Gartner Lee Associates Limited

Consulting Engineering Geologists and Hydrogeologists

Toronto - Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

HYDROGEOLOGICAL REVIEW
OF
HYDE PARK LANDFILL
SUMMONS AND AGREEMENT

PREPARED FOR:

ENVIRONMENT CANADA

GLAL 81-73

JUNE 17, 1981

Gartner Lee Associates Limited

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Toronto-Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

June 17, 1981.

Environment Canada,
Ontario Region,
55 St. Clair Avenue East,
Toronto, Ontario.
M4T 1M2

Attention: Dr. R. W. Slater,
Regional Director General

Dear Sir:

Re: Hydrogeological Review of Hyde Park Landfill - (GLAL 81-73)

We are pleased to submit our review of the hydrogeological aspects of the Summons and Agreement for the Hyde Park Landfill.

I will be out of town for the week of June 22, 1981, but would be pleased to discuss this review with you later this week or when I return.

Yours very truly,

GARTNER LEE ASSOCIATES LIMITED

Grant Anderson

E. Grant Anderson, P.Eng.,
Consulting Hydrogeologist.

EGA:jcm
Enclosure.

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Hyde Park - Bloody Run Landfill
Hydrogeologic Review

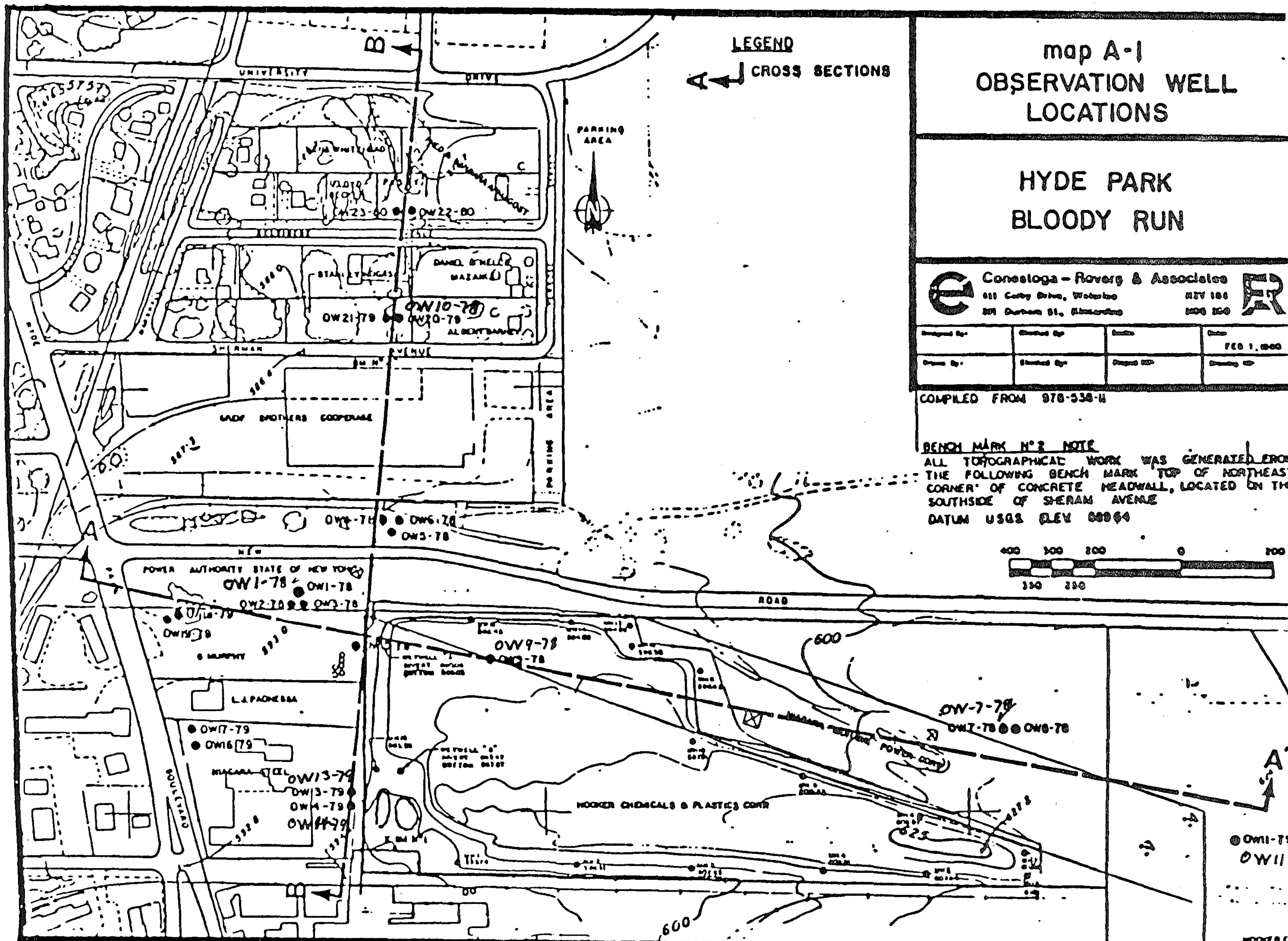
1) Geologic Setting of Site:

This 15 acre± chemical disposal site was developed by excavating and filling pits or cells within glacial silt and clay till soils. Wastes were dumped in bulk and in 45 gallon drums. Excavations were made utilizing a drag line type of operation. Historical airphotos of the site suggest that it was likely a low wet area with the water table near the ground surface prior to landfilling.

Soil borings carried out by Conestoga-Rovers around the site indicate that the area is characterized by an upper glacial silty clay till on surface. Sandwiched between this till and the underlying bedrock is a weathered bedrock zone intermixed with sand and till. The depth of the glacial till overlying the bedrock varies from about 5 feet± (O.W.-7-78) east of the site to 30 feet (O.W.1-78) north west of the site and 16 feet (O.W.13-79) immediately west of the site. (See Map A-1 - Observation Well Locations and borehole logs on following page.) The elevation of bedrock east of the site is 603.7 feet, (O.W.7-78) west of the site bedrock is confirmed at 582.4 feet (O.W.13-79) and north west of the site bedrock is confirmed at 563.1 feet (O.W.1-78). These data indicate that bedrock underlying most of the chemical fill is at about elevation 582 feet or higher by extrapolation between O.W.7-78 and O.W.13-79.

