Supplementary Phase 2 Environmental Site Assessment and Remedial Options Assessment
191 and 193 Lees Avenue
Ottawa, Ontario

Revision: 0 (Final)

Prepared for:
City of Ottawa
Real Estate Partnerships & Development Office
Realty Services Branch
110 Laurier Ave. W., 5th Floor
Ottawa, ON K1P 1J1

Prepared by:

Geofirma Engineering Ltd
1 Raymond St., Suite 200
Ottawa, Ontario K1R 1A2
Tel: (613) 232-2525
Fax: (613) 232-7149
www.geofirma.com

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February 4, 2013

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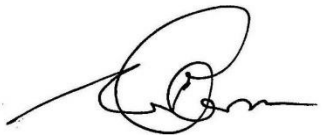
Prepared by:	Kenneth Raven, Sean Sterling, Richard Jackson, Jean-Francois Dion, Vanessa Scharf	
Reviewed by:	Sean Sterling and Kenneth Raven	
Approved by:	 Kenneth Raven, P.Eng., P.Geo.	

EXECUTIVE SUMMARY

Geofirma Engineering Ltd. was retained by the City of Ottawa – Realty Services Branch to complete a Supplementary Phase 2 Environmental Site Assessment (ESA) of the property addressed as 191 and 193 Lees Avenue, Ottawa, Ontario. The Supplementary Phase 2 ESA was completed as follow-up to an initial Phase 2 ESA and Phase 1 ESA completed and submitted to the City under separate covers.

191 Lees Avenue is currently the Lees Avenue Transitway Station. 193 Lees Avenue is vacant adjoining land located immediately north of the Lees Avenue Campus of the University of Ottawa located at 200 Lees Avenue. The assessed site includes 191 and 193 Lees Avenue, excluding a small parcel owned by Enbridge Gas, and including the adjoining City of Ottawa street rights-of-way. The Lees Avenue Transitway Station property is the site of the former Ottawa coal and oil manufactured gas plant, that operated from the early 1920s to 1957. Extensive subsurface investigations and historical reviews of land use and subsurface conditions were completed at the site in 1986-87 following the discovery of coal tar in the adjacent Rideau River in April 1986.

The overall City objectives for assessment of the 191 and 193 Lees Avenue site are the following:

1. Provide an up-dated assessment of the environmental condition of the property in accordance with current MOE O.Reg. 153/04 site condition standards;
2. Assessment of potential suitability of the site for research, demonstration and application of innovative soil remediation technologies (e.g., STAR – Self-sustaining Treatment for Active Remediation, currently under development at the University of Western Ontario, Faculty of Engineering); and
3. Assessment of re-development constraints for currently undeveloped lands around the Transitway Station.

The Supplementary Phase 2 ESA scope of work included the following major activities:

- Reinstatement/salvage or decommissioning of currently unusable groundwater monitoring wells remnant from the 1986/1987 investigations in accordance with O.Reg. 903;
- Drilling, soil sampling and soil screening of seven boreholes completed to the top of till or refusal to better define soil quality to support evaluation of remedial technologies for the site;
- Installation of seven new groundwater monitoring wells to access the deep alluvium or fill to better define groundwater quality to support evaluation of remedial technologies for the site.
- Submission of 42 separate soil samples for laboratory analysis of metals, PAH and/or PHC-F1/BTEX;
- Submission of 37 groundwater samples for analysis of PAH and PHC-F1/BTEX;
- Surveying of new and existing monitoring wells for elevation, position, water level and product thickness; and
- Completion of an assessment of potentially suitable remedial options for coal tar contamination including innovative in-situ remedial technologies (e.g., STAR) as well as more conventional remedial technologies.

The results of the Supplementary Phase 2 ESA and the initial Phase 2 ESA show that the distribution of coal tar contamination from both visual/olfactory observation and laboratory chemical testing is consistent with the distribution described on 1986 and 1987. Coal tar is present within the deep

alluvium and to a lesser extent the shallow alluvium and fill units primarily on the east side of the Transitway below the parking lot. The highest concentrations of coal tar chemicals (i.e., PAH) were found in the fill and deep alluvium to the top of the low permeability basal till unit over the eastern half of the parking lot. Typically coal tar is found in this part of the site at elevations of 53 to 50 mASL at depths of 7 to 10 mBGS. This coal tar appears to be pooled on top of the basal till unit. The occurrence of coal tar at BH12-11 (and historically at OW120B) is consistent with historical movement of coal tar down the sloping till surface to the southeast of the parking lot. Coal tar was also observed within the shallow fill of BH/MW12-13, which was drilled into the former relief gas holding tank, and in the shallow fill and deep alluvium at BH/MW12-15, near the former boiler house tar storage area. The former relief gas holder appears to have an intact base.

Laboratory chemical testing for typical coal gasification plant waste chemicals shows that PAH and PHC-F1/BTEX remain the chemicals of concerns at the site. Metals and cyanide in soil and groundwater were either not detected (cyanide in soil and groundwater) or were found only sporadically in site soil and groundwater at moderately elevated concentrations.

On the west side of the Transitway there are limited exceedences of MOE standards for soil for PAH, PHC-F1/BTEX or metals at five locations. Groundwater west of the Transitway does not show exceedences of MOE standards for metals, PAH, free cyanide and PHC-F1/BTEX at the 15 locations sampled in 2012. These are quite limited exceedences given the historical land use and results of earlier investigations, and these results suggest some redevelopment potential may exist for land located west of the Transitway Station.

PAH and PHC-F1/BTEX exceedences of MOE standards are more frequent and widespread on the east side of the Transitway below the existing parking lot, consistent with visual and olfactory observations of coal tar occurrence in this area. This identified contamination in the shallow fill and the deep alluvium poses a significant impediment to redevelopment of parking lot area. Soil metals, PAH and BTEX exceedences and groundwater PAH and PHC-F1 exceedences of MOE standards were found at BH/MW12-11 on 193 Lees Avenue in proximity to adjacent University of Ottawa land. Soil PAH and BTEX exceedences of MOE standards were also found east of the Lees Avenue overpass at BH12-12 and BH12-16 on 193 Lees Avenue.

Assessment of potentially applicable remedial technologies and strategies for coal tar contamination at the Lees Avenue site identified four strategies combining multiple remediation activities as warranting further consideration. These four strategies can be broadly described as:

1. Excavation and Off-site Combustion.
2. Partial Excavation and In-situ Combustion.
3. Partial Excavation and In-situ Stabilization; and
4. Risk Management and Risk Assessment.

Each of these remedial strategies has different benefits and limitations and even if successful may allow varying degrees of development (i.e. risk management and risk assessment strategy may not allow subsurface development). These strategies also incorporate other aspects such as engineered barriers and institutional controls. Class 5 cost estimates are provided for each strategy for comparison and evaluation purposes only; Class 4 cost estimates should be prepared for each of these strategies as part of a more detailed remedial feasibility study.

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1 INTRODUCTION

Geofirma Engineering Ltd. was retained by the City of Ottawa – Realty Services Branch to complete a Supplementary Phase 2 Environmental Site Assessment (ESA) and Remedial Options Assessment (ROA) of the property addressed as 191 and 193 Lees Avenue, Ottawa, Ontario. The Supplementary Phase 2 ESA was completed as follow-up to a Phase 1 ESA (Geofirma Engineering Ltd., 2012a) and the Phase 2 ESA (Geofirma Engineering Ltd., 2012b) completed and submitted to the City under separate covers. The Phase 2 ESA recommended that supplementary Phase 2 ESA work be undertaken to better delineate the nature and extent of soil and groundwater contamination identified in the Phase 2 ESA and that a formal assessment of remedial options be completed before proceeding with any particular promising cleanup technology.

The Supplementary Phase 2 ESA and Remedial Options Assessment reported herein was completed in accordance with a proposed work plan prepared by Geofirma Engineering Ltd. (2012c), dated July 30, 2012. This work was completed under City of Ottawa Standing Offer RFSO 0190-91843-S01 – Phase 1 and 2 Environmental Site Assessments with Geofirma Engineering Ltd.

1.1 Site Description

191 Lees Avenue is currently the Lees Avenue Transitway Station. 193 Lees Avenue is vacant adjoining land located immediately north of the Lees Avenue Campus of the University of Ottawa located at 200 Lees Avenue. The assessed site includes 191 and 193 Lees Avenue, excluding a small parcel owned by Enbridge Gas, and including the adjoining City of Ottawa street rights-of-way. Figure 1.1 shows the location of the site and Figure 1.2 shows the boundaries of the site assessed as part of this work plotted on a recent 2008 air photo of the property with municipal street addresses.

1.2 Background and Study Objectives

The Lees Avenue Transitway Station property is the site of the former Ottawa coal and oil manufactured gas plant, that operated from the early 1920s to 1957. Extensive subsurface investigations and historical reviews of land use and subsurface conditions were completed at the site in 1986-87 following the discovery of coal tar in the adjacent Rideau River in April 1986. The Phase 1 ESA provides a summary description of site history and previous subsurface investigations completed at 191 and 193 Lees Avenue.

The initial investigations of the Lees Avenue Transitway Station site and surrounding area were completed over 25 years ago by Conestoga Rovers & Associates Limited (1986a, 1986b) for the Regional Municipality of Ottawa-Carleton, and by Intera Technologies Ltd. (1987) for the Ontario Ministry of the Environment (MOE). Provincial environmental quality guidelines and standards for typical coal gasification plant wastes were not available at the time of these investigations. Consequently, there was considerable uncertainty in the environmental condition of the site today and the ability to redevelop the site in accordance with current MOE guidance and regulations.

In 2012, the City of Ottawa completed a Phase 2 ESA of the site based on drilling and testing of soil and groundwater quality from 12 boreholes and groundwater monitoring wells.

LEGEND

- Site Location
- Road
- Highways
- Waterbody

Figure 1.1
Site Location

Scale 1:25,000

0 125 250 500 750 1,000
Meters

Projection: NAD 83 MTM Zone 9
Source: NCC, Geobase Canada

PROJECT No. 11-200-11

PROJECT Supplementary Phase 2 ESA
& Remedial Options Assessment
191 & 193 Lees Avenue, Ottawa

DESIGN: ADG
CAD/GIS: VMS
CHECK: KGR
REV: 0

DATE: 21/01/2013

Geofirma Engineering Ltd

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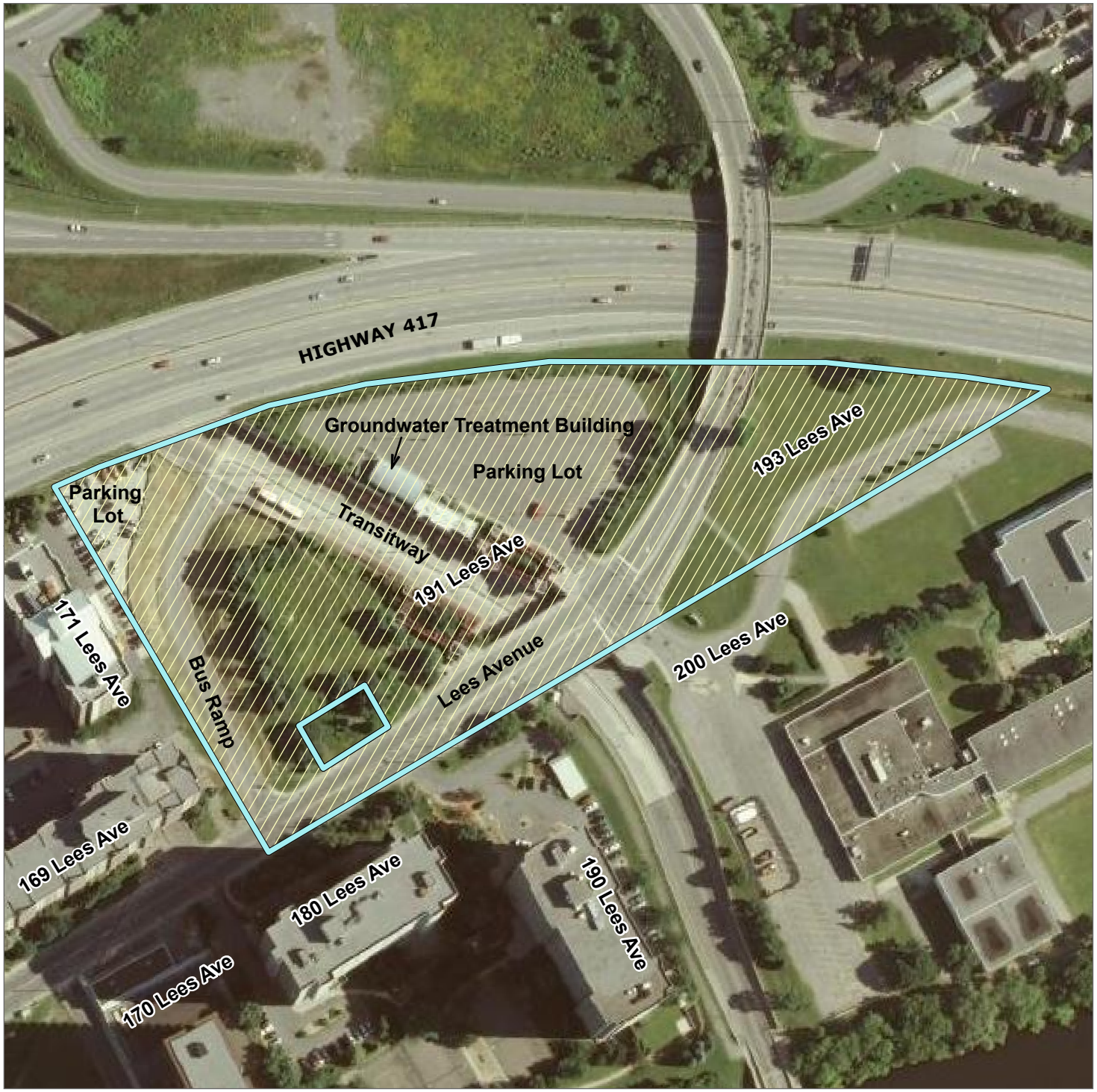

LEGEND

Site Boundary

Figure 1.2
Site Layout

Scale 1:2,000

0 10 20 40 60 80
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa eMap, 2008

PROJECT No. 11-200-11

PROJECT
Supplementary Phase 2 ESA
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The overall City objectives for assessment of the 191 and 193 Lees Avenue site are the following:

1. Provide an up-dated assessment of the environmental condition of the property in accordance with current MOE O.Reg. 153/04 site condition standards (MOE, 2011a);
2. Assessment of potential suitability of the site for research, demonstration and application of innovative soil remediation technologies (e.g., STAR – Self-sustaining Treatment for Active Remediation, currently under development at the University of Western Ontario, Faculty of Engineering); and
3. Assessment of re-development constraints for currently undeveloped lands around the Transitway Station.

1.3 Scope of Work

The Supplementary Phase 2 ESA and Remedial Options Assessment scope of work included the following activities and rationale to broadly meet the City overall objectives for the site:

1. Reinstatement/salvage or decommissioning of currently unusable groundwater monitoring wells remnant from the 1986/1987 investigations in accordance with O.Reg. 903.

2. Additional drilling, soil sampling, monitoring well installation to define soil and groundwater conditions on University of Ottawa property to delineate the extent of metals, PAH, PHC-F1/BTEX and coal tar contamination southeast of BH/MW12-11.

3. Additional drilling soil sampling and laboratory testing to better define the distribution and physical and chemical properties of coal tar in the deep alluvium over the eastern half of the Transitway Station parking lot, and within the former relief gas holder to further and more accurately assess contamination and the potential application of STAR and other remediation technologies at the Lees Avenue site.

4. Additional soil quality testing for metals, PAH and PHC-F1/BTEX on the west side of the Transitway to delineate and confirm the low levels of contamination identified in the initial Phase 2 ESA.

5. A second round of water level monitoring and groundwater sampling of all accessible groundwater monitoring wells for PAH and PHC-F1-BTEX to confirm the initial groundwater quality results.

6. A remedial options assessment of STAR, other innovative in-situ remedial technologies and more conventional ex-situ remedial alternatives before advancing or selecting STAR as a potential preferred remedial technology for the identified coal tar contamination at the site.

Neither the Phase 1 ESA/ Phase 2 ESA completed earlier, nor the supplementary investigation described herein, have been specifically planned to support filing of a Record of Site Condition for the property in accordance with the amended O.Reg. 153/04.

1.4 Report Organization

This report is organized into eight Sections and five Appendices.

Section 1 provides an introduction to the site, including site description, background, study objectives, work scope and organization of the report.

Section 2 provides a summary description of understanding of site conditions presented in the Phase 1 ESA and Phase 2 ESA reports as a Conceptual Site Model (CSM). Section 2 describes the geological framework, hydrostratigraphic units, the groundwater flow system, potential historical contaminating activities, areas of potential environmental concern, and the soil and groundwater contamination. The CSM is presented in Section 2 to provide rationale and context to the Supplementary Phase 2 ESA investigations as well as the evaluation of remedial options.

Section 3 provides a summary description of the methodology and scope of site investigations including environmental, health and safety planning, site inspection, clearance of underground utilities, well rehabilitation, borehole drilling, soil sampling and screening, monitoring well installation, water level surveys, groundwater sampling and field quality assurance procedures..

Section 4 summarizes the results of the field and laboratory investigations including assessments of soil and groundwater quality, groundwater elevations and interpreted flow directions, and nature and extent of soil and groundwater contamination and updated assessment of the conceptual site model.

Section 5 also provides a screening and assessment of the potential application of conventional and innovative in-situ soil remediation technologies for coal tar contamination at the site including STAR (Self-sustaining Treatment for Active Remediation).

Section 6 provides conclusions and recommendations of the work.

Sections 7 and 8 contain a list of report references and a report closure.

Appendix A contains borehole stratigraphic and instrumentation logs of the seven new boreholes and groundwater monitoring wells installed as part of the current supplementary Phase 2 ESA study, as well as the 12 boreholes and monitoring wells installed as part of the initial Phase 2 ESA. Appendix B contains summary tables of soil and groundwater quality analytical results from all sampling and testing completed in 2012, including results from the initial and supplementary Phase 2 ESAs. Appendix C summarizes the results of soil grain size and hydrometer testing to determine soil texture completed as part of the initial Phase 2 ESA. Laboratory analytical reports for the 2012 soil and groundwater sampling and testing completed in this supplementary Phase 2 ESA are included in Appendix D. The MOE well records for the seven new wells are given in Appendix E.

2 CONCEPTUAL SITE MODEL

In accordance with MOE (2011b) guidance, a Conceptual Site Model (CSM) was prepared for the 191 and 193 Lees Avenue site as part of the Phase 1 and 2 ESAs (Geofirma Engineering Ltd., 2012a; 2012b). The CSM was prepared based on review of historical site investigations, 2011 inspection of the site and the 2012 Phase 2 ESA and was prepared to guide Supplementary Phase 2 ESA work. The CSM includes plan and cross-sectional figures and narrative text describing: on-site buildings and structures, underground utilities, areas of potential contaminating activity (PCA), areas of potential environmental concern (APEC), historical occurrences of soil and groundwater quality that exceed current MOE standards, summary of hydrostratigraphic units and elevation tops, contaminant release and migration mechanisms for aqueous and non-aqueous phase liquid contaminants, and role of uncertainty in data that are used to develop the CSM. Figure 2.1 shows the site layout, historical gas plant structures, APECs and historical boreholes and monitoring wells.

Figure 2.2 illustrates the CSM along a vertical cross section constructed from southwest to northeast across the site. Figure 2.3 shows the CSM along a vertical cross section constructed northwest to southeast east of the Transitway. Figure 2.1 shows the location of the cross sections as well as the site layout, historical gas plant structures, and boreholes and monitoring wells. Figures 2.2 and 2.3 show the geological and hydrostratigraphic units, the occurrence of buried former gas plant structures that are APECs today, the pattern of groundwater flow to the deep groundwater collection system installed below the Transitway bus lanes, and the presence of pooled and residual saturation coal tar in the subsurface of the site. Figures 2.2 and 2.3 are based on current and historical investigations including the results of the Supplementary Phase 2 ESA borehole drilling and sampling.

The following sections describe the elements of the CSM that are important to understanding the geology and hydrogeology of the site and the nature and scope of the Supplementary Phase 2 ESA program developed for the site. The following sections describe geological framework, hydrostratigraphic units, groundwater flow system, potential contaminating activities, areas of potential environmental concern, and soil and groundwater contaminants as reported in the Phase 1 ESA. These CSM elements are subsequently updated in Section 4 based on the results of the Supplementary Phase 2 ESA.

2.1 Geological Framework

The geological framework for the site was initially described by Conestoga-Rovers & Associates Limited (1986a, 1986b) and Intera Technologies Ltd. (1987). This geological framework was subsequently updated based on the results of the Phase 2 ESA completed in early 2012. The geological framework consists of four distinct geological layers:

- Sandy granular fill, cinders, ashes, and construction debris, 3-5 m thick @ 0-5 mBGS, deeper near and below the Transitway;
- Silty and fine sand alluvium interbedded with silty clays and coarse sand and gravels, generally coarser with depth, 3-8 m thick @ 3-10 mBGS;
- Dense, basal sandy silt glacial till with some clay and gravel, 0-4m thick @ 7-11 mBGS; and
- Fractured and weathered black shale of the Billings Formation @ depths of 10-12 mBGS, shallower below the Transitway and the bus ramp.

N

B

A

A'

B'

OW115C
OW115B
OW115A
C307
C304
OW513A
OW513B
C303
C308
C306
OW125A
BH 14
E14
H2
OW507B
OW507A
OW507C
C309
C302
OW112B
OW112A
C301
C310
OW123A
OW123B
BH18-86
G18
G12
BH11-86
G11
BH101-86
BH12-86
BH102-86
BH103-86
BH13-86
BH100-86
G13
BH16-86
G16
BH10-86
G10
BH15-86
E10
BH6-86
G6
BH 10
G2
G3
BH105-86
BH104-86
G14
BH14-86
BH 9
M1
BH 7
BH3-86
E7
E-006
G7
BH126-86
BH2-86
OW113A
OW2
E28
E31
E30
BH7-86
BH127-86
BH1-86
BH 28
E29
BH107-86
BH 30
G4
BH128-86
BH 29
BH129-86
G15
OW111B
E1
OW111A
BH108-86
BH4-86
E-112
M2
BH9-86
G9
BH106-86
BH8-86
BH130-86
G17
E-114
BH 5
E5
G5
OW1-86
E6
M3
BH5-86
OW116C
OW116B
OW116A
OW109B
OW109A
L7
BH14-86
E8
OW503A
OW503B
E-115
OW110A
OW110B
BH 1
E4
BH131-86
BH132-86
OW120B
OW120C
OW120A
E3
BH-001
OW601
OW124C
OW124B
L4
L12
L5
L6
L3
OW117C
OW117B
E13
BH 2
J1
F103
OW119B
OW119C
OW119A
OW516C
OW516B
BH 3
E32
OW605
OW604
OW516A
F108
F1
F105
F210
J2
F2
F106
OW606
F202
BH 4
K1
F4
F201
F303
E2
OW121C
OW121A
OW121B
I205
OW506C
OW506B
OW122C
OW122A
OW122B
I206
I204
I208
I207
I18
I1
I101
I16
I11
OW501C
OW501B
OW501A
I10
I12

1 Water Gas Relief Holding Tank
2 Tar Well Adacent to the Old Water Gas Plant
3 Surface and Underground Gas Oil Storage Tanks
4 Water Gas House
5 Tar Storage Area in Boiler House
6 Ammonia Liquor/Tar Well
7 Tar Pump House
8 Underground Tar Separator
9 "Bunker C" Oil Tank
10 Two tar dehydrators
11 Gas Purifying House
12 Tar, Ammonia, Liquor, Separator and Drip Oil Wells South of Purifying House
13 Condenser House
14 Retort House
15 Sump
16 Gas Metering House
17 Coal Shed
18 Gas Holder Tank

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Borehole or Monitoring Well
- Geotechnical Borehole
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping
- Cross Section Lines

Historical Gas Plant Structures (APECs)

Figure 2.1 - Site Layout, Historical Gas Plant Structures (APECs) and Historical Boreholes/Monitoring Wells

Scale 1:1,100

0 5 10 20 30 40
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

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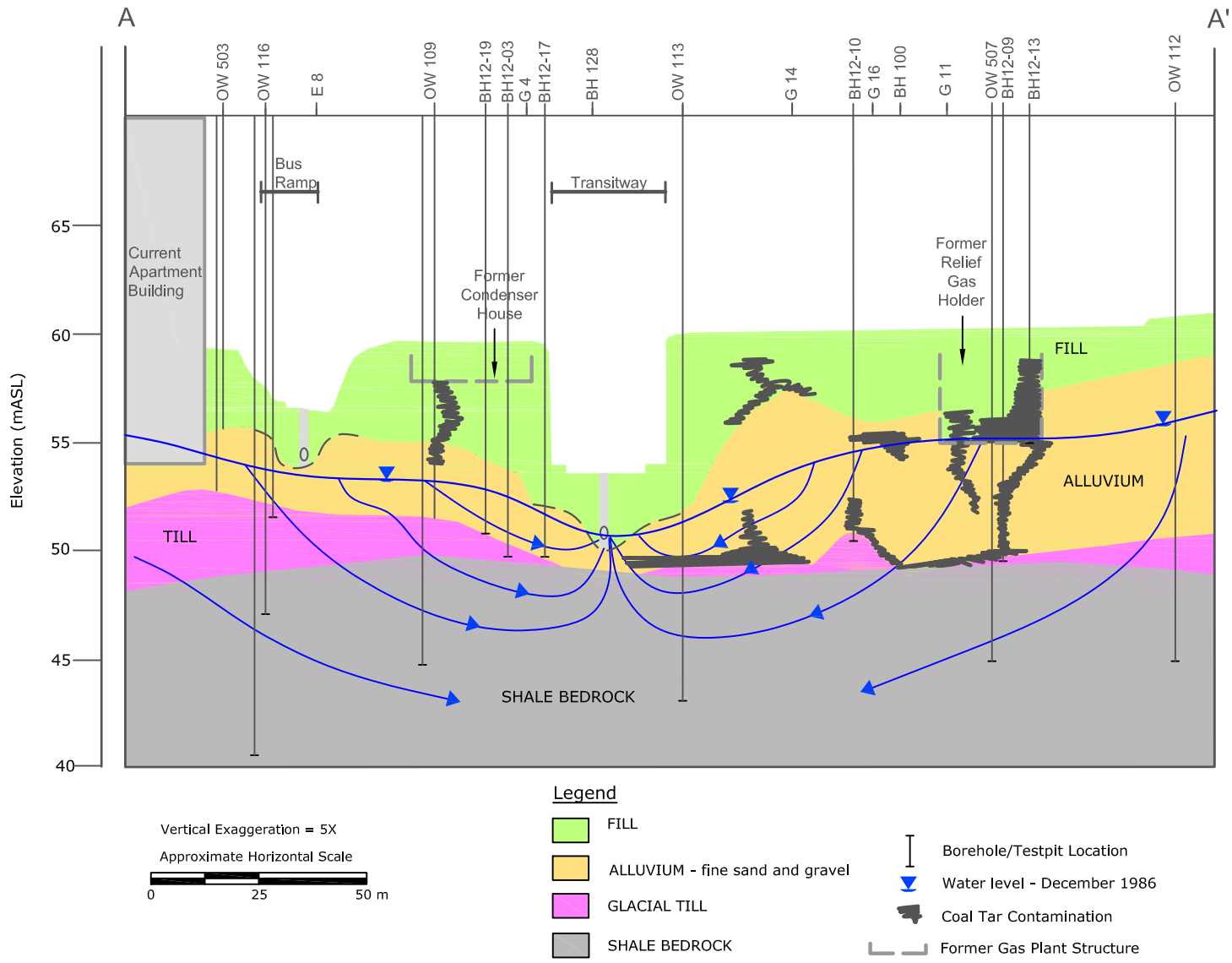

Conceptual Site Model - Cross Section A-A'
Supplementary Phase 2 ESA & Remedial Options Assessment

FIGURE 2.2	Doc. No.: 11-200-11_A-A Cross Section_R0.dwg	Prepared by: DMP/ADG Reviewed by: KGR Date: 17-Jan-13

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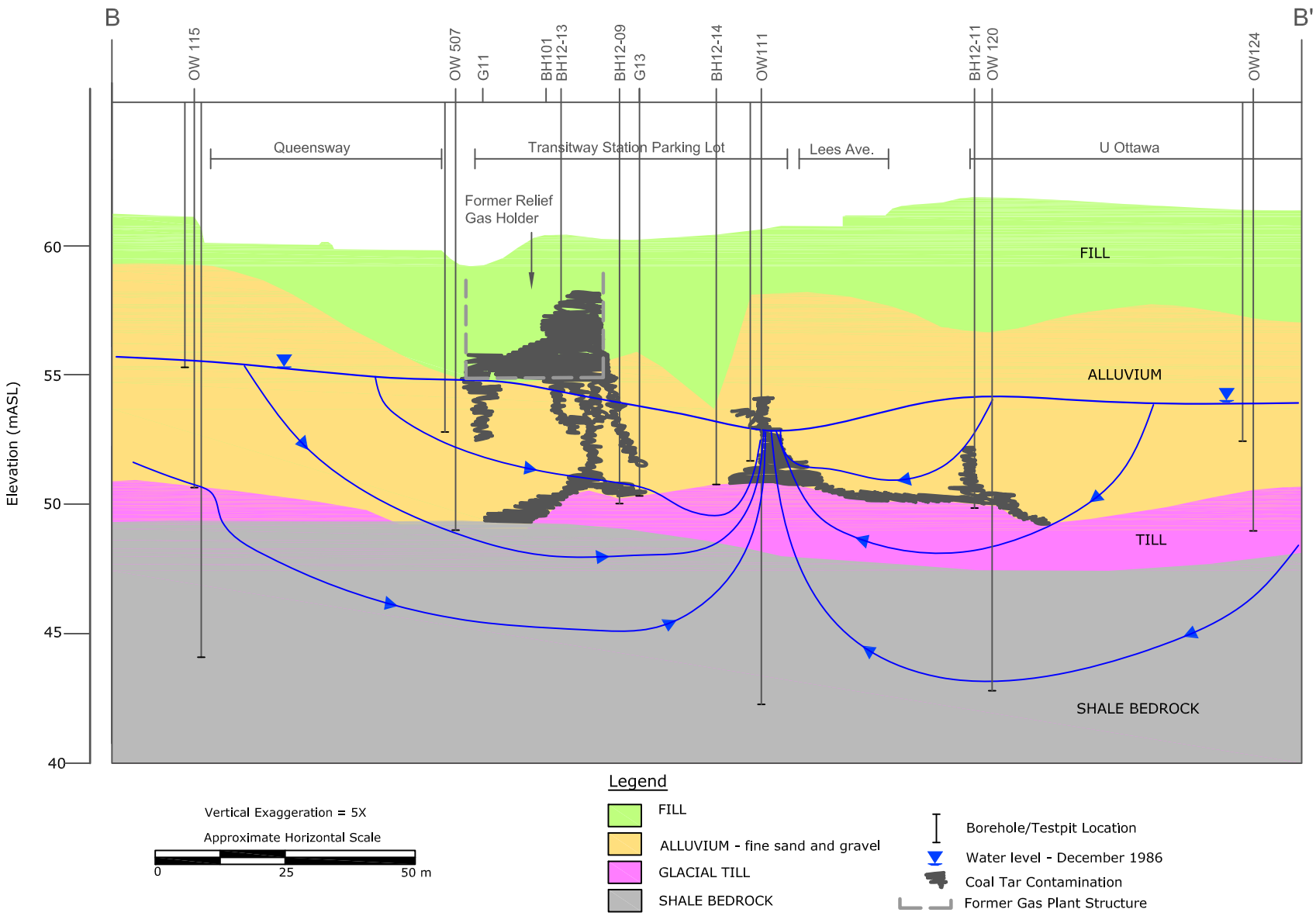


Conceptual Site Model - Cross Section B-B'
Supplementary Phase 2 ESA & Remedial Options Assessment

FIGURE 2.3	Doc. No.: 11-200-11_B-B Cross Section_R0.dwg	Prepared by: DMP/ADG Reviewed by: KGR Date: 17-Jan-13

Geofirma Engineering Ltd

The dense till is absent in several areas below the Transitway Station parking lot and below the Transitway bus lanes. The upper few metres of the bedrock are weathered and fractured.

2.2 Hydrostratigraphic Units

Based on the geological framework, field hydraulic testing and review of water level measurements, the hydrogeology of the 191 and 193 Lees Avenue site can be simplified into four hydrostratigraphic units. A hydrostratigraphic unit is a subsurface unit or group of units that has similar hydraulic characteristics and is defined to facilitate hydrogeological interpretation and analysis.

Based on the initial work described by Intera Technologies Ltd. (1987) and the Phase 2 ESA (Geofirma Engineering Ltd., 2012b), four hydrostratigraphic units exist at the site; fill, alluvium, basal till and shale bedrock. These four hydrostratigraphic units are described in detail below.

2.2.1 Fill Unit

The fill hydrostratigraphic unit is typically comprised of sandy granular anthropogenic material and consists of cinders, ash, wood, brick and metal construction debris. Remnant foundations from former gas plant structures are also likely present. As described above, it is on average 3-5 m thick and found at 0-5 mBGS, deeper and thicker near and below the Transitway. The fill unit is typically permeable (10^{-7} to 10^{-4} m/s) and unsaturated, although some perched water tables are found within the fill layer due to buried concrete foundations and some lower permeability silty layers. The fill unit is typically more permeable than the underlying alluvium. Metal, PAH, PHC and BTEX contamination has been observed and is expected to be present in the fill unit due to former land uses.

2.2.2 Alluvium Unit

The alluvium hydrostratigraphic unit is comprised of silt and fine sand with interbedded sand, gravel and clay. It represents reworked fluvial deposits of the former Ottawa River drainage channel. As described above, it is on average 3-8 m thick and found at 3-10 mBGS. Based on grain size analyses and field testing, the hydraulic conductivity of the alluvium ranges from 10^{-8} to 10^{-4} m/s. Consistent with the increasing grain size with depth, the alluvium unit is typically more permeable at depth than near surface.

The alluvium unit is the main permeable and saturated unit at the site and transmits most of the groundwater across the site and to the Transitway groundwater collection system. Because of the thickness of this unit, groundwater monitoring has historically been completed in both the upper (shallow) and lower (deep) parts of the alluvium. The more permeable deep part of the alluvium is the more important part of the unit given the potential for accumulation of coal tar on the underlying dense low permeability glacial till and considering contamination migration by groundwater movement at the site. Soil and groundwater contamination have been observed within the alluvium unit.

2.2.3 Basal Glacial Till Unit

The basal glacial till is of low permeability and separates the permeable alluvium from the moderately permeable upper part of the underlying bedrock. The glacial till is a dense compact unit that is unlikely to transmit large volumes of water and appears in places to act as a confining unit to the

underlying bedrock (i.e., at OW-125A-86). The hydraulic conductivity of the basal glacial till unit has been estimated at less than 10^{-8} m/s.

As described above, the basal glacial till is patchy and is absent in some areas below the Transitway bus lanes and parking lot. Maximum thickness at the site is about 5 m with the unit found at depths of 7-11 mBGS. The basal glacial till unit has typically not shown evidence of soil or groundwater contamination by gas plant wastes.

The upper surface of the dense basal glacial till is important in assessing the migration potential of denser-than-water coal tar at the 191 and 193 Lees Avenue site. The elevation of the upper surface of the basal glacial till unit is based on interpolation of all of the information from historical drilling investigations, as well as from the six interpreted geological cross-sections given in the Intera Technologies Ltd (1987) report. There are depressions in the till surface below the former relief gas holder, below the current groundwater treatment building, below some of the Transitway and near OW-120-86. Generally, till surface elevation rises both eastward and westward from the Transitway.

The thickness of the basal glacial till surface is important in assessing the historical potential for downward contaminant migration into the underlying bedrock. The thickness of the glacial till unit interpolated from available data on the elevations of the till surface and the top of the bedrock surface. The till thickness at the 191 and 193 Lees Avenue site ranges from 0 to about 5 m. The till is absent below the former relief gas holder and in several pockets below and near the bus lanes of the Lees Avenue Transitway Station.

2.2.4 Shale Bedrock

The bedrock is primarily competent black shale of the Billing Formation. It is typically found at depths of 10-12 mBGS. Observations of core and field hydraulic testing shows the upper several metres of the bedrock unit is weathered and fractured with average hydraulic conductivity of 10^{-6} to 10^{-5} m/s. The deeper more intact parts of the bedrock unit will have hydraulic conductivity of less than 10^{-8} m/s comparable to that of the basal glacial till. Historical investigations of the bedrock did not conclusively show evidence of gas plant wastes.

The elevation of the upper surface of the bedrock unit is based on interpolation of the all of the information from historical drilling investigations, as well as from the six interpreted geological cross-sections given in the Intera Technologies Ltd (1987) report. The bedrock surface is relatively flat lying, typically found at elevations of 48 to 50 mASL at the site.

2.3 Groundwater Flow System

The groundwater flow system at the 191 and 193 Lees Avenue property is complicated by the presence of several hydraulic sinks the most important of which is the Lees Avenue groundwater collection system installed below the bus lanes of the Transitway Station. In addition to this major sink, additional drainage works exist below the bus ramp and underground parking garages at 169, 170, 171, 180 and 190 Lees Avenue. Most of the groundwater flow at the site occurs within the permeable alluvium unit, in particular the deep alluvium unit.

The lowest point of the Transitway groundwater collection system is about 50 mASL and the Lees Avenue pumping wet well extends to an elevation of about 45 mASL. The bus ramp is also under-drained but to a lesser extent than the bus lanes of the Transitway.

The underground parking garages of 169, 170, 171, 180 and 190 Lees Avenue (see Figure 1.2 for locations of these addresses) are typically drained to an elevation of less than 54 mASL, which is the elevation of the lower-most parking levels in these buildings. For reference the average water level in the nearby Rideau River approximates 56.5 mASL.

The interpreted historical pattern of groundwater flow in the deep alluvium is based on data available in May and December 1986. This was the last comprehensive set of water level measurements and hence the last integrated assessment of groundwater flow made for the Lees Avenue area. The 1986 data clearly shows the significant drawdown effect of the Transitway Station groundwater collection system on groundwater flow in the area of 191 and 193 Lees Avenue. These data show all the groundwater at 191 and 193 Lees Avenue property appears to be collected by the Transitway Station groundwater collection system and that with this collection system in place there is no off-site migration of groundwater from 191 and 193 Lees Avenue. Patterns of groundwater flow within the overlying shallow alluvium and fill units and in the underlying upper bedrock are expected to be like the pattern for the deep alluvium.

Potential revisions to the 1986 groundwater flow pattern may have occurred due to development of the apartment building at 171 Lees Avenue in about 1991. The underground parking garage at 171 Lees Avenue may create a groundwater divide at the west end of the site and divert groundwater flow to the west toward the parking garage underdrains.

2.4 Potential Contaminating Activities

The primary potential contaminating activity at the 191 and 193 Lees Avenue site, as per MOE (2011b) guidance is the operation of the coal and oil gasification plants, which under the amended O. Reg. 153/04 (Table 2 of Appendix D) are item 38 – Coal Gasification.

The range of potential contaminants at coal gasification plant sites is discussed in Intera Technologies Ltd. (1987). The major types of wastes and by-products likely to be present at former coal gasification plants include, in order of significance:

- Coal tar and oil tar;
- Sludges;
- Tar liquors and ammonia liquors;
- Spent iron oxide;
- Ash, slag and cinders; and
- Dust, off-grade coal and coke.

Tar residues and sludges were produced in the gas cleanup process during the cooling, condensation and scrubbing of the raw gas. On–site storage areas include underground tar tanks and wells located in proximity to the gas condenser and gas purifying houses. Tars typically contained up to 80 PAH with lesser amounts of aromatic hydrocarbons (e.g., BTEX) and phenolics. Coal and oil tar is

typically a dense non-aqueous phase liquid (DNAPL) contaminant, which can migrate in directions independent of groundwater flow directions, and be long-term sources of dissolved PAH and BTEX contamination. Coal and oil tar at former gasification plant sites are typically found as pools within former gas plant structures (e.g., relief and main gas holders, underground tar tanks and wells), as pools within depressions in low-permeability surfaces (e.g., dense till), and as residual saturation ganglia and pockets in granular materials (Raven and Beck, 1992)

Spent iron oxide is a waste product created from removal of sulphur and nitrogen-containing impurities from manufactured gas by adsorption onto iron oxide. These wastes contain high concentrations of sulphur, cyanide and ammonia compounds, most of which are chemically bound with iron. These waste products created the need to analyse for free cyanide in soil and groundwater samples in the Phase 2 ESA. However, detections of free cyanide in soil and groundwater in the Phase 2 ESA were typically low and not dectable.

Ash, slag, cinders, dust, off-grade coal and coke were most likely landfilled at the gas plant site or on land adjacent to the gas plant site. These waste materials are generally inert but are sources of trace metal contamination which should be analysed in the Phase 2 ESA.

2.5 Areas of Potential Environmental Concern

Areas of Potential Environmental Concern (APECs) for the 191 and 193 Lees Avenue are discussed in the Phase 1 ESA and are listed and shown in Figure 2.1. The 18 identified APEC are all former manufactured gas plant structures. APEC 18 – the main gas holding tank is not located on the 191 and 193 Lees Avenue site but was located on the adjacent 169 and 171 Lees Avenue property. It was remediated in 1987.

In addition to these 18 APECs, the entire former manufactured gas plant site is considered an APEC based on routine spillage of tars and disposal of other gas plant wastes (ash, cinders, coal, coke and spent oxide) on the property.

2.6 Soil and Groundwater Contamination

PAH, BTEX, phenolics, PHC, heavy metals, cyanide, sulphur and nitrogen compounds are the most likely contaminants at former coal and oil gasification plant sites (Environmental Research and Technology Inc. and Koppers Co. Inc., 1984; Intera Technologies Ltd, 1987). Review of historical soil and groundwater testing at the site (Conestoga-Rovers & Associates Limited, 1986b; Intera Technologies Ltd. 1987; Geofirma Engineering Ltd., 2012b) and comparison of these data to current MOE (2011a) soil and groundwater quality standards shows that the following chemical parameters are priority analytes for the Supplementary Phase 2 ESA:

- PAH in soil and groundwater;
- PHC-F1/BTEX in soil and groundwater; and
- Heavy metals in soil.

PAH and BTEX were frequently analysed in soil and groundwater samples collected as part of the 1986 and 2012 investigations of the 191 and 193 Lees Avenue site. The reported concentrations of the vast majority of samples collected from the site in 1986 and many of 2012 samples exceed current

MOE (2011a) standards in both soil and groundwater. Consequently, PAH and PHC-F1/BTEX remain important chemicals to be analysed in the Supplementary Phase 2 ESA.

Phenols while potentially a groundwater contaminant at the Lees Avenue site were analysed in groundwater in 1986 and were found to not be present in significantly elevated concentrations. The maximum phenol concentration reported from 1986 analyses of groundwater was 369 µg/L, much less than the current MOE standard of 12,000 µg/L.

Ammonia, a nitrogen-based indicator chemical was analysed in 1986 groundwaters, and found to be elevated with a maximum detected concentration of 443,000 µg/L. However, ammonia is not an MOE listed contaminant in O.Reg.153/04, and hence analysing for this chemical would not help in assessing the condition of the site today against current MOE standards.

