MW-13 were redrilled between Jan. 28, 1985 & Feb. 1, 1985

[3]Water Levels were not stabilized on Jan. 4, 1985

[4]Well MW-12 was redrilled on Jan. 29, 1985

TABLE 2

SUMMARY OF GROUNDWATER SAMPLING RESULTS

		BEDROCK WELLS									SHALLOW WELLS						
		Upgradient		Downgradient							Upgradient		Downgradient				
COMPOUND	WEEK	MW-14	MW-17	MW-9	MW-10	MW-11	MW-12	MW-13	MW-15	MW-16	MW-8	MW-3	MW-5	MW-6	MW-7	MW-2	MW-4
pH	1	7.3	7.3	11.4	9.3	9.5	9.4	7.2	11.7	11.5	7.2	7.5	7.4	9.8	7.7	8.6	-
	2	7.2	7.4	11.3	9.4	9.4	9.5	7.4	11.6	11.5	-	-	-	-	-	-	-
	3	7.1	7.4	11.4	9.3	11.1	10.3	7.1	11.4	11.4	-	-	-	-	-	-	-
	4	7.1	7.2	11.2	9.5	10.3	9.7	7.1	11.1	11.5	7.4	7.8	7.5	9.4	7.7	8.4	7.7
	8	7.5	8.1	11.4	9.7	10.7	9.8	8.0	11.4	11.5	7.9	8.3	8.0	9.5	8.1	8.8	7.9
	12	7.9	8.1	10.5	9.1	10.0	9.3	7.5	10.7	10.3	8.0	8.2	7.7	8.7	8.2	8.4	-
Specific Conductance (umhos/cm)	1	2700	12000	71000	62000	17000	32000	2500	15000	14000	3900	3400	1700	2200	5200	82000	-
	2	2600	12000	70000	61000	15000	32000	2500	15000	14000	-	-	-	-	-	-	-
	3	2400	10000	94000	90000	38000	28000	2300	18000	17000	-	-	-	-	-	-	-
	4	2400	19000	91000	94000	29000	36000	2300	18000	20000	2900	2900	1900	670	2400	82000	3600
	8	3000	14000	71000	77000	29000	26000	2000	42000	16000	2300	3100	1600	1500	3000	83000	3500
	12	2600	14000	63000	67000	26000	26000	3000	17000	16000	2200	2700	1400	1600	2600	77000	-
TOC (mg/l)	1	30	70	650	1500	80	170	30	340	460	70	50	20	80	80	950	-
	2	40	70	620	1500	80	190	40	320	510	-	-	-	-	-	-	-
	3	40	110	620	1700	530	250	50	310	530	-	-	-	-	-	-	-
	4	40	40	480	1500	460	190	30	220	560	80	40	20	20	90	940	40
	8	100	120	500	1800	430	240	60	280	480	50	30	10	10	40	1300	50
	12	20	50	500	2000	260	60	30	200	700	40	30	10	90	30	1800	-
Phenol (mg/l)	1	<0.1	<0.1	50	370	3.6	1.1	<0.1	11	87	<0.1	<0.1	<0.1	<0.1	<0.1	13	-
	2	<0.1	<0.1	56	380	4.5	1.2	<0.1	6.4	81	-	-	-	-	-	-	-
	3	<0.1	<0.1	47	390	28	4.2	<0.1	8.2	82	-	-	-	-	-	-	-
	4	<0.1	<0.1	38	390	14	1.1	0.1	4.5	80	<0.1	<0.1	<0.1	<0.1	<0.1	64	<0.1
	8	<0.1	<0.1	28	420	13	<0.1	<0.1	1.9	24	<0.1	<0.1	<0.1	<0.1	<0.1	110	-
	12	<0.1	<0.1	37	367	34	<0.1	<0.1	<0.1	63	<0.1	<0.1	<0.1	<0.1	<0.1	85	-
THO (ug/l)	1	-	-	-	-	-	-	-	-	-	0.06	0.16	0.01	0.20	0.14	0.05	-
	4	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	0.13	0.23	-
	8	-	-	-	-	-	-	-	-	-	1.0	1.8	2.5	0.7	20	83	-
	12	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	0.2	0.8	3.8	-
Cyanide (mg/l)	1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.18	-
	4	<0.02	0.04	0.97	0.78	0.40	0.11	0.04	0.78	0.57	<0.02	0.04	<0.02	<0.02	<0.02	0.95	-
	8	<0.1	<0.1	1.9	1.6	1.4	0.1	<0.1	0.8	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	3.3	<0.1
	12	<0.1	<0.1	1.1	1.2	0.5	<0.1	<0.1	0.6	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	1.5	-
Thio-cyanate (mg/l)	1	-	-	-	-	-	-	-	-	-	0.46	0.66	1.6	I8	0.98	50	-
	4	-	-	-	-	-	-	-	-	-	0.10	0.14	0.35	3.9	0.22	11.2	-
	8	-	-	-	-	-	-	-	-	-	0.6	0.6	<0.5	4.2	1.9	43	1.0
	12	-	-	-	-	-	-	-	-	-	0.4	0.5	<0.1	15	1.3	43	-
Chloride (mg/l)	1	-	-	-	-	-	-	-	-	-	570	370	270	240	1100	4400	-
	4	-	-	-	-	-	-	-	-	-	480	440	530	70	540	42000	730
	8	-	-	-	-	-	-	-	-	-	190	320	310	130	490	32800	630
	12	-	-	-	-	-	-	-	-	-	130	330	300	980	500	52000	-
Sulfate (mg/l)	1	-	-	-	-	-	-	-	-	-	800	900	100	340	600	4400	-
	4	-	-	-	-	-	-	-	-	-	480	750	1290	33	540	3700	120
	8	-	-	-	-	-	-	-	-	-	650	500	150	80	200	3500	1100
	12	-	-	-	-	-	-	-	-	-	200	580	120	250	880	3800	-
Sodium (mg/l)	1	-	-	-	-	-	-	-	-	-	490	460	220	240	590	6800	-
	4	-	-	-	-	-	-	-	-	-	100	200	190	40	250	10000	180
	8	-	-	-	-	-	-	-	-	-	50	140	90	40	170	850	140
	12	-	-	-	-	-	-	-	-	-	70	200	170	40	280	10700	-

TABLE 2

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		BEDROCK WELLS									SHALLOW WELLS						
		Upgradient		Downgradient							Upgradient		Downgradient				
COMPOUND	WEEK	MW-14	MW-17	MW-9	MW-10	MW-11	MW-12	MW-13	MW-15	MW-16	MW-8	MW-3	MW-5	MW-6	MW-7	MW-2	MW-4
Arsenic (mg/l)	1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
	4	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	8	-	-	-	-	-	-	-	-	-	<0.05	<0.1	<0.05	0.1	0.2	0.2	<0.05
	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron (mg/l)	1	-	-	-	-	-	-	-	-	-	0.2	<0.1	0.8	2.2	<0.1	3.9	-
	4	<0.5	<0.5	<0.5	1.4	<0.5	<0.5	<0.5	<0.5	0.67	<0.5	<0.5	<0.5	<0.5	<0.5	2.2	<0.5
	8	<0.1	0.1	3.3	6.7	0.6	0.3	<0.1	0.4	0.4	<0.1	<0.1	0.1	0.2	<0.1	3.6	0.2
	12	0.1	0.1	0.7	3.7	0.2	0.1	0.2	0.2	0.6	<0.1	<0.1	0.2	0.2	<0.1	8.2	-
Manganese (mg/l)	1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	0.4	0.5	-
	4	-	-	-	-	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	0.21	<0.5
	8	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	0.1	0.7	<0.05
	12	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	0.11	<0.05	0.42	-
Nickel (mg/l)	1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	-
	4	<0.1	0.14	0.24	0.27	0.18	0.14	<0.1	0.10	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	0.85	<0.1
	8	<0.1	<0.1	0.9	1.2	0.2	0.2	<0.1	0.4	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	2.0	<0.1
	12	<0.1	<0.1	0.6	0.5	0.2	<0.1	<0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	1.3	-
Chromium (mg/l)	4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-	-	-	-
	8	<0.1	<0.1	0.3	0.21	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
	12	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
Cadmium (mg/l)	4	<0.01	<0.01	0.07	0.08	0.03	0.02	<0.1	<0.01	0.02	-	-	-	-	-	-	-
	8	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
	12	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
Copper (mg/l)	4	<0.05	<0.05	0.05	0.37	<0.05	<0.05	<0.05	0.14	<0.05	-	-	-	-	-	-	-
	8	0.3	<0.05	<0.05	<0.05	0.23	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-
	12	<0.05	<0.05	0.10	0.19	<0.05	<0.05	<0.05	0.2	0.05	-	-	-	-	-	-	-
Zinc (mg/l)	4	0.16	0.07	0.19	0.46	0.04	0.05	0.08	0.04	0.07	-	-	-	-	-	-	-
	8	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
	12	0.05	0.06	0.56	0.77	0.06	<0.05	0.10	0.08	0.06	-	-	-	-	-	-	-

Notes: - Parameter not analyzed

TABLE 3

SUMMARY OF VOLATILE ORGANIC DATA

Volatile Organics (ug/l)	Lab[1]	Upgradient Wells			Downgradient Wells						NYDEC[4] Guidance Criteria	NYDEC[5] Groundwater Standard
		MW-14	MW-17	MW-9	MW-10	MW-11	MW-12	MW-13	MW-15	MW-16		
Benzene	E	152	290	40,600	690	83,200	88,800	137	11,100	116,000	1.5	N.D.
	Z	23	63	870	124	>1,600	>1,600	6.4	141	725		
Carbon Tetrachloride	E	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	0.3	5
	Z	297	2.4	1,520	187	>24,000	16	343	5.6	157		
Chlorobenzene	E	N.D.[2]	221	10,600	167	42,100	2,900	63.1	7,000	2,140		
	Z	62	500	3,630	388	979	1,230	20	851	806	20	-
1,2-Dichloro-ethane	E	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]	N.D.[2]		
	Z	6.5	1.4	457	20	701	141	5.3	249	6.6	1.0	-
1,1,1-Tri-chloroethane	E	835	883	1,350	1,160	22,100	18,000	1,750	359	7,540		
	Z	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	[50][6]	-
1,1-Dichloro-ethane	E	<50	<50	2,810	<50	722	643	<50	<50	2,890		
	Z	55	5.7	>2,250	107	2.4	515	86	59	702	[50][6]	-
Chloroform	E	197	<50	52.3	59.8	706	98.8	<50	416	489		
	Z	17	6.3	29	15	253	11	107	15	70	0.2	100
1,1-Dichloro-ethene	E	<50	<50	<50	<50	<50	<50	<50	<50	<50		
	Z	43	12	549	234	230	695	1,100	148	242	0.9	-
Methylene Chloride	E	<50	134	17,400	2,130	6,910	551	73.2	1,060	18,000		
	Z	6.7	2.8	993	294	>1,340	79	3.3	88	200	10	-
Tetrachloro-ethene	E	50	<50	1,620	<50	6,150	900	78.2	68.3	342		
	Z	47	2.9	1,410	107	>9,300	422	32	46	259	2	-
Toluene	E	182	409	14,700	4,310	26,100	10,200	1,150	5,190	40,500		
	Z	29	128	809	716	>4,300	683	66	526	>3,000	[50][6]	-
Trichloro-ethene	E	206	<50	4,040	1,020	2,540	17,400	327	455	2,760		
	Z	68	4.5	1,360	241	>5,400	1,410	20	121	572	5	10
Chlorotoluene	E	17500	46,000	9,700	105,000	108,000	3,400	1,270	4,760	33,000		
	Z	233	>4,700	3,340	>11,500	>26,500	1,210	419	2,000	>4,700	-	-
Methyl Toluene	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	4.6	5.6	140	59	414	33	1.7	41	170	-	-
Dichloro-toluene	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	0.7	0.4	8.3	11	92	25	0	35	0	-	-
Bromobenzene	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	0.4	0	38	3	88	23	0	27	19	-	-
Dichloro-benzene	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	64	4.9	1,950	261	>100,000	1,370	20	3,200	484	20	4.7
Trichloro-benzene	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	5.5	1.3	97	26	1,060	157	2.3	241	0	10	-
Dichloro-fluoroethane	E	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]	N.A.[3]		
	Z	0	0	2.4	21	71	0	0.2	5.5	18	-	-

[1] Lab E is Ecology and Environment, Lab Z is Zenon Environmental.

