APPENDIX F
SOIL AND GROUNDWATER CONDITIONS

Golder Associates Ltd.

243-1889 Springfield Road
Kelowna, B.C., Canada V1Y 5V5
Telephone (604) 860-8424
Fax (604) 860-9874

REPORT TO
REID CROWTHER & PARTNERS LTD.

ON

WESTSIDE LANDFILL SUMMARY OF PRELIMINARY INVESTIGATION

WESTBANK, BRITISH COLUMBIA

DISTRIBUTION:

1 Copy	-	Reid Crowther & Partners Ltd. Kelowna, B.C.
1 Copy	-	Golder Associates Ltd. Kelowna, B.C.

February 16, 1993 922-4210

Golder Associates Ltd.

243-1889 Springfield Road
Kelowna, BC, Canada V1Y 5V5
Telephone (604) 860-8424
Fax (604) 860-9874

Golder Associates

January 28, 1993

Our Ref: 922-4210

Reid Crowther & Partners Ltd.
#203 - 1664 Richter Street
Kelowna, B.C.
V1Y 8N3

Attention: Mr. Ray Bilevicius

RE: WESTSIDE LANDFILL
SUMMARY OF FACTUAL RESULTS
WESTBANK, BRITISH COLUMBIA

Dear Sir:

This letter presents a summary of the soil conditions encountered at the above noted site during our general field reconnaissance and field investigation program. The factual results are based on our visual observations together with the test pit and seismic survey results. In addition, we have calculated the volume of potential cover material available at the landfill site. These calculations are based on available field survey.

1.0 TEST PIT AND SEISMIC SURVEY RESULTS

A total of five seismic refraction surveys were carried out on November 10, 1992 using a two channel signal enhancement seismograph. The seismic lines were generally carried out outside of the active landfill area along the east property line as shown on Figure 1. Table 1 summarizes the inferred soil and bedrock conditions encountered at each seismic survey location. In summary, the results of the seismic survey indicates relatively thin granular soil cover overlying bedrock at a depth varying between 1.5 and 1.8 m at SL 1 and SL 4, inclusively. At SL 5, the bedrock surface was inferred at a depth of about 13 m.

.... /2

A total of eight test pits were excavated on November 16, 1992 using a rubber tired backhoe at the locations shown on Figure 1. The various soil conditions encountered at each test pit location is summarized on the attached Record of Test Pit sheets. Based on the results of the test pits excavated along the east property line, bedrock was encountered at depths varying between 0.9 and 2.0 m. Bedrock was not encountered at the test pit locations along the south and west portions of the active landfill where TP 1, TP 2 and TP 8 were terminated within native cobbly sand and gravel at depths of about 3.2 m.

At the time of the test pit investigation, no groundwater seepage was observed within any of the test pits.

Available water well records from the Provincial Water Management Branch for the domestic water well located near the northwest corner of the landfill indicates bedrock at a depth of about 9 m with the overlying soils consisting of about 4 m of surficial sand and gravel followed by silty sand and gravel. It is understood that the well was drilled in July, 1986 and extended to a depth of about 55 m. However, no groundwater data has been obtained to date.

Based on these results to date, we have outlined the approximate site area occupied by exposed and/or shallow bedrock as shown on Figure 1.

2.0 COVER MATERIAL CALCULATIONS

It is understood that under existing landfill procedures, approximately 12,000 m^3/year of cover material is required per refuse lift. Based on our field results, preliminary calculations indicate that approximately 150,000 m^3 of granular landfill cover may exist within the present landfill site.

Our calculations indicate that about 50,000 m^3 of cover material is available along the west property line between Asquith Road and the existing landfill treeline with the remaining

.... /3

100,000 m^3 located south of the active landfill area and extending to the south property line. These volume calculations are based on available topographical information and using the following assumptions:

- 1.5 (h) to 1 (v) slope cut from the west property line along Asquith Road extending east to a proposed base elevation of about 533 m near TP 8 ranging to an elevation of about 537 m at a distance of about 200 m north of TP 8.

- 2 (h) to 1 (v) slope cut along the south treeline and/or south landfill toe extending to the south property line at a base elevation ranging between the existing ground surface elevations at the south property line together with a 1.5 (h) to 1 (v) cut face along Asquith Road.

It should be noted that these volumes are rough estimates based only on available topographical information and that a detailed field survey be carried out within the proposed borrow areas to further define the potential volumes.

We trust the foregoing provides the information you require at this time. Should you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.

B. Carlsen, P. Eng.

RT/BC/pc
Encl.

RECORD OF TEST PITS

24 November 1992 922-4210

TEST PIT NO.	DEPTH (m)	SOIL DESCRIPTION
TP 1	0.0 - 0.3	Loose brown sandy **SILT** with some gravel and occasional cobbles.
	0.3 - 3.2	Compact brown silty **SAND** and **GRAVEL** with some cobbles and occasional boulders grading to a dense gravelly silty **SAND** with occasional cobbles. Some oxidized staining noted throughout.
		No groundwater seepage observed at the time of excavation.
TP 2	0.0 - 0.2	Loose brown sandy **SILT** with a trace of gravel and root fibres throughout.
	0.2 - 3.4	Compact to dense light brown silty **SAND** with some gravel grading to a compact cobbly **SAND** and **GRAVEL** with occasional boulders at depth.
		Further excavation restricted by a large boulder at 3.4m. Increase in moisture content noted at 3.1m with no groundwater seepage observed during the time of excavation.
TP 3	0.0 - 0.4	Loose brown sandy **SILT**.
	0.4 - 0.6	Loose brown **SAND** with some cobbles.
	0.6 - 0.9	Compact brown cobbly **SAND** and **GRAVEL**.
	@0.9	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 4	0.0 - 0.2	Compact brown cobbly **SAND** and **GRAVEL**. **(ROADFILL)**
	0.2 - 2.0	Loose **WOOD CHIPS** and miscellaneous **MUNICIPAL DEBRIS**. (FILL)
	@2.0	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.

RECORD OF TEST PITS

24 November 1992 922-4210

TEST PIT NO.	DEPTH (m)	SOIL DESCRIPTION
TP 5	0.0 - 1.8	Compact brown cobbly **SAND** and **GRAVEL** with occasional boulders.
	@1.8	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 6	0.0 - 0.2	Loose dark brown **SILT**. **(TOPSOIL)**
	0.2 - 2.0	Compact brown cobbly **SAND** and **GRAVEL** with a trace of silt and occasional boulders.
	@2.0	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 7	0.0 - 0.2	Loose brown **SILT**. **(TOPSOIL)**
	0.2 - 1.6	Compact brown cobbly **SAND** and **GRAVEL** with a trace of silt.
	@1.6	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 8	0.0 - 3.2	Loose to compact brown cobbly **SAND** and **GRAVEL** with occasional boulders.
		No groundwater seepage observed at the time of excavation.

TABLE 1

SUMMARY OF SEISMIC SURVEY RESULTS

November 12/92

922-4210

Seismic Survey Line No.	Average Depth (m)	Average Velocity (m/sec)	Inferred Soil and Bedrock Conditions
SL 1	0.0 - 1.5 @ 1.5	322 1405	Loose SAND. **BEDROCK**
SL 2	0.0 - 1.8 @ 1.8	238 2134	Loose SAND. **BEDROCK**
SL 3	0.0 - 1.7 @ 1.7	317 2903	Loose SAND. **BEDROCK**
SL 4	0.0 - 1.8 @ 1.8	270 2315	Loose SAND. **BEDROCK**
SL 5	0.0 - >13	312	Loose SAND.

Golder Associates Ltd.

243-1889 Springfield Road
Kelowna, B.C., Canada V1Y 5V5
Telephone (604) 860-8424
Fax (604) 860-9874

February 15, 1993 Our Ref: 922-4210

Reid Crowther & Partners Ltd.
#203 - 1664 Richter Street
Kelowna, British Columbia
V1Y 8N3

Attention: Mr. Ray Bilevicius, P.Eng.

RE: WESTSIDE LANDFILL
SUMMARY OF PRELIMINARY INVESTIGATION
WESTBANK, BRITISH COLUMBIA

Dear Sir:

This letter presents the results of the preliminary investigation of the soil and groundwater conditions encountered at the borehole locations shown on Figure 1 and 2. This letter may be considered as an addendum to our letter dated January 28, 1993 summarizing the factual results of our field investigation.

1.0 SUBSURFACE CONDITIONS

The field work was carried out on February 9 and 10, 1993 during which time a total of three boreholes were advanced using a truck mounted air rotary drill rig at the locations shown on Figure 2. Borehole BH1 and BH2 were located downslope of the existing landfill and within existing gully areas. Borehole BH3 was located between the Westbank Kinsmen Recreational Park and the existing Shannon Lake Mobile Home Park west of Shannon Lake Road. It is understood that the present Recreational Park site was previously occupied by a solid waste disposal facility which has since been reclaimed. The boreholes were drilled to depths varying between about 4.7 and 21.2 m at BH2 and BH3, respectively.

.... /2

TABLE 1

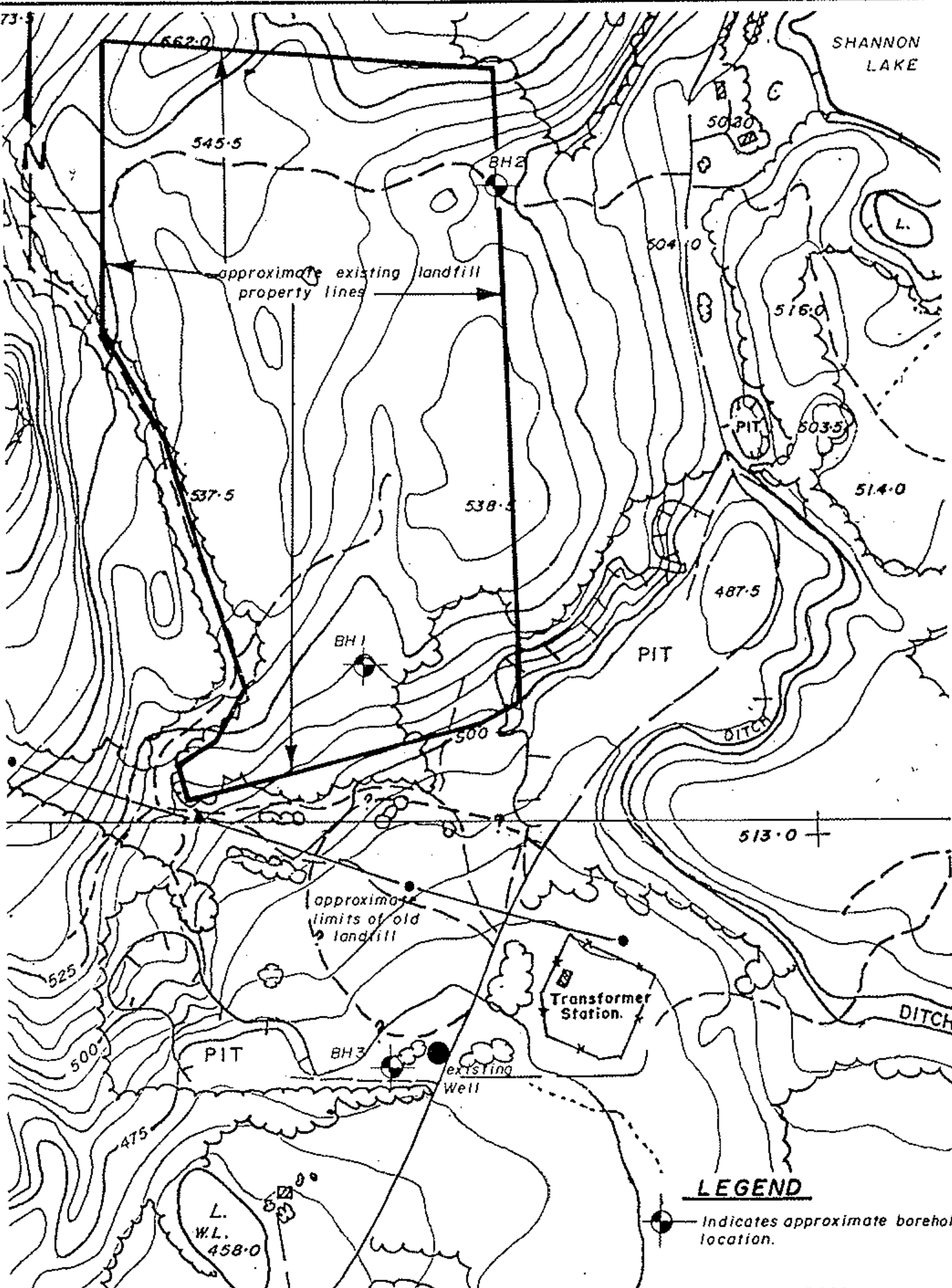
SUMMARY OF SEISMIC SURVEY RESULTS

November 12/92 922-4210

Seismic Survey Line No.	Average Depth (m)	Average Velocity (m/sec)	Inferred Soil and Bedrock Conditions
SL 1	0.0 - 1.5 @ 1.5	322 1405	Loose **SAND.** **BEDROCK**
SL 2	0.0 - 1.8 @ 1.8	238 2134	Loose **SAND.** **BEDROCK**
SL 3	0.0 - 1.7 @ 1.7	317 2903	Loose **SAND.** **BEDROCK**
SL 4	0.0 - 1.8 @ 1.8	270 2315	Loose **SAND.** **BEDROCK**
SL 5	0.0 - >13	312	Loose **SAND.**
SL 6	0.0 - 3.7 @ 3.7	300 2565	Loose to compact **SAND** and **GRAVEL.** **BEDROCK**

BOREHOLE LOCATION PLAN

Figure 2



Golder Associates

PROJECT No. 922-4210 DRAWN rr REVIEWED rt DATE Feb./93

At BH1, located south of the existing landfill site, the bedrock surface was encountered at a depth of about 3.7 m and the borehole was terminated at a depth of 5.7 m below the existing ground surface. The upper 0.45 m bedrock surface was easily drilled indicating soft and/or weathered conditions. The bedrock was overlain by 3.7 m of sandy gravel material with a varying silt content. Groundwater seepage was encountered along the bedrock surface at the time of drilling and found producing approximately 4 - 5 gpm within the 16.8 cm cased borehole. A strong odour was also noted within the groundwater. Upon completion, a 50 mm diameter PVC monitoring well was installed as detailed on the attached Record of Borehole sheet. The static groundwater level was measured at a depth of 2.46 m below the ground surface on February 12, 1993 with a strong odour evident within the monitoring well.

Borehole BH2 was drilled to a total depth of 4.65 m below the existing ground surface along the gully at the northeast corner of the landfill site. Soft bedrock was encountered at a depth of about 1.8 m and extended to a depth of 2.7 m where bedrock became more competent. The surficial material generally consisted of a cobbly sand and gravel with a trace of silt. Slight groundwater seepage was noted within the borehole at a depth of 2.7 m and produced minimal discharge flows of about 0.5 gpm within the 16.8 cm cased borehole. No noticeable odours were evident within the borehole at the time of drilling. A 50 mm diameter PVC monitoring well was installed as shown on the Record of Borehole log sheet. On February 12, 1993, the static groundwater level was measured at a depth of 2.42 m below the existing ground surface.