PHCs were not analysed in soil or groundwater samples in 1986, as they were not considered to be important indicator parameters for coal gasification plant wastes. Although Bunker C oil was stored at the site, the recent testing of soil and groundwater at two locations at the site by Golder Associates Ltd. (2011) shows that conventional PHCs are likely not important contaminants for the Lees Avenue site today. There were no exceedences current MOE standards for PHCs in soil or groundwater, where the same samples showed exceedences of MOE standards for PAHs. This indicates that today PAH are better indicator parameters of former gas plant contamination than PHCs.

Cyanide was not routinely analysed in 1986 investigations as no guidelines were available for that chemical compound. Thiocyanate (SCN) was analysed as an indicator parameter in groundwater samples collected in 1986 and was reported to be present in elevated concentrations of up to 29,700 µg/L (OW109B-86), near the former gas purifying house. However, testing of soil and groundwater samples in the 2012 Phase 2 ESA for free cyanide showed that free cyanide is not a contaminant of concern at Lees Avenue. None of the 37 soil samples showed detections of free cyanide and none of the 27 groundwater samples showed exceedences of MOE standards (note maximum CN^- was 10 µg/L, much less than the MOE standard of 66 µg/L).

Heavy metals commonly associated with coal, ash and cinders (e.g., arsenic, copper, lead, zinc, etc.) were not analysed in soil samples collected in the 1986 investigations as the focus of the 1986 investigations was delineation of coal tar contamination. Heavy metals were analysed in 1986 groundwater samples and these were not found to be elevated. Soil and groundwater samples from the Phase 2 ESA were analysed for metals in 2012. Based on these 1986 and 2012 analyses, metals in soil remain potential contaminants of concern and metals in groundwater are not a concern for the proposed Supplementary Phase 2 ESA.

3 FIELD INVESTIGATION METHODOLOGY

Project-related field activities were conducted by Geofirma between September 24 and October 29, 2012 and included:

- Preparation and implementation of Environment, Health and Safety Plan;
- Rehabilitation of several 1986 groundwater monitoring wells that were found to be inaccessible for sampling in the 2012 Phase 2 ESA;
- Site inspection and utility locates;
- Borehole drilling;
- Soil screening and sampling;
- Monitoring well installation;
- Elevation and GPS surveying of boreholes/monitoring wells;
- Water level and product level monitoring;
- Groundwater purging and sampling; and
- Implementation of quality assurance/ quality control program.

Access to all field work sites, except for groundwater monitoring wells OW507A, OW507B, OW507C, BH-001, OW122A, OW122B and OW122C was granted by the City of Ottawa. Access to the OW507-series wells located on the MTO right-of-way of Highway 417 was granted by the Ontario Ministry of Transportation through Encroachment Permit EC-2011-420-98 issued to Geofirma Engineering Ltd. on October 19, 2012. Access to wells BH-001 and OW122-series wells located on University of Ottawa property was granted through a Consent to Enter dated September 20, 2012.

3.1 Health and Safety Plan

Given the hazardous nature of coal tar contamination, it was necessary to develop a site-specific Environment, Health and Safety Plan (EHSP) for the Supplementary Phase 2 ESA. The EHSP described procedures and protocols for ensuring protection of the environment and worker health and safety during the intrusive Supplementary Phase 2 ESA investigations. The EHSP described:

- Purpose, scope and responsibilities of the plan;
- Background and environmental concerns;
- Site operations;
- Use of personal protective equipment;
- Waste material handling and disposal;
- Site restoration; and
- Emergency procedures and contingency plan.

3.2 Well Rehabilitation

All of the six proposed well rehabilitations were completed: OW109B, OW110A, OW110B, OW111A,

OW111B and OW116B. The wells were rehabilitated using a vacuum truck and vacuum wand. Water levels were collected for all wells, and three of the wells were sampled. OW109B, OW110B and OW111A did not contain a sufficient volume of water for sampling or did not recover to produce sufficient water for sampling following well purging.

3.3 Site Inspection and Utility Locates

All but one of the proposed borehole locations were cleared of underground utilities/structures including telephone, gas, hydro and private utilities by Ottawa Valley Locates prior to the advancement of the boreholes. Three of the ten boreholes mentioned in the proposal were not drilled for the following reasons:

- The proposed location for a borehole and well north of BH/MW12-11 and its surrounding area could not be cleared for locates and thus was not drilled.
- The proposed location for a borehole and well at the northern limit of the parking lot adjacent to the Transitway south of Lees Avenue on University of Ottawa property was not drilled as an existing well (BH-001) was used in its place.
- The proposed location for a borehole and well north of OW109B and east of OW116B was not drilled as rehabilitation of these two nearby wells eliminated the need for a borehole and well at this location.

Clearance of overhead obstructions was completed as part of an initial site inspection prior to finalizing drilling locations.

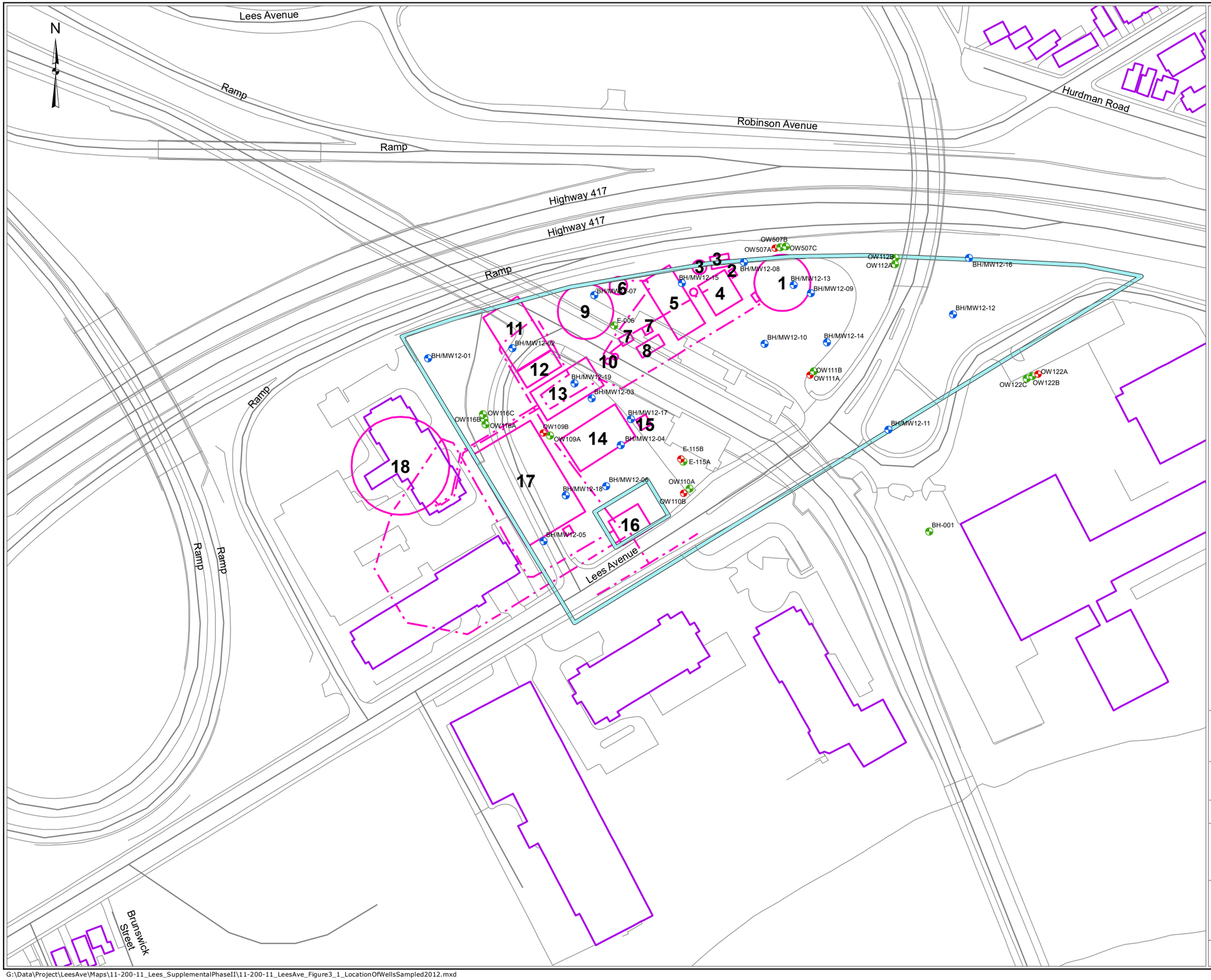
3.4 Borehole Drilling

Seven boreholes (BH12-13 to BH12-19) were drilled in various locations on the site in September 2012 under the supervision of Geofirma personnel. Borehole drilling was completed using a direct push Geoprobe 7822DT drill rig operated by Strata Drilling Group of Richmond Hill, Ontario.

Boreholes were advanced through the overburden using the direct push, dual-tube method consisting of an outer steel tube 83 mm in diameter and 1.5 m long, fitted with a hollow steel inner tube that was in turn lined with a clear plastic tube. The assembly was hammered pneumatically into the ground. Following each 1.5 m long advancement (or less depending on soil conditions), the inner barrel was returned to the surface and the clear plastic tube containing the bored soil was extruded and split lengthwise. Soil logging and sampling procedure are described in Section 3.5.

The locations of boreholes are shown on Figure 3.1. The rationale for the location of these seven new monitoring wells is provided below in Table 3.1.

Boreholes were typically terminated at the top of till to help delineate the coal tar plume in the overlying permeable alluvial soils and to minimize the risk of creating a contaminant migration pathway through the till with the underlying bedrock. If the till was inadvertently drilled to depths greater than about 0.3-0.5 m, the borehole was backfilled with bentonite pellets to a depth of at least original top of till surface. Bentonite backfilling was not deemed necessary at any of the newly drilled boreholes.



LEGEND

- Road
- Current Building Footprint
- 2012 Borehole/Monitoring Well
- Historical Monitoring Well Sampled in Fall 2012
- Historical Monitoring Well Not Suitable for Sampling in Fall 2012
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping

Historical Gas Plant Structures (APECs)

1 Water Gas Relief Holding Tank
2 Tar Well Adacent to the Old Water Gas Plant
3 Surface and Underground Gas Oil Storage Tanks
4 Water Gas House
5 Tar Storage Area in Boiler House
6 Ammonia Liquor/Tar Well
7 Tar Pump House
8 Underground Tar Separator
9 "Bunker C" Oil Tank
10 Two tar dehydrators
11 Gas Purifying House
12 Tar, Ammonia, Liquor, Separator and Drip Oil Wells South of Purifying House
13 Condenser House
14 Retort House
15 Sump
16 Gas Metering House
17 Coal Shed
18 Gas Holder Tank

Figure 3.1 - Location of Phase 2 ESA Boreholes and Monitoring Wells

Scale 1:1,700

0 10 20 40 60 80
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

PROJECT No. 11-200-11

PROJECT Supplementary Phase 2 ESA & Remedial Options Assessment 191 & 193 Lees Avenue, Ottawa

DESIGN: ADG
CAD/GIS: ADG
CHECK: KGR
REV: 0

DATE: 21/01/2013

Geofirma Engineering Ltd

G:\Data\Project\LeesAve\Maps\11-200-11_Lees_SupplementalPhaseII\11-200-11_LeesAve_Figure3_1_LocationOfWellsSampled2012.mxd

Table 3.1 Summary of Purpose and Rationale for New Boreholes and Groundwater Monitoring Wells

Borehole/Well Designation	*Hydrostratigraphic Unit Monitored*	*Purpose/Rationale*
BH/MW12-13	Fill	Assess coal tar presence within former relief gas holder
BH/MW12-14	Deep Alluvium	Assess extent of coal tar pool in deep alluvium
BH/MW12-15	Deep Alluvium	Assess coal tar presence in deep alluvium near APEC 5 (Boiler House Tar Storage)
BH/MW12-16	Deep Alluvium	Assess eastern extent of coal tar presence in deep alluvium
BH/MW12-17	Deep Alluvium	Assess soil and groundwater quality in area west of Transitway
BH/MW12-18	Deep Alluvium	Assess soil and groundwater quality in area west of Transitway
BH/MW12-19	Deep Alluvium	Assess soil and groundwater quality in area west of Transitway

Exceptions to this drilling protocol include BH12-13 which was terminated at refusal on the suspected base of the relief gas holding tank, BH12-17 that was drilled about 1.0 m into the till with the well screen straddling the deep alluvium and till, and BH12-19 which did not encounter till.

3.4.1 Decontamination Procedures

Clean, de-contaminated drilling and sampling equipment was used at each drilling location. The core barrel was lined with a new disposable plastic sleeves at each sampling interval to prevent cross contamination. Drilling equipment such as augers, rods and core barrels, was also decontaminated by removal of excess material through brushing, followed by steam-cleaning when necessary. Smaller field equipment such as sampling implements, probes, metres etc. were decontaminated using a three-step technique of soapy water wash, methanol wipe (where equipment allowed), and a distilled water rinse.

Decontamination was conducted in a dedicated area with sufficient tarps and/or berms to contain any contaminated fluid. All wash water resulting from decontamination of equipment and personnel was contained, drummed and disposed of with monitoring well purge waters in an appropriate manner. Further details regarding decontamination procedures were included in the Environment, Health and Safety Plan.

3.4.2 Waste Material Management

As part of the plan for management of waste materials, Geofirma established a storage and staging area in the corner of the parking lot to the east of the Transitway station. This storage and staging area was used for temporary storage of drummed drill cuttings and containers for wash water and development water prior to testing and final disposal. The storage and staging area was fenced with lockable gates to provide secure storage of excess waste materials generated in this project.

Soil cuttings were collected at each borehole location, inspected for evidence of contamination, and drummed for disposal. The drums were transported to a common location following collection. Following completion of drilling, a composite sample of all drummed soil cuttings was submitted for laboratory analysis in accordance with Ontario Regulation 558, for subsequent disposal at a local licensed landfill. A total of 2 drums of soil cuttings and a total of 1,000L of oily decontamination and

well purging water were collected and contained in the Supplementary Phase 2 ESA investigation. All solid and liquid waste materials were collected by Triangle Pump Service of Ottawa, Ontario for disposal at licensed facilities under MOE manifests.

3.5 Logging and Soil Sampling/Screening

The recovered soil samples were logged in the field for soil stratigraphy, texture, moisture, and visual and olfactory evidence of contamination. The recovered soil samples were then split into one or more samples depending on amount of recovery and number of distinct soil intervals. Samples were collected in re-sealable plastic bags for soil vapour screening. Sample intervals selected for laboratory analysis were then transferred into laboratory-supplied glass jars.

Bagged soil samples were allowed to reach ambient temperature and soil headspace organic vapour concentrations were measured in the field using a Gastec Combustible Gas Indicator (CGI) operated in methane elimination mode and calibrated to a high (44% Lower Explosive Limit) and low (400 parts per million) concentration hexane standard and a photoionization detector (PID) calibrated by Pine Environmental using isobutylene.

3.6 Soil Quality Analyses

Parameters of concern for the soil sampling program include heavy metals, polycyclic aromatic hydrocarbons (PAHs) and PHC-F1/benzene, ethylbenzene, toluene, and xylenes (BTEX).

Jarred soil samples were stored on ice in a cooler for possible laboratory submission. Soil samples to be submitted for PHC-F1/BTEX parameters were jarred immediately after collection and placed on ice in laboratory-supplied bottles.

In general, samples were selected for laboratory analysis based on results of CGI and PID readings, visual/olfactory evidence of contamination, and to provide spatial and depth coverage of the site. Two to eight soil samples from each of the seven newly installed boreholes were collected and submitted to the laboratory for analyses and two blind duplicate samples were collected and analysed for QA/QC purposes. As shown on Table 3.2, a total of 42 separate soil samples were submitted for laboratory analyses. Table 3.2 also summarizes the depth and hydrostratigraphic unit of all soil samples submitted from each borehole for laboratory analyses. Samples for metals analyses were preferentially selected from the fill unit. Samples for PAH and PHC-F1/BTEX were selected throughout the soil column based on visual, olfactory and instrument evidence of contamination.

Jarred soil samples selected for laboratory analyses were stored and shipped in a cooler with ice packs and submitted to Paracel Laboratories Ltd. of Ottawa, Ontario, a CALA certified analytical laboratory, operating under standard chain of custody procedures.

Soil conditions and laboratory analytical results are discussed in Section 4.

Table 3.2 Summary of Soil Samples Submitted for Laboratory Testing

Borehole ID	*Depth Interval (mBGS)*	*Laboratory Analysis*	*Hydrostratigraphic Unit*
BH12-13	3.05 - 4.57	PHC-F1/BTEX	Fill
	4.57 - 4.87	Metals, PAH, PHC-F1/BTEX	Fill
BH12-14	0.00 - 1.52	Metals	Fill
	1.52 - 2.29	PAH	Fill
	3.05 - 3.81	Metals	Fill
	4.57 - 5.34	PHC-F1/BTEX	Fill
	6.10 - 6.86	PHC-F1/BTEX	Fill
	6.86 - 7.62	Metals, PAH	Fill/Shallow Alluvium
	8.38 - 9.14	PAH, PHC-F1/BTEX	Deep Alluvium
BH12-15	1.83 - 2.29	PAH	Fill
	2.29 - 3.05	Metals	Fill
	3.05 - 3.20	PHC-F1/BTEX	Shallow Alluvium
	3.81 - 4.57	PAH	Shallow Alluvium
	4.57 - 5.34	PHC-F1/BTEX	Shallow Alluvium
	6.10 - 6.86	Metals, PAH	Deep Alluvium
	6.86 - 7.62	PHC-F1/BTEX	Deep Alluvium
	8.38 - 8.69	Metals, PAH	Deep Alluvium
BH12-16	1.52 - 2.15	Metals, PAH, PHC-F1/BTEX	Fill
	3.81 - 4.57	Metals, PAH	Shallow Alluvium
	4.57 - 4.88	PHC-F1/BTEX	Shallow Alluvium
	4.88 - 5.64	PAH	Shallow Alluvium
	6.86 - 7.62	Metals	Deep Alluvium
	7.62 - 8.38	PHC-F1/BTEX	Deep Alluvium
BH12-17	1.52 - 2.29	Metals, PAH	Fill
	3.05 - 3.81	PAH	Fill
	4.57 - 5.33	PHC-F1/BTEX	Fill
	6.10 - 6.86	Metals	Fill/Shallow Alluvium
	6.86 - 7.62	Metals, PAH	Alluvium
	7.62 - 8.38	PHC-F1/BTEX	Alluvium
	8.38 - 9.14	PHC-F1/BTEX	Deep Alluvium
BH12-18	0.00 - 1.52	Metals, PAH, PHC-F1/BTEX	Fill
	1.52 – 2.29	Metals	Fill
	2.29 - 3.05	Metals, PAH	Fill
	3.05 - 3.81	PHC-F1/BTEX	Fill
	5.33 - 6.10	PAH	Shallow Alluvium
	7.62 - 8.38	PHC-F1/BTEX	Deep Alluvium
BH12-19	0.00 - 1.52	Metals	Fill
	3.05 - 3.81	PHC-F1/BTEX	Fill
	3.81 - 4.57	Metals, PAH	Fill
	4.57 - 5.33	Metals, PAH, PHC-F1/BTEX	Fill
	6.10 - 6.86	PHC-F1/BTEX	Shallow Alluvium
	6.86 - 7.62	PAH	Deep Alluvium

3.7 Monitoring Well Installation

Groundwater monitoring wells were installed in all 7 boreholes drilled during the program described above. All well installations were completed by Strata Drilling Group, an MOE licensed well installer, in accordance with Ontario Regulation 903. Water well records were submitted to MOE by Strata, on behalf of the City of Ottawa. Individual well records were submitted for the seven shallow wells – BH/MW12-13 to BH/MW12-19. Copies of the MOE well records are provided in Appendix E. The MOE well tags were affixed to each individual well.

One monitoring interval was typically installed at each borehole location to access the permeable deep alluvium. Exceptions to this protocol include MW12-13 which was installed in the fill layer and MW12-17 which was installed across the deep alluvium/till interface. MW12-14, MW12-17 to MW12-19 were instrumented with a conventional 51 mm diameter, Schedule 40 PVC (10 slot) well screens, 1.5 metres in length, finished to ground surface with flush-threaded PVC risers. MW12-13, MW12-15 and MW12-16 were instrumented with a conventional 38mm diameter, Schedule 40 PVC (10 slot) well screens, 1.5 metres in length, finished to ground surface with flush-threaded PVC risers. The smaller size was required in some cases due to flowing sand partially collapsing in the borehole. A silica sand pack was placed around the screened interval, topped with a bentonite seal to surface. A steel flush-mount casing or steel protective casing was cemented into place at each location.

Each new groundwater monitoring well and historical well to be sampled were equipped with a dedicated Waterra™ foot valve and high-density polyethylene tubing to allow collection of groundwater samples.

3.8 Elevation and GPS Surveying

A site survey was completed on September 27 and 28, and October 3, 2012. The locations of all newly drilled monitoring wells and existing wells to be sampled (Figure 3.1) were located with reference to existing site features. Elevations of borehole ground surface and monitoring well top of casing (TOC) were referenced to known benchmarks (other monitoring wells) and measured to the nearest 0.001 m using a Nikon XL level. Geodetic elevations were reported in metres above sea level (mASL) based on surveying of monitoring wells by Geofirma in February 2012.

GPS readings of horizontal position were taken at each well using a Garmin Etrek Legend to an accuracy of 6m. The locations of all monitoring wells surveyed and sampled in the Supplementary Phase 2 ESA are included on Figure 3.1. The TOC elevations and the GPS locations of all new monitoring wells are included on the borehole logs given in Appendix A.

3.9 Water Level Monitoring

Geofirma completed groundwater monitoring, including the measurement of depth to water level and liquid phase hydrocarbon (LPH), if any, on September 27 and October 23, 2012. Measurements were referenced to the TOC, to the nearest 0.001 m. A Solinst electronic oil-water interface meter was used for this task. The interface probe was thoroughly cleaned with a methyl alcohol and distilled water solution between each well to prevent cross contamination.

3.10 Well Purging and Groundwater Sampling

One round of groundwater sampling was performed; collected samples were analysed for PAH and PHC-F1/BTEX. Groundwater samples were collected from the 19 2012 wells (7 installed in September and 12 installed in February 2012) and from 15 wells of the existing monitoring well network. Table 3.3 lists the historical groundwater monitoring wells that were sampled. Figure 3.1 shows the location of the new and historical groundwater monitoring wells that were sampled, and historical wells that were not suitable for sampling. Wells OW109B, OW110B, OW111A, OW122A and E-115B that were originally proposed to be sampled, were not sampled due to insufficient water or dry conditions.

Table 3.3 Summary of Historical Groundwater Monitoring Wells Sampled in 2012

Borehole/Well Designation	***Hydrostratigraphic Unit Monitored***	***Purpose/Rationale***
BH-001*	Shallow Alluvium	Assess groundwater quality and flow in shallow alluvium
OW109A-86	Shale Bedrock	Assess groundwater quality and flow in bedrock near APECs 13 and 14
OW110A-86	Shale Bedrock	Assess groundwater quality and flow in bedrock
OW111B-86	Deep Alluvium	Assess groundwater quality and flow in deep alluvium
OW112A-86	Shale Bedrock	Assess groundwater quality in former downgradient area of contamination
OW112B-86	Deep Alluvium	Assess groundwater quality in former downgradient area of contamination
OW116A-86	Shale Bedrock	Assess groundwater quality and flow in bedrock on western side of site
OW116B-86	Till	Assess groundwater quality and flow in till on western side of site
OW116C-86	Shallow Alluvium	Assess groundwater quality and flow in shallow alluvium on western side of site
OW122B-86*	Till and Deep Alluvium	Assess off-site groundwater flow system in deep alluvium
OW122C-86*	Shallow Alluvium	Assess off-site groundwater flow system in shallow alluvium
OW507B-86**	Deep Alluvium	Assess off-site groundwater flow system in deep alluvium near APEC 1
OW507C-86**	Shallow Alluvium	Assess off-site groundwater flow system in shallow alluvium near APEC 1
E-006	Deep Alluvium	Assess groundwater quality and flow in deep alluvium
E-115A	Deep Alluvium	Assess groundwater quality and flow in deep alluvium
* located on University of Ottawa property; ** located on MTO property:		

Monitoring wells were purged of three well volumes or three times dry in order to reduce groundwater turbidity and to remove fine-grained sediments that may have accumulated inside the well casing subsequent to the drilling program or over time for existing wells. Purging was also completed to remove the “stagnant” water from the well and surrounding annulus. Well purging was accomplished by removing water from the wells at a rate fast enough to hydraulically stress the formation and to re-suspend and extract sediment from the bottom, where present. Purging was conducted using a dedicated 5/8” LDPE tubing and foot valve. The foot valve was positioned at the bottom of each well and was agitated during pumping to disturb and extract any sediment. The outlet was directed into a graduated 20L pail for cumulative purge volume measurements. Purge waters was drummed for later testing and disposal as described on Section 3.4.2. The pumping rate was generally kept between 1.5 to 2 L/minute or as fast as the well could recharge. Following well purging, the LDPE tubing was dedicated to each well, for subsequent groundwater sampling.

Groundwater sampling was completed from October 1 to 29, 2012. The low-flow sampling was used for the collection of groundwater samples from the monitoring wells. The low flow method was employed to collect samples that were free of suspended fine-grained particles (which can sorb otherwise immobile contaminants) and to minimize the potential loss of any volatile constituents. Sampling was accomplished using a Master flow peristaltic pump. A short section of 3/8" silicon tubing was installed at the pump head and was attached to the dedicated ¼" LDPE tubing in the well. The pump intake was positioned in the center of the saturated screen interval or approximately 0.3m above the well bottom. The silicone tubing and ¼" LDPE outlet tubing were replaced at each well.

The flow rate of the peristaltic pump was adjusted based on the hydraulic performance of each well to achieve a minimal, stabilized drawdown at a constant flow rate less than 0.5 L/min. The ¼" discharge tubing was cut approximately 10 cm from the silicon tubing at the outlet of the peristaltic pump, and the groundwater was transferred into clean, laboratory prepared sample containers that were labelled prior to sample collection.

Parameters of concern for the groundwater sampling program included PAHs and PHC-F1/BTEX. One groundwater sample was submitted from each of 34 monitoring wells (19 2012 installed and 15 historical).

Upon collection, the samples were placed in laboratory-supplied insulated coolers with ice packs and submitted to Paracel Laboratories of Ottawa Ontario under a chain-of-custody within 24 hours of collection.

3.11 Quality Assurance/Quality Control Program

Geofirma maintains a Quality Management System (QMS) certified and registered as ISO9001:2008. All relevant Geofirma QMS Procedures, Work Instructions and Field Protocols were strictly adhered to during the completion of the assignment.

As well as internal laboratory QC performed by Paracel Laboratories of Ottawa, Ontario, field quality control samples were collected. A total of two blind duplicate soil samples and three blind duplicate groundwater samples were collected for QA/QC purposes. One field blank groundwater sample was also prepared in the field based on circulation of deionized water through the field sampling equipment. Blind duplicate and field blank samples were analysed for analytes of interest – metals, PAH and PHC-F1/BTEX.

4 SITE INVESTIGATION RESULTS

4.1 Evaluation of Applicable Regulatory Standards

Soil and groundwater quality analytical results were compared to current MOE (2011a) provincial standards mandated under O.Reg. 153/04. Given the fact that the property and surrounding area is serviced by municipal water supply, full depth, non-potable (MOE Table 3) standards are applicable. Based on the observed soil texture and results of grain size/hydrometer analyses (see Section 4.2), site soils are predominately coarse textured under O.Reg. 153/04.

Current land use at the site is commercial (Transitway Station and parking lot at 191 Lees Avenue) and vacant land (open field at 193 Lees Avenue). Given the City need to assess future development potential for the site, soil and groundwater quality are compared to both residential/ parkland and commercial/industrial land use standards.

4.2 Soil Texture

Laboratory grain size analysis was not performed for the supplementary portion of this investigation. The soil textures observed during the supplementary drilling were consistent with those from the initial Phase 2 ESA drilling completed in February/March 2012. The results from the February/March 2012 sieve and sieve/hydrometer analyses for determination of grain size distributions of site soils are given in Tables C.1 and C.2 of Appendix C. Tables C.1 and C.2 show that 10 of the 12 soil samples submitted to grain size analysis are considered coarse textured by MOE under O.Reg. 153/04. These analytical results, in conjunction with soil texture observations recorded during soil sampling (see borehole stratigraphic logs in Appendix A) and historical data, indicate that soil quality standards for coarse-textured soils are applicable to the site.

4.3 Site Stratigraphy

All of the boreholes drilled for the Supplementary Phase 2 ESA comprised stratigraphic profiles consistent with expectations based on previous drilling programs and the historical CSM described in Section 2.2 of this report and the initial Phase 2 ESA report. Shallow anthropogenic fill represents the surficial soil, which is underlain by fine sand to silt/clay alluvium, which in turn is underlain by dense sandy clay till. The fill unit is predominately coarse-grained sand with some silt and gravel, and traces of ash and construction debris. The fill thickness ranged from 2.2 m (BH12-16) to 7.3 m (BH12-14), with an average thickness of about 5 m. The underlying silty to sandy alluvium containing some gravel and clay ranged in thickness from 1.8 m (BH12-14) to 7.25 m (BH12-16), with an average thickness of about 3.3 m.

The basal glacial till is of low permeability and separates the permeable alluvium from the moderately permeable upper part of the underlying bedrock. The glacial till is a dense compact unit that is unlikely to transmit large volumes of water and appears in places to act as a confining unit to the underlying bedrock (i.e., at OW-125A-86). The hydraulic conductivity of the basal glacial till unit has been estimated at less than 10^{-8} m/s.

The basal glacial till is patchy and is absent in some areas below the Transitway bus lanes and parking lot. Maximum thickness at the site is about 4 m with the unit found at depths of 7-11 mBGS. The basal glacial till unit has typically not shown evidence of soil or groundwater contamination by gas

plant wastes.

The upper surface of the dense basal glacial till is important in assessing the migration potential of denser-than-water coal tar at the 191 and 193 Lees Avenue site. Figure 4.1 shows the interpolated surface of the basal till unit based on the surface presented in the Phase 1 ESA updated with the results of the 2012 drilling programs. Where till is absent the elevation of the till surface in Figure 4.1 is taken as the top of bedrock. The till surface based on the 2012 borehole data is very similar to that presented in the Phase 1 ESA Report based on historical borehole information. Figure 4.1 shows that there are depressions in the till surface below the former relief gas holder, below the current groundwater treatment building, below some of the Transitway and near OW-120-86. Generally, till surface elevation rises both eastward and westward from the Transitway.

Figures 4.2 and 4.3 show the bedrock surface elevation and till thickness plots, respectively, updated with the 2012 drilling information. Because drilling was terminated in the upper metre of the till, the bedrock surfaces and till thicknesses shown in Figures 4.2 and 4.3 are the same as those shown in the Phase 1 ESA Report and the initial Phase 2 ESA Report.

The thickness of the basal glacial till surface is important in assessing the historical potential for downward contaminant migration into the underlying bedrock. Figure 4.3 shows the thickness of the glacial till unit interpolated from available data on the elevations of the till surface and the top of the bedrock surface (Figure 4.2). Figure 4.3 shows that the till thickness at the 191 and 193 Lees Avenue site ranges from 0 to about 5 m. Figure 4.3 shows that the till is absent below the former relief gas holder and in several pockets below and near the bus lanes of the Lees Avenue Transitway Station.

4.4 Groundwater Flow

The groundwater flow system at the 191 and 193 Lees Avenue property is complicated by the presence of several hydraulic sinks, the most important of which is the Lees Avenue groundwater collection system installed below the bus lanes of the Transitway Station. In addition to this major sink, additional drainage works exist below the bus ramp and underground parking garages at 169, 170, 171, 180 and 190 Lees Avenue. The vast majority of groundwater flow at the site occurs within the permeable alluvium unit, in particular the deep alluvium unit.

The lowest point of the Transitway groundwater collection system is about 50 mASL and the Lees Avenue pumping wet well extends below to an elevation of about 45 mASL. The bus ramp is also under-drained but to a lesser extent than the bus lanes of the Transitway.

The underground parking garages of 169, 170, 171, 180 and 190 Lees Avenue are typically drained to an elevation of less than 54 mASL, which is the elevation of the lower-most parking levels in these buildings. For reference, the average water level in the nearby Rideau River approximates 56.5 mASL.

Measured groundwater elevations from September/October 2012 investigations are summarized in Table 4.1. Water level information for the deep alluvium unit are contoured and shown in Figure 4.4 to illustrate the patterns of horizontal groundwater flow in the deep alluvium. The patterns of horizontal groundwater flow shown in Figure 4.4 are drawn based on water level data from 8 accessible historical wells, 18 of the wells installed in 2012 (MW12-13 is a fill unit well) and the historical

N

C304
C307
OW115C
OW115B
OW115A
OW513A
OW513B
C303
C308
C306
OW125A
BH 14
E14
H2
OW507B
OW507A
OW507C
C309
C302
BH/MW12-16
OW112B
C310
C301
OW123A
OW123B
OW112A
BH18-86
G12
BH11-86
G11
BH/MW12-08
BH101-86
BH/MW12-15
BH12-86
BH102-86
BH13-86
E10
BH6-86
G6
G3
BH105-86
BH104-86
G14
BH100-86
BH103-86
BH/MW12-09
G13
BH 10
G2
M1
BH3-86
BH/MW12-07
BH/MW12-12
BH 9
E7
BH 7
BH14-86
BH16-86
BH2-86
E-006
G7
G16
BH126-86
BH10-86
OW113A
OW2
E28
E31
G10
E30
BH7-86
BH/MW12-14
BH/MW12-02
BH1-86
BH127-86
BH15-86
I205
BH/MW12-01
BH107-86
BH 28
E29
BH/MW12-10
OW506C
OW506B
BH 30
OW111B
G4
BH128-86
G15
E1
BH/MW12-21
BH 29
BH129-86
OW122C
OW122A
BH108-86
BH4-86
E-112
M2
OW111A
BH9-86
OW122B
BH106-86
BH/MW12-03
G9
I206
BH8-86
I204
BH130-86
G17
E-114
I208
BH/MW12-17
OW1-86
BH 5
E5
L7
OW116C
OW116B
OW109B
E6
BH/MW12-11
OW116A
OW109A
G5
OW120B
BH/MW12-04
BH5-86
M3
OW503A
BH14-86
OW120C
E8
OW120A
OW503B
E-115 B
I207
E-115 A
I2
BH/MW12-06
OW110A
BH 1
BH131-86
I18
BH/MW12-18
E4
BH132-86
OW110B
E3
OW601
I1
L4
BH/MW12-05
OW124C
OW119B
OW504C
L12
OW117C
E13
J1
OW124B
OW119C
I101
/504A
L5
L6
L3
BH 2
F103
OW119A
OW117B
OW605
OW516C
BH 3
I16
OW516B
E32
OW604
OW516A
F108
F1
I11
F105
J2
F210
OW121C
BH 4
F106
F2
OW121A
OW501C
K1
OW606
F202
E2
OW121B
OW501B
OW501A
I10
BH 5
F4
F201
F303
I12

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Borehole or Monitoring Well
- Geotechnical Borehole
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping

Till Surface Elevation (mASL)

- 58.5 - 59
- 58 - 58.5
- 57.5 - 58
- 57 - 57.5
- 56.5 - 57
- 56 - 56.5
- 55.5 - 56
- 55 - 55.5
- 54.5 - 55
- 54 - 54.5
- 53.5 - 54
- 53 - 53.5
- 52.5 - 53
- 52 - 52.5
- 51.5 - 52
- 51 - 51.5
- 50.5 - 51
- 50 - 50.5
- 49.5 - 50
- 49 - 49.5
- 48.5 - 49
- 48 - 48.5
- 47.5 - 48
- 47- 47.5

Figure 4.1 - Till Surface Elevation

Scale 1:1,100

0 10 20 40 60 80
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

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N

C304
C307
OW115C
OW115B
OW115A
OW513A
OW513B
C303
C308
C306
OW125A
BH 14
E14
H2
OW507B
OW507A
OW507C
C309
C302
BH/MW12-16
OW112B
C310
C301
OW123A
OW123B
OW112A
BH18-86
G12
BH11-86
G11
BH/MW12-08
BH101-86
BH/MW12-15
BH12-86
BH102-86
BH13-86
E10
BH6-86
G6
G3
BH105-86
BH104-86
G14
BH100-86
BH 10
G2
BH3-86
BH/MW12-07
M1
BH103-86
BH/MW12-09
G13
BH 9
BH 7
E7
BH14-86
BH16-86
BH/MW12-12
BH126-86
BH2-86
E-006
G7
G16
BH10-86
OW113A
OW2
E28
E31
G10
E30
BH7-86
BH/MW12-14
BH/MW12-02
BH1-86
BH127-86
BH15-86
I205
OW506C
BH/MW12-01
BH107-86
BH 28
E29
BH/MW12-10
OW506B
BH 30
OW111B
OW122C
OW122A
G4
BH128-86
G15
E1
BH/MW12-19
BH 29
BH129-86
BH108-86
BH4-86
OW111A
OW122B
E-112
M2
BH9-86
I206
BH106-86
BH/MW12-03
G9
BH8-86
I204
BH130-86
I208
G17
BH/MW12-17
E-114
E5
OW116C
OW1-86
BH 5
BH/MW12-11
L7
OW116B
OW109B
E6
OW120B
OW116A
OW109A
M3
OW120C
OW503A
BH14-86
BH/MW12-04
BH5-86
OW120A
I207
OW503B
E8
E-115 B
E-115 A
I2
BH/MW12-06
OW110A
BH 1
I18
BH/MW12-18
E4
BH131-86
OW110B
BH132-86
E3
BH-001
I1
L4
OW601
BH/MW12-05
OW124C
OW119B
OW504C
L12
E13
OW117C
J1
OW119C
I101
OW124B
/504A
L5
L6
L3
BH 2
F103
OW119A
OW117B
OW605
OW516C
BH 3
I16
OW516B
E32
OW604
OW516A
F108
F1
I11
F210
J2
OW121C
BH 4
F105
OW121A
F106
F2
OW501C
K1
OW606
F202
E2
OW121B
OW501B
OW501A
I10
BH 5
F4
F201
F303
I12

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Borehole or Monitoring Well
- Geotechnical Borehole
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping

Bedrock Surface Elevation (mASL)

- 51.5 - 52
- 51 - 51.5
- 50.5 - 51
- 50 - 50.5
- 49.5 - 50
- 49 - 49.5
- 48.5 - 49
- 48 - 48.5
- 47.5 - 48
- 47 - 47.5
- 46.5 - 47
- 46 - 46.5
- 45.5 - 46
- 45 - 45.5
- 44.5 - 45
- 44 - 44.5
- 43.5 - 44
- 43 - 43.5
- 42.5 - 43
- 42 - 42.5

Figure 4.2 - Bedrock Surface Elevation

Scale 1:1,100

0 10 20 40 60 80

Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

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N

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Borehole or Monitoring Well
- Geotechnical Borehole
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping

Till Thickness (m)

- 0 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 3.5
- 3.5 - 4
- 4 - 4.5
- 4.5 - 5
- 5 - 5.5
- 5.5 - 6
- 6 - 6.5
- 6.5 - 7
- 7 - 7.5
- 7.5 - 8

Figure 4.3 - Till Thickness

Scale 1:1,100

0 10 20 40 60 80

Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

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N

BH/MW12-01 (55.34)
BH/MW12-02 (52.12)
BH/MW12-03 (51.64)
BH/MW12-04 (51.18)
BH/MW12-05 (53.23)
BH/MW12-06 (52.12)
BH/MW12-07 (52.64)
BH/MW12-08 (53.11)
BH/MW12-09 (53.30)
BH/MW12-10 (52.42)
BH/MW12-11 (53.75)
BH/MW12-12 (54.56)
BH/MW12-15 (52.75)
BH/MW12-16 (54.77)
BH/MW12-17 (50.90)
BH/MW12-18 (52.49)
BH/MW12-19 (52.39)
BH/MW12-14 (53.20)
E-006 (50.63)
E-115 A (51.50)
OW107B (53.43)
OW109B (52.74)
OW111B (52.35)
OW112B (54.53)
OW116C (53.43)
OW122B (54.92)

55
54
53
52
51

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Site Boundary
- Interpreted Horizontal Groundwater Flow Direction
- 52 — Contour of Groundwater Elevation (mASL)
- (54.54) — Water Level Elevation (mASL) in Monitoring Wells September/October 2012

Figure 4.4
2012 Groundwater Flow in Deep Alluvium - September/October 2012

Scale 1:1,400

0 10 20 40 60
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

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Supplementary Phase 2 ESA
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Table 4.1 - Groundwater Depths and Elevations

Monitoring Well ID	Ground Surface Elevation (m ASL)	Top of Well PVC Riser Elevation (m ASL)	Measurement Date	Water Level Depth (m BTR)	Water Level Elevation (m ASL)	Hydrostratigraphic Unit
MW12-01	59.19	59.06	27-Sep-12	3.72	55.34	Deep Alluvium
MW12-02	53.98	53.82	27-Sep-12	1.70	52.12	Deep Alluvium
MW12-03	59.55	60.50	27-Sep-12	8.86	51.64	Deep Alluvium
MW12-04	59.69	60.50	27-Sep-12	9.32	51.18	Deep Alluvium
MW12-05	58.37	58.26	27-Sep-12	5.03	53.23	Deep Alluvium
MW12-06	59.54	60.37	27-Sep-12	8.25	52.12	Deep Alluvium
MW12-07	59.41	59.29	27-Sep-12	6.65	52.64	Deep Alluvium
MW12-08	59.69	59.50	09-Oct-12	6.39	53.11	Deep Alluvium
MW12-09	59.99	59.87	27-Sep-12	6.57	53.30	Deep Alluvium
MW12-10	60.22	60.13	27-Sep-12	7.71	52.42	Deep Alluvium
MW12-11	62.22	63.08	27-Sep-12	9.32	53.75	Deep Alluvium
MW12-12	60.92	61.65	27-Sep-12	7.10	54.56	Deep Alluvium
MW12-13	59.81	59.73	27-Sep-12	3.62	56.11	Fill
MW12-14	60.47	60.42	27-Sep-12	7.22	53.20	Deep Alluvium
MW12-15	59.50	59.39	27-Sep-12	6.64	52.75	Deep Alluvium
MW12-16	61.02	61.88	27-Sep-12	7.11	54.77	Deep Alluvium
MW12-17	59.16	60.10	27-Sep-12	9.21	50.90	Deep Alluvium
MW12-18	59.59	60.70	27-Sep-12	8.21	52.49	Deep Alluvium
MW12-19	59.05	60.14	27-Sep-12	7.75	52.39	Deep Alluvium
BH-001	61.92	61.80	02-Oct-12	4.58	57.22	Shallow Alluvium
E-006	59.37	59.26	27-Sep-12	8.64	50.63	Deep Alluvium
E-115A	60.07	59.94	27-Sep-12	8.45	51.50	Deep Alluvium
E-115B	--	59.97	27-Sep-12	dry	--	Shallow Alluvium
OW109A	59.80	59.89	27-Sep-12	8.40	51.50	Shale Bedrock
OW109B	59.80	60.23	27-Sep-12	7.50	52.74	Deep Alluvium
OW110A	60.18	60.57	27-Sep-12	8.34	52.23	Shale Bedrock
OW110B	60.22	60.44	27-Sep-12	dry	--	Deep Alluvium
OW111A	60.93	61.42	27-Sep-12	8.76	52.66	Shale Bedrock
OW111B	60.93	61.22	27-Sep-12	8.86	52.35	Deep Alluvium
OW112A	60.75	61.28	27-Sep-12	6.47	54.81	Shale Bedrock
OW112B	60.76	61.41	27-Sep-12	6.88	54.53	Deep Alluvium
OW116A	55.69	56.04	27-Sep-12	2.67	53.36	Shale Bedrock
OW116B	56.03	56.07	27-Sep-12	2.67	53.40	Till
OW116C	55.59	56.28	27-Sep-12	2.85	53.43	Shallow Alluvium
OW122A	--	--	27-Sep-12	dry	--	Shale Bedrock
OW122B	61.45	61.85	27-Sep-12	6.93	54.92	Deep Alluvium
OW122C	61.45	61.70	27-Sep-12	7.10	54.60	Shallow Alluvium
OW507C	59.13	59.63	23-Oct-12	5.06	54.57	Shallow Alluvium
OW507B	59.17	59.63	23-Oct-12	6.19	53.45	Deep Alluvium
OW507A	59.17	59.58	23-Oct-12	12.72	46.86	Shale Bedrock

Notes:

All measurments in metres (m) unless stated otherwise

-- = not measured

mBTR = metres below top of riser

mASL = metres above sea level

interpretations of groundwater flow developed from other open and accessible wells in 1986 as summarized in the Phase 1 ESA (Geofirma Engineering Ltd., 2012a).

