MORROW ENVIRONMENTAL CONSULTANTS INC

1997 04 01

Project W6134B

Petro Canada
1644 Dublin Avenue
WINNIPEG MB
R3C 2T3

ATTENTION Mr K Paterson Environment & Safety Advisor
Manitoba/Saskatchewan

REFERENCE **Site Sensitivity Assessment and Site Remediation Criteria**
Cresthaven Service and Lunch
Junction of Provincial Trunk Highways No 7 and 67
Stonewall, Manitoba
Location No 67086

As requested by Petro Canada Morrow Environmental Consultants Inc (MECI) has completed the environmental site sensitivity assessment and determined the applicable clean-up criteria for soil at the above referenced site The site sensitivity assessment was performed according to protocols outlined in *A Guideline for the Environmental Investigation and Remediation of Petroleum Storage Sites in Manitoba* Manitoba Environment July 1993 The completed site sensitivity assessment and the appropriate soil clean-up criteria for the above site are attached for your reference

A Petro Canada site sensitivity evaluation was also performed according to the protocols outlined in *Environmental Site Assessment and Remediation Protocol Petro-Canada Products Western Region Environment Safety & Industrial Hygiene* V 10 December 1994 The results of the Petro Canada site sensitivity evaluation are presented in Appendix I The evaluation indicated that the site has a score of 74

We trust that this information is sufficient for your present requirements If you have any questions or concerns please do not hesitate to contact the undersigned

A G Man, E I T

K J Korman P Eng
Regional Manager

MORROW ENVIRONMENTAL CONSULTANTS INC

AGM/te

Attach

SITE SENSITIVITY ASSESSMENT

1 SITE INFORMATION

Location

- northwest corner of Provincial Trunk Highways No 7 and 67 approximately 5 km east of Stonewall Manitoba

Site Description

- former Petro Canada service station and restaurant with three 22 750 L steel underground storage tanks (previously containing regular unleaded gasoline) two 9 090 L steel underground storage tanks (previously containing diesel fuel) associated product distribution lines vents and pumps (pumps removed) closed restaurant/service station building and a closed carwash/autobody repair shop

Surrounding Land Use

- service road to the north beyond which is agricultural land
- Provincial Trunk Highway No 67 to the south beyond which is residential (75 m) and agricultural land
- Provincial Trunk Highway No 7 to the east beyond which is agricultural land and a farm residence (400 m)
- service road to the west beyond which is agricultural land

Groundwater Usage

- 53 registered water wells within 1 600 m of the site 48 of which were listed as domestic production wells The remaining wells were registered as industrial (four) or livestock (one) production wells The wells are generally cased through the overburden and completed as open holes at depths ranging from 2 0 m to 56 7 m below grade in the carbonate bedrock
- the nearest registered domestic water well to the site is approximately 100 m southwest of the site
- discussions with the former site operator revealed that all properties in the vicinity of the site including the site itself have water wells for domestic supply Since these water wells have not been registered with the Manitoba Water Resources Branch the well completion details are unknown
- the on-site domestic water well is located in a crawlspace along the east wall of the service station basement

Surface Water

- marsh located approximately 2 500 m northeast of the site

Nearby Underground Structures

- buried utilities are located on and adjacent to the site
- basement structures in on-site and nearby buildings

Other Special Environmental Concerns

- site is located in a groundwater pollution hazard area The depth to the bedrock aquifer at the site is approximately 10 m

Subsurface Conditions

- soil type sand gravel and clay fill materials to approximately 0 9 m below grade underlain by approximately 0 2 m organic clay and a silt layer which grades to silty sand to approximately 2 5 m below grade Silt till was encountered beneath the above materials to the maximum depth of investigation (7 0 m) A sand layer was encountered in the silt till at depths ranging from 4 4 m to 6 2 m below grade at several locations
- water table approximately 2 7 m below grade

2 SENSITIVITY ASSESSMENT

a) Ingestion

RECEPTOR	RECEPTOR SENSITIVITY	LIKELIHOOD OF IMPACT	SENSITIVITY RANKING
-on-site water well	high	high	high
-surrounding water wells	high	medium	moderate

SITE SENSITIVITY RANKING - INGESTION **HIGH**

b) Inhalation (Vapours from Soil)

RECEPTOR	RECEPTOR SENSITIVITY	LIKELIHOOD OF IMPACT	SENSITIVITY RANKING
-agricultural (north and west)	low	medium	moderate
-residential/agricultural (south)	high	medium	moderate
-residential/agricultural (east)	high	medium	moderate
-on-site building	medium	high	moderate

SITE SENSITIVITY RANKING INHALATION (SOIL) **MODERATE**

c) Inhalation (Vapours from Groundwater)

RECEPTOR	RECEPTOR SENSITIVITY	LIKELIHOOD OF IMPACT	SENSITIVITY RANKING
-agricultural (north and west)	low	medium	moderate
-residential/agricultural (south)	high	medium	moderate
-residential/agricultural (east)	high	medium	moderate
-on-site building	medium	high	moderate

SITE SENSITIVITY RANKING - INHALATION (GROUNDWATER) **MODERATE**

3 CLEAN-UP CRITERIA - SOIL

- site sensitivity ranking is **HIGH** - soil clean-up to **LEVEL I**

4 CLEAN-UP CRITERIA - WATER

- at present Manitoba Environment does not have any published guidelines for water quality however where water is used for domestic consumption the levels of BTEX components and lead should not exceed the Canadian Drinking Water Guidelines criteria at the point of withdrawal

5 DISCUSSION

a) Ingestion

There are 53 registered water wells within 1 600 m of the site 48 of which were listed as domestic production wells The nearest registered domestic water well to the site is approximately 100 m southwest of the site The wells are generally cased through the overburden and completed as open holes at depths ranging from 2 0 m to 56 7 m below grade in the carbonate bedrock The former site operator indicated that all properties in the vicinity of the site including the site have water wells for domestic supply Due to the presence of the on-site and nearby surrounding domestic water wells the receptor sensitivity is high The depth to the carbonate bedrock aquifer is approximately 10 m and the site is located in a groundwater pollution hazard area as defined by Manitoba Natural Resources Water Resources Division The likelihood of impact to the bedrock aquifer is therefore high and the site sensitivity ranking is **HIGH**

b) Inhalation (Vapours from Soil and/or Groundwater)

The receptor sensitivity of the nearby residences and the on-site building is high and medium respectively The likelihood of impact to the above receptors is medium and high respectively and the sensitivity ranking for inhalation is **MODERATE**

APPENDIX I

Petro Canada Site Sensitivity Evaluation

APPENDIX I **PETRO-CANADA SITE SENSITIVITY EVALUATION**

1 Proximity to Buildings (check box that best describes worst case)
[e g if a school is <500 m but >300 m and a shopping centre is <300 m but >100 m Score = 8]

		≤100 m	≤300 m	≤500 m
1	Hospital school apartment dwelling etc	28 ☒	14 ☐	7 ☐
2	Shopping centre commercial district etc	16 ☐	8 ☐	4 ☐
3	Industrial area etc	4 ☐	2 ☐	0 ☐
4	None of the above	0 ☐		

28

2 Distance from underground structures such as storm water or sanitary sewer water mains buried utilities parking garages etc [<100 m = 8 <300 m = 4 >300 m = 0] 8

3 Soil conditions/groundwater depth (check appropriate box)

Depth to Groundwater		Porous Soil	Tight Soil
1	< 3 m	8 ☒	4 ☐
2	> 3 m	4 ☐	2 ☐
3	unknown	8 ☐	8 ☐

8

4 Distance from a groundwater well
[<100 m = 28 <300 m = 14 <500 m = 7 >500 m = 0] 28

5 Distance from surface water lake stream ocean or wildlife habitat
[<100 m = 18 <300 m = 12 <500 m = 6 >500 m = 0] 0

6 Is groundwater flow direction towards (check all applicable boxes)

		Yes	No	Unknown
1	a water well (<500 m)	2 ☐	0 ☐	2 ☒
2	a private residence (<200 m)	1 ☐	0 ☒	1 ☐
3	surface water (<100 m)	1 ☐	0 ☒	1 ☐

2

TOTAL 74

FORMER PETRO CANADA

CRESTHAVEN SERVICE AND LUNCH
PROVINCIAL TRUNK HIGHWAYS NO 7 AND 67
STONEWALL, MANITOBA
LOCATION NO 67086

PHASE II ENVIRONMENTAL SITE ASSESSMENT

Prepared By

A G Man E I T

Reviewed By

K J Korman P Eng
Regional Manager

PRIVILEGED & CONFIDENTIAL

MORROW ENVIRONMENTAL CONSULTANTS INC

W6134B
1997 04 01

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EXECUTIVE SUMMARY

This report presents the results of the Phase II Environmental Site Assessment performed at the former Petro Canada service station located at the northwest corner of Provincial Trunk Highways No 7 and 67 approximately 5 km east of Stonewall Manitoba The purpose of the assessment was to determine if petroleum hydrocarbons had impacted the soil and/or groundwater beneath the site as a result of petroleum storage and transfer activities at the subject site

Field work at the site was conducted on 1997 02 11 and consisted of the drilling of 15 boreholes recovery and laboratory analysis of selected soil samples and installation of monitoring wells in selected boreholes The site was monitored on 1997 02 11 and 1997 03 06 for liquid levels and subsurface vapour concentrations Groundwater samples were collected from three monitoring wells on 1997 03 06 An additional groundwater sample was collected from the on-site potable water well on 1997 03 19

The environmental site assessment has revealed that the soil and groundwater beneath the site have been impacted by petroleum hydrocarbons at concentrations greater than the Manitoba Environment Level I criteria and Canadian Council of Ministers of the Environment (CCME) Drinking Water criteria respectively Based on correlation between laboratory analyses and soil headspace vapour concentrations the lateral extent of residually impacted soil has been delineated toward the east south and west through north However a narrow vertical extent of residually impacted soil appears to extend toward the northeast

The results of the hydrochemical analyses of the groundwater samples obtained from three of the monitoring wells indicated that one or more of the benzene toluene ethylbenzene and xylene (BTEX) components were present at concentrations greater than the CCME Drinking Water criteria Dissolved benzene was detected at a concentration greater than the CCME Drinking Water criterion in a water sample collected from the on site potable water well Since the water well was not registered with the Manitoba Water Resources Branch no completion details were available for the well However since the available records indicate that the

surrounding registered domestic water wells are completed in the limestone bedrock it is presumed that the on-site potable water well is also screened in the limestone bedrock aquifer

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1 0 INTRODUCTION

As requested Morrow Environmental Consultants Inc (MECI) has completed a Phase II Environmental Site Assessment (ESA) at the former Cresthaven Service and Lunch Petro Canada Service Station The former service station is located at the northwest corner of Provincial Trunk Highways No 7 and 67 approximately 5 km east of Stonewall Manitoba as shown on the Key Plan Drawing W6-134B-001 Appendix I The purpose of the environmental assessment was to determine if petroleum hydrocarbons had impacted the soil and/or groundwater beneath the site as a result of petroleum storage and transfer activities at the subject site The Phase II ESA was undertaken once the results of the recent Phase I had been compiled