[2] N.D. is not detected by laboratory.

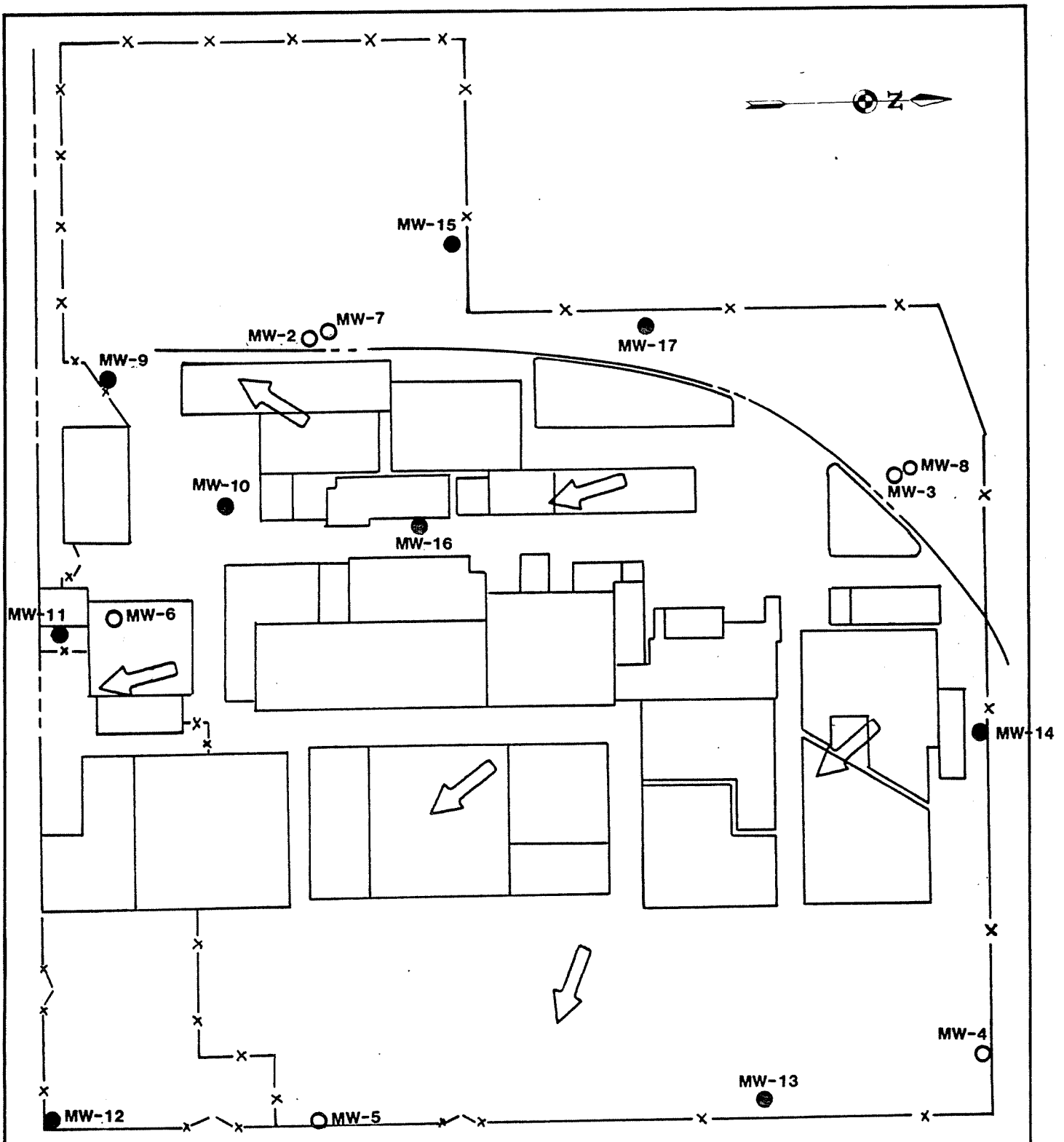
[3] N.A. is not analyzed by laboratory.

[4] Guidance Criteria are from: New York State Department of Environmental Conservation, 1984,"Ambient Water Quality Criteria", Technical and Operational Guidance Series, Memorandum Number 84-W-38.

[5] Groundwater Standards are from 6NYCRR Part 703.

[6] This limit is a general organic guideline not specific to this parameter

DRAWINGS



● MONITORING WELL installed by Empire Soils Investigations

○ MONITORING WELL installed by others

GENERAL DIRECTION OF GROUNDWATER FLOW IN BEDROCK

(see Appendix A for Water Table Map)

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

Groton ▪ Buffalo ▪ Rochester ▪ Syracuse ▪ Albany
New York ▪ Edison, New Jersey

MONITORING WELL LOCATIONS FRONTIER CHEMICALS

DR. BY: SC	SCALE: 1" = 100±	PROJ. NO.: BD-84-142
CK'D. BY: MC-1	DATE: May 1985	DRWG. NO.: 1

APPENDIX A

Frontier Chemical Hydrogeologic Investigation

TABLES

TABLE 1

Water Level Elevations

Well	Reference Point[1]	1-4-85[3]	1-11-85	1-15-85	1-29-85	1-31-85	2-1-85	2-8-85
MW-9[2]	573.9	dry	dry	dry	dry	dry	545.9	546.1
MW-10	575.7	554.4	554.0	554.2	554.0	554.1	554.1	553.8
MW-11[2]	573.7	550.65	dry	dry	dry	544.0	543.8	544.0
MW-12[2]	573.5	557.74	549.9	550.0	549.7	544.1[4]	543.8	544.0
MW-13[2]	574.0	dry	dry	dry	dry	dry	dry	544.6
MW-14	573.5	559.9	558.8	558.5	558.2	558.3	558.0	558.1
MW-15	572.4	556.8	557.0	557.0	556.4	556.5	556.2	556.2
MW-16	573.4	553.9	556.7	556.8	556.8	556.5	556.6	554.9
MW-17	573.0	558.2	557.9	557.9	557.6	557.6	557.6	557.6

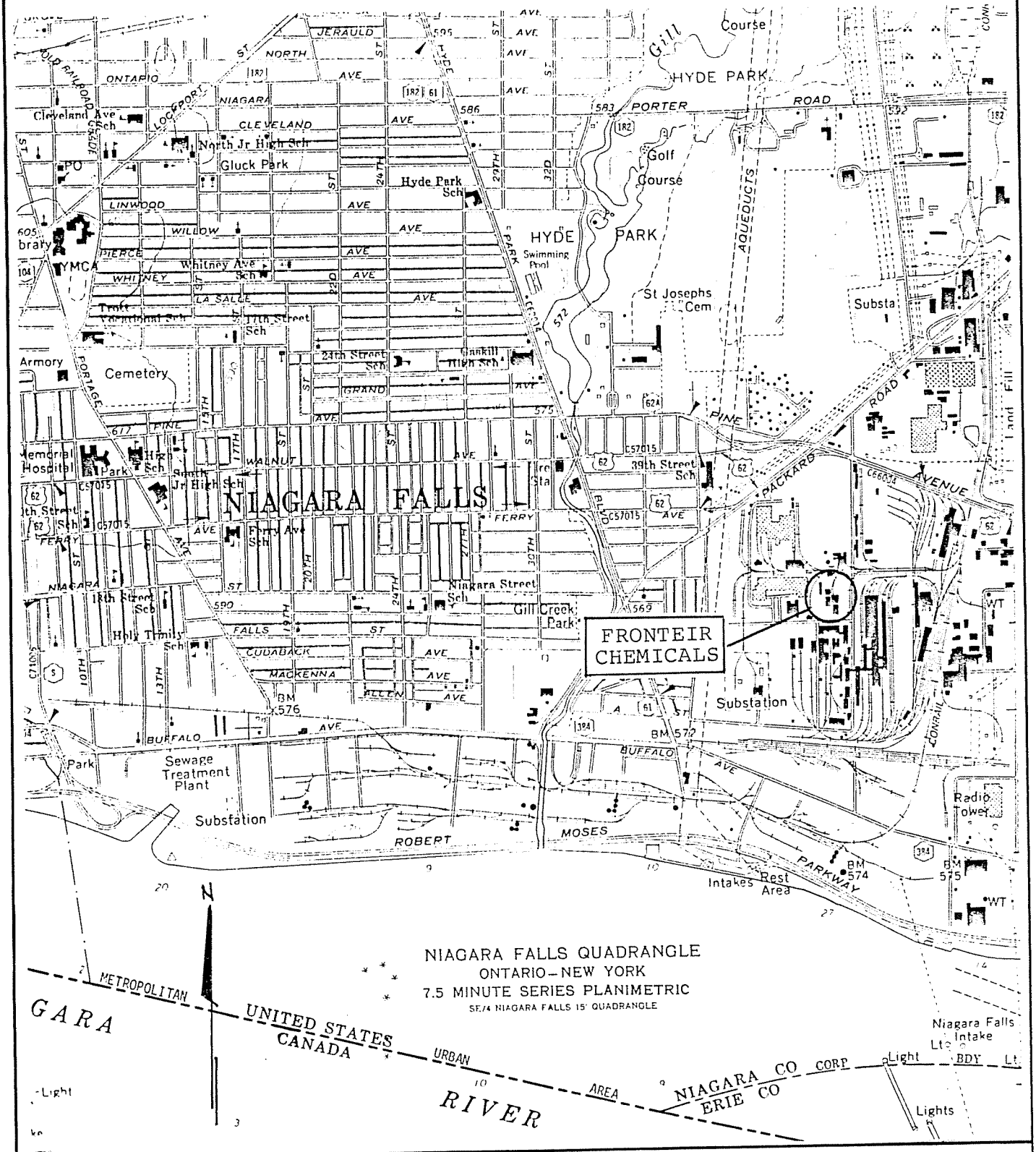
[1]Reference Point is top of PVC

[2]Wells MW-9,MW-11,MW-12, and MW-13 were redrilled between Jan. 28, 1985 and Feb. 1, 1985

