

Golder Associates Ltd.

10th Floor, 940 6th Avenue S.W.
Calgary, Alberta, Canada T2P 3T1
Telephone (403) 299-5600
Fax (403) 299-5606

*This document has been
digitized by the Oil Sands
Research and Information
Network, University of
Alberta, with permission of
Alberta Environment and
Sustainable Resource
Development.*



REPORT ON

**HYDROGEOLOGY WINTER WORK PROGRAM
OIL SANDS LEASE 13**

Submitted to:

**Shell Canada Limited
400 - 4 Avenue SW
P.O. Box 100, Station 'M'
Calgary, AB T2P 2H5**

December 1997

972-2221

Golder Associates Ltd.

10th Floor, 940 6th Avenue S.W.
Calgary, Alberta, Canada T2P 3T1
Telephone (403) 299-5600
Fax (403) 299-5606



January 14, 1998

Proj. No. 972-2221

Dr. Doug Mead
Senior Environmental Scientist
Safety and Environmental Resources
Shell Canada Limited.
400 - 4th Avenue SW
P.O. Box 100, Station M
Calgary, AB T2P 2H5

RE: Lease 13 Winter Work Program - Final Report for Hydrogeology

Dear Doug:

Attached is the final report for the Hydrogeology Winter Work Program for Shell Oil Sands Lease 13. This data report provides a review of the Hydrogeology Winter Work program completed for Shell in 1997. No data interpretation has been undertaken as this was planned as part of the Hydrogeology component of the Muskeg River Mine Project Environmental Impact Assessment.

If you have any questions about the final report, please call me at 299-5640.

Yours very truly,

GOLDER ASSOCIATES LTD.


John R. Gulley
Oil Sands Project Director

attachment

cc. Judy Smith (Shell)
Ian Mackenzie (EIA Project Manager)

r:\1997\2221\5000\shell5.ltr

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
2.0 PROCEDURES.....	2
3.0 RESULTS	4
4.0 CLOSURE	5

LIST OF TABLES

Table 1	Summary of Monitoring Well Data
Table 2	Field Water Quality Parameters

LIST OF FIGURES

Figure 1	Monitoring Well Location Map
Figure 2	Completion Details MW97-47
Figure 3	Completion Details MW97-47A

LIST OF APPENDICES

Appendix I	Record of Borehole Logs
Appendix II	Laboratory Reports

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) undertook the hydrogeology component of the Shell Canada Limited (Shell) 1997 Winter Work Program at Oil Sands Lease 13. The purpose of the hydrogeology work was to obtain additional information that would be needed for completing an Environmental Impact Assessment later in 1997. The objectives of the hydrogeology component of the Winter Work Program were to:

- identify the types of surficial (overburden) deposits adjacent to the Muskeg River;
- determine the elevation of the water table at several sites adjacent to the Muskeg River;
- obtain data for estimating the hydraulic conductivity of the surficial deposits;
- obtain water quality data for the surficial deposits;
- determine the depth, thickness and hydraulic conductivity of the Basal Aquifer near Isadore's Lake;
- obtain water quality data for the Basal Aquifer near Isadore's Lake; and
- obtain data to be used to assess the vertical component of groundwater flow above the Devonian surface near Isadore's Lake.

2.0 PROCEDURES

A considerable number of groundwater monitoring wells were installed in Lease 13 between 1979 and 1981 as part of the Shell Alsands project. Available information indicated that many of the wells were located adjacent to the Muskeg River. The first task of the Winter Work Program was to conduct a search for those wells and, if found, to obtain the required information for the surficial deposits from the wells. The UTM coordinates of eleven wells were provided to McMurray Resources Ltd. (MRRT) of Fort McMurray (under subcontract to Golder) who subsequently conducted a field search on March 13 and 14, 1997. However, none of the wells could be found, therefore new wells had to be installed.

A total of eight groundwater monitoring wells were installed, tested and sampled during the Lease 13 Winter Work Program in March and April, 1997. Six shallow wells, designated as MW97-1 to MW97-6, were installed at six sites located near the Muskeg River. Two deeper wells, designated as MW97-47 and MW97-47A, were installed at one site located approximately 300 m east of Isadore's Lake. The locations of the wells are shown on Figure 1. The six shallow wells were drilled and constructed by Mobile Augers and Research Ltd. of Edmonton, Alberta under the supervision of Mr. B. Kirkham of MRRT Ltd. The two deeper wells were drilled and constructed by Elgin Drilling Ltd. of Calgary, Alberta under the supervision of Mr. J. Reinson of Golder. The deeper wells were completed on March 25/26, 1997, and the shallow wells were installed between March 27 and 29, 1997. All drilling and well completion work was completed using Golder's protocols for hydrogeologic installations.

The boreholes for the six shallow wells were drilled to depths ranging from 2.2 to 6.7 m using solid stem augers. Monitoring wells were completed in the boreholes to total depths ranging from 1.7 to 5.2 m. The wells were completed with 51 mm PVC pipe and screen. The annular spaces of the wells were filled with, in ascending order, 10/20 filter sand, bentonite and cement grout. A steel casing protector with locking cap was installed over the PVC casing stickup of each well. The keys for the locks are currently in the possession of MRRT Ltd. in Fort McMurray. Upon completion, the wells were developed using bailers until the groundwater recharging the wells was clear. All wells contained groundwater except MW97-6. Completion diagrams for the wells are included in Appendix I.

The boreholes for the two deeper wells installed near Isadore's Lake, MW97-47 and MW97-47A, were drilled to depths of 101.0 and 24.5 m, respectively, using a mud rotary rig. These two wells are located approximately 3 m apart. The Oil Sand, Water Sand and Basal Sand deposits were cored, and the cores were packed, labelled and stored according to Shell's procedures. Once the boreholes had been drilled, Schlumberger Canada Ltd. ran a suite of geophysical logs to total depth. One monitoring well was completed in each borehole to a total depth of 89.0 m (MW97-47) and 22.9 m (MW97-47A). MW97-47 was completed in the Basal Aquifer and MW97-47A was completed in a Water Sand deposit (intra-oil sand deposit). One monitoring well was to have been completed at the water table at the site, but the 3.3 m of surficial deposits overlying the oil sand at the site was unsaturated. The monitoring wells were completed using the same materials noted above for the shallow wells. Upon completion, the wells were developed using bailers until the groundwater recharging the wells was clear. Completion diagrams for the wells are provided on Figures 2 and 3.

Can-Am Surveys Ltd. of Edmonton, Alberta, (under subcontract to Golder), surveyed the locations of the six shallow monitoring wells on April 3, 1997. The location and elevation of MW 97-47 was surveyed as part of the geophysical logging package by Schlumberger on March 26, 1997. Well MW 97-47A is only 3 m from MW 97-47, and at virtually the same elevation; therefore its coordinates were not surveyed separately.

Hydraulic response (rising head) tests were performed on six of the monitoring wells on April 4, 1997, and on one well on May 1, 1997. The purpose of the tests was to obtain data for estimating the hydraulic conductivity of the geologic material in which each well was completed. Tests were completed on all of the wells except MW97-2 and MW97-47A, for which the rate of water-level recovery following bailing was too rapid for the measurement of water levels.

Groundwater samples were collected from seven of the eight wells (MW97-6 was dry) on April 4, 6 and 10, 1997. A duplicate sample from MW 97-47A, labelled MW97-07, was also obtained for QA purposes. The samples were submitted to Enviro-Test Laboratories Ltd. of Edmonton, Alberta. All seven samples were analysed for "routine" water quality parameters (major parameters and major ions). A sample from MW 97-03 was also analysed for polycyclic aromatic hydrocarbons (PAHs), alkylated PAHs and phenolic compounds.

3.0 RESULTS

Descriptions of the geologic materials encountered by the boreholes drilled for MW97-1 to MW97-6 are presented on the Record of Borehole logs (Appendix I). Descriptions of the materials encountered by MW97-47 and MW97-47A are provided on Figures 2 and 3. Detailed descriptions for MW97-47 and MW97-47A are not provided, as the materials penetrated by the boreholes were cored and taken for storage by Shell personnel. In summary, the materials encountered by MW97-1 to MW97-6 consisted of muskeg, silty to sandy clay, fine to medium silty sand and silty gravel.

The water levels in the monitoring wells were measured on April 3, 1997. The water levels and the corresponding water-level elevations are shown in Table 1. The results of the hydraulic response tests are also provided in Table 1. Due to the rapid water-level responses in MW97-2 and MW97-47A, the hydraulic conductivity of the materials in which those two wells are completed is greater than 10^{-2} cm/s.

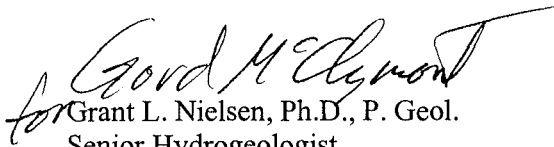
The chemical analysis results for the groundwater samples collected from the wells are presented in the laboratory reports in Appendix II. The field water quality parameters measured at the time of sample collection are shown in Table 2.