Two wells were drilled through the waste. These were wells O.W.9-78 and 10-78. O.W.10-78 was destroyed during construction and is not shown on Map A-1. However O.W.9-78 met refusal on assumed concrete rubble at elevation 580.3 feet and O.W.10-78 hit refusal at elevation 583.2 feet on bedrock. Both of these well records (attached) indicate that chemical wastes have been filled in direct contact with the underlying bedrock.

The underlying bedrock is known locally as the Lockport Dolomite. At this site, it is about 100 feet thick. It is generally described as massive to thin bedded dolomite. The upper 15 feet of the rock is very fractured and solutioned cavities are reportedly common. (Refer to logs of O.W.11-79 and 13-79). Below this


map A-1
OBSERVATION WELL LOCATIONS
HYDE PARK
BLOODY RUN
Conestoga - Rovers & Associates
LEGEND
CROSS SECTIONS
COMPILED FROM 979-538-H
BENCH MARK N° 2 NOTE
ALL TOPOGRAPHICAL WORK WAS GENERATED FROM THE FOLLOWING BENCH MARK TOP OF NORTHEAST CORNER OF CONCRETE HEADWALL, LOCATED ON THE SOUTHSIDE OF SHERAM AVENUE
DATUM USGS ELEV
FEB 1, 1980
UNIVERSITY
DRIVE
PARKING AREA
SHERMAN AVENUE
PARKING AREA
ROAD
POWER AUTHORITY STATE OF NEW YORK
HOOKER CHEMICALS & PLASTICS CORP
BOULEVARD
OW23-80
OW22-80
OW21-79
OW20-79
OW10-78
OW4-78
OW6-78
OW5-78
OW1-78
OW2-78
OW3-78
OW18-79
OW19-79
OW9-78
OW17-79
OW16-79
OW13-79
OW3-79
OW4-79
OW7-78
OW8-78
OW11-79
600
625
A
A'
B

879-6

TABLE 1

OBSERVATION WELL INSTALLATIONS (1)

HYDE PARK LANDFILL

DATE ? WELL NO.	WELL CASING ELEV.	GROUND ELEVATION (feet)	DEPTH OF INSTALLATION BELOW GROUND (feet)	LOCATION OF INSTALLATION
OW 1-78	596.99	596.2	49.9	Bedrock
OW 2-78	597.19	596.1	25.2	Overburden
OW 3-78	597.77	596.3	34.0	Interface
OW 4-78	596.01	594.5	42.1	Bedrock
OW 5-78	596.29	594.6	29.3	Interface
OW 6-78	596.05	594.6	15.2	Overburden
OW 7-78	613.80	612.5	20.8	Bedrock
OW 8-78	614.08	612.4	7.0	Interface
OW 9-78	610.66	609.2	26.0	Overburden
OW 10-78 (2)	616.66	615.1	29.0	Interface
OW 11-79	626.20	622.2	28.0	Bedrock
OW 13-79	597.94	598.4	36.2	Bedrock
OW 14-79	593.03	598.3	16.0	Interface
OW 15-79	600.26	597.8	20.5	Overburden
OW 16-79	596.03	596.6	51.5	Bedrock
OW 17-79	596.06	596.6	29.5	Interface
OW 18-79	599.14	596.7	85.5	Bedrock
OW 19-79	599.02	596.6	33	Interface
OW 20-79	590.57	587.8	45.4	Bedrock
OW 21-79	590.77	587.6	25.0	Interface
OW 22-80		588.5	43.3	Bedrock
CW 23-80		588.6	23.3	Interface

(1) DATUM = USGS (2) Well Destroyed During Construction

OW 7-78

From	To (Feet)		
0 (609.7	4 - 605.5)		Red-brown dry silty loam with clay traces, no stones
4 (605.5	4.6 - 604.9)	Blowcounts	68/6" 100/1" Stiff dry silty clay and crushed grey stone
4.6 (604.9	5.8 - 603.7)		Weathered bedrock fragments in dark grey coarse sand matrix - no spoon sample
5.8 (603.7	8.1 - 601.4)		Medium grey, coarse grained weathered dolomite, horizontal bedding, fractures and solution voids
8.1 (601.4	13.6 - 595.9)		Light-medium grey, medium grained dolomite fractured, with pores, horizontal bedding
13.6 (595.9	18 - 591.5)		Light grey, medium grained dolomite, horizontal beds, darker horizontal bands with dark specks, fractures
18 (591.5	20.6 - 588.9)		Light grey, coarse-medium grained dolomite, horizontal beds and darker bands, less fractured.

BOREHOLE LOGS AND BLOWCOUNTS

OW 1-78

From	To (Feet)		Description
0 (593.4	1.5 - 591.9)		Silty sand, some cinders, 3/4" stone medium brown to dark brown clay at spoon tip
		Blowcounts	4/6" 5/6" 10/6"
1.5 (591.9	5.0 - 588.4)		Medium brown, stiff silty clay till, 1/16" - 1/8" stone, some fill material, glass, cinders etc.
5.0 (588.4	10.0 - 583.4)	Blowcounts	Dark brown to black silty organics, grey clay 3/6" 2/6" 2/6"
10 (583.4	15 - 578.4)	Blowcounts	Light brown silty clay 4/6" 9/6" 10/6"
15 (578.4	20 - 573.4)	Blowcounts	Light brown clay 5/6" 5/6" 6/6"
20 (573.4	25 - 568.4)	Blowcounts	Stiff light brown clay till, some 1/8" stones 4/6" 7/6" 7/6"
25 (568.4	30 - 563.4)	Blowcounts	Stiff reddish-light brown clay till 2/6" 2/6" 4/6"
30 (563.4	30.3 - 563.1)		Light brown dry clay, with bluish-grey rounded stones and crushed rock fragments
30.3 (563.1	30.8 - 562.6)		Light grey dolomite rock
30.8 (562.6	36.5 - 556.9)		Dark grey shale with stiff clay, washed coarse grey sand and dark grey rock fragments
		Blowcounts	6/6" 37/6" 81/6" 50/1"
36.5 (556.9	37.9 - 555.5)		Grey, coarse grained dolomite, horizontal bedding planes, fractured with solution voids
37.9 (555.5	38.1 - 555.3)		Clay streak
38.1 (555.3	47.7 - 545.7)		Grey, coarse grained dolomite, horizontal bedding planes, fractured solution voids, dark grey horizontal and oblique streaks, several small clay seams, crystals within solution voids
47.7 (545.7	50.2 - 543.2)		Grey medium grained dolomite, horizontal bedding planes, fractures, solution voids, more porous, many horizontal and oblique thin streaks