This report presents the results of the detailed Phase II ESA undertaken by MECI The detailed subsurface assessment consisted of a soil and groundwater investigation The soil investigation included the drilling of boreholes and the recovery of soil samples for visual soil classification headspace vapour concentration measurements and laboratory chemical analyses The groundwater investigation included installation of monitoring wells measurement of the wells for liquid levels and vapour concentrations and the collection of groundwater samples for laboratory hydrochemical analyses

2 0 BACKGROUND

MECI conducted a Phase I ESA prior to the Phase II ESA at the subject site The results of the Phase I ESA complete with historical information and site inspection observations are presented in MECI s report dated 1997 01 22

A Site Sensitivity Assessment was also conducted at the site in accordance with the protocols published by Manitoba Environment The assessment was performed to characterize the site and establish the appropriate remediation criteria for the site The results of the assessment are provided in a separate letter entitled Site Sensitivity Assessment and Site Remediation Criteria dated 1997 04 01 The results of the assessment indicate that the soil clean-up criteria for the site is Level I At present Manitoba Environment does not have any published guidelines for water quality however where groundwater is used for domestic consumption the levels of benzene toluene ethylbenzene and xylenes (BTEX) components and lead should not exceed the Canadian Drinking Water Guidelines May 1996 criteria at the point of withdrawal

Fifty-three registered water wells are located within 1 600 m of the site Of the registered water wells 48 were listed as domestic production wells The remaining wells included four industrial production wells and one livestock well The wells are generally cased through the overburden and completed as open holes at depths ranging from 2 0 m to 56 7 m below grade in the limestone bedrock The closest registered domestic water well to the site as determined by the available water well records is located approximately 100 m southwest of the site Discussions with the former site operator Ms Pat Carriere revealed that all properties in the vicinity of the site including the site itself have water wells for domestic supply Since these discussions MECI personnel has confirmed the presence of a functional domestic water well and supply system on site However since this water well has not been registered with the Manitoba Water Resources Branch the well completion details are unknown

3 0 RESULTS OF ASSESSMENT

3 1 Phase II - Detailed Site Investigation

3 1 1 *Soil Investigation*

On 1997 02 11 MECI personnel supervised the locating of underground services by the various utility owners and the drilling of 15 boreholes at the locations shown on the Site Plan Drawing W6 134B-002 Appendix I The boreholes were drilled using a truck-mounted drill rig equipped with continuous flight solid stem augers to a maximum depth of 7 0 m Borehole 97-1 was drilled to the east of the former east pump island Boreholes 97-2 and 97-5 were drilled to the south and north of the tank basins respectively Boreholes 97-3 97-4 and 97 6 were drilled to the south north and west of the former west pump island respectively Borehole 97-7 was drilled to the north of the tank basin for the purpose of delineation Boreholes 97-8 97-13 and 97-14 were drilled to the east north and south of the east pump island respectively for the purpose of delineation Borehole 97-9 was drilled to the south of the west pump island and Boreholes 97-12 and 97-15 were drilled to the north of the west pump island for the purpose of delineation Borehole 97-10 was drilled to the west of the service station Borehole 97-11 was drilled to the west of the concrete pad associated with the autobody shop at the north end of the site

Based on soil vapour concentrations stratigraphy and locations four soil samples were selected for laboratory chemical analysis of one or more of the following hydrocarbon constituents benzene toluene ethylbenzene and xylenes (BTEX) total volatile and semi-volatile hydrocarbons and lead as outlined in *A Guideline for the Environmental Investigation and Remediation of Petroleum Storage Sites in Manitoba* Manitoba Environment July 1993

A summary of the Phase II Soil Investigation Methodology is presented in Appendix II

3 1 1 1 Soil Conditions

Detailed descriptions of the soil profile encountered during drilling are presented on the Borehole Logs Appendix III The site stratigraphy generally consisted of sand and gravel fill to approximately 0 3 m below grade Clay fill was encountered beneath the sand and gravel fill to approximately 0 9 m below grade The above fill materials were underlain by approximately 0 2 m of organic clay A silt layer which graded into a silty sand was encountered beneath the organic clay to approximately 2 5 m below grade Silt till was encountered beneath the above deposits and extended to the maximum depth of investigation (7 0 m) A sand layer was encountered in the silt till at depths ranging from 4 4 m to 6 2 m below grade in several boreholes The thickest portion of the sand layer appeared to trend in an east-west direction across the service station portion of the site The sand layer was not encountered in the southern western and northern most boreholes Grey staining was observed in soil samples obtained from Boreholes 97-3 97-4 97-5 97-12 and 97-13 at depths ranging from 1 2 m to 4 1 m below grade

3 1 1 2 Soil Sample Vapour Concentrations

The results of headspace vapour concentration measurements on the soil samples collected during drilling are presented on the Borehole Logs Appendix III The maximum soil headspace vapour concentration measurements are summarized on Table 1 The maximum soil headspace vapour concentration was 9 350 ppm in a sample obtained from Borehole 97-3 at 1 5 m below grade Elevated headspace vapour concentrations (>1 000 m) were detected in soil samples obtained from Boreholes 97-2 97-3 97-4 97 5 97-6 and 97-12 at depths ranging from 0 8 m to 5 9 m below grade Vapour concentrations measured in soil samples recovered from the remaining boreholes were less than 1 000 ppm

3 1 1 3 Analytical Results

Based on the Site Sensitivity Assessment performed in accordance with the Manitoba Environment guidelines the site remediation criteria for soil is Level I The results of the laboratory analysis conducted on selected soil samples obtained during drilling are presented

on Table 2 along with the Manitoba Environment Level I Remediation Criteria for Soil The laboratory report detailing the methodology used during analysis is included in Appendix IV

The concentrations of one or more of the BTEX components and total volatile hydrocarbons were detected in soil samples recovered and analysed from Boreholes 97-3 97-5 97 6 and 97-7 at concentrations greater than the Manitoba Environment Level I criteria The total semi volatile hydrocarbon concentration detected in a soil sample recovered and analysed from Borehole 97-3 was greater than the referenced Level I criterion Total semi-volatile hydrocarbon concentrations were not detected in the remaining soil samples analysed The concentration of lead was less than the referenced Level I criterion in a sample recovered and analysed from Borehole 97-3

Gas chromatography (GC) analysis of the total semi-volatile constituents detected in soil samples obtained from Borehole 97-3 indicated that the majority of the hydrocarbons present were in the $<C_{15}$ carbon range with patterns indicative of weathered gasoline

3 1 2 *Groundwater Investigation*

On 1997 02 11 and 1997 03 06 the monitoring wells at the site were measured for liquid levels and subsurface vapour concentrations Representative groundwater samples were recovered from Monitoring Wells 97-3 97 7 and 97-8 on 1997 03 06 for hydrochemical analysis An additional groundwater sample was collected from the on-site potable water well on 1997 03 19 The complete monitoring results are presented in Appendix V

A summary of the Phase II groundwater investigation methodology is presented in Appendix II

3 1 2 1 Monitoring Results

The subsurface vapour concentrations measured on 1997 02 11 and 1997 03 06 are presented on Table 3 The maximum subsurface vapour concentration measured on 1997 02 11 was 8 030 ppm in Monitoring Well 97-3 located adjacent to the former west pump island Elevated subsurface vapour concentrations (>1 000 ppm) were measured in Monitoring Well 97-1 located adjacent to the former east pump island Monitoring Wells 97-2 97-5 and 97-7 located adjacent to the tank basin and Monitoring Wells 97-4 and 97-6 located adjacent to the former west pump island Subsurface vapour concentrations measured in the remaining monitoring wells did not exceed 275 ppm

The maximum subsurface vapour concentration measured on 1997 03 06 was 7 260 ppm in Monitoring Well 97-3 located adjacent to the former west pump island Elevated subsurface vapour concentrations (>1 000 ppm) were measured in Monitoring Wells 97-4 and 97-5 located adjacent to the former west pump island and the tank basin respectively Subsurface vapour concentrations measured in the remaining monitoring wells did not exceed 770 ppm

On 1997 02 11 following drilling the groundwater levels had not stabilized in the monitoring wells The groundwater levels measured on 1997 03 06 are plotted on the Borehole Logs Appendix III On 1997 03 06 the average depth to groundwater at the site was 2 7 m below grade The groundwater elevations measured on 1997 03 06 are contoured on Drawing W6-134B-003 Appendix I The apparent direction of groundwater flow on this date was northeast at an average gradient of 0 02

On 1997 03 19 the static groundwater elevation in the on-site potable water well was determined to be 93 59 m approximately 5 3 m below grade This suggests a downward vertical gradient from the overburden to the underlying bedrock aquifer

Liquid hydrocarbons to date have not been encountered in any of the monitoring wells

3 1 2 2 Analytical Results

Since Manitoba Environment currently does not have any groundwater quality criteria the CCME Drinking Water criteria are referenced

The results of hydrochemical analyses of the groundwater samples recovered from Monitoring Wells 97-3 97-7 and 97-8 are presented on Table 4 along with the CCME Drinking Water criteria The laboratory report detailing the methodology used during the analyses of the water samples is attached in Appendix IV

Dissolved concentrations of one or more of the BTEX components were detected at concentrations greater than the CCME Drinking Water criteria in water samples recovered from Monitoring Wells 97-3 97-7 and 97-8 The dissolved concentration of lead detected in a water sample collected from Monitoring Well 97-3 was greater than the CCME Drinking Water criteria

Dissolved benzene was detected at a concentration greater than the CCME Drinking Water criterion in a water sample recovered from the on site potable water well

4 0 DISCUSSION

The Phase II Environmental Assessment confirms that the soil and groundwater beneath the site have been impacted by petroleum hydrocarbons Residual hydrocarbon components at concentrations greater than the Manitoba Environment Level I criteria were present in soil samples obtained and analysed from boreholes located adjacent to the former west pump island and north of the tank basin Dissolved hydrocarbon components were present in groundwater samples obtained from monitoring wells located near the west pump island north of the tank basin and along the east property line and from the on-site potable water well at concentrations exceeding the CCME drinking water criteria

Based on soil vapour concentration measurements and the results of confirmatory laboratory analyses the vertical extent of residually impacted soil appears to extend from 0 8 m to approximately 6 1 m below grade at the former west pump island area Adjacent to the tank basin the vertical extent of residually impacted soil appears to extend from approximately 2 2 m to 5 3 m below grade

Based on correlation between laboratory analyses and soil headspace vapour concentrations the lateral extent of residually impacted soil has been delineated toward the east south and west through north However a narrow vertical extent of residually impacted soil at depths between 3 7 m to 4 1 m below grade appears to extend beyond the asphalt covered area toward the northeast The soil headspace vapour concentration associated with this soil was 660 ppm

To date liquid hydrocarbons have not been detected in any of the monitoring wells