[3]Water levels were not stabilized on Jan. 4, 1985

[4]Well MW-12 was redrilled on Jan. 29, 1985

FIGURES



NIAGARA FALLS QUADRANGLE
ONTARIO–NEW YORK
7.5 MINUTE SERIES PLANIMETRIC
SE/4 NIAGARA FALLS 15' QUADRANGLE

THOMSEN ASSOCIATES

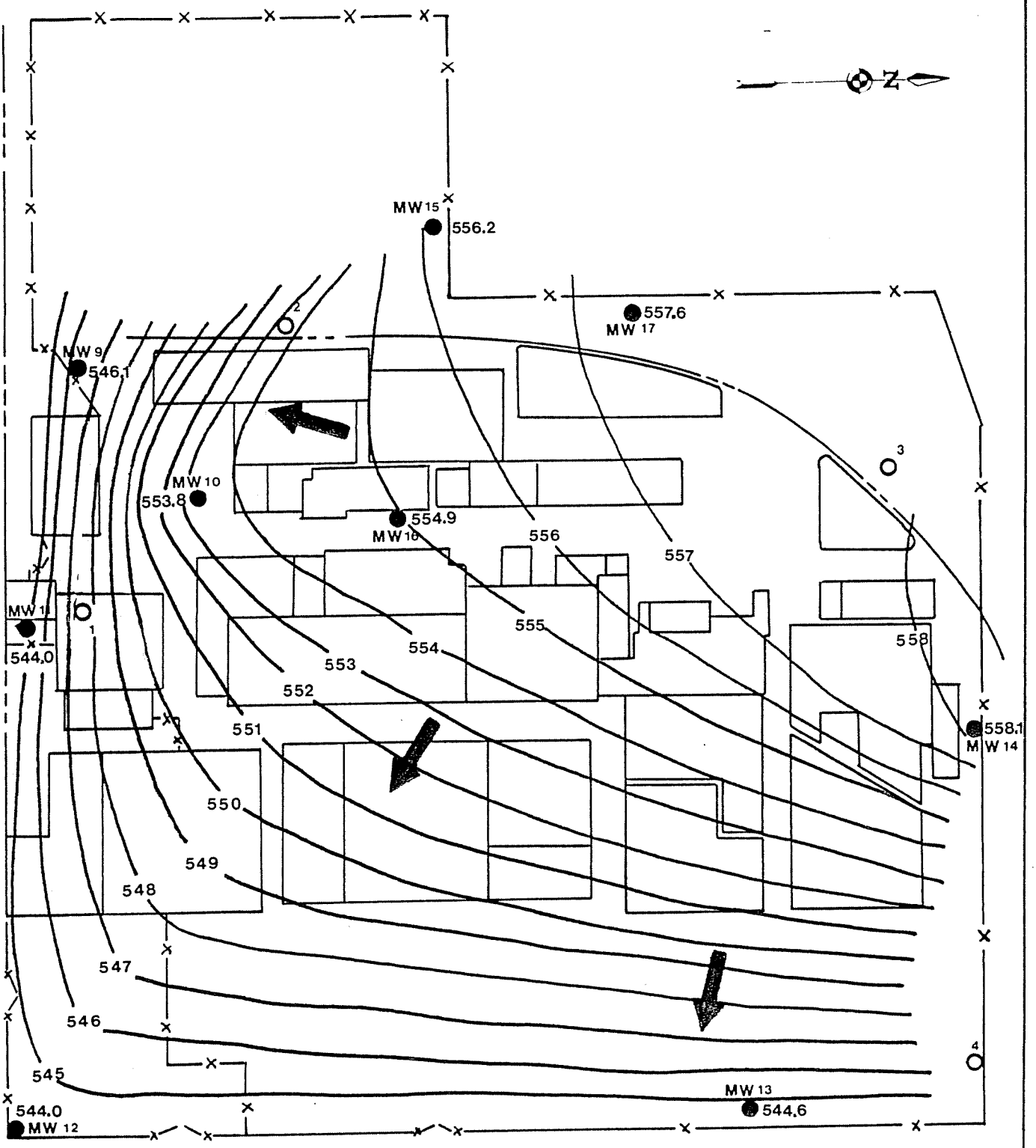
CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

Groton ▪ Buffalo ▪ Rochester ▪ Syracuse ▪ Albany
New York ▪ Edison, New Jersey

SITE LOCATION PLAN

FRONTEIR CHEMICAL

DR. BY: --	SCALE: 1" = 2000'	PROJ. NO.: BD-84-142	
CK'D. BY:	DATE: Feb. 1985	DRWG. NO.: 1	



● MONITORING WELL

555 WATER TABLE CONTOUR

DIRECTION OF FLOW

NOTES: 1.)Water table contours based on water level measured on February 8, 1985.

2.)Base Map provided by Fronteir Chemicals.

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

Groton ▪ Buffalo ▪ Rochester ▪ Syracuse ▪ Albany
New York ▪ Edison, New Jersey

MONITORING WELL LOCATIONS AND WATER TABLE MAP
Fronteir Chemicals

DR. BY: sc	SCALE: 1"≈100'	PROJ. NO.: BD-84-142	
CK'D. BY:	DATE: Feb. 1985	DRWG. NO.: 2	

APPENDIX A

FRONTIER CHEMICAL
HYDROGEOLOGIC INVESTIGATION

FOR

Frontier Chemical

Niagara Falls, New York

Job No. BD-84-142

February 1985

TABLE OF CONTENTS

FRONTIER CHEMICAL
HYDROGEOLOGIC INVESTIGATION

1.0 INTRODUCTION

1.1 Purpose and Scope

Empire Soils Investigations was retained by Frontier Chemical Waste Process, Inc. in November 1984 to install monitoring wells around their facility in Niagara Falls, New York and prepare a report describing hydrogeologic conditions encountered during the investigation. The purpose of this work was to comply with the requirements of the New York Department of Environmental Conservation for a ground water monitoring program at the facility. Specifically, the purpose of our work was to:

- Install wells around the site periphery to provide monitoring points at the property boundaries.
- Provide additional monitoring wells in the vicinity of the inactive sludge settler.
- Determine the direction of groundwater flow .

The scope of our work was limited to analyzing the data obtained from our field investigation and available information on general geology of the area. The field investigation included drilling and installing monitoring wells at nine locations, surveying the location and elevation of the wells and measuring water levels over a period of five weeks.

This report has been prepared for the exclusive use of Frontier Chemicals for specific application to groundwater monitoring at their facility in Niagara Falls, New York. No other warrenty, expressed or implied is made.

1.2. Site Location

Frontier Chemical Waste Process, Inc. is located in Niagara Falls, New York (see Figure 1). The property is bordered by Royal Avenue on the south and 46th Street on the east. The facility is approximately 3800 feet north of the Niagara River. The property is generally flat except for a swale along the western property boundary. The swale is found along the fence lines west of MW-17 and north of MW-15.

1.3 Methodology

Nine monitoring wells (MW-9 through MW-17) were installed around the periphery of the site and in the vicinity of the inactive sludge settler (Figure 2). The borings for the monitoring wells were advanced using a combination of hollow stem augers in the unconsolidated deposits and "NX" rock coring in bedrock. Soil samples were taken every five feet from the borings. The rock core was retrieved from each boring to investigate bedrock integrity. After coring bedrock, the borehole was enlarged to accommodate the monitoring well by reaming with a 3½ inch diameter roller bit.

Initially, all borings were advanced to a depth of 4.7 to 6.2 feet below the top of bedrock and wells installed with the bottom of the well screens placed between 3.4 and 5.8 feet below the top of rock. However, at the completion of drilling, 3 wells were found to be dry (MW-9, MW-11 and MW-13) and MW-12 had less than 1 foot of water, due to steep gradients along the southern and eastern property boundaries (see Section 2.2). These four wells (MW-9, MW-11, MW-12, and MW-13) were redrilled and new wells installed. The new wells were advanced to a depth of 15 to 17.7 feet below the top of limestone (see Appendix A for boring logs).

Wells were installed in all borings using 2 inch I. D. PVC pipe (threaded flush joints) for the well screen and riser pipe. The well screens have 0.01 inch slots. Clean silica sand was placed around the well screens. A bentonite pellet seal was placed above the sand and the remainder of the annular space filled with cement grout. A four-inch I. D. locking metal protector pipe was cemented over the PVC riser pipe. Well construction details for each well are shown on the hydrogeologic logs in Appendix A.

To minimize cross contamination between borings the drilling equipment was washed with clean water between borings. When suspected soil contamination was encountered in MW-15, the soil sampler was rinsed with acetone between samples and after completing the boring.

The locations and the elevations of the wells were surveyed by Empire Soils. After the wells were installed they were developed by bailing. Water levels in the wells were monitored over a five week period (see Table 1).

2.0 FINDINGS OF INVESTIGATION

2.1 Geology

The borings encountered between 11.0 and 18.2 feet of unconsolidated deposits overlying dolostone bedrock. The unconsolidated deposits consisted of between 0.6 and 7.5 feet of fill on top of silt and sand. Except at borings MW-10, MW-14, and MW-17, lacustrine silt, clay and sand deposits were encountered below the fill, with red brown glacial till consisting of silt and sand with some gravel found between the lacustrine deposits and bedrock. Only lacustrine silts and clays were encountered below the fill in borings MW-10 and MW-17. At boring MW-14 only glacial till was encountered below the fill.

Bedrock beneath the site is Lockport Dolomite of Upper Silurian age. (Richard and Fisher, 1970). The dolostone encountered was gray, weathered, hard, thin bedded to bedded with occasional carbon partings and some solution cavities and voids.

2.2 Groundwater Flow

Water elevations in the wells were monitored over a five week period (see Table 1). Water table contours are shown on Figure 2. Water table contours are based on water levels measured on February 8, 1985. Ground water flow in the bedrock aquifer is from the northwest corner of the site toward the east and south (Royal Avenue and 46th Streets). Wells MW-14, MW-15 and MW-17 are upgradient of the facility. Wells MW-9, MW-11, MW-12 and MW-13 are downgradient of the facility. Well MW-10 is downgradient of the inactive sludge settler.

The horizontal gradient varies from 0.01 ft/ft south of MW-17 to 0.08 ft/ft in the vicinity of MW-11. The steeper horizontal gradients found along the eastern and southern property boundaries (46th Streets and Royal Avenue) are attributed to deep sewers beneath the streets. A sewer 50 feet deep is found beneath Royal Avenue probably causing the steep gradients along the southern property boundary, and another deep sewer along 46th Street probably accounts for the steep gradients along the eastern edge of the property.

Groundwater flow in bedrock is primarily through fractures and solution cavaties. Voids or solution cavaties were encountered at wells MW-11, MW-13, MW-14 and MW-15.

3.0 CONCLUSIONS

Groundwater flow in the dolostone bedrock beneath the site is from the northwestern property corner toward both 46th Street and Royal Avenue. Monitoring wells MW-14, MW-15, MW-17 are upgradient of the facility while monitoring wells MW-9, MW-11, MW-12 and MW-13 are downgradient of the facility. Monitoring well MW-10 is downgradient of the inactive sludge settler. Comparison of water quality between the upgradient wells (MW-14, MW-15 and MW-17) and downgradient wells (MW-9, MW-10, MW-11, MW-12 and MW-13) should provide an assessment of the impact of the facility on groundwater quality in the dolostone aquifer.

4.0 REFERENCES

Rickard, L. V. and D. W. Fisher, 1970, "Geologic Map of New York, Niagara Sheet", New York State Museum and Science Service Map and Chart Series, No. 15.

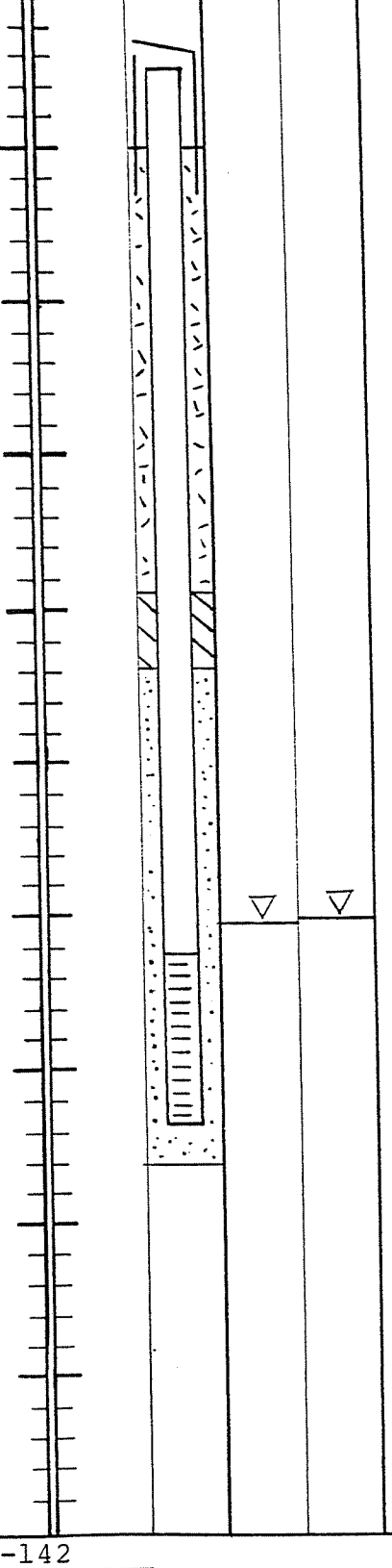
Respectfully submitted,
EMPIRE-THOMSEN

Marjory B. Rinaldo-Lee

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

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	571.8		1			7	TOPSOIL				
			2			6	Gray-Green SILT, trace clay, trace sand, trace brick (FILL) (Moist-Loose) becomes wet, firm, contains occasional fine Sand partings and seams 8.5'				
5			3			12					
			4			12					
			5			17					
10			6			15	Red-Brown Silty CLAY (Moist-Stiff) 10.5'				
							Red-Brown Clayey SILT and fine-coarse SAND, little fine gravel (Wet-Medium) 16.7'				
15			7			105					
			8			-	Gray Dolostone ROCK, Hard, sound bedded, minor pitting, occasional carbon partings				
			1A		92.0	0.8					
20			1B		100	0.8					
25			2B		95.0	0.2	Contains Red Sandstone pebbles				
30			3B		100	100	Occasional mineral precipitates				
35							Boring Terminated @ 33.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
573.9 (Top of PVC)