4.0 CLOSURE


We trust this report meets your needs and expectations. Please contact the undersigned should you have any questions.


GOLDER ASSOCIATES LTD.

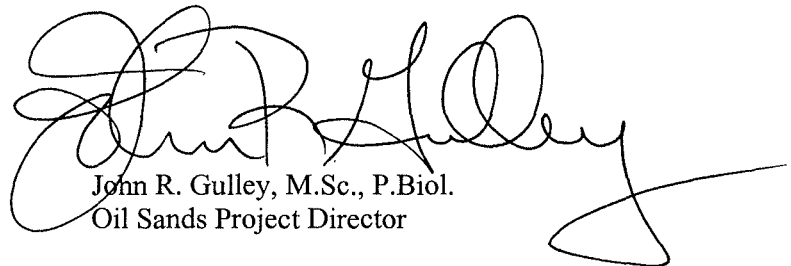
Report prepared by:


for Grant L. Nielsen, Ph.D., P. Geol.
Senior Hydrogeologist

Report reviewed by:


Ian Mackenzie, M.Sc.
EIA Project Manager


Gordon L. McClymont, P.Geol.
Associate, Senior Hydrogeologist


John R. Gulley, M.Sc., P.Biol.
Oil Sands Project Director

December 1997

TABLE 1

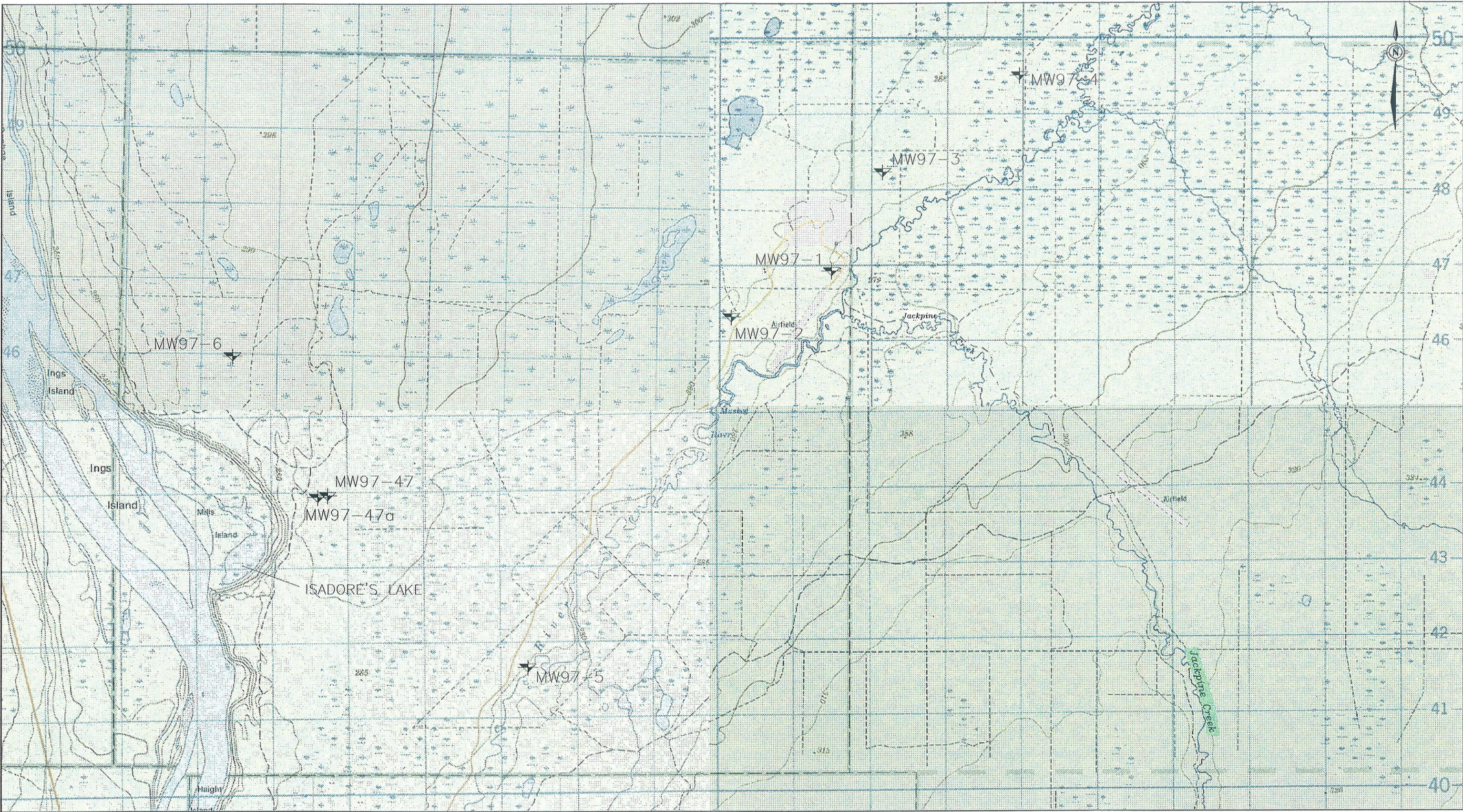
972-2221

SUMMARY OF MONITORING WELL DATA

Monitoring Well	Borehole Total Depth (m)	Well Depth (m)	Lithology	Water level depth (m)	Water level elev.(m)	K (cm/sec)
				April 3, 1997		
MW97-1	4.6	3.7	Silty gravel	3.18	282.32	4×10^{-5}
MW97-2	3.8	2.8	Fine - med. sand	1.17	282.7	$>10^{-2}$
MW97-3	6.7	5.2	Silty fine-med sand	3.48	283.82	9×10^{-5}
MW97-4	4.3	3.3	Silty med. sand	1.14	281.11	2×10^{-5}
MW97-5	4.6	3.7	Fine-med slty grav.	3.51	281.44	2×10^{-4}
MW97-6	2.2	1.7	Sandy silt	dry	dry	--
MW97-47	101	89	Basal Sand	50.5	230.86	$>10^{-2}$
MW97-47A	24.5	22.9	Water sand	14.14	~267.3	7×10^{-6}

FIELD WATER QUALITY PARAMETERS

Well No.	Sampling Date	pH	Elec. Conduct. MicroSeimens	Temp ° C.
MW 97-1	Apr. 4/97	7.14	741	2.1
MW 97-2	Apr. 4/97	7.14	377	1.1
MW 97-3	Apr. 4/97	6.80	518	0.9
MW 97-4	Apr. 4/97	6.96	867	1.3
MW 97-5	Apr. 4/97	7.70	1285	2.3
MW 97-6	Apr. 4/97	Dry	-	-
MW 97-47	Apr. 10/97	7.13	3740	6.9
MW 97-47A	Apr. 6/97	6.92	1326	4.5