Borehole BH3 was drilled along a relatively flat area south of the old landfill site. The borehole was terminated within a dense glacial till deposit at a depth of 21.15 m. In summary, the soil conditions at the borehole generally consists of sequence of silty clay, silt, sand and gravelly sand grading to a sandy gravel overlying the glacial till deposit at a depth of 18.6 m. The glacial till deposit generally consists of a dense well graded silty gravelly sand material. A detailed description of the various soil conditions encountered are presented on the attached Record of Borehole sheet. At the time of drilling, groundwater seepage was limited within the lower sand and gravel deposits with no seepage detected in

.... /3

the cased borehole within the underlying dense glacial till deposit. A static water level was measured at a depth of 14.8 m below the existing ground surface on February 12, 1993. A typical monitoring well was installed as detailed on the attached summary log sheet. It should be noted that no detectable odour within the borehole was evident at the time of the field investigation.

An existing cased well was located east and north of BH3 near Shannon Lake Road along the east end of the lower fenced playing field. The well is founded at about the same elevation as BH3 with a measured static water level at a depth of 13.4 m. No other details of this well installation is known.

Based on the results of the borehole investigation, the existing groundwater seepage is generally flowing along the bedrock surface as no observed seepage was noted within the surficial granular deposit within the test pit locations near BH1 and BH2. It is expected that the seepage is originating from surface runoff percolating through the refuse within the upslope areas at the existing landfill site and directed along the south and east drainage gullies as shown on Figure 2. At BH3, the groundwater is located within the sand and gravel deposit overlying the dense glacial till deposit.

The results of the investigation will be used to determine the overall groundwater regime in the area and scope of work in Phase II including the chemical water analysis to provide our conclusions regarding the impact of the landfill operation in the future.

We trust the foregoing provides the information you require at this time. Should you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.

B. Carlsen, P. Eng.

RT/BC/pc
Encl.

RECORD OF TEST PITS

24 November 1992 | 922-4210

TEST PIT NO.	DEPTH (m)	SOIL DESCRIPTION
TP 1	0.0 - 0.3	Loose brown sandy **SILT** with some gravel and occasional cobbles.
	0.3 - 3.2	Compact brown silty **SAND** and **GRAVEL** with some cobbles and occasional boulders grading to a dense gravelly silty **SAND** with occasional cobbles. Some oxidized staining noted throughout.
		No groundwater seepage observed at the time of excavation.
TP 2	0.0 - 0.2	Loose brown sandy **SILT** with a trace of gravel and root fibres throughout.
	0.2 - 3.4	Compact to dense light brown silty **SAND** with some gravel grading to a compact cobbly **SAND** and **GRAVEL** with occasional boulders at depth.
		Further excavation restricted by a large boulder at 3.4m. Increase in moisture content noted at 3.1m with no groundwater seepage observed during the time of excavation.
TP 3	0.0 - 0.4	Loose brown sandy **SILT**.
	0.4 - 0.6	Loose brown **SAND** with some cobbles.
	0.6 - 0.9	Compact brown cobbly **SAND** and **GRAVEL**.
	@0.9	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 4	0.0 - 0.2	Compact brown cobbly **SAND** and **GRAVEL**. **(ROADFILL)**
	0.2 - 2.0	Loose **WOOD CHIPS** and miscellaneous **MUNICIPAL DEBRIS. (FILL)**
	@2.0	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.

RECORD OF TEST PITS

24 November 1992 922-4210

TEST PIT NO.	DEPTH (m)	SOIL DESCRIPTION
TP 5	0.0 - 1.8	Compact brown cobbly **SAND** and **GRAVEL** with occasional boulders.
	@1.8	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 6	0.0 - 0.2	Loose dark brown SILT. (TOPSOIL)
	0.2 - 2.0	Compact brown cobbly **SAND** and **GRAVEL** with a trace of silt and occasional boulders.
	@2.0	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 7	0.0 - 0.2	Loose brown SILT. (TOPSOIL)
	0.2 - 1.6	Compact brown cobbly **SAND** and **GRAVEL** with a trace of silt.
	@1.6	Refusal on **BEDROCK**.
		No groundwater seepage observed at the time of excavation.
TP 8.	0.0 - 3.2	Loose to compact brown cobbly **SAND** and **GRAVEL** with occasional boulders.
		No groundwater seepage observed at the time of excavation.

PROJECT: Landfill

RECORD OF BOREHOLE - BH 1

SHEET: 1 OF 1

PROJECT LOCATION: Westbank

BORING DATE: February 9/93

DATUM:

PROJECT NUMBER: 922-4210

BORING LOCATION: See Figure 1

BOREHOLE TYPE: 16.8cm Casing

Sampler Hammer: 63.5 kg., Drop 0.76m.

DEPTH SCALE (m)	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES NUMBER	TYPE	BLOWS / 0.15m.	N	OTHER TESTS	PENETRATION RESISTANCE BLOWS/0.3m / WATER CONTENT, PERCENT Wp —o W— Wl	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE		0.00							
0–2.74	Compact brown cobbly sandy GRAVEL with a trace of silt.			1	CS					Cuttings
				2	CS					Bentonite Seal
2.74–3.66	Compact brown SAND and GRAVEL with a trace of silt and occasional cobbles.		2.74	3	CS					▽ 0745hrs Feb. 10/93; Fraction Sand #2/12
3.66–4.11	Soft weathered BEDROCK.		3.66	4	CS					
4.11–5.73	Hard BEDROCK.		4.11							50 mm PVC .25mm Slots
5.73	END OF BOREHOLE Note: Strong odor noted within the monitoring well.		5.73							WL=2.46m Feb. 12/93

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Capri Drilling

DRILLER: R.R.

Golder Associates

LOGGED: R.T.

CHECKED: R.T.

DATE: Feb 9/93

PROJECT: Landfill

PROJECT LOCATION: Westbank

PROJECT NUMBER: 922-4210

Sampler Hammer: 63.5 kg., Drop 0.76m.

RECORD OF BOREHOLE - BH 2

BORING DATE: February 9/93

BORING LOCATION: See Figure 1

SHEET: 1 OF 1

DATUM:

BOREHOLE TYPE: 16.8cm Casing

DEPTH SCALE (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 0.15m.	N	OTHER TESTS	PENETRATION RESISTANCE BLOWS/0.3m; WATER CONTENT, PERCENT Wp W Wl	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE		0.00							Cuttings
1	Compact brown cobbly SAND and GRAVEL with a trace of silt.			1	CS					Bentonite Seal
				2	CS					
2	Soft BEDROCK.		1.83	3	CS				.50mm Screen Slots from 1.60 to 3.13m.	1305hrs Feb. 10/93
3	Soft to hard BEDROCK.		2.74							Fraction Sand #2/12
4				4	CS				.25mm Screen Slots from 3.13 to 4.65m.	50 mm PVC Screen
5	END OF BOREHOLE Note: No odor detected within the monitoring well.		4.65							WL=2.42m Feb. 12/93
6										
7										
8										
9										
10										

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Capri Drilling

DRILLER: R.R.

Golder Associates

LOGGED: R.T.

CHECKED: R.T.

DATE: Feb 9/93

PROJECT: Landfill

PROJECT LOCATION: Westbank

PROJECT NUMBER: 922-4210

Sampler Hammer: 63.5 kg., Drop 0.76m.

RECORD OF BOREHOLE - BH 3

BORING DATE: February 9-10/93

BORING LOCATION: See Figure 1

SHEET: 1 OF 2

DATUM:

BOREHOLE TYPE: 15.8cm Casing

DEPTH SCALE (m)	SOIL PROFILE – DESCRIPTION	ELEV / DEPTH	SAMPLES – NUMBER	TYPE	BLOWS / 0.15m.	N	OTHER TESTS	PENETRATION RESISTANCE BLOWS/0.3m; WATER CONTENT, PERCENT Wp — W — Wl	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE								
0 – 1.50	Compact brown silty gravelly SAND with occasional cobbles. (FILL)	0.00	1	CS					
1.50 – 3.20	Stiff brown silty CLAY with a trace of gravel.	1.50	2	CS					
3.20 – 4.00	Compact light brown SILT with a trace of clay and occasional thin clayey silt layers.	3.20	3	CS					
4.00 – 4.60	Compact light brown fine SAND with a trace of silt.	4.00	4	CS					
4.60 – 5.65	Interlayered compact fine silty SAND and stiff brown clayey SILT.	4.60	5	CS					
5.65 – 7.00	Compact brown SILT with a trace to some fine sand grading to a fine SAND and SILT at depth.	5.65	6	CS					
7.00 – 9.75	Compact to dense light brown SAND and GRAVEL with occasional cobbles at depth.	7.00	7	CS					Cuttings
9.75 – 14.00	Compact light brown medium to fine SAND becoming loose with increasing depth.	9.75	8	CS					
			9	CS					
			10	CS					Bentonite Seal
14.00 –	Loose light brown gravelly SAND grading to a compact SAND and GRAVEL at depth.	14.00	11	CS					▽ 1245hrs Feb. 10/93

CONTINUED ON NEXT PAGE

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Capri Drilling

DRILLER: R.R.

Golder Associates

LOGGED: R.T.

CHECKED: R.T.

DATE: Feb 10/93

PROJECT: Landfill

PROJECT LOCATION: Westbank

PROJECT NUMBER: 922-4210

Sampler Hammer: 63.5 kg., Drop 0.76m.

RECORD OF BOREHOLE - BH 3

BORING DATE: February 9-10/93

BORING LOCATION: See Figure 1

DATUM:

BOREHOLE TYPE: 16.8cm Casing

DEPTH SCALE (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 0.15m.	N	OTHER TESTS	PENETRATION RESISTANCE BLOWS/0.3m; WATER CONTENT, PERCENT Wp —O^W— Wl	PIEZOMETER OR STANDPIPE INSTALLATION
	CONTINUED FROM PREVIOUS PAGE									
15–17	Loose light brown gravelly SAND grading to a compact SAND and GRAVEL at depth.									Fraction Sand #2/12
17–18.6	Compact brown sandy GRAVEL with a trace of silt and occasional cobbles.		17.10	12	CS					50 mm PVC .50mm Slots
18.6–21.15	Dense grey silty gravelly SAND. (GLACIAL TILL)		18.60	13	CS					Bentonite Seal; Cuttings
21.15	END OF BOREHOLE Note: No odor detected within the monitoring well.		21.15							WL=14.60m Feb. 12/93

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Capri Drilling

DRILLER: R.R.

Golder Associates

LOGGED: R.T.

CHECKED: R.T.

DATE: Feb 10/93

APPENDIX G
IN-SITU DENSITY TESTS

IN-SITU DENSITY TESTS

Procedure

On February 23, 1993, tests were performed to determine the actual compaction of waste in the landfill. Four sites were selected, based on the estimated time since the waste had been placed: Pits 1 and 4, approximately 1 week; Pit 2, approximately 1 month; and Pit 3, approximately 1 year. The location of each Pit is shown in Figure F.1.

The Regional District's backhoe was used to dig the pits. Cover material was scraped off until refuse was encountered. The refuse was loaded onto a truck and weighed at the scale. The weight tickets are included in this Appendix. The dimensions of each pit were then measured before it was refilled. Table F-1 summarizes the results.

Conclusions

The densities measured return an average of about 435 kg/m^3, indicating that the target density of 500 kg/m^3 is easily achievable, and may even be exceeded, with improvement in the present compaction method.

Table F–1
Westside Landfill
In–situ Density Tests

Date: Feb 23/93

Pit	Age	Length (in)	Width (in)	Depth (in)	Volume (m3)	Weight (kg)	Density (kg/m3)
1	1 wk	70	76	40	3.49	2300	660
2	1 mo	66	68	36	2.65	700	264 *
3	1 yr	74	60	40	2.91	880	302
4	1 wk	72	64	36	2.72	1400	515
							435 avg

* Mostly chunks of lumber

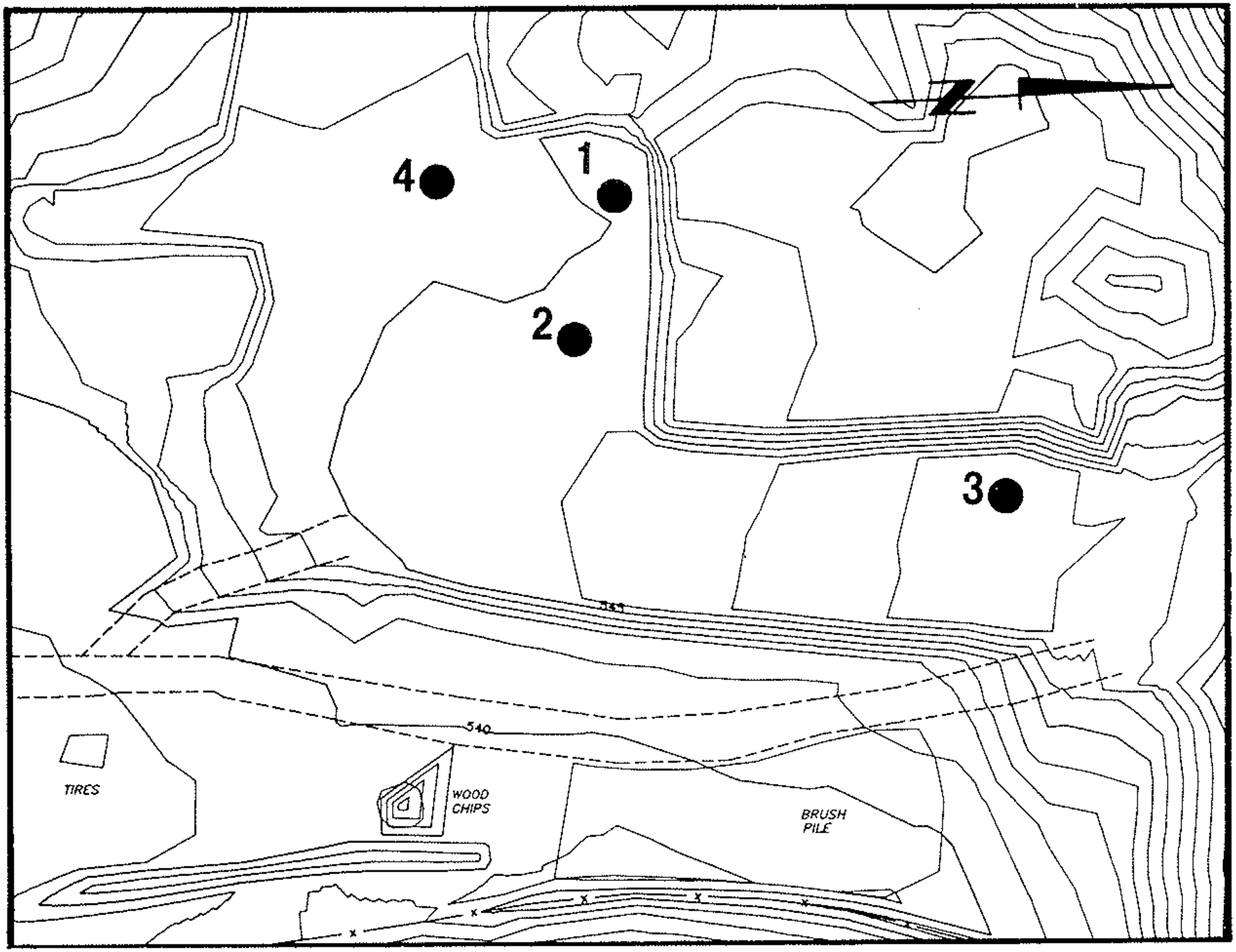


Figure F.1 LOCATION OF DENSITY TEST PITS, WESTSIDE LANDFILL

APPENDIX H
EQUIPMENT HOURLY COST ESTIMATE

EQUIPMENT HOURLY COST ESTIMATE

The following forms are taken from the Caterpillar Performance Handbook 23rd Edition. Based on average conditions, both the D6 tractor and 916 loader have a suggested ownership period of 10,000 hours. Assuming the machines operate half the time at most, this translates to a minimum of seven years' operating life. Interest rate is assumed to be 6% and insurance rate 10%. Fuel is assumed to cost $0.50/L. Tires are assumed to have an operating life of 3000 hours and cost $750 each. Tire replacement cost applies only to the loader. All other values and formulas taken from Section 17 of the Caterpillar Performance Handbook 23rd Edition. Residual value of the machines at the end of the ownership period has been assumed to be zero to present a worst case.

