LINCOLN
APPLIED GEOLOGY, INC.

January 6, 1989

Ms. Patricia Poundstone
Waste Managemnt Division
Department of Environmental Conservation
103 South Main Street
Waterbury, Vt. 05676

Re: LeBlanc's Citgo - St. Albans, Vt.

Dear Pat:

This letter report is written to summarize the findings and conclusions of the hydrogeologic investigation performed by Lincoln Applied Geology, Inc. (LAG) at the above referenced site.

Introduction

In early August 1988, the Champlain Oil Company (COC) discovered a leak in the delivery lines at the LeBlanc's Citgo Station located on the south side of the Route 7-Lakeview Terrace intersection in St. Albans (shown on Figure 1). The leak was reported to the Vermont Department of Environmental Conservation (VDEC) immediately. In response, the VDEC issued a 1283 letter to COC requesting that a subsurface investigation be conducted at LeBlanc's Citgo. The investigation was requested so that a clear definition of the extent and degree of petroleum contamination associated with the underground gasoline storage tank (UST) area could be made. COC initiated the investigation by installing five four-inch monitoring wells. The location of these wells are shown on the detailed site map labeled Figure 2. The wells were installed, under the supervision of the VDEC on August 24 and 29, 1988 utilizing a 4-inch solid stem auger. Each well was drilled to the depth at which auger refusal occurred. Refusal appeared to be due to encountering bedrock. After drilling was completed a section of 4-inch 10 slot PVC well screen was installed. Specific details regarding the amounts of screen and riser pipe in each well are unknown due to the absence of formal well logs. None of the 4-inch wells were sand packed or developed after installation. Each well was finished at grade with an 8-inch accessway and cement collar.

Within several days of installation several of the wells contained measurable amounts of free product floating on the ground water within them. At this time, COC began manual recovery of the free product on a weekly basis. These facts prompted the VDEC to issue another 1283 letter on September 6, 1988 specifying that a more detailed hydrogeologic investigation of the site be performed on behalf of COC by a qualified ground water consultant. In response to this letter, COC contracted LAG to perform the necessary work. This more detailed investigation was initiated by LAG on September 16, 1988.

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Geologist - Hydrogeologist

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Scope of Investigation

The scope of the hydrogeologic investigation initiated by LAG included:

1. the review of regional geologic information,
2. the installation and development of additional monitoring wells,
3. the collection of ground water and product elevation data, along with HNU photoionization data, from all monitoring wells on-site,
4. the compilation of ground water elevation maps indicating ground water flow directions and gradients,
5. the informal interviews with personnel on-site and,
6. the compilation and review of all data collected to determine the need for implementation of additional remedial techniques.

Methods of Investigation

Three additional monitoring wells were installed on October 17, 1988, and October 20, 1988. These wells are labeled MW-6, 7 and 8 and their locations are shown on Figure 2. The drilling techniques for well installation consisted of drilling with a 4-inch hollow stem auger to penetrate through the blacktop and its fill type sub-base to a depth ranging between 2 and 3 feet. The hollow stem auger was removed and a four-inch flush coupled casing was then driven to 5 feet in depth for monitoring wells 6 and 8, and 2 feet for MW-7. A 4-inch tricone bit was then used to drill through the remainder of the fill and into the top of bedrock. Monitoring wells were installed at least 2 feet into the water table. The wells are constructed of 2-inch PVC riser pipe, and 2-inch 10 slot PVC well screen. A silica sand packing material was then placed in the annular space between the well screen and the bore hole walls. The packing is continuous from the bottom of the bore hole to at least 1 foot above the top of the screen. A 1 foot bentonite seal and concrete accessway were then installed around the wells which were terminated flush to grade. The lithology and well construction details for each well are shown as Figures 3a through 3c. Following installation, all wells were flushed and further developed with a peristaltic pump. At least 10 well volumes of ground water were pumped from each of the wells using the peristaltic pump.

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Methods of Investigation cont.

Measurements of ground water and product depths in the monitoring wells were collected by utilizing either an interface probe or an electric tape and clean bailer.

A survey of the site was performed to determine locations and elevations of the eight monitoring wells, this data was used in conjunction with the depth to ground water measurements to accurately determine ground water and product elevations. This data was additionally used to compile the detailed site map and ground water contour maps presented with this report.

Results of Investigation

Although no site specific references are available, regional scale surficial and subsurface information was available in the form of both a bedrock and surficial geology map (Doll & others 1961; Doll & others 1970). The surficial geology of the site area has been described as a glacial till and glacio-lacustrine deposits mantling bedrock. The surficial deposits found on-site are fill and glacial till mantling bedrock.