ROCK CORING
Run #1A 16.7'-21.7'
Run #1B 16.7'-26.7'
Run #2B 26.7' 28.7'
Run #3B 28.7'-33.0'
Roller bit from 16.7'-33.0'

NOTES
1. Boring drilled to 21.7' on 12-17-84 and well installed with bottom of well at 20.1'. Rock cored from 16.7'-21.7' (Run #1A). Free standing water at 5.7' before coring.
2. Boring redrilled deeper on 1-31-85 and new well installed. Original well dry before redrilling. Rock cored from 16.7' to 33.0' (Runs #1B,2B,3B)

NOTE: See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 571.8
Date Started 1-30-85
Date Completed 1-31-85
Number of Installations in Boring 1
Method of installation Hollow Stem Auger
NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K. & O.W. Checked MR-L

HYDROGEOLOGIC LOG

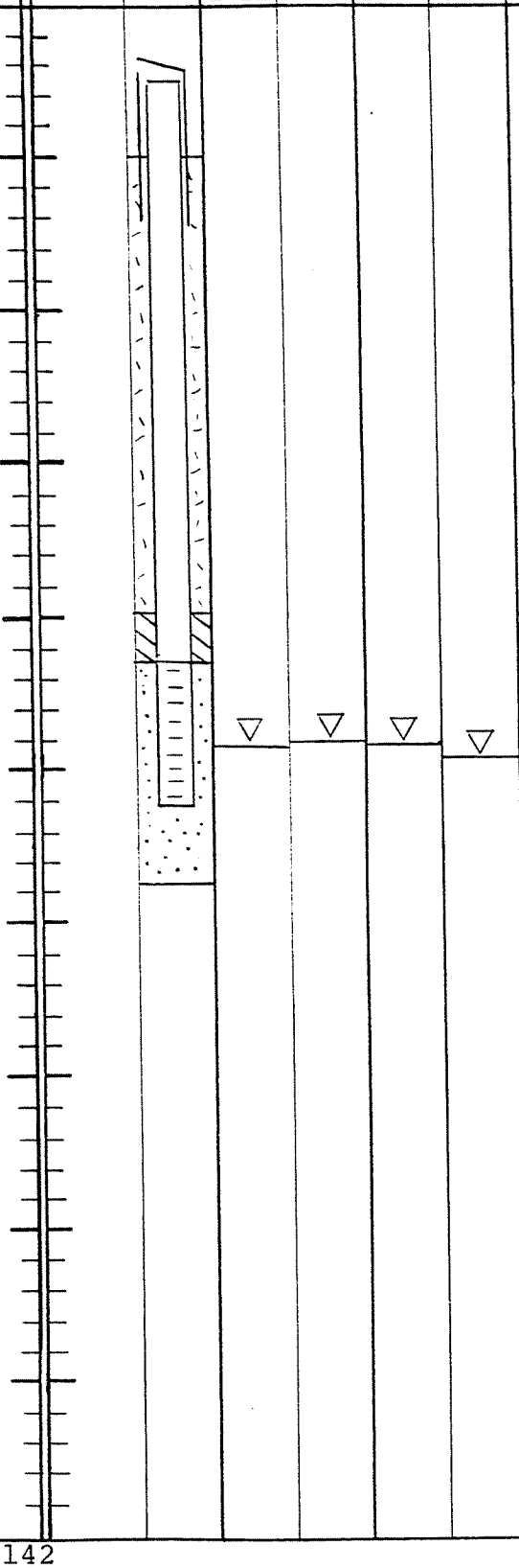
THOMSEN ASSOCIATES

MONITOR NO. MW-9

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	573.3		1			-	Brown fine-coarse SAND, little silt, trace gravel, clay & brick fragments (FILL) (Moist) 3.5'±				
5			2			7	Green-Gray Clayey SILT, Some Cinders, contains trace white silt (Moist-Loose)				
10			3			8	becomes wet 13.5'±				
15			4			12	Red-Brown CLAY (Moist-Medium) 17.4'				
20			1		99.6	0.95	Light Gray DOLOSTONE, hard, sound, bedded				
25							Boring Terminated @ 23.6'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION

Well Screen: 2" ID PVC, .0.01" machine slots

Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING

4" ID locking steel pipe

REFERENCE ELEVATION:

575.67 (Top of PVC)

ROCK CORING

Run #1 17.6'-22.6'

Roller bit to 23.6'

Free standing water at 23.0' prior to coring

Chemical odor in sample #3

Free standing water at 8.3' after coring

NOTE: See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 573.3
Date Started 12-17-84
Date Completed 12-18-84
Number of Installations in Boring 1
Method of installation Hollow Stem Auger, NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY

Classified By A.K.&O.W. Checked MR-L

HYDROGEOLOGIC LOG

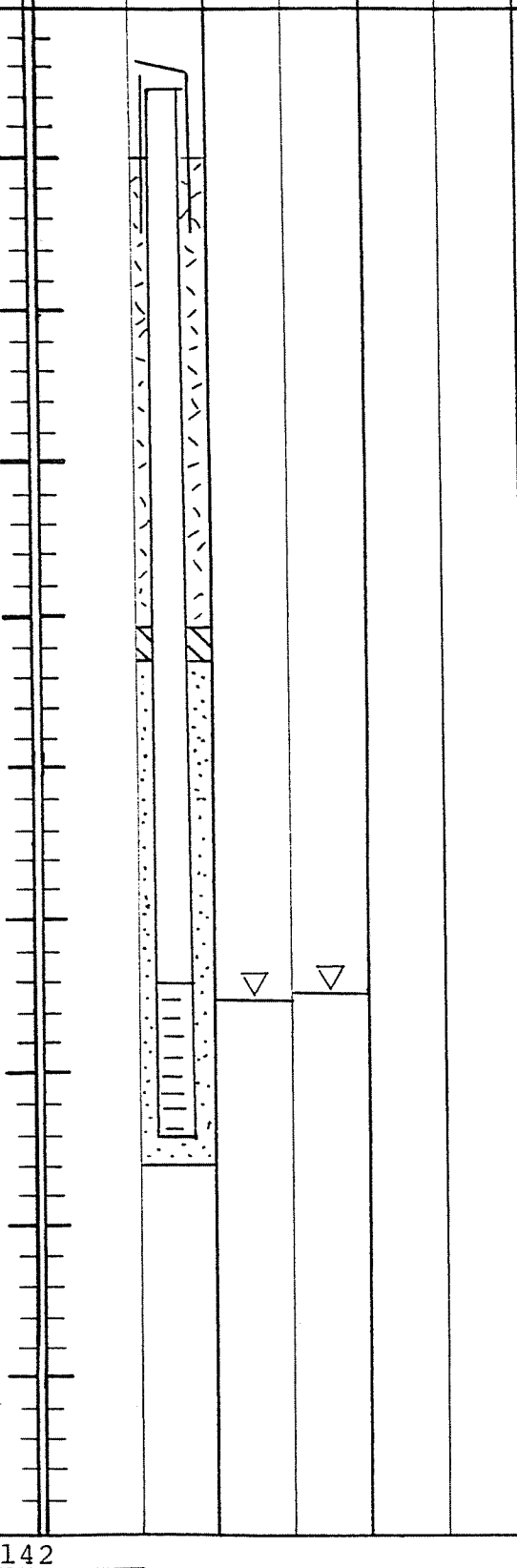
THOMSEN ASSOCIATES

MONITOR NO. MW-10

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	571.3										
		/	1			14	Brown fine-coarse SAND, Some Gravel, little clay, trace silt trace brick fragments (FILL) (Moist-Firm) 4.0'±				
5		/	2			22	Gray SILT, trace clay, trace gravel (Moist-Stiff) 8.5'±				
10		/	3			12	Red-Gray CLAY (Moist-Medium) becomes Orange-Red				
15		/	4			56	becomes compact-contains "and" fine-coarse gravel 17.0'.				
			1A		90.0	0.62	Light Gray, stylolytic Dolostone ROCK, Hard, Sound, bedded, minor pitting contains occasional carbon partings Void @ 19.0'-19.3'				
20											
25			1B		99.4	0.80					
30			2B		62.0	0.52					
35							Boring Terminated @ 33.0'				

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC, 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
573.7 (Top of PVC)

ROCK CORING
Run #1A 17.0'-22.0'
Run #1B 19.3'-28.0'
Run #2B 28.0'-33.0'

Roller bit from 16.9'-19.0' and 19.3'-33.0'

NOTES
1. Boring drilled to 22.0' on 12-27-84 well installed with bottom of well @ 22.0' Rock cored from 17.0' to 22.5' (Run #1A)
2. Boring redrilled deeper on 1-30-85 and new well installed. Original well dry before drilling. Rock cored from 19.3' to 33.0' (Runs #1B,2B)

NOTE: See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 571.3
Date Started 1-29-85
Date Completed 1-30-85
Number of Installations in Boring 1
Method of installation Hollow Stem Auger
NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K. & O.W. Checked MR-L

HYDROGEOLOGIC LOG

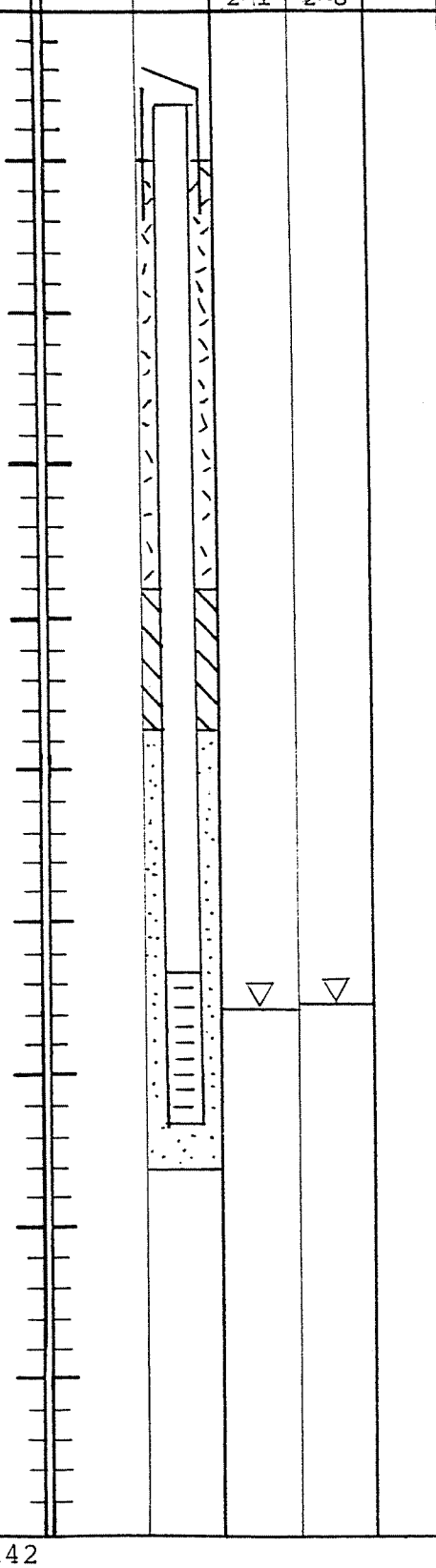
THOMSEN ASSOCIATES

MONITOR NO. MW-11

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	571.6						ASPHALT CONCRETE 0.2'				
							CONCRETE 0.8'				
							CRUSHED STONE 2.0'				
5		/	1			12	Gray SILT, little fine sand, trace clay (FILL) (Moist-Firm) Becomes Greeen-gray 10.0'				
10		/	2			15	Red-Brown silty CLAY w/Silt lenses and partings (Moist-Medium) 12.5±				
15		/	3			21	Red-Brown SILT and fine-coarse SAND, Some fine-coarse Gravel, trace clay (Moist-Firm) 18.2'				
			4			-					
20			1A		90.0	0.70	Gray Dolostone ROCK , Hard, sound, bedded to thin bedded, with occasional oblique fractures, sand seams at 23.0' to 23.6'; brown staining at 22.6', 22.8', 23.0'				
			2A		100	0.71					
25			1B		89.8	0.83					
30											
							Boring Terminated @ 33.0'				
35											

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC, 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
573.5 (Top of PVC)

ROCK CORING
Run #1A 18.2'-21.2'
Run #2A 21.2'-24.0'
Run #1B 23.2'-33.0'

Roller bit from 23.2'-33.0'