Table G-1 Caterpillar 916 Loader

Owning & Operating Costs | Estimating Form

HOURLY OWNING AND OPERATING COST ESTIMATE

DATE ______

	(1)	(2)
Machine Designation	916	
Estimated Ownership Period (Years)	7	
Estimated Usage (Hours/Year)	1400	
Ownership Usage (Total Hours)	10000	
OWNING COSTS		
1. a. Delivered Price (including attachments)	112000	
b. Less Tire Replacement Cost if desired	/	
c. Delivered Price Less Tires		
2. Less Residual Value at Replacement (__%) (See subsection 2A on back)	/ (__%)	
3. a. Value to be recovered through work (line 1c less line 2)	112000	
b. Cost Per Hour: Value / Hours (1) 112000 / 10000 (2) ____	11.20	
4. Interest Costs (N = No. Yrs.) $\frac{\frac{N+1}{2N} \times \text{Del. Price} \times \text{Simple Int. \% Rate}}{\text{Hours/Year}}$ = (1) $\frac{7+1}{14}$ x 112000 x .06 % / __ Hours/Yr. = (2) $\frac{+1}{}$ x __ x __ % / __ Hours/Yr. =	2.80	
5. Insurance (N = No. Yrs.) $\frac{\frac{N+1}{2N} \times \text{Del. Price} \times \text{Insurance \% Rate}}{\text{Hours/Year}}$ = (1) $\frac{7+1}{14}$ x 112000 x .10 % / __ Hours/Yr. = (2) $\frac{+1}{}$ x __ x __ % / __ Hours/Yr. = Or $____ Per Yr. ÷ ____ Hours/Yr. =	4.60	/

CATERPILLAR FORM NO. 01-085419-01 (52.00)

Table G-1 Caterpillar 916 Loader (continued)

Estimating Form | **Owning & Operating Costs**

	(1)	(2)
6. Property Tax $\frac{N+1}{2N}$ × Del. Price × Tax Rate % / Hours/Year = (N = No. Yrs.) (1) +1 × ____ × ____ % / ____ Hours/Yr. = (2) +1 × ____ × ____ % / ____ Hours/Yr. = Or $____ Per Yr. ÷ ____ Hours/Yr. =	/	
7. TOTAL HOURLY OWNING COST (add lines 3b, 4, 5, and 6)	18.60	
OPERATING COSTS		
8. Fuel: Unit Price × Consumption (1) .50 × 11 L/hr = (2) ____ × ____ =	5.50	
9. Lube Oils, Filters, Grease: (See subsection 9A on back)	.50	
10. a. Tires: Replacement Cost ÷ Life in Hours Cost / Life (1) 750×4 / 3000 (2) ____	1.00	
b. Undercarriage (Impact + Abrasiveness + Z Factor) × Basic Factor (1) (____ + ____ + ____) = ____ × ____ = (2) (____ + ____ + ____) = ____ (Total) × ____ (Factor) =	N/A	
11. Repair Reserve (Extended Use Multiplier × Basic Repair Factor) (1) 1.0 × 3.25 = (2) ____ × ____ =	3.25	
12. Special Wear Items: Cost ÷ Life (See subsection 12A on back)	/	
13. TOTAL OPERATING COSTS (add lines 8, 9, 10a (or 10b), 11 and 12)	10.25	
14. MACHINE OWNING PLUS OPERATING (add lines 7 and 13)	28.85	
15. OPERATOR'S HOURLY WAGE (include fringes)	15.00	
16. TOTAL OWNING AND OPERATING COST	44.00	

17

Table G-2 Caterpillar D6H Tractor

Owning & Operating Costs | Estimating Form

HOURLY OWNING AND OPERATING COST ESTIMATE

DATE ______

	(1)	(2)
Machine Designation	D6H	
Estimated Ownership Period (Years)	7	
Estimated Usage (Hours/Year)	1400	
Ownership Usage (Total Hours)	10,000	

OWNING COSTS

	(1)	(2)
1. a. Delivered Price (including attachments)	330,000	
b. Less Tire Replacement Cost if desired	N/A	
c. Delivered Price Less Tires		
2. Less Residual Value at Replacement (See subsection 2A on back)	(___%) Ø	(___%)
3. a. Value to be recovered through work (line 1c less line 2)	330,000	
b. Cost Per Hour: Value/Hours (1) 330,000/10,000 (2) ______	33	
4. Interest Costs, N = No. Yrs. $\frac{\frac{N+1}{2N} \times \text{Del. Price} \times \text{Simple Int. \% Rate}}{\text{Hours/Year}} =$ (1) $\frac{\frac{7+1}{14} \times 330000 \times .06}{1400 \text{ Hours/Yr.}} =$ (2) $\frac{\frac{+1}{\quad} \times \_\_ \times \_\_\%}{\_\_ \text{ Hours/Yr.}} =$	8	
5. Insurance, N = No. Yrs. $\frac{\frac{N+1}{2N} \times \text{Del. Price} \times \text{Insurance \% Rate}}{\text{Hours/Year}} =$ (1) $\frac{\frac{7+1}{14} \times 330000 \times 10\%}{1400 \text{ Hours/Yr.}} =$ (2) $\frac{\frac{+1}{\quad} \times \_\_ \times \_\_\%}{\_\_ \text{ Hours/Yr.}} =$ Or $______ Per Yr. ÷ ______ Hours/Yr. =	13.50	

CATERPILLAR FORM NO. 01-065419-01 (52.00)

Table G-2 Caterpillar D6H Tractor (continued)

	(1)	(2)
6. Property Tax $\frac{N+1}{2N}$ × Del. Price × Tax Rate % / Hours/Year = ; N = No. Yrs. (1) ___ +1 × ___ × ___ % / ___ Hours/Yr. = (2) ___ +1 × ___ × ___ % / ___ Hours/Yr. = Or $___ Per Yr. ÷ ___ Hours/Yr. =	/	
7. TOTAL HOURLY OWNING COST (add lines 3b, 4, 5, and 6)	54.50	
OPERATING COSTS		
8. Fuel: Unit Price × Consumption (1) .50 × 20 L/hr = (2) ___ × ___ =	$10	
9. Lube Oils, Filters, Grease: (See subsection 9A on back)	.60	
10. a. Tires: Replacement Cost ÷ Life in Hours; Cost/Life (1) ___ (2) ___	N/A	
b. Undercarriage (Impact + Abrasiveness + Z Factor) × Basic Factor (1) (.2 + .2 + .5) = .9 (Total) × 6.2 (Factor) = (2) (___ + ___ + ___) = ___ × ___ =	5.60	
11. Repair Reserve (Extended Use Multiplier × Basic Repair Factor) (1) 1.00 × 4.50 = (2) ___ × ___ =	4.50	
12. Special Wear Items: Cost ÷ Life (See subsection 12A on back)	/	
13. TOTAL OPERATING COSTS (add lines 8, 9, 10a (or 10b), 11 and 12)	20.70	
14. MACHINE OWNING PLUS OPERATING (add lines 7 and 13)	75.20	
15. OPERATOR'S HOURLY WAGE (include fringes)	15.00	
16. TOTAL OWNING AND OPERATING COST	90.20	

17

APPENDIX I
LEACHATE ANALYSIS

CHEMAC

CHEMAC ENVIRONMENTAL SERVICES
(A DIVISION OF CARO ENTERPRISES INC.)
#1 - 368 Industrial Avenue, Kelowna, British Columbia, Canada V1Y 7E8 • Telephone (604) 763-1535

CERTIFICATE OF ANALYSIS

April 13, 1993

Central Okanagan Regional District
540 Groves Avenue
KELOWNA, BC V1Y 4Y7

Attention: Mr. Charlie Cameron

Dear Sir:

Following are the results of the analysis of groundwater samples taken on the dates indicated, and identified as shown:

Project: Westbank Landfill Monitoring Well

ICP Scan		March 22, 1993 Monitoring well
Silver	mg/L	<0.001
Aluminum	mg/L	11.5
Barium	mg/L	0.18
Beryllium	mg/L	<0.001
Bismuth	mg/L	<0.004
Calcium	mg/L	300
Cadmium	mg/L	<0.001
Cobalt	mg/L	0.014
Chromium	mg/L	<0.020
Copper	mg/L	0.014
Iron	mg/L	21.2
Potassium	mg/L	6.2
Magnesium	mg/L	165
Manganese	mg/L	8.60
Molybdenum	mg/L	0.002
Sodium	mg/L	110
Nickel	mg/L	0.044
Lead	mg/L	0.032
Strontium	mg/L	2.30
Titanium	mg/L	1.2
Vanadium	mg/L	0.034
Tungsten	mg/L	<0.020
Zinc	mg/L	0.088

...2

Page 2
Central Okanagan Regional District
April 13, 1993 (cont)

Other Parameters		March 22, 1993 Westbank Landfill Monitoring Well
Chloride	mg/L	315
Nitrate & Nitrite	mg/L as N	<0.01
Total Kjeldahl Nitrogen	mg/L as N	3.5
Ammonia Nitrogen	mg/L as N	1.6
Total Phosphorus	mg/L as P	1.15
Ortho Phosphate	mg/L as P	<0.01
Arsenic	mg/L	0.020
Mercury	mg/L	<0.0005
Selenium	mg/L	<0.001
pH	pH units	7.0
Alkalinity	mg/L as CaCO3	1440
Colour	true colour units	45
Conductivity	umhos/cm	3350
Total Dissolved Solids	mg/L	2110
Chemical Oxygen Demand	mg/L	337
BOD	mg/L	36
Total Organic Carbon	mg/L	120
Sulphate	mg/L	32
Sulphide	mg/L	<0.025
Boron	mg/L	1.1
Fluoride	mg/L	1.0
Cyanide	mg/L	<0.01
Tannin & Lignin	mg/L	12.5
Total Hardness	mg/L as CaCO3	1430
Phenol	mg/L	0.16

Depth from top of well to water 2.88 m.

Yours truly,
CHEMAC ENVIRONMENTAL SERVICES

Janice M. Fraser, B.Sc.
Lab Supervisor

cc: Ray Bilevicius, Reid, Crowther & Partners

APPENDIX J
STAGE 2 HYDROGEOLOGICAL PROPOSAL

DRAFT

May 19, 1993

Our Reference: P93-4065

Reid Crowther & Partners Ltd.
Suite 201 - 3275 Lakeshore Road
Kelowna, B.C.
V1W 3S9

Attention: Mr. R. Bileviceous, P. Eng.

RE: HYDROGEOLOGICAL INVESTIGATION, SECOND PHASE
WESTSIDE LANDFILL SITE
WESTBANK, BRITISH COLUMBIA

Dear Sir:

Golder Associates Ltd. (Golder) is pleased to submit this proposal for the second phase of the groundwater investigation at the Westside Landfill in Westbank, B.C. The proposal follows the general scope for the hydrogeological investigation procedures outlined in the letter proposal to you of August 31, 1992 and is also based on the preliminary results of the investigation presented in our report dated February 16, 1993. The present phase addresses the more extensive investigation work required to characterize the groundwater migration routes and migration rates.

In addition to the engineering staff proposed in our original proposal we will utilize the services of Knut Andersson, Senior Hydrogeologist, who is located in our Kelowna office. We have enclosed his resume with this proposal.

.... /2

1.0 OBJECTIVES AND INVESTIGATIVE APPROACH

The main objectives of this investigation are to determine the behaviour of the groundwater at and adjacent to the landfill and the natural up-gradient background levels of dissolved and suspended matter in the groundwater, to determine the potential leachate from the landfill in the groundwater, and the present and potential future distribution of this leachate at the site and surrounding environment. To achieve these goals, Golder proposes the following approach and procedures.

- Sampling and analysis of the water in the existing wells.

- A geophysical survey using either or both of seismic and conductivity methods to map the subsurface bedrock contour and possibly areal distribution of any leachate plume. In areas of shallow bedrock, a test pit investigation is proposed to determine the bedrock contour and depth near areas of the proposed monitoring wells. The purpose of this program is to determine the best locations for the monitoring wells to minimize the number of wells and maximize the probability that the wells will enter the desired part of the groundwater.

- A drilling program to install additional monitoring wells. One up-gradient well is proposed to determine the quality of the groundwater onto the site as background information. An additional purpose of the drilling program is to sample sediment or rock type encountered for stratigraphic and permeability purposes. It is estimated that 5 or 6 wells are required for this phase.

- Measuring the groundwater elevations in each available well in order to calculate groundwater gradient slope and bearing.

- Sample groundwater and possibly surface water for analytical purposes in order to detect any impact of leachate on the tested water samples.

- Analyze the acquired data, make conclusions and recommendations.

.... /3

2.0 PROPOSED INVESTIGATION COMPONENTS

2.1 Analysis of Water Samples from Existing Test Wells (BH 1 through BH 3)

No groundwater samples have yet been analyzed from the existing wells. Golder therefore proposes that water samples are collected and analyzed for the most common indicators of the presence of leachate. During purging and sampling, pH, temperature and EC (electric conductivity) of the removed water will be measured and recorded. Samples will also be obtained for analysis of the existing pond below the old landfill. The results will be useful in finalizing the details of the assessment program outlined in this proposal. The proposed drilling program will also be evaluated following the analysis.

2.2 Well Location Determination by Geophysical and Test Pit Investigation

Golder proposes that geophysical methods be applied to determine the bedrock profile and/or the existence of a leachate plume. The methods to be applied potentially include a series of seismic lines and an inductive conductivity test using an Electromagnetic Terrain Conductivity System EM-34 device. The first method can detect the depth to bedrock and can therefore indicate low areas where groundwater would concentrate and wells should be located. This seismic survey will be extended into the proposed borrow area to evaluate the quantity of available materials. The latter method is based on the principle that leachates have an electrical conductivity that is one to two orders of magnitude higher than that of natural groundwater. A leachate plume will therefore be characterized by an area of high conductivity. However, metallic objects in fill will also increase conductivity and the method is best used in areas with native soil. We recommend that water from the existing wells be tested for conductivity and this method be applied only if the water conductivity in the most contaminated well is 10 times that of water from an uncontaminated well.

..... /4

The backhoe test pit investigation will be concentrated to topographic saddles where there are lows in the bedrock but the soil is shallow. The following areas are regarded feasible for test pit lines: The area west of BH-1 to the landfill access road in the area of the up-gradient well. The purpose of this well would be the monitoring of the quality of groundwater entering the site. If this line reveals that this is an unlikely area for water entry to the site, an alternate location for this line is midway along the northern property line.

In areas of deep soil the position of wells will be determined from the general topography and exposed bedrock. From BH-3 it is evident that thick till may be encountered in the lowest areas. If so, the wells will be seated in the till. However, at least one well will be drilled to bedrock in order to determine if groundwater is also present below the till. These wells will need to be cased to prevent that verticals conduits are not created between different aquifers. At two or three positions, mainly south of the present landfill, possibly also at Shannon Lake Park, it may therefore be necessary to have both shallow and deep monitoring wells at two to three locations.