The bedrock geology of the study area is characterized by two units of the regional St. Albans Synclenorium. The two geologic units described in the immediate area are: slates with interfingerings of limestone of the Ordovician Morse's Line formation, and the black carbonaceous slate of the Cambrian Sweetsburg formation.

The bedrock encountered at the site during drilling activities was a calcareous, quartz and calcite rich, dark gray to black slate, thought to be part of the Morse's Line formation.

Three basic geologic units were encountered during drilling at the St. Albans site. The units are described as follows:

Unit 1: Dark black to brown sand and gravel fill, concrete, brick, cobbles, and debris. MW-3 had a slight gasoline odor. Entirely non-native material.

Unit 2: Light brown to gray glacial till, highly compact, some gravel ranging in size from 2-10 mm., very poorly sorted, chaotic depositional regime, no soil structure.

Unit 3: Dark gray slate, calcareous with both quartz and calcite veins, microcrystalline slate with interfingerings of limestone, abundant multi-colored quartz and calcite fragments present.

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Results of Investigation cont.

The well logs of MW-6, 7, and 8 indicate that the underlying geology is not uniform across the site. At MW-6, 2 feet of fill overlying bedrock was observed. MW-7 revealed 3.5 feet of fill overlying 6.5 feet of unsaturated native till material. Bedrock was reached at a depth of 11.5 feet. MW-8 revealed 3 feet of fill (with a slight gas odor) overlying bedrock. Further details of well lithology are shown on Figures 3a through 3c.

HNU photoionization detector and olfactory screening of soils during drilling of MW-6, MW-7, and MW-8 indicated that only soils associated with MW-8 were contaminated with gasoline.

A site survey was conducted on November 2, 1988 and December 5, 1988 to obtain top of casing elevations for the eight monitoring wells. A detailed location map was constructed from this survey. During the study period several well surveys were conducted to obtain ground water levels, and detect the presence of product on the water table. Utilizing the data obtained in the surveys, ground water and liquid level contour maps were constructed. HNU data from the head space of each well was also collected during the December 21, 1988 site visit. This data reveals the significant presence of gasoline vapors in all wells except MW-6, and 7. All ground water, product thickness, and HNU data collected to date by LAG are included as Table 1.

The ground water and overall liquid level contour maps for December 5, 1988 and December 21, 1988 are enclosed as Figures 4a and 4b; and 5a and 5b. The December 5, 1988 maps show a ground water ridge running parallel to MW-2, 4, and 5. It is worth noting that the only wells containing free product are those north of this ridge. The maps generated from the December 21, 1988 data show a more distinct ridge on the south side of the tank area. This data also confirms the presence of product only on the north side of the ridge. Ground water flowing through the site will generally flow in two directions. On the north side of the ridge ground water will flow towards the northwest. On the south side of the ridge ground water will flow to the south-southwest. The majority of the ground water flowing through the site will flow in the two directions described, however, a small amount of ground water will flow due east along the ridge line.

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Results of Investigations cont.

Manual recovery of free product has been performed on a weekly to bi-weekly basis by COC since July 21, 1988. Product thickness is measured utilizing a tank stick and indicator paste, and the amount of product recovered is estimated by COC personnel. Table 2 shows all recovery records to date. The data presented in Table 2 represents product recovery from all the wells which have shown product on the ground water during the study period. A review of the data confirms the fact that free product exists in wells on the north side of the tank area only. The data also shows a steady decrease of product thickness in MW-1, and MW-3. The exception to this trend occurs from the last week of November through the first week of December. At this time, product thickness increased slightly. Since December 7, 1988 product thicknesses in MW-1 and 3 have decreased. Please note that in early December measurable amounts of free product became evident on MW-8, located directly downgradient of the tank area. The thickness of product on the ground water of this well fluctuates between a trace (i.e. 1/16") to .08 feet as shown by the COC recovery records and LAG's monitoring records. The appearance of product in MW-8 indicates that small amounts of product are migrating away from the tank area. The current estimated extent of the free product plume is shown on Figure 6.

Using the December 5, 1988, and December 21, 1988 data, an average ground water gradient through the tank area of 0.025 feet per foot can be calculated. When combined with an estimated porosity of 30%, an estimated permeability range of 1 to 10 feet/day, and a travel distance of 50 feet, the time for ground water to travel from the edge of the tank area to Route 7 can be estimated to range from 62.4 to 624 days. The lower half of this range matches the history of the spill and could be used to estimate the rate of migration of an uncontrolled spill.

LAG personnel conducted several informal interviews with COC and LeBlanc employees. These discussions revealed the fact that the UST's are located in an old cellar hole. The old cellar walls appear to be containing the majority of the free product seen on-site. This is illustrated by the fact that the monitoring wells associated with the UST area (i.e. MW-1, and 3) have contained the largest amounts of product. Unfortunately, small amounts of product are being measured outside the UST area in MW-8. This fact indicates that the cellar walls are not totally containing the free product.