The recent groundwater monitoring data (1997 03 06) indicated that the apparent direction of groundwater flow is toward the northeast The nearest registered domestic water well is located approximately 100 m southwest of the subject site This well is cased through the over burden and completed as an open hole from 5 5 m to 31 1 m below grade in the limestone bedrock According to the former site operator all properties in the vicinity of the site use water wells for domestic supply MECI personnel has confirmed the presence of an on site potable

water well The nearest downgradient building is located approximately 400 m northwest of the subject site

The lateral extent of impacted shallow groundwater appears to extend downgradient to the northeast of the tank basin area and off site to the east Laboratory analyses of a groundwater sample collected from the on-site potable water well indicated that the groundwater was impacted by benzene No completion details are available through the Manitoba Water Resources Branch since the well is not registered However since the available records indicate that surrounding registered water wells are completed in the limestone bedrock it is presumed that the on-site potable water well is also screened in the limestone bedrock aquifer

5 0 CLOSURE STATEMENT

The preceding Environmental Site Assessment has been prepared for the exclusive use of Petro Canada using methods in accordance with generally accepted hydrogeological and engineering practice and guidelines issued by Manitoba Environment

The results and conclusions of the Environmental Assessment are based on observations and the analysis of a limited data set collected while completing the assessment program The analytical testing pertained specifically to hydrocarbon components and metals associated with petroleum storage and distribution facilities

This report is not intended to represent a legal opinion It is possible that hydrocarbon or other contamination exists in areas not investigated as part of this assessment Additionally levels of contamination greater than that indicated may reside in areas between borehole and/or sample locations Hence this report should not be regarded as a certification of the actual chemical character of the site

6 0 REFERENCES

- A Guideline for the Environmental Investigation and Remediation of Petroleum Storage Sites in Manitoba Manitoba Environment July 1993
- Environmental Site Assessment and Remediation Protocol Petro Canada - Western Region Environment Safety and Industrial Hygiene December 1994 Version 10
- Interim Canadian Environmental Quality Criteria for Contaminated Sites Canadian Council of Ministers of the Environment September 1991

TABLE 1 Maximum Hydrocarbon Vapour Concentrations - Soil Samples

Borehole	Depth (m)	Soil Vapour Concentration[1] (ppm)	Stratigraphy
97 2	3 8	2 530	silt till
97 3	0 8	3 740	fill clay
	1 5	9 350	silt
	2 3 3 7	3 630 9 130	silt till
97-4	0 8	1 870	clay
	1 4	3 300	silt
97 5	2 3	1 760	silt till
	5 0	3 080	sand
97 6	3 1	1 100	silt till
	5 3	1 100	silt till
	5 9	1 760	sand
97 12	3 1	2 200	silt till

[1] measured with Gastech hydrocarbon vapour analyser with no methane response

Note only soil vapour measurements greater than 1 000 ppm are shown above

Table 2 Results of Laboratory Analyses - Soil Samples

						Manitoba Criteria[1]
Borehole No	97 3	97 5	97-6	97 7		
Sample No	3 2	5-7	6-4	7 5		
Depth (m)	1 5	5 0	3 1	3 8		
Soil Vapour Concentration (ppm)	9 350	3 080	1 100	275		
Parameter					Detection Limit	Level I
Benzene	**43 2**	**1 17**	**<0 2[4]**	**0 49**	<0 05	0 05
Toluene	**331**	**5 07**	**<0 1[4]**	**2 54**	<0 05	0 1
Ethylbenzene	**97 4**	**2 85**	**1 43**	**2 64**	<0 05	0 1
Xylene(s)	**625**	**12 45**	**7 47**	**9 89**	<0 05	0 1
Total Volatile Hydrocarbons[2]	**5 240**	**194**	**104**	**147**	5	100
Total Semi-Volatile Hydrocarbons[3]	**752**	<40	<40	<40	40	500
Lead	9	NA	NA	NA	2	375

Results expressed in milligrams per dry kilogram (ppm)

NA not analysed

1 *A Guideline for the Environmental Investigation and Remediation of Petroleum Storage Sites in Manitoba* Manitoba Environment July 1993

2 C_5 to C_9

3 C_{10} to C_{30}

4 the detection limit has been raised due to the presence of hydrocarbons that interfere with the quantitation of these compounds

BOLD contamination exceeds referenced Manitoba Environment guideline

TABLE 3 Vapour Concentrations in Monitoring Wells (ppm)

Date	MW 97 1	MW 97 2	MW 97 3	MW 97-4	MW 97 5	MW 97-6	MW 97 7	MW 97-8
1997 02 11	1 210	1 540	8 030	4 180	2 420	1 100	1 210	100
1997 03 06	NM[1]	150	7 260	5 830	1 760	770	400	ND

NM not monitored

[1] monitoring well beneath snow bank

TABLE 3 **Vapour Concentrations in Monitoring Wells (ppm) - pg 2**

Date	MW 97 9	MW 97 10	MW 97 11	P 1	P 2	P 3	P 4
1997 02 11	260	140	110	275	170	90	NM[2]
1997 03 06	225	65	50	75	25	45	NM[2]

NM not monitored

[2] well cap frozen

TABLE 4 Results of Laboratory Analyses - Water Samples

Monitoring Well No	MW 97 3	MW 97 7	MW 97 8	PW		CCME Criteria[1]
Parameter					Detection Limit	DW
Benzene	**31 6**	**2 35**	**0 850**	**0 0191**	0 0005	0 005
Toluene	**37 0**	**2 86**	<0 0005	>0 0005	0 0005	≤0 024
Ethylbenzene	**3 83**	**0 947**	<0 002[2]	>0 0005	0 0005	≤0 0024
Xylene(s)	**21 34**	**4 10**	0 0028	>0 0005	0 0005	≤0 3
Lead	**0 058**	NA	NA	NA	0 001	0 01

Results expressed in milligrams per litre (mg/L)

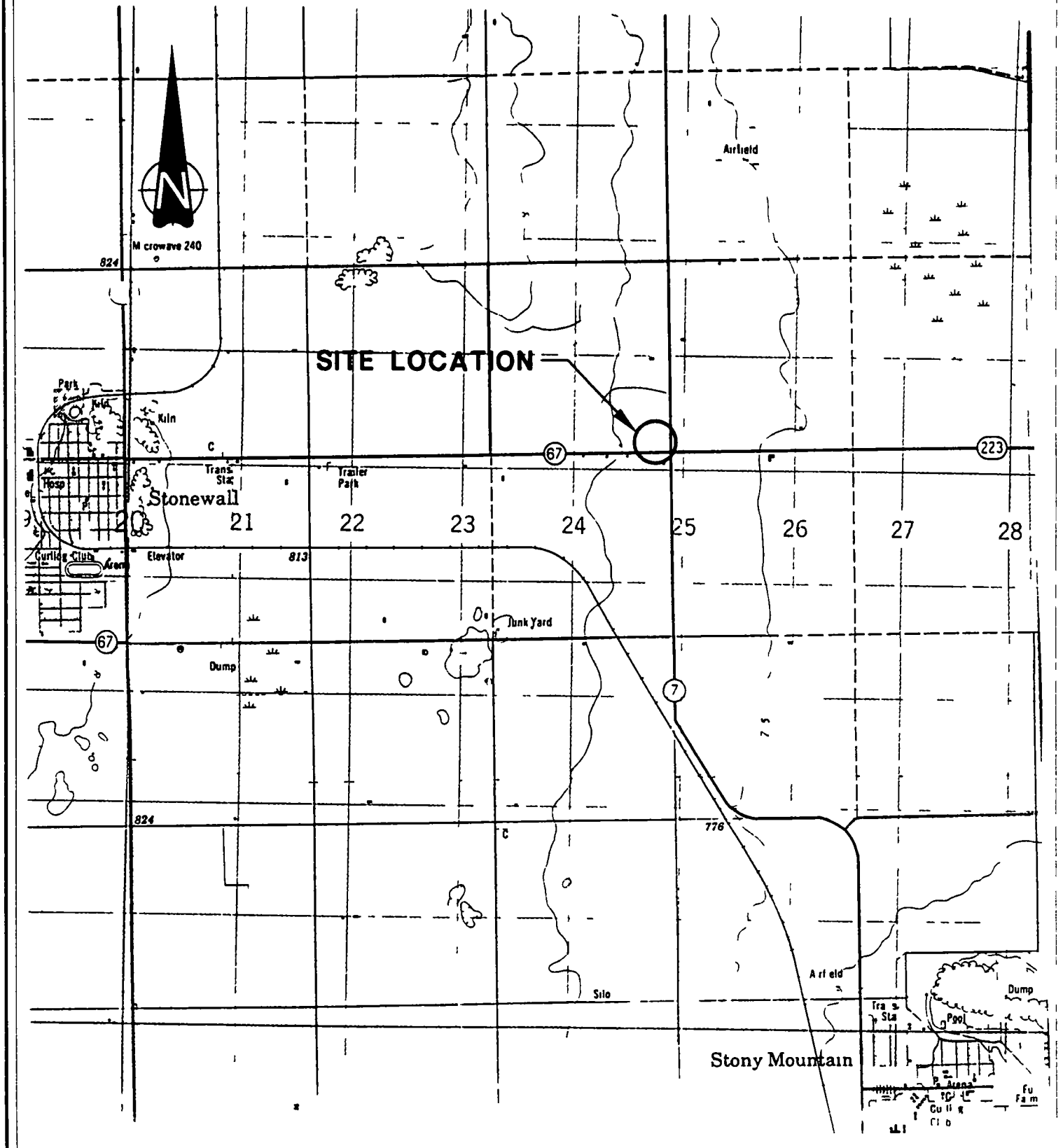
1 *CCME Interim Canadian Environmental Quality Criteria for Contaminated Site* September 1991
2 detection limit raised due to the presence of hydrocarbons that interfere with the quantitation of this compound

NA not analysed
DW drinking water
PW potable water well
BOLD contamination exceeds referenced CCME guideline