2.3 Drilling Program

Golder proposes 6 new monitoring wells at positions described below and in Figure 1. In addition, it is proposed to drill two boreholes in the proposed borrow area on the south side to evaluate the quantity and quality of borrow materials. This proposed well installation program should be re-evaluated as data are collected during the implementation of the proposed measures.

a. In the swale entering the site from the northwest on the west side of the property, along the property line a short distance north of the continuation of the landfill access road. This well is believed to be located at the most likely area of inflow of groundwater to the site and would serve to determine background quality of the groundwater entering the site. Depending on the outcome of the test pits, an alternative place for this well is midway along the northern property line, where another up-gradient bedrock low point may be located.

b. West of existing well BH-1, between it and the landfill access road. This area has the potential of being a low point in the bedrock across the saddle south of the landfill area. This general area appears to be the main route for groundwater migration from the fill site. It is therefore important that the water passing this area is monitored carefully, and one additional well would be important at this time. However, if the geophysical or test pit programs indicate that the existing well is located in the main groundwater flow area, this well may not be needed.

c. South of the landfill access road at the north side of the sports park. This position is at or adjacent to the northern edge of the old fill and is possibly directly in the path of potential leachate from the fill, down-gradient of BH-1 and the potential new well described ~~above~~ in b. above.

d. On the south side of the gravel pit southwest of the old landfill and west of the existing BH-3. This is a possible route for leachate migration from the old and the existing landfills, and is also just upgradient of a small lake that could become impacted. Both a deep and a shallow well may be needed here.

e. On the west side of Shannon Lake Road between the landfill access road and a point across from the transformer substation. Deep and shallow well may be required at this point also.

.... /6

f. The area below the existing BH-2, near the entrance to Shannon Lake Park. This is a position where leachate from the northeastern part of the landfill may migrate, potentially bypassing BH-2. The sediment at this site is not well known and the position and depth will have to be determined from data acquired during the project implementation.

During drilling soil samples will be collected, preferably with a split spoon sampler. The samples will be used to establish sediment stratigraphy and for a rough estimation of permeability. Drilling of each hole should end at solid bedrock or after penetrating two metres or more of dense till. If in till, the hole should be backfilled to the top of the till with bentonite. Each hole will be completed as a well by installing a 50 mm PVC well pipe, sand filter pack, bentonite seal and cement or bentonite grout. Slotted portion of pipe should extend from bottom of hole to 0.5 m above estimated high water level for shallow wells, 1 to 2 m for deeper wells. Each well will be equipped with a lockable steel well monument and a sealing well cap.

2.4 Determination of Groundwater Elevations and Migration Patterns

After the installation and development of the wells, the measuring point (generally a marked point at the top of the riser pipe) of each new and existing well will be surveyed to a convenient reference point, preferably an established bench mark if available. The water levels will then be measured in all wells and the elevation of these levels calculated. These data can then be used for an approximate determination of general groundwater gradient slope and bearing. However, because of the irregular bedrock surface and expected variations in soil hydraulic conductivities, the groundwater flow is likely complex in the site vicinity.

..... /7

The hydraulic conductivity of the sediment can be determined approximately by applying rising head well tests. The hydraulic conductivity values together with the gradient slope are required to determine the migration velocity of the groundwater.

2.5 Groundwater Sampling and Analytical Program

After installation and development of the wells, each well will be purged and water samples collected for analyses. During purging and sampling, pH, temperature and EC (electric conductivity) of the removed water will be measured and recorded. Water samples will then be collected in sample bottles containing appropriate preservatives as required. The bottles will immediately be placed in ice chests at temperatures between 0 and 4 degrees C, and transported as soon as possible to the selected analytical laboratory. A chain of custody form will be used in order to ensure sample integrity. To our knowledge no analytical work has been performed on groundwater at this landfill. We therefore propose that first water samples from the three existing wells be analyzed for common leachate "tracer" parameters for a rough determination if the wells are located within a leachate plume. The same analysis is proposed for the new wells as an initial analytical round. This includes the following parameters and compounds:

Biochemical Oxygen Demand (BOD)
Total Organic Carbon (TOC)
Major anions: Cl^-, SO_4^{2-}, CO_3^{2-}/HCO_3^-

The results of this initial analytical work will serve to determine further chemical groundwater characterization. Because of the odour detected in BH-1, leachate is to be expected in one or more wells, and more extensive analytical work may have to be performed on samples from at least some down-gradient wells, and for purposes of determining the role of the landfill, the background well to the northwest.

2.6 Report with Data Analysis, Conclusions and Recommendations

After the work has been completed and the analytical data are available a report will be compiled. The report will contain a record of the work performed, the produced data and data analysis, conclusions and recommendations. Site plan with positions of seismic lines and wells will be presented. Borehole and Test Pit logs, work notes and analytical report sheets will be included in appendices.

3.0 ESTIMATED COSTS AND PROJECT SCHEDULE

Golder proposes to perform this site assessment on a time and materials basis. Total estimated costs (excluding the GST) is $41,500. The costs are itemized in Table 1. Billing will be based on time, materials and expenses. The stated costs will not be exceeded without the prior authorization by Reid Crowther & Partners Ltd.

The project will be undertaken by members of Golder's Kelowna office with assistance from the Burnaby office as required. A senior hydrogeologist and an associate with the Environmental Division based in Burnaby, B.C., will be available for technical review of the report.

We trust the foregoing provides the information you require at this time and we look forward to being of service to you on this project.

Yours very truly,

GOLDER ASSOCIATES LTD.

K. A. Andersson, Ph.D.

B. Carlsen, P.Eng.

KAA\BC\at
encl.

Knut A. Andersson

EDUCATION:	Ph.D., Geology, University of Wyoming, Laramie, Wyoming, 1982 M.S., Geology, University of Wyoming, Laramie, Wyoming, 1978 M.A., Biology, Pacific Union College, Angwin, California, 1972 Fil. mag., Chemistry, Botany, Zoology, Uppsala University, Sweden, 1967 Fil. kand., Chemistry, Botany, Zoology, Lund University, Sweden, 1966
AFFILIATIONS:	Idaho Registered Professional Geologist California Registered Environmental Assessor

EXPERIENCE:

1992 to date

Golder Associates
Environmental Division
Responsible for site contamination investigations, for the development and implementation of site remediations, and for environmental property audits. Includes management and advisory functions for subsurface contaminants investigations, soil and groundwater remediation, historical searches of property conditions, and groundwater quality and availability studies.

1989 to 1992

Geological Technics Inc., Modesto, California an environmental geological and resources management firm
Geologist/Sedimentologist (1989), Senior Geologist (1990)

Environmental Site Assessments (ESA):

- Project manager for pre-acquisition ESAs of sites generally for industrial development and consisting of 2-27 acre land with former or present commercial or agricultural usage. Included historical searches, subsurface data reviews, soil (auger holes) and groundwater (existing wells) sampling and analysis.
- Project manager, geologist or hydrogeologist for numerous sites with leaking hydrocarbon fuel tanks. Included the definition of contaminant plumes in soil and groundwater, design of analytical soil and groundwater sampling, design of monitoring wells and sampling programs, mass balance calculations of contaminant volumes, supervision of drilling activities, writing of work plans and reports, and budgeting.

Site Monitoring Programs:

- Managing site monitoring programs for sites with large scale metal (chromium, arsenic from wood preservation sites) contamination, some under EPA supervision. Included semimonthly, monthly, quarterly and annual reporting of laboratory data and maintenance data for extraction, treatment and reinjection of groundwater, and the supervision of well sampling, analysis of well and laboratory data, and plume definition.

Site Remediations:

- Project manager or geologist for soil and groundwater remediations, such as excavations, bioremediation and vapour extraction systems. Included the design of system layout and supervision of installation and maintenance of wells, extraction pumps, activated carbon units and thermal oxidation systems.

Knut A. Andersson

Groundwater Quality and Availability Studies:

- Geologist and hydrogeologist for projects involving planned housing developments. Included the groundwater balance calculations, installation of water wells and drawdown step testing, and recommending maximum safe water use for the areas. Input of nitrogen compounds from agriculture, housing areas, golf courses and septic systems were estimated quantitatively.

Proposals and Budgeling:

- Involved in the budget, bidding and contract process for the company.

1988 to 1989 — **California State University, Sacramento**
Lecturer in Geology
One year full-time replacement position.

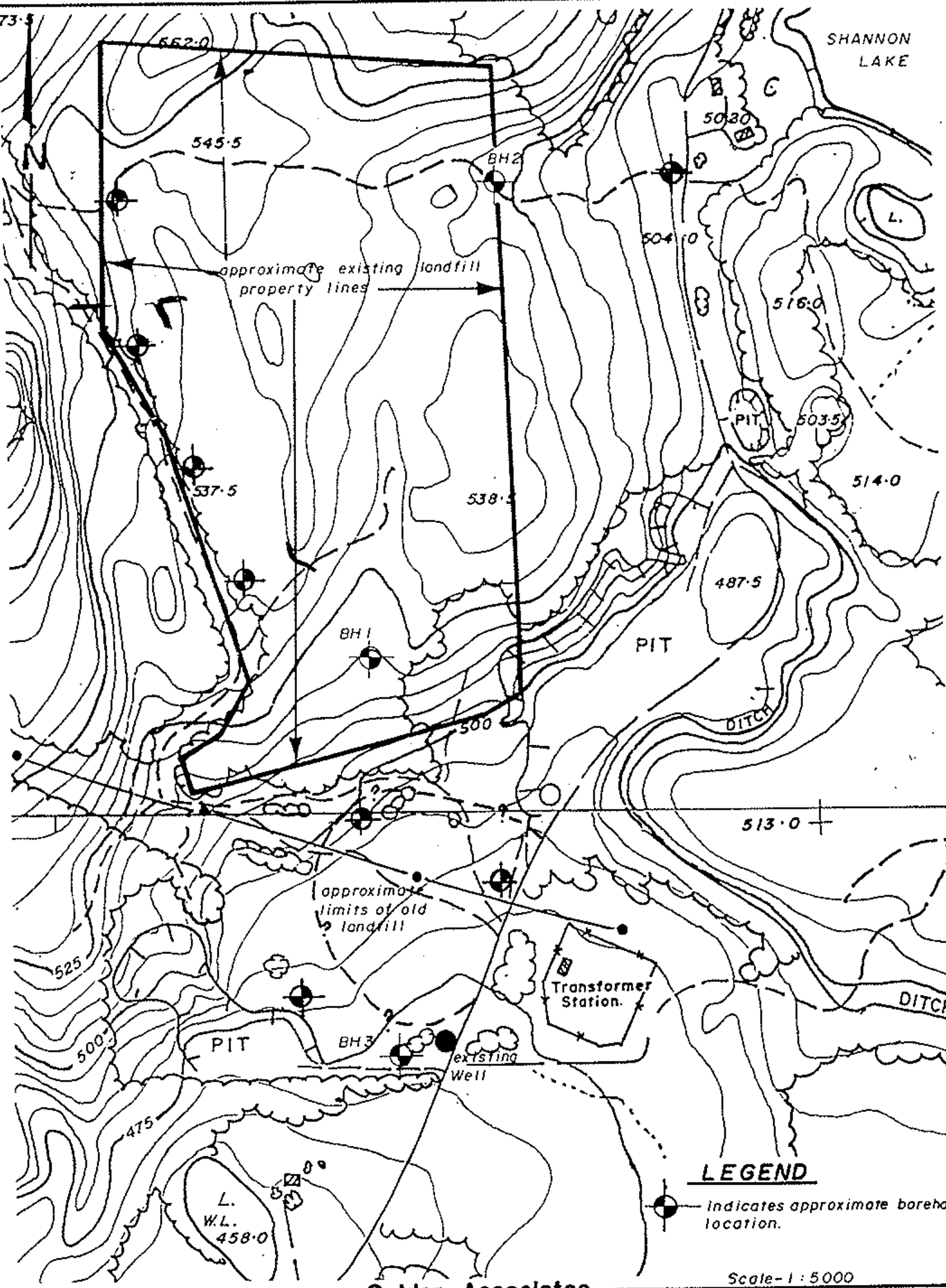
1981 to 1988 — **Loma Linda University, Riverside, California**
Assistant Professor (1981), Associate Professor (1984), Chairman (1985-1987), Department of Geology

1978 to 1981 — **University of Wyoming, Laramie, Wyoming**
Teaching Assistant and Student Teacher - Geology

1966 to 1976 — **Ekebyholmsskolan, Rimbo, Sweden**
Teacher
Junior high school to junior college teacher in biology, chemistry, general science and geography with some study leaves.

BOREHOLE LOCATION PLAN

Figure 2



PROJECT No. 922-4210 DRAWN rr REVIEWED rt DATE Feb./93

Golder Associates

TABLE 1
ESTIMATED FEES AND DISBURSEMENTS FOR
PROPOSED GROUNDWATER ASSESSMENT
Westside Landfill, Westbank, B.C.

		Units (hrs)	Unit Rate ($)	Estimated Total ($)
Task 1: Sampling and Analysis of Groundwater in Existing Wells				
a. Preparation of Equipment		1	65	65
b. Purging of Wells, Sample Collection		20	65	1,300
c. Analytical Fees	Units			
BOD	3		40	120
TOC	3		30	90
Major Anions	3		170	510
		Initial Groundwater Subtotal		**2,085**
Task 2: Geophysical and Test Pit Program				
a. Seimic Lines and/or Conductivity Testing				5,000
b. Backhoe and Crew		16	50	800
c. Supervision of Test Pit Program		16	65	1,040
d. 5% Administrative Fee for Non–Golder Services				40
		Test Pit Program Subtotal		**6,880**
Task 3: Well Drilling Program				
a. Drillers Fees		70	125	8,750
(Drill footage surcharge, 600 ft. @ $1.25/ft)				750
b. Technician		70	65	4,550
c. Professional Supervision		20	70	1,400
d. Monitoring Well Materials	6		350	2,100
e. Field Instruments (OVM, GasTechtor), 7 days				750
f. 5% Administrative Fee for Non–Golder Services				580
		Drilling Program Subtotal		**18,880**
Task 4: Well Survey and Groundwater Gradient Determination				
a. Well Survey (includes EDM rental)				750
b. Depth Measurements		10	65	650
c. Data Analysis		10	65	650
		GW Gradient Subtotal		**2,050**
Task 5: Sampling and Analysis of Groundwater in New Wells				
a. Preparation of Equipment		2	65	130
b. Purging of Wells, Sample Collection		24	65	1,560
c. Analytical Fees	Units			
BOD	8		40	320
TOC	8		30	240
Major Anions	8		170	1,360
		Phase II Groundwater Subtotal		**3,610**
Task 6: Data Analysis and Report				
a. Data Analysis		20	76	1,520
b. Report Preparation		40	70	2,800
c. Drafting		15	60	900
d. Senior Review		20	95	1,900
e. Word Processing and Report Production		15	45	675
f. Miscellaneous (FAX, Courier, Computer, etc.)				200
			Subtotal	**7,995**
		TOTAL (GST not included)		**41,500**

APPENDIX K
GAS MONITORING REPORT

LANDFILL GAS INVESTIGATION

AT

WESTSIDE LANDFILL, WESTBANK, B.C.

Prepared for:

Reid Crowther & Partners Ltd.
201 - 3275 Lakeshore Road
Kelowna, B.C.
V1W 3S9

Prepared by:

E.H. Hanson & Associates Ltd.
#4 - 7550 River Road
Delta, B.C.
V4G 1C8

April 1993

1.0 INTRODUCTION

Reid Crowther & Partners Ltd. was retained by the Central Okanagon Regional District (CORD) to prepare an Operations and Closure Plan for the Westside Landfill. E.H. Hanson & Associates Ltd. were retained by Reid Crowther to prepare an analysis of the Landfill Gas production from the refuse. This report details our investigation procedure and the results obtained.