NOTES
1. Boring drilled to 24.0' on-12-19-84 and well installed with bottom of well @ 23.2'. Rock cored from 18.2'-21.2' (Run #1A) and 21.2' to 24.0' (Run #2A). No free standing water before coring.
2. Boring redrilled deeper on 1-29-85 and new well installed. Water level in original well before redrilling at 21.9'. Rock cored from 23.2' to 33.0' (Run #1B).
3. Lost coring water @26.9'

NOTE: See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 571.6
Date Started 12-19-84
Date Completed 12-19-84
Number of Installations in Boring 1
Method of installation Hollow Stem Auger
NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K. & O.W. Checked MR-L

HYDROGEOLOGIC LOG

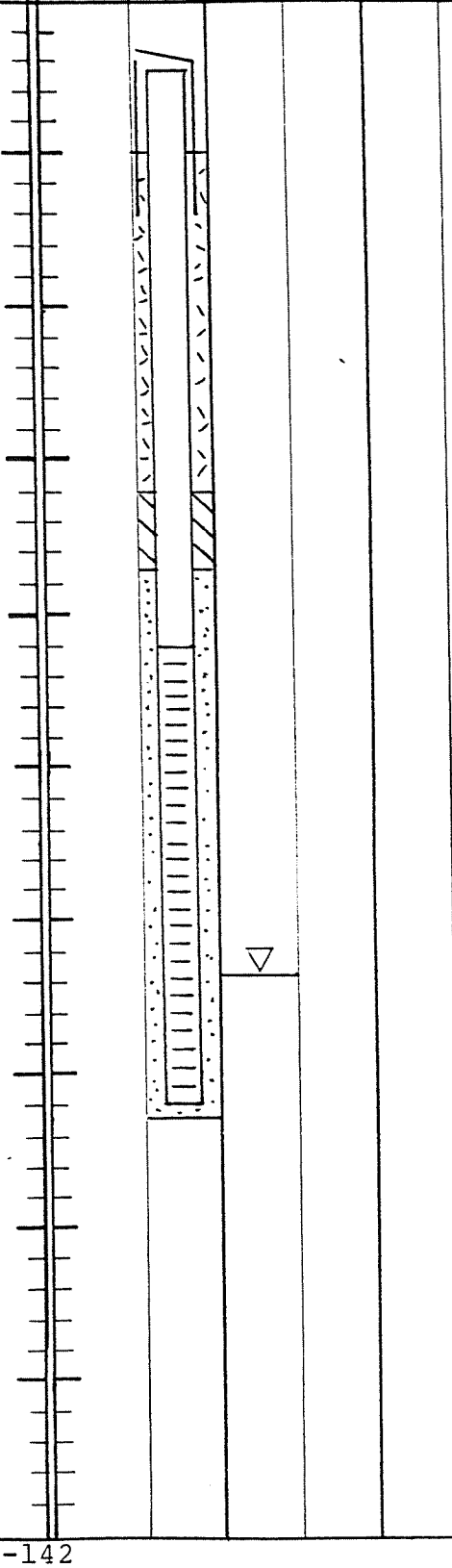
THOMSEN ASSOCIATES

MONITOR NO. MW-12

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	571.3										
			1			6	Black fine-coarse SAND, Some Silt, little slag (FILL) (Moist-Loose) 3.5'±				
5			2			7	Brown-Tan SILT w/fine Sand seams trace clay (Moist-Medium) 8.0'±				
10			3			4	Gray Clayey SILT, Some fine Sand (Moist-Soft) 11.5'				
			4			-	Red-Brown Clayey SILT & fine-coarse Sand, Some fine-coarse Gravel (Wet-Loose) 13.6'				
15			1A		98.0	0.83	Gray Dolostone ROCK, Hard, sound thin bedded to bedded w/carbon partings				
			1B		97.1	0.86	Void @ 16.1'-16.2'				
			2B		67.6	0.39					
20											
25			3B		95.2	0.91					
30							Boring Terminated @ 31.3'				
35											

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



WATER PROBE READINGS

Temp. (°C)	Cond. (µmho/cm)	Eh (mV)	pH

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
574.0 (Top of PVC)

ROCK CORING
Run #1A 13.6'-18.6'
Run #1B 13.6'-17.1'
Run #2B 17.1'-20.8'
Run #3B 20.8'-31.3'

Roller bit from 13.6'-31.3'

NOTES
1. Boring drilled to 18.6' on 12-18-84 and well installed with bottom of well at 18.6'. Rock cored from 13.6'-18.6' (Run #1A). No free standing water prior to coring.
2. Boring redrilled deeper on 2-1-85 and new well installed. Original well dry before drilling. Rock cored from 13.6' to 31.3' (Runs #1B,2B,3B).

NOTE:
See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 571.3
Date Started 2-1-85
Date Completed 2-1-85
Number of Installations in Boring 1
Method of installation Hollow Stem Auger
NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K.&O.W. Checked MR-L

HYDROGEOLOGIC LOG

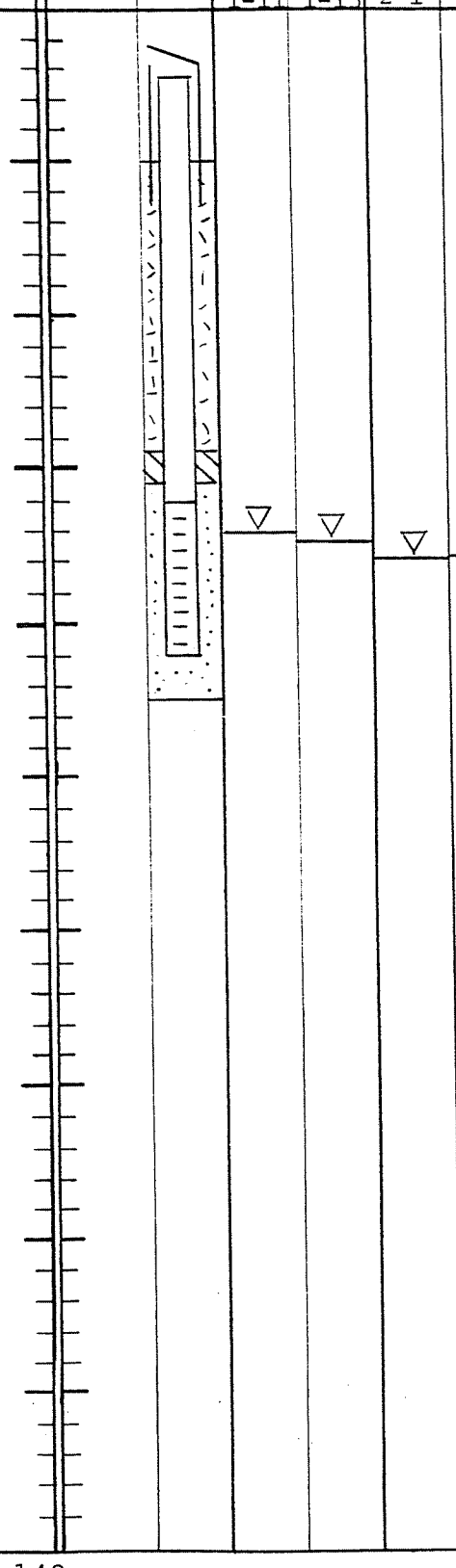
THOMSEN ASSOCIATES

MONITOR NO.
MW-13

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	570.8		1			15	Brown fine-coarse GRAVEL (FILL) (Wet-Firm) 2.5'±				
5			2			6	Brown SAND with Gravel and Clay, (Possible Fill) (Wet-Loose) 7.5'±				
10			3			-	Red-Brown Clayey SILT and fine-coarse SAND, Some fine-coarse Gravel (Wet-Firm) 11.3'				
			1		100	0.74	Gray DOLOSTONE, Hard, Weathered, thin bedded-bedded, solution cavaties from 14.3'-15.0', occasional carbon partings				
15			2		80	0.44					
							Boring Terminated @ 17.3'				
20											

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC, 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
573.39 (Top of PVC)

ROCK CORING
Run #1 11.3'-14.8'
Run #2 14.8'-17.3'

Roller bit from 11.3-17.3'
No free standing water prior to coring.

NOTE:
See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 570.8
Date Started 12-20-84
Date Completed 12-20-84
Number of Installations in Boring 1
Method of installation Hollow Stem Auger, NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K. & O.W. Checked MR-L

HYDROGEOLOGIC LOG

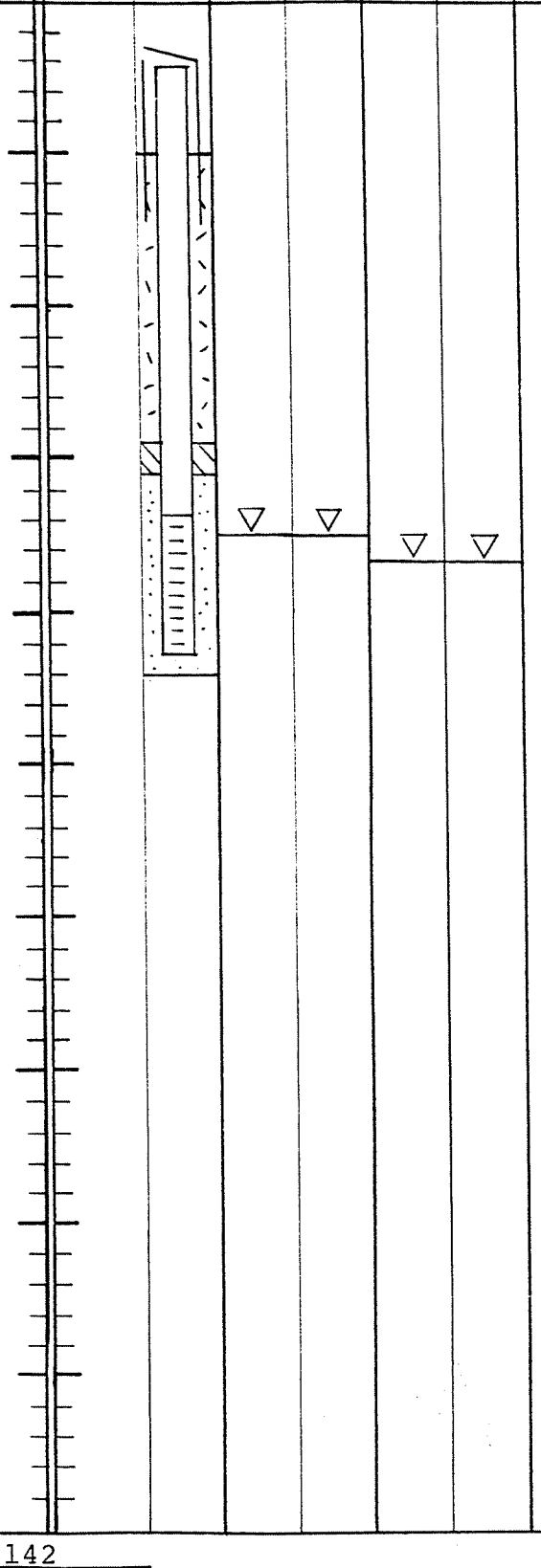
THOMSEN ASSOCIATES

MONITOR NO.
MW-14

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	569.5										
			1			3	SLAG, SILT, TOPSOIL (FILL) 0.6'				
							Tan-Brown SILT, little fine sand, trace clay (Moist-Loose)				
5			2			8	becomes Moist-wet, contains fine-medium Sand seams				
							8.5'±				
10			3			-	Red-Brown Clayey SILT and fine-coarse SAND (Wet-Compact) 11.0'				
			1		91	40.57	Gray Dolostone ROCK with occasional carbon partings, hard, weathered, thin bedded to bedded				
15			2		100	0.84	Voids at 15.5' to 15.9'				
							Boring Terminated @ 17.0'				
20											

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

NOTES

WELL CONSTRUCTION
Well Screen: 2" ID PVC, 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION
572.37 (Top of PVC)

ROCK CORING
Run #1 11.0'-14.5'
Run #2 14.5'-17.0'

Roller bit from 11.0-17.0'
No free standing water encountered prior to coring

Chemical odor to full depth during drilling, especially from 6.1 to 6.3 ft.
Soil sampler rinsed with acetone between samples and after drilling