The patterns of groundwater flow in the deep alluvium shown in Figure 4.4 are very similar to those interpreted in 1986. Figure 4.4 clearly shows the continued significant drawdown effect of the Transitway Station groundwater collection system on groundwater flow in the area of 191 and 193 Lees Avenue. Figure 4.4 shows that the groundwater at 191 and 193 Lees Avenue property appears to be collected by the Transitway Station groundwater collection system. This collection system provides hydraulic control over groundwater in the deep alluvium across the 191 and 193 Lees Avenue site.

The noteworthy changes in water levels between 1986 and 2012 occur to the west of the Transitway Station, with lower water levels measured in 2012 compared to 1986. These lower water levels are likely reflecting the interception of groundwater below the new underground parking garages constructed at 171 Lees Avenue in 1987 and 1988.

4.5 Soil Quality

4.5.1 Coal Tar Occurrence

Table 4.2 and Figure 4.5 summarize the occurrences of visible oil and coal tar contamination from historical and 2012 borehole drilling and soil sampling. Table 4.2 shows the elevations of occurrence of visible oil and tar in boreholes during borehole drilling. Most coal tar occurrences are within the granular fill and deeper sandy alluvium. Coal tar presence on the top of the tight basal till was frequently reported (e.g., OW111B, OW112B, OW120B, BH/MW12-09, BH/MW12-10, BH/MW12-11 and BH/MW12-15) confirming the important role that the upper till surface plays in controlling the migration and distribution of coal tar in the subsurface of the site. Coal tar was also observed within the shallow fill of BH/MW12-13, which was drilled into the former relief gas holding tank, and in the shallow fill at BH/MW12-15. The relief gas holding tank is likely still partially intact underground and is containing some amount of coal tar. The borehole ended within the fill at refusal, likely because the rig was unable to push through the remnants of the base of holding tank.

Figure 4.5 shows the record of historical and 2012 occurrences of visible oil and tar in boreholes and excavations at the 191 and 193 Lees Avenue site superimposed on the historical gas plant structures shown in Figure 2.1. Also shown on Figure 4.5 is the area of confirmed visible oil and tar occurrence observed during excavation of the bus Transitway lanes for installation of the groundwater collection system in 1986.

Based on the known persistence and low solubility of coal tar in groundwater systems (Raven and Beck, 1992), it is reasonable to assume that occurrences of visible coal tar noted in 1986, most likely remain at the site today. This assumption is supported by the observation of coal tar blebs during groundwater sampling in 2012 for those wells that were reported in 1986 as having coal tar present (i.e., OW112B). Persistence of coal tar from 1986 to 2012 is also supported by the results of drilling of 2012 wells proximal to areas previously reported in 1986 to have coal tar present (i.e., BH/MW12-09, BH/MW12-10, BH/MW12-11, BH/MW12-13, BH/MW12-15).

N

OW125A
BH 14
E14
H2
C304
C307
OW115C
OW115B
OW115A
OW513A
OW513B
C303
C308
C306
OW507B
OW507A
OW507C
C309
C302
BH/MW12-16
OW112B
OW112A
C301
C310
OW123A
OW123B
G18
G12
BH/MW12-08
BH11-86
G11
BH18-86
BH101-86
BH/MW12-15
BH12-86
BH/MW12-13
BH102-86
BH13-86
BH104-86
G14
BH100-86
G13
BH/MW12-09
BH103-86
BH/MW12-12
E10
BH6-86
G6
BH/MW12-07
BH105-86
BH 10
G2
G3
BH3-86
M1
BH 9
BH 7
BH2-86
E7
E-006
BH14-86
BH16-86
G16
G7
BH10-86
G10
BH126-86
OW113A
OW3
E28
E31
E30
BH7-86
BH/MW12-14
BH/MW12-02
BH1-86
BH127-86
BH15-86
BH/MW12-10
BH/MW12-01
BH 28
E29
BH107-86
BH 30
OW111B
I205
OW506C
OW506B
G4
BH128-86
BH 29
BH129-86
G15
E1
OW122C
OW122A
BH108-86
BH/MW12-19
BH4-86
E-112
M2
OW111A
OW122B
BH106-86
BH/MW12-03
BH8-86
BH9-86
G9
I206
I204
BH130-86
E-114
BH 5
E5
I208
OW116C
G17
BH/MW12-17
OW1-86
BH/MW12-11
L7
OW116B
OW109B
E6
OW120B
OW116A
OW109A
G5
BH5-86
M3
OW120C
OW503A
BH/MW12-04
OW120A
BH14-86
E8
E-115 B
I207
OW503B
E-115 A
BH/MW12-06
OW110A
BH 1
BH131-86
I18
BH/MW12-18
E4
BH132-86
OW110B
E3
BH-001
I1
L4
BH/MW12-05
OW601
OW124C
OW504C
L12
E13
OW117C
BH 2
J1
OW119B
OW124B
OW119C
I101
504A
L5
L6
L3
F103
OW119A
OW117B
OW605
OW516C
BH 3
OW516B
E32
I16
OW604
OW516A
F108
F1
I11
F210
F105
J2
OW121C
BH 4
F106
F2
OW121A
OW501C
K1
OW606
F202
E2
OW121B
OW501B
I10
OW501A
F4
F201
F303
I12
3H 5

LEGEND

- Road
- Current Building Footprint
- Monitoring Well
- Borehole or Monitoring Well
- Geotechnical Borehole
- Visible Oil and Tar Occurrences
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping

Figure 4.5
Visible Oil and Tar Occurrences

Scale 1:1,100

0 5 10 20 30 40
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

PROJECT No. 11-200-11

PROJECT
Supplementary Phase 2 ESA
& Remedial Options Assessment
191 & 193 Lees Avenue, Ottawa

DESIGN: ADG
CAD/GIS: ADG
CHECK: KGR
REV: 0

DATE: 21/01/2013

Geofirma Engineering Ltd

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Table 4.2 Summary of Elevations of Visible Coal Tar during Drilling of Historical and 2012 Boreholes

Well Designation	*Report Reference*	*Elevation of Visible Coal Tar During Drilling (mASL)*
BH101-86	Conestoga-Rovers & Associates Ltd (1986b)	56.00 to 54.70
BH103-86	Conestoga-Rovers & Associates Ltd (1986b)	57.63 to 55.12
BH104-86	Conestoga-Rovers & Associates Ltd (1986b)	56.5 to 52.00
BH105-86	Conestoga-Rovers & Associates Ltd (1986b)	54.9 to 53.8
BH6-86	Conestoga-Rovers & Associates Ltd (1986b)	56.97 to 56.93
BH106-86	Conestoga-Rovers & Associates Ltd (1986b)	59.41 to 54.84
OW111B-86	Conestoga-Rovers & Associates Ltd (1986b)	53.54 to 51.16
OW112B-86	Conestoga-Rovers & Associates Ltd (1986b)	49.62 to 49.04
OW120B-86	Conestoga-Rovers & Associates Ltd (1986b)	60.02 to 59.00
OW120B-86	Conestoga-Rovers & Associates Ltd (1986b)	53.01 to 52.00
BH130-86	Conestoga-Rovers & Associates Ltd (1986b)	50.88 to 50.03
G7	Golder Associates Ltd. (1986)	50.41 to 49.83
G10	Golder Associates Ltd. (1986)	51.64 to 50.57
G11	Golder Associates Ltd. (1986)	55.87 to 54.11
G13	Golder Associates Ltd. (1986)	55.34 to 53.81
G16	Golder Associates Ltd. (1986)	57.0 to 50.5
G18	Golder Associates Ltd. (1986)	56.5 to 56.27
E10	Golder Associates Ltd. (1986)	58.13 to 57.21
M1	RMOC (1979)	57.76 to 55.63
BH/MW12-09	Geofirma Engineering Ltd. (2012b)	53.9 to 50.1
BH/MW12-10	Geofirma Engineering Ltd. (2012b)	52.3 to 51.7
BH/MW12-11	Geofirma Engineering Ltd. (2012b)	52.4 to 50.8
BH/MW12-13	Current Report	57.9 to 56.8
BH/MW12-15	Current Report	57.5 to 55.0 & 51.1 to 50.8

Figure 4.5 shows that the most frequent occurrences of oil and tar contamination were below the Lees Avenue Transitway parking lot, but other occurrence were also reported south of Lees Avenue on University of Ottawa property, and in the northern part of the parcel of land located between the bus ramp and the Transitway near the former gas condenser house. Most reported occurrences of visible oil and tar were on lands located east of the Transitway near APECs 1 to 9.

4.5.2 Laboratory Chemical Results

The results of the 2012 soil laboratory analysis for metals, PAH, PHC-F1/BTEX and pH/cyanide are summarized in Tables B.1, B.2, B.3 and B.4, respectively, in Appendix B. Complete laboratory certificates of analysis from the current investigation are included in Appendix D. Soil analytical results were compared to relevant MOE Table 3 standards for residential/parkland and commercial/industrial land use as indicated in Section 4.1.

A review of the soil analytical results from the February and September 2012 sampling for the site indicates the following:

- Metals contamination of fill is generally low level and not widespread. There was only one instance of contamination of the native soils, which was in the deep alluvium unit of BH12-15. Three of the 19 soil samples submitted for metals in September 2012 exceeded MOE Table 3 standards for residential/parkland land use. The exceedences for the September round of drilling and sampling were noted for mercury at BH12-13 and BH12-15.

  In addition, data from the initial Phase 2 ESA showed that 6 of the 35 soil samples submitted for metals exceeded MOE Table 3 standards for residential/parkland land use. The exceedences were noted for barium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, silver and zinc at BH12-04, BH12-06 or BH12-11. BH12-04 and BH12-18 were the only locations where metal concentrations exceeded commercial/industrial standards.

- PAH contamination is present in the fill and in the underlying native alluvium, predominately on the eastern side of the Transitway in the vicinity of the former gas plant structures and APECs 1 through 9. Nine of the 19 soil samples submitted for PAH from September 2012 sampling exceeded MOE Table 3 standards for at least one analyte for both residential/parkland and commercial/industrial land use. The most frequently reported exceedences were for heavy molecular weight carcinogenic PAH including benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene. However, exceedences were also noted for low molecular weight PAH including naphthalene and methylnaphthalenes. The highest PAH concentrations were found in boreholes BH12-13 and BH12-15, the former in the fill and the latter in the fill and deep alluvium. As discussed in Section 4.5.1, BH12-13 was drilled into the former water gas relief holding tank; this structure likely houses a certain amount of coal tar remaining from the former gas plant activities. These highest PAH analytical results correspond with the observations of coal tar presence in recovered soil samples made in the field.

  In addition, data from the initial Phase 2 ESA showed that 12 of the 35 soil fill samples submitted for PAH exceeded MOE Table 3 standards for both residential/parkland and commercial/industrial land use. Elevated PAH concentrations were found in boreholes BH12-09, BH12-10 and BH12-11 in the fill and below depths of 3 m within the deep alluvium.

- Five of the 20 soil samples submitted of BTEX/PHC F1 from September 2012 exceeded MOE Table 3 standards for residential/parkland land use for at least one analyte. Four samples exceeded MOE Table 3 standards for commercial industrial land use for at least one analyte. Benzene was the most frequently reported analyte exceeding MOE Table 3 standards. The exceedences of MOE Table 3 standards were found in BH12-13, BH12-14, BH12-16 and BH12-19, generally in the areas where PAH exceedences were reported. The soil quality exceedences for PHC-F1/BTEX were from samples collected below a depth of 3 m in the fill and alluvium with the exception of BH/MW12-16 where the exceedence occurs near the surface.

  In addition, data from the initial Phase 2 ESA showed that 8 of the 34 soil fill samples submitted for BTEX/PHC F1 exceeded MOE Table 3 standards for residential/parkland land use for at least one analyte. Seven samples exceeded MOE Table 3 standards for commercial/industrial land use for

at least one analyte. The exceedences of MOE Table 3 standards were found in BH12-03, BH12-09, BH12-10, BH12-11 and BH12-12, generally in the areas where coal tar was observed and PAH exceedences were reported.

- No soil samples were submitted from the September 2012 work for analysis of free cyanide. All 35 samples submitted for free cyanide from the initial Phase 2 ESA showed non-detectable concentrations at a method detection limit of 0.03 µg/g, which is below MOE Table 3 standard of 0.051 µg/g.

- No soil samples were submitted from the September 2012 work for analysis of pH. The 12 soil samples submitted for pH analysis from the initial Phase 2 ESA showed pH of 7.4 to 8.20 with an average measurement of 7.8. This is considered neutral pH and is likely buffered by carbonate content of the native soils in the area.

4.6 Groundwater Quality

4.6.1 Free Product Occurrence

Measurement and observation of free product occurrence in monitoring wells was reported from the September/October 2012 monitoring and sampling based on oil-water interface probe (see Section 3.9) and observations of free product blebs or sheen on collected purge waters. No measurable thickness of floating product was reported from the oil-water interface probe survey. Although the interphase probe did indicate sinking product below the water table in several monitoring wells (e.g., MW12-10, MW12-13 and MW12-15), the data were not considered reliable enough to quantify product thickness. Blebs of coal tar were reported in the collected purge water from wells OW112B, MW12-09, MW12-10, MW12-11, MW12-13 and MW12-15 located in the vicinity of the former gas plant structures and APECs 1 through 9. These results are consistent with the results of visible oil and tar presence during drilling of these boreholes (see Section 4.5.1) and from historical 1986/1987 investigations and the initial Phase 2 ESA work.

4.6.2 Laboratory Chemical Results

The results of the March/April and October 2012 groundwater laboratory analysis for metals and free cyanide, PAH and PHC-F1-BTEX are summarized in Tables B.5, B.6 and B.7, respectively, in Appendix B. Complete laboratory certificates of analysis from the current September/October 2012 investigation are included in Appendix D. Groundwater analytical results were compared to relevant MOE Table 3 standards for non-potable groundwater as indicated in Section 4.1. MOE Table 3 non-potable groundwater standards are the same for both residential/parkland and commercial/ industrial land use.

A review of the groundwater analytical results from the March/April and October 2012 sampling for the site indicates the following:

- Metals and cyanide contamination of groundwater is not a concern at the site. There was only one exceedence of MOE Table 3 standards for non-potable groundwater in the 26 samples submitted from the initial Phase 2 ESA, and that was from well E-006 for sodium. The detected concentration of sodium at 2,750 mg/L only marginally exceeded the MOE standard of 2,300 mg/L.

No groundwater samples were submitted from the October 2012 work for analysis of metals and free cyanide.

- PAH contamination of groundwater exceeding MOE Table 3 standards primarily occurs in areas of identified coal tar contamination of soil. Exceedences of MOE Table 3 standards for several light to heavy molecular weight PAH were found in fill or deep alluvium groundwater at OW112B, MW12-09, MW12-10, MW12-11, MW12-13 and MW12-14 from a total of 34 samples submitted in October 2012. Low levels of soluble PAH (e.g., naphthalene and phenanthrene) were found at several other wells. These PAH occurrences in groundwater are consistent with the solubility and sorption characteristics of PAH.

  The results of the October 2012 groundwater sampling confirm the results of the initial Phase 2 ESA which showed PAH groundwater quality exceedences at wells OW112B, MW12-09, MW12-10 and MW12-11.

- PHC-F1 and BTEX exceedences of MOE Table 3 non-potable groundwater standards are limited to those boreholes with evidence of coal tar presence and/or PAH exceedences of MOE Table 3 standards. PHC-F1, benzene exceedences were found at OW112B, MW12-09, MW12-10, MW12-11 (spring 2012 only), MW12-13 and MW12-14. The very high concentrations of PHC-F1 measured in fall 2012 sampling at MW12-09 indicate the presence of free product.

  The results of the October 2012 groundwater sampling generally confirm the results of the initial Phase 2 ESA which showed groundwater quality exceedences for PHC-F1 and BTEX at wells OW112B, MW12-09 and MW12-10. A PHC-F1 exceedence measured in March 2012 at MW12-11 was not detected in October 2012 sampling.

4.7 Quality Assurance - Quality Control Results

Laboratory analyses in the current investigation were completed by Paracel Laboratories, a CALA (Canadian Association for Laboratory Accreditation)-certified laboratory. Paracel completed all analyses in accordance with internal laboratory QC programs that included referenceable standardized analytical methods and procedures and use of laboratory quality control samples. Certificates of quality control were provided by Paracel for all completed analyses. These certificates summarize standardized analytical methods, and the laboratory's results for laboratory QA/QC samples including replicate samples, process blanks, standard surrogate additions and matrix spikes. Complete laboratory analytical reports for Geofirma's September/October 2012 sampling program are provided in Appendix D. Laboratory field blank and blind duplicate analyses are included on the summary analytical tables in Appendix B.

Geofirma review of Paracel QA/QC certificates indicates that all analytical results fell within acceptable QA/QC limits for constituent recovery as defined by the protocols for the analytical methods.

Blind duplicate samples were collected for soil and groundwater analysis to assess the reproducibility and precision of the field sampling and analytical work. The following Table 4.3 summarizes the blind duplicate sample naming convention that allows correlation of duplicate analytical results with original analytical results.

Table 4.3 Summary of Duplicate Sample Identifiers for Soil and Groundwater Analyses

Blind Duplicate Sample	*Original Sample*	*Lab Analytical Parameters*
Soil		
BH12-DUP1	BH12-15 SA8	Metals, PAH
BH12-DUP1	BH12-15 SA4	PHC-F1/BTEX
BH12-DUP2	BH12-16 SA5	Metals, PAH
BH12-DUP2	BH12-16 SA6	PHC-F1/BTEX
Groundwater		
MWD1	E-115A	PAH, PHC-F1/BTEX
MWD2	MW12-13	PAH, PHC-F1/BTEX
MWD3	OW112A	PAH, PHC-F1/BTEX

Analytical result precision was determined as relative percent differences from blind duplicate analyses. Relative percent difference (RPD) between sets of duplicate groundwater and soil samples was calculated as follows:

$$RPD = \frac{|X_1 - X_2|}{\bar{X}}$$

where: X_1= concentration of original sample

X_2 = concentration of duplicate sample

$\bar{X}$ = average concentration of original and duplicate sample

The calculated relative percent differences for samples with detections greater than five times the analytical method detection limit was determined for sets of analytical suites for both soil and groundwater. For soil metals, PAH and PHC-F1/BTEX, the average RPD values were 42%, 77% and 22%, respectively. For groundwater, PAH and PHC-F1/BTEX the average RPD values were 17% and 18%, respectively. These average RPDs are in accordance with expectations based on expected contaminant distribution and behaviour in soil and groundwater and indicate good analytical precision and reproducibility.

A field blank identified as FB was prepared in the field using laboratory-supplied sample bottles, deionized water and groundwater sampling equipment. PAH and PHC-F1/BTEX were not detected in the field blank.

Based on review of the laboratory and field QA/QC documentation, the soil and groundwater analytical results from 2012 sampling are considered of acceptable quality and can be used in this report without qualification.

4.8 Summary of Site Conditions

4.8.1 Updated Conceptual Site Model

The results of the 2012 subsurface investigations confirm the central elements of the Conceptual Site Model (CSM) described in Section 2 of this report. The site stratigraphy, hydrostratigraphic units and groundwater flow system as described in Section 4.3 and 4.4 of this report are entirely consistent with the CSM. The thickness and elevation of the fill, alluvium and basal glacial till units evident from the 2012 drilling and soil sampling are very similar to expectations based on the CSM developed from earlier investigations. The 2012 groundwater flow system is largely unchanged from that evident in 1986. Groundwater at the 191 and 193 Lees Avenue site is captured by the Lees Avenue Transitway Station pumping system.

4.8.2 Soil and Groundwater Quality Exceedences

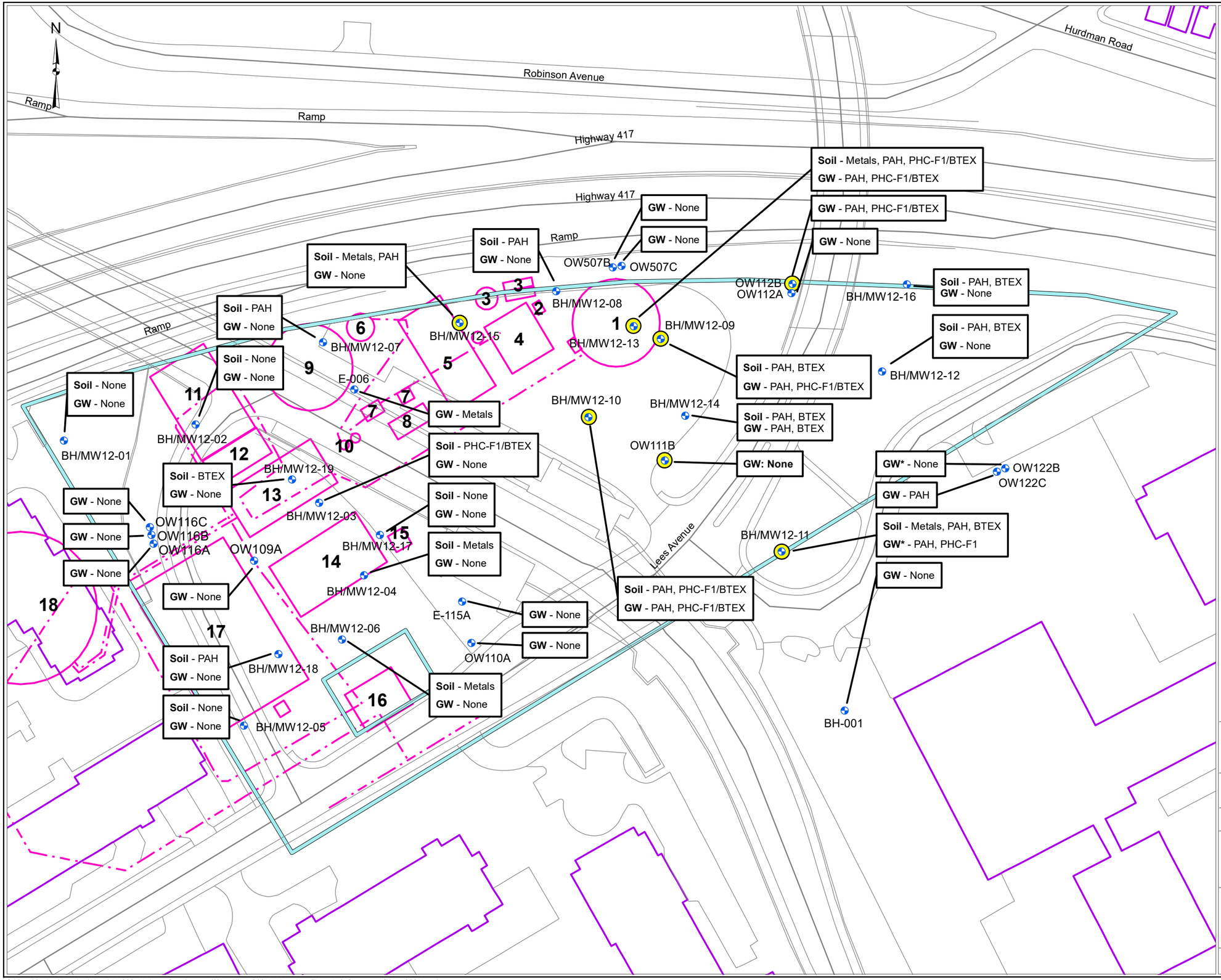
Laboratory chemical testing for typical coal gasification plant waste chemicals shows that PAH and PHC-F1/BTEX remain the chemicals of concerns at the site. Metals and cyanide in soil and groundwater were either not detected (cyanide in soil and groundwater) or were found only sporadically in site soil and groundwater at elevated concentrations.

Figure 4.6 summarizes the locations where soil and groundwater samples collected in March/April and/or September/October 2012 were found to exceed MOE (2011a) Table 3 standards for residential/parkland land use. Figure 4.6 also shows those sampled boreholes and wells that showed evidence of the presence of coal tar during soil and groundwater sampling. Application of commercial/industrial land use results in essentially the same distribution of exceedences.

Figure 4.6 shows that there are five areas exceedences of MOE standards for soil for PAHs (one location), PHC-F1/BTEX (two locations) and metals (two locations) on the west side of the Transitway. Groundwater west of the Transitway does not show exceedences of MOE standards for metals, PAH, free cyanide and PHC-F1/BTEX at the 15 sampling locations. These are quite limited exceedences given the historical land use and results of earlier investigations. Figure 4.6 also shows that PAH and PHC-F1/BTEX exceedences of MOE standards are more frequent and widespread on the east side of the Transitway, consistent with visual and olfactory observations of coal tar occurrence in this area.

4.8.3 Coal Tar Presence

The distribution of coal tar contamination from both visual/olfactory observation and laboratory chemical testing observed in 2012 is consistent with the distribution described in 1986 and 1987. Coal tar is present within the deep alluvium and to a lesser extent the shallow alluvium and fill units primarily on the east side of the Transitway below the parking lot. The highest concentrations of coal tar chemicals (i.e., PAH) were most often found in the fill and in the deep alluvium to the top of the low permeability basal till unit over the eastern half of the parking lot. Typically, coal tar is found in this part of the site at elevations of 53 to 50 mASL at depths of 7 to 10 mBGS (e.g., BH12-09, BH12-10 and BH12-15). This coal tar appears to be pooled on top of the basal till unit. The occurrence of coal tar at BH12-11 (and historically at OW120B) is consistent with historical movement of coal tar within the fill and deep alluvium and down the sloping till surface to the southeast of the parking lot. Coal tar is also shown to be present at shallow depths of 1.9 to 3.0 mBGS (elevations of 57.9 to 56.8 mASL) within fill in the former relief gas holder (BH12-13) and in BH12-15.



LEGEND

- Road
- Current Building Footprint
- Borehole/Monitoring Well Sampled in 2012
- **Soil** - PAH / **GW** - PAH: Exceedence of MOE 2011, Table 3 Standards for Residential/Parkland Use
- Site Boundary
- Former Gas Plant Structure
- Former Gas Mains/Underground Piping
- Visible Oil and Tar Occurrences

Historical Gas Plant Structures (APECs)

1 Water Gas Relief Holding Tank
2 Tar Well Adacent to the Old Water Gas Plant
3 Surface and Underground Gas Oil Storage Tanks
4 Water Gas House
5 Tar Storage Area in Boiler House
6 Ammonia Liquor/Tar Well
7 Tar Pump House
8 Underground Tar Separator
9 "Bunker C" Oil Tank
10 Two tar dehydrators
11 Gas Purifying House
12 Tar, Ammonia, Liquor, Separator and Drip Oil Wells South of Purifying House
13 Condenser House
14 Retort House
15 Sump
16 Gas Metering House
17 Coal Shed
18 Gas Holder Tank

* March/April 2012 Groundwater Values Represented Instead of October/November 2012 (Greater Number of Exceedences)

Figure 4.6 - Summary of Phase 2 ESA Soil and Groundwater Quality Exceedences

Scale 1:1,100

0 10 20 40 60 80
Meters

Projection: NAD 83 MTM Zone 9
Source: City of Ottawa, Geobase Canada

PROJECT No. 11-200-11

PROJECT
Supplementary Phase 2 ESA
& Remedial Options Assessment
191 & 193 Lees Avenue, Ottawa

DESIGN: ADG
CAD/GIS: ADG
CHECK: KGR
REV: 0

DATE: 21/01/2013

Geofirma Engineering Ltd

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5 REMEDIAL OPTIONS ASSESSEMNT

Due to the location of the Lees Avenue site in relation to the proposed light rail transit route (along existing OC Transpo Transitway) with a rail station planned at the Lees Avenue site, as well as the close proximity of 191 and 193 Lees Avenue to the University of Ottawa and downtown, the Lees Avenue site has a high re-development potential and therefore sufficient potential property value that the City is considering remedial measures.

The following sections provide a description and initial screening of potentially applicable remedial technologies for coal tar contaminated sites, and a comparative evaluation of the retained remedial technologies to the Lees Avenue site. The intent of the screening and comparative evaluation of remedial technologies at this stage is not to recommend any single technology to move forward with, but rather to give an overview of options and to narrow the search down to a few technologies that warrant further consideration and evaluation.

Based on the results of historical and recent subsurface investigations, the contaminants of concern at the 191 and 193 Lees Avenue site are NAPL coal tar, and specifically PAH and PHC-F1/BTEX in soil and groundwater. Metals, pH, and free cyanide are not contaminants of concern at the site.

5.1 Remedial Action Objectives

For the Lees Avenue site, the following five remedial action objectives have been established, which will form the basis for the screening and comparative assessment of remedial technologies:

1) At a minimum, eliminate or mitigate all significant threats to public health and the environment (likely already achieving this);

2) Minimize or eliminate any offsite migration of contamination (likely already achieving this);

3) Remove, to the extent practical, the source of contamination (including historical gas holders and piping and NAPL phase as much as practical);

4) Restoration of the site to a condition that future development can occur both above and below grade; and,

5) Minimize or eliminate the need for and costs associated with the onsite OC Transpo Transitway groundwater collection and treatment system.

5.2 Screening of Potentially Applicable Remedial Technologies

A variety of remedial technologies have been developed and tested to address the remediation of viscous non-aqueous phase liquids (NAPLs) like coal tar and creosote. Some rely on traditional geotechnical methods to fix the NAPL in place, others seek to destroy in-situ by oxidation or combustion, while yet others seek to encapsulate the NAPL in-situ. Agencies in the US, such as the Environmental Protection Agency (EPA) and the Interstate Technology & Regulatory Council (ITRC), have conducted lengthy evaluations of the various remedial technologies. As a reference point, conventional excavation and off-site disposal remediation is also described.

The remedial technologies considered here are:

1) Excavation and Off-Site Disposal
2) Treatment
    a) Ex-situ Treatment
        i. Combustion (Co-burning)
        ii. Thermal Desorption
        iii. Bioremediation (Slurry Phase Bioreactors, Landfarming, Biopiles)
    b) In-situ Treatment
        i. Combustion (Smouldering)
        ii. Thermal Treatment Methods
        iii. Intrinsic Bioremediation
        iv. Surfactant Enhanced Remediation
        v. Chemical Oxidation
3) Engineered Containment
    a) Cap/Cover site
    b) DNAPL Recovery Wells
    c) Hydraulic Control
    d) Containment Barriers
    e) In-situ Solidification and Stabilization
    f) In-situ Geochemical Stabilization
4) Institutional Controls

Table 5.1 summarizes the screening evaluation of these remedial technologies by considering effectiveness to meet the remedial action objectives, ease to implement at the site, and cost. Estimated unit costs are presented at this stage for general information only and are not considered to be a deciding factor during this screening stage. The general principles of each technology and the particular constraints/concerns on its use at Lees Avenue are described in the following sections. Although each technology is discussed independently, the best path forward will likely include multiple treatment activities (i.e., excavation and off-site treatment or disposal of some contaminated material, followed by smaller area(s) of in-situ treatment and containment with ongoing monitoring costs) to address various chemical components.

5.2.1 Excavation and Off-Site Disposal

Excavation and off-site disposal is described as the reference remedial technology against which other more innovative remedial technologies may be assessed. It is a proven but costly technology that has historically been applied to numerous coal tar and creosote contaminated sites. Excavation and dewatering addresses both soil and groundwater/NAPL contamination. During excavation, an engineered barrier (i.e., sheet piling or cement-soil impermeable wall) would be required around the site and/or perimeter groundwater extraction wells would need to be installed to assist with groundwater dewatering issues. Also, in order to deal with logistical issues of fugitive emissions, the entire excavation area would require covering with an inflatable or rigid structure equipped with air remediation equipment prior to discharging to the outside environment along with completion of the soil excavation in stages or phases. Figure 5.1 shows an example of a rigid structure used during an

Table 5.1 Summary of Screening Evaluation of Remedial Technologies for Coal Tar Contamination at Lees Avenue Transitway Site

Approach or Technology	Technology sub-category	Effectiveness	Implementability	Cost	Status for Consideration
Excavation and Off-Site Disposal	Excavate above till (above ~ 10m)	Effective	Difficult - overwhelm capacity of exiting collection and treatment system? - air releases (odours) - large offsite waste disposal costs - dewaterling	Very High **Excavation** $2M-$5M excavation and site containment **Disposal** $30-$50 per tonne non-hazardous waste (~$1M-$3M) $400-500 per tonne hazardous waste (~$6.4-$12M)	Retained
	Excavate below till (to bedrock)	Questionable - extent of contamination below till is unknown and assumed to be low	Difficult - potential to provide pathway for tar and contaminated groundwater into bedrock	Very High **Excavation** $2M-$5M excavation and site containment **Disposal** $30-$50 per tonne non-hazardous waste (~$1M-$3M) $400-500 per tonne hazardous waste (~$6.4-$12M)	Not Retained - not known if contamination extends below till, thereofore not cost effective or necessary at this stage
Ex-Situ Treatment	Combustion (Co-burning)	Effective	Moderate - technology proven but availability of contractor is unknown	Medium to High **Excavation** $2M-$5M excavation and site containment **Treatment** $50-$150 per tonne for soils $150-$350 per tonne for tar	Retained
	Thermal Desorption	Effective - proven at other MGP sites	Moderate - space onsite to set up facility may be an issue - technology proven - no known locally permitted facility	Medium **Excavation** $2M-$5M excavation and site containment **Treatment** $100 to $200 per tonne	Retained as a backup to ex-situ combustion
	Bioremediation (Slurry Phase Bioreactors, Landfarming, Biopiles)	Still in development stage - high concentrations may reduce effectiveness	Difficult - technology not proven - not enough space onsite	Medium to High **Excavation** $2M-$5M excavation and site containment **Treatment** $75 per cubic metre - landfarming $100 to $200 per cubic metre - biopiles $150 to $250 per cubic metre - bioreactor	Not Retained - not effective with large volumes of NAPL
In-Situ Treatment	Combustion (Smouldering)	Seems effective but ultimately unknown at this stage (still in development)	Difficult - ability to direct and control combustion - fate and effect of combustion by-products at Transitway - damage to existing infrastructure	Medium $100 to $150 per cubic metre	Retained
	Thermal Treatment Methods (in-situ thermal desportion, electrical resistance heating, in-situ steam injection)	Seems effective but ultimately unknown at this stage	Difficult - ability to direct and control thermal heating process in heterogenous environment - fate and effect of thermal heating by-products at Transitway - damage to existing infrastructure	Medium to High $120 to $300 per cubic metre	Retained

Table 5.1 Summary of Screening Evaluation of Remedial Technologies for Coal Tar Contamination at Lees Avenue Transitway Site

Approach or Technology	Technology sub-category	Effectiveness	Implementability	Cost	Status for Consideration
In-Situ Treatment (Continued)	Intrinsic Bioremediation	Seems effective but large volume of NAPL makes this technology only feasible in conjunction with more aggressive remediation strategy (i.e. Excavation).	Difficult - not effective where large volumes of DNAPL present	Low ~$50 per cubic metre	Not Retained - not effective with large volumes of NAPL
	Surfactant-Enhanced Remediation	The difficulty is achieving contact between surfactant and contaminated soil in heterogenious environment - therefore ultimate effectiveness unknown at this time	Difficult - not effective with DNAPL - ability to direct and control surfactant contact process in heterogenous environment - fate and effect of surfactant and surfactant-coal tar mixture by-products at Transitway - damage to existing infrastructure	Medium to High $150-$250 per cubic metre	Not Retained - not effective with large volumes of NAPL
	In-situ Chemical Oxidation (ISCO)	Seems effective but ultimately unknown at this stage	Difficult - ability to direct and control ISCO contact process in heterogeneous environment	Medium to High $150-$250 per cubic metre	Not Retained - not effective with large volumes of NAPL
Engineered Containment	Cap/cover site	Effective to reduce exposure Not effective in limiting migration	Easy	Low ~$5 to $20 per square metre surface	Retained - current conditions have ~1-2 m soil cover and asphalt parking lot
	DNAPL recovery wells	Effective to remove DNAPL but connectivity not well understood	Easy	Low to Medium ~$1 per litre DNAPL	Not Retained - DNAPL plume is too widespread for this to be effective
	Hydraulic Control (similar to current system)	Effective to reduce mobilization	Difficult	Low to Medium ~$50K to $100K per year	Retained - current conditions have Transitway collection and treatment system
	Containment Barriers	Effective to reduce mobilization	Easy	Low ~$50 per square metre wall surface	Retained
	In-situ Solidification and Stabilization (S/S)	Effective to reduce mobilization	Difficult	Low $20-$30 per cubic metre	Retained
	In-situ Geochemical Stabilization (ISGS)	Seems effective but ultimately unknown at this stage	Difficult - ability to direct and control ISGS contact process in heterogeneous environment	Low $10-$50 per cubic metre	Not Retained - not a proven technology
Institutional Controls	Access controls, H&S Plans, Long-Term Monitoring (similar to present)	- Effective - exposure to workers - not Effective in limiting migration	Easy	Low ~$10K to $100K per year	Retained

environmental remediation.

Figure 5.1 Example of a Rigid Structure Used During Environmental Remediation

Given current provincial waste management regulations, much of this heavily contaminated material would in all likelihood be considered hazardous liquid and solid industrial waste. For the purpose of cost estimates and logistical planning, 50% is assumed to be classified as hazardous (16,000 to 24,000 tonnes) and 50% contaminated but not hazardous. In order to access this deep contamination approximately 1-2 metres thick (8,000 to 16,000 m^3 or 16,000 to 32,000 tonnes) of marginally contaminated material would need to be excavated and sorted for off-site disposal and possible on-site reuse. Similarly, for the purpose of cost estimates and logistical planning 25% of this (4,000 to 8,000 tonnes) is assumed to be contaminated and 75% assumed to be re-usable onsite. Another 4-5 m (30,000 to 40,000 m^3 or 60,000 to 80,000 tonnes) of uncontaminated soil would require excavation and stockpiling for re-use onsite.

Benefits of this remedial option include that all of any remaining manufactured gas plant infrastructure (gas holders, piping, etc.) and contaminated soil are removed from site, thereby allowing full development on the site to the depth of remediation. Constraints and concerns for application of excavation and off-site disposal at the Lees Avenue site include the control of groundwater inflow to the excavation, fugitive releases of coal tar and elevated dissolved PAH/BTEX to the Transitway Station groundwater collection and treatment system, fugitive releases to ambient air due to exposure of coal tar volatiles during excavation activities, and off-site waste disposal costs. Estimated costs associated with excavation and offsite disposal are approximately $30 to $50 per tonne to deal with disposal of non-hazardous waste (36,000 to 56,000 tonnes), approximately $400 to $500 per tonne of hazardous material (16,000 to 24,000 tonnes), and $2M to $5M for excavation activities and other special equipment and environmental health and safety associated with such a grossly contaminated site.

Excavation and off-site disposal methods are further considered as potentially applicable remediation technologies for coal tar NAPL at the Lees Avenue site.

5.2.2 Treatment

Most remediation technologies can be performed either in the ground without disturbing the contamination (in-situ) or in a controlled environment after the material has been removed from the ground (ex-situ). In general, ex-situ treatment is (a) more expensive due to the added costs associated with excavation of soil, and (b) quicker to reduce concentrations due to the controlled environment and ability to ensure optimum contact between treatment technology and the contaminated soil. In-situ treatment on the other hand is (a) less of a hazard to workers due to the fact that grossly contaminated soil and groundwater is not excavated and exposed/transported, and (b) less disruptive to site operations and nearby community.

5.2.2.1 Ex-situ Treatment

The ex-situ treatment technologies presented below primarily address soil contamination without treatment of groundwater or NAPL. Any ex-situ treatment technology will involve excavation of the contaminated soil and will have the same logistical challenges as excavation and disposal such as dewatering to control groundwater/NAPL inflow during excavation and treatment/disposal of this water/NAPL, and covering the site with a structure equipped with air treatment to deal with fugitive air emissions. Ex-situ treatment technologies can be performed on-site or near site using a mobile facility or off-site at a permanent, licensed facility. For the Lees Avenue site, space is at a premium as the area of contamination requiring excavation is essentially the entire parking lot which is bounded on the west by the Transitway Station, on the south and east by Lees Avenue and on the north by Highway 417, therefore off-site ex-situ treatment is preferred.

Combustion - Co-Burning

Co-burning involves the combustion of coal tar and tar contaminated soils with coal in utility boilers (i.e. stokers, cyclones, and those fired by pulverized coal). Contaminated soils are screened to remove oversized material and blended with coal feedstock in the range of 5 to 10 percent coal.

Benefits of this technology are that it reduces the amount of waste requiring disposal and it destroys organic wastes. Limitations include limited contractor availability, and the possibility for long-term impacts on boiler efficiency, maintenance and operation. Estimated costs for co-burning are $50 to $150 per tonne for soils and $150 to $350 per tonne for tar.

Co-burning treatment is further considered as a potentially applicable remediation technology for coal tar NAPL at the Lees Avenue site.

Thermal Desorption

Thermal desorption has been successfully used to remediate soils containing coal tar wastes since the early 1980's, achieving concentration reductions of more than 98 percent for TPHs, BTEX compounds, PAHs, and cyanide. Thermal desorption uses temperatures ranging from 100°C to 650°C to heat soil and volatilize chemicals that are sorbed to soil. Lower temperatures (100°C - 450°C) are usually sufficient to desorb VOCs and many PAH compounds, while higher temperatures

(up to 650°C) are required to desorb higher-molecular weight PAHs. Off-gassing chemicals are treated, and the cleaned air is vented to the atmosphere. This technology can be completed either on-site with a mobile unit or off-site at a facility. The treated soil is cooled with water and stockpiled awaiting confirmation sampling concentrations prior to being returned to the excavation or disposed on off-site.

Figure 5.2 shows the surface equipment required for ex-situ thermal desorption treatment at a site in New Jersey with a similar size to the 191 Lees Avenue parking lot.

Figure 5.2 Surface Equipment for Ex-Situ Thermal Desorption Treatment

Benefits of this technology include high production rates if using larger equipment and proven removal of total and carcinogenic PAHs. Limitations of this technology include potential air emissions of by-products that may need treatment, high organic content soil (e.g., peat) is not suitable, and wet soil (saturated) requires dewatering prior to treatment. Treatment rates range from 8 to 45 tons per hour depending on the size of dryer unit used. Estimated costs for thermal desorption range from approximately $100 to $200 per tonne of soil, including general contracting (excavation), confirmation sampling, management, permits and transportation.

Ex-situ thermal desorption treatment is further considered as a potentially applicable remediation technology for coal tar NAPL at the Lees Avenue site.