APPENDIX I

Drawings

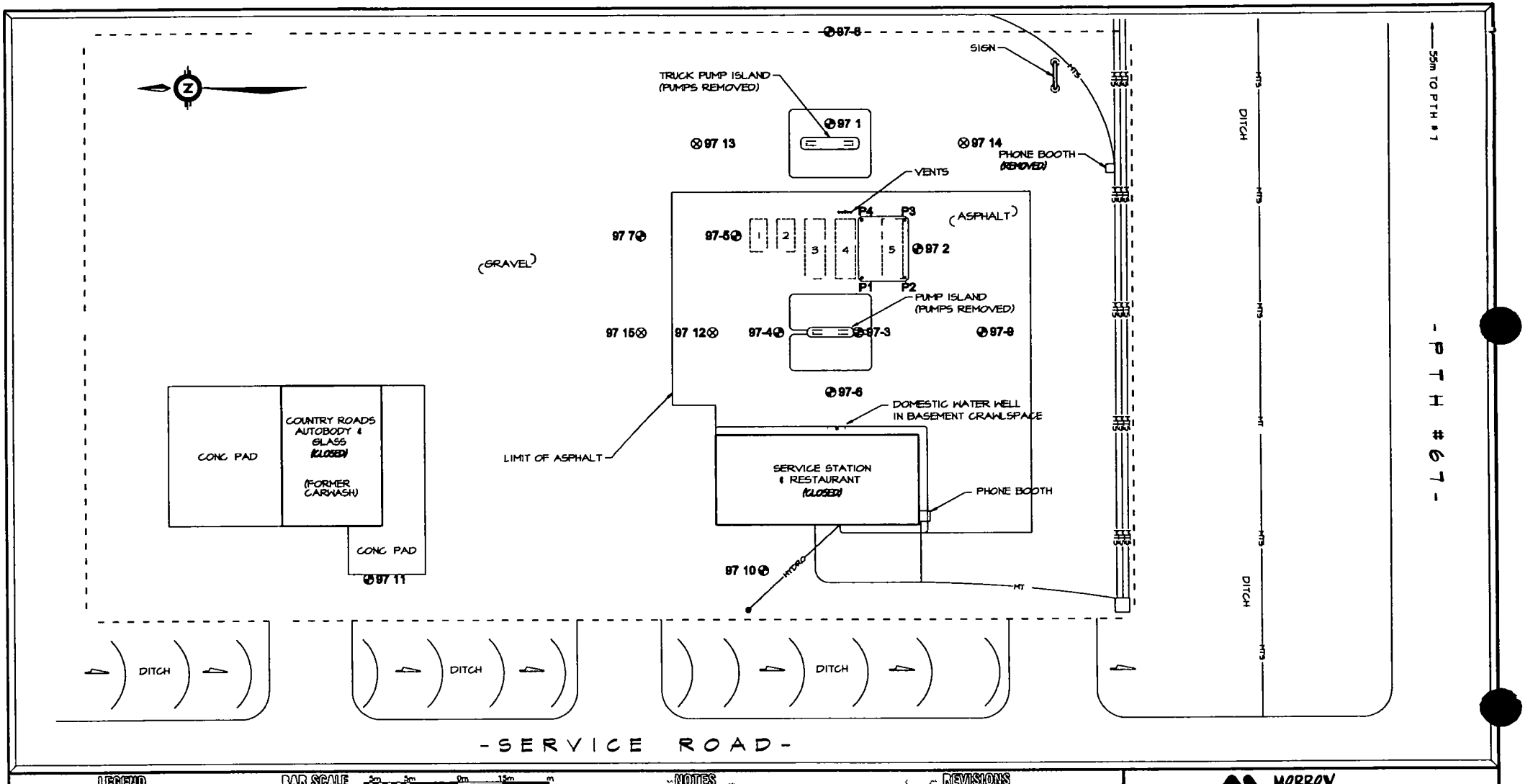
W6-134B-001 - Key Plan
W6-134B-002 - Site Plan
W6-134B-003 - Apparent Direction of Groundwater Flow (1997 03 06)



MORROV ENVIRONMENTAL CONSULTANTS inc

KEY PLAN

DATE: 97 04 01	DRAWN BY: SAD	CHECKED: KJK	CLIENT NAME: PETRO CANADA	CLIENT ADDRESS: JCT PTH N 7 & 67 STONEWALL MB	DRAWING NUMBER: W6-134 001	PLOTTED: 1997 0 11 3



LEGEND

- BOREHOLE LOCATION (MONITORING WELL INSTALLED) 1995 04 11
- BOREHOLE LOCATION (MONITORING WELL NOT INSTALLED)
- DOMESTIC WATER WELL

BAR SCALE 3m 6m 9m 15m m

NOTES

DRAWING DERIVED FROM SITE PLAN No 944064 PROVIDED BY PETRO CANADA

TANK	CAPACITY (L)	TYPE	STATUS
1	9 090	DIESEL	(INACTIVE)
2	9 090	DIESEL	(INACTIVE)
3	22 750	GASOLINE	(INACTIVE)
4	22 750	GASOLINE	(INACTIVE)
5	22 750	GASOLINE	(INACTIVE)

REVISIONS

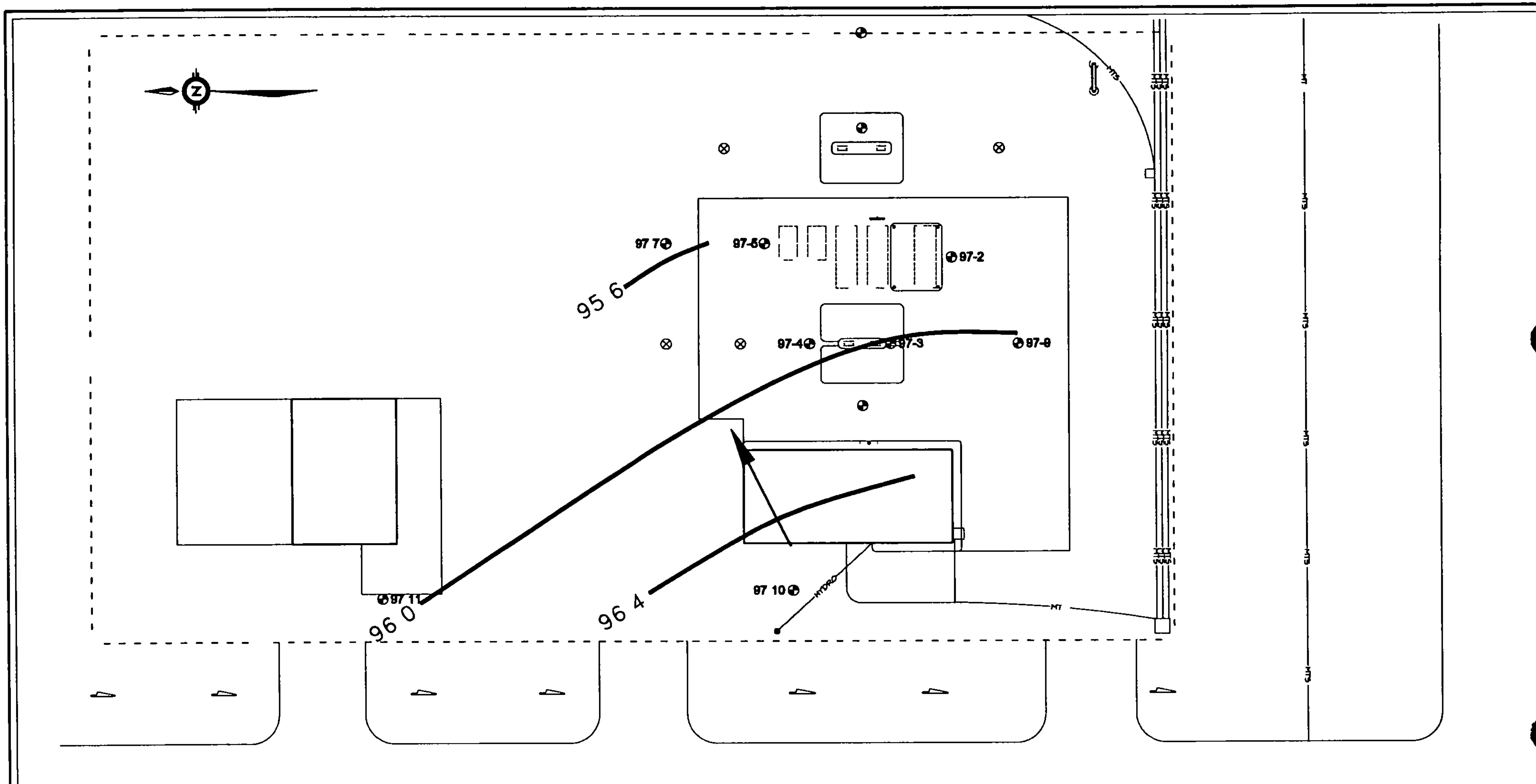
REV	DATE	DESCRIPTION	BY
–	–	–	

MORROW ENVIRONMENTAL CONSULTANTS INC.

SCALE: AS SHOWN	APPROVED BY: MECH: AGM / CLIENT: PC	DRAWN BY: JAP/SAD	
DATE: 97 04 01		CHECKED: KJK	
CLIENT NAME: PETRO CANADA	LOCATION ADDRESS: JCT PTH N 7 & 67 STONEWALL, MB		

SITE PLAN

DRAWING NUMBER: W6 134 002 PLOTTED: 97/04/01 21



LEGEND

- BOREHOLE LOCATION (MONITORING WELL INSTALLED) 1995 04 11
- BOREHOLE LOCATION (MONITORING WELL NOT INSTALLED)
- APPARENT DIRECTION OF GROUNDWATER FLOW

BAR SCALE

NOTES

1 UTILITY LOCATIONS ARE APPROXIMATE AND SHOULD BE CONFIRMED ON-SITE

2 UNDERGROUND ELECTRICAL LINES ARE NOT SHOWN

3 ONLY LABELLED MONITORING WELLS WERE USED FOR CONTOURING

4 ALL CONTOURS ARE IN METRES

REVISIONS

REV	DATE	DESCRIPTION	BY
	–		–

MORROW ENVIRONMENTAL CONSULTANTS INC

SCALE: AS SHOWN	APPROVED BY MECI: AGM	CLIENT: PC	DRAWN BY: JAP/SAD
DATE: 97 04 01			CHECKED: KJK
CLIENT NAME: PETRO CANADA –		LOCATION ADDRESS: JCT PTH N 7 & 67 STONEWALL, MB	

APPARENT DIRECTION OF GROUNDWATER FLOW (1997 03 06)

DRAWING NUMBER: W6 134 003 PLOTTED: 970401 27

APPENDIX II

Investigation Methodology

APPENDIX II Investigation Methodology

PHASE II

Soil Investigation

As the boreholes were advanced the soil conditions were logged in detail

Soil samples were recovered from each borehole using the following sampling protocols

- Representative soil samples were collected at regular depth intervals during drilling The samples were recovered directly from the auger flights (disturbed samples) The samples were split and transferred immediately to laboratory supplied glass jars for potential laboratory analysis and to sealable polyethylene bags
- The polyethylene bags were field screened for hydrocarbon vapour concentrations once the soil samples had warmed to ambient temperature A Gastech® hydrocarbon vapour analyser (calibrated to a hexane standard with no methane response) was used to screen the bagged soil samples
- All jarred samples were stored in ice chilled coolers and shipped via courier to Analytical Services Laboratories (ASL) in Vancouver B C within 24 hours of collection The samples were maintained at a constant temperature of 4°C prior to shipping
- The augers were steam cleaned between boreholes

Groundwater Investigation

Upon completion of drilling selected boreholes were fitted with threaded 50 mm diameter slotted PVC monitoring wells constructed void of glues or solvents to allow for future monitoring of the subsurface conditions and recovery of representative groundwater samples The annulus in each borehole was backfilled with clean silica sand over the slotted portion of the monitoring well In all the monitoring well installations a bentonite seal and a concrete cap were placed to prevent surface run-off from contaminating the monitoring well installation A metal road box casing was installed at grade to protect each installation The bentonite was activated with clean water and a 0 3 m concrete cap was poured in-place to seal the borehole