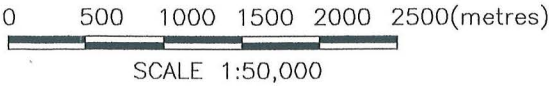




LEGEND

MW97-1  MONITORING WELL AND NUMBER

REFERENCE

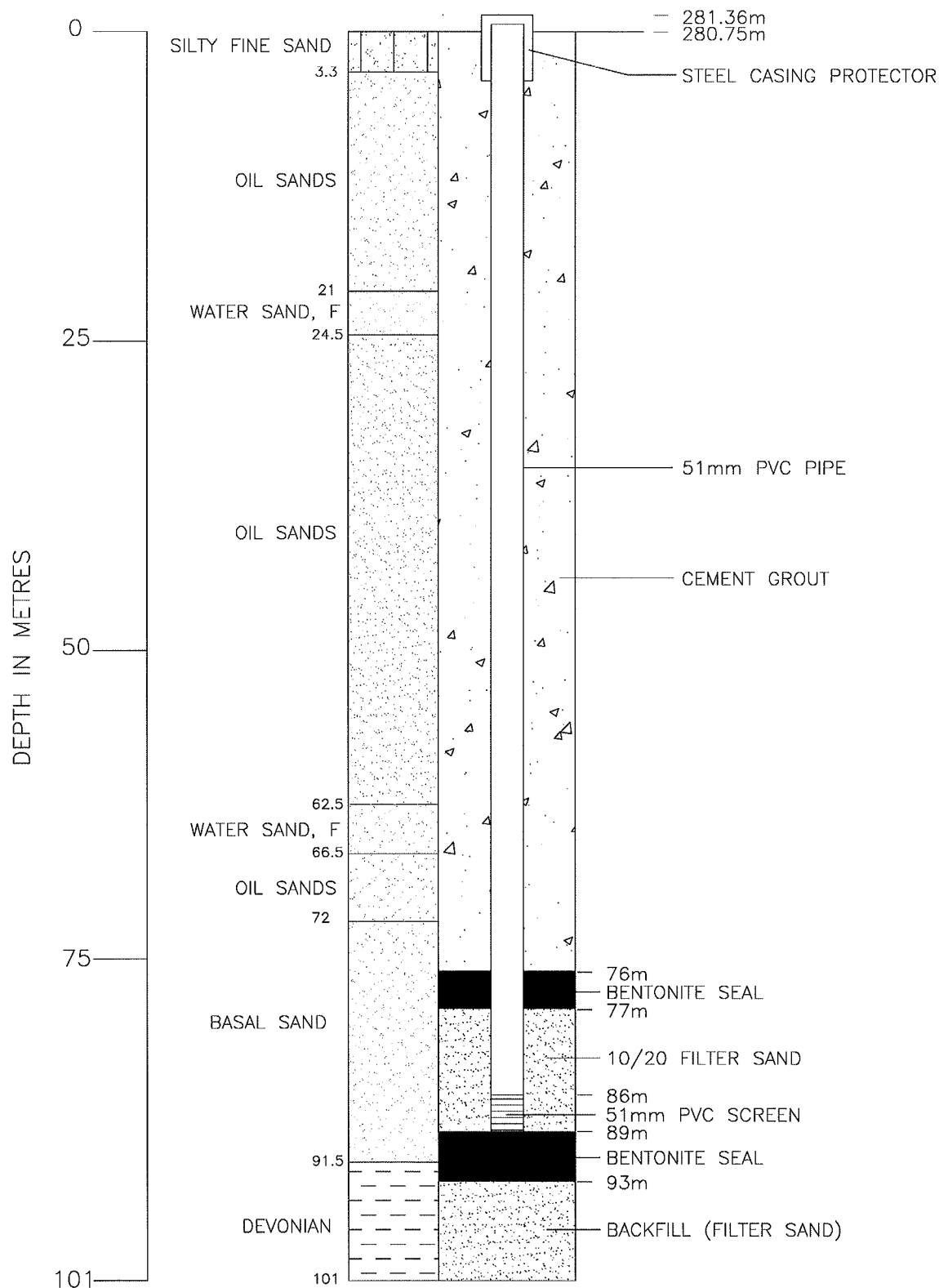
BASE MAP FROM NTS SERIES MAPS 74E/3, 74E/4, 74E/5 and 74E/6



		 SHELL CANADA LIMITED
LOCATIONS OF MONITORING WELLS		
21 MAY 97	FIG. No. 1	JOB No. 972-2221

COMPLETION DETAILS MW 97-47

Figure 2

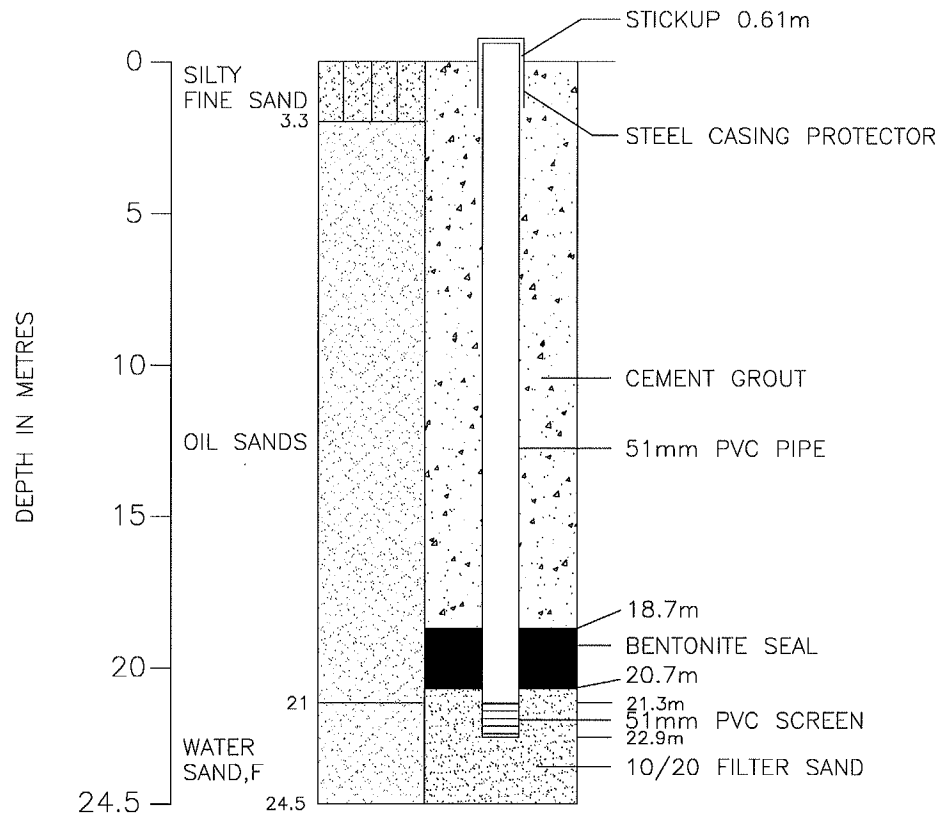


WELL COMPLETED MARCH 26, 1997.

Golder Associates

COMPLETION DETAILS MW 97-47A

Figure 3



WELL COMPLETED MARCH 26, 1997.

PROJECT 972-2221 DRAWN VS REVIEWED DATE 20 MAY 97 J:\1997\2221\MONWELL2

APPENDIX I

RECORD OF BOREHOLE LOGS

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole", on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
SC soil core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 0.3 m (12 in.)

Standard Penetration Resistance, *N*:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 0.3 m (12 in.).

WH sampler advanced by static weight-weight, hammer

PH sampler advanced by pressure-pressure, hydraulic

PM sampler advanced by pressure-pressure, manual

III. SOIL DESCRIPTION

(a) Cohesionless Soils

	<i>'N'</i> <u>Blows/0.3 m</u> <u>or Blows ft.</u>
<i>Relative Density</i>	
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

(b) Cohesive Soils

	<i>'Cu'</i> <u>kPa</u>	<u>psf</u>
<i>Consistency</i>		
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer¹
Q undrained triaxial²
R consolidated undrained triaxial²
S drained triaxial
U unconfined compression
V field vane test

NOTES:

¹Combined analyses when 5 to 95 percent of the material passes the No. 200 sieve

²Undrained triaxial tests in which pore pressures are measured, are shown as \bar{Q} or \bar{R} .

LIST OF SYMBOLS

I. GENERAL

π	= 3.1416
e	= base of natural logarithms 2.7183
$\log_e a$ or $\ln a$	natural logarithm of a
$\log_{10} a$ or $\log a$	logarithm of a to base 10
t	time
g	acceleration due to gravity
V	volume
W	weight
M	moment
F	factor of safety

II. STRESS AND STRAIN

μ	pore pressure
σ	normal stress
σ'	normal effective stress (σ is also used)
τ	shear stress
e	linear stress
e_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) Unit weight

γ	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles
	$G_s = \gamma_s / \gamma_{10}$
e'	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) Consistency

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_S	shrinkage limit
I_L	liquidity index = $(w - w_P) / I_P$
I_C	consistency index = $(w_L - w) / I_P$
e_{\max}	void ratio in loosest state
e_{\min}	void ratio in densest state
D_r	relative density $(e_{\max} - e) / (e_{\max} - e_{\min})$

(c) Permeability

h	hydraulic head or potential
q	rate of discharge
v	velocity of flow
i	hydraulic gradient
k	coefficient of permeability
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

m_v	coefficient of volume change $= -\Delta e / (1 + e) \Delta \sigma'$
C_c	compression index = $-\Delta e / \Delta \log_{10} \sigma'$
c_v	coefficient of consolidation
T_v	time factor = $c_v t / d^2$ (d , drainage path)
U	degree of consolidation

(e) Shear Strength

τ_f	shear strength	
c'	effective cohesion	in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	effective angle of shearing	
	intercept	
c_u	apparent cohesion*	in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
ϕ'	apparent angle of shearing	
	resistance, or friction	
μ	coefficient of friction	
S_t	sensitivity	

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-1

SHEET 1 OF 1

LOCATION: N6346972.36 E471481.81 (UTM ZONE)

BORING DATE: 28 March 97

DATUM:

DIP:

SAMPLER HAMMER,

kg; DROP,

mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES					GAS CONCENTRATION ()				HYDRAULIC CONDUCTIVITY, k, cm/s				INSTALLATIONS		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING	% LEL				WATER CONTENT, PERCENT					
										20	40	60	80	20	40	60	80		
0	Solid Stem Auger	GROUND SURFACE		284.77															
		Silty CLAY, stiff, moist, low to medium plastic, medium brown ---frozen to 0.5m		0.00															
1				284.12															
		Fine to medium silty SAND, trace clay, dense, moist, poorly graded reddish-brown ---occasional pebbles 5mm in diameter		0.65															
2				282.81															
3		Silty GRAVEL, trace clay, damp, coarse, poorly graded, red-brown ---subangular to 50mm diameter		1.96															
4		---seepage at 3.35m., gravel saturated																	
5		FINE Silty OIL SAND, trace clay, damp, dense, dark brown ---oil saturation ---strong hydrocarbon odor		280.67															
				4.10															
6		END OF BOREHOLE		280.17															
7				4.60															
8																			
9																			
10																			