Bioremediation - Slurry Phase Bioreactors, Biopiles, Landfarming

Slurry phase biological treatment involves mixing excavated soil with water to form a suspension of solids and subsequently treating the soil in a controlled environment (bioreactor) where nutrients and

oxygen (possibly microorganisms if necessary) are mixed with the mixture. The mixture of soil and water is completed after the soil is physically separated into gravel, sand, and debris and the ratio of soil to water is dependent upon the concentration of contaminants of concern, the rate of biodegradation and the physical nature of the soils. The slurry typically contains 10 to 50 percent solids by weight. Upon completion of biodegradation, the soil slurry is dewatered using a variety of filters, clarifiers and other dewatering devices. The rate and extent of degradation for a particular site will vary depending on the specific soil conditions and contaminant concentrations. A preliminary treatability study will need to be completed and should identify amendment mixtures that best promote microbial activity, percent reduction and lowest achievable concentration limit of contaminant and potential degradation rate.

Biopile treatment is a variation of composting where excavated soils are mixed with soil amendments (i.e. nutrients, moisture, or bulking agents such as wood chips) and placed in piles in a treatment area. Typically, biopiles require a leachate collection system and some form of aeration. Figure 5.3 shows an example of a biopile used to treat petroleum contamination.

Figure 5.3 Example of Biopile Technology Used to Treat Petroleum Contamination

Similarly, landfarming involves placing contaminated soil in linear beds approximately 18 inches deep and periodically turning the soil or tilling it to aerate the waste. Nutrients can be added as necessary to promote the degradation of contaminants.

Benefits of this technology include the shorter treatment times compared to in-situ treatment and more certainty about the uniformity of treatment compared to in-situ. Limitations of this technology include the need for space on ground surface to stockpile the waste semi-long term while the biodegradation process occurred, high costs associated with dewatering treated fine-grained soil, heterogeneous and

clayey soils can create serious materials handling problems, and non-recycled wastewaters require disposal. Bioremediation is not effective for NAPL or higher molecular-weight hydrocarbons, and the treatment process is slower that other, more aggressive technologies. Estimated costs associated with the various ex-situ bioremediation technologies are approximately $75 per cubic metre (landfarming), $100 to $200 per cubic metre (biopiles), and $200 to $250 per cubic metre (bioreactor).

Ex-situ bioremediation is not further considered as a potentially applicable remediation technology for the Lees Avenue site due to its unproven success with the large volumes of expected coal tar DNAPL.

5.2.2.2 In-situ Treatment

The in-situ treatment technologies presented below are considered based on their effectiveness and ability to clean up both soil and contaminated groundwater/NAPL at the Lees Avenue site. The benefits of in-situ treatment include not having to deal with fugitive releases of air emissions or groundwater/NAPL dewatering issues. The primary limitation with in-situ treatment is that it is difficult in heterogeneous soils to ensure adequate physical contact and treatment time between the remedial technology and the contamination of interest. The volume of material requiring in-situ treatment is not fully understood, however for the purpose of this assessment it is assumed that approximately 4-5 m (30,000 to 40,000 m^3) will require treatment.

Smouldering/Combustion

STAR (Self-sustaining Treatment for Active Remediation) was identified in the Phase 1 ESA as an innovative in-situ treatment for non-aqueous phase liquid (NAPL) hydrocarbon contamination such as coal tar that might have application at 191 and 193 Lees Avenue. It was developed at Western University (formerly the University of Western Ontario). The technology is being marketed and applied in Canada through Geosyntec Consultants, Guelph Ontario. STAR is a smouldering combustion technology that is applicable to coal tar both above and below the water table provided hydrocarbon concentrations are sufficient to support smouldering combustion. It requires control of the subsurface combustion or smouldering process through preheating to 200º C to 400º C and controlled injection of air (oxygen) to ignite coal tar NAPL and maintain/control the combustion process. Such preheating and air delivery would be achieved through a network of boreholes and stainless-steel casings/ screened wells. Figure 5.4 shows the STAR pilot test at a DuPont former cresol manufacturing facility in Newark, New Jersey.

Based on communication with Western University and Geosyntec Consultants, the site characterization information necessary for assessment of application of the STAR technology to the Lees Avenue Transitway Station site include the following:

- Presence or absence of coal tar NAPL;
- Location and extent of coal tar NAPL (i.e. connectivity of NAPL occurrences);
- Geology of the coal tar NAPL zone and the geology of the zone above and below the zone; and
- Chemical data on soil PAH/BTEX concentration, and NAPL composition.

Figure 5.4 Surface Equipment Layout for a Pilot Test of STAR Technology at a Cresol Manufacturing Facility in Newark, New Jersey

The most critical data to screen STAR for potential demonstration are the geology and soils chemical data. The data collected as part of the Phase 2 ESAs indicate the following information relevant to assessment of STAR technology application at the site:

- Coal tar as DNAPL is present at saturation levels within the lower 2-4 m of deep sandy alluvium located over the eastern half of Transitway Station parking lot and in the shallow fill at both residual and full saturation levels. The continuity of coal tar contamination in these areas is uncertain.
- The deeper coal tar contamination in the sandy alluvium is found typically below the groundwater table within coarse-textured soil consisting of gravel to silt (see grain size analysis for BH12-09, sample 7.31-7.92 mBGS). The geology below and above this coal tar contaminated zone is dense basal till and sandy alluvium, respectively.
- The largest volume of shallow coal tar contamination is found above the groundwater table in sandy silty clay fill within (BH12-13) the former relief gas holder located in the northeast corner of the Transitway Station parking lot. The coal tar contamination rests on the assumed concrete base of the former gas plant structure.
- Chemical concentrations of total priority PAH and PHC-F1/BTEX in these coal tar contaminated areas (BH12-09, BH12-10, BH12-13) approximate several hundred to several thousand µg/g, and several hundred µg/g, respectively.

Consultation with the company responsible for marketing and field implementation of STAR indicates that these deep coal tar contaminated soils are potentially suitable for STAR technology demonstration. However, additional soil texture and chemical/coal tar delineation testing is recommended to obtain a better understanding of potential STAR demonstration locations, and to effectively design a pilot scale demonstration. STAR and other in-situ and ex situ coal tar remediation technologies are expensive and often complex remedial methods to apply at former manufactured coal gas plant sites. Successful application is often dictated by a good understanding of subsurface conditions, site application constraints and technology limitations and realistic assessment of achievable clean-up goals.

Benefits of this technology include the fact that DNAPL is destroyed in-situ with minimal disturbance to surface activities and neighbouring community. Constraints and concerns for STAR application at the Lees Avenue site include the ability to direct and control the combustion process in a heterogeneous subsurface environment where coal tar is preferentially present in the coarser-grained soil units, the fate and effect of combustion by-products (carbon monoxide and carbon dioxide) on the Transitway Station and Station visitors, and the potential for combustion damage to underground infrastructure (e.g., storm water and groundwater collection drains below the Transitway) due to uncontrolled combustion and movement of the combustion front. Estimate costs associated with STAR treatment technology are approximately $100 to $150 per cubic metre.

Smouldering/combustion methods (e.g., STAR) are further considered as potentially applicable remediation technologies for coal tar NAPL at the Lees Avenue site.

Thermal Treatment Methods

Thermal treatment methods are based on the application of heat to subsurface contamination to desorb, mobilize or destroy NAPL coal tar in-situ. Three thermal methods are potentially applicable to the Lees Avenue site:

a) In-situ thermal desorption;

b) Electrical resistance heating; and

c) In-situ steam injection.

In-situ thermal desorption (ITSD) was developed by Shell Oil using its experience in thermally enhanced oil recovery. At a site like Lees Avenue, electrical heaters would be installed in stainless steel wells within the NAPL zone to destroy and vaporize the contaminants. The thermal wells would be placed on 2-metre centers in order to achieve an in-situ soil temperature of >250ºC. In soil or rock, heat flows from heater wells out into the formation by grain-to-grain contact (in soil) and across solid objects (rocks), i.e., by thermal conduction. The fluids (water, air, NAPL) in contact with the solids also heat up at the same time. The heat moves out radially from each thermal well until the heat fronts overlap.

Figure 5.5 shows a schematic of vapor extraction wells recovering the volatilized contaminants and groundwater that are prevented from being emitted from the treated zone because of a surface vapor barrier.

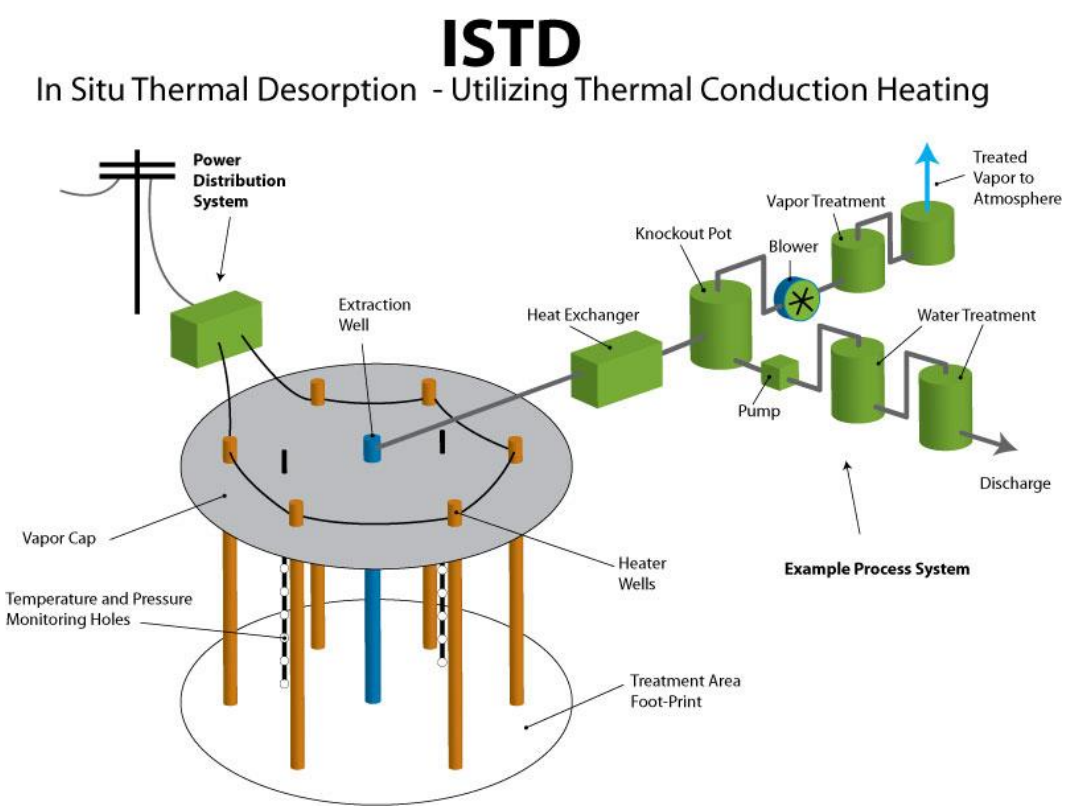

Figure 5.5 Schematic of Application of In-Situ Thermal Desorption at a Hydrocarbon Contaminated Site

Electrical resistance heating uses arrays of electrodes installed around a central neutral electrode to create a concentrated flow of current toward the central point. Resistance to flow in the soils generates heat greater than 100ºC, producing steam and readily mobile contaminants that are recovered via vacuum extraction and processed at the surface. Electrical resistance heating is an extremely rapid form of remediation with case studies of effective treatment of soil and groundwater in less than 40 days. Three-phase heating and six-phase soil heating are varieties of this technology (Cummings, 2012).

In-situ steam injection is also borrowed from enhanced oil recovery technology. The steam heats the soil and groundwater and enhances the release of contaminants from the soil matrix by decreasing viscosity and accelerating volatilization. Steam injection may also destroy some contaminants. As steam is injected through a series of wells within and around a source area, the steam zone grows radially around each injection well. The steam front drives the contamination to a system of ground-water extraction wells in the saturated zone and soil vapor extraction wells in the vadose zone (Cummings, 2012).

Any choice of these thermal remediation technologies will require careful consideration even before pilot testing. It will be critical to carefully control the zones where heat is applied so that unwanted side effects causing infrastructure damage or failure are prevented. Constraints and concerns for thermal remediation technology application at the Lees Avenue site include the ability to direct and control the heating process in a heterogeneous subsurface environment, the fate and effect of fugitive releases including heating by-products (i.e., gases) and steam on the Transitway Station and Station visitors, and the potential for heating-related damage to underground infrastructure.

Benefits of in-situ thermal treatment for Lees Avenue include that it will work in a wide range of soil types, treatment is possible in areas where excavation is not possible, and minimal disruption to nearby neighborhoods or operations (Transitway). Limitations to in-situ treatment include high utility costs, thermal desorption works best in unsaturated conditions, and the unknown effectiveness of electrical resistance heating and steam injection technologies with NAPLs. Estimated costs for in-situ thermal treatment are $120 to $300 per cubic metre.

Thermal treatment methods are further considered as a potentially applicable remediation technologies for coal tar NAPL at the Lees Avenue site with a focus on in-situ thermal desorption.

Intrinsic Bioremediation

Bioremediation has been used to attenuate groundwater contamination associated with the dissolution of coal-tar NAPL, however the effective application of intrinsic bioremediation relies on removing the NAPL source zone and the presence of strong oxidants in the groundwater, such as dissolved oxygen (Neuhauser et al., 2009). This is because the electron transfer reactions that are mediated by microbes in the groundwater function only in aqueous electrolytes; coal-tar NAPL is a non-aqueous liquid that provides no terminal electron accepting species, such as dissolved oxygen, to which electrons may be transferred and no electrolytic function. Therefore, the use of bioremediation is not considered feasible as a stand-alone remediation strategy but could be considered in conjunction with a remediation technique that removes the NAPL phase.

Benefits of in-situ bioremediation include low cost, low effort, and the lack of major equipment and disruption to the site and neighbouring community. Limitations to this technology include that it does not work effectively with NAPL, and difficulty with distributing dissolved oxygen in a heterogeneous subsurface environment. Costs associated with in-situ bioremediation are estimated at approximately $500K to $1M for short term capital costs and setup and approximately $1M to $3M for 20 years of long-term monitoring and adjustments.

Intrinsic bioremediation is not further considered as a potentially applicable remediation technology for the Lees Avenue site due to its unproven success with the large volumes of expected coal tar DNAPL.

Surfactant-Enhanced Remediation

Surfactant-enhanced remediation of coal tar NAPL involves the injection and contact of a surfactant to mobilize and remove coal tar from the subsurface. It would involve the sweeping of a coal tar contaminated zone via a network of surfactant injection wells and extraction wells, and treatment and/or disposal of the captured coal tar and surfactant groundwater mixture.

Surfactant-enhanced remediation of coal tar NAPL was undertaken at the pilot scale at a former Manufactured Gas Plant (MGP) site in Indiana by Young et al. (2002). Initially heated water was injected into the alluvial aquifer containing coal-tar NAPL to reduce its viscosity and allow it to be displaced by the subsequent injection of a surfactant/polymer flood. The presence of polymer in the surfactant solution – again a method developed for enhanced oil recovery – acts to raise the viscosity of the injectate to improve mobilization of the NAPL, i.e., to prevent viscous fingering of a lower viscosity fluid through the coal tar.

Figure 5.6 shows the layout of the injection and extraction wells and the surfactant storage tanks, and the miscellaneous surface control equipment for application of a surfactant-enhance remediation of the TCE NAPL zone at Hill Air Force Base in Utah.

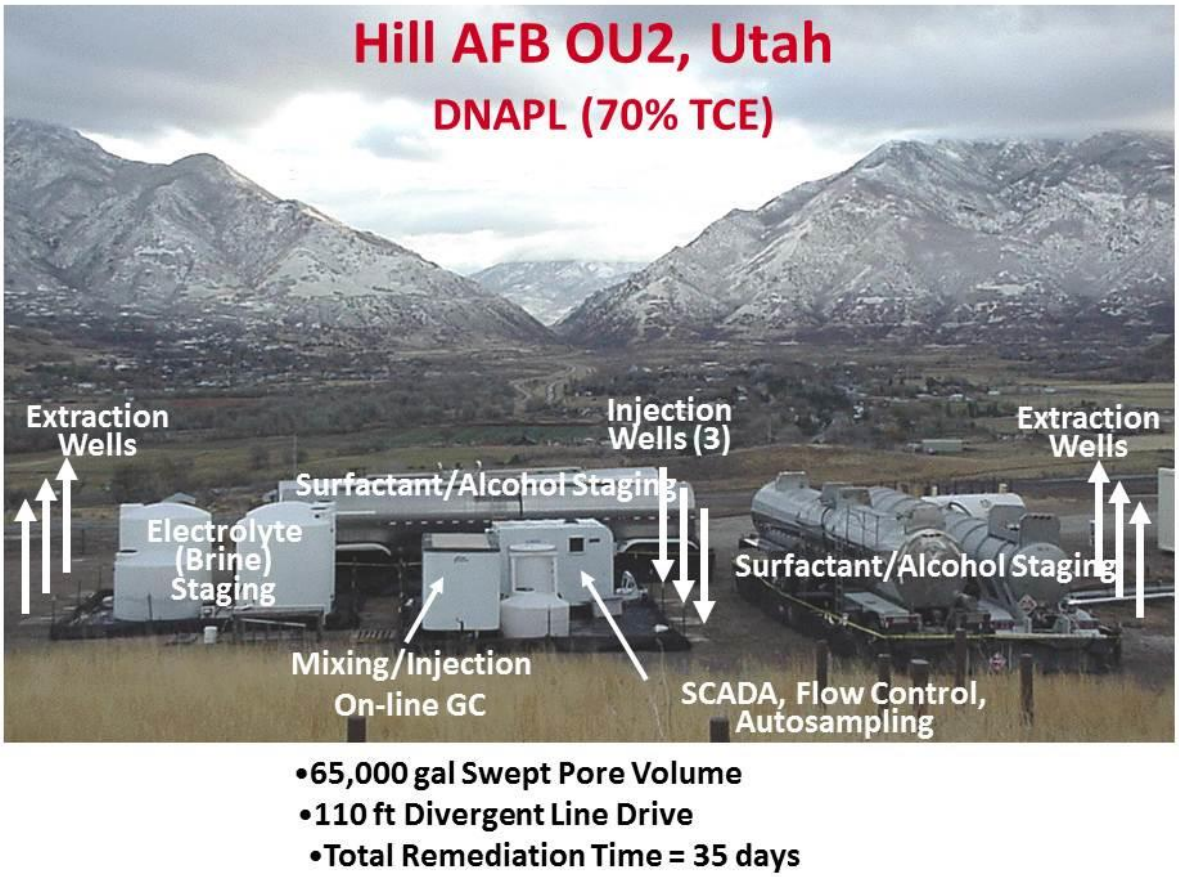

Figure 5.6 Layout of Equipment for Surfactant-Enhanced Remediation of NAPL (TCE) Contamination at Hill Air Force Base, Utah

Mobilization occurs due to the decrease in interfacial tension caused by the surfactant contacting the NAPL and releasing it from the soil, to which it is sorbed, and the polymer acting as a snow plough to drive the NAPL to a recovery well. More than 80% of the coal-tar NAPL in the treated zone was removed by the surfactant flood, of which most was recovered as mobilized NAPL in the extraction wells.

Benefits of surfactant-enhanced remediation include that the technology is proven in controlled settings to enhance DNAPL solubility and mobility. Constraints and concerns for surfactant-enhanced remediation technology application at the Lees Avenue site include the ability to direct and control the surfactant contact process in a heterogeneous subsurface environment, the fate and effect of fugitive surfactant and surfactant-coal tar mixture releases to the Transitway groundwater collection and treatment system, and uncontrolled downward coal tar NAPL migration and releases due to enhanced mobilization. Estimated costs associated with surfactant-enhanced remediation are $150 to $250 per cubic metre.

Surfactant-enhanced remediation is not further considered as a potentially applicable remediation technology for the Lees Avenue site due to its unproven success with the large volumes of expected coal tar DNAPL.

In-situ Chemical Oxidation (ISCO)

In-situ chemical oxidation remediation of coal tar NAPL involves the injection and contact of liquid oxidants to chemically destroy coal tar in the subsurface. At sites like Lees Avenue it would involve the injection of liquid oxidants to a coal tar contaminated zone via a network of injection wells and possibly use of extraction wells to control oxidant sweep.

The injection of permanganate, hydrogen peroxide (Fenton's solution), persulfate or other oxidant solutions into zones of coal-tar NAPL contamination has been attempted frequently with many claims of success by vendors. This typically involves the injection of oxidant solutions into the NAPL zone of a contaminated aquifer through injection wells with the reaction being allowed to proceed without extraction of treated groundwater. This implies that the NAPL zone is sufficiently well characterised so that the injected solution is brought into contact with the NAPL causing its dissolution and subsequent oxidation. It is attractive because it is inexpensive, rapid and relatively unaffected by the nature of the contaminant (Basel and Nelson, 2000).

Independent observers have identified a number of problems with ISCO projects, including the by-passing of the NAPL zone by the injectate because it has a lower hydraulic conductivity due to the occlusion of the NAPL-filled pores and, in the case of permanganate solutions, the precipitation of manganese oxides in the contaminated zones (Thomson et al., 2008). Furthermore, Thomson and colleagues (2008) at the University of Waterloo have undertaken a series of field tests of ISCO remediation of coal-tar creosote, a distilled form of coal tar, at Canadian Forces Base Borden. Post-treatment, they monitored the downgradient plume of polycyclic aromatic hydrocarbons (PAHs) that was generated by the coal-tar creosote NAPL zone over periods of 1, 2 and 4 years. While over 2 years there was a decreased in dissolved PAH discharge from the NAPL zone, by 4 years there was a rebound in PAH concentrations to "*pre-treatment levels or higher*." They concluded that "*there was no long-term (years) impact on the ability of this coal tar creosote source zone to generate a multi-component plume*", i.e., the ISCO treatment failed to remediate the NAPL zone.

Benefits of ISCO include that the technology is proven and is effective at destroying source material (DNAPL) and the general benefits associated with in-situ treatment (no excavation required). Limitations of ISCO include that it is not as effective with higher molecular weight PAHs, with NAPL phase, or in high organic content (i.e. peat). The common limitation with all in-situ technologies also remains - the potential inability to control the chemical oxidant contact process in a heterogeneous subsurface environment. Estimated costs for ISCO are between $150 and $250 per cubic metre.

Consequently, in-situ chemical oxidation is not further considered as a potentially applicable remediation technology for the Lees Avenue site due to its unproven success with the large volumes of expected coal tar DNAPL.

5.2.3 Engineered Containment

Engineered containment as a remedial alternative is applicable to soil, groundwater and NAPL source zones at the site. The goal with engineered containment does not include remediation of the site but rather prevention of contact with the contaminated soil and prevention of groundwater/NAPL mobilization off-site. Therefore, these technologies are included as options to maintain the sites current conditions and prevent further migration of contamination offsite in conjunction with other, more aggressive remedial options and not as stand-alone remedial options. For groundwater and NAPL, effective containment can be achieved by constructing and maintaining physical barriers or systems that prevent potential migration. Examples of these alternatives include caps/covers, sheet pile walls, soil-bentonite cut-off walls, and active hydraulic control including groundwater and DNAPL recovery wells. Each of these alternatives is discussed below.

5.2.3.1 Cap/Cover Site

Engineering controls at ground surface refer to a cap or cover of the site to provide an effective control of contaminant pathways to future workers and pedestrians. This alternative was included for completeness of this evaluation. This remedial option is considered to already be in place at the site since the majority of the site is covered in asphalt and used as a parking lot. The effectiveness of this cover for long term containment should be evaluated. This remedial option, which could be installed either at ground surface or at depth, is considered as a supporting remediation technology at the Lees Avenue site if it is used in conjunction with other more aggressive remediation strategies. Estimated costs for the Lees Avenue site is approximately $100K to $500K. This form of engineered containment is further considered as a potentially applicable option with other remedial technologies at the Lees Avenue site.

5.2.3.2 DNAPL Recovery

DNAPL recovery wells are simply large diameter wells constructed in known DNAPL source areas with the purpose of providing a reservoir for DNAPL to collect in and allowing removal of this DNAPL by active pumping. This remedial technology is intended to slowly achieve lower DNAPL volumes over a long-term schedule. Active pumping could change this option into a pump-and-treat system to collect DNAPL and treat contaminated groundwater. Long-term costs associated with this option are high with minimal success for site cleanup, therefore this remedial option is not considered as a potentially applicable remediation technology at the Lees Avenue site. Estimated costs for the Lees Avenue site is approximately $100K to $200K start-up costs with $500K to $2M ongoing operating costs. This form of engineered containment is not further considered as a potentially applicable option with other remedial technologies at the Lees Avenue site due to the large volume of coal tar NAPL.

5.2.3.3 Hydraulic Control

Hydraulic control measures are intended to establish capture zones strategically located and sufficiently large to prevent off-site migration of contaminants. The current groundwater collection and treatment system associated with the OC Transpo Transitway drain is effectively acting as a hydraulic control as evidenced by the local groundwater flow directions measured and presented in Figure 4.4. Any active remediation that may be implemented at the Lees Avenue site needs to consider the effect on the current treatment system and the potential that this system will require upgrades or a complete re-design. This remedial option is considered as a supporting remediation technology at the Lees

Avenue site if it is used in conjunction with other more aggressive remediation strategies. Estimated costs for the Lees Avenue site is assumed to be the same as operating costs of the current system, approximately $50K to $100K per year. This form of engineered containment is further considered as a potentially applicable option with other remedial technologies at the Lees Avenue site.

5.2.3.4 Containment Barriers

Containment barriers such as metal sheet pilling or Waterloo barrier are methods that are intended to isolate or prevent contaminated groundwater or NAPL from mobilizing past the barrier. The perimeter of the Lees Avenue parking lot is estimated to be approximately 500 metres and the depth required for containment barrier installation is approximately 10 to 11 metres, therefore requiring approximately 17,500 square metres of containment wall. These methods could be used to prevent contamination migration off of the subject property, or conversely to prevent contamination from migrating onto a neighbouring property. This type of remedial measure can effectively be used in conjunction with other, more aggressive remedial technologies to assist in controlling the movement of chemicals during in-situ treatment. Estimated costs for the Lees Avenue site are assumed to be approximately $50 to $80 per square metre of wall. This form of engineered containment is further considered as a potentially applicable option with other remedial technologies at the Lees Avenue site.

5.2.3.5 In-situ Solidification and Stabilization

The principal remedial goal of solidification/stabilization (S/S) methods is to reduce the dissolved flux of contaminants, typically PAHs and BTEX compounds, which are dissolving from the coal-tar NAPL zone within an aquifer, by encapsulating the contaminants within a solid matrix that minimises their mobility and leaching. Solidification involves the mechanical mixing of the contamination into a solid form such that the exposed surface area of the NAPL is much reduced and also its solubility. Thus solidification traps the contaminant in cementitious or other solid matrix. Stabilization is the process whereby chemical reactions occur to limit the release or leaching of compounds from the contaminant. Therefore, stabilization is meant to bind free-phase (mobile) and residual NAPL and immobilize it within the solid matrix.

At the Lees Avenue site in-situ S/S could involve deep cementitious soil mixing using augers to either encircle or to entomb the complete zone of coal tar NAPL contamination located below the Transitway Station parking lot. Such an application of in-situ S/S would have a long-term beneficial effect on the volumes of groundwater being pumped and treated in the Transitway groundwater collection and treatment system.

A relevant S/S project was that conducted in 2009 at Sag Harbor on Long Island, New York at a former MGP site in the downtown area (ENR New York, 2009). The project required excavation of 37,000 tons of surficial contaminated soil from the upper 15 cm of the site. In order to prevent excessive groundwater infiltration into the excavation area, a soil-mix wall was installed composed of Portland cement mixed with native soils; this wall stabilized 6,500 tons of saturated soils. Subsequently, the dewatering flow rates averaged ~240 m^3/day (60,000 gals/d), which was treated onsite and discharged to the harbor over a distance of one km. Furthermore, the wall also acted as a foundation, reduced vibration and noise to the community and generally helped expedite the work.

An attractive feature of cement-based S/S is that it can incorporate contaminant sorbents such as clays and activated carbon used either as a pre-treatment or as additives in the cement mix. Figure 5.7 shows a soil mix barrier wall (soil+cement+clay) being constructed at a Superfund site with a design criterion of 1x 10^{-8} m/s.

Figure 5.7 Outer Barrier Wall Construction using Cutter Soil Mixing at US EPA's Brunswick, Georgia Superfund Site

Paria and Yuet (2006) have discussed the application of cementitious S/S remediation in light of its use at the Sydney Tar Ponds, Cape Breton, Nova Scotia. They indicated the following beneficial aspects of cementitious S/S remediation:

1) Relatively low cost and ease of use and processing;
2) The composition of Portland cement is consistent, thus eliminating a variable in the design of S/S projects;
3) Good long-term physical and chemical stability;
4) Good impact and comprehensive strength;
5) Non-toxic reagents;
6) Resistant to biodegradation; and
7) Low hydraulic conductivity.

Benefits of S/S technology include the ability to immobilize contaminants without full remediation. Constraints and concerns for in-situ S/S remediation technology application at the Lees Avenue site include the adverse effects of up-gradient groundwater mounding, fugitive mobilization of dissolved coal tar contamination outside of the treatment area (e.g., on University of Ottawa property) and adverse effect on the current sand filtration and activated carbon treatment systems due to pH

increases associated with cement injection. Estimated costs associated with S/S technology are approximately $20 to $30 per cubic metre with approximately 80,000 m^3 onsite (8000 m^2 x 10m depth). This form of engineered containment is further considered as a potentially applicable option with other remedial technologies at the Lees Avenue site.

5.2.3.6 In-situ Geochemical Stabilization

In-situ geochemical stabilization (ISGS) using a permanganate solution is somewhat similar to S/S. This technology has been applied at creosote and MGP sites (Mueller et al., 2011), in particular by Beazer East of Pittsburgh PA, a major owner of creosote-contaminated sites. ISGS, according to Mueller et al. (2011) involves the injection of a catalyzed sodium permanganate solution in order to produce a crystalline, aluminum hydrosilicate crust around NAPL ganglia. The resulting compound is meant to immobilize the NAPL, plug pore throats, reduce hydraulic conductivity and contaminant solubility and reduce the contaminant mass.

At the Lees Avenue site, it would involve the injection of treatment solutions to a coal tar contaminated zone via a network of injection wells and possibly use of extraction wells to improve treatment solution contact with coal tar.

A pilot test of ISGS was conducted at a Superfund site in Gainesville, Florida and the results were reviewed by an independent panel including a Geofirma engineer. While Mueller et al. (2011) claim an average reduction of total PAHs of 50% and a reduction in hydraulic conductivity due to the plugging of 27-81% of pore space, the independent panel noted that the sweep of the injected solution was poor, i.e., much of the NAPL was not contacted by the injected solution.

Despite this negative conclusion, the US EPA has approved the large-scale application of ISGS at the Gainesville site. Previous application of ISGS at a site in Denver, Colorado also produced results that the vendor claimed to be evidence of success, but an independent observer was skeptical of this conclusion.

Benefits of ISGS include that the technology is proven and is effective at immobilizing NAPL, along with the general benefits associated with in-situ treatment (no excavation required). Limitations of ISGS include that it has not been proven as a full-scale field remediation technology, as well as the common in-situ treatment technology constraint of the potential inability to control the chemical oxidant contact process in a heterogeneous subsurface environment. Estimated costs for ISGS are between $100 and $200 per cubic metre.

Similar to in-situ chemical oxidation, in-situ geochemical stabilization is not further considered as a potentially applicable remediation technology for coal tar NAPL at the Lees Avenue site due to the large volume of coal tar DNAPL present.

5.2.4 Institutional Controls

Institutional controls include access control measures, deed restrictions, and established procedures for managing excavation below grade. The specific details of institutional controls would be established depending on the remedial action implemented and the intended future land use. Examples of access controls include fencing, security and general site monitoring are intended to prevent uninformed persons from creating a potential exposure pathway to contamination. Deed

restrictions, environmental easements and/or MOE Certificates of Property Use are legal documents that inform any potential future property owners of the environmental conditions and any restrictions in place. Procedures for managing excavation below grade include establishing plans for ensuring worker health and safety as well as managing any contaminated soil and groundwater encountered during excavation. Like engineering containment, institutional controls are not intended to be a remediation option but rather are useful tools to minimize exposure to contamination. Typically, institutional controls are implemented in conjunction with and to support other active remedial measures. Estimated costs for institutional controls are wide ranging depending on what is required and could range from $10K to $100K per year. Institutional controls are further considered as part of any remedial strategy.

5.3 Technical Issues

The implementability and effectiveness of any of the above-described remedial technologies for use at the Lees Avenue site is constrained by the following site conditions:

1) Significant groundwater inflows (~50 to 90 L/min) to the groundwater collection and treatment system underlying the Transitway;
2) Presence of buildings, highways and subsurface infrastructure that inhibit the implementation of all technologies; and
3) The irreducible uncertainties in the spatial distribution of the NAPL.

The proximity of the Rideau River, Highway 417 and much-drained surface surrounding the Lees Avenue site indicates that there will be problems in dewatering the site should this be required for remediation. Most of the technologies discussed above do not require dewatering, but some (e.g., smouldering and thermal) may function better in the absence of substantial groundwater flow through the treatment zone.

The presence of major infrastructure foundations has to be carefully considered in the application of thermal technologies. This necessitates the ability to quickly control the progress of remediation should damage occur or appear to be imminent if remediation were to continue. Some of the technologies discussed above may be difficult to control once they have been initiated, e.g., smouldering. This is perhaps the criterion of greatest importance in technology selection.

Finally, because there are always uncertainties in the volume and mobility of viscous NAPLs in the subsurface, the remedial technology chosen must be robust in the sense that it should be able to be employed satisfactorily where unexpectedly high NAPL volumes are encountered. In such conditions, thermal and smouldering technologies might be advantageous.

5.4 Proposed Remedial Strategies

Due to the fact that the majority of the coal tar DNAPL is interpreted to be under the parking lot at 191 Lees to the east of the Transitway, this remedial options assessment is focused solely on this parking lot area and does not attempt to address contamination outside of this area. Incorporating remedial options for contamination outside of this area should be considered once off-site contamination distribution is better understood and as remediation alternatives are finalized.

As discussed above, the best path forward for the Lees Avenue site will likely be a remedial strategy that incorporates multiple remedial technologies and activities. Considering this, various combinations of the retained remedial activities were considered together to provide the following seven remedial strategies for 191 Lees Avenue parking lot east of the Transitway:

Strategy 1: Excavation and Off-site Disposal. This strategy involves excavation to the bottom of coal tar which is theoretically coincident with the top of till (approximately 10 to 11 mBGS), off-site disposal of all contaminated material and underground infrastructure (gas holder and piping), engineered containment and dewatering/treatment of groundwater, treatment of air emissions, and ongoing institutional controls.

Strategy 2: Excavation and Ex-situ Combustion Treatment. This strategy involves excavation to bottom of coal tar which is theoretically coincident with the top of till (approximately 10 to 11 mBGS) and off-site combustion of excavated material, disposal of any remnant underground infrastructure (e.g., relief gas holder and piping) with engineered containment around site and ongoing institutional controls. Excavated material will be sorted and if more cost effective, non-hazardous material may be disposed of or treated using another ex-situ technology. For cost estimating purposes as part of this comparative assessment, all excavated material is assumed to be treated by ex-situ combustion.

Strategy 3: Excavation and Ex-situ Thermal Desorption Treatment. This strategy involves excavation to bottom of coal tar which is theoretically coincident with the top of till (approximately 10 to 11 mBGS) and off-site treatment using thermal desorption technology, disposal of any remnant underground infrastructure (e.g., relief gas holder and piping) with engineered containment around site and ongoing institutional controls.

Strategy 4: Partial Excavation and In-situ Combustion Treatment. This strategy involves partial excavation in vicinity of relief gas holder to remove and dispose of any contaminated soil and remnant underground infrastructure associated with historical coal tar operations followed by in-situ combustion treatment (STAR) with engineered containment around site and ongoing institutional controls.

Strategy 5: Partial Excavation and In-situ Thermal Treatment. This strategy involves partial excavation in vicinity of relief gas holder to remove and dispose of any contaminated soil and remnant underground infrastructure associated with historical coal tar operations followed by in-situ thermal treatment with engineered containment around site and ongoing institutional controls.

Strategy 6: Partial Excavation and In-situ Stabilization. This strategy involves excavation to top of coal tar (approximately 6 mBGS), removal and disposal of any contaminated soil and remnant underground infrastructure associated with historical coal tar operations followed by in-situ stabilization at depth of coal tar contaminated material with ongoing institutional controls.

Strategy 7: Risk Management and Risk Assessment. This strategy involves continue operating Transitway collection and treatment system with consideration for upgrades if necessary, with completion of an ecological and human health risk assessment in accordance with O.Reg. 153/04, and implementation of risk management measures to be defined by the risk assessment.

5.5 Comparative Assessment of Proposed Remedial Strategies

Table 5.2 presents a comparative matrix of the seven remedial strategies discussed above for the Lees Avenue site. Each remedial strategy is evaluated with respect to the following criteria:

1) Overall Protection of Human Health and Environment
2) Ability to meet MOE Standards
3) Long-Term Effectiveness and Permanence (allow development below grade)
4) Reduction of Toxicity, Mobility and Volume
5) Short-Term Impacts and Effectiveness
6) Minimize or Eliminate Need for and Costs Associated with Current Treatment System
7) Implementability
8) Cost

The estimated costs presented in this section for each remedial technology are based on limited data and are intended to provide a relative context for evaluation among various technologies. For the purpose of this assessment, these cost estimates were prepared with the focus solely on the volumes of estimated soil contamination below the parking lot area at 191 Lees Avenue because it could be more easily defined and contains the bulk of the contaminated area as defined in the Phase II ESA. These remedial strategies and this assessment are also applicable to areas with contamination outside of this parking lot and these additional volumes of contaminated soil and associated costs can be added at a later stage when there is more information to define the scope of work.

These cost estimates should be considered as Class 5 cost estimates as defined by the Association for the Advancement of Cost Engineering (AACE, 1997) with a margin of error of approximately -20% to +100%. By definition, Class 5 cost estimates are generally prepared based on very limited information, the end usage is strategic business planning purposes (screening or feasibility) and they are usually made using professional judgement.

The evaluation was completed qualitatively as having either a low, medium or high desirability with respect to each criterion. Upon review, it became apparent that each of the remedial technology options satisfies the remedial action objectives to some degree and each technology has challenges, therefore it is not surprising that most were rated with an overall moderate desirability for use at the Lees Avenue site. However, if combustion technology is feasible (in-situ or ex-situ) this would be a preferred technology since it not only removes but destroys coal tar NAPL phase as well as dissolved phase.

Based on this evaluation, the following four options are considered worthy of further investigation research for use at the Lees Avenue site:

- Strategy 2: Excavation and Ex-situ Combustion Treatment.
- Strategy 4: Partial Excavation and In-situ Combustion Treatment
- Strategy 6: Partial Excavation and In-situ Stabilization
- Strategy 7: Risk Management and Risk Assessment

Table 5.2 Comparative Assessment of Remedial Strategies for the Coal Tar Contamination at Lees Avenue Transitway Site

		Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5	Strategy 6	Strategy 7
Criteria	Sub-Criteria	Excavate above till (above ~ 10m) and offsite disposal	Excavation and Ex-Situ Combustion (Co-burning)	Excavation and Ex-situ Thermal Desorption	Partial Excvation In-situ Combustion (Smouldering)	Partial Excavation In-situ Thermal Treatment Methods	Partial Excavation and In-situ Solidification and Stabilization	Risk Management Risk Assessment
Overall Protection of Human Health and Environment	Human Health	H	H	H	M	M	H	H
	Environment	M	M-H	M-H	M	H	H	L
	Overall Rating	*High*	*High*	*High*	*Moderate*	*Moderate*	*High*	*Moderate*
MOE Standards	Soil	H	H	H	M	M	L	L
	Groundwater	H	H	H	M	M	L	L
	Overall Rating	*High*	*High*	*High*	*Moderate*	*Moderate*	*Low*	*Low*
Long-Term Effectiveness and Permanence (allow development below grade?)	Achieve Goals?	H	H	H	M	M	H	M
	Remaining Risk	H	H	H	M	M	H	L
	Reliability of Success	H	H	M	M	M	H	M
	Permanance	H	H	H	M	M	L	M
	Overall Rating	*High*	*High*	*High*	*Moderate*	*Moderate*	*High*	*Moderate*
Reduction of Toxicity, Mobility and Volume	Amount of Material Destroyed or treated	H	H	H	M	M	L	L
	Degree of Toxicity, Mobility, or Volume reduced	H	H	H	H	H	H	L
	Irreversibility	H	H	H	H	H	L	L
	Residuals Remaining	H	H	H	M	M	L	L
	Overall Rating	*High*	*High*	*High*	*Moderate-High*	*Moderate*	*Moderate*	*Low*
Short-Term Impacts and Effectiveness	Protection of Community during Remedial Action	L	L	L	H	H	H	H
	Environmental Impacts	L	L	M	M	M	H	H
	Time Required to Meet Remedial Objectives (develop below grade)	L	L	L	M	L	M	H
	Protection of Workers	L	L	L	M	M	M	H
	Overall Rating	*Low*	*Low*	*Low*	*Moderate*	*Moderate*	*Moderate*	*High*
Implementability	Technical Feasibility	H	H	M	M	M	M	H
	Administrative Feasibility	L	L	L	L	H	M	H
	Availability of Services	H	M	M	M	M	M	H
	Overall Rating	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate-High*	*Moderate*	*High*
Reduce Need for Current Collection/Treatment System	Reduce Need	M	M	M	M	M	H	L
	Lower Costs	H	H	H	M	M	H	L
	Overall Rating	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Low*
Cost*	Capital Costs	L ($10-21M)	M ($7-24M)	M ($7-16M)	M ($5-9M)	M ($4-12M)	L ($5-8M)	H ($1-3M)
	O&M Costs	H	H	H	M	M	H	H
	Contingency	L (50%)	L (50%)	L (50%)	L (50%)	L (50%)	L (50%)	H
	Overall Rating	*Low*	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*High*
Overall Rating		**Moderate**	**Moderate-High**	**Moderate**	**Moderate-High**	**Moderate**	**Moderate-High**	**Moderate-High**

Legend:
Low = not desireable; Moderate = Possibly Desireable; High = Desireable

* = Cost estimates provided are considered to be Class 5 cost estimates, as defined by the Association for the Advancement of Cost Engineering (1997) and for the purpopse of this compartive assessment of strategies, focus only on the parking lot area at 191 Lees Avenue because this was a well defined area that incorporates most of the identified contamination as coal tar DNAPL. Areas on 191 and 193 Lees Avenue that are impacted by coal tar contamination can also be included in later stages of feasibility studies as more information is known and the scope of work is better defined.

Strategy 1 is not recommended for further consideration as a stand-alone strategy due to the high costs associated with disposal of hazardous material and the fact that excavation and off-site disposal are incorporated as an optional component to all other active remedial strategies where cost effective.

Strategy 2 is recommended for further consideration due to the fact that it is intended to remove all contamination from the site and destroy this contamination, therefore not requiring disposal, which is considered to be cheaper compared to excavation and off-site disposal of hazardous material. Excavation is the most certain of all remedial options to remove contamination and this strategy meets all five of the remedial action objectives. Fully removing all contamination will provide the best development opportunities, remove any future concerns of mobilization or exposure to contamination, and reduce the reliance on the existing Transitway collection and treatment system. As discussed above, excavated material will be sorted and if more cost effective, non-hazardous material may be disposed of or treated using another ex-situ technology.