OW 13-79

Date Installed - September 17, 18, 19, 1979
Machine - CME 55
Crew - Joe Jensen, Leo Jensen

Soil Log
Depth (feet)

FROM	TO	Sample No.	N	DESCRIPTION
0	1.5	--	--	Stone cover
1.5	3.0	1	5/6/7	Brown and gray silt and fine sand - roots - odorous
4.5	6.0	2	6/10/15	Medium brown silt and fine sand with - traces of clay - gravel - clean
9.5	11.0	3	5/6/6	Medium to reddish brown clayey silt with - black residue - odorous
14.5	16.0	4	5/7/15	Medium brown silt and sand (fine to coarse) - slight odor
16.2	36.2	--	--	Bedrock - dolomite 16.2 - 25 solid 25 - 30 badly pitted Seams 19.0 - 19.1 23.7 - 23.9 25.0 - 25.2 Lost all water 33.0

NOTES:

- The well pulled up 4 feet when the temporary casing was pulled out. The well was driven back down excpet for 18 inches. The well was checked to insure that it was in operating condition after this incident.
- At a drilled depth of 25 feet, the flushing water no longer came to the surface.
- The top of the well was set below ground elevation to eliminate interference with private roadway.

Top of sand - 30.0' below ground surface
Top of bentonite plug - 28.5' below ground surface
Total pipe length installed - 33.9'

OW 9-78

From	To (Feet)		
0 (606.3	5 - 601.3)		Coarse gravel fill and black chemical residue
5 (601.3	10 - 596.3)	Blowcounts	Stiff silty clay and black chemical residue 3/15" 1/3"
10 (596.3	15 - 591.3)	Blowcounts	Soft silty clay, some 1/4" stones, black organic-like residue and light coloured sugar-like crystals 9/6" 5/6" 1/6"
15 (591.3	20 - 586.3)	Blowcounts	Black chemical residue with medium sand, metal barrels 7/6" 31/6" 100/2"
20 (586.3	26 - 580.3	Blowcounts	Black chemical slurry with medium sand 28/6" 75/5"
26 (580.3)			Refusal - probably concrete rubble

OW 10-78 WELL DESTROYED DURING CONSTRUCTION

From	To (Feet)		
0 (612.2 -	5 607.2)		Grey gravel
5 (607.2 -	10 602.2)	Blowcounts	Medium sand with black chemical residue and 1" - 1½" stones 9/6" 11/6" 23/6"
10 (602.2 -	15 597.2)	Blowcounts	Silty gravel with clay and black chemical traces 2/6" 6/6" 3/6"
15 (597.2 -	20 592.2)	Blowcounts	Sample lost 2/6" 1/6" 1/6"
20 (592.2 -	25 587.2)	Blowcounts	Black medium sand and red-brown clay 9/6" 11/6" 13/6"
25 (587.2 -	29 583.2)		Rock fragments, till
29 (583.2)			Refusal

OW 11-79

Date Installed - September 10, 11, 12, 13, 1979
Machine - GME 45C - Augered, Cored, 3 1/2" ream
Crew - Roger Logel, Pete Pietrzak
Machine - CME 55 - 6" Ream
Crew - Joe Jensen, Leo Jensen

Soil Log
Depth (feet)

FROM	TO	Sample No.	N	DESCRIPTION
0	0.1	1	5/11/15	Topsoil
0.1	1.3	1	5/11/15	Fill - Medium brown silt, fine sand and vegetation
1.3	1.5	1	5/11/15	Reddish-brown silty clay (encountered rock at 4 feet - augered through)
1.5	4.9	--	--	Reddish-brown silty clay (encountered rock at 4 feet - augered through)
4.9	5.9	--	--	Rock - cored through
5.9	6.6	2	$30/\frac{100}{0.2}$	Reddish-brown fine sand and silt
6.6	6.8	2	$30/\frac{100}{0.2}$	Medium brown fine sand and silt
6.8	28.0			Bedrock - dolomite - voids encountered from 7.5 to 7.8 10.8 to 11.1 22.4 to 22.6 23.2 to 23.5

NOTES:

- The original auger hole encountered rock at 4.9 feet. In an attempt to get around this, the hole was moved 4 feet to the east. However, the same rock layer was encountered.

- Water was used as the flushing medium druing the coring and reaming operations.

- The flushing water no longer reached the surface after a depth of 11 feet.

Top of sand - 21.0' below ground surface
Top of bentonite plug - 19.5' below ground surface
Total pipe length installed - 32'

15 foot zone, vertical fractures are less frequent but horizontal fractures (bedding planes) are common for the remaining vertical distance to the underlying Rochester Shale about 100 feet below the top of the Lockport Dolomite.

In summary, chemical wastes have been deposited in direct contact with very solutioned and fractured bedrock. The previously existing glacial silt and clay tills were breached during drag line excavations prior to filling with bulk chemicals and drums.