The monitoring wells at the site were measured for liquid levels and hydrocarbon vapour concentrations (measured in ppm relative to a hexane standard) The groundwater samples were collected utilizing the protocols outlined in *Petro Canada Western Region Environmental Site Assessment and Remediation Protocol* V 10 December 1994 Since groundwater recovery was slow the monitoring wells were bailed dry and allowed to recover 50% prior to sampling The on-site potable water well was pumped for 10 minutes prior to collection of a groundwater sample The water samples were shipped within 24 hours of collection to Analytical Services Laboratories (ASL) in Vancouver B C for hydrochemical analysis The samples were maintained at a constant temperature of 4°C prior to shipping

APPENDIX III

Borehole Logs

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-1

BOREHOLE LOG

PLOTTED 19970304 1349
CAD FILE No 6134B7-1

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**GRAVEL (FILL)** some sand some clay well graded brown dense dry			97-1 1			
1	**CLAY (FILL)** some sand trace gravel trace organics well graded stiff high plasticity damp			97 1 2			
	SILT clayey tan soft low plasticity moist			97 1 3			
2	**CLAY** silty trace sulphates brown firm high plasticity moist			97-1-4			
	SAND fine grained silty well graded grey loose moist						
	SILT (TILL) clayey some sand some gravel well graded very firm -silt content increasing with depth -firm with depth			97 1 5			
4	-some oxidization at 4 4 m			97 1 6			
	SAND & GRAVEL coarse grained well graded light brown loose wet			97 1 7			
5				97 1 8			
6	End of Borehole at 6 1 m						
7							
8							
9							

LEGEND

od b
50 mm ø PVC p p
backfill
50 mm ø slotted PVC pipe
eal
b t t se l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
N/A	OBSERVED WATER LEVEL
TOP OF CASING ELEVATION (m)	LOGGED BY
N/A	AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-2

BOREHOLE LOG

PLOTTED 19970304 1406
CAD FILE No 6134B7-2

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**ASPHALT**						
	SAND & GRAVEL (FILL) some clay well graded brown dense dry			97-2 1			
	CLAY (FILL) some sand some gravel silty black high plasticity damp						
1	**CLAY** trace organics black stiff high plasticity damp			97 2 2			
	SAND and silt fine grained light brown loose low plasticity wet			97 2 3			
2	**CLAY** silty trace sulphates brown firm high plasticity moist						
	-fine graned silty wet sand lense ~ 100mm thick at 2 7 m			97-2-4			
3	**SILT (TILL)** some medium grained sand some gravel clayey light brown firm low plasticity moist			97-2 5			
4				97 2 6			
5	-increasing silt and sand content decreasing gravel content(coarse) at 5 3 m			97 2 7			
				97 2 8			
	Auger refusal at 5 8 m						
6							
7							
8							
9							

LEGEND

d b
50 mm ø PVC p p
b kfill d
50 mm ø lott d PVC pipe
eal t
b t t l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 423	OBSERVED WATER LEVEL 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 279	AGM

SHEET 1 OF 1

CLIENT: PETRO CANADA	DRILLING CONTRACTOR: MAPLE LEAF ENTERPRISES	PROJECT No: W6134B
LOCATION: JCT PTH No 7 & 67 STONEWALL MB	DRILLING METHOD: SOLID STEM AUGER — DIAMETER: 125 mm	BOREHOLE No: 97-3

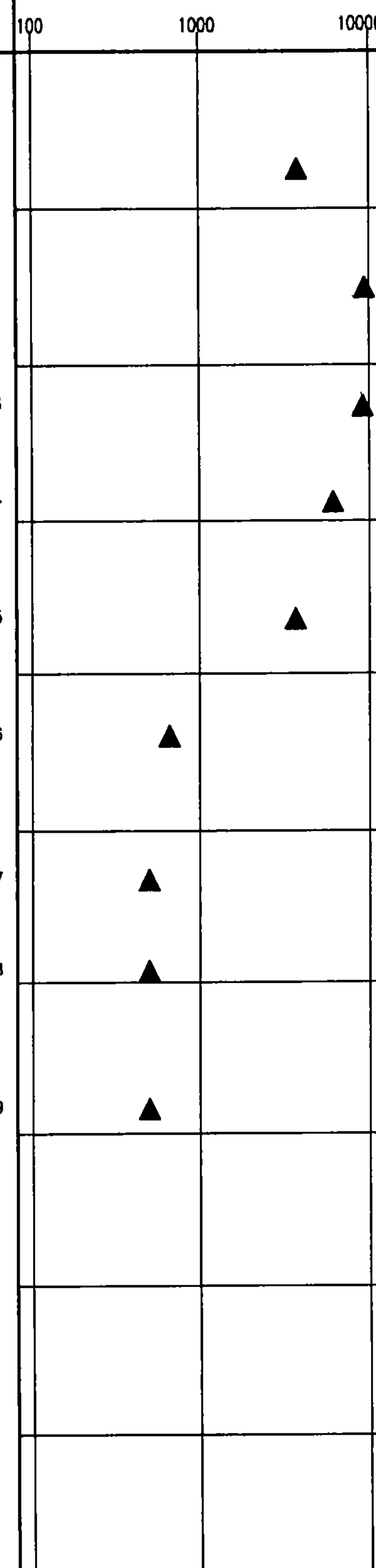
BOREHOLE LOG

PLOTTED 19970304 1417
CAD FILE No 6134B7-3

SAMPLE TYPE: CORE / SPLIT SPOON / SHELBY / DISTURBED / NO RECOVERY

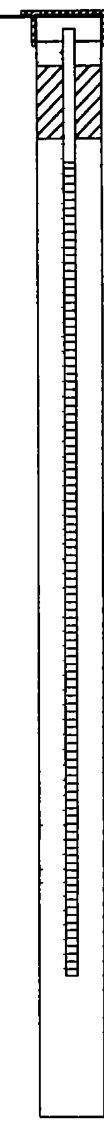
DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER
0	**ASPHALT**		
	SAND & GRAVEL (FILL) well graded light brown dense dry	Disturbed	97-3 1
	CLAY some silt trace organics black stiff high plasticity moist		
1	**SILT** clayey some fine grained sand well graded light brown low plasticity moist grey staining –increasing coarse sand & gravel with depth	Disturbed	97 3 2
2	**SILT (TILL)** some sand some gravel clayey firm low plasticity moist	Disturbed	97 3 3
		Disturbed	97-3-4
3		Disturbed	97 3 5
4	–increasing gravel content with depth	Disturbed	97 3 6
5		Disturbed	97 3 7
		Disturbed	97 3 8
6	–greyish brown at 6 9 m	Disturbed	97 3 9
7	End of Borehole at 7 0 m		
8			
9			

SOIL VAPOUR CONCENTRATION (ppm)



WATER LEVEL

MONITORING WELL INSTALLATION



LEGEND
ood b
50 mm ø PVC p p
1 b ckf'll d
50 mm ø lotted PVC pipe
eal t
b t t l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC	GROUND SURFACE ELEVATION (m): 98 765	DATE DRILLED: 1997 02 11
		OBSERVED WATER LEVEL: 1997 03 06
	TOP OF CASING ELEVATION (m): 98 617	LOGGED BY: AGM
		SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-4

BOREHOLE LOG

PLOTTED 19970304 1432
CAD FILE No 6134B7-4

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER
0	**ASPHALT**			
	CLAY (FILL) some silt trace sand trace organics black stiff high plasticity moist			97-4 1
	CLAY trace gravel trace organics black stiff high plasticity moist			
1	**SILT** some fine grained sand clayey light brown firm low plasticity moist grey staining from 1 2m to 1 7m			97 4-2
	CLAY (TILL) silty trace sand trace gravel brown firm high plasticity			
2	**SILT (TILL)** clayey some sand some gravel light brown firm low plasticity moist			97-4 3
				97-4-4
3	-less clay with depth -increasing silt with depth			97 4 5
4				97 4 6
5	**SAND & GRAVEL** fine grained silty trace clay well graded light brown dense wet			97-4 7
				97 4 8
6	End of Borehole at 6 1 m			
7				
8				
9				

SOIL VAPOUR CONCENTRATION (ppm)
100 1000 10000

WATER LEVEL

MONITORING WELL INSTALLATION

LEGEND
ad bo
50 mm ø PVC p pe
b kfill
50 mm ø lotted PVC pipe
eal
b t l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 723	OBSERVED WATER LEVEL 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 578	AGM

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-5

BOREHOLE LOG

PLOTTED 19970305 1008
CAD FILE No 6134B7-5

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded brown dense dry			97-5 1			
1	**CLAY** silty trace sulphates brown firm high plasticity moist			97 5 2			
2	**SILT (TILL)** clayey some sand some gravel brown firm low plasticity fissured moist oxidized -grey staining ~10mm thick clayey lenses from 27 m to 30 m			97 5 3 97-5 4			
3	-moisture content increases softening at 38 m			97 5 5			
4	-soft at 46 m			97 5 6			
	SAND some gravel trace silt well graded coarse grained loose wet			97 5 7			
5	**SILT (TILL)** clayey some sand some gravel brown firm low plasticity fissured moist oxidized			97 5 8			
6	End of Borehole at 61 m						
7							
8							
9							

LEGEND

d b
50 mm ø PVC p p
sa d
ba kfil
50 mm ø lotted PVC pip
t
l
b t t
l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 543	OBSERVED WATER LEVEL. 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 446	AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-6

BOREHOLE LOG

PLOTTED 19970305 1046
CAD FILE No 6134B7-6

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER
0	**ASPHALT**			
	SAND & GRAVEL (FILL) coarse grained well graded brown dense dry			97-6 1
	CLAY (FILL) some sand some gravel trace organics black stiff high plasticity damp			
1	**CLAY**, some silt trace organics black firm high plasticity some silt black firm high plasticity			97 6 2
	SILT, clayey, light brown, soft, low plasticity, moist			
	SAND fine grained silty poorly graded greyish brown loose slight grey staining			
2				97 6 3
	SILT (TILL) some sand some gravel clayey light brown firm low plasticity moist			
3				97-6-4
				97 6 5
4				97 6 6
5				97 6-7
	SAND fine to coarse grained trace gravel well graded loose wet			97 6 8
6	**SILT (TILL)** some sand some gravel clayey light brown firm low plasticity moist			97 6 9
	End of Borehole at 6 9 m			
7				
8				
9				

SOIL VAPOUR CONCENTRATION (ppm): 100 | 1000 | 10000

WATER LEVEL

MONITORING WELL INSTALLATION

LEGEND

d b
50 mm ø PVC p p
l backf'll d
50 mm ø l tt d PVC pip
eal t
be t t l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 900	OBSERVED WATER LEVEL 1997 03 06
TOP OF CASING ELEVATION (m) 98 801	LOGGED BY AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-7