Strategy 3 is not recommended for further consideration due to the fact that thermal desorption is most effective if low temperatures can be used to remove all contaminants from the soil and the fact that after the desorption process is complete, the by-product still requires disposal. For coal tar contaminated soils, thermal desorption requires heating of excavated material to very high temperatures in order to remove the higher molecular weight PAH compounds from the soil. If such high temperatures are required, this strategy was dropped in favour of ex-situ combustion which also used high temperatures but does not have the added costs to dispose of the desorbed chemical by-product.

Strategy 4 is recommended for further consideration due to its ability to fully destroy all of the coal tar contamination with minimal disturbance to surface operations and neighbouring community at the site, and its low cost compared to excavation and ex-situ combustion. This strategy is being retained for consideration based on the assumption that the major concerns with containing and controlling the combustion reaction in the ground in such proximity to an active public transit station, underground infrastructure, and provincial highway can be overcome. Assuming this strategy is effective at the Lees Avenue site, it meets all five of the remedial action objectives. It will provide full development opportunities, remove any future concerns of mobilization or exposure to contamination, and reduce the reliance on the existing Transitway collection and treatment system. Lab bench-scale tests and a pilot test would be necessary before this treatment strategy was recommended, therefore acquiring some of this information is the logical next step.

Strategy 5, similar to strategy 3, is not recommended for further consideration due to the fact that thermal desorption is most effective if low temperatures can be used to remove all contaminants from the soil and the fact that after the desorption process is complete, the by-product still requires removal from the subsurface and ultimate disposal. Also, like strategy 3, this strategy was dropped in favour of in-situ combustion which does not require the removal and ultimate disposal of desorbed chemical by-products from the subsurface.

Strategy 6 is recommended for further consideration due to its balanced approach of minimal disturbance to subsurface contamination, removal of contaminated infrastructure and soil down the interpreted top of grossly contaminated coal tar soil with DNAPL, locking the contamination in place to prevent mobility of contaminants, and its lower cost compared to other remedial strategies. Strategy 6 meets most of the five remedial action objectives. It will provide reasonable development

opportunities, reduce any future concerns of mobilization or exposure to contamination, and reduce the reliance on the existing Transitway collection and treatment system.

Strategy 7 is recommended for further consideration due to its low cost and minimal disruption to the site and surrounding neighbourhoods. The limitations associated with Strategy 7 are more certain than the other strategies and include not meeting three of the identified remedial objectives outlined in Section 5.1 (not removing any contamination, restrictions on subsurface development, and long-term reliance on the existing Transitway groundwater collection and treatment system in its current capacity) as well uncertainty of MOE approval of risk assessment and scope of resultant risk management measures. However, due to the benefits associated with this strategy (low cost and minimal disruption, i.e., status quo) at this time, it has been retained for further consideration as a comparison strategy.

6 CONCLUSIONS AND RECOMMENDATIONS

The results of the Supplementary Phase 2 ESA and Remedial Options Assessment described in this report support the following conclusions.

1. The site stratigraphy, hydrostratigraphic units and groundwater flow system determined from the initial and supplementary 2012 investigations are entirely consistent with the Conceptual Site Model defined based on 1986 and 1987 data. The thickness and elevation of the fill, alluvium and basal glacial till units evident from the 2012 drilling and soil sampling are very similar to expectations based on the CSM developed from earlier investigations. The 2012 groundwater flow system defined in March/April and September/October is largely unchanged from that evident in 1986. Groundwater at the 191 and 193 Lees Avenue site is captured by the Lees Avenue Transitway Station pumping system.

2. The distribution of coal tar contamination from both visual/olfactory observation and laboratory chemical testing is consistent with the distribution described on 1986 and 1987. Coal tar is present within the deep alluvium and to a lesser extent the shallow alluvium and fill units primarily on the east side of the Transitway below the parking lot. The highest concentrations of coal tar chemicals (i.e., PAH) were found in the fill and deep alluvium to the top of the low permeability basal till unit over the eastern half of the parking lot. Typically, coal tar is found in this part of the site at elevations of 53 to 50 mASL at depths of 7 to 10 mBGS. This coal tar appears to be pooled on top of the basal till unit. The occurrence of coal tar at BH12-11 (and historically at OW120B) is consistent with historical movement of coal tar down the sloping till surface to the southeast of the parking lot. Coal tar was also observed within the shallow fill of BH/MW12-13, which was drilled into the former relief gas holding tank, and in the shallow fill and deep alluvium at BH/MW12-15, near the former boiler house tar storage area. The former relief gas holder appears to have an intact base.

3. Laboratory chemical testing for typical coal gasification plant waste chemicals shows that PAH and PHC-F1/BTEX remain the chemicals of concerns at the site. Metals and cyanide in soil and groundwater were either not detected (cyanide in soil and groundwater) or were found only sporadically in site soil and groundwater at moderately elevated concentrations.

4. There are limited exceedences of MOE standards for soil for PAH, PHC-F1/BTEX and metals at five locations on the west side of the Transitway. Groundwater west of the Transitway does not show exceedences of MOE standards for metals, PAH, free cyanide and PHC-F1/BTEX at the 15 locations sampled in 2012. These are quite limited exceedences given the historical land use and results of earlier investigations, and these results suggest some redevelopment potential may exist for land located west of the Transitway Station.

5. PAH and PHC-F1/BTEX exceedences of MOE standards are more frequent and widespread on the east side of the Transitway below the existing parking lot, consistent with visual and olfactory observations of coal tar occurrence in this area. This identified contamination in the shallow fill and the deep alluvium poses a significant impediment to redevelopment of parking lot area.

6. Soil metals, PAH and BTEX exceedences and groundwater PAH and PHC-F1 exceedences of MOE standards were found at BH/MW12-11 on 193 Lees Avenue in proximity to adjacent

University of Ottawa land. Soil PAH and BTEX exceedences of MOE standards were also found east of the Lees Avenue overpass at BH12-12 and BH12-16 on 193 Lees Avenue.

7. Screening of potentially applicable remedial technologies for coal tar contamination identified the following treatment technologies that warrant further consideration to remediate the 191 Lees Avenue site to a level such that subsurface development may occur: combustion treatment (ex-situ co-burning and in-situ smouldering (STAR)), and thermal treatment .technologies (ex-situ and in-situ). In addition, excavation, off-site disposal, engineering barriers to reduce mobility of contaminants and institutional controls are all worthy of consideration to augment the treatment technologies identified above.

8. Comparative assessment of potentially applicable remedial strategies for coal tar contamination at the 191 Lees Avenue site identified four strategies combining multiple remediation activities as warranting further consideration. These four strategies can be broadly described as [1] excavation and offsite combustion, [2] partial excavation and in-situ combustion, [3] partial excavation and in-situ stabilization, and [4] risk management and risk assessment. Each of these remedial strategies have different benefits and limitations and even if successful may allow varying degrees of development (i.e. do nothing and risk assessment strategy may not allow subsurface development). These strategies also incorporate other aspects such as engineered barriers and institutional controls.

Based on these conclusions, the following recommendations are offered:

1. Complete a feasibility study that further investigates the potential effectiveness and develop a Class 4 cost estimate, in accordance with AACE (1997) cost estimate classification, for the four recommended remedial strategies such that one remedial strategy will be recommended, and a second retained as a backup strategy, based on a similar comparative assessment as shown above. A Class 4 cost estimate, by definition, has a margin of error of approximately -15% to +50%, generally prepared based on limited information where the level of project definition is typically 1 to 15%, and the end usage is concept or feasibility study.

2. Complete any necessary preliminary tests required to prepare for a pilot study such as a lab-bench scale test for in-situ combustion/smouldering using STAR technology and any similar tests required to confirm the effectiveness of thermal treatment technologies.

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8 CLOSURE

This report has been prepared for the exclusive use of the City of Ottawa, Realty Services Branch using methodologies for conducting a Phase 2 Environmental Site Assessment and Remedial Options Assessment that is acceptable within the profession. Historical and current data obtained from subsurface investigations represent the conditions about a limited area surrounding the sampling location at the time of the sampling and as such can be expected to be variable with respect to location and time. Geofirma Engineering Ltd. has exercised professional judgment in collecting and analysing the information and in formulating recommendations based on the results of the study. The evaluation and assessment contained in the report have been prepared based on conditions in evidence at the time of the site investigations and on the basis of information provided to Geofirma. Accordingly, Geofirma cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of persons providing information.

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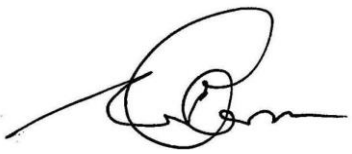
Respectfully Submitted,

Geofirma Engineering Ltd.



Kenneth Raven, P.Eng., P.Geo.
Principal and Senior Hydrogeologist

Sean Sterling, P.Eng., P.Geo.
Senior Hydrogeologist

APPENDIX A

Borehole Stratigraphic and Instrumentation Logs

BH/MW12-01 to BH/MW12-19

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-01

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 22-Feb-12

Client: City of Ottawa

Supervisor: SNS

Site Location: 191 Lees Ave

Ground Surface Elevation: 59.19 mASL

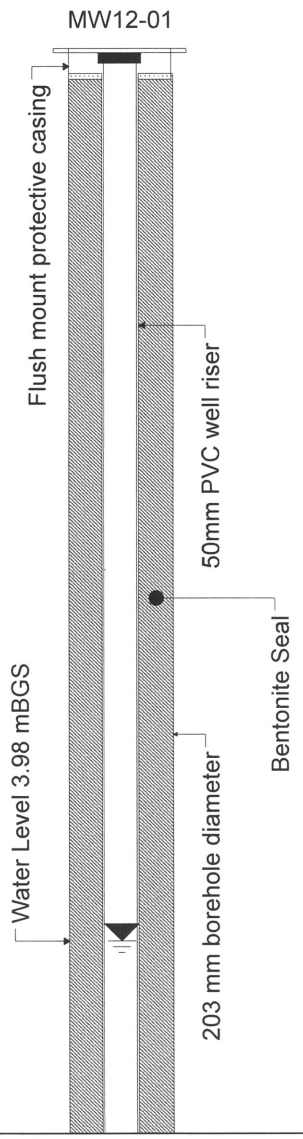
Coordinates: 447453E, 5029445N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
-1 / 0							GROUND SURFACE
0 / 1							CONCRETE
1 / 2				0	--		FILL Coarse-grained sand, brown, gravely, dry. - Trace brick in upper 0.3 - 0.61 mBGS - Boulder at 0.91mBGS
3 / 1							
4				25	--		
5							- Iron-stained sand from 1.5 - 1.8 mBGS
6 / 2		X		0	0.3		- Silty with organic matter from 1.8 - 2.4m
7							
8				40	0		
9							
10 / 3		X		25	0		SAND and clay interbedded. Medium to fine-grained sand with some gravel, grey to greyish brown. Clay with trace gravel, grey. Moist to wet.
11							
12				15	320		
13 / 4							
14		X		25	130		
15							

INSTALLATION



Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-01

Template: 2011 Geofirma Template

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BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-01

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 22-Feb-12

Client: City of Ottawa

Supervisor: SNS

Site Location: 191 Lees Ave

Ground Surface Elevation: 59.19 mASL

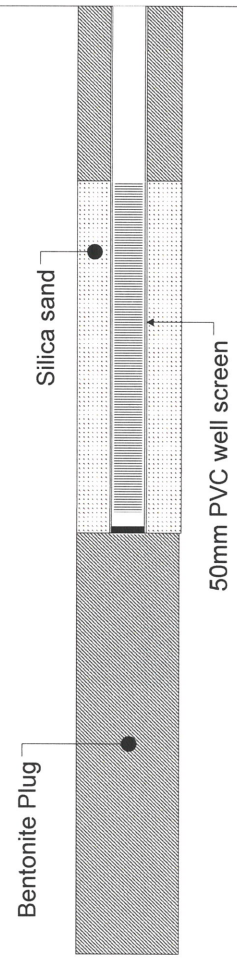
Coordinates: 447453E, 5029445N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
16	5			5	2.2		
17							
18		X		25	--		
19							
20	6			0	0		
21							
22				0	0		
23	7						TILL Clay with some pebbles and gravel, dark grey, wet.
24				0	0		
25							
26	8	X		0	--		
27							CLAY Grey, wet
28				0	0.3		
29							BOREHOLE TERMINATED Total Depth of BH12-01 8.53 mBGS
30	9						
31							
32							

INSTALLATION



Total Depth of MW12-01
6.71 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-02

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 17-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 53.98 mASL

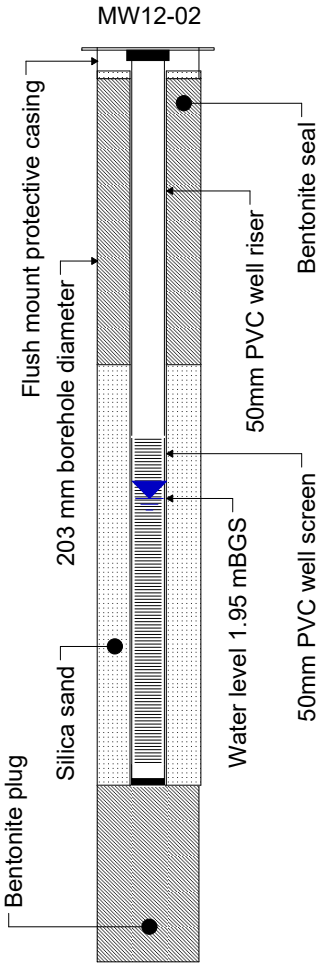
Coordinates: 447453E, 5029442N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
							GROUND SURFACE
0 – 4 ft (0 – 1.2 m)				0	0.5		FILL Coarse sand, brown, moist. - gravely for upper 1.8 mBGS - Ash and fibrous membrane in 0.6 to 1.4 mBGS section
4 – 5 ft (1.2 – 1.5 m)		X		0	0.9		
5 – 6 ft (1.5 – 1.8 m)		X		15	0.35		
6 – 7 ft (1.8 – 2.1 m)							SAND Fine to medium-grained, grey, wet.
7 – 8 ft (2.1 – 2.4 m)		X		50	0.15		CLAY Dark grey, wet.
8 – 9 ft (2.4 – 2.7 m)							SAND Brown to grayish brown, wet. - Normal grading from fine-grained to medium-grained from 2.3 to 3.0 mBGS
9 – 10 ft (2.7 – 3.0 m)		X		25	0.1		
10 – 11 ft (3.0 – 3.4 m)							- Reverse grading from medium to fine-grained from 3.0 to 3.7 mBGS
11 – 12 ft (3.4 – 3.7 m)		X		25	0.15		
12 – 13 ft (3.7 – 4.0 m)				0	0.1		TILL Dark brown clay with some gravel and pebbles, wet.
							BOREHOLE TERMINATED Total depth of BH12-02 4.0 mBGS

INSTALLATION



Total depth of MW12-02
3.23 mBGS

Prepared by: VMS
Reviewed by: JFD/MEB/KGR
Doc: 11-200-7_Well Installation_MW12-02
Template: 2011 Geofirma Template

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-03

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 16-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.55 mASL

Coordinates: 447493E, 5029425N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	MW12-03
1				0	11		FILL Sand with trace gravel, Brown to dark brown, dry to moist.	Flush mount protective casing
3 / 1				0	13			Bentonite seal
5		X		0	26			
7 / 2		X		0	0.70		- Ash at 1.8-2.4 and 4.3-5.5 mBGS	50mm PVC well riser
9				0	0.39			
10 / 3								203 mm borehole diameter
11		X		23	0.35			
13 / 4				0	0.20			
15		X		0	2.3		- Odour in the following intervals: 4.9-5.5 and 6.1-7.3 mBGS	

Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-03

Template: 2011 Geofirma Template

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-03

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 16-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.55 mASL

Coordinates: 447493E, 5029425N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
17		X		20	0.40			
18							SAND Grey and dark brown, moist to wet. - Gravely from from 5.6 to 7.0 mBGS - medium to coarse-grained from 5.5 to 6.7 mBGS - Silty from 5.5 to 5.6 and 7.0 to 7.9 mBGS - Fine to medium-grained from 6.7 to 7.9 mBGS	
19				3	0.45			
20								
21		X		0	0.85			
22								
23				0	0.35			
24								
25				0	1.1			
26							TILL Clay with some gravel and pebbles, grey.	
27				0	0.20			
28							BOREHOLE TERMINATED Total depth of BH12-03 8.5 mBGS	water level 7.87 mBGS Silica sand 50mm PVC well screen Total depth of MW12-03 8.5 mBGS
29								
30								
31								
32								
33								
34								
35								
36								

5 6 7 8 9 10

Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-03

Template: 2011 Geofirma Template

Geofirma Engineering Ltd

H12-03

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-04

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 16-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

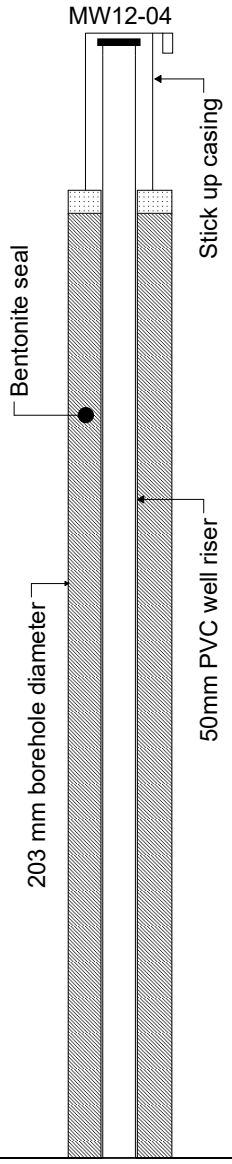
Ground Surface Elevation: 59.69 mASL

Coordinates: 447506E, 5029403N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	
0				0	0.1		FILL Medium to coarse-grained sand with trace gravel and silty sections, brown to dark brown, dry to moist	
3 / 1		X		0	0.05			
5		X		35	0		- Boulder around 1.2 to 1.8 mBGS (almost 0% recovery)	
7 / 2		X		0	10		- Silty sections from 0.61 to 1.2 and 1.8 to 4.1	
9		X		0	380			
10 / 3								
11		X		0	0.15			
13 / 4		X		50	0.25			
15				60	0.40			
16 / 5								
17				50	0.65			



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-04

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 16-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

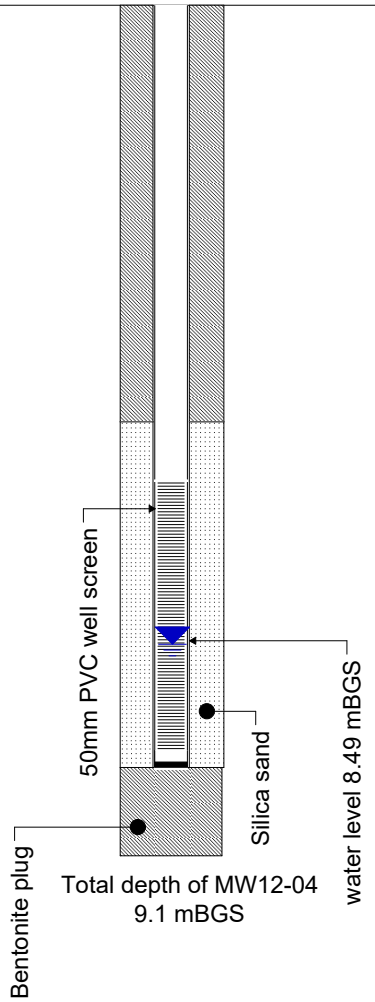
Ground Surface Elevation: 59.69 mASL

Coordinates: 447506E, 5029403N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
18							
19				25	0.30		SAND Medium to coarse-grained with traces of gravel, tan to grey, moist to wet
20 6							
21		X		70	1.8		
22							
23 7		X		100	1.3		- Fine-grained from 7.0 to 8.5 mBGS
24							
25				65	0.65		
26 8							
27				100	0.55		- Cobble at 8.4 mBGS
28							- Silty from 8.5 to 9.1 mBGS
29				26	0.15		
30 9							
31		X		120	0.35		TILL Clay with some gravel and pebbles, grey, wet
32							BOREHOLE TERMINATED Total depth of BH12-04 9.6 mBGS
33 10							
34							
35							
36 11							
37							



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-05

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 21-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 58.37 mASL

Coordinates: 447473E, 5029361N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	MW12-05
0				0	1.0		FILL Medium to coarse-grained sand with gravelly and silty section, brown and grey. One bed of grey clay, dry.	Flush mount protective casing
3 / 1		X		0	0.40		- Gravelly from 0.61 to 1.2 mBGS	Bentonite seal
5				0	0			
6							- Silty from 1.7 to 1.8 and 3.0 to 3.7 mBGS	
7 / 2				0	0		- Clay section from 2.0 to 3.0 mBGS	50mm PVC well riser
9				0	0			
10 / 3								203 mm borehole diameter
11		X		0	0		- Brown fibrous membrane at 3.2 mBGS	
12								
13 / 4				0	0			
14								
15				0	0			

Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-05

Template: 2011 Geofirma Template

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-05

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 21-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 58.37 mASL

Coordinates: 447473E, 5029361N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
16							SAND Fine to medium-grained, silty, grey to brownish grey, moist to wet.	
17	5	X		0	0		- Trace gravel 3.7 to 5.5 mBGS	
18							- Black cobble at 5.5 mBGS	
19		X		0	0			
20	6							
21				0	0			
22								
23	7	X		0	0			
24							TILL Clay with some gravel and pebbles with trace sand streaks, grey, wet.	
25				0	0			
26	8						BOREHOLE TERMINATED Total depth of BH12-05 7.92 mBGS	Water level 5.18 mBGS 50mm PVC well screen Silica sand Total depth of MW12-05 7.92 mBGS
27								
28								
29	9							
30								
31								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-06

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 21-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.54 mASL

Coordinates: 447499E, 5029384N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 ft / 0 m							GROUND SURFACE	MW12-06
0 – 1 ft / 0 – 0.3 m				20	0.30		FILL Silty, trace gravel, brown and grey, dry. - Ash beds at 1.07 to 1.22 and 1.8 to 1.9 mBGS	Stick up casing
1 ft / 0.3 m		X		5	0.10			Bentonite seal
1 – 2 ft / 0.3 – 0.6 m				0	0.05			
2 ft / 0.6 m							- Very soft from 1.8 to 4.3 mBGS	
2 ft / 0.6 m		X		0	0.15			50mm PVC well riser
2 – 3 ft / 0.6 – 0.9 m				0	0.05			
3 ft / 0.9 m		X		25	0.05			203 mm borehole diameter
3 – 4 ft / 0.9 – 1.2 m				0	26			

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-06

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 21-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

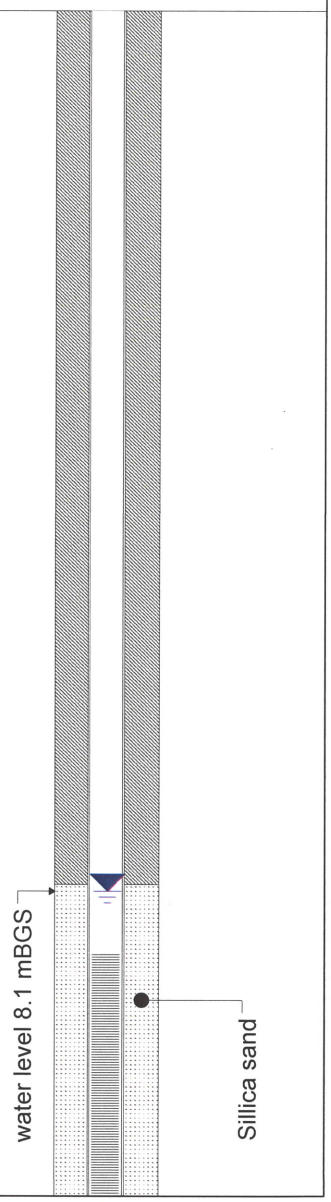
Ground Surface Elevation: 59.54 mASL

Coordinates: 447499E, 5029384N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
14							SAND Medium to coarse-grained with fine-grained silty bed and gravelly sections, grey, moist to wet.	
15		X		10	360			
16							- Silty fine-grained bed from 4.3 to 4.8 mBGS	
17		X		25	--		- Gravelly from 4.3 to 5.5 and 6.7 to 8.5 mBGS	
18								
19				5	--			
20								
21				30	--			
22								
23		X		50	--			
24								
25				25	--			
26							- Mild odour in 7.9 to 8.5 mBGS interval	
27				25	--			
28								
29				15	0.20		- Boulder at 9.2 mBGS	
30								



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-06

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 21-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.54 mASL

Coordinates: 447499E, 5029384N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
31		X		55	1.3			
32				45	0		TILL Clay with some gravel and pebbles, grey. - Small bed of wet brown fine-grained sand at bottom of spoon	
33 10							BOREHOLE TERMINATED Total depth of BH12-06 10.0 mBGS	Total depth of MW12-06 10.0 mBGS 50mm PVC well screen
34								
35								
36 11								
37								
38								
39								
40 12								
41								
42								
43 13								
44								
45								
46 14								
47								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-07

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 15-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

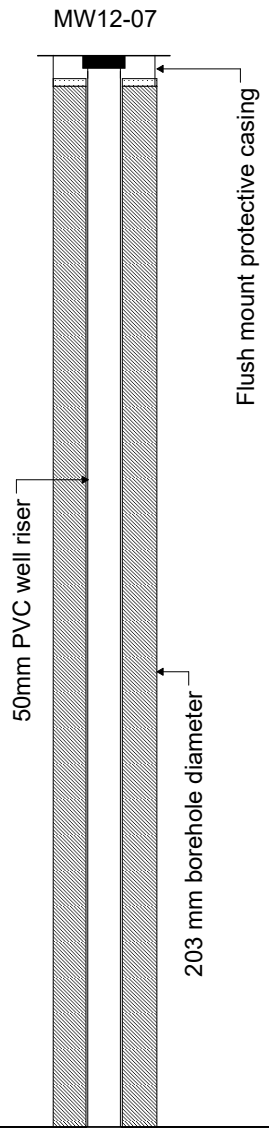
Ground Surface Elevation: 59.41 mASL

Coordinates: 447495E, 5029473N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-1 / 0							GROUND SURFACE	MW12-07
0 / 0							FILL Sand, silty, trace gravel, brown and grey, dry. - Ash beds at 1.07 to 1.22 and 1.8 to 1.9 mBGS	Flush mount protective casing
1 / 1				0	14			
2 / 1		X		5	35			
3 / 1								
4 / 1				0	34			
5 / 2								
6 / 2				0	200		- Very soft from 1.8 to 4.3 mBGS	50mm PVC well riser
7 / 2								
8 / 2		X		25	320			
9 / 3								
10 / 3				25	140			203 mm borehole diameter
11 / 3								
12 / 4		X		0	0			
13 / 4								



Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-07

Template: 2011 Geofirma Template

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-07

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 15-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

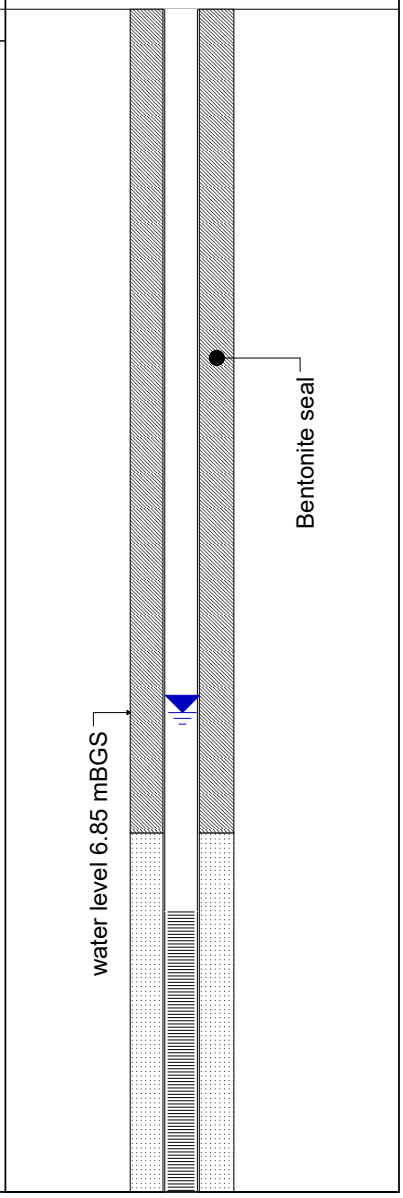
Ground Surface Elevation: 59.41 mASL

Coordinates: 447495E, 5029473N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
14								
15		X		0	29		SAND Medium to coarse-grained with fine-grained silty bed and gravelly sections, grey, moist to wet.	
16	5						- Silty fine-grained bed from 4.3 to 4.8 mBGS	
17				0	20		- Gravelly from 4.3 to 5.5 and 6.7 to 8.5 mBGS	
18								
19		X		0	67			
20	6							
21				0	65			
22								
23	7			0	0			
24								
25		X		0	8.0		- Mild odour in 7.9 to 8.5 mBGS interval	
26	8							
27				0	1.4		- Boulder at 9.2 mBGS	
28								



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-07

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 15-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.41 mASL

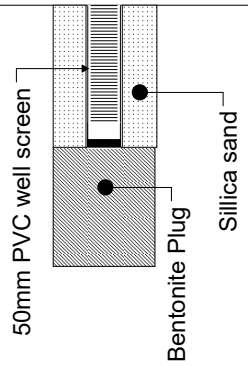
Coordinates: 447495E, 5029473N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
29		X		55	--			
30							TILL Clay with some gravel and pebbles, grey, wet.	
31				--	--			
32							BOREHOLE TERMINATED Total depth of BH12-07 9.6 mBGS	
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								

9 10 11 12 13



Total depth of MW12-07
9.1 mBGS

Prepared by: VMS
Reviewed by: JFD/MEB/KGR
Doc: 11-200-7_Well Installation_MW12-07
Template: 2011 Geofirma Template

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-08

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 14-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

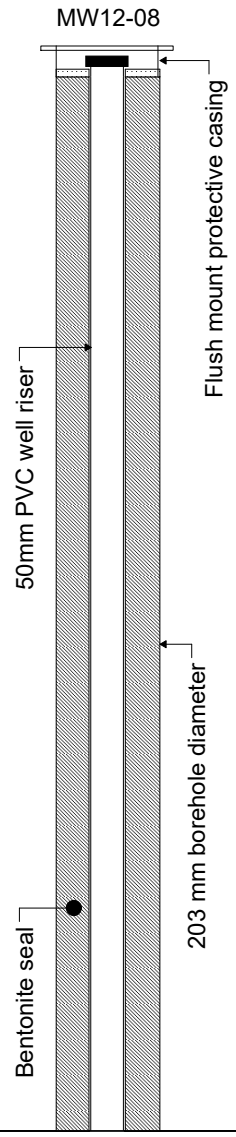
Ground Surface Elevation: 59.69 mASL

Coordinates: 447565E, 5029487N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-1 /							GROUND SURFACE	MW12-08
0 /							FILL Coarse-grained sand with some gravel, grey and brown, dry to moist.	
1 /		X		50	480			
2 /							- Gravelly clay with trace ash from 0.6 to 0.9 mBGS	
3 / 1		X		0	6.3		- Black stain from 0.9 to 1.2 mBGS	
4 /							- Ash from 1.2 to 1.8 mBGS	
5 /				0	7.7			
6 /								
7 / 2				0	730			
8 /							- Strong odour from 2.1 to 3.7 mBGS	
9 /				0	7000			
10 / 3								
11 /		X		25	--			
12 /								
13 / 4				50	80			
14 /								
15 /				40	--			
16 /								



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-08

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 14-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

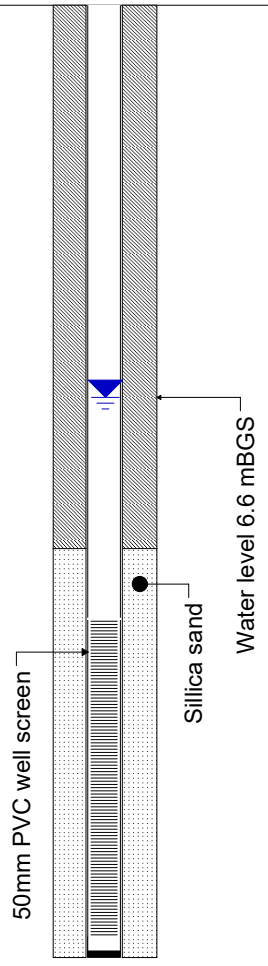
Ground Surface Elevation: 59.69 mASL

Coordinates: 447565E, 5029487N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
5 / 17		X		150	55		SAND Fine to medium-grained with one clayey sand section with some gravel, grey, moist to wet.
18							- Black stain and odour from 4.3 to 5.5 mBGS
19				0	970		- Strong odour and sheen from 4.9 to 5.5 and 6.1 to 7.3 mBGS
6 / 20							- Grey clayey sand section with some gravel from 5.2 to 6.1 mBGS
21				70	--		
22							
23 / 7				0	280		
24							- Mild odour from 7.3 to 7.9 mBGS
25		X		0	--		
26 / 8							
27				0	7.7		
28							
29				0	0.85		TILL Clay and sand with some gravel and pebbles, grey, wet.
9 / 30							BOREHOLE TERMINATED Total depth of BH12-08 9.1 mBGS
31							
32							
33 / 10							



Total depth of MW12-08
9.1 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-09

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 13-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

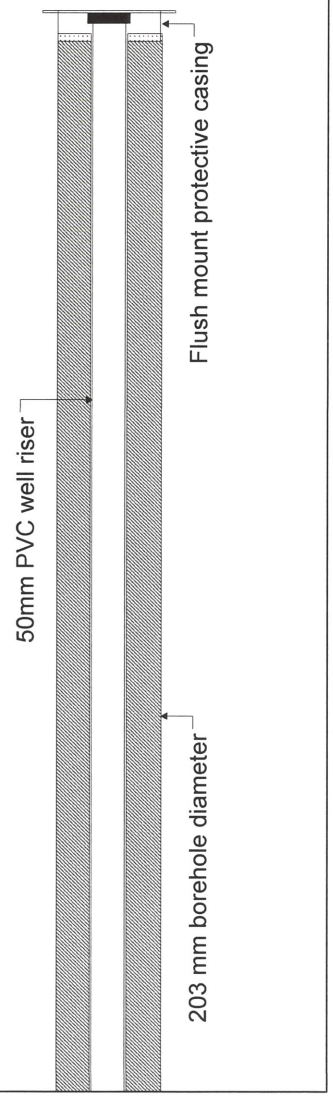
Ground Surface Elevation: 59.99 mASL

Coordinates: 447596E, 5029472N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-1								MW12-09
0							GROUND SURFACE	
1		X		0	38		FILL Sand with grey clay bed, brown	
2							- Trace black staining from 0.61 to 1.3 mBGS	
3 (1 m)		X		0	11			
4								
5				0	3.4			
6								
7 (2 m)				0	3.7			
8							- Clay bed from 2.4 to 2.6 mBGS	
9				0	360		- Black staining from 2.6 to 4.9 mBGS	
10 (3 m)								
11		X		0	820			
12							- Odour from 3.7 to 4.9 mBGS	
13 (4 m)				100	570			
14								
15		X		275	440			



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-09

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 13-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

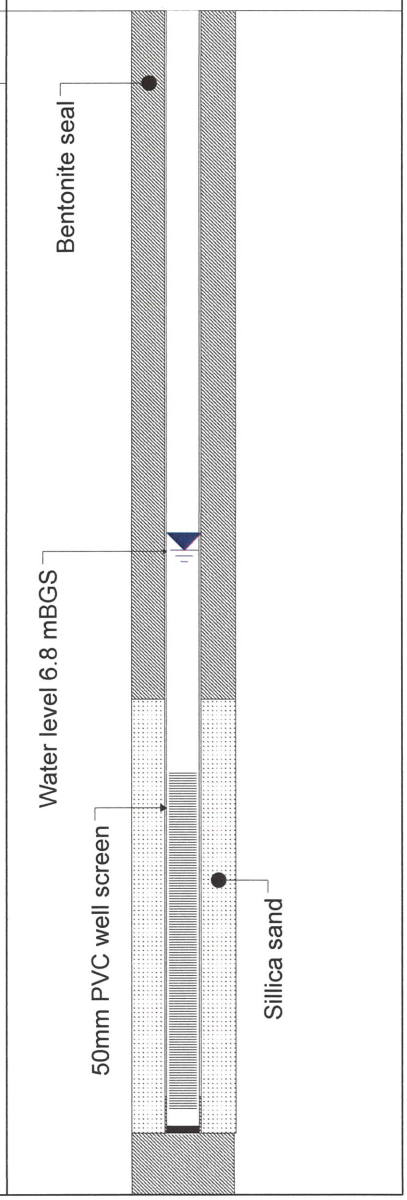
Ground Surface Elevation: 59.99 mASL

Coordinates: 447596E, 5029472N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
16	5						SAND Fine-grained silty, some gravel, grey, moist to wet
17				110	250		- Strong odour from 4.9 to 6.1 mBGS
18							
19				75	54		
20	6						
21		X		50	98		- Coal tar on soil from 6.1 to 9.1 mBGS
22							
23	7			50	49		
24							
25		X		10	45		
26	8						
27				12.5	95		
28							- Pure coal tar present from 8.8 to 9.9 mBGS
29				48	720		
30	9						
31				15	4100		



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-09

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 13-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 59.99 mASL

Coordinates: 447596E, 5029472N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
32								
33	10	X		75	10K		TILL Clay with some gravel and pebbles, grey	
34							BOREHOLE TERMINATED Total depth of BH12-09 10.2 mBGS	Total depth of MW12-09 9.3 mBGS Bentonite Plug
35								
36	11							
37								
38								
39	12							
40								
41								
42								
43	13							
44								
45								
46	14							
47								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-10

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 15-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

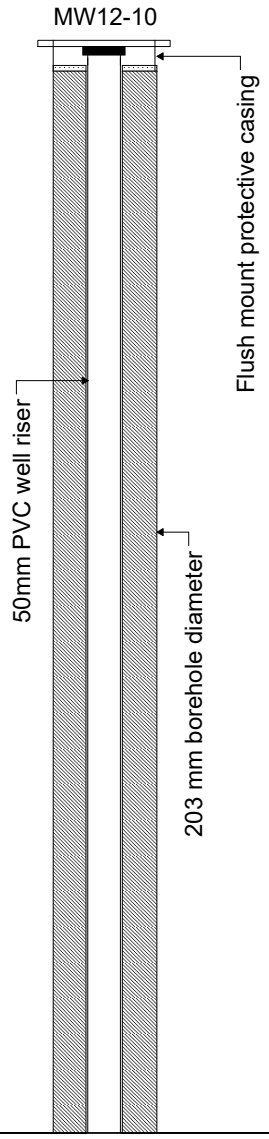
Ground Surface Elevation: 60.22 mASL

Coordinates: 447574E, 5029449N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-1 / 0							GROUND SURFACE	MW12-10
0 / 0							FILL Medium to fine-grained sand with some gravel and silty sections, tan to brown, dry to moist.	
1 / 0		X		50	--			
2 / 0							- Some gravel from 0 to 1.2 mBGS	
3 / 1		X		0	98			
4 / 1							- Ash bed from 1.15 to 1.2 mBGS	
5 / 1		X		0	--		- Silty from 1.2 to 3.7 mBGS	
6 / 2								
7 / 2				0	--			
8 / 2								
9 / 2		X		75	--			
10 / 3								
11 / 3				60	--			
12 / 3								
13 / 4		X		40	81			
14 / 4								
15 / 4				25	--			
16 / 5								
17 / 5				0	68			



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-10

MOE Well ID: A122889

Project Number: 11-200-7

Date Completed: 15-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 191 Lees Avenue

Ground Surface Elevation: 60.22 mASL

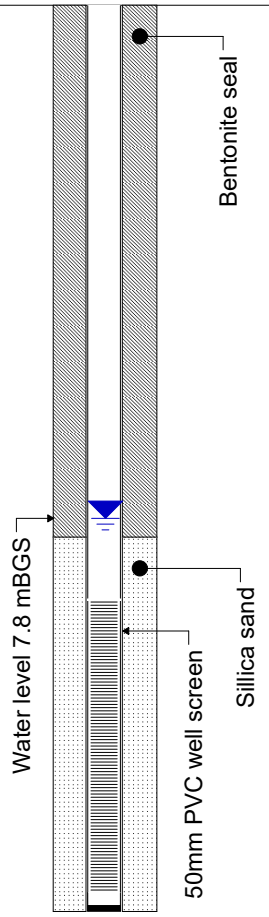
Coordinates: 447574E, 5029449N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
18							SAND Fine to medium-grained, interbedded silty sand and sand, grey, moist to wet.
19				0	35		
20	6						- silty clay bed from 5.2 to 5.3 mBGS
21				0	64		- Odour from 5.2 to 5.3, 6.1 to 7.3 mBGS
22							
23	7			25	20		
24							
25				20	5.6		
26	8						- Some gravel from 7.9 to 8.5 mbgs
27				0	28		- Odour, stained soil and coal tar from 7.9 to 9.6 mBGS
28							
29		X		150	470		
30	9						
31		X		400	830		
32							TILL Clay with some gravel and pebbles, grey, wet.
33	10						
34							BOREHOLE TERMINATED Total depth of BH12-10 9.8 mBGS
35							
36							

INSTALLATION



Total depth of MW12-10
9.8 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-11

MOE Well ID: A122887

Project Number: 11-200-7

Date Completed: 17-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 193 (200) Lees Avenue

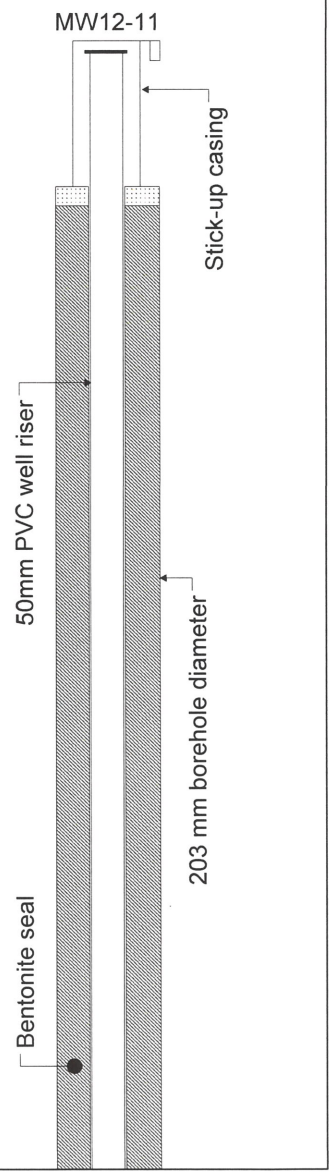
Ground Surface Elevation: 62.22 mASL

Coordinates: 447632E, 5029406N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
							GROUND SURFACE
0 – 1				0	0.15		FILL Medium to fine-grained sand, with sections of silty and/or some gravel, brown, dry to moist.
3	1	X		0	0.10		- Some ash present in 0.6 to 1.2, 1.8 to 3.0 mBGS
5				0	0.90		
6 – 7	2			30	0.10		
8							- Brick from 2.4 to 2.9 mBGS
9		X		50	0.10		
10	3						- Concrete from 2.8 to 3.0 mBGS
11		X		10	20		- Several layers of construction tar paper at 3.0 mBGS
12							
13	4			25	280		- Boulder at 3.5 mBGS
14							
15		X		75	400		
16	5						
17				30	230		
18							
19				30	380		