2.0 INVESTIGATION PROCEDURE

The investigation of landfill gas production at the Westside Landfill consisted of the following activities:

a. Review of relevant soil, geotechnical, and location information.
b. Extraction testing of wells.
c. Determination of methane gas production coefficient for modelling of landfill gas production.

The review of the soil and geotechnical information was done using the reports prepared by Golder Associates Ltd. which were contained in the Stage 2 Draft Interim Report. The extraction testing was done on leachate monitoring wells installed by Golder Associates Ltd. The location of the wells is shown in Appendix D.

3.0 REVIEW OF SOIL AND GEOTECHNICAL INFORMATION

In our review of the soil and geotechnical information presented in the reports by Golder Associates, two important characteristics with respect to landfill gas production were noted. These characteristics were the generally dry ground conditions and the fact that the surface material was a sandy soil.

The test pits excavated on November 24 indicated no seepage of ground water. As no ground water was noted we would expect that most of the refuse would be relatively dry.

In our experience sandy soil is a good conductor of landfill gas so that if a large amount of gas is being produced in the landfill, lateral migration of the gas could occur.

Additionally, the borehole and test pit information indicate that bedrock is fairly close to the surface. Bedrock presents a barrier to landfill gas migration.

4.0 EXTRACTION TESTING

The extraction testing at the Westside Landfill was done on February 25 and 26, 1993. Extraction testing consists of installing slotted wells in the test area and then applying a vacuum to the well and measuring the methane content and quantity of the gas being removed. Extraction testing at wells provides important data not obtainable through rod probes or static testing alone. Although static testing provides data on gas contents at any time it does not give reliable information on the rate of gas production or parameters on migration potential of that area. Extraction tests are done to provide an estimate of relative porosity of the fill and approximate steady state production within the vicinity of the well. This data is instrumental in determining the rate of gas production from the landfill.

As the process begins, the immediate contents of the well are withdrawn and the gases in the vicinity of the well tested. Within the first minute the initial samples are tested and recorded in conjunction with flow rates and suction pressure. As the extraction proceeds, the contents of the gas usually varies; generally speaking, the methane percentage slowly drops until a stable withdrawal rate and methane content are reached. This may occur within a few hours and represents a short term balance between air intrusion and void space storage. If the extraction continues, the methane contents may continue to recede until a new stable rate is achieved. This level, when combined with the radius of influence of the well, enables us to calculate the long term steady state production of the area. The tests conducted yield data on the short term rate of production from the void space. Extraction test also provide information on any anomalies such as abnormally high or abnormally low rates of generation.

During the extraction tests no methane was detected. Additionally, the suction being applied to the wells was quite high. This high suction indicates that either the porosity of the ground is very low or that the slots in the wells were blocked. It is difficult to determine which problem would have caused the high vacuum but, the wells were placed in an area of sandy surface soils, so it would seem likely that the porosity of the soil would be sufficient.

Unfortunately, none of the wells were placed directly in the fill. A well placed in the fill would have given a better indication of whether any gas is being produced in the landfill.

5.0 DETERMINATION OF METHANE GAS PRODUCTION COEFFICIENT

In the modelling of landfill gas production from refuse a coefficient of gas production is determined. In the model developed by E.H. Hanson & Associates Ltd. the coefficient is a number indicating the volume of methane evolved from a tonne of refuse each year. For landfills in the coastal region of British Columbia, we use a coefficient of 4.0 to 4.4 cubic metres per tonne, per year.

There are numerous factors which will influence the methane production coefficient. These are as follows:

a. Moisture supplied to the waste;
b. Type of waste buried;
c. pH of waste and leachate;
d. Type and porosity of capping material;
e. Ambient temperature.

The most important factor from the above list with respect to gas production is the amount of moisture supplied to the waste. If there is not sufficient water in the waste, no significant microbial action will occur.

From the information obtained through the review of the soil and geotechnical information, it appears that there is not much ground water in the area. Additionally, the precipitation in the Kelowna area, as indicated by the graph in Appendix B, is less than at other locations where we are aware that landfill gas is produced. These two factors combined suggest that the refuse is too dry to produce any gas. We are aware of this situation in a number of other locations, such as Cache Creek, Kamloops and Spokane.

The other factors indicate that gas could be produced from the refuse if the moisture conditions were to change. As shown in Appendix C, the ambient temperature is similar to the coastal region temperatures. The type of waste buried is similar in make-up to other municipal wastes. From visual inspection of the capping material it is likely that water should be able to get through it into the refuse.

6.0 CONCLUSIONS AND RECOMMENDATIONS

- The test wells were placed at the perimeter of the landfill outside of the burial area and revealed some anomalies such as high vacuum and low air or gas flows in soils which were thought to be porous and would offer little resistance to air or soil gas flow.

- Gas tests taken from these wells revealed that there is no methane gas accumulation. Consequently, there is no evidence that underground methane migration is occurring and no gas migration barriers or other remedial measures are required under current conditions.

- There is no evidence of any significant methane gas generation on the site and consequently a collection and flaring system is not required at present.

- To confirm these findings and monitor for increases in methane generation we recommend that three monitoring wells be installed in the landfill where the bulk of the refuse has been placed and be tested under various seasonal conditions or about four times per year.

  As the mass of refuse increases, the moisture content and biological activity within the landfill can change and gas generation may then increase and become significant.

Submitted by:

E.H. HANSON & ASSOCIATES LTD.

Alan Martin, P.Eng.

File: AM\Reid2.Pro

Appendix A

GENERAL CLIMATOLOGICAL DATA

KELOWNA A

49°58'N 119°23'W/O, 429m — 1959 to/à 1990

	Jan janv	Feb févr	Mar mars	Apr avr	May mai	Jun juin	Jul juill	Aug août	Sep sept	Oct oct	Nov nov	Dec déc	Year année	
Temperature														**Température**
Daily Maximum (°C)	-0.7	2.8	9.4	15.2	20.0	24.3	27.6	27.2	20.9	13.5	5.4	0.2	13.8	Maximum quotidien (°C)
Daily Minimum (°C)	-8.4	-6.3	-2.7	0.5	4.7	8.4	10.0	9.7	5.3	0.5	-2.9	-6.9	1.0	Minimum quotidien (°C)
Daily Mean (°C)	-4.5	-1.7	3.4	7.9	12.4	16.4	18.8	18.5	13.1	7.0	1.3	-3.3	7.4	Moyenne quotidien (°C)
Extreme Maximum (°C)	14.8	14.7	20.3	28.1	34.4	37.1	38.6	38.3	34.8	26.8	20.6	14.5		Maximum extrême (°C)
Date	989/30	988/21	986/27	987/27	983/29	987/30	979/20	971/11	987/01	984/08	975/04+	980/27		Date
Extreme Minimum (°C)	-31.7	-25.2	-19.4	-8.9	-3.7	-0.6	2.6	0.6	-6.1	-15.7	-28.4	-36.1		Minimum extrême (°C)
Date	969/23	986/19	976/03	975/01	985/12	973/11+	977/05	973/19	972/27	984/31	985/28	968/30		Date
Degree-Days														**Degrés-jours**
Above 18 °C	0.0	0.0	0.0	0.0	2.7	21.0	53.3	45.5	2.9	0.0	0.0	0.0	125	Au-dessus 18°C
Below 18 °C	699.9	556.4	453.3	303.9	177.8	69.7	27.8	30.7	148.9	341.2	501.8	662.2	3974	Au-dessous 18°C
Above 5 °C	0.4	1.0	16.8	94.1	228.0	341.3	428.6	417.9	244.3	80.8	10.3	0.7	1864	Au-dessus 5°C
Below 0 °C	156.0	78.6	12.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8	37.1	124.1	410	Au-dessous 0°C
Precipitation														**Précipitations**
Rainfall (mm)	5.9	8.0	16.9	24.4	37.5	36.9	33.7	33.9	35.8	21.3	17.5	8.8	280.7	Chutes de pluie (mm)
Snowfall (cm)	31.9	18.2	5.4	0.7	0.0T	0.0T	0.0	0.0	0.0	0.7	12.2	36.5	105.5	Chutes de neige (cm)
Precipitation (mm)	31.1	23.1	22.1	25.1	37.6	36.9	33.7	33.9	35.8	21.9	28.4	36.9	366.4	Précipitations (mm)
Extreme Daily Rainfall (mm)	9.7	12.9	13.7	27.6	21.4	29.8	25.6	19.8	33.4	18.3	13.2	14.2		Extrême quotidien de pluie (mm)
Date	977/18	981/25	972/22	987/30	981/25	990/10	989/15	984/13	985/06	973/07	978/03	972/21		Date
Extreme Daily Snowfall (cm)	26.0	19.1	9.4	4.2	0.8	0.0	0.0	0.0	0.0	6.9	17.0	19.3		Extrême quotidien de neige (cm)
Date	982/23	973/04	969/05	981/06	982/03	990/30+	990/31+	990/31+	990/30+	971/31	990/24	971/08		Date
Extreme Daily Pcpn. (mm)	24.7	16.0	13.7	27.6	21.4	29.8	25.6	19.8	33.4	19.3	17.0	14.2		Extrême quotidien de préc. (mm)
Date	982/23	973/04	972/22	987/30	981/25	990/10	989/15	984/13	985/06	973/07	990/24	972/21		Date
Month-end Snow Cover (cm)	15	7	0	0	0	0	0	0	0	0	2	12		Couver. de neige, fin de mois (cm)
Days With														**Journées avec**
Maximum Temperature > 0°C	16	21	30	30	31	30	31	31	30	31	27	17	326	Température maximale > 0°C
Measurable Rainfall	3	5	9	9	11	10	8	9	9	9	9	4	96	Hauteur de pluie mesurable
Measurable Snowfall	12	8	3	*	*	0	0	0	0	*	5	12	40	Hauteur de neige mesurable
Measurable Precipitation	14	11	10	9	11	10	8	9	9	9	13	14	129	Hauteur de précipitation mesurable
Moisture														**Humidité**
Rel. Humidity - 0600L (%)	87	89	87	82	79	75	77	83	90	89	89	88		Humidité relative - 0600L (%)
Rel. Humidity - 1500L (%)	78	70	51	40	40	40	37	38	46	55	72	79		Humidité relative - 1500L (%)

PRINCE GEORGE A

53°53'N 122°41'W/O, 676m — 1942 to/à 1990

	Jan janv	Feb févr	Mar mars	Apr avr	May mai	Jun juin	Jul juill	Aug août	Sep sept	Oct oct	Nov nov	Dec déc	Year année	
Temperature														**Température**
Daily Maximum (°C)	-5.8	-0.7	4.6	10.8	16.0	19.7	22.1	21.4	16.0	9.8	0.6	-4.5	9.2	Maximum quotidien (°C)
Daily Minimum (°C)	-14.1	-10.3	-6.0	-1.4	2.8	6.4	8.4	7.7	3.6	-0.1	-6.8	-12.5	-1.9	Minimum quotidien (°C)
Daily Mean (°C)	-9.9	-5.4	-0.7	4.7	9.4	13.1	15.3	14.6	9.8	4.8	-3.1	-8.4	3.7	Moyenne quotidien (°C)
Extreme Maximum (°C)	12.8	12.8	17.8	29.7	36.0	33.9	34.4	33.4	31.4	25.2	17.4	11.7		Maximum extrême (°C)
Date	981/22+	986/27+	960/20	977/25	983/29	958/24	961/13	981/09	988/04	987/01	981/11	952/13		Date
Extreme Minimum (°C)	-50.0	-45.0	-37.8	-25.6	-8.3	-2.8	-1.7	-3.9	-12.2	-26.5	-41.7	-45.6		Minimum extrême (°C)
Date	950/02	956/15	955/24	954/04	954/01	949/26+	950/31	973/19+	951/26	984/31	955/26	964/16		Date
Degree-Days														**Degrés-jours**
Above 18 °C	0.0	0.0	0.0	0.0	0.6	2.6	9.0	6.9	0.3	0.0	0.0	0.0	19	Au-dessus 18°C
Below 18 °C	867.4	663.9	580.3	398.6	265.9	149.7	93.4	112.2	245.4	408.2	634.4	821.9	5241	Au-dessous 18°C
Above 5 °C	0.5	0.7	2.8	35.4	139.7	242.9	318.6	297.7	150.0	46.3	2.7	0.3	1238	Au-dessus 5°C
Below 0 °C	319.0	174.4	70.8	4.9	0.0	0.0	0.0	0.0	0.1	8.3	124.7	273.2	975	Au-dessous 0°C
Precipitation														**Précipitations**
Rainfall (mm)	5.3	8.2	12.0	19.5	49.2	64.5	60.0	61.2	58.6	51.4	16.6	8.7	415.2	Chutes de pluie (mm)
Snowfall (cm)	60.1	31.6	25.2	8.8	2.5	0.0T	0.0T	0.0T	0.8	8.0	42.7	54.1	233.8	Chutes de neige (cm)
Precipitation (mm)	54.4	35.0	34.3	28.3	51.7	64.5	60.0	61.2	59.3	59.4	52.7	53.8	614.7	Précipitations (mm)
Extreme Daily Rainfall (mm)	12.4	17.8	18.0	25.5	24.9	38.9	28.2	50.0	33.3	38.9	24.9	16.0		Extrême quotidien de pluie (mm)
Date	960/29	962/02	957/31	990/24	984/13	960/06	983/13	948/04	964/24	962/03	972/01	976/16		Date
Extreme Daily Snowfall (cm)	29.0	22.9	19.8	21.8	9.4	0.5	0.2	0.0	9.1	22.1	26.9	30.8		Extrême quotidien de neige (cm)
Date	958/22	954/12	955/21	966/10	968/05	974/06	989/29	990/31+	961/28	971/25	965/22	990/30		Date
Extreme Daily Pcpn. (mm)	29.0	22.9	19.8	25.5	24.9	38.9	28.2	50.0	33.3	38.9	28.4	29.0		Extrême quotidien de préc. (mm)
Date	958/22	954/12	955/21	990/24	984/13	960/06	983/13	948/04	964/24	962/03	972/01	949/14		Date
Month-end Snow Cover (cm)	31	22	7	0	0	0	0	0	0	1	11	21		Couver. de neige, fin de mois (cm)
Days With														**Journées avec**
Maximum Temperature > 0°C	10	16	26	30	31	30	31	31	30	30	19	10	294	Température maximale > 0°C
Measurable Rainfall	2	3	5	7	13	14	13	13	13	13	6	3	107	Hauteur de pluie mesurable
Measurable Snowfall	16	12	9	5	1	*	*	0	*	3	13	15	75	Hauteur de neige mesurable
Measurable Precipitation	16	13	12	9	13	14	13	13	13	15	16	17	166	Hauteur de précipitation mesurable
Freezing Precipitation	1	1	*	*	0	0	0	0	0	*	*	2	6	Précipitation verglaçante
Fog	5	6	3	1	2	3	4	6	9	7	7	6	57	Brouillard
Thunderstorms	0	*	*	1	3	5	6	5	2	*	0	0	22	Orages
Sunshine (Hrs)	55.9	84.2	145.5	205.9	245.3	270.9	292.4	258.9	161.9	112.2	61.0	48.2	1942.4	**Insolation (h)**
Station Pressure (kPa)	93.40	93.33	93.19	93.30	93.39	93.40	93.60	93.56	93.56	93.38	93.21	93.35	93.39	**Pression à la station (kPa)**
Moisture														**Humidité**
Vapour pressure (kPa)	0.31	0.35	0.41	0.49	0.68	0.93	1.11	1.12	0.89	0.65	0.44	0.34	0.64	Pression de vapeur (kPa)
Rel. Humidity - 0600L (%)	80	80	79	76	76	79	84	88	90	85	84	83		Humidité relative - 0600L (%)
Rel. Humidity - 1500L (%)	75	68	55	42	43	46	47	49	55	61	76	79		Humidité relative - 1500L (%)
Wind														**Vent**
Speed (km/h)	11	11	11	11	10	9	8	8	9	12	12	11	10	Vitesse (km/h)
Most Frequent Direction	S	S	S	S	S	S	S	S	S	S	S	S	S	Direction la plus fréquente
Extreme Hourly Speed (km/h)	68	64	80	61	61	55	56	63	58	72	74	64		Vitesse horaire extrême (km/h)
Direction	S	W	S	SW	S	SW	S	S	N	S	S	S		Direction
Extreme Gust Speed (km/h)	129	113	121	119	101	97	113	92	91	129	121	105		Vitesse extrême du coup de vent (km/h)
Direction	S	W	S	W	W	S	SW	W	S	W	S	S		Direction