NOTE:
See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 569.5
Date Started 12-18-84
Date Completed 12-18-84
Number of Installations in Boring 1
Method of installation Hollow Stem Auger, NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY
Classified By A.K.&O.W. Checked MR-L

HYDROGEOLOGIC LOG

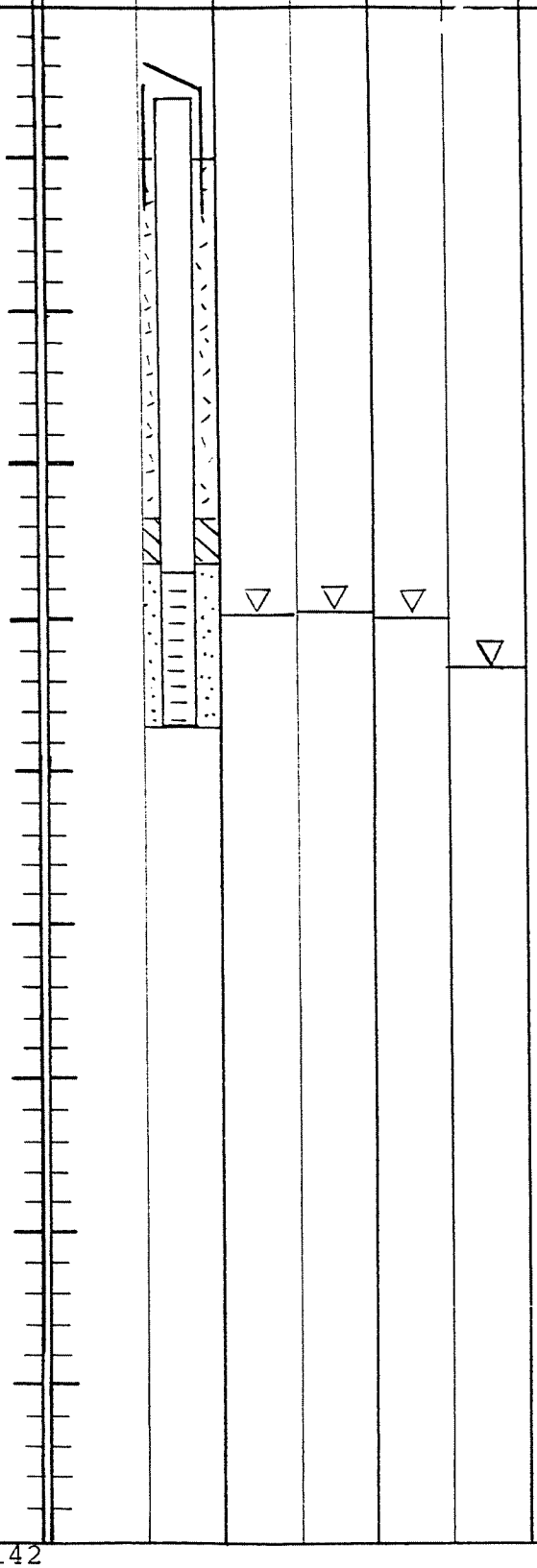
THOMSEN ASSOCIATES

MONITOR NO.
MW-15

Sheet 1 of 1

DEPTH	ELEVATION	SAMPLES	SAMPLE NO.	CHEM. SMPL	RECOVERY (Inches)	N	SOIL or ROCK CLASSIFICATION	UNIFIED SOIL CLASSIF.	DENSITY (PCF)	WATER CONTENT (Percent)	PERMEABILITY (cm/sec)
0	571.4										
			1			31	Black-Brown fine GRAVEL & SAND, trace silt (Moist-Compact) 3.0'				
5			2			24 24	Gray SILT, trace clay (Moist-Stiff) 10.0'				
10			3				Gray ROCK FRAGMENTS, trace silt (Moist-Very Compact) 13.1'				
							~~Red-Gray TILL & ROCK FRAGMENTS (Very Compact) 13.8'~~				
15			1		96	0.90	Light Gray DOLOSTONE, hard, sound, bedded				
							Boring Terminated @ 18.5'				
20											

MONITOR/PIEZOMETER CONSTRUCTION DETAILS



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

WELL CONSTRUCTION
Well Screen: 2" ID PVC, 0.01" machine slots
Riser Pipe: 2" ID PVC, threaded flush joint

PROTECTIVE CASING
4" ID locking steel pipe

REFERENCE ELEVATION:
573.39 (Top of PVC)

ROCK CORING
Run #1 13.2'-18.2'

Roller bit to 18.5'

Free standing water encountered at 15.8' prior to coring

NOTE:
See key and explanation to log.

RUN NO.	RECOVERY (Percent)	RQD

Surface Elevation 571.4
Date Started 12-26-84
Date Completed 12-27-84
Number of Installations in Boring 1
Method of installation Hollow Stem Auger, NX Core and 3½" Roller Bit

Project No. BD-84-142
Project Title Frontier Chemicals
Location Niagara Falls, NY

Classified By A.K.&O.W. Checked MR-L

HYDROGEOLOGIC LOG

THOMSEN ASSOCIATES

MONITOR NO.
MW-16

Sheet 1 of 1

APPENDIX B

Water Quality Data

FRONTIER
CHEMICAL WASTE PROCESS INC.

March 1, 1985

Mr. E. Belmore
Associate Chemical Engineer
New York State Department of
Environmental Conservation
600 Delaware Avenue
Buffalo, New York 14202-1073

ATTENTION: Ms. Mc Intosh

RE: Groundwater Monitoring

Dear Ms. McIntosh:

Attached you will find the analytical sampling and purging data on the monitoring wells for the first three (3) weeks, commencing on February 6, 1985. The sampling and analytics for the wells are in accordance with the guidelines set forth in Frontier Chemical's Groundwater Program (December 5, 1984).

Wells #1 & #4 were dry and therefore not sampled. The elevations for the wells are measured from the top of the water to the top of the casings.

Any questions concerning the above, please call.

Yours truly,

Edward Turner

ET:jsd
Attachment(s)

cc: Mr. P. Counterman
Mr. M. Antonetti
Ms. C. Jones
Mr. J. Kehoe/NCHD
Mr. E. Turner (Frontier)
Mr. R. Scarpelli (Frontier)

GROUND WELL ANALYTICAL DATA

EEK 1st

Well #	pH	Conductivity umhos/cm	TOC[1] mg/L	THO[2] ug/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L	Nickel mg/L	Sulfur mg/L
2	8.6	82,000	950	0.05	13	0.18	50	40,000	4,400	< 0.1	3.9	0.5	0.5	6,800
3	7.5	3,400	50	0.16	<0.1	<0.10	0.66	370	900	< 0.1	<0.1	<0.1	<0.1	460
5	7.4	1,700	20	0.01	<0.1	<0.10	1.6	270	100	< 0.1	0.8	<0.1	<0.1	220
6	9.8	2,200	80	0.20	<0.1	<0.10	18	240	340	< 0.1	2.2	<0.1	<0.1	240
7	7.7	5,200	80	0.14	<0.1	<0.10	0.98	1,100	600	< 0.1	<0.1	0.4	<0.1	590
8	7.2	3,900	70	0.06	<0.1	<0.10	0.46	570	800	< 0.1	0.2	<0.1	<0.1	490
9	11.4	71,000	650		50									
10	9.3	62,000	1500		370									
11	9.5	17,000	80		3.6									
12	9.4	32,000	170		1.1									
13	7.2	2,500	30		<0.1,									
14	7.2	2,700	30		<0.1									
15	11.7	15,000	340		11									
16	11.5	14,000	460		87									
17	7.3	12,000	70		<0.1									

[4] - Indicates the lowest concentration with procedure used.
[1] - Total organic carbon.
[2] - Total halogenated organics as Lindane.

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 1st

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
2	2/6/85	18.3	1	2/7/85	18.6	Completed sampling on 2/8/85
3	2/7/85	14.2	1½	2/8/85	14.8	Completed sampling on 2/11/85
4	2/7/85	16.6	-	-	-	Dry
5	2/7/85	8.3	3	2/8/85	9.8	
6	2/6/85	8.1	4	2/7/85	9.4	
7	2/6/85	4.3	5	2/7/85	4.3	
8	2/7/85	6.1	10+	2/8/85	6.1	
9	2/7/85	27.6	10+	2/8/85	27.6	
10	2/6/85	21.4	2	2/7/85	22.1	
11	2/6/85	29.5	10+	2/7/85	29.5	
12	2/7/85	29.2	10+	2/8/85	29.2	
13	2/7/85	29.0	10+	2/8/85	29.1	
14	2/7/85	15.3	10+	2/8/85	15.3	
15	2/6/85	16.1	10+	2/7/85	16.1	
16	2/6/85	16.6	3½	2/7/85	18.6	
17	2/7/85	15.3	10+	2/8/85	15.3	

+ Greater amount of liquor than 10 liters available for purging.

GROUND WELL ANALYTICAL DATA

WEEK 2nd

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	THO(2) ug/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L	Nitrate mg/L
9	11.3	70,000	620		56								
10	9.4	61,000	1500		380								
11	9.4	15,000	80		4.5								
12	9.5	32,000	190		1.2								
13	7.4	2,500	40		<0.1								
14	7.2	2,600	40		<0.1								
15	11.6	15,000	320		6.4								
16	11.5	14,000	510		81								
17	7.4	12,000	70		<0.1								

( ) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon.
(2) - Total halogenated organics as Lindane.

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 2nd

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
9	2/14/85	27.6	10+	2/15/85	27.6	
10	2/14/85	21.4	2	2/15/85	22.1	
11	2/14/85	29.4	10+	2/15/85	29.4	
12	2/14/85	29.2	10+	2/15/85	29.1	
13	2/14/85	29.0	10+	2/15/85	29.0	
14	2/14/85	15.2	10+	2/15/85	15.2	
15	2/14/85	16.2	10+	2/15/85	16.2	
16	2/14/85	16.6	4	2/15/85	18.8	
17	2/14/85	15.2	10+	2/15/85	15.3	

+ Greater amount of liquor than 10 liters available for purging.

GROUND WELL ANALYTICAL DATA

WEEK 3rd

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	THO(2) ug/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L
9	11.4	94,000	620		47							
10	9.3	90,000	1700		390							
11	11.1	38,000	530		28							
12	10.3	28,000	250		4.2							
13	7.1	2,300	50		< 0.1							
14	7.1	2,400	40		< 0.1							
15	11.4	18,000	310		8.2							
16	11.4	17,000	530		82							
17	7.4	10,000	110		< 0.1							

( ) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon.
(2) - Total halogenated organics as Lindane.

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 3rd

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
9	2/21/85	27.5	10+	2/21/85	27.5	
10	2/21/85	21.4	2	2/21/85	23	
11	2/21/85	29.4	10+	2/21/85	29.4	
12	2/21/85	29.1	10+	2/21/85	29.1	
13	2/21/85	29.0	10+	2/21/85	29.0	
14	2/21/85	14.9	10+	2/21/85	14.9	
15	2/21/85	16.0	10+	2/21/85	15.9	
16	2/21/85	16.6	3½	2/21/85	19.8	
17	2/21/85	15.2	10+	2/21/85	15.1	

+ Greater amount of liquor than 10 liters available for purging.

GROUND WELL ANALYTICAL DATA

WEEK 4

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	THO(2) ug/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L	Nickel mg/L	Sod Mg/
2	8.4	82,000	940	0.23	64	0.95	11.2	42,000	3700	<0.1	2.2	0.21	0.85	10,00(
3	7.8	2,900	40	<0.1	<0.1	0.04	0.14	440	750	<0.1	<0.5	<0.05	<0.1	20(
4	7.7	3,600	40	*	<0.1	*	*	730	1290	<0.1	<0.5	<0.05	<0.1	18(
5	7.5	1,900	20	<0.1	<0.1	<0.02	0.35	530	120	<0.1	<0.5	<0.05	<0.1	19(
6	9.4	670	20	<0.1	<0.1	<0.02	3.9	70	33	<0.1	<0.5	<0.05	<0.1	4(
7	7.7	2,400	90	0.13	<0.1	<0.02	0.22	540	230	<0.1	<0.5	<0.05	<0.1	25(
8	7.4	2,900	80	<0.1	<0.1	<0.02	0.10	480	800	<0.1	<0.5	0.10	<0,1	10(

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon.
(2) - Total halogenated organics as Lindane.