2) GROUND WATER FLOW:

Generally speaking, two ground water flow systems exist at this site. These are

a) Ground Water Flow in Overburden (Soils)

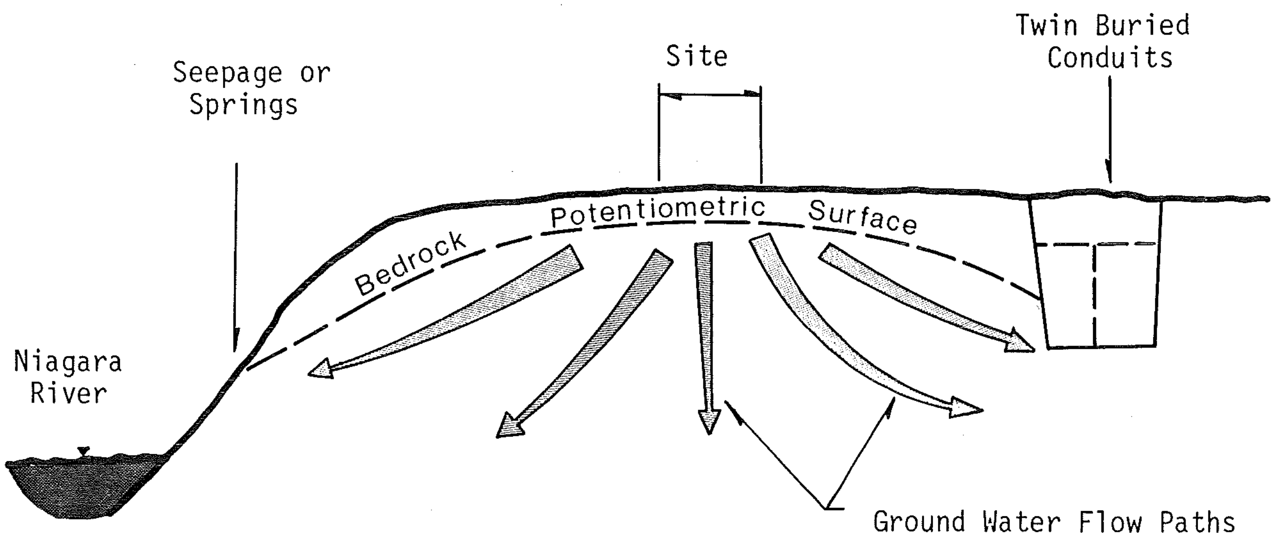
b) Ground Water Flow in Bedrock

The velocity of ground water movement is defined by $v = \frac{ki}{n}$

where v = velocity
k = hydraulic conductivity
i = gradient
n = effective porosity

The quantity (Q) of ground water movement is defined by $Q = kiA$ where A is the cross sectional area of flow.

No quantitative analysis of ground water flow was available in the information packet accompanying the agreement. However, preliminary calculations can be carried out once one has a basic understanding of flow directions. According to the agreement, ground water flows to the north west (page 5) towards the Niagara Gorge in the bedrock. No technical data supports this flow direction. In fact, data indicates that the landfill is, in fact, located in a ground water recharge area with flow (in the shallow bedrock zone at least) moving westerly, northerly and easterly away from the site. These radial flow directions are influenced by the Niagara Gorge to the west, the twin buried conduits to the east and the open canal to the north. (See Figure 14, page 54 in Ground Water in the Niagara Falls Area, New York by R.H. Johnston). The location of the landfill has been imposed onto the "Present Condition" of the figure. If a cross section were drawn between the Niagara Gorge, through the site and to the Conduit the following condition would exist.



SCHEMATIC CROSS SECTION SHOWING
GROUND WATER FLOW BETWEEN CONDUITS AND
THE NIAGARA GORGE

Not to Scale

It is apparent that immediately below the site, ground water movement is vertically downwards and radiates both east and west of the site. This is a typical example of a ground water recharge area.

Knowing that the chemicals are deposited directly on top of the bedrock, we can compare the quantity of contaminated ground water moving into the rock to the quantity of contaminated ground water moving into the soil adjacent to the site. To simplify the calculation we will assume that flow takes place through a unit area and that the gradient in the rock and glacial till is the same. (In actual fact the gradient in the rock will be greater by at least one order of magnitude and the total area of flow out the bottom of the 15 acre site is greater than the area of flow through the side walls of the fill around the entire site by a factor of 20.) Thus the