BOREHOLE LOG

PLOTTED 19970305 1107
CAD FILE No 6134B7-7

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded light brown dense dry						
	CLAY (FILL) some sand some gravel trace organics well graded black stiff high plasticity			97-7 1			
1	**SILT** some fine grained sand clayey light brown firm low plasticity moist			97 7 2			
	SILT (TILL) some sand some gravel clayey light brown firm low plasticity moist						
2				97 7 3			
	-softening increasing moisture content with depth						
3				97-7 4			
	-clay content increasing at 3 7 m			97 7 5			
4				97 7 6			
	SAND fine grained silty clayey well graded soft loose wet						
5	**SILT (TILL)** some sand some gravel clayey light brown firm low plasticity moist			97 7 7			
				97 7 8			
6	End of Borehole at 6 1 m						
7							
8							
9							

LEGEND

d b
50 mm ø PVC p p
a d
ba kfll
50 mm ø sl tt d PVC pip
t
eal
b t t
l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 261	OBSERVED WATER LEVEL. 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 136	AGM

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-8

BOREHOLE LOG

PLOTTED 19970305 1138
CAD FILE No 6134B7-8

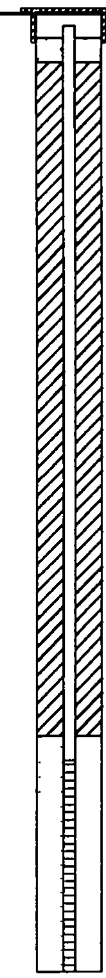
SAMPLE TYPE: CORE, SPLIT SPOON, SHELBY, DISTURBED, NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER
0	**SAND & GRAVEL (FILL)**		
	CLAY (FILL) some sand some gravel trace organics stiff high plasticity damp	Disturbed	97 8 1
1	**CLAY** some silt trace organics black stiff high plasticity damp	Disturbed	97 8 2
	SILT some sand trace gravel clayey soft low plasticity		
2	-moisture increasing sand content increasing wet at 2 3 m	Disturbed	97 8 3
	SILT (TILL) some sand some gravel clayey stiff low plasticity moist	Disturbed	97-8-4
3			
	-soft wet below 3 7 m	Disturbed	97 8 5
	-softening with depth		
4	-sand content increasing at 4 3 m	Disturbed	97 8 6
	SAND fine grained silty poorly graded loose wet		
5		No recovery (0)	
	SILT (TILL) some sand some gravel clayey trace cobbles stiff low plasticity wet	Disturbed	97 8 7
6	End of Borehole at 6 4 m		
7			
8			
9			

SOIL VAPOUR CONCENTRATION (ppm): 100, 1000, 10000

WATER LEVEL

MONITORING WELL INSTALLATION



LEGEND

o d b
50 mm ø PVC p p
l d backf ll
50 mm ø sl tt d PVC plp
co t l
b t t se l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED
97 858	1997 02 11
TOP OF CASING ELEVATION (m)	OBSERVED WATER LEVEL 1997 03 06
97 737	LOGGED BY AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-9

BOREHOLE LOG

PLOTTED 19970305 1316
CAD FILE No 6134B7-9

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**ASPHALT**						
	SAND & GRAVEL (FILL) well graded light brown dense dry			97-9-1			
1	**CLAY (FILL)** some sand trace gravel dark brown firm high plasticity moist			97 9 2			
	SILT some fine grained sand trace gravel brown firm low plasticity damp						
2	**SAND** silty poorly graded brown loose moist			97 9 3			
	SILT (TILL) some sand trace gravel clayey brown firm low plasticity moist			97-9-4			
3	-softening moisture increasing with depth			97 9 5			
4	-soft at 4 6 m			97 9 6			
5	-firm at 5 2 m			97 9 7			
				97 9 8			
6	End of Borehole at 6 1 m						
7							
8							
9							

LEGEND

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 536	OBSERVED WATER LEVEL 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 425	AGM

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-10

BOREHOLE LOG

PLOTTED 19970305 1334
CAD FILE No 6134B710

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded light brown dry						
	CLAY (FILL) some sand trace gravel dark brown firm high plasticity moist			97-10 1			
1	**SILT** some fine grained sand clayey tan soft low plasticity damp -increasing moisture with depth			97-10 2			
2	**CLAY** silty trace sulphates brown firm high plasticity moist			97-10 3			
	SILT some fine grained sand clayey tan soft low plasticity damp						
3	**CLAY** silty trace sulphates brown firm high plasticity moist			97 10 4			
	SILT (TILL) some sand some gravel clayey light brown firm low plasticity moist			97-10 5			
4				97-10 6			
5				97-10 7			
				97-10 8			
6	End of Borehole at 6 1 m						
7							
8							
9							

LEGEND

ad b
50 mm ø PVC p p
l aa d backf ll
50 mm ø lotted PVC pipe
t eal
b t t l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
98 987	OBSERVED WATER LEVEL 1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY
98 845	AGM

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-11

BOREHOLE LOG

PLOTTED 19970305 1412
CAD FILE No 6134B711

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT / SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 / 1000 / 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded light brown dense dry					
	CLAY (FILL) some sand some gravel trace organics dark brown high plasticity damp		97-11 1			
1	**CLAY (TILL)** silty some sand some gravel brown firm to stiff high plasticity moist		97-11 2			
	SILT (TILL) some sand trace gravel some clay firm low plasticity moist		97-11 3			
2	-moisture increasing softening with depth				▼	
			97 11-4			
3	-soft wet below 3 7 m		97-11 5			
4			97-11 6			
5			97-11 7			
	Auger refusal at 5 6 m					
6						
7						
8						
9						

LEGEND

- oad bo
- 50 mm ø PVC pip
- a sa d b kfill
- 50 mm ø lott d PVC pipe
- co c t se l
- b t nit l
- l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED	1997 02 11
98 584	OBSERVED WATER LEVEL	1997 03 06
TOP OF CASING ELEVATION (m)	LOGGED BY	
98 460	AGM	SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-12

BOREHOLE LOG

PLOTTED 19970305 1507
CAD FILE No 6134B712

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**ASPHALT**					NO MONITORING WELL INSTALLED	
	SAND & GRAVEL (FILL) well graded coarse grained light brown dense dry			97-12 1			
1	**CLAY (FILL)** some sand some gravel dark brown firm high plasticity damp			97-12 2			
	CLAY black firm high plasticity damp						
2	**SILT** and fine grained sand some clay tan soft low plasticity wet			97-12 3			
	SILT (TILL) some sand some gravel clayey well graded light brown firm low plasticity moist			97 12 4			
3				97-12 5			
4				97-12 6			
	End of Borehole at 4 6 m						
5							
6							
7							
8							
9							

LEGEND

- od b
- 50 mm ø PVC p p
- l sa d b kf ll
- 50 mm ø l tt d PVC pipe
- o t eal
- b t t al
- l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
N/A	OBSERVED WATER LEVEL
TOP OF CASING ELEVATION (m)	LOGGED BY
N/A	AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR.	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER.**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-13

BOREHOLE LOG

PLOTTED 19970305 1513
CAD FILE No 6134B713

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded coarse grained light brown dense dry					NO MONITORING WELL INSTALLED	
	CLAY (FILL) some sand trace gravel well graded dark brown stiff						
1	**SILT (TILL)** some sand some gravel clayey light brown firm low plasticity moist						
2							
3				97-13-1	▲		
				97-13 2	▲		
4	-wet slight grey staining at 4 0 m			97-13 3	▲		
				97 13 4	▲		
	End of Borehole at 4 9 m						
5							
6							
7							
8							
9							

LEGEND

- add b
- 50 mm ø PVC p p
- l d b kfll
- 50 mm ø lott d PVC pipe
- et eal
- b t t l
- l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
N/A	OBSERVED WATER LEVEL.
TOP OF CASING ELEVATION (m)	LOGGED BY
N/A	AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR.	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B
LOCATION	**DRILLING METHOD** / **DIAMETER.**	**BOREHOLE No**
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER / 125 mm	97-14

BOREHOLE LOG

PLOTTED 19970305 1521
CAD FILE No 6134B714

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded light brown dense dry					NO MONITORING WELL INSTALLED	
	CLAY (FILL) some concrete some sand trace gravel brown firm high plasticity damp						
1	**CLAY (FILL)** some sand some gravel silty brown firm high plasticity moist			97-14 1	▲		
	CLAY silty trace sulphates brown firm high plasticity moist						
2							
3				97-14 2	▲		
				97-14 3	▲		
4				97 14 4	▲		
	End of Borehole at 4 6 m						
5							
6							
7							
8							
9							

LEGEND

- rood b
- 50 mm ø PVC p p
- l backf ll d
- 50 mm ø l tt d PVC pip
- o l t
- b t t l
- l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
N/A	OBSERVED WATER LEVEL
TOP OF CASING ELEVATION (m)	LOGGED BY
N/A	AGM

SHEET 1 OF 1

CLIENT	DRILLING CONTRACTOR	PROJECT No
PETRO CANADA	MAPLE LEAF ENTERPRISES	W6134B

LOCATION	DRILLING METHOD	DIAMETER	BOREHOLE No
JCT PTH No 7 & 67 STONEWALL MB	SOLID STEM AUGER	125 mm	97-15

BOREHOLE LOG

PLOTTED 19970305 1529
CAD FILE No 6134B715

SAMPLE TYPE: CORE | SPLIT SPOON | SHELBY | DISTURBED | NO RECOVERY

DEPTH (m)	SOIL DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE TYPE	SAMPLE NUMBER	SOIL VAPOUR CONCENTRATION (ppm) 100 1000 10000	WATER LEVEL	MONITORING WELL INSTALLATION
0	**SAND & GRAVEL (FILL)** well graded coarse grained light brown dense dry					NO MONITORING WELL INSTALLED	
	CLAY (FILL) some sand some gravel dark brown firm high plasticity damp						
1	**SILT** and fine grained sand some clay tan soft low plasticity wet						
2	**CLAY** silty trace sulphates brown firm high plasticity moist						
3				97-15 1			
	SILT (TILL) some fine grained sand trace gravel clayey soft to firm moist						
4				97-15 2			
	End of Borehole at 4 6 m			97-15 3			
5							
6							
7							
8							
9							

LEGEND

ro d b
50 mm ø PVC p p
l d
b krll
50 mm ø lott d PVC pip
c t l
b t te l
l gh

MORROW ENVIRONMENTAL CONSULTANTS INC

GROUND SURFACE ELEVATION (m)	DATE DRILLED 1997 02 11
N/A	OBSERVED WATER LEVEL
TOP OF CASING ELEVATION (m)	LOGGED BY
N/A	AGM

SHEET 1 OF 1

APPENDIX IV

Laboratory Reports

1988 Triumph Street Vancouver B C C [redacted] 1K5

analytical service laboratories ltd

FAX (604) 253 6700 TEL (604) 253 4188

CHEMICAL ANALYSIS REPORT

Date	February 24 1997
ASL File No	G9339
Report On	W6-134B Soil Analysis Petro Canada
Report To	**Morrow Environmental Consultants** Unit E - 1420 Clarence Avenue Winnipeg MB R3T 1T6
Attention	**Mr Alex Man**
Received	February 17 1997