GROUND WELL ANALYTICAL DATA

Week 4

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	Phenol mg/L	Cyanide mg/L	mg/L Iron	mg/L Nickel	mg/L Chromium	mg/L Cadmium	mg/L Copper	mg/L Zinc
9	11.2	91,000	480	38	0.97	<0.5	0.24	<0.2	0.07	0.05	0.19
10	9.5	94,000	1500	390	0.78	1.4	0.27	<0.2	0.08	0.37	0.46
11	10.3	29,000	460	14	0.40	<0.5	0.18	<0.2	0.03	<0.05	0.04
12	9.7	36,000	190	1.1	0.11	<0.5	0.14	<0.2	0.02	<0.05	0.05
13	7.1	2,300	30	0.1	0.04	<0.5	<0.1	<0.2	<0.01	<0.05	0.08
14	7.1	2,400	40	<0.1	<0.02	<0.5	<0.1	<0.2	<0.01	<0.05	0.16
15	11.1	18,000	220	4.5	0.78	<0.5	0.10	<0.2	<0.01	0.14	0.04
16	11.5	20,000	560	80	0.57	0.67	0.15	<0.2	0.02	<0.05	0.07
17	7.2	19,000	40	0.1	0.04	<0.5	0.14	<0.2	<0.01	<0.05	0.07

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 4

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
2	2/27/85	555.0	1-3/4	2/28/85	554.8	
3	"	560.8	3	"	558.7	
4	"	557.3	--	"	557.2	Well not purged due to low volume. Collected approx. 5 oz. of liquor.
5	"	568.7	10+	"	568.4	
6	"	568.8	10+	"	568.3	
7	"	569.6	10+	"	569.5	
8	"	569.3	10+	"	569.2	
9	"	547.0	10+	"	547.1	
10	"	554.3	2½	"	553.8	
11	"	544.5	10+	"	544.5	
12	"	544.6	10+	"	544.6	
13	"	545.6	10+	"	545.5	
14	"	560.4	10+	"	560.2	
15	"	557.8	10+	"	557.8	
16	"	556.8	3-3/4	"	555.6	
17	"	558.7	10+	"	558.6	

+ Greater amount of liquid than 10 liters available for purging.

GROUND WELL ANALYTICAL DATA

WEEK 8

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	THO(2) µg/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L	Nickel mg/L	Sodium mg/L
2	8.8	83,000	1300	83	110	3.3	43	32,800	3,500	0.2	3.6	0.7	2.0	8,50(
3	8.3	3,100	30	1.8	<0.1	<0.1	0.6	320	500	0.1	<0.1	<0.05	<0.1	14(
4	7.9	3,500	50	-	-	<0.1	1.0	630	1,100	<0.05	0.2	<0.05	<0.1	14(
5	8.0	1,600	10	2.5	<0.1	<0.1	<0.5	310	150	<0.05	0.1	<0.05	<0.1	9(
6	9.5	1,500	10	0.7	<0.1	<0.1	4.2	130	80	0.1	0.2	<0.05	<0.1	4(
7	8.1	3,000	40	20	<0.1	<0.1	1.9	490	200	0.2	<0.1	0.1	<0.1	17(
8	7.9	2,300	50	1.0	<0.1	<0.1	0.6	190	650	<0.05	<0.1	<0.05	<0.1	5(

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon.
(2) - Total halogenated organics as Lindane.

GROUND WELL ANALYTICAL DATA

Week 8

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	Phenol mg/L	Cyanide mg/L	mg/L Iron	mg/L Nickel	mg/L Chromium	mg/L Cadmium	mg/L Copper	mg/l Zinc
9	11.4	71,000	500	28	1.9	3.3	0.9	0.3	<0.1	<0.05	<0.1
10	9.7	77,000	1,800	420	1.6	6.7	1.2	0.21	0.1	<0.05	0.4
11	10.7	29,000	430	13	1.4	0.6	0.2	<0.1	<0.1	0.23	<0.1
12	9.8	26,000	240	<0.1	0.1	0.3	0.2	<0.1	<0.1	<0.05	<0.1
13	8.0	2,000	60	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1
14	7.5	3,000	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1
15	11.4	42,000*	280	1.9	0.8	0.4	0.4	<0.1	<0.1	0.3	<0.1
16	11.5	16,000	480	24*	1.4	0.4	0.3	<0.1	<0.1	<0.05	<0.1
17	8.1	14,000	120	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.05	<0.1
* Duplicate analysis											

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 8

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
2	3/27/85	554.9	1	3/28/85	535.8	
3	"	559.8	4	"	558.6	
4	"	557.3	-	"	557.3	Well not purged due to low volume. Collected approximately 4 oz. liquor
5	"	566.9	10+	"	567.0	
6	"	568.2	10+	"	568.0	
7	"	568.9	10+	"	568.7	
8	"	568.6	10+	"	568.8	
9	"	546.8	10+	"	546.8	
10	"	554.4	3	"	754.1	
11	"	544.4	10+	"	544.5	
12	"	544.4	10+	"	544.6	
13	"	545.5	10+	"	545.9	
14	"	559.3	10+	"	559.3	
15	"	557.5	10+	"	557.5	
16	"	556.7	4	"	555.8	
17	"	557.8	10+	"	557.9	

+ = Greater amount of liquid than 10 liters available for purging.

GROUND WELL ANALYTICAL DATA

WEEK 12

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	THO(2) µg/L	Phenol mg/L	Cyanide mg/L	Thiocyanate mg/L	Chloride mg/L	Sulfate mg	Arsenic mg/L	Iron mg/L	Manganese mg/L	Nickel mg/L	Sodiu Mg/L
2	8.4	77,000	1,800	3.8	85	1.5	43	52,000	3,800	*	8.2	0.42	1.3	10,70
3	8.2	2,700	30	<0.1	<0.1	<0.1	0.5	330	580	*	<0.1	<0.05	<0.1	20
5	7.7	1,400	10	<0.1	<0.1	<0.1	<0.1	300	120	*	0.2	<0.05	<0.1	17
6	8.7	1,600	90	0.2	<0.1	<0.1	15	980	250	*	0.2	0.11	<0.1	4
7	8.2	2,600	30	0.8	<0.1	<0.1	1.3	500	880	*	<0.1	0.05	<0.1	28
8	8.0	2,200	40	<0.1	<0.1	<0.1	0.4	130	200	*	<0.1	<0.05	<0.1	7
*	No quartz cell for AA.													

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon.
(2) - Total halogenated organics as Lindane.

GROUND WELL ANALYTICAL DATA

Week 12

Well No.	pH	Conductivity umhos/cm	TOC(1) mg/L	Phenol mg/L	Cyanide mg/L	mg/L Iron	mg/L Nickel	mg/L Chromium	mg/L Cadmium	mg/L Copper	mg/L Zinc
9	10.5	63,000	500	37	1.1	0.7	0.6	<0.1	0.1	0.10	0.56
10	9.1	67,000	2,000	367	1.2	3.7	0.5	0.1	0.1	0.19	0.77
11	10.0	26,000	260	34	0.5	0.2	0.2	<0.1	<0.1	<0.05	0.06
12	9.3	26,000	60	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.05	<0.05
13	7.5	3,000	30	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.05	0.10
14	7.9	2,600	20	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.05	0.05
15	10.7	17,000	200	<0.1	0.6	0.2	0.1	<0.1	<0.1	0.20	0.08
16	10.3	16,000	700	63	0.4	0.6	0.2	<0.1	<0.1	0.05	0.06
17	8.1	14,000	50	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.05	0.06

(<) - Indicates the lowest concentration with procedure used.
(1) - Total organic carbon

GROUNDWATER WELL

SAMPLING & PURGING DATA

WEEK NO. 12

WELL NO.	PURGING			SAMPLING		REMARKS
	DATE	WATER LEVEL; FEET	VOLUME; L	DATE	WATER LEVEL; FEET	
2	4/24/85	554.7	1	4/25/85	554.5	
3	"	559.4	2½	"	558.6	
4	"	557.1	-	"	557.1	No sample
5	"	565.7	6	"	565.5	
6	"	565.9	6	"	564.7	
7	"	568.5	5	"	568.4	
8	"	568.0	10+	"	567.8	
9	"	546.5	10+	"	546.5	
10	"	554.4	2¼	"	553.9	
11	"	544.3	10+	"	544.2	
12	"	544.3	10+	"	544.3	
13	"	545.9	10+	"	545.9	
14	"	558.9	10+	"	558.8	
15	"	556.5	10+	"	556.4	
16	"	555.5	2	"	555.3	
17	"	557.6	10+	"	557.6	

+ Greater amount of liquid than 10 liters available for purging.

FRONTIER
CHEMICAL WASTE PROCESS INC.

April 23, 1985

Ecology & Environment, Inc.
P.O. Box D
Buffalo, NY 14225

Attn: Mr. Gary Hahn, Manager

Dear Mr. Hahn:

This letter will serve to formalize Frontier Chemical's displeasure and disappointment with Ecology and Environment over the analytical data reported on March 28, 1985 on nine samples (numbered 9 through 17) submitted March 7, 1985. The analysis was a GC/MS volatile scan (EPA Procedure #624).

A number of the values reported are unreasonable as they relate to Total Organic Carbon data and to solubility data for the given compounds; i.e. some of the values reported are higher than the solubility of that compound in its aqueous medium. The unreasonableness of some of the results was partially attested to by Ecology and Environment when one of the samples was re-run and indicated that toluene, originally reported at 428,000 µg/L, was actually at a not detected level. The latter implies a potential discrepancy not only with that particular sample but with the remainder of the samples as well. The results, therefore, are not acceptable to Frontier Chemical. A copy of this letter has been sent to Mary McIntosh of the New York State Department of Environmental Conservation.

Sincerely,

Husein Sitabkhan

Husein Sitabkhan, PhD
Laboratory Director

cc: Ms. Mary McIntosh/NYS DEC
Mr. E. Turner/Frontier
Mr. R. Scarpelli/Frontier

HS/lb

RESULTS OF WATER ANALYSIS FOR
VOLATILE ORGANIC COMPOUNDS

(all results in ug/L)

PP #	CAS #	Compound	E & E Lab No. 85-	1197	1198	1199	1200	1201
			Sample Identity	13	14	15	16	17
(4V)	71-43-2	benzene		137	152	11,100	116,000	290
(6V)	56-23-5	carbon tetrachloride		<50	<50	<50	<50	<50
(7V)	108-90-7	chlorobenzene		63.1	BMDL	7000	2140	221
(10V)	107-06-2	1,2-dichloroethane		<50	<50	<50	<50	<50
(11V)	71-55-6	1,1,1-trichloroethane		1750	835	359	7540	883
(13V)	75-34-3	1,1-dichloroethane		<50	<50	<50	2890	<50
(14V)	79-00-3	1,1,2-trichloroethane		<50	<50	<50	<50	<50
(15V)	79-34-5	1,1,2,2-tetrachloroethane		<50	<50	<50	<50	<50
(16V)	75-00-3	chloroethane		<50	<50	<50	<50	<50
(19V)	100-75-8	2-chloroethylvinyl ether		<50	<50	<50	<50	<50
(23V)	67-66-3	chloroform		<50	197	416	489	<50
(29V)	75-35-4	1,1-dichloroethene		<50	<50	<50	<50	<50
(30V)	156-60-5	trans-1,2-dichloroethene		<50	<50	<50	<50	<50
(32V)	78-87-5	1,2-dichloropropane		<50	<50	<50	<50	<50
(33V)	10061-02-6	trans-1,3-dichloropropene		<50	<50	<50	<50	<50
	10061-01-05	cis-1,3-dichloropropene		<50	<50	<50	<50	<50
(38V)	100-41-4	ethyl benzene		73.2	<50	1060	18,000	134
(44V)	75-09-2	methylene chloride		<50	<50	<50	<50	<50
(45V)	74-87-3	chloromethane		<50	<50	<50	<50	<50
(46V)	74-83-9	bromomethane		<50	<50	<50	<50	<50
(47V)	75-25-2	bromoform		<50	<50	<50	<50	<50
(48V)	75-27-4	bromodichloromethane		<50	<50	<50	<50	<50
(49V)	75-69-4	fluorotrichloromethane		<50	<50	<50	<50	<50
(50V)	75-71-8	dichlorodifluoromethane		<50	<50	<50	<50	<50
(51V)	124-48-1	chlorodibromomethane		78.2	50.0	68.3	342	<50
(85V)	127-18-4	tetrachloroethene		1150	182	5190	40,500	428,000
(86V)	108-88-3	toluene		327	206	455	2760	<50
(87V)	79-01-6	trichloroethene		<50	<50	<50	<50	<50
(88V)	75-01-4	vinyl chloride		5860	80,600	21,900	152,000	212,000
		chlorotoluene						