INSTALLATION

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-11

MOE Well ID: A122887

Project Number: 11-200-7

Date Completed: 17-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 193 (200) Lees Avenue

Ground Surface Elevation: 62.22 mASL

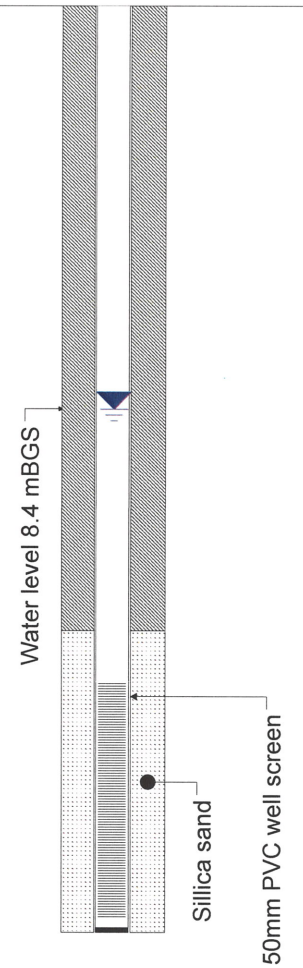
Coordinates: 447632E, 5029406N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
20								
21		X		60	400			
22								
23	7			50	400		SAND Medium-grained sand with some gravel, black and tan, moist to wet.	
24								
25				25	400		- Boulder at 7.3 mBGS - Odour from 7.9 to 9.7 mBGS	
26	8							
27				0	0			
28								
29				0	30			
30	9							
31		X		0	35			
32								
33	10			0	15		- Coal tar and sheen from 9.8 to 11.4 mBGS	
34								
35				0	23			
36	11							
37		X		50	79			
38							TILL Clay with some gravel and pebbles, grey, wet.	
39	12							
40								
41								
42								

BOREHOLE TERMINATED
Total depth of BH12-11
11.6 mBGS



Total depth of MW12-11
11.6 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-12

MOE Well ID: A122887

Project Number: 11-200-7

Date Completed: 22-Feb-12

Client: City of Ottawa

Supervisor: JFD

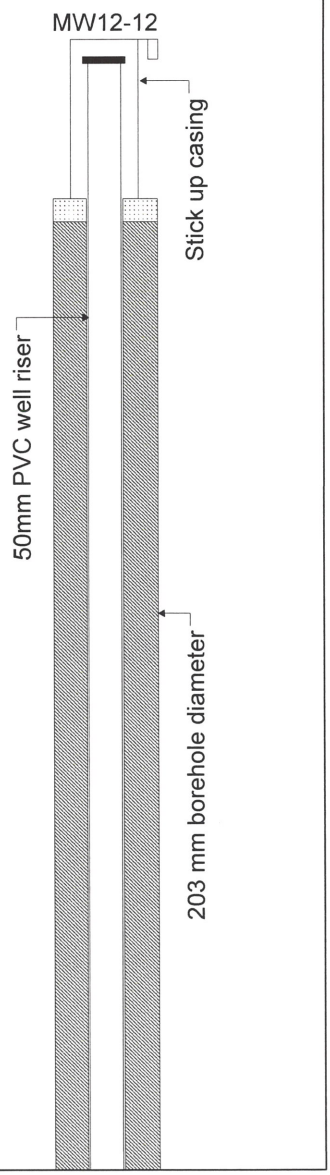
Site Location: 193 (200) Lees Avenue

Ground Surface Elevation: 60.92 mASL

Coordinates: 447662E, 5029461N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-3 to 16 ft; 1 to 4 m							GROUND SURFACE	
0 ft / 0 m				90	--		FILL Fine to medium-grained sand, brown and grey, dry to moist.	
3 ft / 1 m		X		55	--			
5 ft				10	--		-Brick from 1.1 to 1.2 mBGS	
6 ft / 2 m							- Concrete from 1.8 to 2.4 mBGS	
8 ft							- Wood from 2.4 to 2.45 mBGS	
9 ft				5	78			
10 ft / 3 m								
11 ft		X		0	0			
12 ft							- Boulder in 3.7 to 4.2 mBGS interval, <5% recovery	
13 ft / 4 m				30	--			
15 ft				25	--			
16 ft								

Prepared by: VMS

Reviewed by: JFD/MEB/KGR

Doc: 11-200-7_Well Installation_MW12-12

Template: 2011 Geofirma Template

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-12

MOE Well ID: A122887

Project Number: 11-200-7

Date Completed: 22-Feb-12

Client: City of Ottawa

Supervisor: JFD

Site Location: 193 (200) Lees Avenue

Ground Surface Elevation: 60.92 mASL

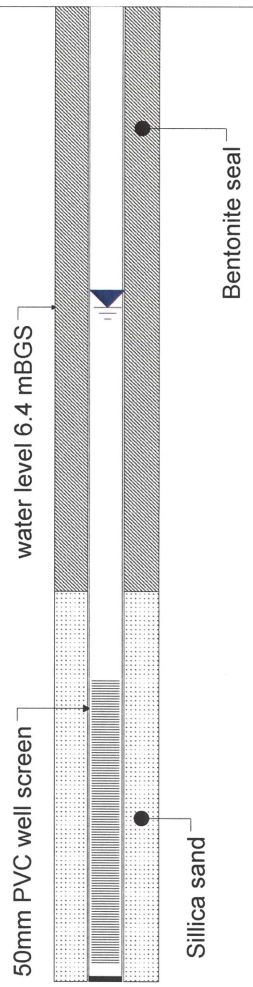
Coordinates: 447662E, 5029461N (UTM Zone 18)

Date of Water Level Measurement: 7-Mar-12

Drilling Method: Hollow Stem Auger with Split Spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
17 – 5				20	200		SAND Very fine to medium-grained, greyish brown to grey, moist to wet.
18							
19				75	0		
20 – 6							
21		X		40	0		- Odour from 6.7 to 9.1 mBGS
22							
23 – 7		X		60	--		
24							
25				25	--		
26 – 8							
27				50	--		
28							
29				75	43		
30 – 9							
31		X		140	14		TILL Clay with sand, gravel and pebbles, grey, wet.
32							
33 – 10							BOREHOLE TERMINATED Total depth of BH12-12 9.8 mBGS
34							
35							

INSTALLATION



Total depth of MW12-12
9.8 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

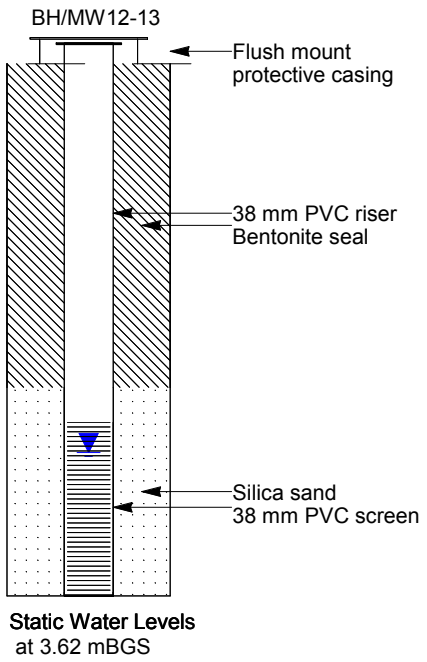
Borehole Number: BH/MW12-13

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447588E, 5029476N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135005
Date Completed: 25-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 59.81
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0 – 3 / 1				5.5	0		FILL Silty clay with some gravel, fine to medium grained, loose, non-plastic, grey, dry
3 / 1 – 6 / 2				7.7	0		
6 / 2 – 9 / 3							
9 / 3 – 12 / 4		X		2000	40k		Pure phase coal tar, staining, black, dry
12 / 4 – 15 / 5		X		4500	20k		Gravely sand, pure phase coal tar, sheen with staining, medium grained, loose, non-plastic, black, dry
15 / 5 – 39 / 11							BOREHOLE TERMINATED Total Depth of BH/MW12-13 4.88 mBGS

INSTALLATION



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

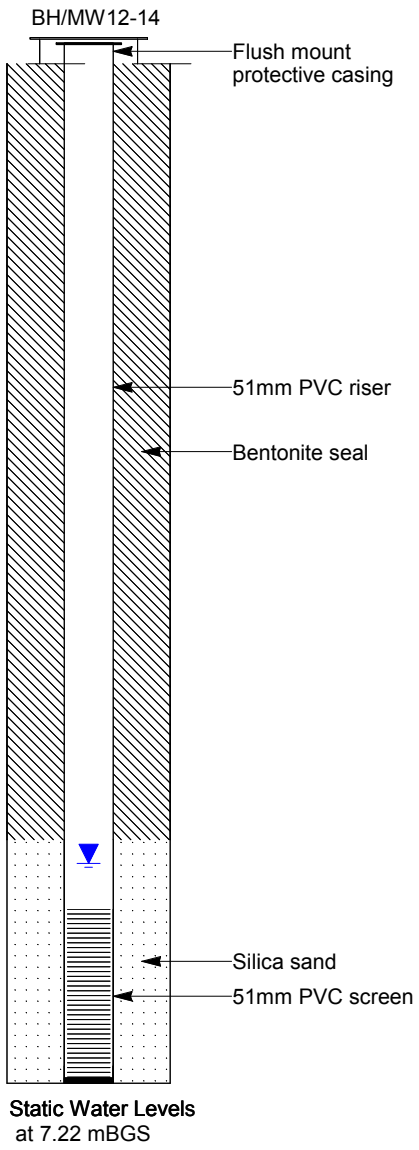
Borehole Number: BH/MW12-14

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447603E, 5029449N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135004
Date Completed: 25-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 60.47
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 – 3 / 0 – 1		X		6	50		FILL Gravel with clay and sand, fine to medium grained, loose, low plasticity, brown to dark brown, dry
5 – 7 / 1 – 2		X		320	20		Black staining from 1.22 to 1.52 mBGS
8 – 9 / 2 – 3			`	21	30		Sand, fine grained, loose, non-plastic, brown, dry
10 – 12 / 3 – 4		X		16	0		
13 – 14 / 4				5.2	0		
15 – 16 / 5		X		6.3	120		
17 – 19 / 5 – 6				54	40		
20 – 21 / 6		X		170	390		Coal tar odour, grey
22 – 24 / 7		X		230	100		
25 – 26 / 8				41	210		SAND Silty with some gravel, fine to medium grained, loose, low plasticity, grey, wet Strong coal tar odour
27 – 29 / 8 – 9		X		170	140		
30 / 9							TILL Clayey sand with some silt and gravel, fine to medium grained, dense, non-plastic, dark brown, moist to dry
31 – 39 / 10 – 11							BOREHOLE TERMINATED Total Depth of BH/MW12-14 9.14 mBGS

INSTALLATION



Prepared By: JFD
Reviewed By: KGR
Doc: 11-200-11_BHLOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

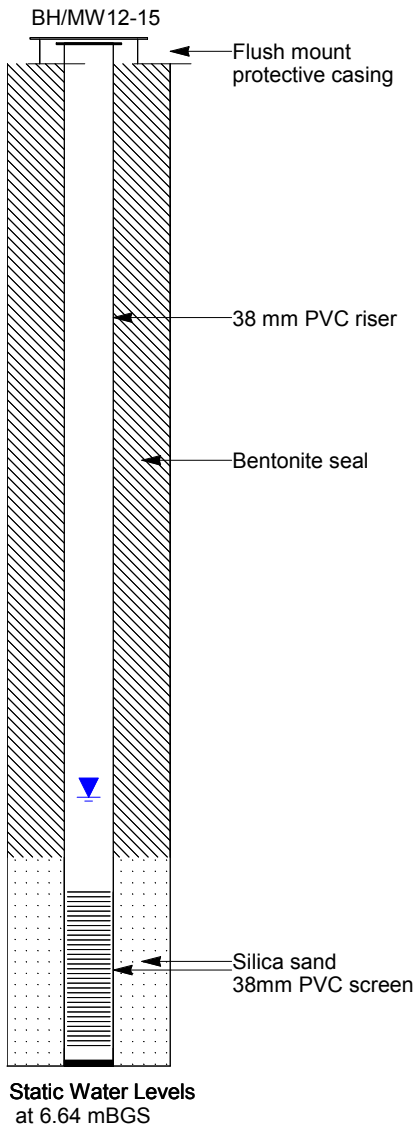
Borehole Number: BH/MW12-15

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447536E, 5029478N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135003
Date Completed: 25-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 59.50
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0							ASPHALT Black
1 / 0				2.3	0		FILL Silty gravel with trace of clay, fine to medium grained, compact, non-plastic, grey, dry
2 / 1		X		79.5	5		Sand, fine to medium grained, loose, non-plastic, coal tar odour, black staining, brown, dry
3 / 1		X		68.3	20		Black staining, coal tar
4 / 1		X		18.1	100		Gravel with some silt, fine grained, loose, non-plastic, dry
4 / 1		X		31.6	5		SAND medium to coarse grained, loose, non-plastic, bands of black staining, brown, dry
5 / 2		X		7.5	100		
6 / 2				7.7	50		
6 / 2		X		20.8	80		Black staining Some Gravel and trace of silt, fine to medium grained, loose, non-plastic, slight coal tar odour, brown, moist to wet
7 / 2		X		5	125		Fine grained, loose, non-plastic, coal tar odour, grey, wet
8 / 3				3	40		
8 / 3		X		21.7	80		Strong coal tar odour, black staining, coal tar
9 / 3							TILL Refusal at 8.99 mBGS, inferred till.
10 / 3							BOREHOLE TERMINATED Total Depth of BH/MW12-15 8.99 mBGS

INSTALLATION



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

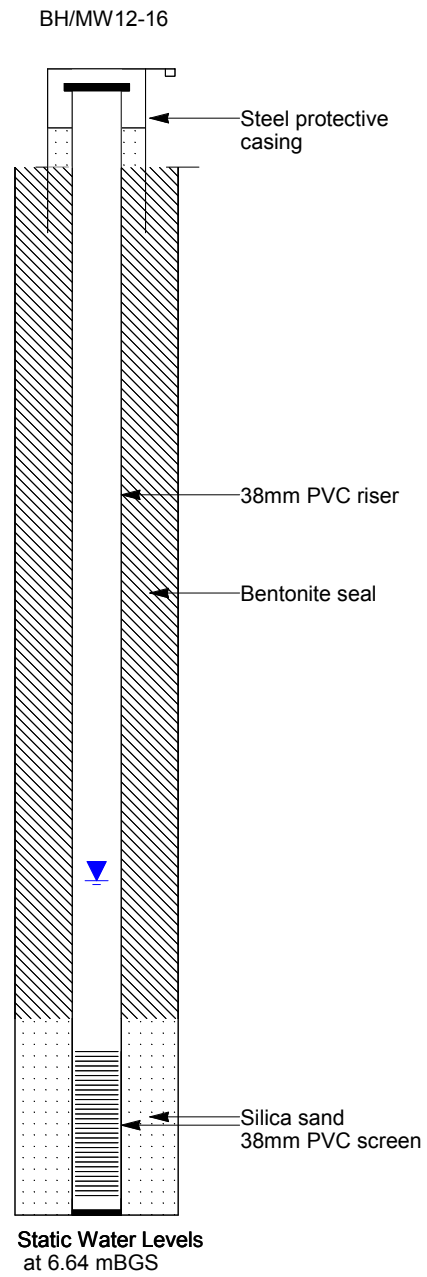
Borehole Number: BH/MW12-16

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447670E, 5029487N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135006
Date Completed: 26-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 61.02
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0				0	0		GROUND SURFACE TOPSOIL Brown
3 / 1				1.6	30		FILL Silty sand with gravel, fine to medium grained, loose, non-plastic, brown, dry
6 / 2		X		330	275		Coal tar odour, black staining Gravel with clay, fine grained, dense, low plasticity, brown, dry
9 / 3				8	55		Coal tar odour, black staining Auger, no recovery
11 / 3				8	50		CLAY With gravel and trace of sand, fine grained, dense, low plasticity, slight coal tar odour, black staining, dark brown, dry
14 / 4		X		11	80		
15 / 4		X		6	100		Silty with sand and gravel, fine grained, dense, low plasticity, dark grey, moist
17 / 5		X		4	25		
20 / 6				2.5	75		SAND Medium grained, compact, non-plastic, grey, moist
24 / 7		X		2	225		
26 / 8		X		0.2	425		Slight coal tar odour, wet
29 / 9				1.5	50		
31 / 9				1	0		
32 / 10							TILL Clay with some gravel, fine grained, compact, non-plastic, dark brown
							BOREHOLE TERMINATED Total Depth of BH/MW12-16 9.75 mBGS

INSTALLATION



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

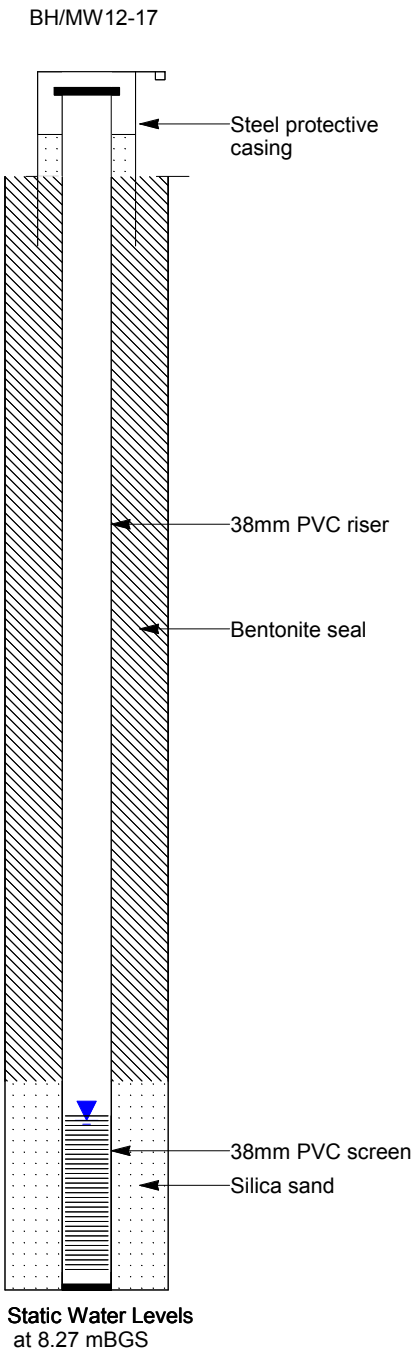
Borehole Number: BH/MW12-17

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447511E, 5029415N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135000
Date Completed: 24-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 59.16
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0							TOPSOIL Brown
3 / 1				4.2	10		FILL Sand, fine to medium grained, loose, non-plastic, brown, moist
6 / 2		X		13	0		
9 / 3				6	0		
11 / 3.5		X		5.3	325		
14 / 4				4.6	10		Sand with trace of clay, fine to medium grained, loose, non-plastic, brown, moist
16 / 5		X		7.6	--		
19 / 6				2.6	0		
21 / 6.5		X		2.5	0		SAND Sand, medium to coarse grained, loose, non-plastic, brown, moist
24 / 7		X		3.9	5		
26 / 8		X		4.5	100		Clay beds at 7.01 and 8.80 mBGS (~5cm thickness), non-plastic, light grey, dry
29 / 9		X		14.5	25		TILL Clay with some silt, sand and gravel, fine to medium grained, dense, non-plastic, slight odour, dark brown, moist to dry
31 / 9.5				4.0	75		
32 / 9.75							BOREHOLE TERMINATED Total Depth of BH/MW12-17 9.75 mBGS

INSTALLATION



Static Water Levels
at 8.27 mBGS

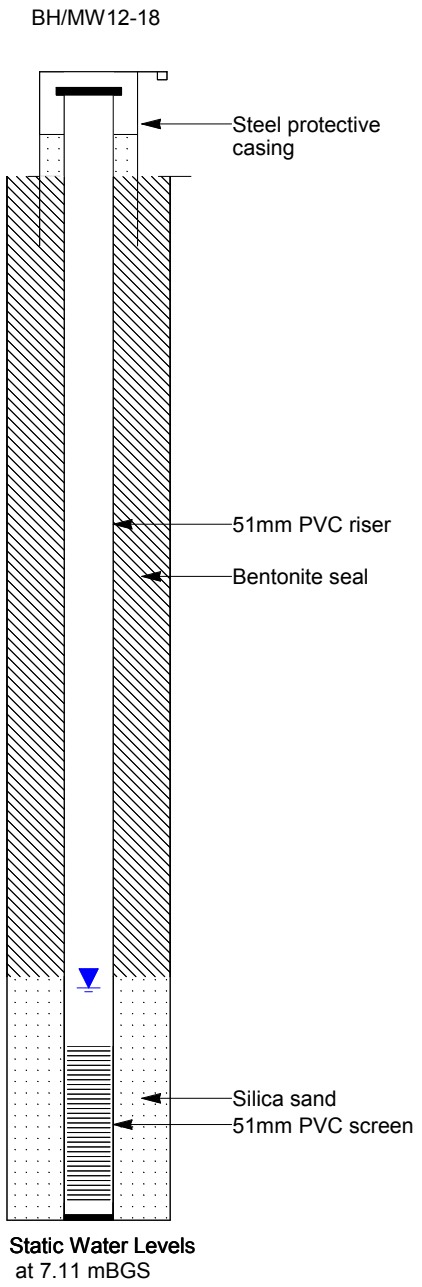
BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW12-18

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447480E, 5029380N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822 DT

MOE Well ID: A135002
Date Completed: 24-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 59.59
Date of Water Level Measurement: 27-Sep-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 – 1 / 0 – 0.3							TOPSOIL Brown, dry
1 – 3 / 0.3 – 1		X		1.4	125		FILL Sitly clayey sand with some gravel, ash and brick, fine grained, compact, non-plastic, black staining, brown, dry
3 – 4 / 1 – 1.2		X		5.2	50		Sand with some gravel and trace of clay and ash, fine grained, loose, non-plastic, black staining, brown, dry
4 – 5 / 1.2 – 1.5		X		4.9	50		Sand, medium grained, loose, non-plastic, brown, dry
5 – 6 / 1.5 – 1.8		X		3.4	125		Clay with trace of gravel, fine grained, dense, plastic, grey, wet
6 – 7 / 1.8 – 2.1				3.8	25		Silty sand with some clay, fine grained, dense, high plasticity, grey, wet
7 – 8 / 2.1 – 2.4				1.8	25		
8 – 9 / 2.4 – 2.7		X		3.1	0		SAND Silty sand, fine grained, compact, high plasticity, grey, wet
9 – 10 / 2.7 – 3				2	0		
10 – 11 / 3 – 3.4				1.2	0		Sand, medium grained, loose, non-plastic, dark grey, wet
11 – 12 / 3.4 – 3.7		X		0.9	150		Silty sand with trace of clay, fine grained, dense, medium plasticity, brown, wet
12 – 13 / 3.7 – 4				2.1	0		
13 – 14 / 4 – 4.3							TILL Clay with silt and gravel, fine grained, dense, medium plasticity, dark grey, dry
14 – 35 / 4.3 – 10.7							BOREHOLE TERMINATED Total Depth of BH/MW12-18 9.14 mBGS



Prepared By: JFD
Reviewed By: KGR
Doc: 11-200-11_BHLOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

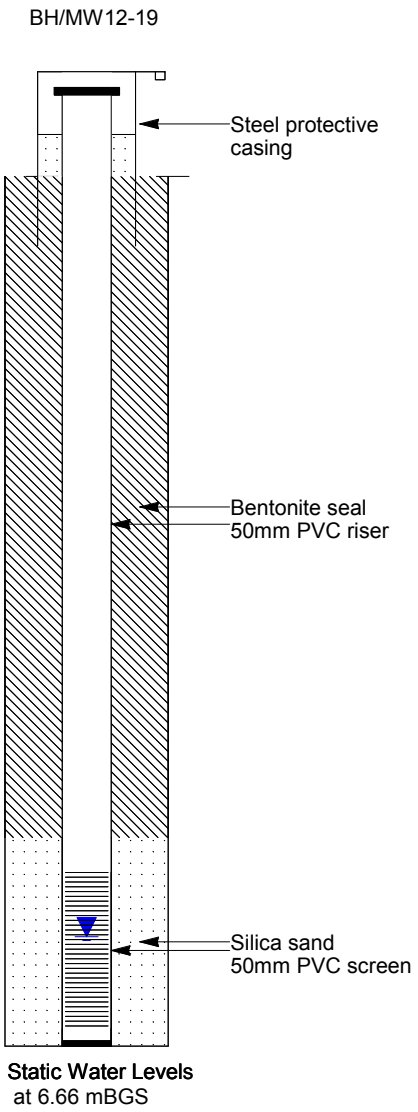
Borehole Number: BH/MW12-19

Project Number: 11-200-11
Client: City of Ottawa
Site Location: 191, 193 Lees Ave, Ottawa, Ontario
Coordinates: 447485E, 5029432N (UTM Zone 18)
Drilling Method: Direct push
Drilling Rig: Geoprobe 7822

MOE Well ID: A135001
Date Completed: 24-Sep-12
Supervisor: JFD
Logged By: JFD
Ground Surface Elevation: 59.05
Date of Water Level Measurement: 27-SEP-12

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0							TOPSOIL Brown, dry
3 / 1		X		3.2	0		FILL Sand, fine grained, loose, non-plastic, brown, moist
7 / 2				5.1	0		
11 / 3		X		5.2	200		
13 / 4		X		5.3	175		Sand with some gravel and traces of ash, fine to medium grained, loose, non-plastic, brown, moist
16 / 5		X		5.4	175		
18 / 5							Gravel, Black staining
19 / 6				3.2	175		SAND Sand, fine to medium grained, loose, non-plastic, slight coal tar odour, grey, wet
21 / 6		X		2.2	250		
23 / 7		X		2.3	175		Silty sand, fine grained, compact, non-plastic, slight coal tar odour, grey, wet
25 / 8							BOREHOLE TERMINATED Total Depth of BH/MW12-19 7.62 mBGS

INSTALLATION



Static Water Levels
at 6.66 mBGS

APPENDIX B

Soil and Groundwater Analytical Results Tables

Table B.1 – Soil Analytical Results – Metals

Table B.2 – Soil Analytical Results – Polycyclic Aromatic Hydrocarbons

Table B.3 – Soil Analytical Results - PHC-F1 and BTEX

Table B.4 – Soil Analytical Results - pH and Cyanide

Table B.5 – Groundwater Analytical Results – Metals and Cyanide

Table B.6 – Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons

Table B.7 – Groundwater Analytical Results – PHC-F1 and BTEX

Notes for Soil Analytical Results

Notes:

All units are µg/g unless otherwise noted
NV = No Value
-- = Parameter not analysed
mBGS = Meters below ground surface
*The boron standards are for hot water soluble extract for all surface soils. For subsurface soils the standards are for total boron (mixed strong acid digest), as ecological criteria are not considered.
**The methylnaphthalene standards are applicable to both 1-methylnaphthalene and 2-methylnaphthalene, with the provision that if both are detected the sum of the two must not exceed the standard
***F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.
< Parameter concentraton is less than method detection limit (MDL)
**** MDL is greater than MOE standards.
MOE = Soil, Groundwater and Sediment Standards for use under Part XV.1 of the Environmental Protection Act, April 2011
Table 3 = Full depth generic site condition standards in a non-potable groundwater condition for coarse textured soil
bold = indicates concentrations which exceed MOE 2011 Table 3 standards for residential/parkland land use
= indicates concentrations which exceed MOE 2011 Table 3 standards for commercial/industrial land use

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	BH12-01			BH12-02			BH12-03			
Sample Depth (mBGS)>	Table 3	Table 3	1.52-2.13	2.74-3.35	3.96-4.57	0.6-1.22	Duplicate	2.43-3.05	1.82-2.43	3.05-3.65	4.26-4.87	Duplicate
Date Sampled>	Com/Ind	Res/Park	22-Feb-12	22-Feb-12	22-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12
Antimony	40	7.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	18	18	2	<1	2	1	1	3	3	<1	<1	2
Barium	670	390	157	43	58	209	168	69	125	57	16	42
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	120	120	7.4	<5	<5	15.1	10.9	6.9	6.7	5.0	6.3	9.7
Cadmium	1.9	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	39	12	10	8	8	11	18	8	6	10
Cobalt	80	22	6	5	5	3	3	6	5	3	3	6
Copper	230	140	17	6	13	6	7	26	19	7	6	14
Lead	120	120	7	3	4	6	5	9	90	3	2	6
Mercury	3.9	0.27	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
Molybdenum	40	6.9	<1	<1	1	3	2	3	1	1	2	2
Nickel	270	100	18	13	14	13	11	19	13	8	6	17
Selenium	5.5	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	<1	<1	<1	<1	<1	1	<1	<1	1	1
Vanadium	86	86	48	15	17	<10	<10	18	26	17	13	16
Zinc	340	340	31	39	<20	<20	<20	<20	86	<20	<20	<20

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	BH12-04			BH12-05			BH12-06		
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	1.82-2.43	2.43-3.05	0.6-1.22	3.05-3.65	5.48-6.09	0.6-1.22	1.82-2.43	4.87-5.48
Date Sampled>	Com/Ind	Res/Park	17-Feb-12	17-Feb-12	17-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12
Antimony	40	7.5	<1	3	<1	<1	<1	<1	<1	<1	<1
Arsenic	18	18	6	9	13	1	<1	<1	5	2	<1
Barium	670	390	94	**486**	43	243	63	18	87	282	22
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Boron (total)	120	120	6.8	64.4	8.0	11.3	<5	<5	11.4	9.8	<0.5
Cadmium	1.9	1.2	<0.5	**6.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	22	**2410**	17	9	13	<5	24	27	<5
Cobalt	80	22	6	**29**	5	3	5	2	6	7	3
Copper	230	140	18	**9780**	13	5	12	5	20	14	6
Lead	120	120	44	**486**	4	7	2	1	29	8	2
Mercury	3.9	0.27	**0.3**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	40	6.9	1	**5870**	**14**	2	1	<1	**13**	**7**	2
Nickel	270	100	17	97	11	14	9	<5	15	16	6
Selenium	5.5	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	20	<0.3	**44.5**	<0.3	<0.3	<0.3	<0.3	0.4	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	86	86	32	31	35	<10	26	<10	23	35	11
Zinc	340	340	53	**5010**	<20	<20	<20	<20	26	28	<20

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	BH12-07			BH12-08			BH12-09		
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	3.65-4.26	4.26-4.87	0-0.6	0.6-1.22	7.31-7.92	0-0.6	0.6-1.22	9.75-10.21
Date Sampled>	Com/Ind	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	14-Feb-12	14-Feb-12	14-Feb-12	13-Feb-12	13-Feb-12	13-Feb-12
Antimony	40	7.5	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	18	18	<1	3	<1	<1	<1	<1	1	3	2
Barium	670	390	38	82	24	63	60	15	48	35	111
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	120	120	<5	<5	<5	8.0	<5	<5	5.6	<5.0	7.6
Cadmium	1.9	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	7	13	6	10	11	5	10	9	17
Cobalt	80	22	4	10	3	2	4	2	4	3	7
Copper	230	140	12	23	7	<5	10	5	9	8	17
Lead	120	120	2	8	2	6	3	2	14	12	6
Mercury	3.9	0.27	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	40	6.9	<1	3	<1	<1	<1	<1	1	1	1
Nickel	270	100	10	28	7	10	10	<5	11	8	19
Selenium	5.5	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	<1	2	<1	<1	<1	<1	<1	<1	1
Vanadium	86	86	20	22	12	13	19	11	22	15	26
Zinc	340	340	<20	<20	<20	<20	<20	<20	<20	<20	21

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	BH12-10			BH12-11			BH12-12		
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	1.22-1.82	8.53-9.1	0.6-1.22	2.43-3.05	3.05-3.65	0.6-1.22	3.05-3.65	6.7-7.31
Date Sampled>	Com/Ind	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	22-Feb-12	22-Feb-12	22-Feb-12
Antimony	40	7.5	<1	<1	<1	<1	3	<1	<1	<1	<1
Arsenic	18	18	1	<1	<1	<1	5	2	2	2	<1
Barium	670	390	40	34	13	20	182	109	68	56	17
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	120	120	<5	<5	<5	5.6	8.1	7.9	<5	7.0	<5
Cadmium	1.9	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	10	9	6	6	23	17	9	15	7
Cobalt	80	22	4	4	3	2	8	6	3	7	3
Copper	230	140	9	27	6	5	81	22	7	17	7
Lead	120	120	10	8	2	3	**168**	32	10	7	2
Mercury	3.9	0.27	<0.1	<0.1	<0.1	<0.1	**4.4**	0.1	<0.1	<0.1	<0.1
Molybdenum	40	6.9	<1	<1	<1	6	**8**	2	<1	2	<1
Nickel	270	100	10	9	7	<5	16	16	7	23	7
Selenium	5.5	2.4	<1	<1	<1	<1	<1	1	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3	<0.3	0.5	<0.3	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	<1	<1	<1	<1	<1	1	<1	1	<1
Vanadium	86	86	30	17	<10	16	26	30	12	21	15
Zinc	340	340	<20	<20	<20	<20	128	34	<20	25	<20

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	**BH12-13**	**BH12-14**			**BH12-15**			
Sample Depth (mBGS)>	Table 3	Table 3	4.57-4.87	0.0-1.52	3.05-3.81	6.86-7.62	2.29-3.05	6.10-6.86	Duplicate	8.38-8.69
Date Sampled>	Com/Ind	Res/Park	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
Antimony	40	7.5	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	18	18	<1	<1	<1	<1	<1	<1	<1	<1
Barium	670	390	46	43	14	51	11	20	21	15
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	120	120	--	--	--	--	--	--	--	--
Cadmium	1.9	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	10	7	5	8	6	9	8	10
Cobalt	80	22	3	3	2	4	3	3	3	4
Copper	230	140	6	10	<5	8	5	7	6	8
Lead	120	120	23	24	1	2	2	29	8	3
Mercury	3.9	0.27	**3.3**	<0.1	<0.1	<0.1	**0.7**	<0.1	<0.1	**0.3**
Molybdenum	40	6.9	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	270	100	9	7	<5	8	6	7	6	10
Selenium	5.5	2.4	<1	<1	<1	<1	1	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	--	--	--	--	--	--	--	--
Vanadium	86	86	20	13	12	14	12	11	<10	<10
Zinc	340	340	27	<20	<20	<20	<20	<20	<20	<20

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	BH12-16				BH12-17			BH12-18		
Sample Depth (mBGS)>	Table 3	Table 3	1.52-2.15	3.81-4.57	Duplicate	6.86-7.62	1.52-2.29	6.10-6.86	6.86-7.62	0-1.52	1.52- 2.29	2.29-3.05
Date Sampled>	Com/Ind	Res/Park	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
Antimony	40	7.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	18	18	<1	<1	<1	<1	<1	<1	<1	3	1	<1
Barium	670	390	385	48	58	22	25	18	110	67	80	385
Beryllium	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron (total)	120	120	--	--	--	--	--	--	--	--	--	--
Cadmium	1.9	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium Total	160	160	12	9	10	5	8	<5	17	11	13	42
Cobalt	80	22	3	6	7	3	3	3	6	5	5	12
Copper	230	140	8	15	15	6	8	6	14	25	8	19
Lead	120	120	47	7	11	2	2	1	3	98	5	5
Mercury	3.9	0.27	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Molybdenum	40	6.9	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Nickel	270	100	7	15	16	6	6	6	12	14	11	26
Selenium	5.5	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	33	23	--	--	--	--	--	--	--	--	--	--
Vanadium	86	86	21	13	14	11	15	<10	26	22	22	51
Zinc	340	340	30	21	23	<20	<20	<20	25	46	21	61

Table B.1 - Soil Analytical Results - Metals in µg/g

Parameter	MOE	MOE	**BH12-19**		
Sample Depth (mBGS)>	Table 3	Table 3	0.0-1.52	3.81-4.57	4.57- 5.33
Date Sampled>	Com/Ind	Res/Park	24-Sep-12	24-Sep-12	24-Sep-12
Antimony	40	7.5	<1	<1	<1
Arsenic	18	18	<1	<1	<1
Barium	670	390	49	16	26
Beryllium	8	4	<0.5	<0.5	<0.5
Boron (total)	120	120	--	--	--
Cadmium	1.9	1.2	<0.5	<0.5	<0.5
Chromium Total	160	160	16	<5	7
Cobalt	80	22	5	3	4
Copper	230	140	11	7	9
Lead	120	120	14	1	2
Mercury	3.9	0.27	<0.1	<0.1	<0.1
Molybdenum	40	6.9	<1	<1	<1
Nickel	270	100	10	5	7
Selenium	5.5	2.4	<1	<1	<1
Silver	40	20	<0.3	<0.3	<0.3
Thallium	3.3	1	<1	<1	<1
Uranium	33	23	--	--	--
Vanadium	86	86	19	10	13
Zinc	340	340	33	<20	<20

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-01**			**BH12-02**		**BH12-03**			
Sample Depth (mBGS)>	Table 3	Table 3	2.74-3.35	5.18-5.79	7.62-8.22	0.6-1.22	3.05-3.65	1.22-1.82	3.05-3.65	6.09-6.7	Duplicate
Date Sampled>	Com/Ind	Res/Park	22-Feb-12	22-Feb-12	22-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12
Acenaphthene	96	7.9	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	0.15	0.15	<0.02	<0.02	<0.02	0.03	<0.02	0.14	<0.02	<0.02	<0.02
Anthracene	0.67	0.67	<0.02	<0.02	<0.02	<0.02	<0.02	0.09	<0.02	<0.02	<0.02
Benzo[a]anthracene	0.96	0.5	<0.02	<0.02	<0.02	0.02	<0.02	0.48	0.02	0.03	0.04
Benzo[a]pyrene	0.3	0.3	<0.02	<0.02	<0.02	<0.02	<0.02	0.25	<0.02	0.02	0.04
Benzo[b]fluoranthene	0.96	0.78	<0.02	<0.02	<0.02	<0.02	<0.02	0.69	0.02	0.02	0.04
Benzo[g,h,i]perylene	9.6	6.6	<0.02	<0.02	<0.02	<0.02	<0.02	0.26	<0.02	<0.02	<0.02
Benzo[k]fluoranthene	0.96	0.78	<0.02	<0.02	<0.02	<0.02	<0.02	0.47	<0.02	<0.02	0.04
1,1-Biphenyl	52	0.31	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chrysene	9.6	7	<0.02	<0.02	<0.02	0.04	0.02	0.55	0.03	0.04	0.06
Dibenzo[a,h]anthracene	0.1	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.02	<0.02
Fluoranthene	9.6	0.69	<0.02	<0.02	<0.02	<0.02	<0.02	0.28	0.02	0.02	0.04
Fluorene	62	62	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Indeno[1,2,3-cd]pyrene	0.76	0.38	<0.02	<0.02	<0.02	<0.02	<0.02	0.31	<0.02	<0.02	<0.02
1-Methylnaphthalene	NV	NV	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2-Methylnaphthalene	NV	NV	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	<0.02	0.02
Methylnaphthalene (1&2)	76	0.99	<0.04	<0.04	<0.04	0.05	<0.04	0.04	<0.04	<0.04	<0.04
Naphthalene	9.6	0.6	<0.01	<0.01	<0.01	0.03	0.03	0.04	0.03	0.21	0.53
Phenanthrene	12	6.2	<0.02	<0.02	<0.02	0.04	0.03	0.10	0.03	0.04	0.06
Pyrene	96	78	<0.02	<0.02	<0.02	0.03	<0.02	0.37	0.03	0.03	0.05

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-04**			**BH12-05**			**BH12-06**		
Sample Depth (mBGS)>	Table 3	Table 3	2.43-3.05	6.09-6.7	9.1-9.75	0.6-1.22	3.05-3.65	6.7-7.31	1.82-2.43	4.26-4.87	6.7-7.31
Date Sampled>	Com/Ind	Res/Park	17-Feb-12	17-Feb-12	17-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12
Acenaphthene	96	7.9	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	0.15	0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	0.67	0.67	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Benzo[a]anthracene	0.96	0.5	0.04	<0.02	<0.02	0.03	<0.02	<0.02	0.08	<0.02	<0.02
Benzo[a]pyrene	0.3	0.3	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	<0.02	<0.02
Benzo[b]fluoranthene	0.96	0.78	0.03	<0.02	<0.02	0.03	<0.02	<0.02	0.08	<0.02	<0.02
Benzo[g,h,i]perylene	9.6	6.6	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02
Benzo[k]fluoranthene	0.96	0.78	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	0.06	<0.02	<0.02
1,1-Biphenyl	52	0.31	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02
Chrysene	9.6	7	0.03	<0.02	0.02	0.03	<0.02	<0.02	0.08	<0.02	<0.02
Dibenzo[a,h]anthracene	0.1	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	9.6	0.69	0.06	<0.02	<0.02	0.04	<0.02	<0.02	0.12	<0.02	<0.02
Fluorene	62	62	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Indeno[1,2,3-cd]pyrene	0.76	0.38	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02
1-Methylnaphthalene	NV	NV	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.15	<0.02	<0.02
2-Methylnaphthalene	NV	NV	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.20	<0.02	<0.02
Methylnaphthalene (1&2)	76	0.99	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.35	<0.04	<0.04
Naphthalene	9.6	0.6	<0.01	0.28	0.01	0.01	<0.01	<0.01	0.21	<0.01	<0.01
Phenanthrene	12	6.2	0.03	0.03	0.04	0.02	<0.02	<0.02	0.14	<0.02	<0.02
Pyrene	96	78	0.06	<0.02	0.02	0.04	<0.02	<0.02	0.12	<0.02	<0.02

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-07**			**BH12-08**			**BH12-09**		
Sample Depth (mBGS)>	Table 3	Table 3	2.43-3.05	5.48-6.09	8.53-9.14	0-0.6	3.05-3.65	7.31-7.92	3.05-3.65	6.09-6.7	9.75-10.21
Date Sampled>	Com/Ind	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	14-Feb-12	14-Feb-12	14-Feb-12	13-Feb-12	13-Feb-12	13-Feb-12
Acenaphthene	96	7.9	0.04	<0.02	<0.02	<0.02	1.89	<0.02	**16.4**	1.01	0.12
Acenaphthylene	0.15	0.15	**0.84**	<0.02	0.02	<0.02	**1.66**	<0.02	**2.33**	**1.65**	**2.40**
Anthracene	0.67	0.67	0.41	<0.02	<0.02	<0.02	**0.71**	<0.02	**38.2**	**2.88**	**0.70**
Benzo[a]anthracene	0.96	0.5	**0.68**	<0.02	<0.02	0.03	**1.54**	<0.02	**48.3**	**2.79**	**0.67**
Benzo[a]pyrene	0.3	0.3	**0.70**	<0.02	<0.02	0.03	**1.25**	<0.02	**34.4**	**2.10**	**0.49**
Benzo[b]fluoranthene	0.96	0.78	**1.00**	<0.02	<0.02	0.05	0.55	<0.02	**37.4**	**2.05**	0.35
Benzo[g,h,i]perylene	9.6	6.6	0.28	<0.02	<0.02	0.02	0.44	<0.02	**9.30**	0.56	0.14
Benzo[k]fluoranthene	0.96	0.78	0.71	<0.02	<0.02	0.02	0.44	<0.02	**25.5**	**1.19**	0.26
1,1-Biphenyl	52	0.31	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	**1.56**	**0.44**	**0.49**
Chrysene	9.6	7	0.60	<0.02	0.03	0.05	1.64	<0.02	**44.2**	2.48	0.58
Dibenzo[a,h]anthracene	0.1	0.1	**0.12**	<0.02	<0.02	<0.02	**0.20**	<0.02	**2.79**	**0.19**	0.04
Fluoranthene	9.6	0.69	**1.05**	<0.02	<0.02	0.03	**2.77**	<0.02	**91.6**	**6.64**	**0.86**
Fluorene	62	62	0.09	<0.02	0.03	<0.02	0.71	<0.02	19.9	2.10	1.20
Indeno[1,2,3-cd]pyrene	0.76	0.38	0.33	<0.02	<0.02	<0.02	0.38	<0.02	**9.26**	**0.57**	0.12
1-Methylnaphthalene	NV	NV	0.18	0.04	0.04	<0.02	0.47	<0.02	3.80	3.36	4.09
2-Methylnaphthalene	NV	NV	0.28	0.07	0.07	<0.02	<0.02	<0.02	6.40	6.07	6.57
Methylnaphthalene (1&2)	76	0.99	0.46	0.11	0.12	<0.04	0.47	<0.04	**10.2**	**9.42**	**10.7**
Naphthalene	9.6	0.6	0.23	0.11	0.07	<0.01	0.19	<0.01	**14.6**	**11.3**	**10.9**
Phenanthrene	12	6.2	0.43	0.04	0.07	0.02	0.08	<0.02	**139**	**9.02**	2.81
Pyrene	96	78	0.97	0.02	0.03	0.03	4.90	<0.02	77.3	6.33	1.46