Further interviews and a walking survey by LAG revealed that no private water supplies or structures with basements exist directly downgradient of the site. The survey also revealed the existence of sanitary and storm sewer lines adjacent to the site in Route 7.

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Conclusions

After compiling and reviewing the data gathered to date, the following conclusions are set forth:

1. leaking delivery lines at LeBlanc's Citgo caused a spill of gasoline which resulted free in product floating on the ground water in the monitoring wells adjacent to the UST area,

2. the UST's are located within an old cellar foundation which acts as a moderately effective containment area for the product,

3. the unconsolidated material encountered beneath the site consists of fill. The fill directly overlies dark gray to black slate. In the area of MW-7 several feet of till lies between the fill and the bedrock, and represents the only area where till was encountered on site,

4. a ground water ridge exists on the southern side of the UST area. This may be due in part to the old cellar walls deflecting the flow of ground water to the south,

5. ground water flows south, southwest, and northwest beneath the site,

6. ground water flows to the northwest from the UST area towards Route 7,

7. free product is found only in the monitoring wells on the northwest side of the ground water ridge,

8. continuing manual recovery has collected approximately 40 gallons of free product and is containing the majority of free product on-site, within the UST area, and

9. dissolved petroleum migrating off-site could encounter the St. Albans storm and sanitary sewer lines, and cause mild petroleum odors in these systems. No other receptors currently exist downgradient of the site.

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Recommendations

In light of the conclusions set forth above, the following recommendations are made:

1. Manual recovery of product from all wells containing free product should be continued on at least a weekly basis by COC. A detailed account of product thickness in each well and total amount recovered each visit must be maintained. This data will better enable LAG to determine the effectiveness of recovery.

2. Monthly ground water and product thickness measurements should be taken by LAG to determine flow directions and flow rates through the site. This data will also assist in determining the effectiveness of recovery.

3. Quarterly reports should be compiled by LAG and submitted to the VDEC and COC which will include: ground water and overall liquid contour maps for all ground water data collected during the quarter, total amounts of product recovered to date, and any recommendations regarding the need for additional investigatory work or modifications to the current recovery techniques, and

4. Once product has been absent from all monitoring wells on-site for at least two months ground water measurements will occur quarterly for one year as per VDEC protocols.

Please remember that if product thickness increases significantly, a more sophisticated full time recovery mechanism will need to be placed on-site to insure that migration of free product off-site does not occur. Product thickness in monitoring well 8 will be the critical factor in determining the need for active recovery techniques, such as pumping ground water to form a depression, or collection point for product in the area. If the thickness of the free product in MW-8 exceeds 1.5-inches (.13') an active recovery system must be installed to keep free product from moving off-site. Unfortunately a large diameter shallow dug recovery well is not recommended at this site. Due to the presence of shallow bedrock, this type of well would only penetrate a maximum of one foot into the water table. Therefore, an affective depression of the ground water in the area will not be created. The active recovery method recommended for this site consists of installing a 12-inch drilled recovery well between MW-3 and 8. Due to the presence of bedrock the well would be installed utilizing an air rotary drill with a 12-inch bit. The well would be a total of 20 feet in

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depth. A double pump system would be installed in the well to depress ground water and recover product simultaneously. Before any major modifications to the current recovery scheme are made, the VDEC will be appraised of the situation by LAG and COC.

If you have any questions regarding the above matter, please do not hesitate to give me a call at 453-4384.