0.73m Steel Casing Stickup

Bentonite Seal

10/20 Sand Filter

3 April 97

Bentonite Seal

-51mm PVC pipe and PVC screen

DATA INPUT: R.Fox

DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G. Nielsen

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-2

SHEET 1 OF 1

LOCATION: N6346326.73 E470167.77 (UTM ZONE)

BORING DATE: 28 March 97

DATUM:


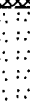
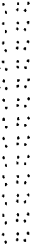

DIP:

SAMPLER: HAMMER,

kg: DROP,

mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES					GAS CONCENTRATION ()		HYDRAULIC CONDUCTIVITY, k, cm/s		INSTALLATIONS		
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING	()		k, cm/s			
				DEPTH (m)						% LEL	□	Wp	W	Wi	
0	Solid Stem Auger	GROUND SURFACE		283.14											<div><div></div><div>.73m Steel Casing Stickup</div></div> <div><div></div><div>3 April 97</div></div> <div><div></div><div>10/20 Sand Filter</div></div> <div><div></div><div>.51mm PVC pipe and PVC screen</div></div> <div><div></div><div>Bentonite Seal</div></div>
		PEAT, fibrous, black ---frozen to 0.3m ---strong organic odour ---becoming granular at 0.3m		0.00											
1		FINE to MEDIUM SAND, trace silt, trace organics, dense, saturated, poorly graded, reddish brown to black ---seepage at 0.6m		282.54 0.60											
2		---becoming greyish-brown at 1.7m													
3		FINE to MEDIUM Silty OIL SAND, trace clay, dense, damp, poorly graded, dark brown ---strong hydrocarbon odour ---oil saturated		280.09 3.05											
4	END OF BOREHOLE ---water at 2.7m upon completion		279.34 3.80												
5															
6															
7															
8															
9															
10															

DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G. Nielsen

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-3

SHEET 1 OF 1

LOCATION: N6348197.85 E472159.91 (UTM ZONE)

BORING DATE: 28 March 97

DATUM:

DIP:

SAMPLER: HAMMER,

kg; DROP, mm.



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES				GAS CONCENTRATION ()		HYDRAULIC CONDUCTIVITY, k, cm/s		INSTALLATIONS		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m RECOVERY %	LAB. TESTING	%		WATER CONTENT, PERCENT			
									20	40	60	80	% LEL	20
0	Solid Stem Auger	GROUND SURFACE		287.30										
		MEDIUM SAND, trace silt, damp, dense, poorly graded, medium brown ---oxidized zone from 3.5m to 3.7m		0.00										
1														
2														
3		Sandy CLAY, firm, moist, medium plastic, greyish brown ---oxidized zones		284.55 2.75										
		---seepage at 3.35m		283.95 3.35										
4		MEDIUM Silty SAND, trace clay, loose to compact, saturated, reddish-brown												
5		---loose to compact at 4.3m. ---trace silt, trace peat at 4.3m. ---strong organic odour at 4.3m. ---saturated at 4.3m. ---poorly graded at 4.3m.												
6		FINE Silty OIL SAND, trace clay, dense, damp, poorly graded, dark brown ---oil saturation ---strong hydrocarbon odour		281.65 5.65										
7		END OF BOREHOLE ---hole sloughed in at 4.4m ---moved 1.5m. Drilled second test hole for monitoring well installation.		280.60 6.70										
8														
9														
10														

Bentonite
Seal

0.7m Steel Casing Stickup

-51mm PVC pipe
and PVC screen3 April 97
10/20 Sand
Filter

DATA INPUT: R.Fox

DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G. Nielsen

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-4

SHEET 1 OF 1

LOCATION: N6349317.77 E473979.21

BORING DATE: 28 March 97

DATUM:

DIP:

SAMPLER HAMMER,

kg; DROP, mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES					GAS CONCENTRATION ()		HYDRAULIC CONDUCTIVITY, k, cm/s		INSTALLATIONS					
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m RECOVERY % LAB. TESTING	20 40 60 80		20 40 60 80								
								% LEL		WATER CONTENT, PERCENT								
								20 40 60 80		Wp — W — Wi 20 40 60 80								
0	Mobile Auger	GROUND SURFACE		282.25														
		Peat, poorly graded, reddish-brown to black ---amorphous granular with scattered fibres ---strong organic odour ---frozen to 0.9m.		0.00														
1																		
2																		
	Solid Stem Auger	CLAY, organic, moist, soft, low plastic, nuggety, light grey ---strong organic odour		280.30 1.95														
		MEDIUM Silty SAND, loose, saturated poorly graded, medium grey ---seepage at 2.29m.		279.95 2.30														
3																		
4																		
		FINE Silty OIL SAND, trace clay, dense, damp, poorly graded, mottled dark brown ---strong hydrocarbon odor ---oil saturation		278.60 3.65														
				278.00 4.25														
		END OF BOREHOLE AT 4.3m.																
5																		
6																		
7																		
8																		
9																		
10																		

0.61m Steel Casing Stickup

Bentonite Seal

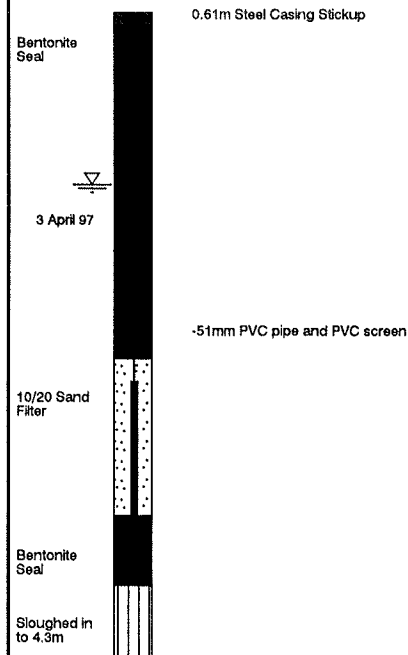
3 April 97

-51mm PVC pipe and PVC screen

10/20 Sand Filter

Bentonite Seal

Sloughed in to 4.3m



DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G. Nielsen

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-5

SHEET 1 OF 1

LOCATION: N6342639.63 E467332.66 (UTM ZONE)

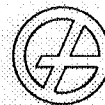
BORING DATE: 28 March 97

DATUM:

DIP:

SAMPLER HAMMER,

kg; DROP, mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES				GAS CONCENTRATION ()				HYDRAULIC CONDUCTIVITY, k, cm/s				INSTALLATIONS			
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING	% LEL				WATER CONTENT, PERCENT					
										20	40	60	80	20	40	60	80	Wp	W
0	Solid Stem Auger	GROUND SURFACE		284.95															
		Silty GRAVEL, trace sand, coarse, dense, moist, poorly graded ---subrounded to 50mm in diameter.		0.00															
1		---scattered, interbedded, fine to medium grained sand, trace silt, damp, poorly graded, reddish-brown at 0.6m.																	
2																			
3																			
		---seepage at 3.51m.																	
		FINE SAND, trace silt, dense, saturated, poorly graded, light reddish brown		281.45															
				3.50															
4		FINE to MEDIUM Silty OIL SAND, trace clay, dense, damp, poorly graded ---oil saturation ---strong hydrocarbon odour		281.00															
				3.95															
				280.35															
				4.60															
5		END OF BOREHOLE ---sloughed in at 4.3m, upon completion																	
6																			
7																			
8																			
9																			
10																			

0.85m Steel Casing Stickup

Bentonite Seal

10/20 Sand Filter

3 April 97

Bentonite Seal

-51mm PVC pipe and PVC screen

DATA INPUT: R.Fox

DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G.Nielsen

PROJECT: 972-2221

RECORD OF BOREHOLE MW97-6

SHEET 1 OF 1

LOCATION: N6345926.26 E463570.99 (UTM ZONE)

BORING DATE: 29 March 97

DATUM:

DIP:

SAMPLER HAMMER,

kg; DROP, mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES				GAS CONCENTRATION () @				HYDRAULIC CONDUCTIVITY, k, cm/s				INSTALLATIONS		
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING	% LEL				WATER CONTENT, PERCENT					
									20	40	60	80	20	40	60	80		
0	Solid Stem Auger	GROUND SURFACE	283.32															
		FOREST LITTER - mixture of roots, leaves, trace top soil, frozen to 0.4m	0.00															
1		Sandy SILT, trace clay, dense, moist, nonplastic, reddish-brown ---becoming dark grey at 0.3m																
2		FINE Silty OIL SAND, trace clay, moist, poorly graded, dark brown ---oil saturation ---strong hydrocarbon odour ---seepage at 2.1m	281.62 1.70 281.12 2.20															
3		END OF BOREHOLE ---hole open upon completion ---test hole dry, April 3, 1997																
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Bentonite Seal