VANCOUVER INT'L A

49°11'N 123°10'W/O, 3m — 1937 to/à 1990

	Jan janv	Feb févr	Mar mars	Apr avr	May mai	Jun juin	Jul juill	Aug août	Sep sept	Oct oct	Nov nov	Dec déc	Year année	
Temperature														**Température**
Daily Maximum (°C)	5.7	8.0	9.9	12.7	16.3	19.3	21.7	21.7	18.4	13.5	9.0	6.1	13.5	Maximum quotidien (°C)
Daily Minimum (°C)	0.1	1.4	2.6	4.9	7.9	11.0	12.7	12.9	10.1	6.4	3.0	0.8	6.1	Minimum quotidien (°C)
Daily Mean (°C)	3.0	4.7	6.3	8.8	12.1	15.2	17.2	17.4	14.3	10.0	6.0	3.5	9.9	Moyenne quotidien (°C)
Extreme Maximum (°C)	15.3	18.4	19.4	25.0	30.4	30.6	31.7	33.3	29.3	23.5	18.4	14.9		Maximum extrême (°C)
Date	981/21+	986/27	960/25	987/27	983/29	970/02	961/13	960/09	988/03	980/03	980/04	980/26		Date
Extreme Minimum (°C)	-17.8	-16.1	-9.4	-3.3	0.6	3.9	6.7	6.1	0.0	-5.9	-14.3	-17.8		Minimum extrême (°C)
Date	950/14	950/01	955/04+	951/19	954/01	976/01	949/02	937/28	950/29	984/31	985/27	968/29		Date
Degree-Days														**Degrés-jours**
Above 18 °C	0.0	0.0	0.0	0.0	0.4	4.0	15.7	16.3	1.7	0.0	0.0	0.0	38	Au-dessus 18°C
Below 18 °C	466.4	375.9	362.9	276.2	183.1	88.8	39.5	36.0	112.8	248.8	360.3	451.1	3002	Au-dessous 18°C
Above 5 °C	18.4	29.1	53.5	114.2	220.2	305.1	379.2	383.2	278.9	155.3	55.2	25.4	2018	Au-dessus 5°C
Below 0 °C	16.9	4.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.7	15.3	41	Au-dessous 0°C
Precipitation														**Précipitations**
Rainfall (mm)	131.6	115.6	105.4	74.9	61.7	45.7	36.1	38.1	64.4	115.3	167.2	161.2	1117.2	Chutes de pluie (mm)
Snowfall (cm)	20.6	8.6	4.1	0.5	0.0T	0.0	0.0	0.0	0.0	0.0T	2.6	18.6	54.9	Chutes de neige (cm)
Precipitation (mm)	149.8	123.6	108.8	75.4	61.7	45.7	36.1	38.1	64.4	115.3	169.9	178.5	1167.4	Précipitations (mm)
Extreme Daily Rainfall (mm)	68.3	64.2	49.3	44.5	29.0	40.4	45.2	31.8	49.5	60.7	65.0	89.4		Extrême quotidien de pluie (mm)
Date	968/18	982/13	974/09	946/10	990/31	942/14	972/12	948/20	959/24	975/29	989/03	972/25		Date
Extreme Daily Snowfall (cm)	29.7	28.6	25.9	3.8	0.0	0.0	0.0	0.0	0.0	0.3	22.1	31.2		Extrême quotidien de neige (cm)
Date	971/13	990/15	962/02	983/10	990/31+	990/30+	990/31+	990/31+	990/30+	971/30+	975/30	968/31		Date
Extreme Daily Pcpn. (mm)	68.3	64.2	49.3	44.5	29.0	40.4	45.2	31.8	49.5	60.7	65.0	89.4		Extrême quotidien de préc. (mm)
Date	968/18	982/13	974/09	946/10	990/31	942/14	972/12	948/20	959/24	975/29	989/03	972/25		Date
Month-end Snow Cover (cm)	1	1	0	0	0	0	0	0	0	0	0	4		Couver. de neige, fin de mois (cm)
Days With														**Journées avec**
Maximum Temperature > 0°C	29	28	31	30	31	30	31	31	30	31	30	29	361	Température maximale > 0°C
Measurable Rainfall	17	15	16	13	12	10	7	7	9	15	19	19	159	Hauteur de pluie mesurable
Measurable Snowfall	5	2	1	*	0	0	0	0	0	*	*	4	13	Hauteur de neige mesurable
Measurable Precipitation	19	16	16	13	12	10	7	7	9	15	19	21	164	Hauteur de précipitation mesurable
Freezing Precipitation	*	*	0	0	0	0	0	0	0	0	*	*	1	Précipitation verglaçante
Fog	5	4	1	*	*	*	*	1	5	7	5	5	34	Brouillard
Thunderstorms	*	*	*	*	*	*	1	*	*	*	*	*	6	Orages
Sunshine (Hrs)	54.9	86.9	131.6	171.9	237.3	242.2	295.9	264.9	188.9	124.4	66.7	53.6	1919.3	Insolation (h)
Station Pressure (kPa)	101.72	101.67	101.54	101.68	101.69	101.64	101.71	101.61	101.64	101.73	101.55	101.68	101.66	Pression à la station (kPa)
Moisture														**Humidité**
Vapour pressure (kPa)	0.67	0.73	0.77	0.86	1.05	1.27	1.44	1.49	1.32	1.06	0.82	0.70	1.02	Pression de vapeur (kPa)
Rel. Humidity - 0600L (%)	88	88	87	85	84	84	85	88	91	91	88	88		Humidité relative - 0600L (%)
Rel. Humidity - 1500L (%)	81	76	70	65	63	63	62	63	69	77	79	82		Humidité relative - 1500L (%)
Wind														**Vent**
Speed (km/h)	12	12	13	13	11	11	11	11	10	11	12	12	12	Vitesse (km/h)
Most Frequent Direction	E	E	E	E	E	E	E	E	E	E	E	E	E	Direction la plus fréquente
Extreme Hourly Speed (km/h)	69	89	77	72	61	52	48	47	64	76	89	71		Vitesse horaire extrême (km/h)
Direction	W	W	W	W	W	W	W	W	W	SE	W	W		Direction
Extreme Gust Speed (km/h)	97	119	108	100	90	69	71	85	87	126	129	100		Vitesse extrême du coup de vent (km/h)
Direction	SW	W	W	W	W	NW	W	NW	W	SE	W	SE		Direction

N VANCOUVER CAPILANO

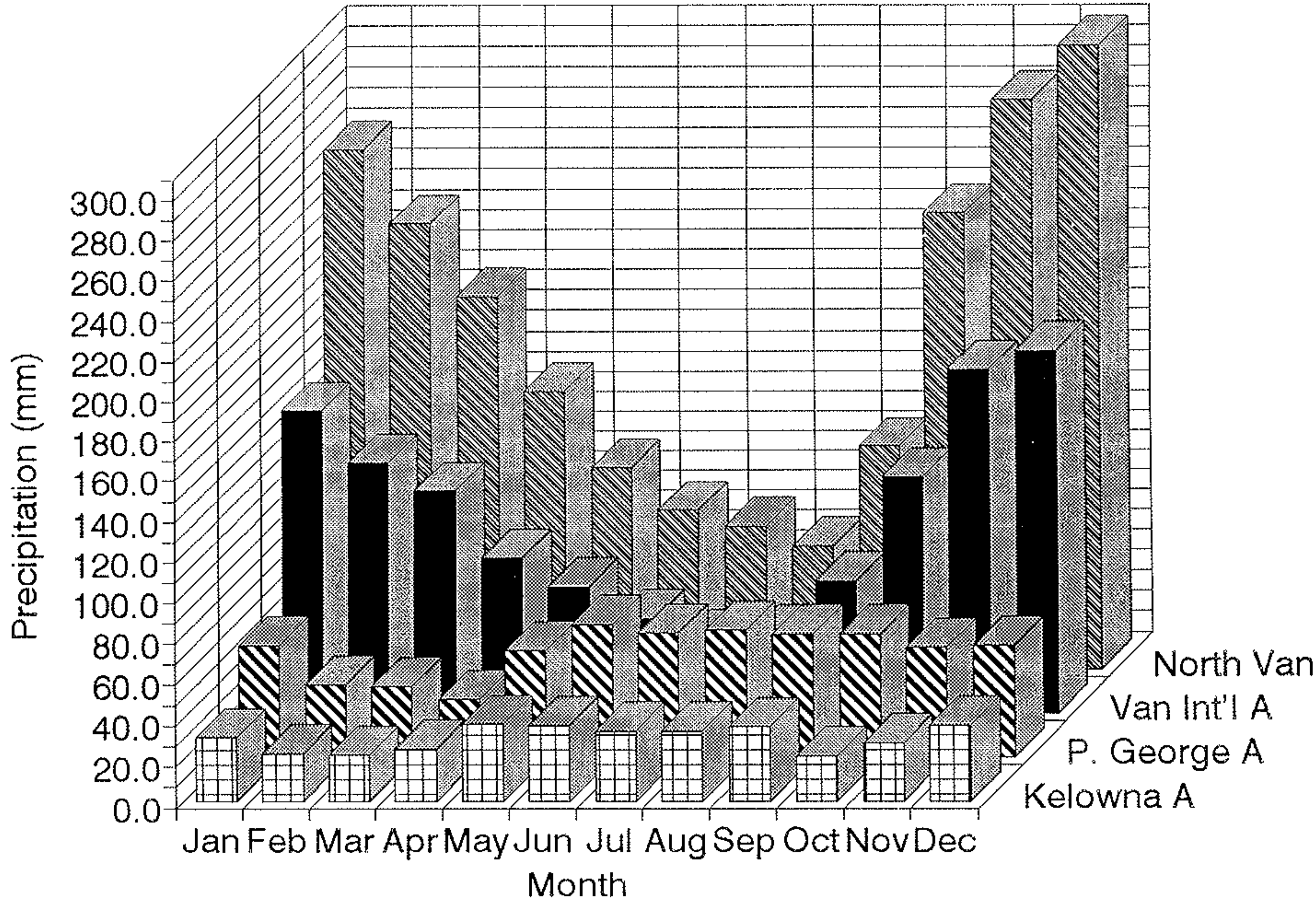
49°21'N 123°07'W/O, 93m — 1955 to/à 1990

	Jan janv	Feb févr	Mar mars	Apr avr	May mai	Jun juin	Jul juil	Aug août	Sep sept	Oct oct	Nov nov	Dec déc	Year année	
Precipitation														Précipitations
Rainfall (mm)	233.8	209.7	181.8	137.4	99.5	77.8	69.8	60.2	110.0	225.7	277.2	284.6	1967.2	Chutes de pluie (mm)
Snowfall (cm)	23.1	11.1	2.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0T	3.6	22.9	63.8	Chutes de neige (cm)
Precipitation (mm)	256.8	220.7	184.5	137.7	99.5	77.8	69.8	60.2	110.0	225.8	280.9	307.5	2031.1	Précipitations (mm)
Extreme Daily Rainfall (mm)	115.8	84.4	65.0	42.0	75.7	45.2	86.1	42.8	107.2	109.2	122.4	112.0		Extrême quotidien de pluie (mm)
Date	968/18	983/19	974/15	982/02	974/24	956/08	972/11	981/31	968/16	975/16	955/02	972/25		Date
Extreme Daily Snowfall (cm)	27.7	34.3	11.4	5.1	0.0	0.0	0.0	0.0	0.0	2.0	14.2	31.5		Extrême quotidien de neige (cm)
Date	971/12	971/26	956/08	972/08	987/31+	990/30+	990/31+	990/31+	990/30+	984/31	975/30	975/12		Date
Extreme Daily Pcpn. (mm)	115.8	84.4	65.0	42.0	75.7	45.2	86.1	42.8	107.2	109.2	122.4	112.0		Extrême quotidien de préc. (mm)
Date	968/18	983/19	974/15	982/02	974/24	956/08	972/11	981/31	968/16	975/16	955/02	972/25		Date
Month-end Snow Cover (cm)	3	2	0	0	0	0	0	0	0	0	1	M		Couver. de neige, fin de mois (cm)
Days With														Journées avec
Measurable Rainfall	17	16	17	15	12	11	8	8	10	16	19	18	167	Hauteur de pluie mesurable
Measurable Snowfall	4	2	1	*	0	0	0	0	0	*	*	4	12	Hauteur de neige mesurable
Measurable Precipitation	19	17	17	15	12	11	8	8	10	16	20	21	173	Hauteur de précipitation mesurable