Sincerely,

Steven J. LaRosa
Hydrogeologist

SJL: DA
enclosures
cc: Mr. Tony Cairns, Champlain Oil Company

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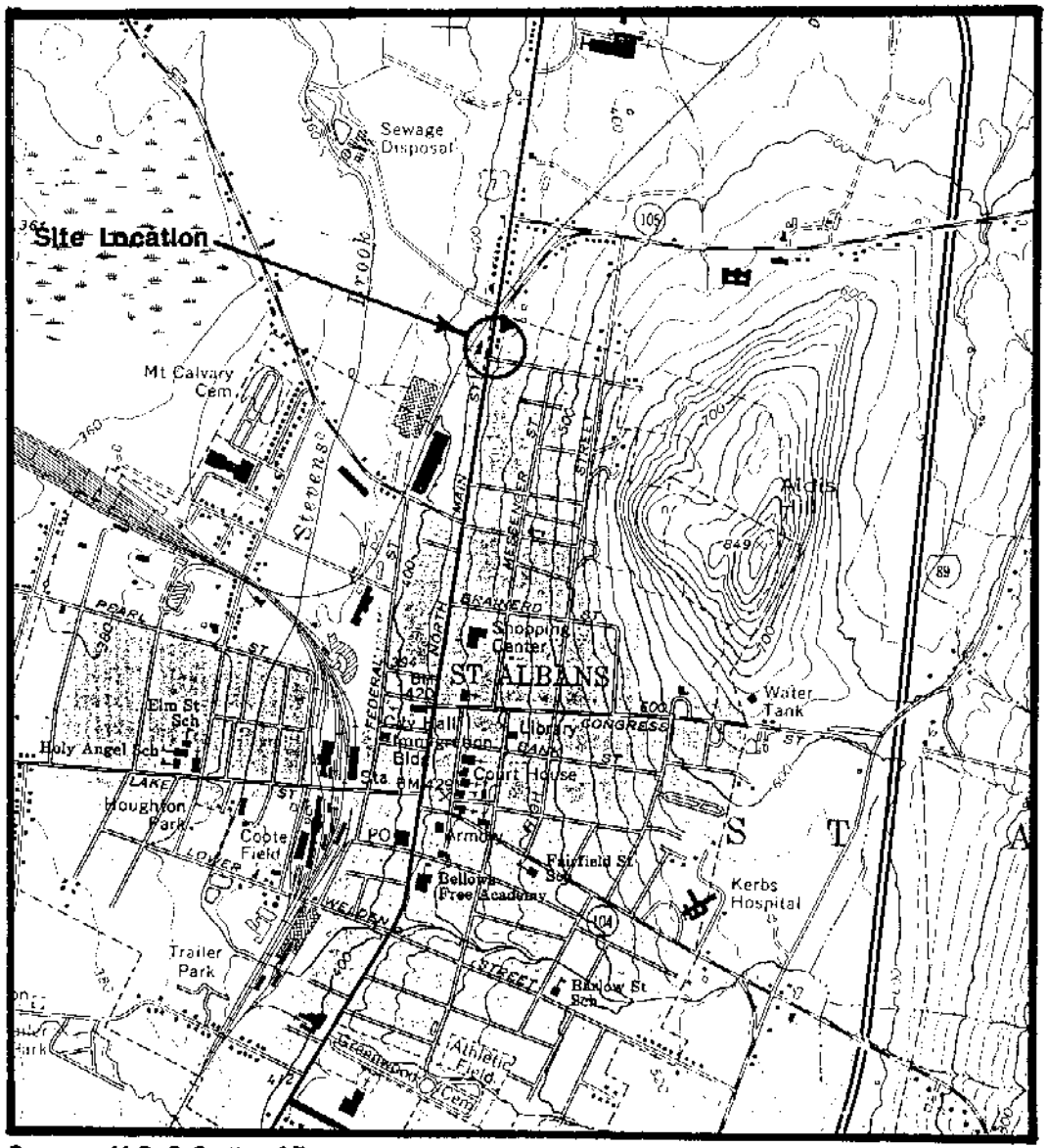
General Location Map



Source: U.S.G.S. 7.5 Minute Series
St. Albans Quad.

Scale: 1:24,000

Figure 1

LeBlanc's Citgo

Approx. True North

MW-6

MW-1

MW-2

Underground Storage Tank Area

Pump Island

MW-3

MW-4

MW-8

MW-5

Route 7

MW-7

LEGEND:

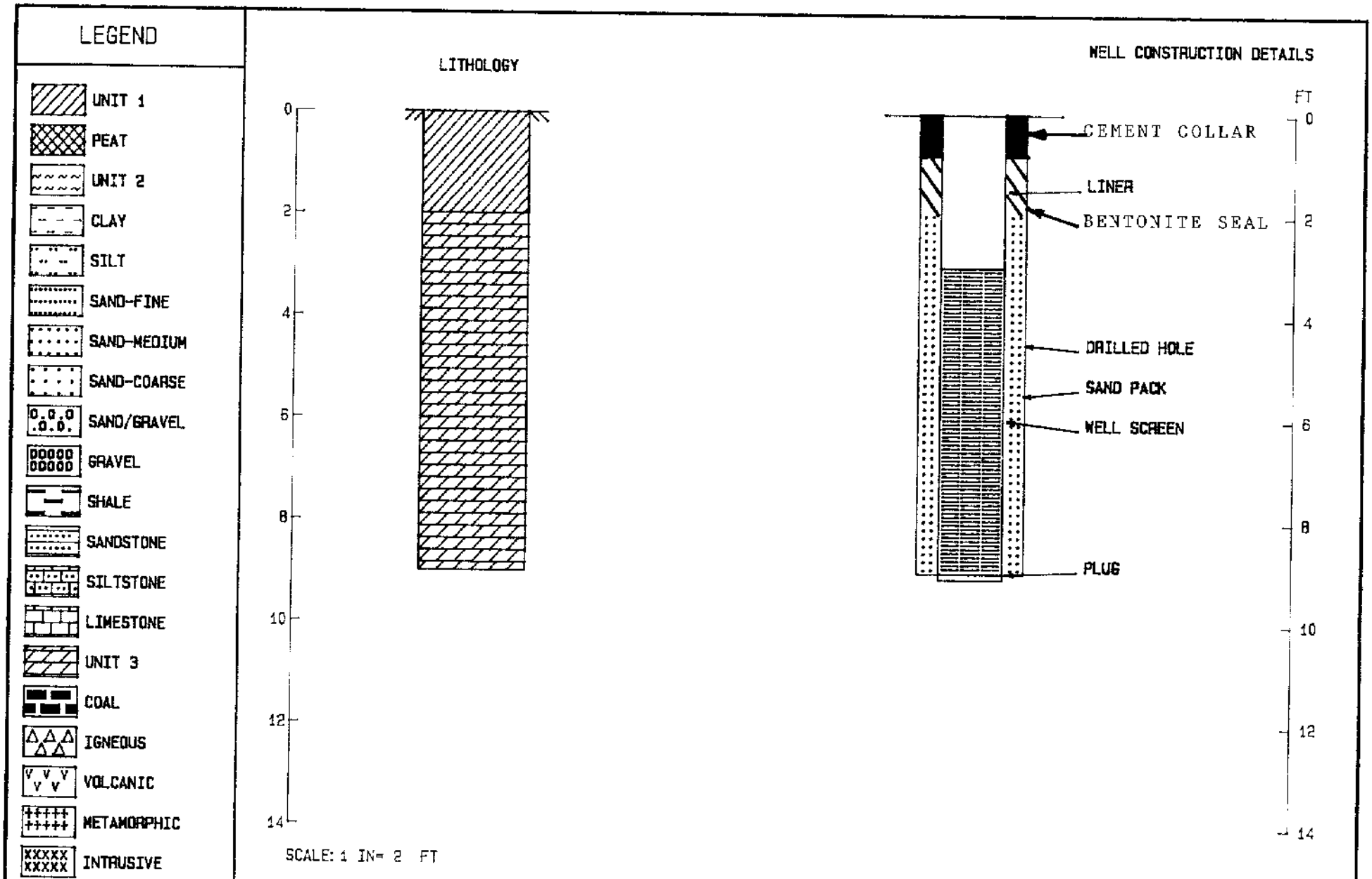
MW-2 4" Monitoring Well

MW-3 2" Monitoring Well

Sewer Accessway

Figure 2

CHAMPLAIN OIL CO.- ST. ALBANS	
Scale: 1"=10'	Drawn by: B. Canavan
Detailed Site Map	
Date: 12/88	Problem: Petroleum Leakage onto the Groundwater



PROJECT: ST. ALBANS
FILE: LAG/12/88
LOCATION: ST. ALBANS

MONITORING WELL #6

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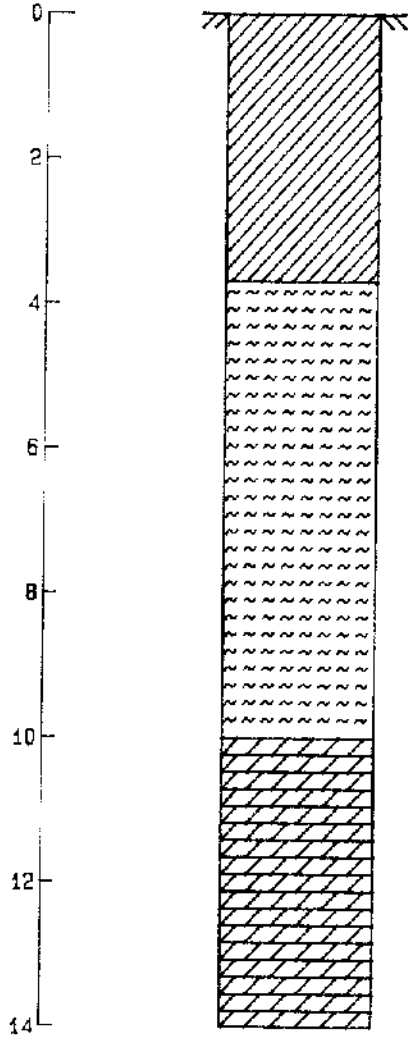
FIGURE: 3a