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-10**			**BH12-11**				**BH12-12**		
Sample Depth (mBGS)>	Table 3	Table 3	0-0.6	3.65-4.26	9.14-9.75	4.26-4.87	9.14-9.75	Duplicate	10.97-11.58	0.6-1.22	3.05-3.65	9.14-9.75
Date Sampled>	Com/Ind	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	22-Feb-12	22-Feb-12	22-Feb-12
Acenaphthene	96	7.9	0.03	<0.02	**52.7**	4.37	0.16	0.16	<0.40	0.03	<0.02	<0.02
Acenaphthylene	0.15	0.15	**1.38**	**0.23**	**84.7**	<0.4****	**1.46**	**0.84**	**3.06**	**0.31**	<0.02	0.03
Anthracene	0.67	0.67	0.59	0.17	**43.5**	**10.8**	**1.48**	0.50	**1.24**	0.22	<0.02	<0.02
Benzo[a]anthracene	0.96	0.5	0.35	0.35	**35.8**	**38.4**	**2.71**	**0.73**	**1.14**	**0.66**	<0.02	<0.02
Benzo[a]pyrene	0.3	0.3	**2.10**	0.28	**28.1**	**28.3**	**2.43**	**0.59**	**0.79**	**0.76**	<0.02	<0.02
Benzo[b]fluoranthene	0.96	0.78	**1.55**	0.29	**18.9**	**27.5**	**1.49**	0.47	**0.9**	**1.00**	<0.02	<0.02
Benzo[g,h,i]perylene	9.6	6.6	1.13	0.11	**7.70**	**7.23**	0.54	0.14	<0.40	0.43	<0.02	<0.02
Benzo[k]fluoranthene	0.96	0.78	**1.24**	0.21	**12.5**	**18.2**	**1.17**	0.30	<0.40	0.58	<0.02	<0.02
1,1-Biphenyl	52	0.31	0.06	<0.02	**24.5**	<0.4****	0.08	0.10	**0.66**	<0.02	<0.02	<0.02
Chrysene	9.6	7	0.49	0.31	**31.6**	**32.9**	2.72	0.73	1.21	0.62	<0.02	<0.02
Dibenzo[a,h]anthracene	0.1	0.1	**0.39**	0.04	**2.41**	**2.28**	**0.21**	0.05	<0.40****	**0.13**	<0.02	<0.02
Fluoranthene	9.6	0.69	0.27	0.45	**53.8**	**70.8**	**3.48**	**0.83**	**1.19**	**1.16**	<0.02	<0.02
Fluorene	62	62	0.16	0.14	**64.1**	3.71	0.38	0.43	1.83	0.05	<0.02	<0.02
Indeno[1,2,3-cd]pyrene	0.76	0.38	**0.95**	0.11	**6.80**	**7.76**	**0.57**	0.15	<0.40****	**0.40**	<0.02	<0.02
1-Methylnaphthalene	NV	NV	0.47	0.14	199	<0.4	0.28	0.34	6.04	0.02	<0.02	0.16
2-Methylnaphthalene	NV	NV	0.94	0.05	356	0.50	0.06	0.08	7.29	0.03	<0.02	<0.02
Methylnaphthalene (1&2)	76	0.99	**1.41**	0.19	**554**	0.87	0.34	0.42	**13.3**	0.05	<0.04	0.16
Naphthalene	9.6	0.6	**1.15**	0.07	**671**	**2.12**	0.25	0.32	**15.6**	0.06	<0.01	0.02
Phenanthrene	12	6.2	0.34	0.50	**150**	**35.3**	2.36	1.28	3.39	0.64	<0.02	<0.02
Pyrene	96	78	0.55	0.87	**90.8**	56.4	6.48	1.51	2.12	1.03	<0.02	<0.02

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-13**	**BH12-14**			**BH12-15**			
Sample Depth (mBGS)>	Table 3	Table 3	4.57-4.87	1.52-2.29	6.86-7.62	8.38-9.24	1.83-2.29	3.81-4.57	Duplicate	8.38-8.69
Date Sampled>	Com/Ind	Res/Park	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
Acenaphthene	96	7.9	**14.2**	<0.02	1.19	0.07	0.66	<1	<0.4	<1
Acenaphthylene	0.15	0.15	**180**	<0.02	**3.62**	**1.28**	**18.4**	**17.7**	**5.02**	**15.9**
Anthracene	0.67	0.67	**66.8**	<0.02	<0.4	<0.02	**5.21**	**19.1**	**2.05**	**9.40**
Benzo[a]anthracene	0.96	0.5	**36.7**	0.06	<0.4	<0.02	**17.6**	**30.4**	**6.80**	**23.9**
Benzo[a]pyrene	0.3	0.3	**33.2**	0.05	<0.4****	<0.02	**22.2**	**27.6**	**7.20**	**22.9**
Benzo[b]fluoranthene	0.96	0.78	**21.5**	0.05	<0.4	<0.02	**25.1**	**32.1**	**8.18**	**28.5**
Benzo[g,h,i]perylene	9.6	6.6	**18.4**	<0.02	<0.4	<0.02	**12.3**	**14.1**	4.11	**12.2**
Benzo[k]fluoranthene	0.96	0.78	**14.6**	0.03	<0.4	<0.02	**16.8**	**19.8**	**5.38**	**18.9**
1,1-Biphenyl	52	0.31	**34.9**	<0.02	<0.4****	0.07	<0.4****	<1****	<0.4****	<1****
Chrysene	9.6	7	**37.6**	0.05	<0.4	<0.02	**15.8**	**26.5**	6.47	**22.1**
Dibenzo[a,h]anthracene	0.1	0.1	**5.42**	<0.02	<0.4****	<0.02	**4.00**	**4.97**	**1.35**	**4.29**
Fluoranthene	9.6	0.69	**61.0**	0.08	<0.4	<0.02	**44.6**	**81.9**	**14.0**	**52.0**
Fluorene	62	62	**87.2**	<0.02	<0.4	<0.02	0.73	3.07	<0.4	1.15
Indeno[1,2,3-cd]pyrene	0.76	0.38	**12.6**	0.02	<0.4****	<0.02	**12.7**	**14.2**	**3.87**	**12.2**
1-Methylnaphthalene	NV	NV	308	<0.02	7.63	2.05	0.42	<1	<0.4	<1
2-Methylnaphthalene	NV	NV	580	<0.02	4.20	2.25	0.53	<1	<0.4	<1
Methylnaphthalene (1&2)	76	0.99	**889**	<0.04	**11.8**	**4.30**	0.95	<2****	<0.8	<2****
Naphthalene	9.6	0.6	**1750**	<0.01	**24.0**	**10.8**	**1.76**	**1.95**	**1.09**	**2.93**
Phenanthrene	12	6.2	**141**	<0.02	<0.4	<0.02	0.88	**11.7**	0.84	4.19
Pyrene	96	78	**106**	0.08	<0.4	<0.02	42.4	76.6	15.0	55.7

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-16**				**BH12-17**			**BH12-18**		
Sample Depth (mBGS)>	Table 3	Table 3	0.15-1.52	3.05-3.81	Duplicate	4.88-5.64	1.52-2.29	3.05-3.81	6.86-7.62	0.0-1.52	2.29-3.05	5.33-6.10
Date Sampled>	Com/Ind	Res/Park	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
Acenaphthene	96	7.9	0.81	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<1	<0.02	<0.02
Acenaphthylene	0.15	0.15	**8.88**	0.04	0.02	<0.02	0.13	0.02	<0.02	**3.81**	<0.02	0.02
Anthracene	0.67	0.67	**8.08**	0.02	<0.02	<0.02	0.14	<0.02	<0.02	**5.48**	<0.02	<0.02
Benzo[a]anthracene	0.96	0.5	**20.4**	0.09	0.05	<0.02	0.16	0.03	<0.02	**8.62**	<0.02	0.03
Benzo[a]pyrene	0.3	0.3	**9.94**	0.04	<0.02	<0.02	0.12	<0.02	<0.02	**5.59**	<0.02	<0.02
Benzo[b]fluoranthene	0.96	0.78	**27.6**	0.13	0.07	<0.02	0.12	<0.02	<0.02	**11.7**	<0.02	0.02
Benzo[g,h,i]perylene	9.6	6.6	**10.2**	0.05	0.03	<0.02	0.08	<0.02	<0.02	4.68	<0.02	<0.02
Benzo[k]fluoranthene	0.96	0.78	**14.2**	0.10	0.05	<0.02	0.08	<0.02	<0.02	**7.31**	<0.02	<0.02
1,1-Biphenyl	52	0.31	**0.47**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<1	<0.02	<0.02
Chrysene	9.6	7	**18.7**	0.12	0.07	<0.02	0.17	0.03	<0.02	**8.51**	<0.02	0.03
Dibenzo[a,h]anthracene	0.1	0.1	**4.56**	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	**1.66**	<0.02	<0.02
Fluoranthene	9.6	0.69	**49.3**	0.13	0.06	<0.02	0.22	0.02	<0.02	**14.1**	<0.02	0.03
Fluorene	62	62	3.00	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	1.17	<0.02	<0.02
Indeno[1,2,3-cd]pyrene	0.76	0.38	**11.4**	0.06	0.03	<0.02	0.07	<0.02	<0.02	**4.43**	<0.02	<0.02
1-Methylnaphthalene	NV	NV	1.44	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<1	<0.02	<0.02
2-Methylnaphthalene	NV	NV	1.09	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<1	<0.02	<0.02
Methylnaphthalene (1&2)	76	0.99	**2.53**	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<2****	<0.04	<0.04
Naphthalene	9.6	0.6	**2.01**	0.01	0.01	<0.01	0.03	<0.01	<0.01	**0.76**	<0.01	<0.01
Phenanthrene	12	6.2	**27.1**	0.06	0.03	<0.02	0.14	<0.02	<0.02	4.71	<0.02	<0.02
Pyrene	96	78	40.3	0.11	0.05	<0.02	0.41	0.04	<0.02	14.4	<0.02	0.05

Table B.2 - Soil Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/g

Parameter	MOE	MOE	**BH12-19**		
Sample Depth (mBGS)>	Table 3	Table 3	3.81-4.57	4.57-5.33	6.86-7.62
Date Sampled>	Com/Ind	Res/Park	24-Sep-12	24-Sep-12	24-Sep-12
Acenaphthene	96	7.9	<0.02	<0.02	<0.02
Acenaphthylene	0.15	0.15	<0.02	<0.02	<0.02
Anthracene	0.67	0.67	<0.02	<0.02	<0.02
Benzo[a]anthracene	0.96	0.5	<0.02	<0.02	<0.02
Benzo[a]pyrene	0.3	0.3	<0.02	<0.02	<0.02
Benzo[b]fluoranthene	0.96	0.78	<0.02	<0.02	<0.02
Benzo[g,h,i]perylene	9.6	6.6	<0.02	<0.02	<0.02
Benzo[k]fluoranthene	0.96	0.78	<0.02	<0.02	<0.02
1,1-Biphenyl	52	0.31	<0.02	<0.02	<0.02
Chrysene	9.6	7	<0.02	<0.02	<0.02
Dibenzo[a,h]anthracene	0.1	0.1	<0.02	<0.02	<0.02
Fluoranthene	9.6	0.69	<0.02	<0.02	<0.02
Fluorene	62	62	<0.02	<0.02	<0.02
Indeno[1,2,3-cd]pyrene	0.76	0.38	<0.02	<0.02	<0.02
1-Methylnaphthalene	NV	NV	0.03	<0.02	<0.02
2-Methylnaphthalene	NV	NV	0.03	<0.02	<0.02
Methylnaphthalene (1&2)	76	0.99	0.05	<0.04	<0.04
Naphthalene	9.6	0.6	0.50	0.07	<0.01
Phenanthrene	12	6.2	<0.02	<0.02	<0.02
Pyrene	96	78	<0.02	<0.02	<0.02

Table B.3 - Soil Analytical Results - PHC - F1 and BTEX in µg/g

Parameter	MOE	MOE	BH12-01		BH12-02		BH12-03			
Sample Depth (mBGS)>	Table 3	Table 3	5.18-5.79	7.62-8.22	1.82-2.43	3.05-3.65	3.05-3.65	4.87-5.48	6.09-6.7	Duplicate
Date Sampled>	Com/Ind	Res/Park	22-Feb-12	22-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12
F1 PHCs	55	55	<7	--	<7	<7	9	49	**77**	**79**
Benzene	0.32	0.21	<0.02	<0.02	<0.02	<0.02	0.02	0.17	**4.24**	**2.44**
Ethylbenzene	9.5	2	<0.05	<0.05	<0.05	<0.05	0.14	**6.14**	**18.5**	**19.8**
Toluene	68	2.3	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.34	0.26
Xylenes, m,p-	NV	NV	<0.05	<0.05	<0.05	<0.05	<0.05	1.55	10.6	11.6
Xylene, o-	NV	NV	<0.05	<0.05	<0.05	<0.05	<0.05	1.46	8.05	8.87
Xylenes, Total	26	3.1	<0.05	<0.05	<0.05	<0.05	0.08	3.02	**18.6**	**20.5**

Parameter	MOE	MOE	BH12-04			BH12-05			BH12-06		
Sample Depth (mBGS)>	Table 3	Table 3	1.22-1.82	3.65-4.26	6.7-7.31	3.05-3.65	4.87-5.48	6.7-7.31	3.05-3.65	6.7-7.31	9.14-9.75
Date Sampled>	(µg/g)	Res/Park	17-Feb-12	17-Feb-12	17-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12
F1 PHCs	55	55	<7	<7	<7	<7	18	<7	<7	<7	21
Benzene	0.32	0.21	<0.02	<0.02	0.11	<0.02	<0.02	<0.02	<0.02	0.07	<0.02
Ethylbenzene	9.5	2	<0.05	<0.05	0.81	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	68	2.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes, m,p-	NV	NV	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene, o-	NV	NV	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes, Total	26	3.1	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Parameter	MOE	MOE	BH12-07			BH12-08			BH12-09		
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	2.43-3.05	8.53-9.14	0-0.6	3.05-3.65	4.87-5.48	4.26-4.87	7.31-7.92	9.75-10.21
Date Sampled>	(µg/g)	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	14-Feb-12	14-Feb-12	14-Feb-12	13-Feb-12	13-Feb-12	13-Feb-12
F1 PHCs	55	55	<7	<7	<7	<7	<7	<7	<70****	9	<7
Benzene	0.32	0.21	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.60**	0.05	**3.63**
Ethylbenzene	9.5	2	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	**25.1**	**7.34**	**3.99**
Toluene	68	2.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**17.7**	0.57	**5.26**
Xylenes, m,p-	NV	NV	0.12	<0.05	0.08	<0.05	<0.05	<0.05	84.8	4.55	8.39
Xylene, o-	NV	NV	0.05	<0.05	<0.05	<0.05	0.07	<0.05	45.1	4.06	3.75
Xylenes, Total	26	3.1	0.17	<0.05	0.11	<0.05	0.10	<0.05	**130**	**8.61**	**12.1**

Parameter	MOE	MOE	BH12-10			BH12-11				BH12-12		
Sample Depth (mBGS)>	Table 3	Table 3	0-0.6	2.43-3.05	9.14-9.75	2.43-3.05	6.09-6.70	Duplicate	10.97-11.58	0.6-1.22	6.09-6.7	9.14-9.75
Date Sampled>	(µg/g)	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	22-Feb-12	22-Feb-12	22-Feb-12
F1 PHCs	55	55	<7	<7	**171**	<7	<7	<7	<7	<7	<7	<7
Benzene	0.32	0.21	0.03	<0.02	**20.4**	0.09	**0.52**	**0.46**	0.05	<0.02	<0.02	**3.19**
Ethylbenzene	9.5	2	<0.05	<0.05	**76.5**	<0.05	<0.05	<0.05	1.09	<0.05	0.06	0.37
Toluene	68	2.3	0.09	<0.05	**79.8**	0.26	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes, m,p-	NV	NV	0.06	<0.05	130	0.09	<0.05	<0.05	0.86	<0.05	0.05	0.06
Xylene, o-	NV	NV	<0.05	<0.05	59.2	<0.05	<0.05	<0.05	0.50	<0.05	<0.05	0.08
Xylenes, Total	26	3.1	0.09	<0.05	**189**	0.13	0.06	<0.05	1.36	<0.05	0.06	0.15

Table B.3 - Soil Analytical Results - PHC - F1 and BTEX in µg/g

Parameter	MOE	MOE	BH12-13		BH12-14			BH12-15			
Sample Depth (mBGS)>	Table 3	Table 3	3.05-4.57	4.57-4.87	4.57-5.34	6.10-6.86	8.38-9.14	3.05-3.80	Duplicate	4.57-5.34	6.86-7.62
Date Sampled>	(µg/g)	Res/Park	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
F1 PHCs	55	55	**238**	**18700**	<7	<7	18	<7	<7	<7	<7
Benzene	0.32	0.21	**44.2**	**107**	<0.02	0.07	0.19	<0.02	<0.02	<0.02	<0.02
Ethylbenzene	9.5	2	**15.4**	**23.7**	<0.05	<0.05	**8.48**	<0.05	<0.05	<0.05	<0.05
Toluene	68	2.3	135	199	<0.05	0.10	<0.05	<0.05	0.05	<0.05	<0.05
Xylenes, m,p-	NV	NV	78.6	215	<0.05	0.35	0.58	<0.05	0.31	<0.05	<0.05
Xylene, o-	NV	NV	31.1	80.9	<0.05	0.17	3.45	<0.05	0.12	<0.05	<0.05
Xylenes, Total	26	3.1	**110**	**296**	<0.05	0.52	**4.03**	<0.05	0.42	<0.05	<0.05

Parameter	MOE	MOE	BH12-16				BH12-17			BH12-18		
Sample Depth (mBGS)>	Table 3	Table 3	0.15-1.52	4.57-4.88	Duplicate	7.62-8.38	4.57-5.33	7.62-8.38	8.38-9.14	0.0-1.52	3.05-3.81	7.62-8.38
Date Sampled>	(µg/g)	Res/Park	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
F1 PHCs	55	55	30	<7	9	<7	<7	<7	<7	<7	<7	<7
Benzene	0.32	0.21	**0.35**	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethylbenzene	9.5	2	0.73	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	68	2.3	0.75	0.20	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes, m,p-	NV	NV	1.30	0.36	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene, o-	NV	NV	0.43	0.13	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes, Total	26	3.1	1.73	0.50	0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Parameter	MOE	MOE	BH12-19		
Sample Depth (mBGS)>	Table 3	Table 3	3.05-3.81	4.57-5.33	6.10-6.86
Date Sampled>	(µg/g)	Res/Park	24-Sep-12	24-Sep-12	24-Sep-12
F1 PHCs	55	55	<7	<7	<7
Benzene	0.32	0.21	<0.02	**0.35**	0.17
Ethylbenzene	9.5	2	<0.02	<0.05	<0.05
Toluene	68	2.3	<0.05	0.18	0.16
Xylenes, m,p-	NV	NV	<0.05	0.05	0.08
Xylene, o-	NV	NV	<0.05	<0.05	<0.05
Xylenes, Total	26	3.1	<0.05	0.08	0.12

Table B.4 - Soil Analytical Results - pH and Cyanide in µg/g

Parameter	MOE	MOE	BH12-01				BH12-02			
Sample Depth (mBGS)>	Table 3	Table 3	1.52-2.13	2.74-3.35	3.96-4.57	5.18-5.79	0.6-1.22	Duplicate	1.22-1.82	2.43-3.05
Date Sampled>	Com/Ind	Res/Park	22-Feb-12	22-Feb-12	22-Feb-12	22-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12
pH	NV	NV	--	--	--	8.20	--	--	7.95	--
Free Cyanide	0.051	0.051	<0.03	<0.03	<0.03	--	<0.03	<0.03	--	<0.03

Parameter	MOE	MOE	BH12-03					BH12-04			
Sample Depth (mBGS)>	Table 3	Table 3	1.82-2.43	3.05-3.65	4.26-4.87	Duplicate	4.87-5.48	0.6-1.22	1.82-2.43	2.43-3.05	6.7-7.31
Date Sampled>	(µg/g)	Res/Park	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12
pH	NV	NV	--	--	--	--	7.57	--	--	--	7.86
Free Cyanide	0.051	0.051	<0.03	<0.03	<0.03	<0.03	--	<0.03	<0.03	<0.03	--

Parameter	MOE	MOE	BH12-05				BH12-06			
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	3.05-3.65	4.87-5.48	5.48-6.09	0.6-1.22	1.82-2.43	3.05-3.65	4.87-5.48
Date Sampled>	(µg/g)	Res/Park	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12	21-Feb-12
pH	NV	NV	--	--	7.93	--	--	--	7.40	--
Free Cyanide	0.051	0.051	<0.03	<0.03	--	<0.03	<0.03	<0.03	--	<0.09

Parameter	MOE	MOE	BH12-07				BH12-08			
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	3.65-4.26	4.26-4.87	7.31-7.92	0-0.6	0.6-1.22	4.87-5.48	7.31-7.92
Date Sampled>	(µg/g)	Res/Park	15-Feb-12	15-Feb-12	15-Feb-12	15-Feb-12	14-Feb-12	14-Feb-12	14-Feb-12	14-Feb-12
pH	NV	NV	--	--	--	7.93	--	--	7.51	--
Free Cyanide	0.051	0.051	<0.03	<0.03	<0.03	--	<0.03	<0.03	--	<0.03

Parameter	MOE	MOE	BH12-09				BH12-10			
Sample Depth (mBGS)>	Table 3	Table 3	0-0.6	0.6-1.22	7.31-7.92	9.75-10.21	0.6-1.22	1.22-1.82	2.43-3.05	8.53-9.14
Date Sampled>	(µg/g)	Res/Park	13-Feb-12	13-Feb-12	13-Feb-12	13-Feb-12	15-Feb-12	15-Feb-12	15-Feb-12	15-Feb-12
pH	NV	NV	--	--	7.78	--	--	--	7.79	--
Free Cyanide	0.051	0.051	<0.03	<0.03	--	<0.03	<0.03	<0.03	--	<0.03

Parameter	MOE	MOE	BH12-11				BH12-12			
Sample Depth (mBGS)>	Table 3	Table 3	0.6-1.22	2.43-3.05	3.05-3.65	6.09-6.7	0.6-1.22	3.05-3.65	6.09-6.7	6.7-7.31
Date Sampled>	(µg/g)	Res/Park	17-Feb-12	17-Feb-12	17-Feb-12	17-Feb-12	22-Feb-12	Duplicate	22-Feb-12	22-Feb-12
pH	NV	NV	--	--	--	7.92	--	--	7.97	--
Free Cyanide	0.051	0.051	<0.03	<0.03	<0.03	--	<0.03	<0.03	--	<0.03

Notes for Groundwater Analytical Results

Notes:

All units are µg/L unless otherwise noted
NA = Not applicable because no standard is required for that parameter
-- = Parameter not analysed
** The methylnaphthalene standards are applicable to both 1-methylnaphthalene and 2-methylnaphthalene, with the provision that if both are detected the sum of the two must not exceed the standard
*** F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.
MOE = Soil, Groundwater and Sediment Standards for use under Part XV.1 of the Environmental Protection Act, April 2011
< Parameter concentraton is less than method detection limit (MDL)
**** MDL is greater than MOE standards.
Table 3 = Full depth generic site condition standards, coarse textured soil in a non-potable groundwater condition
bold = indicates concentrations which exceed MOE 2011 Table 3 standards for non-potable groundwater

Table B.5 - Groundwater Analytical Results - Metals and Cyanide in µg/L

Parameter	MOE Table 3	E-006	E-115A	MW12-01	MW12-02	MW12-03	MW12-04	MW12-05	MW12-06
Date Sampled>	non-potable	12-Mar-12	14-Mar-12	14-Mar-12	14-Mar-12	14-Mar-12	14-Mar-12	12-Mar-12	12-Mar-12
Antimony	20,000	<0.5	<0.5	0.7	<0.5	0.6	0.5	0.6	<0.5
Arsenic	1,900	<1	<1	<1	<1	2	<1	<1	<1
Barium	29,000	92	181	123	49	38	20	42	63
Beryllium	67	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	45,000	73	147	176	26	128	169	65	86
Cadmium	2.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	810	8	13	10	16	10	9	8	13
Cobalt	66	1.3	1	3.3	0.9	1.6	4.5	1.8	0.9
Copper	87	3.8	0.7	2.1	1.1	1.2	1.8	2.1	1.3
Lead	25	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium	NV	96,100	45,200	91,900	30,400	45,800	41,900	179,000	62,600
Manganese	NV	98	110	364	172	97	545	162	305
Mercury	0.29	--	<0.1	--	--	--	--	<0.1	--
Molybdenum	9,200	2.9	2.2	16.8	6.0	4.9	5.5	21.5	0.8
Nickel	490	14	4	17	6	8	26	10	5
Selenium	63	<1	<1	<1	<1	<1	2	<1	<1
Silver	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3
Sodium	2,300,000	**2,750,000**	351,000	1,690,000	222,000	64,100	182,000	1,980,000	1,590,000
Thallium	510	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1
Uranium	420	0.6	1.5	4.1	1	1.9	4.1	3.7	0.2
Vanadium	250	<0.5	7.3	1.4	4.3	12.4	11.9	0.9	2.8
Zinc	1,100	<5	<5	<5	<5	6	9	5	<5
Free Cyanide	66	<2	<2	<2	<2	<2	<2	10	5

Table B.5 - Groundwater Analytical Results - Metals and Cyanide in µg/L

Parameter	MOE Table 3	MW12-07	MW12-08	MW12-09	MW12-10	MW12-11	MW12-12	OW109A	OW112A
Date Sampled>	non-potable	12-Mar-12	09-Mar-12	09-Mar-12	09-Mar-12	12-Mar-12	12-Mar-12	14-Mar-12	12-Mar-12
Antimony	20,000	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	1,900	2	<1	<1	1	<1	<1	<1	<1
Barium	29,000	162	64	49	58	57	41	185	5,130
Beryllium	67	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	45,000	56	60	65	56	264	44	481	278
Cadmium	2.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	810	16	14	8	28	12	12	9	1
Cobalt	66	1.5	0.7	0.6	0.7	0.7	0.9	0.8	1.3
Copper	87	1.1	1.3	0.9	1.1	0.9	19.5	0.8	16.5
Lead	25	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium	NV	59,500	47,200	44,400	45,000	58,000	69,900	72,400	104,000
Manganese	NV	284	110	58	60	117	208	141	629
Mercury	0.29	<0.1	--	<0.1	--	<0.1	<0.1	<0.1	--
Molybdenum	9,200	7.7	4.3	1.8	0.9	0.9	4.3	1.2	<0.5
Nickel	490	9	5	6	6	6	7	3	5
Selenium	63	<1	<1	<1	<1	<1	<1	1	<1
Silver	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	2,300,000	1,200,000	548,000	1,160,000	1,460,000	374,000	1,360,000	698,000	1,300,000
Thallium	510	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	420	2.8	0.9	0.5	<0.1	0.3	13.8	0.1	<0.1
Vanadium	250	3.9	6.2	2.4	8.5	6.9	2.3	1.6	1.9
Zinc	1,100	5	8	<5	<5	6	<5	8	<5
Free Cyanide	66	<2	<2	<2	<2	<2	<2	6	<2

Table B.5 - Groundwater Analytical Results - Metals and Cyanide in µg/L

Parameter	MOE	OW112B		OW116A	OW116C	OW122B	OW122C		OW507C
Date Sampled>	Table 3 non-potable	14-Mar-12	Duplicate 14-Mar-12	13-Mar-12	14-Mar-12	13-Mar-12	13-Mar-12	Duplicate 13-Mar-12	16-Apr-12
Antimony	20,000	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.7	<0.5
Arsenic	1,900	<1	<1	<1	<1	<1	<1	<1	<1
Barium	29,000	41	40	393	23	37	45	46	12
Beryllium	67	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron (total)	45,000	61	57	840	88	579	364	390	67
Cadmium	2.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	810	9	8	12	19	10	7	7	13
Cobalt	66	<0.5	<0.5	<0.5	0.8	0.6	<0.5	<0.5	4.1
Copper	87	0.8	0.8	<0.5	1.7	1.4	0.7	0.7	2.6
Lead	25	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3
Magnesium	NV	43,600	42,300	7,990	137,000	156,000	193,000	195,000	--
Manganese	NV	98	99	11	237	30	156	160	--
Mercury	0.29	--	--	--	--	--	<0.1	<0.1	<0.1
Molybdenum	9,200	2.7	2.8	<0.5	1.1	0.8	5.7	5.6	8.3
Nickel	490	5	5	<1	6	6	2	2	143
Selenium	63	<1	<1	<1	<1	<1	1	1	14
Silver	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	2,300,000	911,000	889,000	313,000	1,980,000	241,000	185,000	182,000	1,050,000
Thallium	510	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Uranium	420	0.2	0.2	<0.1	<0.1	<0.1	0.1	0.1	1.6
Vanadium	250	1.3	1.4	3.6	3.6	2.5	1.6	1.6	14.3
Zinc	1,100	6	<5	<5	5	<5	<5	<5	6
Free Cyanide	66	<2	<2	<2	<2	<2	<2	<2	<2

Table B.5 - Groundwater Analytical Results - Metals and Cyanide in µg/L

Parameter	MOE	OW507B		Field Blank
Date Sampled>	Table 3 non-potable	16-Apr-12	Duplicate 16-Apr-12	19-Apr-12
Antimony	20,000	<0.5	<0.5	<0.05
Arsenic	1,900	<1	<1	<1
Barium	29,000	99	96	<1
Beryllium	67	<0.5	<0.5	<0.5
Boron (total)	45,000	40	42	<10
Cadmium	2.7	<0.1	<0.1	<0.1
Chromium	810	6	7	<1
Cobalt	66	<0.5	<0.5	<0.5
Copper	87	<0.5	0.5	<0.5
Lead	25	0.2	0.2	<0.1
Magnesium	NV	--	--	--
Manganese	NV	--	--	--
Mercury	0.29	<0.1	<0.1	<0.1
Molybdenum	9,200	0.8	0.7	<0.5
Nickel	490	3	3	<1
Selenium	63	<1	<1	<1
Silver	1.5	<0.1	<0.1	<0.1
Sodium	2,300,000	154,000	157,000	<200
Thallium	510	<0.1	<0.1	<0.1
Uranium	420	<0.1	<0.1	<0.1
Vanadium	250	3.3	3.5	<0.5
Zinc	1,100	<5	<5	<5
Free Cyanide	66	<2	<2	<2

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	BH-001	E-006		E-115A			MW12-01	
Date Sampled>	Table 3 non-potable	04-Oct-12	12-Mar-12	05-Oct-12	14-Mar-12	02-Oct-12	Duplicate 02-Oct-12	14-Mar-12	03-Oct-12
Acenaphthene	600	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	1.8	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	2.4	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]anthracene	4.7	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]pyrene	0.81	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[g,h,i]perylene	0.2	<0.25****	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Biphenyl	1,000	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chrysene	1	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	130	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	400	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<0.25****	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 1-	NV	<0.25	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 2-	NV	<0.25	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 2-(1-)-**	1,800	<0.05	<0.1	0.13	<0.10	<0.10	<0.10	<0.10	<0.10
Naphthalene	1,400	<0.25	0.54	0.25	0.31	<0.05	<0.05	0.27	<0.05
Phenanthrene	580	<0.25	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pyrene	68	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	MW12-02		MW12-03		MW12-04		MW12-05	
Date Sampled>	Table 3 non-potable	14-Mar-12	01-Oct-12	14-Mar-12	03-Oct-12	14-Mar-12	03-Oct-12	12-Mar-12	03-Oct-12
Acenaphthene	600	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	1.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	2.4	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01
Benzo[a]anthracene	4.7	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]pyrene	0.81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[g,h,i]perylene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Biphenyl	1,000	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01
Chrysene	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	130	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01
Fluorene	400	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 1-	NV	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05
Methylnaphthalene, 2-	NV	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05
Methylnaphthalene, 2-(1-)-**	1,800	<0.10	<0.10	<0.10	0.11	<0.10	0.14	<0.10	<0.10
Naphthalene	1,400	<0.05	<0.05	0.06	<0.05	<0.05	0.10	0.12	0.09
Phenanthrene	580	<0.05	<0.05	0.07	<0.05	0.08	<0.05	0.62	<0.05
Pyrene	68	<0.01	0.01	0.16	<0.01	0.05	<0.01	0.08	<0.01

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	MW12-06		MW12-07		MW12-08		MW12-09	
Date Sampled>	Table 3 non-potable	12-Mar-12	01-Oct-12	12-Mar-12	04-Oct-12	09-Mar-12	02-Oct-12	09-Mar-12	02-Oct-12
Acenaphthene	600	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<2.50	<50
Acenaphthylene	1.8	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	**241**	**60.8**
Anthracene	2.4	<0.01	<0.01	0.03	<0.01	0.03	<0.01	**12.5**	**11.7**
Benzo[a]anthracene	4.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**12.4**	<10****
Benzo[a]pyrene	0.81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**7.77**	<10****
Benzo[b]fluoranthene	0.75	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**6.97**	<50****
Benzo[g,h,i]perylene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<2.5****	<50****
Benzo[k]fluoranthene	0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**5.02**	<50****
Biphenyl	1,000	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	32.4	<50
Chrysene	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**12.5**	<50****
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<2.5****	<50****
Fluoranthene	130	<0.01	<0.01	<0.05	<0.01	0.06	0.02	12.1	15
Fluorene	400	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	42.8	<50
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<2.5****	<50****
Methylnaphthalene, 1-	NV	<0.05	<0.05	0.08	<0.05	0.08	<0.05	447	132
Methylnaphthalene, 2-	NV	<0.05	<0.05	0.11	<0.05	0.09	0.06	842	212
Methylnaphthalene, 2-(1-)-**	1,800	<0.10	<0.10	0.19	<0.10	0.17	<0.10	1320	344
Naphthalene	1,400	0.63	0.29	0.53	0.15	0.43	0.12	**7120**	1210
Phenanthrene	580	0.12	<0.05	0.17	0.08	0.15	<0.05	50.3	<50
Pyrene	68	0.05	0.02	0.08	<0.01	0.09	0.03	20	23.1

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	MW12-10		MW12-11		MW12-12		MW12-13	
Date Sampled>	Table 3 non-potable	09-Mar-12	02-Oct-12	12-Mar-12	04-Oct-12	12-Mar-12	04-Oct-12	02-Oct-12	Duplicate 02-Oct-12
Acenaphthene	600	128	36.3	2.76	2.72	0.07	<0.05	<50	<50
Acenaphthylene	1.8	**317**	**48.3**	**73.1**	**59.2**	0.32	<0.05	<50****	**77.3**
Anthracene	2.4	**69.4**	**7.12**	**2.94**	**5.02**	0.02	<0.01	**11.7**	**19.9**
Benzo[a]anthracene	4.7	**84**	<5****	<0.05	3.38	<0.01	<0.01	<10****	<10****
Benzo[a]pyrene	0.81	**59.9**	<5****	<0.05	**3.10**	<0.01	<0.01	<10****	<10****
Benzo[b]fluoranthene	0.75	**50.6**	<25****	<0.25	**3.24**	<0.05	<0.05	<50****	<50****
Benzo[g,h,i]perylene	0.2	**21.1**	<25****	<0.25****	**1.30**	<0.05	<0.05	<50****	<50****
Benzo[k]fluoranthene	0.4	**36.5**	<25****	<0.25	**1.25**	<0.05	<0.05	<50****	<50****
Biphenyl	1,000	76.3	<25	<0.25	3.94	<0.05	<0.05	<50	<50
Chrysene	1	**75.5**	<25****	<0.25	**3.24**	<0.05	<0.05	<50****	<50****
Dibenzo[a,h]anthracene	0.52	<2.5****	<25****	<0.25	**0.57**	<0.05	<0.05	<50****	<50****
Fluoranthene	130	90.8	12	3.07	6.14	<0.01	<0.01	21.2	24.6
Fluorene	400	140	25.1	13.4	12.6	<0.05	<0.05	<50	<50
Indeno[1,2,3-cd]pyrene	0.2	**15.2**	<25****	<2.5****	**1.32**	<0.05	<0.05	<50****	<50****
Methylnaphthalene, 1-	NV	1040	247	148	98.5	1.48	<0.05	163	277
Methylnaphthalene, 2-	NV	1850	295	142	7.73	<0.05	<0.05	240	301
Methylnaphthalene, 2-(1-)-**	1,800	**2890**	542	290	106	1.48	<0.10	404	578
Naphthalene	1,400	**7350**	**1680**	**1,510**	91.1	1.31	<0.05	800	981
Phenanthrene	580	300	45.5	15.8	13.1	0.15	<0.05	53.9	69
Pyrene	68	**150**	19.3	4.82	11.9	0.05	<0.01	30.4	40.8

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	MW12-14	MW12-15	MW12-16	MW12-17	MW12-18	MW12-19	OW109A	
Date Sampled>	Table 3 non-potable	05-Oct-12	02-Oct-12	02-Oct-12	05-Oct-12	03-Oct-12	03-Oct-12	14-Mar-12	03-Oct-12
Acenaphthene	600	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	1.8	**19.0**	0.19	0.14	<0.05	<0.05	0.10	0.21	<0.05
Anthracene	2.4	<1	0.05	0.03	<0.01	0.02	0.03	<0.01	<0.01
Benzo[a]anthracene	4.7	<10****	0.23	<0.01	<0.01	0.09	0.09	<0.01	<0..01
Benzo[a]pyrene	0.81	<1****	0.19	<0.01	<0.01	0.04	0.05	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<5****	0.21	<0.05	<0.05	0.09	0.09	<0.05	<0.01
Benzo[g,h,i]perylene	0.2	<5****	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<5****	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Biphenyl	1,000	<5	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chrysene	1	<5****	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<5****	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	130	<1	0.42	0.05	<0.01	0.12	0.09	<0.01	<0.01
Fluorene	400	<5	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<5****	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 1-	NV	38.8	0.09	0.19	0.12	0.09	0.06	<0.05	0.10
Methylnaphthalene, 2-	NV	37.6	0.12	0.20	0.17	0.09	0.08	<0.05	0.14
Methylnaphthalene, 2-(1-)-**	1,800	76.4	0.21	0.39	0.29	0.18	0.14	<0.10	0.24
Naphthalene	1,400	631	0.38	0.76	0.91	0.18	0.24	0.81	0.29
Phenanthrene	580	<5	0.06	0.10	<0.05	0.20	0.11	0.09	<0.05
Pyrene	68	<1	0.45	0.06	<0.01	0.12	0.11	<0.01	<0.01

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	OW110A	OW111B	OW112A			OW112B		
Date Sampled>	Table 3 non-potable	01-Oct-12	09-Oct-12	12-Mar-12	02-Oct-12	Duplicate 02-Oct-12	14-Mar-12	Duplicate 14-Mar-12	05-Oct-12
Acenaphthene	600	<0.05	<0.05	<0.05	0.07	0.08	<12	<12	<10
Acenaphthylene	1.8	<0.05	0.80	<0.05	0.23	0.23	**302**	**278**	**127**
Anthracene	2.4	<0.01	0.02	0.03	0.09	0.11	**57.6**	**60.8**	**3.46**
Benzo[a]anthracene	4.7	<0.01	0.04	<0.01	0.15	0.20	**51.4**	**47.7**	<2
Benzo[a]pyrene	0.81	<0.01	<0.01	<0.01	0.09	0.12	**33.6**	**30.7**	<2****
Benzo[b]fluoranthene	0.75	<0.01	<0.05	<0.05	0.08	0.10	**29.6**	**23.7**	<10****
Benzo[g,h,i]perylene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	**18.1**	**14.9**	<10****
Benzo[k]fluoranthene	0.4	<0.05	<0.05	<0.05	<0.05	0.08	<12****	**13.9**	<10****
Biphenyl	1,000	<0.05	0.11	<0.05	<0.05	<0.05	45.1	42.5	19.7
Chrysene	1	<0.05	<0.05	<0.05	0.12	0.17	**47**	**42.1**	<10****
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<12****	<12****	<10****
Fluoranthene	130	<0.01	0.06	0.05	0.10	0.14	59.4	54	<2
Fluorene	400	<0.05	0.07	<0.05	0.12	0.12	111	101	20.1
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	**14.3**	<12****	<10****
Methylnaphthalene, 1-	NV	<0.05	2.50	0.09	0.23	0.27	623	581	312
Methylnaphthalene, 2-	NV	0.09	0.36	0.11	0.30	0.34	701	657	212
Methylnaphthalene, 2-(1-)-**	1,800	0.13	2.86	0.20	0.53	0.61	1320	1240	524
Naphthalene	1,400	0.21	2.24	0.58	0.46	0.47	**4830**	**4440**	**2560**
Phenanthrene	580	<0.05	0.11	0.10	0.34	0.43	195	179	18.4
Pyrene	68	<0.05	0.09	0.07	0.21	0.28	**104**	**94.7**	5.09

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	OW116A		OW116B	OW116C		OW122B	
Date Sampled>	Table 3 non-potable	13-Mar-12	01-Oct-12	01-Oct-12	14-Mar-12	03-Oct-12	13-Mar-12	04-Oct-12
Acenaphthene	600	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	1.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	2.4	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Benzo[a]anthracene	4.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]pyrene	0.81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05
Benzo[g,h,i]perylene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Biphenyl	1,000	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chrysene	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	130	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01
Fluorene	400	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 1-	NV	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 2-	NV	<0.05	0.06	0.07	0.05	0.05	<0.05	<0.05
Methylnaphthalene, 2-(1-)-**	1,800	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10
Naphthalene	1,400	0.41	0.3	0.77	0.18	0.30	0.39	0.63
Phenanthrene	580	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05
Pyrene	68	<0.01	<0.05	<0.05	0.05	<0.01	<0.01	<0.01