ASL ANALYTICAL SERVICE LABORATORIES LTD
per

Joanne Patrick B Sc
Project Chemist

/2cc Liana Campbell B Sc
Project Chemist

REMARKS

File No G9339

It was necessary to increase the detection limits for benzene and toluene for the sample identified as 6-4 This sample contains hydrocarbons that interfere with the quantitation of these compounds

RESULTS OF ANALYSIS - Sediment/Soil

File No G9339

		3 2	5 7	6 4	7 5
		97 02 11	97 02 11	97 02 11	97 02 11
Physical Tests					
Moisture	%	17 4	13 4	8 4	21 7
Total Metals					
Lead	T Pb	9			
Non halogenated Volatiles					
Benzene		43 2	1 17	<0 2	0 49
Ethylbenzene		97 4	2 85	1 43	2 64
Toluene		331	5 07	<0 1	2 54
meta & para Xylene		472	9 93	6 22	8 35
ortho Xylene		153	2 52	1 25	1 54
Light Hydrocarbons (C5 9)		5240	194	104	147
Extractables					
Total Extr Hydrocarbons (C10 30)		752	<40	<40	<40

Remarks regarding the analyses appear at the beginning of this report
Results are expressed as milligrams per dry kilogram except where noted
< = Less than the detection limit indicated

METHODOLOGY File No G9339

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Moisture

This analysis is carried out gravimetrically by drying the sample to constant weight at 103 C

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from Test Methods for Evaluating Solid Waste SW-846 Method 3050 or Method 3051 published by the United States Environmental Protection Agency (EPA) The procedures involve a digestion using a 1 1 ratio of nitric acid and hydrochloric acid along with hotplate or microwave heating Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010)

Method Limitation The stated acid digestion will provide excellent results for total recoverable metals however it is only partially effective on mineralized or non-environmentally available metals

Volatile Organic Compounds in Sediment/Soil - Headspace Method

This analysis is based on U S EPA Methods 3500 3810 8015 and 8020 (Publ #SW-846 3rd ed Washington DC 20460) and British Columbia Ministry of Environment Lands and Parks Method 'Volatile Petroleum Hydrocarbons in Soil The procedure involves extraction of the sediment/soil sample with methanol An aliquot of this methanol extract is then added to a vial containing a constant volume of water This vial is sealed and heated causing the volatile compounds to partition into the headspace above the sample A portion of this gaseous headspace is then analysed by capillary column gas chromatography with photo-ionization and flame-ionization detection

Total Extractable Hydrocarbons in Sediment/Soil

This analysis is carried out in accordance with U S EPA Method 3500/8015 (Publ # SW-846 3rd ed Washington DC 20460) This procedure involves hexane/acetone extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection

End of Report

HYDR ARBON DISTRIBUTION REPORT

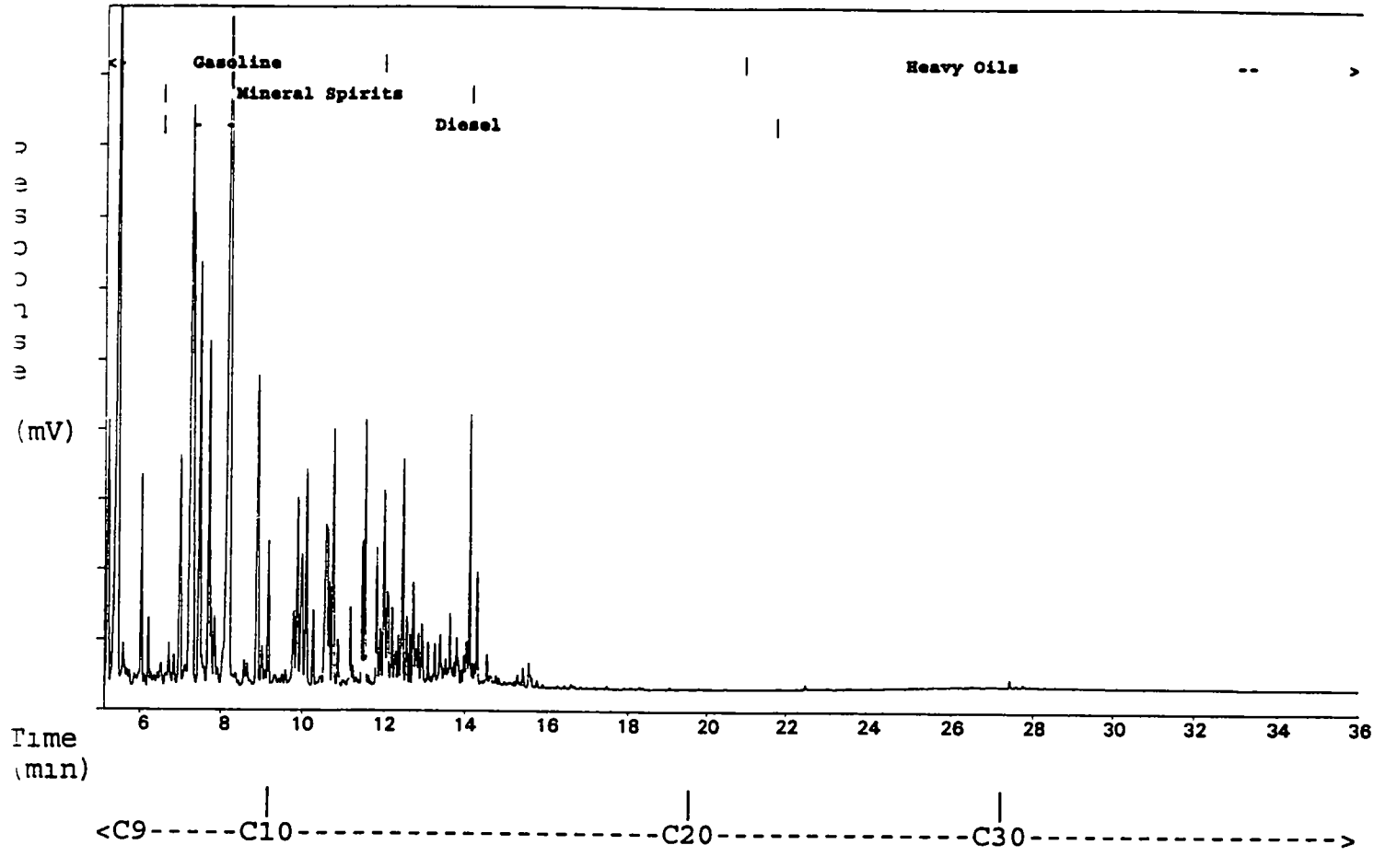
SAMPLE NAME G9339 1

3-2

Sample acquired FEB 19 1997 05 25 20

File Name C \TEH\FEB18\TEHFEB18 48R Sample Name G9339 1

Sequence file TEHFEB18



ASL Sample ID G9339 1* 8 0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	45 5
C10-C19	(beg-nC10 to beg-nC20)	50 5
C20-C30	(beg-nC20 to beg-nC31)	1 3
C31-C40	(beg-nC31 to beg-nC41)	2 7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40 and are based solely on the areas of those peaks

MORROW ENVIRONMENTAL CONSULTANTS NC

SAMPLE SUBMISSION FORM & CHAIN OF CUSTODY

PROJECT NO WG134B LOCATION Stonewall, MB LAB ASL

CLIENT PC LOC CODE 67086

SAMPLING DATE 97 02 11 SUBMISSION DATE 970212 RESULTS TO MECI BY Normal

SAMPLES TAKEN BY AM SUBMITTED BY AM

PROJECT MANAGER AM NO OF SAMPLE SETS 33

Sample Identification	Sample Type	Preservation	Container	Analysis Required: BTEX/LH (methanol)	TEH	Pb					
1-3	Soil	4°C	2 x 125mL jar								
1-4	"	"	"								
1-5	"	"	"								
1-7	"	"	"								
2-4	"	"	"								
2-5	"	"	"								
2-7	"	"	"								
3-2	"	"	"								
3-4	"	"	"								
3-5	"	"	"								

COMMENTS Please FAX back for Analysis Request

FAXED

Thanks!
Alex

Relinquished By (Signature)	Affiliation	Date	Time	Received By (Signature)	Affiliation	Date	Time
AG/Cam	MECI	970212	4 30pm		ASL	Feb13/97	

If any samples are not intact at time of transfer please describe on back of this form

KEY **BETX** Benzene Ethylbenzene Toluene Xylenes **LAH** Light Aliphatic Hydrocarbons **Metals** CMCS Level B Metals **Min O/G** Mineral Oil and Grease **O/G** Total Oil and Grease **PAH** Polycyclic Aromatic Hydrocarbons **Phenols** Total Phenols **TEH** Total Extractable Hydrocarbons

COPIES white to follow results yellow lab copy pink submitter s copy

MORROW ENVIRONMENTAL CONSULTANTS NC

SAMPLE SUBMISSION FORM & CHAIN OF CUSTODY

PROJECT NO WG134B LOCATION Stonewall, MB. LAB ASL

CLIENT PC LOC CODE 67086

SAMPLING DATE 97 02 11 SUBMISSION DATE 97 02 12 RESULTS TO MECI BY Normal

SAMPLES TAKEN BY AM SUBMITTED BY AM

PROJECT MANAGER AM NO OF SAMPLE SETS 33

Sample Identification	Sample Type	Preservation	Container	Analysis Required: BTEX/LH (methanol)	TEH	PS					
3-6	Soil	4°C	2x 125mL jar								
4-1	↓	↓	↓								
4-2											
4-5											
5-3											
5-7											
6-3											
6-4											
6-8											
7-5											

COMMENTS

Relinquished By (Signature)	Affiliation	Date	Time	Received By (Signature)	Affiliation	Date	Time
AG Zum	MECI	970212	4 30				

If any samples are not intact at time of transfer please describe on back of this form

KEY **BETX** Benzene Ethylbenzene Toluene Xylenes **LAH** Light Aliphatic Hydrocarbons **Metals** CMCS Level B Metals **Min O/G** Mineral Oil and Grease **O/G** Total Oil and Grease **PAH** Polycyclic Aromatic Hydrocarbons **Phenols** Total Phenols **TEH** Total Extractable Hydrocarbons

COPIES white to follow results yellow lab copy pink submitter s copy

MORROW ENVIRONMENTAL CONSULTANTS

SAMPLE SUBMISSION FORM & CHAIN OF CUSTODY

PROJECT NO W6134B LOCATION Stonewall, MB LAB ASL

CLIENT PC LOC CODE 67086

SAMPLING DATE 97 02 11 SUBMISSION DATE 97 02 12 RESULTS TO MECI BY Normal

SAMPLES TAKEN BY AM SUBMITTED BY AM

PROJECT MANAGER AM NO OF SAMPLE SETS 33

Sample Identification	Sample Type	Preservation	Container	Analysis Required: BTEX/LH (Methanol)	TEH	Pb					
7-6	Soil	4°C	2x125 mL jar								
8-4	↓	↓	↓								
8-7											
9-3											
9-4											
10-5											
11-1											
11-5											
12-4											
13-3											