LEGEND

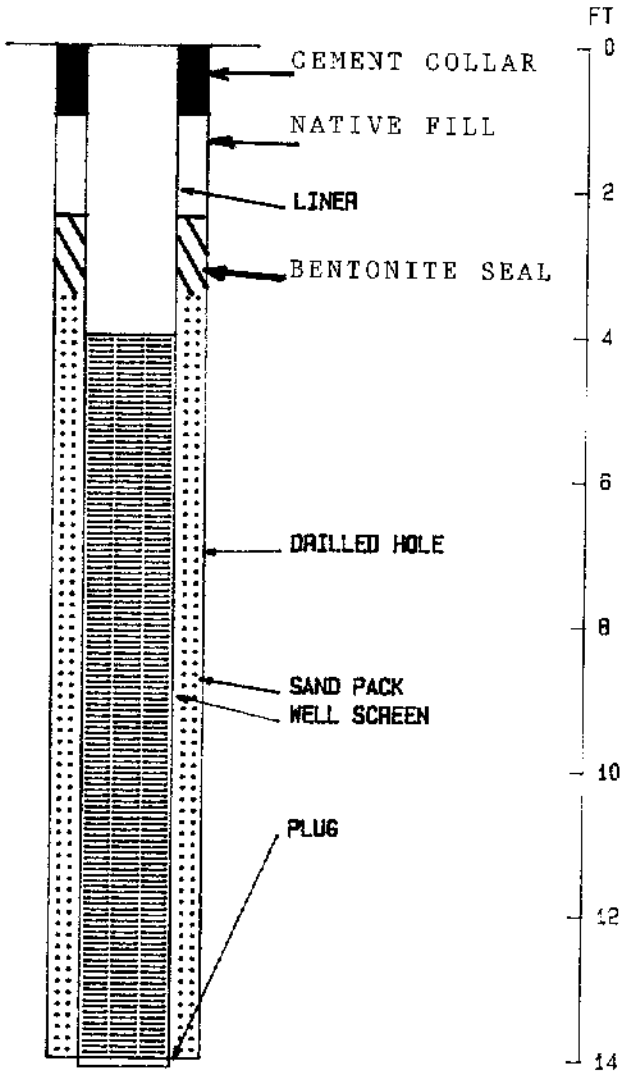
- UNIT 1
- PEAT
- UNIT 2
- CLAY
- SILT
- SAND-FINE
- SAND-MEDIUM
- SAND-COARSE
- SAND/GRAVEL
- GRAVEL
- SHALE
- SANDSTONE
- SILTSTONE
- LIMESTONE
- UNIT 3
- COAL
- IGNEOUS
- VOLCANIC
- METAMORPHIC
- INTRUSIVE