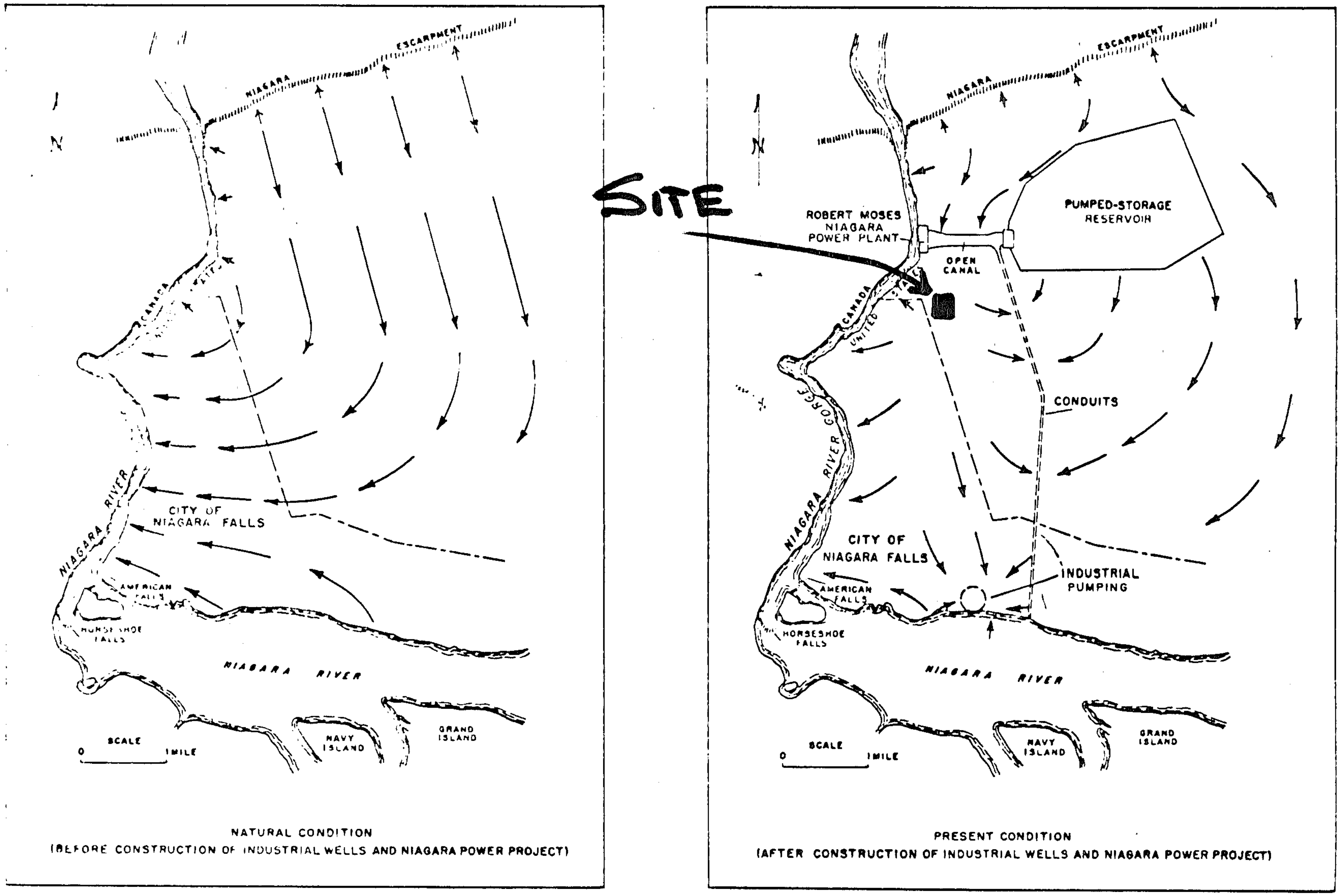


Figure 14.--Inferred direction of ground-water movement in the upper water-bearing zones of the Lockport Dolomite in the vicinity of Niagara Falls.

quantity of flow in the rock compared to the quantity of flow in the soil is proportional to the permeability of the rocks and soil. The permeability of the soil is 10^{-7} cm/sec and the permeability of the rock will be at least 10^{-4} cm/sec. Therefore, at least 1000 times more contaminated ground water would move downwards into the rock than would move into the adjacent soil.

Even if we assume that the permeability of the rock and soil are the same (this is the same as assuming clay till under the site and waste is not in contact with rock) but use the realistic gradient and area data previously bracketed, we calculate that 200 times as much contaminated ground water will move downwards as will move laterally through the soil.

These very basic, but fundamental understandings of ground water movement are of paramount importance in assessing the adequacy of any remedial measures proposed at this site.

In a similar manner some very basic calculations on ground water velocity reveal that the velocity of contaminants in the rock will be about 10,000 times faster than in the soil.

In summary, the chemical wastes are resting on the very permeable Lockport Dolomite bedrock aquifer. Conservative calculations indicate that at least 200 times more leachate will move vertically into the rock than laterally through the soil. Velocity of the contaminants in the rock will be 10,000 times faster than in the soil. Once in the rock, contaminants will move through open bedding planes and vertical fractures that form conduits for movement westerly, easterly, northerly and vertically downwards in the bedrock. These contaminants will eventually reach the Niagara River.

3) COMMENTS ON PROPOSED REMEDIAL ACTIONS:

Any proposed remedial concept has to be based on an understanding of the hydrogeology of the site. We have seen no indication in the background data reviewed by us that such an understanding was utilized to conceive the alternative schemes.

3.1 CAPPING OF DRAINAGE SWALES AND PERIPHERAL AREAS

The proposed capping option generally provides for a study to delineate the extent of contamination in the very shallow (upper 2 foot) soil zone. Capping will only minimize infiltration of precipitation and not totally eliminate it. In addition, capping may isolate the waste, temporarily from direct contact by humans or animals. However, there are a number of fundamental geotechnical problems associated with capping drainage swales and lands adjacent to these swales. These problems are related to the long term integrity of the cap.

As a first consideration, the foundation conditions over which the cap is constructed will be variable. The presence of organic soils (topsoil) is expected in some areas. Since these soils are susceptible to differential frost heaving -- and under compaction of the cap, differential settlements might occur -- there is a good likelihood that heaving and cracking of the cap seal will result. Also, some preparation of the surface by means of excavation will be required, necessitating removal and disposal of contaminated soils.

It is our opinion that capping of swales or creeks without removal of the contaminants will only serve as a very short term measure to isolate wastes from exposure to animals or humans. Capping will not prevent release of contaminants to the Niagara River via the ground water system. In addition, the cap itself will be subject to not only frost heave and settlement problems, but surface erosion of sediments will occur with time. Removal of the wastes and replacement with clean fill is the only reasonable option to ensure that contaminants are not released to the Niagara River.

3.2 CAPPING THE LANDFILL SITE

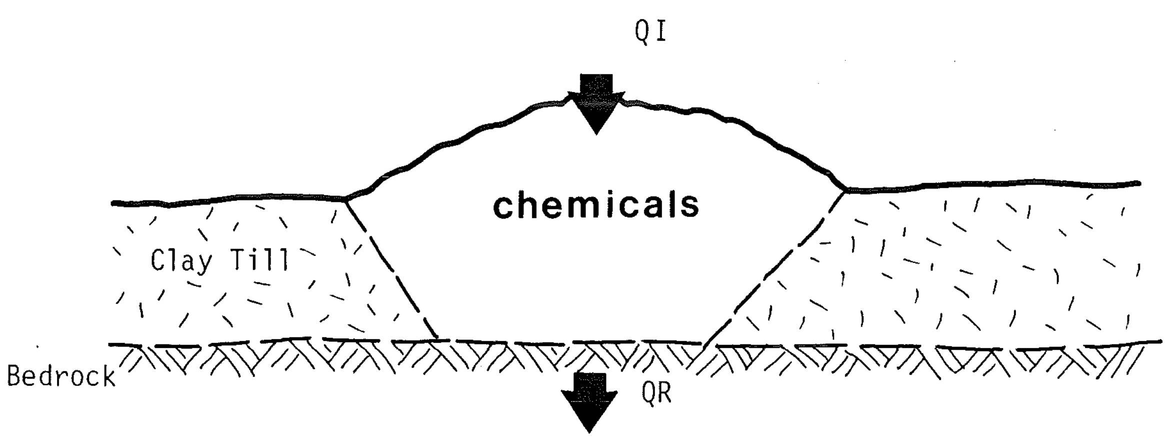
Placing a three foot clay cap on the landfill is again only a short term solution. This cap will not stop the formation of leachate, but only slow down its production and migration through the system. Leachate is formed at sites such as this by the downward percolation of precipitation through the waste. If the amount of precipitation allowed to enter the waste is decreased -- say by a clay cap -- then the leaching action is slowed and the amount of leachate produced is decreased. Thus, it takes longer to completely leach the landfill. This approach to contaminant control is in conflict with the philosophy of leachate collection.