Appendix B

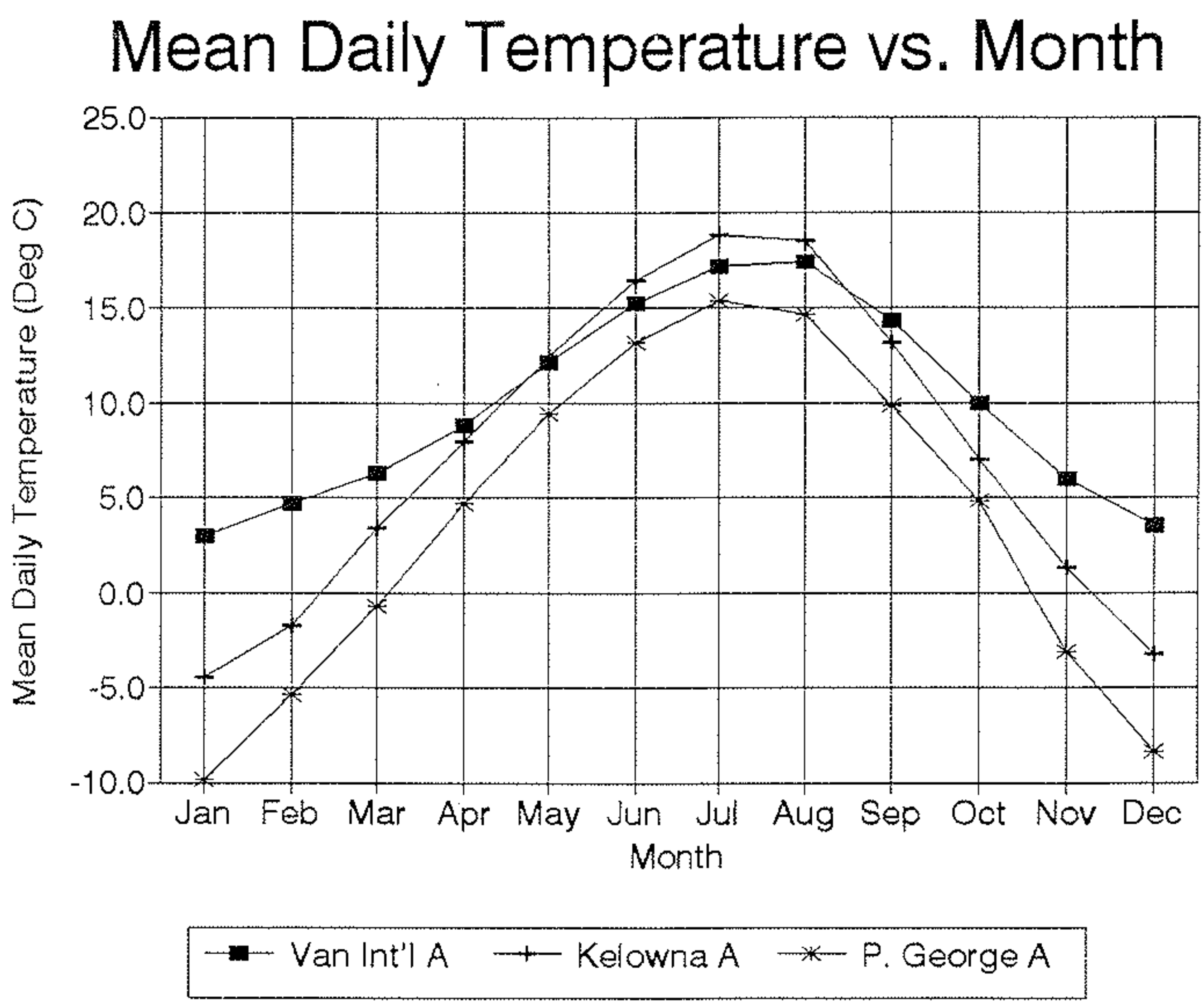
PRECIPITATION COMPARISON

Precipitation vs. Month



Appendix C

TEMPERATURE COMPARISON

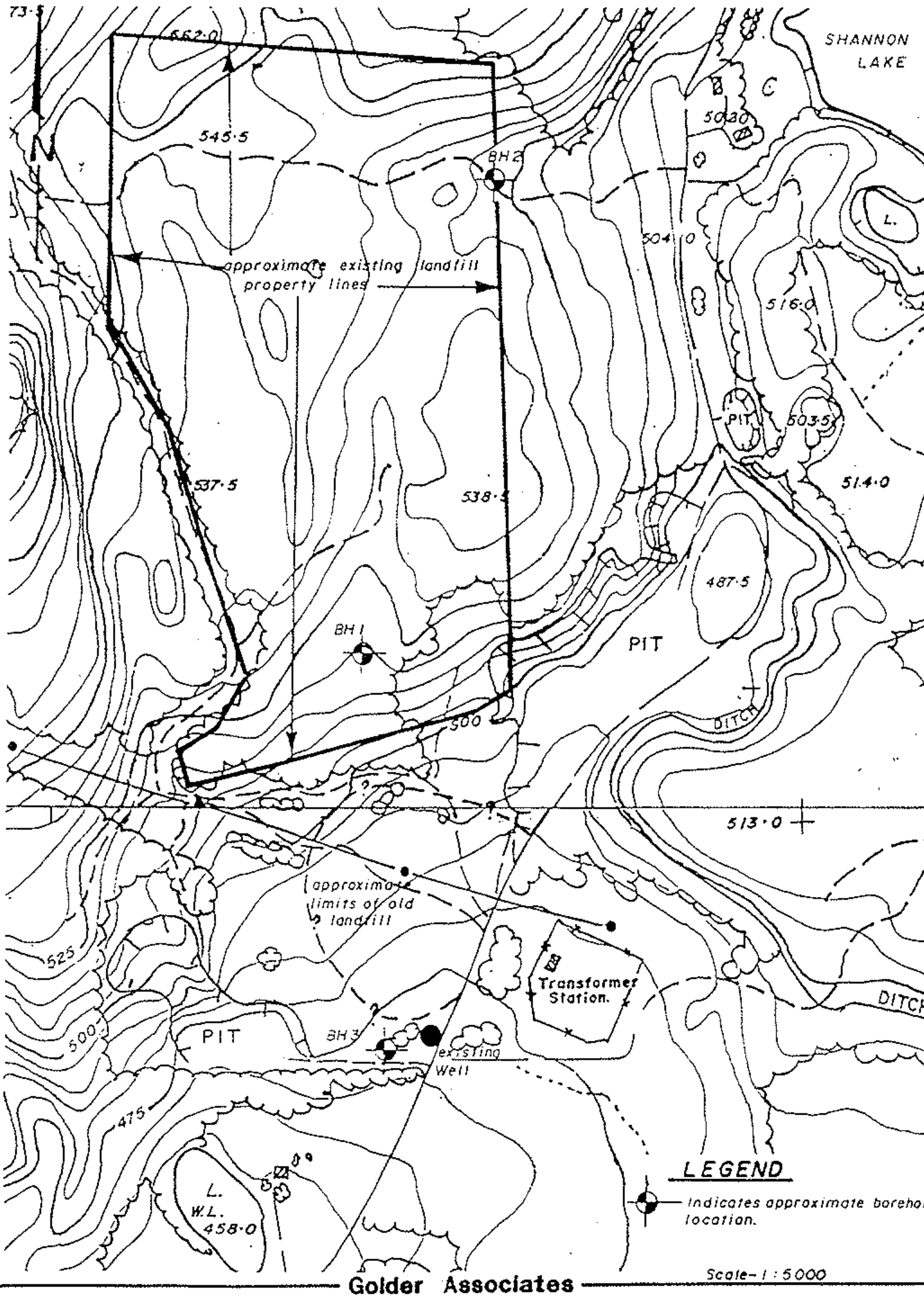

Mean Daily Temperature vs. Month
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
Mean Daily Temperature (Deg C)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Van Int'l A
Kelowna A
P. George A

Appendix D

WELL LOCATIONS

BOREHOLE LOCATION PLAN

Figure 2



PROJECT No. 922-4210 DRAWN FF REVIEWED FF DATE Feb./93

Scale - 1 : 5000

Golder Associates

APPENDIX L
PROPOSED FILL PROGRESSION FROM 545m

APPENDIX L
RAMP FILLING PROGRESSION

Once the fill has reached a uniform elevation of approximately 545m, ramp filling should begin.

A berm is first constructed along the eastern edge of the lift, providing a surface to fill against, as well as a visual and sound barrier. This berm can be made from refuse, or if desired, from more inert material such as construction waste which has been stockpiled for the purpose. Approximate volume of the berm is $11,500m^3$.

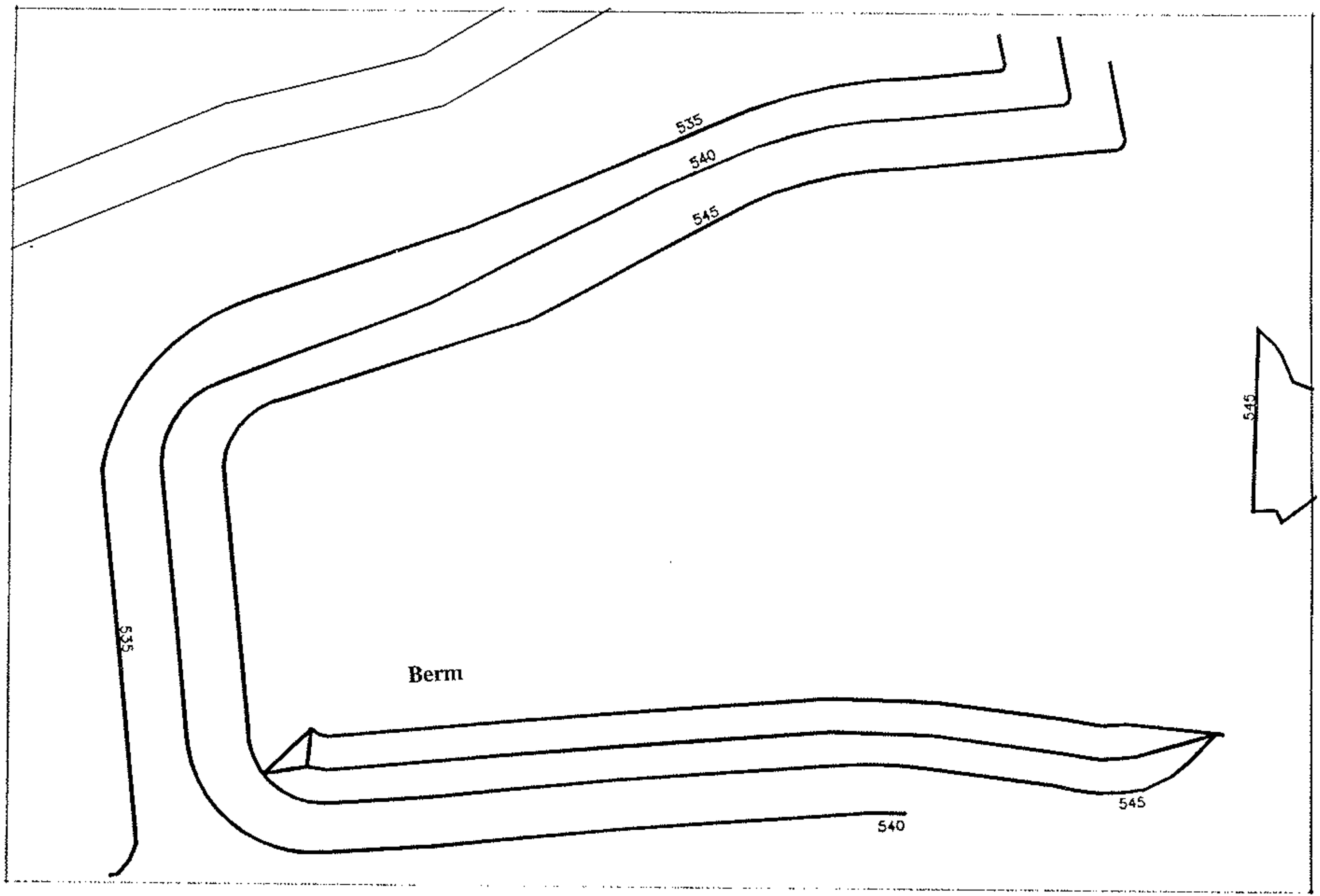
Area 1 is then ready for filling. Beginning at the north end of the berm, cells are placed in a southerly direction for about 100m, or 16 cells. Returning to the north, filling is continued against these cells in the same manner, gradually expanding the fill area to the west. In this way, no more than 16 or 17 days pass before a given cell has another cell is placed on top of it, and will therefore not require additional material as intermediate cover, which must be placed if an area is left unworked for more than 30 days.

Areas 2, 3, and 4 are to be filled in the same manner. Area 3, however, should not be filled to the western limit, as the access road is in this vicinity, and space is required to allow traffic into Area 4. The road should be extended up to the next lift while Area 4 is being filled, and the stockpiles moved up to the next level.

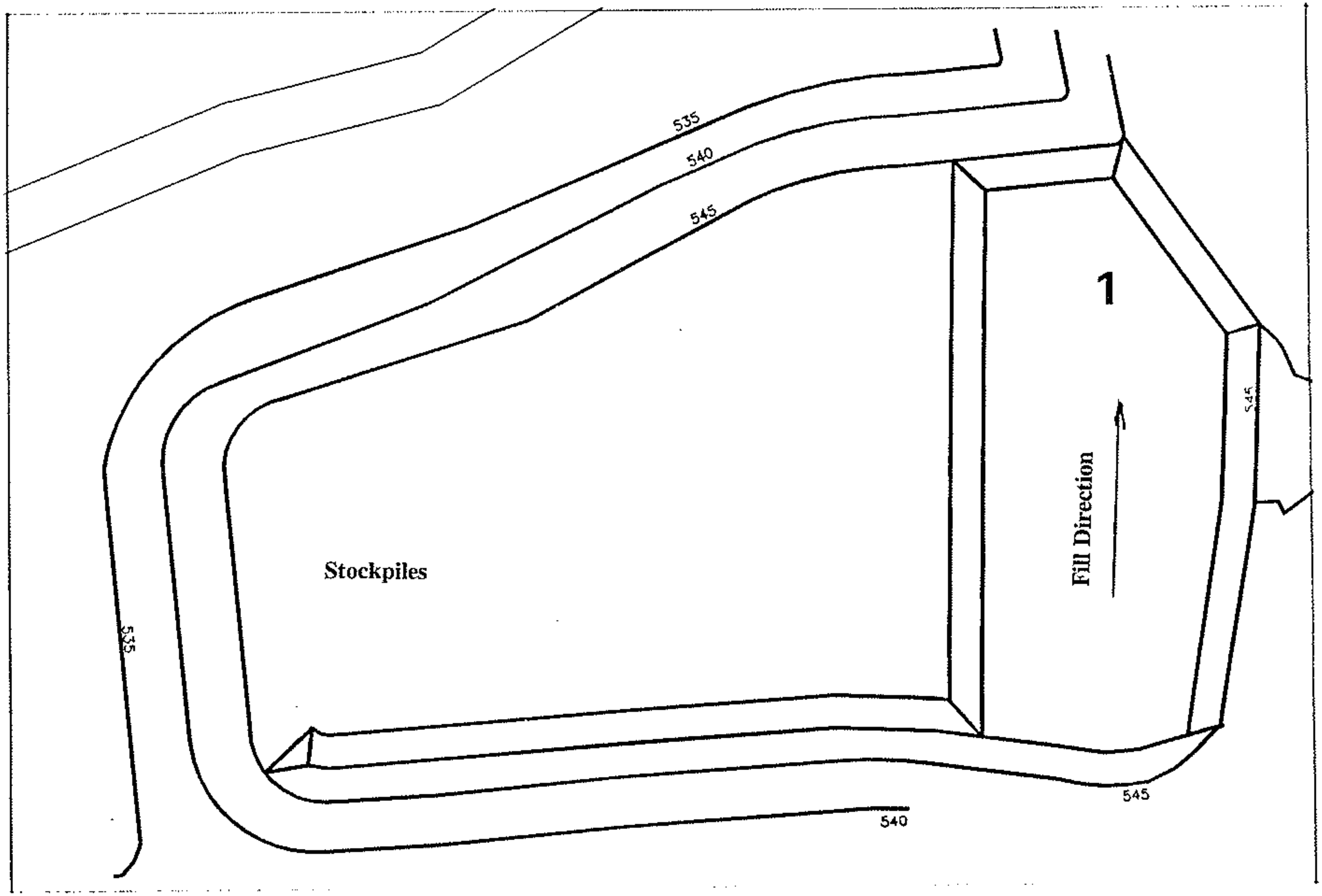
Subsequent lifts should be filled in a similar manner.