10/20 Sand Filter

Bentonite Seal

---test hole dry upon completion

0.76m Steel Casing Stickup

-51mm PVC pipe and PVC screen

DATA INPUT: R.Fox

DEPTH SCALE (ALONG HOLE)

1 to 50

Golder Associates

LOGGED: B.G. Kirkham

CHECKED: G. Nielsen

APPENDIX II

LABORATORY REPORTS

ETL EnviroTest

LABORATORIES

A DIVISION OF ETL CHEMSPEC ANALYTICAL LIMITED

Edmonton (Main)

9936 - 67 Avenue
Edmonton, AB
T6E 0P5
Phone: (403) 413-5227
Fax: (403) 437-2311

Edmonton (Downtown)

2nd Flr., 10158 - 103 Street
Edmonton, AB
T5J 0X6
Phone: (403) 413-5265
Fax: (403) 424-4602

Calgary

Bay 2, 1313-44th Ave. N.E.
Calgary, AB
T2E 6L5
Phone: (403) 291-9897
Fax: (403) 291-0298

Saskatoon

124 Veterinary Road
Saskatoon, SK
S7N 5E3
Phone: (306) 668-8370
Fax: (306) 668-8383
1-800-667-7645

Winnipeg

745 Logan Avenue
Winnipeg, MB
R3E 3L5
Phone: (204) 945-3705
Fax: (204) 945-0763

Thunder Bay Analytical

1081 Barton Street
Thunder Bay, ON
P7B 5N3
Phone: (807) 623-6463
Fax: (807) 623-7598

Canada Wide Phone:

1-800-668-9878

Western Canada Fax:

1-800-286-7319

CHEMICAL ANALYSIS REPORT

GOLDER ASSOCIATES
1011 6 AVE SW
CALGARY AB T2P 0W1

DATE: April 23, 1997

ATTN: GRANT NIELSON

Lab Work Order #: E704185

Sampled By: BK

Project Reference: 75-003 (MRRT)

Date Received: 04/08/97

Project P.O.#: NOT SUBMITTED

Comments:

Routine samples are preserved and left for overnight, F/Mn are run and calculate base on collected vol./preserved vol.

APPROVED BY:



Erv Callin
Project Manager

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN AUTHORITY OF THE LABORATORY. ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS FOLLOWING ANALYSIS. PLEASE CONTACT THE LAB IF YOU REQUIRE ADDITIONAL SAMPLE STORAGE TIME.

ACCREDITATIONS: STANDARDS COUNCIL OF CANADA (SCC), IN COOPERATION WITH THE CANADIAN ASSOCIATION FOR ENVIRONMENTAL ANALYTICAL LABORATORIES (CAEAL): FOR SPECIFIC TESTS AS REGISTERED BY THE COUNCIL (EDMONTON, CALGARY)
AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA): FOR INDUSTRIAL HYGIENE ANALYSIS (EDMONTON)
AGRICULTURE CANADA: UNDER THE CANADIAN FERTILIZER QUALITY ASSURANCE PROGRAM (SASKATOON)

ENVIRO-TEST CHEMICAL ANALYSIS REPORT

LAB ID	SAMPLE ID	TEST DESCRIPTION	RESULT	D.L.	UNITS	EXTRACTED	ANALYZED	BY
E704185-01 MW97-1 Sample Type:WATER Collected:04/04/97								
		Iron (Fe)	23.2	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	2.08	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	104		%		04/11/97	LS
		Bicarbonate (HCO3)	490	5	mg/L		04/09/97	PTT
		Chloride	2.4	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	5	3	T.C.U.		04/14/97	LD
		Conductance (EC)	779	0.2	uS/cm		04/09/97	PTT
		Hardness	456	1	mg/L		04/11/97	LS
		Calcium (Ca)	133	0.5	mg/L		04/08/97	LS
		Potassium (K)	1.9	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	30.0	0.1	mg/L		04/08/97	LS
		Sodium (Na)	7	1	mg/L		04/08/97	LS
		Sulfate (SO4)	48.8	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	<0.05	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.3		pH		04/09/97	PTT
		Total Alkalinity	402	5	mg/L		04/09/97	PTT
		TDS (Calculated)	464	1	mg/L		04/11/97	LS
		Total Suspended Solids	68	2	mg/L		04/15/97	LD
E704185-02 MW97-2 Sample Type:WATER Collected:04/04/97								
		Iron (Fe)	6.30	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	0.215	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	103		%		04/11/97	LS
		Bicarbonate (HCO3)	243	5	mg/L		04/09/97	PTT
		Chloride	2.4	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	13	3	T.C.U.		04/14/97	LD
		Conductance (EC)	423	0.2	uS/cm		04/09/97	PTT
		Hardness	221	1	mg/L		04/11/97	LS
		Calcium (Ca)	68.4	0.5	mg/L		04/08/97	LS
		Potassium (K)	1.0	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	12.3	0.1	mg/L		04/08/97	LS
		Sodium (Na)	7	1	mg/L		04/08/97	LS
		Sulfate (SO4)	28.5	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	<0.05	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.4		pH		04/09/97	PTT
		Total Alkalinity	199	5	mg/L		04/09/97	PTT
		TDS (Calculated)	239	1	mg/L		04/11/97	LS
		Total Suspended Solids	183	2	mg/L		04/15/97	LD
E704185-03 MW97-3 Sample Type:WATER Collected:04/04/97								
		Iron (Fe)	8.98	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	1.14	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	108		%		04/11/97	LS
		Bicarbonate (HCO3)	353	5	mg/L		04/09/97	PTT
		Chloride	1.6	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	70	3	T.C.U.		04/14/97	LD
		Conductance (EC)	559	0.2	uS/cm		04/09/97	PTT
		Hardness	315	1	mg/L		04/11/97	LS
		Calcium (Ca)	88.8	0.5	mg/L		04/08/97	LS
		Potassium (K)	1.5	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	22.7	0.1	mg/L		04/08/97	LS
		Sodium (Na)	6	1	mg/L		04/08/97	LS
		Sulfate (SO4)	13.3	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	<0.05	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	6.8		pH		04/09/97	PTT
		Total Alkalinity	289	5	mg/L		04/09/97	PTT
		TDS (Calculated)	307	1	mg/L		04/11/97	LS

ENVIRO-TEST CHEMICAL ANALYSIS REPORT

LAB ID	SAMPLE ID	TEST DESCRIPTION	RESULT	D.L.	UNITS	EXTRACTED	ANALYZED	BY
E704185-03	MW97-3 Sample Type:WATER Collected:04/04/97	Routine Water Chemistry						
		Total Suspended Solids	58	2	mg/L		04/15/97	LD
E704185-04	MW97-4 Sample Type:WATER Collected:04/04/97	Iron (Fe)	8.23	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	0.516	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	106		%		04/11/97	LS
		Bicarbonate (HCO3)	585	5	mg/L		04/09/97	PTT
		Chloride	24.5	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	25	3	T.C.U.		04/14/97	LD
		Conductance (EC)	926	0.2	uS/cm		04/09/97	PTT
		Hardness	453	1	mg/L		04/11/97	LS
		Calcium (Ca)	135	0.5	mg/L		04/08/97	LS
		Potassium (K)	2.7	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	28.1	0.1	mg/L		04/08/97	LS
		Sodium (Na)	48	1	mg/L		04/08/97	LS
		Sulfate (SO4)	13.3	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	0.07	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.2		pH		04/09/97	PTT
		Total Alkalinity	479	5	mg/L		04/09/97	PTT
		TDS (Calculated)	539	1	mg/L		04/11/97	LS
		Total Suspended Solids	41	2	mg/L		04/15/97	LD
E704185-05	MW97-5 Sample Type:WATER Collected:04/06/97	Iron (Fe)	0.634	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	0.507	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	103		%		04/11/97	LS
		Bicarbonate (HCO3)	472	5	mg/L		04/09/97	PTT
		Chloride	5.0	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	13	3	T.C.U.		04/14/97	LD
		Conductance (EC)	1270	0.2	uS/cm		04/09/97	PTT
		Hardness	292	1	mg/L		04/11/97	LS
		Calcium (Ca)	86.7	0.5	mg/L		04/08/97	LS
		Potassium (K)	3.4	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	18.4	0.1	mg/L		04/08/97	LS
		Sodium (Na)	200	1	mg/L		04/08/97	LS
		Sulfate (SO4)	300	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	0.23	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.9		pH		04/09/97	PTT
		Total Alkalinity	387	5	mg/L		04/09/97	PTT
		TDS (Calculated)	846	1	mg/L		04/11/97	LS
		Total Suspended Solids	26	2	mg/L		04/15/97	LD
E704185-06	MW97-7 Sample Type:WATER Collected:04/06/97	Iron (Fe)	2.85	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	0.421	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	102		%		04/11/97	LS
		Bicarbonate (HCO3)	567	5	mg/L		04/09/97	PTT
		Chloride	122	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	20	3	T.C.U.		04/14/97	LD
		Conductance (EC)	1350	0.2	uS/cm		04/09/97	PTT
		Hardness	285	1	mg/L		04/11/97	LS
		Calcium (Ca)	90.7	0.5	mg/L		04/08/97	LS
		Potassium (K)	29.1	0.1	mg/L		04/08/97	LS
		Magnesium (Mg)	14.2	0.1	mg/L		04/08/97	LS