For example, it makes more sense to expedite leaching to get all the contaminants out of the site into the collection system as quickly as possible in order to decrease maintenance time and expense. In contrast, capping at the site will likely result in lower rates of release to the environment. However, the same amount of waste (loading) will ultimately reach the Niagara River. Capping of the wastes will only increase the migration over a longer period of time. As such, capping alone is not an acceptable remedial option since it does not preclude release to the environment. This is of particular importance when considering very stable wastes of this nature that easily accumulate in the environment.

3.3 OVERBURDEN BARRIER SYSTEM

This proposed option consists conceptually of a tile drain located about 10 feet below ground surface around the periphery of the landfill. Normally, such a system is required when leachate springs emanate from the toe of the landfill and discharge to surface waters.

Capping of the landfill is intended to reduce infiltration. If precipitation infiltrates the landfill at a rate less than the ground water outflow through the bottom, then leachate will not mound and come to ground surface. Thus, there would be no need for a toe drain overburden leachate collection system. It is a simple fundamental calculation required to determine this need. The diagram below illustrates the basic components of the calculations.



SCHEMATIC OF WATER BUDGET THROUGH WASTE

If QI > QR leachate mounds and comes to surface

QI - the quantity of precipitation infiltration can be determined from the rule of thumb used by hydrogeologists. That is 12 inches of infiltration on the average over a year would equate to about 1/2 imperial gallon per minute (IGPM) per acre of fill on the average. Capping should reduce infiltration to less than 6" of precipitation or about 0.25 IGPM per acre.

QR the potential quantity of leachate outflow through the bottom of the fill into the bedrock can be calculated using the formula

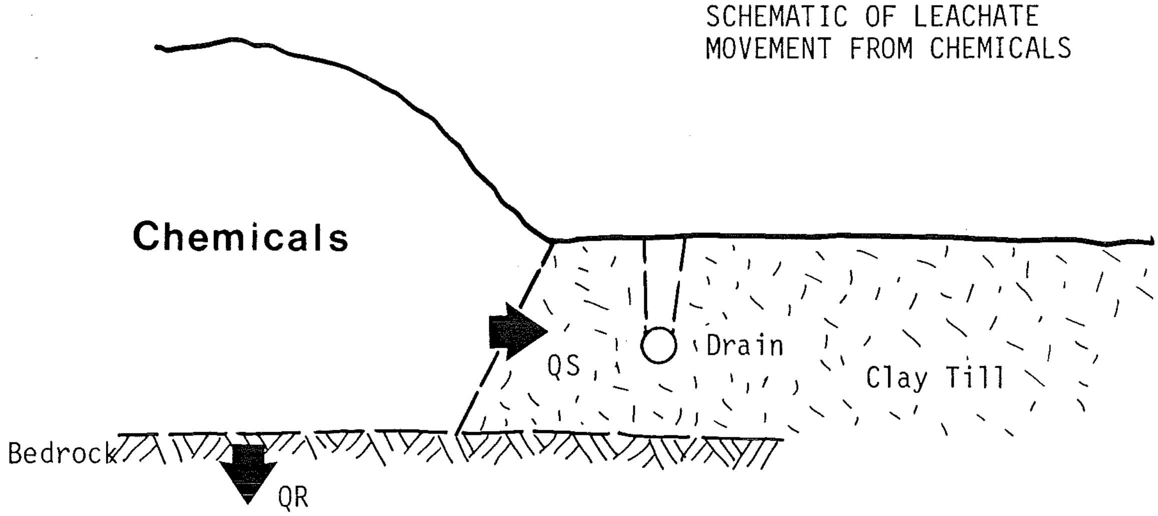
$$QR = kiA \quad \text{where } k = 10^{-4} \text{ cm/sec}$$
$$i = 0.5 \text{ (recharge gradient)}$$
$$A = 43{,}560 \text{ sq. ft. (1 acre)}$$

changing the units and substituting into the equation, QR = 106 IGPM/acre. It is obvious that the potential leachate outflow will exceed the potential precipitation inflow by a factor of 400 times.

Based on this analysis we can only conclude that the overburden barrier system will not be functional in collecting the most significant component of leachate movement away from this site. It is of paramount importance that the contaminants leaving the bottom of the site be collected as the primary line of defence to ensure that dioxin is not released to the environment.

This point can be further emphasized when one considers the fact that the proposed overburden barrier drain is located within natural clay soils outside the fill (see sketch below and Figure 7 in the agreement).

SCHEMATIC OF LEACHATE
MOVEMENT FROM CHEMICALS



Calculations given in Section 2 of this brief indicate that outflow to the bedrock QR is a minimum of 1000 times greater than flow through the soils (QS). This uses a permeability in the soil of 10^{-7} cm/sec and some simplifying assumptions concerning gradients that give all benefit of doubt to the proponent (Hooker Chemical). In actual fact using realistic gradients it can be shown that outflow through the rock could be as much as 200,000 times greater than flow through the clay till.