The approximate capacity of each area, assuming cells 6m wide and 1.3m deep is:

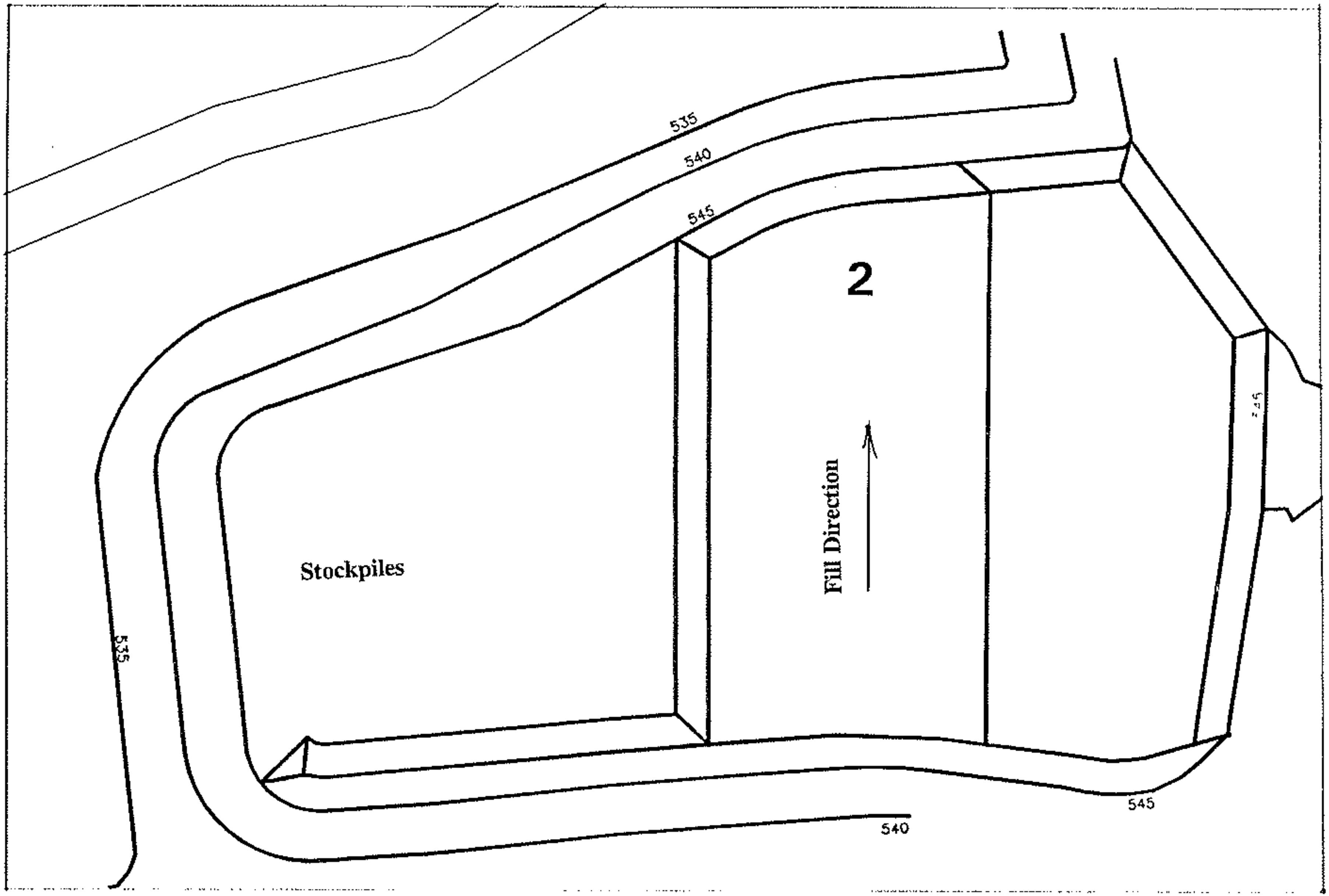
- Area 1, 450 cells;
- Area 2, 480 cells;
- Area 3, 250 cells;
- Area 4, 160 cells;
- Area 5, 120 cells.



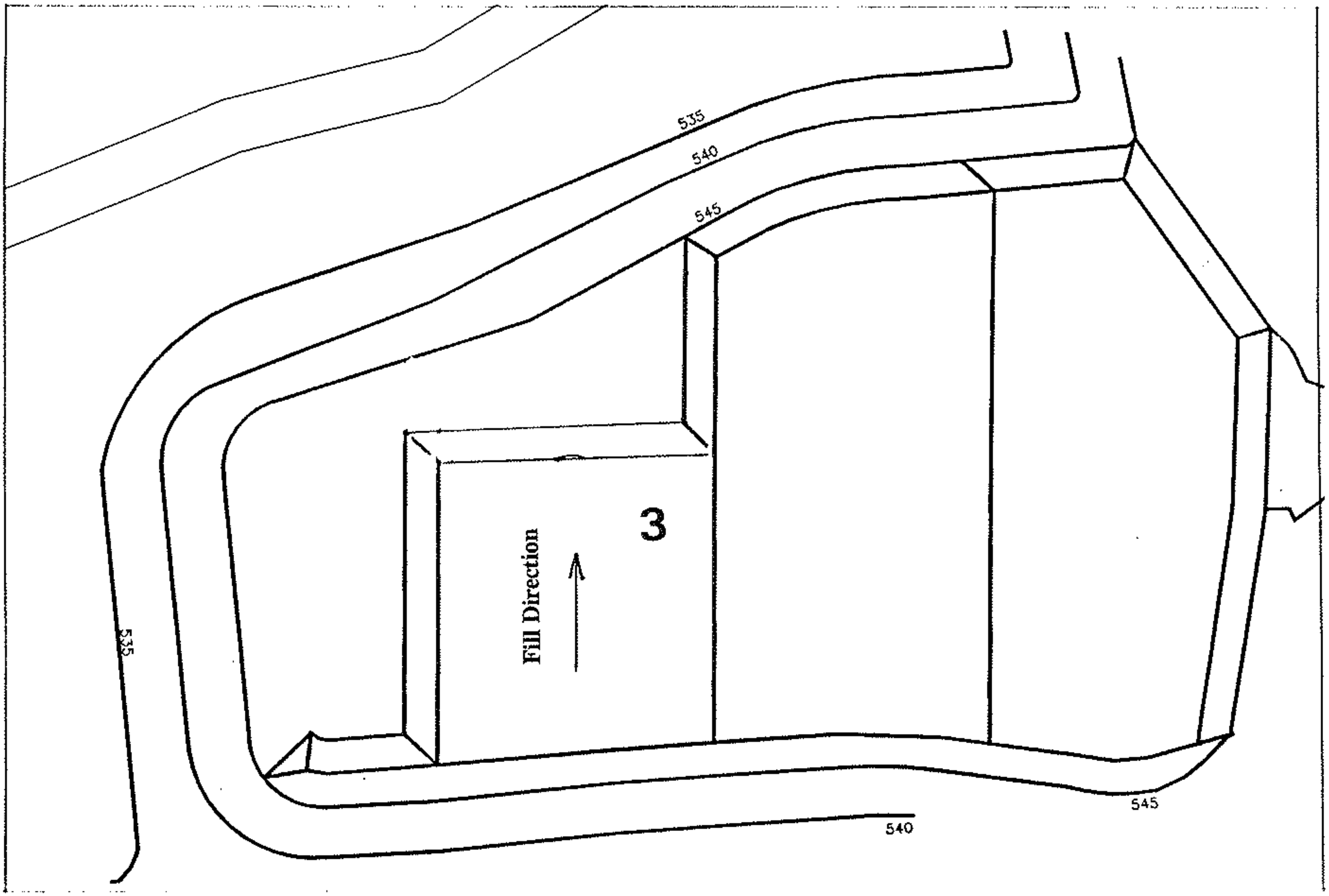
Ramp Filling Progression, First Lift



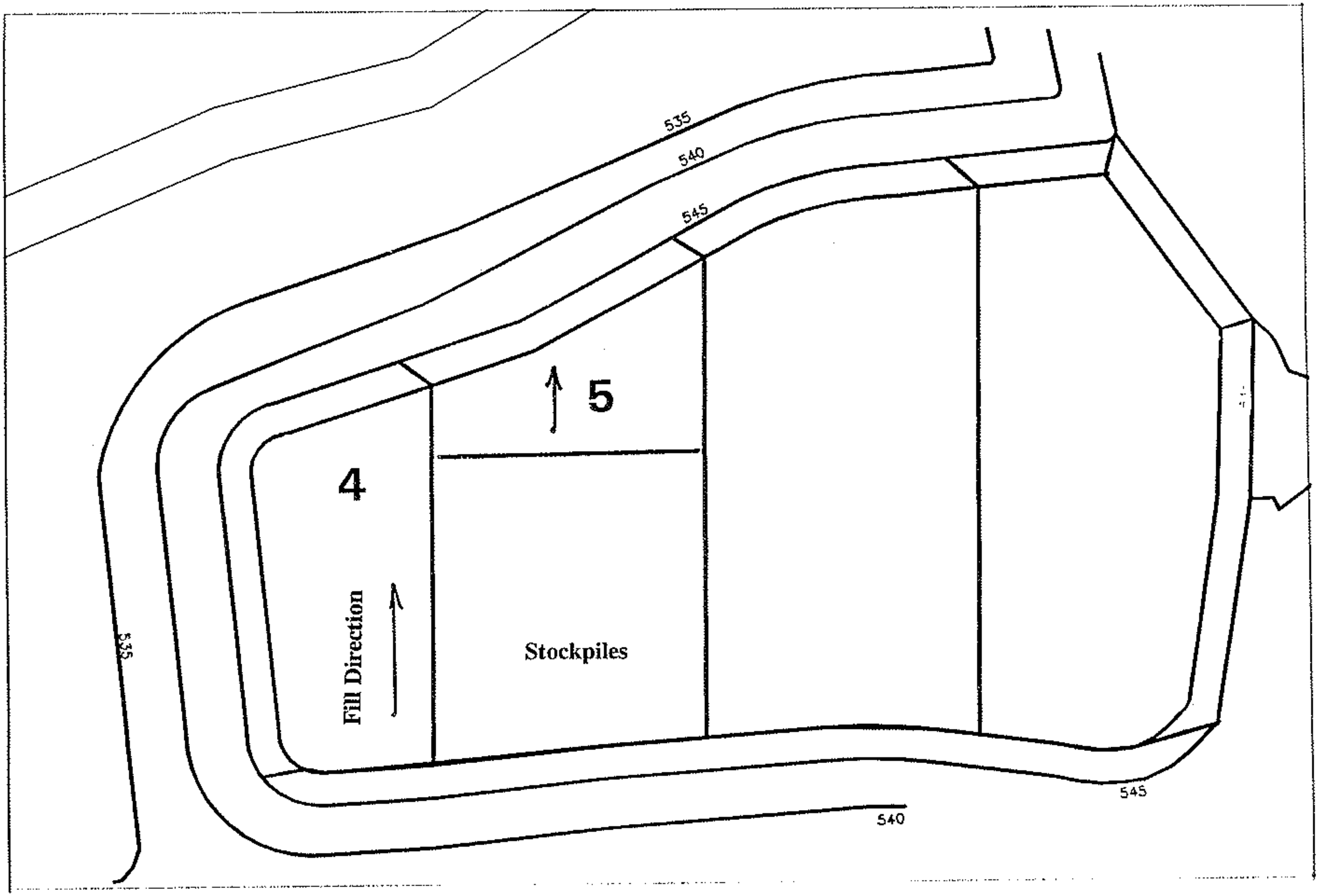
Ramp Filling Progression, First Lift (cont'd)



Ramp Filling Progression, First Lift (cont'd)



Ramp Filling Progression, First Lift (cont'd)



Ramp Filling Progression, First Lift (cont'd)

APPENDIX M
MANAGEMENT OF SPECIFIC SPECIAL WASTES

Prohibition

39. No person shall deposit or discharge or allow or cause special waste to be deposited or discharged into any system of waste disposal operated by a municipality or other public authority unless the deposition or discharge is expressly authorized by a permit, approval, order, regulation or a waste management plan approved by the minister.

PART 6
MANAGEMENT OF SPECIFIC SPECIAL WASTES

Management of waste asbestos

40. (1) No person shall deposit waste asbestos in a landfill other than a secure landfill unless

(a) a permit has been issued under the Act to operate the landfill, or the landfill is operated under a waste management plan,

(b) the waste asbestos is confined during handling, storage and transportation by

(i) dry airtight containment techniques such as

(A) packing in 6 mil plastic bags placed within a non-reuseable drum and then sealed, or

(B) packing in a 6 mil plastic bag placed within a second 6 mil plastic bag and then sealed, or

(ii) wet containment techniques such as saturation with water and containment in non-leaking sealed drums or equivalent, or

(iii) approved containment techniques,

(c) the waste asbestos is disposed of at the landfill by being immediately buried with a minimum of 0.5 m of cover material,

(d) approval of the landfill owner is received before disposal takes place, and

(e) the deposit is authorized by a manager and carried out in accordance with the manager's requirements.

Waste oil

41. (1) Subject to this section, the disposal of waste oil

(a) in the manufacture of pavement,

(b) on any land for the purpose of road construction, repair or dust suppression, or

(c) by combustion as a fuel

is authorized.

(2) No person shall without approval mix waste oil with any material in the manufacture of pavement unless the waste oil meets the following specifications:

Waste Oil Specifications for Manufacture or Applications

Constituent/Property	Allowable Level
flash point	60°C minimum
total arsenic	20 mg/ℓ maximum
total cadmium	3.0 mg/ℓ maximum
total organic halogens (as Cl)	2 000 mg/ℓ maximum
total chromium	10 mg/ℓ maximum
total lead	1 000 mg/ℓ maximum
total polychlorinated biphenyls	5.0 mg/ℓ maximum
total zinc	1 000 mg/ℓ maximum

(3) No person shall, without approval, apply waste oil to any land for the purposes of road construction, repair or dust suppression unless

(a) the waste oil meets the specifications in subsection (2),

(b) the location of proposed application is more than 25 m from surface water or a domestic well,

(c) the application rate will not result in a visible runoff of oil beyond the travelled portion of the road or other land, and

(d) permission has been given by the owner of the land to which the oil is to be applied.

(4) Where a manifest, required under section 5 of the Act, is prepared for the transportation of waste oil for a purpose permitted under subsection (3), the person having the duty of preparing Part C of the manifest shall

(a) identify the land to which the oil is to be applied as the "Receiving Site Address", and

(b) name the owner or lessee of that land as the consignee.

(5) No person shall, without approval, use waste oil as a fuel unless it meets the following specifications:

Waste Oil Specifications for Use as Fuel

Constituent/Property	Allowable Level
flash point	43°C minimum
total arsenic	5.0 mg/ℓ maximum
total cadmium	2.0 mg/ℓ maximum
total organic halogens (as Cl)	1 500 mg/ℓ maximum
total chromium	10 mg/ℓ maximum
total lead	50 mg/ℓ maximum
total polychlorinated biphenyls	3.0 mg/ℓ maximum
total zinc	500 mg/ℓ maximum

Pest control product wastes and containers

42. (1) In this section

"appropriate solvent" means a solvent that does not contain a pest control product and is capable of dissolving or removing a pest control product;

"**empty**" means

(a) to drain a liquid product residue from a container into a spray tank or mixing tank for a period of not less than 30 seconds,

(b) to remove an inner liner, where present, and shake all product residue into a spray tank or mixing tank, or

(c) to use all the product in a pressurized metal container without puncturing the container;

"**pressure rinse**" means to clean by means of pressurized spraying of an appropriate solvent into an empty container for at least 30 seconds so that all interior surfaces of the container are rinsed;

"**product**" means pest control product;

"**rinse**" means

(a) to introduce an appropriate solvent into an empty container in an amount not less than 20% of its volume,

(b) to close and shake the container so that the solvent makes contact with all interior surfaces, and

(c) to open and empty the container.

(2) Subject to this section, the disposal of

(a) a waste product container, and

(b) a waste containing a product

is authorized.

(3) A waste containing a product is not a special waste if

(a) the waste does not fit the criteria for classes 3 to 6.1 and 8 of the Federal Regulations,

(b) the product has a subsidiary classification of 9.2 in the Federal Regulations and is in a concentration less than 0.01%, and

(c) the aquatic toxicity (the 96 hour LC_{50}) of the waste is greater than 500 mg/ℓ as measured by approved methods.

(4) A waste product container that is

(a) emptied and rinsed in the manner set out in this section, or

(b) labelled "Domestic" by the manufacturer and emptied

is not a special waste.

(5) Prior to disposal of a waste product container, the owner of it shall

(a) empty the container, and

(b) rinse it using the appropriate method indicated in the following table.