ENVIRO-TEST CHEMICAL ANALYSIS REPORT

LAB ID	SAMPLE ID	TEST DESCRIPTION	RESULT	D.L.	UNITS	EXTRACTED	ANALYZED	BY
E704185-06	MW97-7	Sample Type:WATER						
		Collected:04/06/97						
		Routine Water Chemistry						
		Sodium (Na)	194	1	mg/L		04/08/97	LS
		Sulfate (SO4)	85.7	0.5	mg/L		04/08/97	LS
		Nitrate + Nitrite-N	0.25	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.4		pH		04/09/97	PTT
		Total Alkalinity	465	5	mg/L		04/09/97	PTT
		TDS (Calculated)	815	1	mg/L		04/11/97	LS
Total Suspended Solids	107	2	mg/L		04/15/97	LD		
E704185-07	MW97-47A	Sample Type:WATER						
		Collected:04/06/97						
		Iron (Fe)	3.32	0.005	mg/L		04/22/97	RG
		Manganese (Mn)	0.453	0.001	mg/L		04/22/97	RG
		Routine Water Chemistry						
		Balance	96		%		04/11/97	LS
		Bicarbonate (HCO3)	581	5	mg/L		04/09/97	PTT
		Chloride	122	0.5	mg/L		04/08/97	AH
		Carbonate (CO3)	<5	5	mg/L		04/09/97	PTT
		Color, True	20	3	T.C.U.		04/14/97	LD
		Conductance (EC)	1380	0.2	uS/cm		04/09/97	PTT
		Hardness	259	1	mg/L		04/11/97	LS
		Calcium (Ca)	82.7	0.5	mg/L		04/11/97	LS
		Potassium (K)	25.9	0.1	mg/L		04/11/97	LS
		Magnesium (Mg)	12.8	0.1	mg/L		04/11/97	LS
		Sodium (Na)	188	1	mg/L		04/11/97	LS
		Sulfate (SO4)	81.3	0.5	mg/L		04/11/97	LS
		Nitrate + Nitrite-N	0.31	0.05	mg/L		04/08/97	LS
		Hydroxide	<5	5	mg/L		04/09/97	PTT
		pH in Water	7.4		pH		04/09/97	PTT
		Total Alkalinity	476	5	mg/L		04/09/97	PTT
		TDS (Calculated)	799	1	mg/L		04/11/97	LS
Total Suspended Solids	135	2	mg/L		04/15/97	LD		
N.D. - NOT DETECTED, LESS THAN THE DETECTION LIMIT								
THIS IS THE FINAL PAGE OF THE REPORT NOT INCLUDING APPENDICES								

Appendix A Test Methodologies

Balance

Instrumental Method: $\text{Sum}(\text{Anions}) / \text{Sum}(\text{Cations}) * 100$
Method Reference: Bal ENVIRODAT 110 APHA 1030 F

Bicarbonate (HCO_3)

Instrumental Method: Calculated from Alkalinity
Method Reference: Bicarbonate ENVIRODAT 6201 APHA 2320B

Chloride

Preparation: Filter through 0.45u filter
Instrumental: Sample analyzed colorimetrically @ 480 nm using ferricyanide
method on a Cobas Fara discrete analyzer
Reference: APHA 4500-Cl, E

or

Preparation Method: 0.45 μ filtration if turbid
Instrumental Method: Ion Chromatography
Method Reference: Cl ENVIRODAT 323 APHA 4110 B

Carbonate (CO_3)

Instrumental Method: Calculated from Alkalinity
Method Reference: Carbonate ENVIRODAT 6301 APHA 2320B

Conductance (EC)

Instrumental Method: Conductivity Meter
Method Reference: Conductance ENVIRODAT 2041 APHA 2510B

Lab Filtered & Preserved

Sample is filtered through a 0.45u membrane filter prior to analysis.
This is typically done under vacuum, but could also be done on Nitrogen
pressure or with a syringe.

Hardness

Instrumental Method: Calculated from Ca+Mg as CaCO_3
Method Reference: Hardness ENVIRODAT 10607 APHA 2340 B

ICP Metals

PREPARATION METHOD:

Dissolved: Filter through 0.45u and preserve with nitric acid
Extractable: Preserve with nitric acid
Total: Preserve with nitric acid; digest with
nitric/hydrochloric acid

INSTRUMENTAL METHOD: ICP Spectrophotometry
METHOD REFERENCE: APHA 3120B/3030F, Standard Methods; 18th ed.

METALS

ENVIRODAT CODE

WAVELENGTH

Appendix A Test Methodologies

Aluminum (Al)	327	308.2
Barium (Ba)	330	455.4
Beryllium (Be)	331	313.0
Boron (B)	329	249.8
Cadmium (Cd)	334	226.5
Calcium (Ca)	333	317.9
Chromium (Cr)	336	267.7
Cobalt (Co)	335	228.6
Copper (Cu)	337	324.7
Iron (Fe)	338	259.9
Lead (Pb)	82360	220.3
Magnesium (Mg)	341	279.1
Manganese (Mn)	342	257.6
Molybdenum (Mo)	343	202.0
Nickel (Ni)	28350	231.6
Phosphorus (P)	N/A	178.3
Potassium (K)	339	766.5
Silicon (Si)	N/A	212.4
Silver (Ag)	326	328.1
Sodium (Na)	11005	589.0
Strontium (Sr)	347	407.8
Thallium (Tl)	349	190.9
Tin (Sn)	346	189.9
Titanium (Ti)	N/A	334.9
Vanadium (V)	N/A	367.0
Zinc (Zn)	N/A	213.8

Routine Metals

PREPARATION METHOD: Filter through 0.45u and preserve with nitric acid

INSTRUMENTAL METHOD: ICP Spectrophotometry

METHOD REFERENCE: APHA 3120B/3030F, Standard Methods; 18th ed.

METALS	ENVIRODAT CODE	WAVELENGTH	DETECTION LIMITS
Calcium (Ca)	333	317.9	0.5
Magnesium (Mg)	341	279.1	0.1
Potassium (K)	366	769.9	0.1
Sodium (Na)	11005	589.0	1
Sulfur		180.7	0.5

Sulfur reported as sulfate. ICP result multiplied by 3 to convert.

Sulfate (S04)

Preparation Method: 0.45 u filtraton if turbid

Instrumental Method: Ion Chromatography or ICP

Method Reference: S04 Dionex Handbook of Ion Chromatography pg 37.

Nitrate+Nitrite-N

Preparation Method: 0.45μ Filtration

Instrumental Method: Automated colorimetry (Cobas Fara Discrete analyzer)
Hydrazine reduction @ 520 nm

Method Reference: NO2-N+NO3-N ENVIRODAT 7120 APHA 4500-NO3-H

or

Preparation Method: 0.45μ filtration if turbid

Instrumental Method: Ion Chromatography

Method Reference: NO3-N ENVIRODAT 7315 APHA 4110 B

Appendix A Test Methodologies

and
Preparation Method: 0.45 μ filtration if turbid
Instrumental Method: Ion Chromatography
Method Reference: APHA 4110 B

Hydroxide

Method Reference: Hydroxide APHA 2320 B

pH in Water

Instrumental Method: pH Meter
Method Reference: pH ENVIRODAT 10301 APHA 4500-H+ B

Total Alkalinity

Instrumental Method: If pH<8.3 on the initial sample, titration for alkalinity will be performed to pH 8.3 and 4.5 endpoint, using autotitrator or manual technique.

Method Reference: T ALK ENVIRODAT 10165 APHA 2320B

TDS (Calculated)

Instrumental Method: Calculated from the sum of ions
Method Reference: TDS ENVIRODAT 203 APHA 1030 F

Total Suspended Solids

Preparation Method: Filter well mixed sample through preweighed GFC filter and dry at 105 degrees celcius
Instrumental Method: Determine solids retained on filter gravimetrically
Method Reference: APHA 2540 D

THIS IS THE LAST PAGE OF THE METHODOLOGY APPENDIX.