COMMENTS

Relinquished By (Signature)	Affiliation	Date	Time	Received By (Signature)	Affiliation	Date	Time
[signature]	MECI	970212	4 30 pm				

If any samples are not intact at time of transfer please describe on back of this form

KEY **BETX** Benzene Ethylbenzene Toluene Xylenes **LAH** Light Aliphatic Hydrocarbons **Metals** CMCS Level B Metals **Min O/G** Mineral Oil and Grease **O/G** Total Oil and Grease **PAH** Polycyclic Aromatic Hydrocarbons **Phenols** Total Phenols **TEH** Total Extractable Hydrocarbons

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MORROW ENVIRONMENTAL CONSULTANTS

SAMPLE SUBMISSION FORM & CHAIN OF CUSTODY

PROJECT NO W6134B LOCATION Stonewall, MB. LAB ASL

CLIENT PC LOC CODE 67086

SAMPLING DATE 97 02 11 SUBMISSION DATE 97 02 12 RESULTS TO MECI BY Normal

SAMPLES TAKEN BY AM SUBMITTED BY AM

PROJECT MANAGER AM NO OF SAMPLE SETS 33

Sample Identification	Sample Type	Preservation	Container	Analysis Required: BTEX/LH (Methanol)	TEH	Pb					
13-4	Soil	4°C	2x 125mL jar								
14-1	↓	↓	↓								
15-1	↓	↓	↓								

COMMENTS

Relinquished By (Signature)	Affiliation	Date	Time	Received By (Signature)	Affiliation	Date	Time
AGTm	MECI	970212	4 30pm				

If any samples are not intact at time of transfer please describe on back of this form

KEY **BETX** Benzene Ethylbenzene Toluene Xylenes **LAH** Light Aliphatic Hydrocarbons **Metals** CMCS Level B Metals **Min O/G** Mineral Oil and Grease **O/G** Total Oil and Grease **PAH** Polycyclic Aromatic Hydrocarbons **Phenols** Total Phenols **TEH** Total Extractable Hydrocarbons

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analytical service laboratories ltd

FAX (604) 253 6700 TEL (604) 253 4188

CHEMICAL ANALYSIS REPORT

Date	March 14 1997
ASL File No	G9895
Report On	W6134B Water Analysis Petro Canada
Report To	**Morrow Environmental Consultants** Unit E - 1420 Clarence Avenue Winnipeg MB R3T 1T6
Attention	**Mr Alex Man**
Received	March 7 1997

ASL ANALYTICAL SERVICE LABORATORIES LTD
per

Joanne Patrick B Sc
Project Chemist

Liana Campbell B Sc
Project Chemist

REMARKS

File No G9895

It was necessary to increase the detection limit for toluene for the sample identified as MW 8 This sample contains hydrocarbons that interfere with the quantitation of toluene

RESULTS OF ANALYSIS - Water

File No G9895

	MW 3	MW 7	MW 8
Dissolved Metals			
Lead D Pb	0 058		
Non halogenated Volatiles			
Benzene	31 6	2 35	0 850
Ethylbenzene	3 83	0 947	<0 0005
Toluene	37 0	2 86	<0 002
meta & para Xylene	15 1	3 05	0 0007
ortho Xylene	6 24	1 05	0 0021
Light Hydrocarbons (C5 9)	101	19 1	1 0

Remarks regarding the analyses appear at the beginning of this report
Results are expressed as milligrams per litre
< = Less than the detection limit indicated

METHODOLOGY File No G9895

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Metals in Water

This analysis is carried out in accordance with procedures described in Standard Methods for the Examination of Water and Wastewater 19th Edition 1995 published by the American Public Health Association and with procedures adapted from Test Methods for Evaluating Solid Waste SW-846 published by the United States Environmental Protection Agency (EPA) The procedures may involve preliminary sample treatment by acid digestion or filtration (EPA Method 3005) followed by instrumental analysis by atomic absorption spectrophotometry (EPA Method 7000) inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010) and/or inductively coupled plasma - mass spectrometry (EPA Method 6020)

Volatile Organic Compounds in Water - Headspace Method

This analysis is based on U S EPA Methods 3810 8015 8020 and 8240 (Publ #SW-846 3rd ed Washington DC 20460) and British Columbia Ministry of Environment Lands and Parks Method 'Volatile Petroleum Hydrocarbons in Water The procedure involves the use of a headspace technique in which the volatile compounds partition into the headspace of a sealed vial A portion of this gaseous headspace is then analysed by capillary column gas chromatography with mass spectrometric / flame-ionization detection or photo-ionization / flame-ionization detection

End of Report

MORROW ENVIRONMENTAL CONSULTANTS INC

SAMPLE SUBMISSION FORM & CHAIN OF CUSTODY

PROJECT NO W6134B LOCATION Stonewall LAB ASL

CLIENT PC LOC CODE 67086

SAMPLING DATE 97 03 06 SUBMISSION DATE 97 03 06 RESULTS TO MECI BY Normal

SAMPLES TAKEN BY AM SUBMITTED BY AM

PROJECT MANAGER AM NO OF SAMPLE SETS 3

9895

Sample Identification	Sample Type	Preservation	Container	Analysis Required: BTEX/LH	Pb-D						
1 MW3	Water	$CuSO_4$/Cool	P+T/125mlplast	✓	✓						
2 MW7	↓	$CuSO_4$/Cool	↓	✓	✓						
3 MW8		$CuSO_4$/Cool		✓	✓						

COMMENTS Please fax back for analysis req/cat.

FAXED

Relinquished By (Signature)	Affiliation	Date	Time	Received By (Signature)	Affiliation	Date	Time
[signature]	MECI	970306	4:30		ASL	970307	2:00 pm

If any samples are not intact at time of transfer please describe on back of this form

KEY **BETX** Benzene Ethylbenzene Toluene Xylenes **LAH** Light Aliphatic Hydrocarbons **Metals** CMCS Level B Metals **Min O/G** Mineral Oil and Grease **O/G** Total Oil and Grease **PAH** Polycyclic Aromatic Hydrocarbons **Phenols** Total Phenols **TEH** Total Extractable Hydrocarbons

COPIES white to follow results yellow lab copy pink submitter s copy

FAX

analytical service laboratories ltd
SPECIALISTS IN ENVIRONMENTAL CHEMISTRY
1988 Triumph Street Vancouver B C V5L 1K5
Telephone (604) 253 4188
Fax (604) 253-6700

FAX

Attention: **Mr. Alex Man**
Company: Morrow Environmental Consultants
Fax # 12044779194

From Joanne Patrick
Date Wednesday March 26, 1997

The number of pages in this transmission (including this page) is 4

Regarding

Here are your results for W6-134B

Regards
Joanne

CHEMICAL ANALYSIS REPORT

Date	INTERIM
ASL File No	H1348
Report On	W6-134B Water Analysis Petro Canada
Report To	**Morrow Environmental Consultants** Unit E - 1420 Clarence Avenue Winnipeg, MB R3T 1T6
Attention	**Mr Alex Man**
Received	March 21, 1997

ASL ANALYTICAL SERVICE LABORATORIES LTD
per

Joanne Patrick B Sc
Project Chemist

RESULTS OF ANALYSIS

File No H1348

	PW-2
	97 03 19
Non-halogenated Volatiles	
Benzene	0 0191
Ethylbenzene	<0 0005
Toluene	<0 0005
meta & para-Xylene	<0 0005
ortho-Xylene	<0 0005
Light Hydrocarbons (C5-9)	<0 1

Results are expressed as milligrams per litre
< = Less than the detection limit indicated

METHODOLOGY File No H1348

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Volatile Organic Compounds in Water - Headspace Method

This analysis is based on U S EPA Methods 3810, 8015 8020 and 8240 (Publ #SW-846 3rd ed Washington DC 20460) and British Columbia Ministry of Environment Lands and Parks Method "Volatile Petroleum Hydrocarbons in Water' The procedure involves the use of a headspace technique in which the volatile compounds partition into the headspace of a sealed vial A portion of this gaseous headspace is then analysed by capillary column gas chromatography with mass spectrometric / flame-ionization detection or photo-ionization / flame-ionization detection

End of Report

APPENDIX V

Monitoring Results

APPENDIX V Monitoring Results (1997 02 11)

Monitoring Well	Ground Surface Elevation (m)	Top of Monitoring Well Elevation (m)	Depth to Liquid Hydrocarbons[1] (m)	Depth to Groundwater[1] (m)	Apparent Thickness of Liquid Hydrocarbon (mm)	Groundwater Elevation (m)	Monitoring Well Vapour Concentration[2] (ppm)	Remarks
97 1				2 946	0		1 210	
97 2	98 423	98 279		2 207	0	96 072	1 540	
97 3	98 765	98 617		5 529	0	93 088	8 030	
97-4	98 723	98 578		3 067	0	95 511	4 180	
97 5	98 543	98 446		2 865	0	95 581	2 420	
97-6	98 900	98 801		4 226	0	94 575	1 100	
97 7	98 261	98 136		2 375	0	95 761	1 210	
97 8	97 858	97 737		4 180	0	93 557	100	
97 9	98 536	98 425		4 510	0	93 915	260	
97 10	98 987	98 845		1 799	0	97 046	140	
97 11	98 584	98 460		2 169	0	96 291	110	
P 1	98 670	98 297		2 035	0	96 262	275	
P 2	98 486	98 277		2 216	0	96 061	170	
P 3	98 365	98 275		2 191		96 084	90	
P 4			NM	NM			NM	well cap frozen

1 measured from top of monitoring well
2 measured using Gastech® hydrocarbon vapour analyser with no methane response

APPENDIX V Monitoring Results (1997 03 06)

Monitoring Well	Ground Surface Elevation (m)	Top of Monitoring Well Elevation (m)	Depth to Liquid Hydrocarbons[1] (m)	Depth to Groundwater[1] (m)	Apparent Thickness of Liquid Hydrocarbon (mm)	Groundwater Elevation (m)	Monitoring Well Vapour Concentration[2] (ppm)	Remarks
97 1			NM	NM			NM	under snow bank
97 2	98 423	98 279		2 366	0	95 913	150	
97 3	98 765	98 617		2 610	0	96 007	7 260	
97-4	98 723	98 578		2 395	0	96 183	5 830	
97 5	98 543	98 446		2 785	0	95 661	1 760	
97-6	98 900	98 801		3 229	0	95 572	770	
97 7	98 261	98 136		2 550	0	95 586	400	
97 8	97 858	97 737		2 274	0	95 463	ND	
97 9	98 536	98 425		2 445	0	95 980	225	
97 10	98 987	98 845		2 182	0	96 663	65	
97 11	98 584	98 460		2 558	0	95 902	50	
P 1	98 670	98 297		2 230	0	96 067	75	
P 2	98 486	98 277		2 389	0	95 888	25	
P 3	98 365	98 275		2 370	0	95 905	45	
P 4			NM	NM			NM	well cap frozen

1 measured from top of monitoring well
2 measured using Gastech® hydrocarbon vapour analyser with no methane response