*BMDL = Compound present below measurable detection limits

RESULTS OF WATER ANALYSIS FOR
VOLATILE ORGANIC COMPOUNDS

(all results in ug/L)

			E & E Lab No. 85-	1193	1194	1195	1196
?P #	CAS #	Compound	Sample Identity	9	10	11	12
(4V)	71-43-2	benzene		40,600	690	83,200	88,800
(6V)	56-23-5	carbon tetrachloride		<50	<50	<50	<50
(7V)	108-90-7	chlorobenzene		10,600	167	42,100	2990
(10V)	107-06-2	1,2-dichloroethane		<50	<50	<50	<50
(11V)	71-55-6	1,1,1-trichloroethane		1350	1160	22,100	18,000
(13V)	75-34-3	1,1-dichloroethane		2810	<50	722	643
(14V)	79-00-3	1,1,2-trichloroethane		<50	<50	<50	<50
(15V)	79-34-5	1,1,2,2-tetrachloroethane		<50	<50	<50	<50
(16V)	75-00-3	chloroethane		<50	<50	<50	<50
(19V)	100-75-8	2-chloroethylvinyl ether		<50	<50	<50	<50
(23V)	67-66-3	chloroform		52.3	59.8	706	98.8
(29V)	75-35-4	1,1-dichloroethene		<50	<50	<50	<50
(30V)	156-60-5	trans-1,2-dichloroethene		<50	<50	<50	<50
(32V)	78-87-5	1,2-dichloropropane		<50	<50	<50	<50
(33V)	10061-02-6	trans-1,3-dichloropropene		<50	<50	<50	<50
	10061-01-05	cis-1,3-dichloropropene		<50	<50	<50	<50
(38V)	100-41-4	ethyl benzene		121	159	107	125
(44V)	75-09-2	methylene chloride		17,400	2130	6910	551
(45V)	74-87-3	chloromethane		<50	<50	<50	<50
(46V)	74-83-9	bromomethane		<50	<50	<50	<50
(47V)	75-25-2	bromoform		<50	<50	<50	<50
(48V)	75-27-4	bromodichloromethane		<50	<50	<50	<50
(49V)	75-69-4	fluorotrichloromethane		<50	<50	<50	<50
(50V)	75-71-8	dichlorodifluoromethane		<50	<50	<50	<50
(51V)	124-48-1	chlorodibromomethane		<50	<50	<50	<50
(85V)	127-18-4	tetrachloroethene		1620	BMDL	6150	900
(86V)	108-88-3	toluene		14,700	4310	26,100	10,200
(87V)	79-01-6	trichloroethene		4040	1020	2540	17,400
(88V)	75-01-4	vinyl chloride		<50	<50	<50	<50
		chlorotoluene		44,800	4830	497,000	15,700

*BMDL = Compound present below measurable detection limits

ecology and environment, inc.
ANALYTICAL SERVICES CENTER, P.O. BOX D, BUFFALO, NEW YORK 14225, TEL. 716-631-0360
International Specialists in the Environmental Sciences

May 31, 1985

Dr. Hussein Sitabkhan
Frontier Chemical Waste Process, Inc.
4624 Royal Avenue
Niagara Falls, New York 14303

RE: Laboratory Report U-1332, March 28, 1985

Dear Dr. Sitabkhan:

Pursuant to your discussion with Mr. Hahn concerning the values for specific compounds in the subject report, an internal quality control audit was initiated. This audit included a thorough review of all data, including instrument operating conditions, calibrations, standards, and calculations.

The audit revealed some errors in the quantitation of toluene in one sample and chlorotoluene in nine samples. All other compounds were found to have been correctly reported. Enclosed are corrected tables for your files.

We apologize for any inconvenience that this may have caused. Should you have any questions with respect to the above, please contact me at (716) 631-0360.

Sincerely,

Russell J. Enos
Director of Analytical Services

RJE/cmp

cc: Ms. Mary McIntosh/NYS DEC

RESULTS OF WATER ANALYSIS FOR
VOLATILE ORGANIC COMPOUNDS

(all results in ug/L)

			E & E Lab No. 85-	1193	1194	1195	1196
PP #	CAS #	Compound	Sample Identity	9	10	11	12
(4V)	71-43-2	benzene		40,600	690	83,200	88,800
(6V)	56-23-5	carbon tetrachloride		<50	<50	<50	<50
(7V)	108-90-7	chlorobenzene		10,600	167	42,100	2990
(10V)	107-06-2	1,2-dichloroethane		<50	<50	<50	<50
(11V)	71-55-6	1,1,1-trichloroethane		1350	1160	22,100	18,000
(13V)	75-34-3	1,1-dichloroethane		2810	<50	722	643
(14V)	79-00-3	1,1,2-trichloroethane		<50	<50	<50	<50
(15V)	79-34-5	1,1,2,2-tetrachloroethane		<50	<50	<50	<50
(16V)	75-00-3	chloroethane		<50	<50	<50	<50
(19V)	100-75-8	2-chloroethylvinyl ether		<50	<50	<50	<50
(23V)	67-66-3	chloroform		52.3	59.8	706	98.8
(29V)	75-35-4	1,1-dichloroethene		<50	<50	<50	<50
(30V)	156-60-5	trans-1,2-dichloroethene		<50	<50	<50	<50
(32V)	78-87-5	1,2-dichloropropane		<50	<50	<50	<50
(33V)	10061-02-6	trans-1,3-dichloropropene		<50	<50	<50	<50
	10061-01-05	cis-1,3-dichloropropene		<50	<50	<50	<50
(38V)	100-41-4	ethyl benzene		121	159	107	125
(44V)	75-09-2	methylene chloride		17,400	2130	6910	551
(45V)	74-87-3	chloromethane		<50	<50	<50	<50
(46V)	74-83-9	bromomethane		<50	<50	<50	<50
(47V)	75-25-2	bromoform		<50	<50	<50	<50
(48V)	75-27-4	bromodichloromethane		<50	<50	<50	<50
(49V)	75-69-4	fluorotrichloromethane		<50	<50	<50	<50
(50V)	75-71-8	dichlorodifluoromethane		<50	<50	<50	<50
(51V)	124-48-1	chlorodibromomethane		<50	<50	<50	<50
(85V)	127-18-4	tetrachloroethene		1620	*	6150	900
(86V)	108-88-3	toluene		14,700	4310	26,100	10,200
(87V)	79-01-6	trichloroethene		4040	1020	2540	17,400
(88V)	75-01-4	vinyl chloride		<50	<50	<50	<50
		chlorotoluene		9,700	105,000	108,000	3,400

*Compound present below measurable detection limits.

RESULTS OF WATER ANALYSIS FOR
VOLATILE ORGANIC COMPOUNDS

(all results in ug/L)

PP #	CAS #	Compound	E & E Lab No. 85-	1197	1198	1199	1200	1201
			Sample Identity	13	14	15	16	17
(4V)	71-43-2	benzene		137	152	11,100	116,000	290
(6V)	56-23-5	carbon tetrachloride		<50	<50	<50	<50	<50
(7V)	108-90-7	chlorobenzene		63.1	*	7000	2140	221
(10V)	107-06-2	1,2-dichloroethane		<50	<50	<50	<50	<50
(11V)	71-55-6	1,1,1-trichloroethane		1750	835	359	7540	883
(13V)	75-34-3	1,1-dichloroethane		<50	<50	<50	2890	<50
(14V)	79-00-3	1,1,2-trichloroethane		<50	<50	<50	<50	<50
(15V)	79-34-5	1,1,2,2-tetrachloroethane		<50	<50	<50	<50	<50
(16V)	75-00-3	chloroethane		<50	<50	<50	<50	<50
(19V)	100-75-8	2-chloroethylvinyl ether		<50	<50	<50	<50	<50
(23V)	67-66-3	chloroform		<50	197	416	489	<50
(29V)	75-35-4	1,1-dichloroethene		<50	<50	<50	<50	<50
(30V)	156-60-5	trans-1,2-dichloroethene		<50	<50	<50	<50	<50
(32V)	78-87-5	1,2-dichloropropane		<50	<50	<50	<50	<50
(33V)	10061-02-6	trans-1,3-dichloropropene		<50	<50	<50	<50	<50
	10061-01-05	cis-1,3-dichloropropene		<50	<50	<50	<50	<50
(38V)	100-41-4	ethyl benzene		<50	<50	<50	<50	<50
(44V)	75-09-2	methylene chloride		73.2	<50	1060	18,000	134
(45V)	74-87-3	chloromethane		<50	<50	<50	<50	<50
(46V)	74-83-9	bromomethane		<50	<50	<50	<50	<50
(47V)	75-25-2	bromoform		<50	<50	<50	<50	<50
(48V)	75-27-4	bromodichloromethane		<50	<50	<50	<50	<50
(49V)	75-69-4	fluorotrichloromethane		<50	<50	<50	<50	<50
(50V)	75-71-8	dichlorodifluoromethane		<50	<50	<50	<50	<50
(51V)	124-48-1	chlorodibromomethane		<50	<50	<50	<50	<50
(85V)	127-18-4	tetrachloroethene		78.2	50.0	68.3	342	<50
(86V)	108-88-3	toluene		1150	182	5190	40,500	409
(87V)	79-01-6	trichloroethene		327	206	455	2760	<50
(88V)	75-01-4	vinyl chloride		<50	<50	<50	<50	<50
		chlorotoluene		1270	17,500	4760	33,000	46,000

*Compound present below measurable detection limits.

FRONTIER - VOLATILE ANALYSIS (UG/L)

COMPOUND	FRONTIER 9	FRONTIER 10	FRONTIER 11	FRONTIER 12	FRONTIER 13	FRONTIER 14	FRONTIER 15	FRONTIER 16	FRONTIER 17
DICHLOROETHENE	549	234	230	695	1100	43	148	242	12
TRICHLORO,TRIFLUOROETHANE	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
DICHLOROMETHANE	993	294	1340+	79	3.3	6.7	88	200	2.8
1,1-DICHLOROETHANE	2250+	107	2.4	515	86	55	59	702	5.7
CHLOROFORM	29	15	253	11	107	17	15	70	6.3
1,2-DICHLOROETHANE	457	20	701	141	5.3	6.5	249	6.6	1.4
DICHLOROFLUOROETHANE	2.4	21	71	0.0	0.2	0.0	5.5	18	0.0
CARBON TETRACHLORIDE	1520	187	24000+	16	343	297	5.6	157	2.4
BENZENE	870	124	16000+	1600+	6.4	23	141	725	63
TRICHLOROETHENE	1360	241	5400+	1410	20	68	121	572	4.5
TETRACHLORODIFLUOROETHANE	0.0	0.0	0.0	0.0	0.40	0.22	0.0	0.0	0.0
TOLUENE	809	716	4300+	683	66	29	526	3000+	128
TETRACHLOROETHYLENE	1410	107	9300+	422	32	47	46	259	2.9
CHLOROBENZENE	3630	388	979	1250	20	62	857	806	500
METHYL TOLUENE	140	59	414	33	1.7	4.6	41	170	5.6
BROMOBENZENE	38	3	88	23	0.0	0.4	27	19	0.0
CHLOROTOLUENE	3340	11500+	26500+	1210	419	233	2000	4700+	4700+
METHYL ETHENYL BENZENE	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
DICHLOROBENZENE	1950	261	100000+	1370	20	64	3200	484	4.9
BROMOCHLOROBENZENE	0.0	0.0	17.4	3.0	0.0	0.0	0.0	0.0	0.0
DICHLOROTOLUENE	8.3	11	92	25	0.0	0.7	35	0.0	0.4
TRICHLOROBENZENE	97	26	1060	157	2.3	5.5	241	0.0	1.3
DICHLOROETHENYL BENZENE	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
TETRACHLOROTHIOPHENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DICHLORO,CHLOROMETHYL BENZENE	0.0	0.0	2.1	4.7	0.0	0.0	0.0	0.0	0.0