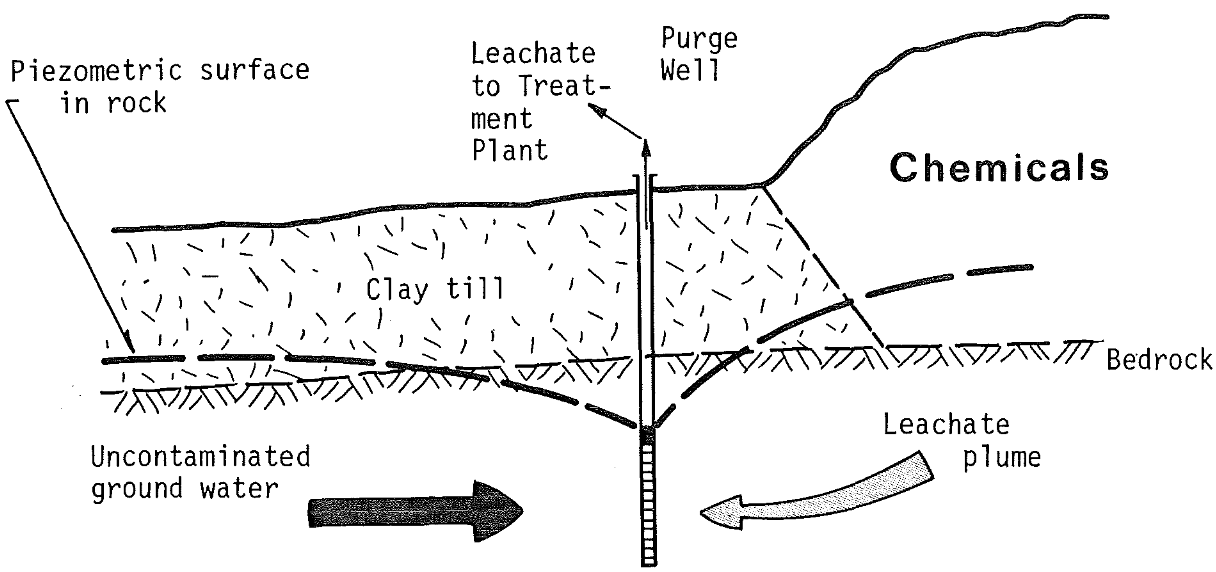
It could be argued that the clay is very fractured and 10^{-7} cm/sec is an unreasonable permeability to use in the equations. If we use a permeability for fracture flow of 10^{-4} cm/sec outflow in the rock would still exceed flow to the drain in the overburden by a factor of 200.

It is obvious that the overburden barrier drain system will not prevent the most significant release of contaminants to the environment and that outflow of chemicals to the bedrock is the most critical aspect of contamination requiring remedial action at this site.

3.4 BEDROCK BARRIER COLLECTION SYSTEM

The proposed bedrock barrier collection system consists of about 11 wells drilled into the Lockport Dolomite along the west end of the chemical fill. The proposed locations are obviously based on a wrong assumption of the ground water flow direction as evidenced on Figure 11 of the agreement and discussed in detail in Section 2 of this Brief. This would mean that wells would have to be similarly spaced along the north and east sides of the fill, ultimately requiring a total of about 30 wells.

However, an examination of this concept should and can be made now based on existing data, prior to ratifying the agreement. An understanding of this proposed concept is very important and the following diagram illustrates the essential components of the system that make it work.



SCHEMATIC OF GROUND WATER AND LEACHATE FLOW
TO A PURGE WELL

The purge well serves two primary functions. It removes leachate from the bedrock and it creates a hydraulic trap such that leachate cannot flow past the well.

To determine if such a system is feasible, even to consider as a concept, some basic calculations can be made. It is critical to understand the quantity of diluted leachate that will require collection, handling and treatment.

To create the hydraulic trap, all water must flow to the wells that are within the potential contaminant plume. A parameter frequently used to describe an aquifer's capability to yield water is its specific capacity. This is defined as yield per unit drawdown and expressed as gallons per minute per foot of drawdown. A reasonable specific capacity for an operating system in the Lockport Dolomite is 0.3 gpm/foot of drawdown for each well. If a 5 foot drawdown is required to insure a hydraulic trap between all wells, then each well would have to pump continuously at about 1.5 gpm. If 30 wells are utilized then the total continuous production of leachate requiring treatment would be 45 gpm or about 65,000 gallons per day. This would fill a 1/4 acre pond that is 5 feet deep every 4 days.

There is an inference in the agreement that leads us to believe that such a system may have to be operated only for a short period of time. For example in Addendum III - Maintenance Program paragraph F of the agreement indicates that any of the barrier systems can be terminated if "a) over a period of four consecutive years no specific chemical parameter listed in paragraph F of Addendum III has been detected at more than 10 ug/L in liquids collected by such system or component thereof."

These criteria may very easily be met on the basis of dilution alone in the purge well system when one considers that leachate production at the landfill is likely only 1/10 of the total volume of water collected (at the most) by the purge well system. These criteria are absolutely absurd at a site of this nature when one considers the basic simple alternative of monitoring the quality of the leachate plume between the waste and the purge well. This leads us to believe that this agreement is based on a very poor understanding of the fundamental hydrogeologic setting of this site.

We must reiterate that as long as the chemicals are present at this location, they will slowly percolate to the water table and migrate. If a purge well system is used, considerable dilute quantities of leachate (65,000 gallons per day) will have to be collected, transported and treated forever. We cannot emphasize enough that the words <u>forever</u> or <u>in perpetuity</u> mean just that. There are no short term solutions by leaving the wastes at this location and it is only naive and totally unreasonable to have an agreement that considers a short term (35 years) maintenance as an option. This site if left in place will require management in perpetuity.

4) <u>CONCLUSIONS:</u>

Based on our review of all available data in addition to the agreement and subsequent comments the following conclusions are made.

1. The Hyde Park Landfill contains large quantities of organic chemicals that are among the most toxic of all man-made compounds.

2. These chemicals have been deposited directly on top of the Lockport Dolomite bedrock in excavations draglined through glacial clay till soils.

3. The Lockport Dolomite is fractured, solutioned and generally a very permeable rock formation that transmits large quantities of water very quickly through it. Movement is through openings (both vertical and horizontal) that are reported by Conestoga Rovers to be as much as 0.3 feet wide. The areal extent of these openings is reported to be in terms of 3 or 4 miles.

4. The chemical dump is located over a ground water recharge area. As such ground water potential gradients are vertically down below the site into the bedrock and subsequently radiate outwards westerly, northerly and easterly from the site.

5. The quantity of leachate that can potentially move down into the rock is 200,000 times greater than outflow into the soil at a maximum worst case scenario. Giving all benefit of the doubt, the potential quantity of outflow into the rocks could be as low as 200 times greater than outflow through the clay soil side walls of the fill. This illustrates the need to place priority on protecting the bedrock aquifer as the primary remedial measure at this location.