Telephone: (403) 413-5227 Fax: (403) 437-2311
Telephone: 1-800-668-9878 Fax: 1-800-286-7319
Telephone: (403) 291-9897 Fax: (403) 291-0298
Telephone: (306) 668-8370 Fax: (306) 668-8383
Telephone: (807) 623-6463 Fax: (807) 623-7598

DATE REQUIRED:

☐ PRIORITY (50% SURCHARGE)
☐ EMERGENCY (100% SURCHARGE)

AS PER QUOTE #: _____ ☐
AS PER LIST PRICE: ☐

Reactive RDU3W1

called client
04/08/97 to
confirm Routine
phg. required

SAMPLE RECEIVED (Y OR N)

RECEIVED (Y OR N)
SAMPLE BROKEN (Y OR N)

	PRESERVED	FILTERED
1. <i>Chlamydomonas reinhardtii</i>	100	100
2. <i>Chlorella vulgaris</i>	100	100
3. <i>Chlorella pyrenoidosa</i>	100	100
4. <i>Chlorella ellipsoidea</i>	100	100
5. <i>Chlorella minutissima</i>	100	100
6. <i>Chlorella zofingiensis</i>	100	100
7. <i>Chlorella kuetzingii</i>	100	100
8. <i>Chlorella saccharophila</i>	100	100
9. <i>Chlorella saccharophila</i>	100	100
10. <i>Chlorella saccharophila</i>	100	100
11. <i>Chlorella saccharophila</i>	100	100
12. <i>Chlorella saccharophila</i>	100	100
13. <i>Chlorella saccharophila</i>	100	100
14. <i>Chlorella saccharophila</i>	100	100
15. <i>Chlorella saccharophila</i>	100	100
16. <i>Chlorella saccharophila</i>	100	100
17. <i>Chlorella saccharophila</i>	100	100
18. <i>Chlorella saccharophila</i>	100	100
19. <i>Chlorella saccharophila</i>	100	100
20. <i>Chlorella saccharophila</i>	100	100
21. <i>Chlorella saccharophila</i>	100	100
22. <i>Chlorella saccharophila</i>	100	100
23. <i>Chlorella saccharophila</i>	100	100
24. <i>Chlorella saccharophila</i>	100	100
25. <i>Chlorella saccharophila</i>	100	100
26. <i>Chlorella saccharophila</i>	100	100
27. <i>Chlorella saccharophila</i>	100	100
28. <i>Chlorella saccharophila</i>	100	100
29. <i>Chlorella saccharophila</i>	100	100
30. <i>Chlorella saccharophila</i>	100	100
31. <i>Chlorella saccharophila</i>	100	100
32. <i>Chlorella saccharophila</i>	100	100
33. <i>Chlorella saccharophila</i>	100	100
34. <i>Chlorella saccharophila</i>	100	100
35. <i>Chlorella saccharophila</i>	100	100
36. <i>Chlorella saccharophila</i>	100	100
37. <i>Chlorella saccharophila</i>	100	100
38. <i>Chlorella saccharophila</i>	100	100
39. <i>Chlorella sac</i>		

NOTE: Failure to properly complete all portions of this form may delay analysis.

NO. SAMPLES SUBMITTED: 1

NO. COOLERS / BOXES: _____ 1

PHONE: 299-5600

FAX: 299-5 006

PURCHASE ORDER. #.:

JOB NO.: 15-003 (MEET)

DATE

TIME	
------	--

DATE 11/11/07

TIME

OTHER (BREAKAGE, LEAKAGE, ETC.): _____

WHITE - Report Copy
PINK - File Copy
YELLOW - Customer Copy

ETL Enviro-Test

LABORATORIES

A DIVISION OF ETL CHEMSPEC ANALYTICAL LIMITED

Edmonton (Main)

9936 - 67 Avenue

Edmonton, AB

T6E 0P5

Phone: (403) 413-5227

Fax: (403) 437-2311

Edmonton (Downtown)

2nd Fl., 10158 - 103 Street

Edmonton, AB

T5J 0X6

Phone: (403) 413-5265

Fax: (403) 424-4602

Calgary

Bay 2, 1313-44th Ave. N.E.

Calgary, AB

T2E 6L5

Phone: (403) 291-9897

Fax: (403) 291-0298

Saskatoon

124 Veterinary Road

Saskatoon, SK

S7N 5E3

Phone: (306) 668-8370

Fax: (306) 668-8383

1-800-667-7645

Winnipeg

745 Logan Avenue

Winnipeg, MB

R3E 3L5

Phone: (204) 945-3705

Fax: (204) 945-0763

Thunder Bay Analytical

1081 Barton Street

Thunder Bay, ON

P7B 5N3

Phone: (807) 623-6463

Fax: (807) 623-7598

Canada Wide Phone:

1-800-668-9878

Western Canada Fax:

1-800-286-7319

CHEMICAL ANALYSIS REPORT

GOLDER ASSOCIATES
1011 6 AVE SW
CALGARY AB T2P 0W1

DATE: April 28, 1997

ATTN: GRANT NIELSON

Lab Work Order #: E704303

Sampled By: BK


Project Reference: 75-003 (MRRT)

Date Received: 04/11/97

Project P.O.#: NOT SUBMITTED

Comments:

APPROVED BY:



Erv Callin
Project Manager

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN AUTHORITY OF THE LABORATORY.
ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS FOLLOWING ANALYSIS. PLEASE CONTACT THE LAB IF YOU REQUIRE
ADDITIONAL SAMPLE STORAGE TIME.

**ACCREDITATIONS: STANDARDS COUNCIL OF CANADA (SCC), IN COOPERATION WITH THE CANADIAN ASSOCIATION FOR
ENVIRONMENTAL ANALYTICAL LABORATORIES (CAEAL): FOR SPECIFIC TESTS AS REGISTERED BY THE
COUNCIL (EDMONTON, CALGARY)
AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA): FOR INDUSTRIAL HYGIENE ANALYSIS (EDMONTON)
AGRICULTURE CANADA: UNDER THE CANADIAN FERTILIZER QUALITY ASSURANCE PROGRAM (SASKATOON)**

ENVIRO-TEST CHEMICAL ANALYSIS REPORT

LAB ID	SAMPLE ID	TEST DESCRIPTION	RESULT	D.L.	UNITS	EXTRACTED	ANALYZED	BY
E704303-01	MW97-3 Sample Type:WATER Collected:04/10/97	PAH & Alkylated PAH's						
		Naphthalene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Acenaphthylene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Acenaphthene	0.02	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Fluorene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Dibenzothiophene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Phenanthrene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Anthracene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Fluoranthene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Pyrene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Benzo(a)anthracene/Chrysene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Benzo(b&k)fluoranthene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Benzo(a)pyrene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Indeno(1,2,3-c)pyrene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Dibenzo(a,h)anthracene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Benzo(ghi)perylene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl naphthalene	N.D.	0.02	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd naphthalene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C3 sub'd naphthalene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C4 sub'd naphthalene	0.05	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Biphenyl	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl biphenyl	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd biphenyl	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl acenaphthene	0.05	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl fluorene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd fluorene	0.12	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl phenanthrene/anthracene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd phenanthrene/anth.	0.07	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C3 sub'd phenanthrene/anth.	0.06	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C4 sub'd phenanthrene/anth.	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl dibenzothiophene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd dibenzothiophene	0.05	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C3 sub'd dibenzothiophene	0.16	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C4 sub'd dibenzothiophene	0.07	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl fluoranthene/pyrene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl B(a)A/chrysene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd B(a)A/chrysene	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Methyl B(b&k)F/B(a)P	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		C2 sub'd B(b&k)F/B(a)P	N.D.	0.04	ug/L (ppb)	04/15/97	04/23/97	RRR
		Phenolic Compounds in H2O						
		Phenol	0.4	0.1	ug/L (ppb)	04/15/97	04/21/97	DWJ
		o-Cresol	N.D.	0.1	ug/L (ppb)	04/15/97	04/21/97	DWJ
		m-Cresol	N.D.	0.1	ug/L (ppb)	04/15/97	04/21/97	DWJ
		p-Cresol	N.D.	0.1	ug/L (ppb)	04/15/97	04/21/97	DWJ
		2,4-Dimethylphenol	N.D.	0.1	ug/L (ppb)	04/15/97	04/21/97	DWJ
		2-Nitrophenol	N.D.	0.2	ug/L (ppb)	04/15/97	04/21/97	DWJ
		4-Nitrophenol	N.D.	2	ug/L (ppb)	04/15/97	04/21/97	DWJ
		2,4-Dinitrophenol	N.D.	2	ug/L (ppb)	04/15/97	04/21/97	DWJ
		4,6-Dinitro-2-methylphenol	N.D.	2	ug/L (ppb)	04/15/97	04/21/97	DWJ
		Group 1 - Conventional						
		Bicarbonate (HCO3)	322	5	mg/L		04/14/97	PTT
		Carbonate (CO3)	<5	5	mg/L		04/14/97	PTT
		Color, True	400	3	T.C.U.		04/14/97	LD
		Total Dissolved Solids	416	10	mg/L		04/18/97	LD
		Conductance (EC)	497	0.2	uS/cm		04/14/97	PTT
		Hardness	274	1	mg/L		04/16/97	LS
		pH in Water	6.9		pH		04/14/97	PTT
		Total Alkalinity	264	5	mg/L		04/14/97	PTT
		Total Suspended Solids	890	2	mg/L		04/15/97	LD
		Group 2 - Major Ions						
		Chloride	0.9	0.5	mg/L		04/15/97	AH
		Calcium (Ca)	76.7	0.5	mg/L		04/14/97	PY
		Potassium (K)	1.1	0.1	mg/L		04/14/97	PY
		Magnesium (Mg)	20.1	0.1	mg/L		04/14/97	PY
		Sodium (Na)	6	1	mg/L		04/14/97	PY
		Sulfate (SO4)	7.1	0.5	mg/L		04/14/97	PY
E704303-02	MW97-47 Sample Type:WATER Collected:04/10/97	Group 1 - Conventional						
		Bicarbonate (HCO3)	1160	5	mg/L		04/11/97	PTT
		Carbonate (CO3)	<5	5	mg/L		04/11/97	PTT