LITHOLOGY



SCALE: 1 IN= 2 FT

WELL CONSTRUCTION DETAILS

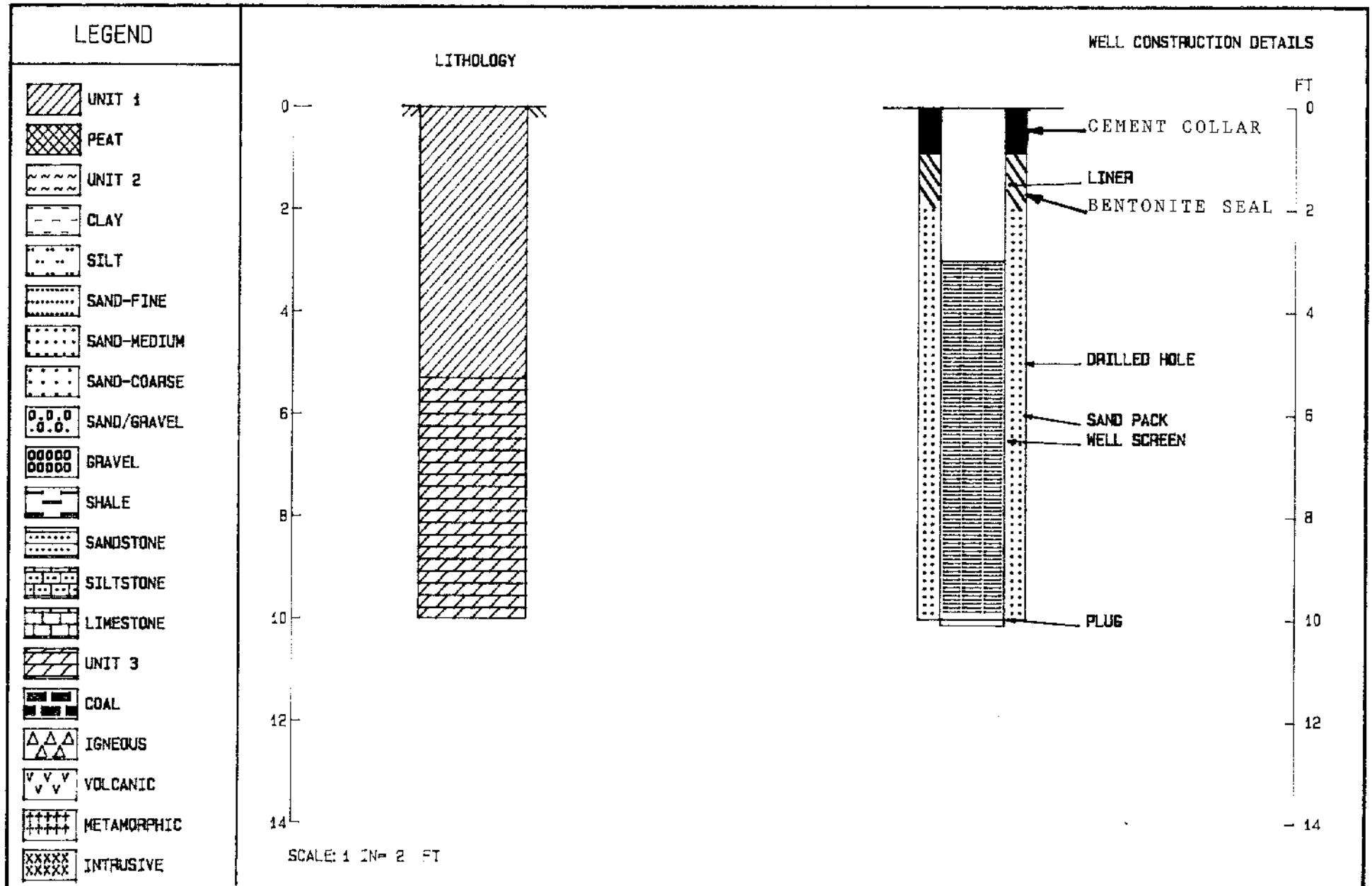


PROJECT: CDC-ST. ALBANS
FILE: LAG/12/88
LOCATION: ST. ALBANS

MONITORING WELL #7

LINCOLN APPLIED GEOLOGY

FIGURE: 3b



PROJECT: COC-ST. ALBANS
FILE: LAG/12/88
LOCATION: ST. ALBANS

MONITORING WELL #8

LINCOLN APPLIED GEOLOGY

FIGURE: 3c

PROJECT Le[illegible] ...ite

LOCATION St. Albans

JOB NO. G ..../88

SHEET 1 OF 1

LINCOLN APPLIED GEOLOGY, INC.

DATA POINT	REFERENCE ELEVATION	GROUND WATER ELEVATIONS						
		DATE	9/16/88	11/2/88	11/10/88	12/5/88	12/21/88	1/11/89
MW-1	100.00		**0.23'** 95.15	95.14	95.46	**0.33'** 95.07	185 **0.03'** 94.89	94.80
MW-2	100.13		95.05	95.21	95.32	95.20	50 95.09	95.04
MW-3	99.31		**0.25'** 94.94	96.21	94.81	**0.33'** 94.47	125 **0.19'** 94.11	94.31
MW-4	99.60		94.90	94.75	95.14	**0.01'** 95.10	100 94.69	94.58
MW-5	98.57		93.50	*	*	94.82	170 94.67	(2) 94.35
MW-6	99.87			95.71	96.10	96.06	5.5 95.28	95.23
MW-7	99.36			92.96	93.96	94.62	2.0 92.76	92.35
MW-8	99.15			93.40	94.23	**0.07'** 94.25	150 **0.08'** 93.32	**0.02'** 92.45

Notes:
1) Elevations are those to top of liquid. No product thickness was measured on this date.
2) No liquid in well.
* Well filled with surface water.

0.19' Product thickness
100 HNU reading (ppm)

Table

LeBlanc's Citgo

Approx. True North

MW-6

96.0

95.5

MW-1

95.0

MW-2

Underground Storage Tank Area

Pump Island

MW-3

94.5

MW-4

MW-8

MW-5

Route 7

MW-7

LEGEND:

- MW-2 4" Monitoring Well
- MW-3 2" Monitoring Well
- Sewer Accessway
- 96.0 Ground Water Contour Line
- Flow Direction

Figure 4a

CHAMPLAIN OIL CO.- ST. ALBANS	
Scale: 1"=10'	Drawn by: B. Canavan
Ground Water Contour Map 12/5/88	
Date: 12/88	Problem: Petroleum Leakage onto the Groundwater

LeBlanc's Citgo

Approx. True North

MW-6 96.6

95.5

MW-1 0.33'

MW-2

Underground Storage Tank Area

Pump Island

MW-3 0.33'

MW-4 0.01'

MW-8 0.07'

94.5

95.0

MW-5

Route 7

MW-7

LEGEND:

- MW-2 — 4" Monitoring Well
- MW-3 — 2" Monitoring Well
- Sewer Accessway
- 95.6 — Liquid Level Contour Line
- .10 — Product Thickness
- Flow Direction

Figure 4b

CHAMPLAIN OIL CO.- ST. ALBANS

Scale: 1"=10'	Drawn by: B. Canavan

Liquid Level Contour Map
12/5/88

Date: 12/88	Problem: Petroleum Leakage onto the Groundwater

LeBlanc's Citgo

Approx. True North

MW-6

MW-1

95.0

MW-2

Underground Storage Tank Area

Pump Island

MW-3

MW-4

93.5

MW-8

94.5

MW-5

94.0

93.5

93.0

MW-7

Route 7

LEGEND:

- MW-2 4" Monitoring Well
- MW-3 2" Monitoring Well
- Sewer Accessway
- 93.5 Ground Water Contour Line
- Flow Direction

Figure 5a

CHAMPLAIN OIL CO.- ST. ALBANS	
Scale: 1"=10'	Drawn by: B. Canavan
Ground Water Contour Map 12/21/88	
Date: 12/88	Problem: Petroleum Leakage onto the Groundwater

LeBlanc's Citgo

Approx. True North

MW-6
0.02'

MW-1
0.03'

95.0

MW-2

Underground Storage Tank Area

Pump Island

MW-3
0.19'

MW-4

MW-8
0.06'

93.5

94.0

94.0

MW-5

94.5

93.5

93.0

MW-7

Route 7

LEGEND:

- MW-2 — 4" Monitoring Well
- MW-3 — 2" Monitoring Well
- Sewer Accessway
- 93.5 — Liquid Level Contour Line
- .10 — Product Thickness
- Flow Direction

Figure 5b

CHAMPLAIN OIL CO.- ST. ALBANS	
Scale: 1"=10'	Drawn by: B. Canavan
Liquid Level Contour Map 12/21/88	
Date: 12/88	Problem: Petroleum Leakage onto the Groundwater

CHAMPLAIN OIL COMPANY-ST.ALBANS
PRODUCT RECOVERY DATA

WELL	DATE	7/21/88	8/5/88	8/9/88	8/16/88	8/23/88	9/9/88	9/23/88	10/6/88	10/19/88	10/28/88	11/9/88	11/29/88	12/7/88	12/16/88	12/30/88
MW-1	PRODUCT THICKNESS (FT)	-	-	-	0.92	1.17	1.25	0.21	0.17	0.08	0.00	0.33	0.42	0.50	0.25	0.25
	GALLONS RECOVERED	-	-	-	1.50	0.50	1.50	-	0.50	0.25	-	-	1.00	2.00	2.00	2.00
MW-2	PRODUCT THICKNESS (FT)	-	-	-	0.08	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GALLONS RECOVERED	-	-	-	-	0.50	-	-	-	-	-	-	-	-	-	-
MW-3	PRODUCT THICKNESS (FT)	-	-	-	0.50	0.00	0.83	0.71	0.25	0.33	0.08	0.25	0.50	0.42	0.42	0.17
	GALLONS RECOVERED	-	-	-	0.00	-	1.00	-	0.50	0.50	0.25	-	1.00	2.00	2.00	0.50
MW-4	PRODUCT THICKNESS (FT)	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	TRACE	0.00	0.00	0.00	0.00
	GALLONS RECOVERED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-5	PRODUCT THICKNESS (FT)	-	-	-	-	-	-	0.33	0.02	0.00	TRACE	0.08	0.00	0.00	0.00	0.00
	GALLONS RECOVERED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-8	PRODUCT THICKNESS (FT)	-	-	-	-	-	-	-	-	-	0.00	0.00	0.02	0.00	0.00	TRACE
	GALLONS RECOVERED	-	-	-	-	-	-	-	-	-	-	0.00	TRACE	-	-	-
	TOTAL GALLONS RECOVERED	3.00	3.00	2.50	2.00	1.00	2.50	3.50	1.00	0.75	0.25	4.50	2.50	4.00	3.50	2.50

Table 2

LeBlanc's Citgo

Approx. True North

MW-6

Approx. Limit of Free Product Plume

MW-1

MW-2

Underground Storage Tank Area

Pump Island

MW-3

MW-4

MW-8

MW-5

Route 7

MW-7

LEGEND:

MW-2 4" Monitoring Well

MW-3 2" Monitoring Well

Sewer Accessway

Figure 6

CHAMPLAIN OIL CO.- ST. ALBANS	
Scale: 1"=10'	Drawn by: B. Canavan
Free Product Plume Map	
Date: 12/88	Problem: Petroleum Leakage onto the Groundwater