6. Ground water velocities in the bedrock are about 10,000 times faster than in the glacial till soils.

7. Contamination of sediments adjacent to the site appears to be caused by the direct runoff of chemicals from the site onto the adjacent lands and subsequent infiltration and not by sub-surface movement of contaminants through the soil for the main part. Capping of these contaminated soils is considered only a short term measure to prevent infiltration of precipitation and isolation from the human environment. Structural failures (cracking and differential heaving) are inevitable with subsequent release of contaminants to the environment.

8. Capping of the chemicals with clay is again only an interim measure which will minimize infiltration of precipitation and thus leaching of chemicals from the wastes. Considering the very stable nature of these chemicals and their ability to bio-accumulate in the environment, they will still pose a very serious threat to the environment over a very long period of time. Capping alone will not prevent release of chemicals to the environment.

9. The proposed overburden barrier system, which is the only system that is described as a definite requirement in the agreement, does not appear to serve any useful function when one considers point (5) of these conclusions. The agreement is lacking in foresight in this particular area as it is obvious now that emphasis must be placed on protecting the rock.

10. Once organic chemicals enter the rock they can migrate quickly for miles unattenuated. This stems from the fact that water is moving in open cavities much the same as water moves through a pipe.

11. A purge well system concept proposed is ill conceived on the basis of a misinterpretation of the ground water flow system. About 3 times as many wells would be required to achieve the goal of hydraulic trap and total leachate collection. Over 60,000 gallons per day of leachate contaminated ground water would require treatment.

12. The agreement suggests that there is a possibility of only operating this purge well system for a short term on the basis of monitoring the outflow from the system and then stopping once certain criteria are met. (Section 3.4). This reflects a basic misunderstanding of the hydrogeologic aspects of such a system again shedding considerable doubt on whether all parties to the agreement have a basic understanding of the fundamental hydrogeologic setting.

13. The agreement indicates that a maintenance period of only 35 years may be required. In our opinion, given the nature of the wastes and the site setting, this is naive and perpetual care will be required.

14. Given the requirement to handle over 60,000 gallons of dilute leachate daily <u>in perpetuity</u>, we are of the opinion that removal of all the contaminated soil and chemical wastes for safe disposal at a properly designed site or destruction where feasible is the only reasonable option available to all parties.

ADDENDUM LETTER

JUNE 18, 1981

Gartner
Lee
Associates Limited

Consulting
Engineering
Geologists and
Hydrogeologists

Toronto - Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

June 18, 1981.

Environment Canada,
Ontario Region,
55 St. Clair Avenue, East,
Toronto, Ontario.
M4T 1M2

Attention: Dr. R. W. Slater,
Regional Director General

Dear Sir:

Re: Addendum to Hydrogeological Review of Hyde Park Landfill, June 17, 1981

Subsequent to issuing the above noted report-brief we received what appeared to be the appendix of a hydrogeological report prepared by Conestoga Rovers in the spring of 1980. We are somewhat horrified that the U.S. Attorney General's office does not have the report that accompanies this appendix as it is likely the most pertinent document used in negotiating the agreement from a hydrogeological point of view. Not having the report, we have evaluated the appendix in light of our brief and offer the following further comments.

1) There was nothing in this appendix that would change any of the interpretations, calculations or conclusions outlined in the brief.

2) The technical data contained in the appendix confirms our calculations and indicates that we have been very conservative in our calculations and indeed have given reasonable benefit of the doubt to Hooker Chemical wherever practicable.

3) Chemical analysis of water samples taken from the bedrock confirm that this site is in a ground water recharge area

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with ground water trying to move downwards. This is proved positively by vertical gradients downwards of .57 in the data provided in the Appendix. Considerable effort is expended in the agreement around whether it will be necessary to collect contaminated ground water in the bedrock from the upper 15 foot zone or deeper. You need only consider the chemistry of the ground water taken from O.W.18-79. This well is about 500 feet west of the site and the well screen is about 50 feet below the rock surface. The chemistry is as follows:

Chlorides (ppm)	190
Phenol (ppb)	14,000
Chloroform (ppb)	1,000
Trichloroethylene (ppb)	500
Tetrachloroethylene (ppb)	900
Benzene (ppb)	270
Chlorobenzene (ppb)	1,200
Ethyl benzene (ppb)	370
Toluene (ppb)	3,200

Surely, it is clear that this zone in the bedrock, 50 feet below the bedrock surface, is extremely contaminated now. This data clearly indicates that all parties to the agreement are not fully aware of the facts as they stand at this time, otherwise there would be no dissertations concerning the "if" question and the "how" could have been dealt with more directly.

Although there are numerous technical concerns that we have regarding both the agreement and the supporting technical data, our severe time constraints will not permit us to itemize and discuss them at this time. We have chosen to try and put into perspective the key factors that must be considered prior to making a decision on the agreement. Apart from all of the complex technical issues some very simple facts remain. These are:

a) There are very toxic organic chemicals disposed in direct contact with a very permeable bedrock aquifer. This aquifer has already started to receive these

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chemicals at least 50 feet below the rock surface 500 feet away from the chemical dump.

b) These chemicals will be removed from the dump in one of two ways; either by slowly leaching out over the next, literally, thousands of years or by physically removing the entire dump. There are no other alternatives to consider in this case.

c) If it is decided to let them leach out over the next thousands of years, the chemicals will definitely reach the Niagara River unless intercepted by a purge well system. Thus, very large quantities of dilute leachate would have to be treated forever.

d) No matter which of the two alternatives noted in (b) are chosen, the end result has to be the same. The chemicals have to be removed from this environment. You can either get them by removing 15 acres of concentrated wastes which could be done in a few years or you can pump, store, handle and treat 15 acres of dilute leachate 5 feet deep every 240 days for thousands of years. These are the only choices available.

Having reviewed the agreement and supporting technical data we are of the opinion that it does not seriously consider either of these options and as such should <u>not</u> be ratified.

Respectfully submitted,

GARTNER LEE ASSOCIATES LIMITED

John f Gardner

for E. Grant Anderson, P.Eng.
Consulting Hydrogeologist.
Principal.

EGA:jcm