ENVIRO-TEST CHEMICAL ANALYSIS REPORT

LAB ID	SAMPLE ID	TEST DESCRIPTION	RESULT	D.L.	UNITS	EXTRACTED	ANALYZED	BY
E704303-02 MW97-47 Sample Type:WATER Collected:04/10/97								
Group 1 - Conventional								
Color, True			50	3	T.C.U.		04/14/97	LD
Total Dissolved Solids			2380	10	mg/L		04/18/97	LD
Conductance (EC)			3880	0.2	uS/cm		04/11/97	PTT
Hardness			113	1	mg/L		04/16/97	LS
pH in Water			7.3		pH		04/11/97	PTT
Total Alkalinity			1200	5	mg/L		04/11/97	PTT
Total Suspended Solids			366	2	mg/L		04/15/97	LD
Group 2 - Major Ions								
Chloride			548	0.5	mg/L		04/15/97	AH
Calcium (Ca)			21.8	0.5	mg/L		04/14/97	PY
Potassium (K)			21.3	0.1	mg/L		04/14/97	PY
Magnesium (Mg)			14.1	0.1	mg/L		04/14/97	PY
Sodium (Na)			853	1	mg/L		04/14/97	PY
Sulfate (SO4)			24.0	0.5	mg/L		04/14/97	PY
N.D. - NOT DETECTED, LESS THAN THE DETECTION LIMIT THIS IS THE FINAL PAGE OF THE REPORT								

ENVIRO-TEST QA/QC REPORT

PAH & Alkylated PAH's

<u>Surrogate Recovery for E70430301A</u>	<u>%</u>
Nitrobenzene d5	74
2-Fluorobiphenyl	70
p-Terphenyl d14	71

Phenolic Compounds in H2O

<u>Surrogate Recovery for E70430301A</u>	<u>%</u>
2-Fluorophenol	28
Phenol d5	18
2,4,6-Tribromophenol	99

Relative percent difference is expressed as RPD.

Percent Recovery is expressed as %.

THIS IS THE LAST PAGE OF THE QAQC REPORT

Appendix A Test Methodologies

Bicarbonate (HCO₃)

Instrumental Method: Calculated from Alkalinity
Method Reference: Bicarbonate ENVIRODAT 6201 APHA 2320B

Chloride

Preparation: Filter through 0.45u filter
Instrumental: Sample analyzed colorimetrically @ 480 nm using ferricyanide
method on a Cobas Fara discrete analyzer
Reference: APHA 4500-Cl, E

or

Preparation Method: 0.45 μ filtration if turbid
Instrumental Method: Ion Chromatography
Method Reference: Cl ENVIRODAT 323 APHA 4110 B

Carbonate (CO₃)

Instrumental Method: Calculated from Alkalinity
Method Reference: Carbonate ENVIRODAT 6301 APHA 2320B

Total Dissolved Solids

Preparation Method: Sample is filtered through a GFC filter. An aliquot of
the filtrate is evaporated to dryness in a tared pan at 180 deg. C
Instrumental Method: Dissolved solids retained is determined gravimetrically
Method Reference: APHA 2540 C

Conductance (EC)

Instrumental Method: Conductivity Meter
Method Reference: Conductance ENVIRODAT 2041 APHA 2510B

Hardness

Instrumental Method: Calculated from Ca+Mg as CaCO₃
Method Reference: Hardness ENVIRODAT 10607 APHA 2340 B

Sulfate (SO₄)

Preparation Method: 0.45 u filtraton if turbid
Instrumental Method: Ion Chromatography or ICP
Method Reference: S04 Dionex Handbook of Ion Chromatography pg 37.

PAH & Alkylated PAH's

Preparation Method: Liquid/liquid extraction with DCM
Instrument Method: GC/MSD analysis
Method Reference: Extraction Method: EPA 3540 (modified)
Analytical Method: EPA 8270 (modified)

Appendix A Test Methodologies

Phenolic Compounds in H₂O

Preparation Method: Liquid/liquid extraction with DCM, acetylation
Instrument Method: GC/MSD analysis
Method Reference: Extraction Method: EPA 3510 (modified)
Analytical Method: EPA 8270 (modified)

pH in Water

Instrumental Method: pH Meter
Method Reference: pH ENVIRODAT 10301 APHA 4500-H+ B

Total Alkalinity

Instrumental Method: If pH<8.3 on the initial sample, titration for alkalinity will be performed to pH 8.3 and 4.5 endpoint, using autotitrator or manual technique.
Method Reference: T ALK ENVIRODAT 10165 APHA 2320B

Total Suspended Solids

Preparation Method: Filter well mixed sample through preweighed GFC filter and dry at 105 degrees celcius
Instrumental Method: Determine solids retained on filter gravimetrically
Method Reference: APHA 2540 D

THIS IS THE LAST PAGE OF THE METHODOLOGY APPENDIX.

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

9936 - 67th Avenue, Edmonton, Alberta T6E 0P5
Edmonton Toll Free Line
1313 - 44 Avenue N.E., Calgary, Alberta T2E 6L5
General Purpose Bldg., 124 Veterinary Road, Saskatoon, Sask. S7N 5E3
1081 Barton Street, Thunder Bay, Ont. R7B 5N3

Telephone: (403) 413-5227 Fax: (403) 437-2311
Telephone: 1-800-668-9878 Fax: 1-800-286-7319
Telephone: (403) 291-9897 Fax: (403) 291-0298
Telephone: (306) 668-8370 Fax: (306) 668-8383
Telephone: (807) 623-6463 Fax: (807) 623-7598

DATE SUBMITTED: April 11/97

DATE REQUIRED: _____

SERVICE REQUESTED: ☒ REGULAR

☐ PRIORITY (50% SURCHARGE)

☐ EMERGENCY (100% SURCHARGE)

PRICING (CHECK ONE):

AS PER QUOTE #: _____

AS PER LIST PRICE: ☐

ANALYSIS REQUESTED:

8a 8b

9

PHN3w1

Routine

SAMPLE RECEIVED (Y OR N)

SAMPLE BROKEN (Y OR N)

SAMPLE ID	SAMPLED BY	DATE / TIME SAMPLED	SAMPLE TYPE											LAB SAMPLE NO.
3 #														
MW97-47	B. Kirkham	April 10/97	Water		✓	✓	✓							E704303-01
MW97-47	B. Kirkham	April 10/97	Water					✓						02
Client wants Bottle IDs changed on the MW97-47s changed to MW97-3.														
8/4/11/97														
McMurray Resources Attn: Brian Kirkham														
Send new bottles			12x 1L amber											
			12x Routines											
PRESERVED														
FILTERED														

NOTES & CONDITIONS:

1. Quote number must be provided to ensure proper pricing.

2. Turnaround times will vary dependant on complexity of analysis & lab workload at time of submission. Please contact the lab to confirm turnaround times.

3. All hazardous samples submitted must be labelled to comply with WHMIS regulations. This must include the nature of the hazard, as well as a contact name and phone number that the lab can contact for further information.

NOTE: Failure to properly complete all portions of this form may delay analysis.

CLIENT: Golden Associates NO. SAMPLES SUBMITTED: _____
CONTACT: Grant Nielson NO. COOLERS / BOXES: _____
REPORT ADDRESS: 1011 Sixth Ave SW PHONE: 299-5600
Calgary AB. T2P 0W1 FAX: 299-5600
BILLING ADDRESS: as above PURCHASE ORDER #: _____
JOB NO.: 15-003 (URPT)

RELINQUISHED BY: <u>[Signature]</u>	DATE: <u>April 11/97</u>	RECEIVED BY: <u>[Signature]</u>	DATE: <u>April 11/97</u>
	TIME: <u>1445</u>		TIME: <u>1445</u>
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

SAMPLE CONDITION UPON RECEIPT:

FROZEN: _____ COLD: _____ AMBIENT: _____

OTHER (BREAKAGE, LEAKAGE, ETC.): _____

WHITE - Report Copy
PINK - File Copy
YELLOW - Customer Copy

This material is provided under educational reproduction permissions included in Alberta Environment and Sustainable Resource Development's Copyright and Disclosure Statement, see terms at <http://www.environment.alberta.ca/copyright.html>. This Statement requires the following identification:

"The source of the materials is Alberta Environment and Sustainable Resource Development <http://www.environment.gov.ab.ca/>. The use of these materials by the end user is done without any affiliation with or endorsement by the Government of Alberta. Reliance upon the end user's use of these materials is at the risk of the end user.