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	OW122C			OW507C		OW507B		
Date Sampled>	Table 3 non-potable	13-Mar-12	Duplicate 13-Mar-12	04-Oct-12	16-Apr-12	29-Oct-12	19-Apr-12	Duplicate 19-Apr-12	29-Oct-12
Acenaphthene	600	<0.05	<0.05	<0.05	--	0.25	<0.05	<0.05	<0.05
Acenaphthylene	1.8	<0.05	**5.47**	<0.05	0.94	0.77	<0.05	<0.05	<0.05
Anthracene	2.4	<0.01	0.06	<0.01	0.02	0.03	<0.01	<0.01	<0.01
Benzo[a]anthracene	4.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[a]pyrene	0.81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[g,h,i]perylene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Biphenyl	1,000	<0.05	<0.05	<0.05	0.25	0.18	<0.05	<0.05	<0.05
Chrysene	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	130	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Fluorene	400	<0.05	0.28	<0.05	0.13	0.08	<0.05	<0.05	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene, 1-	NV	<0.05	0.14	<0.05	0.1	0.05	<0.05	<0.05	0.06
Methylnaphthalene, 2-	NV	<0.05	0.17	<0.05	0.08	0.05	0.6	0.07	0.15
Methylnaphthalene, 2-(1-)-**	1,800	<0.10	0.31	<0.10	0.18	0.10	<0.10	0.11	0.21
Naphthalene	1,400	0.64	13.9	0.84	0.36	0.08	0.67	0.66	0.26
Phenanthrene	580	<0.05	0.38	<0.05	0.08	0.06	<0.05	<0.05	<0.05
Pyrene	68	<0.01	0.04	<0.01	0.03	0.03	<0.01	<0.01	0.04

Table B.6 - Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbons in µg/L

Parameter	MOE	Field Blank	
Date Sampled>	Table 3 non-potable	19-Apr-12	29-Oct-12
Acenaphthene	600	<0.05	<0.05
Acenaphthylene	1.8	<0.05	<0.05
Anthracene	2.4	<0.01	<0.01
Benzo[a]anthracene	4.7	<0.01	<0.01
Benzo[a]pyrene	0.81	<0.01	<0.01
Benzo[b]fluoranthene	0.75	<0.05	<0.05
Benzo[g,h,i]perylene	0.2	<0.05	<0.05
Benzo[k]fluoranthene	0.4	<0.05	<0.05
Biphenyl	1,000	<0.05	<0.05
Chrysene	1	<0.05	<0.05
Dibenzo[a,h]anthracene	0.52	<0.05	<0.05
Fluoranthene	130	<0.01	<0.01
Fluorene	400	<0.05	<0.05
Indeno[1,2,3-cd]pyrene	0.2	<0.05	<0.05
Methylnaphthalene, 1-	NV	<0.05	<0.05
Methylnaphthalene, 2-	NV	<0.05	<0.05
Methylnaphthalene, 2-(1-)-**	1,800	<0.10	<0.10
Naphthalene	1,400	0.1	<0.05
Phenanthrene	580	<0.05	<0.05
Pyrene	68	<0.01	<0.01

Table B.7 - Groundwater Analytical Results - PHC - F1 and BTEX in µg/L

Parameter	MOE	BH-001	E-006		E-115A			MW12-01	
Date Sampled>	Table 3 non-potable	04-Oct-12	12-Mar-12	05-Oct-12	14-Mar-12	02-Oct-12	Duplicate 02-Oct-12	14-Mar-12	03-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	<25	<25
Benzene	44	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	18,000	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, m,p-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylene, o-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, Total	4,200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	MOE	MW12-02		MW12-03		MW12-04		MW12-05	
Date Sampled>	Table 3 non-potable	14-Mar-12	01-Oct-12	14-Mar-12	03-Oct-12	14-Mar-12	03-Oct-12	12-Mar-12	03-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	<25	<25
Benzene	44	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	18,000	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, m,p-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylene, o-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, Total	4,200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	MOE	MW12-06		MW12-07		MW12-08		MW12-09	
Date Sampled>	Table 3 non-potable	12-Mar-12	01-Oct-12	12-Mar-12	04-Oct-12	09-Mar-12	02-Oct-12	09-Mar-12	02-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	**2200**	**52200000**
Benzene	44	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**7210**	**18600**
Ethylbenzene	2,300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	956	1860
Toluene	18,000	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	13000	3850
Xylenes, m,p-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3680	2250
Xylene, o-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1820	1400
Xylenes, Total	4,200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**5500**	3650

Table B.7 - Groundwater Analytical Results - PHC - F1 and BTEX in µg/L

Parameter	MOE	MW12-10		MW12-11		MW12-12		MW12-13	
Date Sampled>	Table 3 non-potable	09-Mar-12	02-Oct-12	12-Mar-12	04-Oct-12	12-Mar-12	04-Oct-12	02-Oct-12	Duplicate 02-Oct-12
F1 PHCs (C6-C10)***	750	**5500**	**1340**	**1770**	<25	<25	<25	**5520**	**5550**
Benzene	44	**5150**	**307**	30	<0.5	38.4	<0.5	**775**	**6390**
Ethylbenzene	2,300	**2490**	**2580**	510	<0.5	6.8	<0.5	**3760**	2180
Toluene	18,000	4490	275	17	<0.5	<0.5	<0.5	958	1210
Xylenes, m,p-	NV	1170	1530	317	<0.5	4.7	<0.5	4120	2480
Xylene, o-	NV	878	1010	218	<0.5	1.0	<0.5	2460	1640
Xylenes, Total	4,200	2050	2540	535	<0.5	5.7	<0.5	**6580**	4120

Parameter	MOE	MW12-14	MW12-15	MW12-16	MW12-17	MW12-18	MW12-19	OW109A	
Date Sampled>	Table 3 non-potable	05-Oct-12	02-Oct-12	02-Oct-12	05-Oct-12	03-Oct-12	03-Oct-12	14-Mar-12	03-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	<25	<25
Benzene	44	**110**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,300	657	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	18,000	45.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, m,p-	NV	168	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylene, o-	NV	692	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, Total	4,200	860	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	MOE	OW110A	OW111B	OW112A			OW112B		
Date Sampled>	Table 3 non-potable	01-Oct-12	09-Oct-12	12-Mar-12	02-Oct-12	Duplicate 02-Oct-12	14-Mar-12	Duplicate 14-Mar-12	05-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	**3850**	**3900**	<1250****
Benzene	44	<0.5	34.3	<0.5	<0.5	<0.5	**1090**	**1080**	**695**
Ethylbenzene	2,300	<0.5	6.9	<0.5	<0.5	<0.5	553	569	644
Toluene	18,000	<0.5	1	<0.5	<0.5	<0.5	3950	3900	2030
Xylenes, m,p-	NV	<0.5	3.4	<0.5	<0.5	<0.5	1580	1600	965
Xylene, o-	NV	<0.5	3.7	<0.5	<0.5	<0.5	830	836	494
Xylenes, Total	4,200	<0.5	7.1	<0.5	<0.5	<0.5	2410	2430	1460

Table B.7 - Groundwater Analytical Results - PHC - F1 and BTEX in µg/L

Parameter	MOE Table 3	OW116A		OW116B	OW116C		OW122B	
Date Sampled>	non-potable	13-Mar-12	01-Oct-12	01-Oct-12	14-Mar-12	03-Oct-12	13-Mar-12	04-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	<25
Benzene	44	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	18,000	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, m,p-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylene, o-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, Total	4,200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	MOE Table 3	OW122C			OW507C		OW507B		
Date Sampled>	non-potable	13-Mar-12	Duplicate 13-Mar-12	04-Oct-12	16-Apr-12	29-Oct-12	16-Apr-12	Duplicate 16-Apr-12	29-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25	<25	<25	<25	<25	<25	<25
Benzene	44	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,300	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	18,000	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, m,p-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylene, o-	NV	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes, Total	4,200	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	MOE Table 3	Field Blank	
Date Sampled>	non-potable	19-Apr-12	29-Oct-12
F1 PHCs (C6-C10)***	750	<25	<25
Benzene	44	<0.5	<0.5
Ethylbenzene	2,300	<0.5	<0.5
Toluene	18,000	<0.5	<0.5
Xylenes, m,p-	NV	<0.5	<0.5
Xylene, o-	NV	<0.5	<0.5
Xylenes, Total	4,200	<0.5	<0.5

APPENDIX C

Soil Texture Tables

Table C.1 – Grain Size Distribution – Sieve Results

Table C.2 – Grain Size Distribution – Sieve and Hydrometer Results

Table C.1 - Grain Size Distribution - Sieve Results in %

Parameter		BH12-02	BH12-03	BH12-04	BH12-05	BH12-06	BH12-07	BH12-10	BH12-11	BH12-12
Sample Depth (mBGS)>	Size	1.22-1.82	4.87-5.48	6.70-7.31	4.87-5.48	3.05-3.65	7.31-7.92	2.43-3.05	6.09-6.70	6.09-6.70
Date Sampled>	mm	17-Feb-12	17-Feb-12	17-Feb-12	21-Feb-12	21-Feb-12	15-Feb-12	15-Feb-12	17-Feb-12	22-Feb-12
Cobbles	>19	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Coarse Gravel	<19 to 4.75	3.40	10.4	2.2	12.1	6.0	1.30	10.00	14.40	<0.1
Fine Gravel	<4.75 to 2	11.3	18.5	2.4	16.9	11.2	3.2	3.8	13.3	0.2
Coarse Sand to Medium Sand	<2 to 0.425	21.5	41.5	24.8	27.9	14.8	7.7	13.4	31.7	3.6
Fine Sand to Very Fine Sand	<0.425 to 0.075	11.1	15.4	53.5	18.2	5.8	37.7	62.8	25.6	86
Silt and Clay	<0.075	52.7	14.3	17.1	24.9	62.2	50	9.9	14.9	10.2
MOE Soil Texture Classification		M&F	C	C	C	M&F	C	C	C	C

Notes:
M&F = Medium and Fine Textured
C = Coarse Textured

Table C.2 - Grain Size Distribution, Sieve and Hydrometer Results in %

Parameter		BH12-01	BH12-08	BH12-09
Sample Depth (mBGS)>	Size	5.18-5.79	4.87-5.48	7.31-7.92
Date Sampled>	mm	22-Feb-12	14-Feb-12	13-Feb-12
Coarse Gravel	>4.75	1.60	0.30	4.80
Fine Gravel	>2-4.75	1.30	1.70	4.40
Very Coarse Sand	>1-2	0.9	1	2.4
Coarse Sand	>0.5-1	1	1.7	5.9
Medium Sand	>0.25-0.5	1	5.9	18.8
Fine Sand	>0.1-0.25	1.5	30	31.3
Very Fine Sand	>0.05-0.1	19.5	34.4	17.7
Silt	>0.002-0.05	64.1	23	10.8
Clay	<=0.002	9.4	2	4
MOE Soil Texture Classification		C	C	C

Notes:
M&F = Medium and Fine Textured
C = Coarse Textured

APPENDIX D

Laboratory Analytical Reports

PARACEL LABORATORIES LTD. | TRUSTED. RESPONSIVE. RELIABLE.

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Head Office
300-2319 St. Laurent Blvd.
Ottawa, Ontario K1G 4J8
p: 1-800-749-1947
e: paracel@paracellabs.com
www.paracellabs.com

Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 94616/5

Report Date: 16-Nov-2012
Order Date: 25-Sep-2012
Revised Report **Order #: 1239131**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1239131-01	MW12-17 SA2
1239131-02	MW12-17 SA4
1239131-03	MW12-17 SA6
1239131-04	MW12-17 SA8
1239131-05	MW12-17 SA9
1239131-06	MW12-17 SA10
1239131-07	MW12-17 SA11
1239131-08	MW12-19 SA4
1239131-09	MW12-19 SA1
1239131-10	MW12-19 SA8
1239131-11	MW12-19 SA5
1239131-12	MW12-19 SA3
1239131-13	MW12-19 SA7
1239131-14	MW12-18 SA1
1239131-15	MW12-18 SA3
1239131-16	MW12-18 SA2
1239131-17	MW12-18 SA7
1239131-18	MW12-18 SA4
1239131-19	MW12-18 SA10

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 8260 - P&T GC-MS	26-Sep-12	29-Sep-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	26-Sep-12	29-Sep-12
Mercury	EPA 7471A - CVAA, digestion	2-Oct-12	3-Oct-12
Metals	EPA 6020 - Digestion - ICP-MS	27-Sep-12	27-Sep-12
PAHs by GC-MS, standard scan	EPA 8270 - GC-MS, extraction	28-Sep-12	2-Oct-12
Solids, %	Gravimetric, calculation	27-Sep-12	27-Sep-12

PARACEL LABORATORIES LTD.

Order #: 1239131

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-17 SA2	MW12-17 SA4	MW12-17 SA6	MW12-17 SA8
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-01	1239131-02	1239131-03	1239131-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	93.5	93.9	93.0	94.0
Metals					
Antimony	1 ug/g dry	<1	-	-	<1
Arsenic	1 ug/g dry	<1	-	-	<1
Barium	1 ug/g dry	25	-	-	18
Beryllium	0.5 ug/g dry	<0.5	-	-	<0.5
Cadmium	0.5 ug/g dry	<0.5	-	-	<0.5
Calcium	200 ug/g dry	15000	-	-	17300
Chromium	5 ug/g dry	8	-	-	<5
Cobalt	1 ug/g dry	3	-	-	3
Copper	5 ug/g dry	8	-	-	6
Iron	200 ug/g dry	7000	-	-	6890
Lead	1 ug/g dry	2	-	-	1
Magnesium	200 ug/g dry	2490	-	-	3180
Manganese	5 ug/g dry	143	-	-	89
Mercury	0.1 ug/g dry	<0.1	-	-	<0.1
Molybdenum	1 ug/g dry	<1	-	-	<1
Nickel	5 ug/g dry	6	-	-	6
Potassium	200 ug/g dry	605	-	-	467
Selenium	1 ug/g dry	<1	-	-	<1
Silver	0.3 ug/g dry	<0.3	-	-	<0.3
Sodium	50 ug/g dry	249	-	-	225
Thallium	1 ug/g dry	<1	-	-	<1
Tin	5 ug/g dry	<5	-	-	<5
Vanadium	10 ug/g dry	15	-	-	<10
Zinc	20 ug/g dry	<20	-	-	<20
Volatiles					
Benzene	0.02 ug/g dry	-	-	<0.02	-
Ethylbenzene	0.05 ug/g dry	-	-	<0.05	-
Toluene	0.05 ug/g dry	-	-	<0.05	-
m,p-Xylenes	0.05 ug/g dry	-	-	<0.05	-
o-Xylene	0.05 ug/g dry	-	-	<0.05	-
Xylenes, total	0.05 ug/g dry	-	-	<0.05	-
Toluene-d8	Surrogate	-	-	105%	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-17 SA2	MW12-17 SA4	MW12-17 SA6	MW12-17 SA8
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-01	1239131-02	1239131-03	1239131-04
	MDL/Units	Soil	Soil	Soil	Soil
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	-	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.02	<0.02	-	-
Acenaphthylene	0.02 ug/g dry	0.13	0.02	-	-
Anthracene	0.02 ug/g dry	0.14	<0.02	-	-
Benzo [a] anthracene	0.02 ug/g dry	0.16	0.03	-	-
Benzo [a] pyrene	0.02 ug/g dry	0.12	<0.02	-	-
Benzo [b] fluoranthene	0.02 ug/g dry	0.12	<0.02	-	-
Benzo [g,h,i] perylene	0.02 ug/g dry	0.08	<0.02	-	-
Benzo [k] fluoranthene	0.02 ug/g dry	0.08	<0.02	-	-
Biphenyl	0.02 ug/g dry	<0.02	<0.02	-	-
Chrysene	0.02 ug/g dry	0.17	0.03	-	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	0.02	<0.02	-	-
Fluoranthene	0.02 ug/g dry	0.22	0.02	-	-
Fluorene	0.02 ug/g dry	0.04	<0.02	-	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	0.07	<0.02	-	-
1-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	-	-
2-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	-	-
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.04	<0.04	-	-
Naphthalene	0.01 ug/g dry	0.03	<0.01	-	-
Phenanthrene	0.02 ug/g dry	0.14	<0.02	-	-
Pyrene	0.02 ug/g dry	0.41	0.04	-	-
2-Fluorobiphenyl	Surrogate	103%	92.5%	-	-
Terphenyl-d14	Surrogate	98.5%	103%	-	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-17 SA9	MW12-17 SA10	MW12-17 SA11	MW12-19 SA4
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-05	1239131-06	1239131-07	1239131-08
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	91.3	91.2	91.3	94.3
Metals					
Antimony	1 ug/g dry	<1	-	-	<1
Arsenic	1 ug/g dry	<1	-	-	<1
Barium	1 ug/g dry	110	-	-	16
Beryllium	0.5 ug/g dry	<0.5	-	-	<0.5
Cadmium	0.5 ug/g dry	<0.5	-	-	<0.5
Calcium	200 ug/g dry	14200	-	-	14300
Chromium	5 ug/g dry	17	-	-	<5
Cobalt	1 ug/g dry	6	-	-	3
Copper	5 ug/g dry	14	-	-	7
Iron	200 ug/g dry	12200	-	-	7600
Lead	1 ug/g dry	3	-	-	1
Magnesium	200 ug/g dry	6050	-	-	2810
Manganese	5 ug/g dry	256	-	-	80
Mercury	0.1 ug/g dry	<0.1	-	-	<0.1
Molybdenum	1 ug/g dry	<1	-	-	<1
Nickel	5 ug/g dry	12	-	-	5
Potassium	200 ug/g dry	2040	-	-	416
Selenium	1 ug/g dry	<1	-	-	<1
Silver	0.3 ug/g dry	<0.3	-	-	<0.3
Sodium	50 ug/g dry	393	-	-	221
Thallium	1 ug/g dry	<1	-	-	<1
Tin	5 ug/g dry	<5	-	-	<5
Vanadium	10 ug/g dry	26	-	-	10
Zinc	20 ug/g dry	25	-	-	<20
Volatiles					
Benzene	0.02 ug/g dry	-	<0.02	<0.02	-
Ethylbenzene	0.05 ug/g dry	-	<0.05	<0.05	-
Toluene	0.05 ug/g dry	-	<0.05	<0.05	-
m,p-Xylenes	0.05 ug/g dry	-	<0.05	<0.05	-
o-Xylene	0.05 ug/g dry	-	<0.05	<0.05	-
Xylenes, total	0.05 ug/g dry	-	<0.05	<0.05	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-17 SA9	MW12-17 SA10	MW12-17 SA11	MW12-19 SA4
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-05	1239131-06	1239131-07	1239131-08
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	-	106%	105%	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	<7	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.02	-	-	<0.02
Acenaphthylene	0.02 ug/g dry	<0.02	-	-	<0.02
Anthracene	0.02 ug/g dry	<0.02	-	-	<0.02
Benzo [a] anthracene	0.02 ug/g dry	<0.02	-	-	<0.02
Benzo [a] pyrene	0.02 ug/g dry	<0.02	-	-	<0.02
Benzo [b] fluoranthene	0.02 ug/g dry	<0.02	-	-	<0.02
Benzo [g,h,i] perylene	0.02 ug/g dry	<0.02	-	-	<0.02
Benzo [k] fluoranthene	0.02 ug/g dry	<0.02	-	-	<0.02
Biphenyl	0.02 ug/g dry	<0.02	-	-	<0.02
Chrysene	0.02 ug/g dry	<0.02	-	-	<0.02
Dibenzo [a,h] anthracene	0.02 ug/g dry	<0.02	-	-	<0.02
Fluoranthene	0.02 ug/g dry	<0.02	-	-	<0.02
Fluorene	0.02 ug/g dry	<0.02	-	-	<0.02
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	<0.02	-	-	<0.02
1-Methylnaphthalene	0.02 ug/g dry	<0.02	-	-	0.03
2-Methylnaphthalene	0.02 ug/g dry	<0.02	-	-	0.03
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.04	-	-	0.05
Naphthalene	0.01 ug/g dry	<0.01	-	-	0.50
Phenanthrene	0.02 ug/g dry	<0.02	-	-	<0.02
Pyrene	0.02 ug/g dry	<0.02	-	-	<0.02
2-Fluorobiphenyl	Surrogate	97.5%	-	-	70.2%
Terphenyl-d14	Surrogate	105%	-	-	75.9%

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-19 SA1	MW12-19 SA8	MW12-19 SA5	MW12-19 SA3
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-09	1239131-10	1239131-11	1239131-12
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	93.7	85.4	94.7	94.4
Metals					
Antimony	1 ug/g dry	<1	-	<1	-
Arsenic	1 ug/g dry	<1	-	<1	-
Barium	1 ug/g dry	49	-	26	-
Beryllium	0.5 ug/g dry	<0.5	-	<0.5	-
Cadmium	0.5 ug/g dry	<0.5	-	<0.5	-
Calcium	200 ug/g dry	16800	-	12000	-
Chromium	5 ug/g dry	16	-	7	-
Cobalt	1 ug/g dry	5	-	4	-
Copper	5 ug/g dry	11	-	9	-
Iron	200 ug/g dry	9300	-	6850	-
Lead	1 ug/g dry	14	-	2	-
Magnesium	200 ug/g dry	3320	-	2810	-
Manganese	5 ug/g dry	201	-	151	-
Mercury	0.1 ug/g dry	<0.1	-	<0.1	-
Molybdenum	1 ug/g dry	<1	-	<1	-
Nickel	5 ug/g dry	10	-	7	-
Potassium	200 ug/g dry	1030	-	632	-
Selenium	1 ug/g dry	<1	-	<1	-
Silver	0.3 ug/g dry	<0.3	-	<0.3	-
Sodium	50 ug/g dry	200	-	205	-
Thallium	1 ug/g dry	<1	-	<1	-
Tin	5 ug/g dry	<5	-	<5	-
Vanadium	10 ug/g dry	19	-	13	-
Zinc	20 ug/g dry	33	-	<20	-
Volatiles					
Benzene	0.02 ug/g dry	-	-	0.35	<0.02
Ethylbenzene	0.05 ug/g dry	-	-	<0.05	<0.05
Toluene	0.05 ug/g dry	-	-	0.18	<0.05
m,p-Xylenes	0.05 ug/g dry	-	-	0.05	<0.05
o-Xylene	0.05 ug/g dry	-	-	<0.05	<0.05
Xylenes, total	0.05 ug/g dry	-	-	0.08	<0.05

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-19 SA1	MW12-19 SA8	MW12-19 SA5	MW12-19 SA3
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-09	1239131-10	1239131-11	1239131-12
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	-	-	105%	106%
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	-	<7	<7
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	<0.02	<0.02	-
Acenaphthylene	0.02 ug/g dry	-	<0.02	<0.02	-
Anthracene	0.02 ug/g dry	-	<0.02	<0.02	-
Benzo [a] anthracene	0.02 ug/g dry	-	<0.02	<0.02	-
Benzo [a] pyrene	0.02 ug/g dry	-	<0.02	<0.02	-
Benzo [b] fluoranthene	0.02 ug/g dry	-	<0.02	<0.02	-
Benzo [g,h,i] perylene	0.02 ug/g dry	-	<0.02	<0.02	-
Benzo [k] fluoranthene	0.02 ug/g dry	-	<0.02	<0.02	-
Biphenyl	0.02 ug/g dry	-	<0.02	<0.02	-
Chrysene	0.02 ug/g dry	-	<0.02	<0.02	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	<0.02	<0.02	-
Fluoranthene	0.02 ug/g dry	-	<0.02	<0.02	-
Fluorene	0.02 ug/g dry	-	<0.02	<0.02	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	<0.02	<0.02	-
1-Methylnaphthalene	0.02 ug/g dry	-	<0.02	<0.02	-
2-Methylnaphthalene	0.02 ug/g dry	-	<0.02	<0.02	-
Methylnaphthalene (1&2)	0.04 ug/g dry	-	<0.04	<0.04	-
Naphthalene	0.01 ug/g dry	-	<0.01	0.07	-
Phenanthrene	0.02 ug/g dry	-	<0.02	<0.02	-
Pyrene	0.02 ug/g dry	-	<0.02	<0.02	-
2-Fluorobiphenyl	Surrogate	-	81.9%	72.5%	-
Terphenyl-d14	Surrogate	-	86.5%	82.9%	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-19 SA7	MW12-18 SA1	MW12-18 SA3	MW12-18 SA2
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-13	1239131-14	1239131-15	1239131-16
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	90.3	93.0	70.1	89.2
Metals					
Antimony	1 ug/g dry	-	<1	<1	<1
Arsenic	1 ug/g dry	-	3	<1	1
Barium	1 ug/g dry	-	67	385	80
Beryllium	0.5 ug/g dry	-	<0.5	0.7	<0.5
Cadmium	0.5 ug/g dry	-	<0.5	<0.5	<0.5
Calcium	200 ug/g dry	-	48700	14800	18200
Chromium	5 ug/g dry	-	11	42	13
Cobalt	1 ug/g dry	-	5	12	5
Copper	5 ug/g dry	-	25	19	8
Iron	200 ug/g dry	-	12100	24800	11100
Lead	1 ug/g dry	-	98	5	5
Magnesium	200 ug/g dry	-	9440	9850	4180
Manganese	5 ug/g dry	-	288	443	280
Mercury	0.1 ug/g dry	-	0.1	<0.1	<0.1
Molybdenum	1 ug/g dry	-	1	<1	<1
Nickel	5 ug/g dry	-	14	26	11
Potassium	200 ug/g dry	-	884	5250	899
Selenium	1 ug/g dry	-	<1	<1	<1
Silver	0.3 ug/g dry	-	<0.3	<0.3	<0.3
Sodium	50 ug/g dry	-	221	857	234
Thallium	1 ug/g dry	-	<1	<1	<1
Tin	5 ug/g dry	-	<5	<5	<5
Vanadium	10 ug/g dry	-	22	51	22
Zinc	20 ug/g dry	-	46	61	21
Volatiles					
Benzene	0.02 ug/g dry	0.17	<0.02	-	-
Ethylbenzene	0.05 ug/g dry	<0.05	<0.05	-	-
Toluene	0.05 ug/g dry	0.16	<0.05	-	-
m,p-Xylenes	0.05 ug/g dry	0.08	<0.05	-	-
o-Xylene	0.05 ug/g dry	<0.05	<0.05	-	-
Xylenes, total	0.05 ug/g dry	0.12	<0.05	-	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-19 SA7	MW12-18 SA1	MW12-18 SA3	MW12-18 SA2
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	24-Sep-12
	Sample ID:	1239131-13	1239131-14	1239131-15	1239131-16
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	107%	107%	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	<7	<7	-	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	<1.00 [1]	<0.02	-
Acenaphthylene	0.02 ug/g dry	-	3.81	<0.02	-
Anthracene	0.02 ug/g dry	-	5.48	<0.02	-
Benzo [a] anthracene	0.02 ug/g dry	-	8.62	<0.02	-
Benzo [a] pyrene	0.02 ug/g dry	-	5.59	<0.02	-
Benzo [b] fluoranthene	0.02 ug/g dry	-	11.7	<0.02	-
Benzo [g,h,i] perylene	0.02 ug/g dry	-	4.68	<0.02	-
Benzo [k] fluoranthene	0.02 ug/g dry	-	7.31	<0.02	-
Biphenyl	0.02 ug/g dry	-	<1.00 [1]	<0.02	-
Chrysene	0.02 ug/g dry	-	8.51	<0.02	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	1.66	<0.02	-
Fluoranthene	0.02 ug/g dry	-	14.1	<0.02	-
Fluorene	0.02 ug/g dry	-	1.17	<0.02	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	4.43	<0.02	-
1-Methylnaphthalene	0.02 ug/g dry	-	<1.00 [1]	<0.02	-
2-Methylnaphthalene	0.02 ug/g dry	-	<1.00 [1]	<0.02	-
Methylnaphthalene (1&2)	0.04 ug/g dry	-	<2.00 [1]	<0.04	-
Naphthalene	0.01 ug/g dry	-	0.76	<0.01	-
Phenanthrene	0.02 ug/g dry	-	4.71	<0.02	-
Pyrene	0.02 ug/g dry	-	14.4	<0.02	-
2-Fluorobiphenyl	Surrogate	-	61.8%	68.9%	-
Terphenyl-d14	Surrogate	-	73.4%	69.7%	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-18 SA7	MW12-18 SA4	MW12-18 SA10	-
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	-
	Sample ID:	1239131-17	1239131-18	1239131-19	-
	MDL/Units	Soil	Soil	Soil	-
Physical Characteristics					
% Solids	0.1 % by Wt.	92.5	78.5	90.6	-
Volatiles					
Benzene	0.02 ug/g dry	-	<0.02	<0.02	-
Ethylbenzene	0.05 ug/g dry	-	<0.05	<0.05	-
Toluene	0.05 ug/g dry	-	<0.05	<0.05	-
m,p-Xylenes	0.05 ug/g dry	-	<0.05	<0.05	-
o-Xylene	0.05 ug/g dry	-	<0.05	<0.05	-
Xylenes, total	0.05 ug/g dry	-	<0.05	<0.05	-
Toluene-d8	Surrogate	-	106%	106%	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	<7	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.02	-	-	-
Acenaphthylene	0.02 ug/g dry	0.02	-	-	-
Anthracene	0.02 ug/g dry	<0.02	-	-	-
Benzo [a] anthracene	0.02 ug/g dry	0.03	-	-	-
Benzo [a] pyrene	0.02 ug/g dry	<0.02	-	-	-
Benzo [b] fluoranthene	0.02 ug/g dry	0.02	-	-	-
Benzo [g,h,i] perylene	0.02 ug/g dry	<0.02	-	-	-
Benzo [k] fluoranthene	0.02 ug/g dry	<0.02	-	-	-
Biphenyl	0.02 ug/g dry	<0.02	-	-	-
Chrysene	0.02 ug/g dry	0.03	-	-	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	<0.02	-	-	-
Fluoranthene	0.02 ug/g dry	0.03	-	-	-
Fluorene	0.02 ug/g dry	<0.02	-	-	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	<0.02	-	-	-
1-Methylnaphthalene	0.02 ug/g dry	<0.02	-	-	-
2-Methylnaphthalene	0.02 ug/g dry	<0.02	-	-	-
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.04	-	-	-
Naphthalene	0.01 ug/g dry	<0.01	-	-	-
Phenanthrene	0.02 ug/g dry	<0.02	-	-	-
Pyrene	0.02 ug/g dry	0.05	-	-	-
2-Fluorobiphenyl	Surrogate	85.5%	-	-	-

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-18 SA7	MW12-18 SA4	MW12-18 SA10	-
	Sample Date:	24-Sep-12	24-Sep-12	24-Sep-12	-
	Sample ID:	1239131-17	1239131-18	1239131-19	-
	MDL/Units	Soil	Soil	Soil	-
Terphenyl-d14	Surrogate	91.6%	-	-	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g						
Metals									
Antimony	ND	1	ug/g						
Arsenic	ND	1	ug/g						
Barium	ND	1	ug/g						
Beryllium	ND	0.5	ug/g						
Cadmium	ND	0.5	ug/g						
Calcium	ND	200	ug/g						
Chromium	ND	5	ug/g						
Cobalt	ND	1	ug/g						
Copper	ND	5	ug/g						
Iron	ND	200	ug/g						
Lead	ND	1	ug/g						
Magnesium	ND	200	ug/g						
Mercury	ND	0.1	ug/g						
Manganese	ND	5	ug/g						
Molybdenum	ND	1	ug/g						
Nickel	ND	5	ug/g						
Potassium	ND	200	ug/g						
Selenium	ND	1	ug/g						
Silver	ND	0.3	ug/g						
Sodium	ND	50	ug/g						
Thallium	ND	1	ug/g						
Tin	ND	5	ug/g						
Vanadium	ND	10	ug/g						
Zinc	ND	20	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Biphenyl	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.23*		*ug/g*		*92.6*	*50-140*			
Surrogate: Terphenyl-d14	*0.945*		*ug/g*		*70.9*	*50-140*			
Volatiles									
Benzene	ND	0.02	ug/g						
Ethylbenzene	ND	0.05	ug/g						
Toluene	ND	0.05	ug/g						
m,p-Xylenes	ND	0.05	ug/g						
o-Xylene	ND	0.05	ug/g						

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Xylenes, total	ND	0.05	ug/g						
Surrogate: Toluene-d8	*8.53*		*ug/g*		*107*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g dry	ND				40	
Metals									
Antimony	ND	1	ug/g dry	ND			0.0	30	
Arsenic	1.3	1	ug/g dry	1.2			5.6	30	
Barium	181	1	ug/g dry	180			0.2	30	
Beryllium	0.54	0.5	ug/g dry	0.56			4.2	30	
Cadmium	ND	0.5	ug/g dry	ND			0.0	30	
Calcium	113000	200	ug/g dry	112000			1.2	30	
Chromium	11.9	5	ug/g dry	12.1			1.5	30	
Cobalt	4.4	1	ug/g dry	4.5			2.7	30	
Copper	10.1	5	ug/g dry	9.8			3.4	30	
Iron	9560	200	ug/g dry	9660			1.0	30	
Lead	4.0	1	ug/g dry	4.1			0.6	30	
Magnesium	11500	200	ug/g dry	11500			0.0	30	
Mercury	ND	0.1	ug/g dry	ND			0.0	35	
Manganese	285	5	ug/g dry	285			0.1	30	
Molybdenum	1.5	1	ug/g dry	ND			0.0	30	
Nickel	11.3	5	ug/g dry	11.0			2.5	30	
Potassium	1400	200	ug/g dry	1570			11.1	30	
Selenium	ND	1	ug/g dry	ND			0.0	30	
Silver	ND	0.3	ug/g dry	ND			0.0	30	
Sodium	516	50	ug/g dry	519			0.5	30	
Thallium	ND	1	ug/g dry	ND			0.0	30	
Tin	ND	5	ug/g dry	ND			0.0	30	
Vanadium	18.7	10	ug/g dry	18.8			0.7	30	
Zinc	ND	20	ug/g dry	20.4			0.0	30	
Physical Characteristics									
% Solids	79.4	0.1	% by Wt.	80.9			1.9	25	
Volatiles									
Benzene	ND	0.02	ug/g dry	ND				50	
Ethylbenzene	ND	0.05	ug/g dry	0.058			0.0	50	
Toluene	ND	0.05	ug/g dry	0.055			0.0	50	
m,p-Xylenes	ND	0.05	ug/g dry	ND				50	
o-Xylene	ND	0.05	ug/g dry	ND				50	
Surrogate: Toluene-d8	*4.88*		*ug/g dry*	*ND*	*106*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	183	7	ug/g	ND	91.5	80-120			
Metals									
Antimony	47.3		ug/L	0.01	94.5	70-130			
Arsenic	43.3		ug/L	0.5	85.6	70-130			
Barium	118		ug/L	72.1	91.4	70-130			
Beryllium	53.9		ug/L	0.22	107	70-130			
Cadmium	43.0		ug/L	ND	86.0	70-130			
Calcium	869		ug/L	ND	86.9	70-130			
Chromium	50.1		ug/L	4.8	90.5	70-130			
Cobalt	47.8		ug/L	1.8	92.0	70-130			
Copper	49.5		ug/L	3.9	91.2	70-130			
Iron	4480		ug/L	3860	61.7	70-130			QS-02
Lead	48.0		ug/L	1.6	92.7	70-130			
Magnesium	5370		ug/L	4590	77.2	70-130			
Mercury	1.26	0.1	ug/g	ND	84.0	72-128			
Manganese	47.7		ug/L	ND	95.3	70-130			
Molybdenum	43.1		ug/L	0.1	85.9	70-130			
Nickel	50.2		ug/L	4.4	91.5	70-130			
Potassium	1450		ug/L	626	81.9	70-130			
Selenium	43.5		ug/L	0.1	86.7	70-130			
Silver	33.7		ug/L	0.02	67.3	70-130			QS-02
Sodium	1030		ug/L	208	82.7	70-130			
Thallium	58.6		ug/L	ND	117	70-130			
Tin	46.0		ug/L	0.2	91.8	70-130			
Vanadium	53.0		ug/L	7.5	90.9	70-130			
Zinc	48.1		ug/L	8.1	79.8	70-130			
Semi-Volatiles									
Acenaphthene	0.134	0.02	ug/g	ND	70.2	50-140			
Acenaphthylene	0.139	0.02	ug/g	ND	72.8	50-140			
Anthracene	0.125	0.02	ug/g	ND	65.3	50-140			
Benzo [a] anthracene	0.122	0.02	ug/g	ND	63.6	50-140			
Benzo [a] pyrene	0.107	0.02	ug/g	ND	56.2	50-140			
Benzo [b] fluoranthene	0.109	0.02	ug/g	ND	56.9	50-140			
Benzo [g,h,i] perylene	0.118	0.02	ug/g	ND	61.9	50-140			
Benzo [k] fluoranthene	0.115	0.02	ug/g	ND	60.4	50-140			
Biphenyl	0.166	0.02	ug/g	ND	86.8	50-140			
Chrysene	0.137	0.02	ug/g	ND	71.5	50-140			
Dibenzo [a,h] anthracene	0.120	0.02	ug/g	ND	62.7	50-140			
Fluoranthene	0.111	0.02	ug/g	ND	58.2	50-140			
Fluorene	0.173	0.02	ug/g	ND	90.5	50-140			
Indeno [1,2,3-cd] pyrene	0.142	0.02	ug/g	ND	74.3	50-140			
1-Methylnaphthalene	0.112	0.02	ug/g	ND	58.5	50-140			
2-Methylnaphthalene	0.123	0.02	ug/g	ND	64.2	50-140			
Naphthalene	0.122	0.01	ug/g	ND	63.7	50-140			
Phenanthrene	0.141	0.02	ug/g	ND	73.7	50-140			
Pyrene	0.133	0.02	ug/g	ND	69.8	50-140			
Surrogate: 2-Fluorobiphenyl	*1.04*		*ug/g*		*68.1*	*50-140*			
Volatiles									

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:25-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzene	0.918	0.02	ug/g	ND	97.1	50-140			
Ethylbenzene	2.14	0.05	ug/g	ND	95.2	50-140			
Toluene	7.65	0.05	ug/g	ND	69.9	50-140			
m,p-Xylenes	6.24	0.05	ug/g	ND	91.6	50-140			
o-Xylene	2.87	0.05	ug/g	ND	105	50-140			

Qualifier Notes:

Sample Qualifiers :

1 : Elevated detection limit because of dilution required due to high target analyte concentration.

QC Qualifiers :

QS-02 : Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

Revision 1 - this report includes revised client Sample ID's.

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Nº 94616

Page 1 of 2

Client Name: Geofirma
Contact Name: Sean Sterling
Address: 1 Raymond St Suite 200 Ottawa ON
Telephone: 613-232-7525

Project Reference: 11-200-11
Quote #: City of Ottawa
PO #:
Email Address: ssterling@geofirma.ca.

TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 1239131

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS +	Hg	CrVI	B (HWS)	Grain size	BTEX + F1	Moisture				
1	MW12-19 SA2 BAG 830	Soil		1	24-Sep-12				✓	✓	✓						-1x	250 mL	-	✓
2	MW12-19 SA4 ✓ BAG 831			1					✓					✓			-2x	250 mL	-	✓
3	MW12-19 SA6 BAG 832			2											✓	✓	-1x	250 mL	+ 1 Vial	✓
4	MW12-19 SA8 BAG 833			1						✓	✓						-1x	250 mL	-	✓
5	MW12-19 SA9 BAG 834			1					✓	✓	✓						-	↓		✓
6	MW12-19 SA10 BAG 835			2											✓	✓	-1x	120 mL	+ 1 Vial	✓
7	MW12-19 SA11 BAG 836	↓		2											✓	✓	-1x	250 mL	+ 1 Vial	✓
8	MW12-21 SA4 BAG 837			1					X	X	✓						-1x	250 mL	-	✓
9	MW12-21 SA1 BAG 838			1						X	✓							↓		✓
10	MW12-21 SA8 ✓ BAG 839	↓		1	↓				X					X			-8x	250 mL	-	✓

Comments: * Grain size analyses not required; add Hg to samples being analyzed for metals; soil may contain high concentrations % moisture not required as extra parameter per Sean MJC

Method of Delivery: Pick Up

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Brooks	T. Dcouse	SUNEEPORN	MJC
Date/Time: 25-SEP-12 2:20	Date/Time: 25/09/12 2:30 PM	Date/Time: SEP 25 2012 04.00	Date/Time: Sept 26/12 12:03
	Temperature: _____ °C	Temperature: 19.4 °C	pH Verified [ ] By: N/A

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Page 2 of 2

Client Name: Geofirma Engineering	Project Reference: 11-205-11	TAT: [X] Regular [ ] 3 Day
Contact Name: Sean Sterling	Quote #	[ ] 2 Day [ ] 1 Day
Address:	PO #	Date Required:
Telephone: 613-232-2525	Email Address: ssterling@geofirma.com	

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses → not required

Paracel Order Number: 123131

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	BTEX+F1	moisture	Grain size	
1	MW12-21 SA5 BAG 840	Soil		2	24-SEP-12				X	X	✓			X			-1x250mL + 1 vial
2	MW12-21 SA3 BAG 841	↓		2	↓									X	X		-1x 120 mL + 1 vial
3	MW12-21 SA7 BAG 842			2										X	X		↓
4	MW12-20 SA1 BAG 843			2					X	X	✓			X			-1x250mL + 1 vial
5	MW12-20 SA3 BAG 844			1					X	X	✓						-1x250mL
6	MW12-20 SA2 BAG 845			1						X	✓						↓
7	MW12-20 SA5			1												X	
8	MW12-20 SA7 BAG 846			1					X								
9	MW12-20 SA4 BAG 847			2										X	X		-1x120 mL + 1 vial
10	MW12-20 SA10 BAG 848	↓		2	↓									X	X		↓

Comments: Soil may contain high concentrations

Method of Delivery: Pick up

Relinquished By (Print & Sign): Melanie Brooks	Received by Driver/Depot: D Crouse	Received at Lab: SUNFEPORM	Verified By: MC
Date/Time: 25-SEP-12 / ~~12~~ 2:20	Date/Time: 25/09/12 2:30 PM	Date/Time: SEP 25 2012 04:00	Date/Time: Sept 26/12 12:03
	Temperature: ____ °C	Temperature: 19.4 °C	pH Verified [ ] By: N/A

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Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 94614/3

Report Date: 9-Oct-2012
Order Date: 27-Sep-2012
Order #: 1239202

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1239202-01	MW12-15 SA2
1239202-02	MW12-15 SA3
1239202-03	MW12-15 SA4
1239202-04	MW12-15 SA5
1239202-05	MW12-15 SA6
1239202-06	MW12-15 SA8
1239202-07	MW12-15 SA9
1239202-08	MW12-15 SA11
1239202-09	MW12-DUP1
1239202-10	MW12-14 SA1
1239202-11	MW12-14 SA2
1239202-12	MW12-14 SA4
1239202-13	MW12-14 SA6
1239202-14	MW12-14 SA8
1239202-15	MW12-14 SA9
1239202-16	MW12-14 SA11
1239202-17	MW12-13 SA3
1239202-18	MW12-13 SA4

Approved By: 

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 8260 - P&T GC-MS	28-Sep-12	3-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	28-Sep-12	3-Oct-12
Mercury	EPA 7471A - CVAA, digestion	28-Sep-12	28-Sep-12
Metals	EPA 6020 - Digestion - ICP-MS	28-Sep-12	29-Sep-12
PAHs by GC-MS, standard scan	EPA 8270 - GC-MS, extraction	27-Sep-12	2-Oct-12
Solids, %	Gravimetric, calculation	28-Sep-12	28-Sep-12

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Order #: 1239202

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-15 SA2	MW12-15 SA3	MW12-15 SA4	MW12-15 SA5
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-01	1239202-02	1239202-03	1239202-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	78.4	95.7	95.6	96.3
Metals					
Antimony	1 ug/g dry	-	<1	-	-
Arsenic	1 ug/g dry	-	<1	-	-
Barium	1 ug/g dry	-	11	-	-
Beryllium	0.5 ug/g dry	-	<0.5	-	-
Cadmium	0.5 ug/g dry	-	<0.5	-	-
Calcium	200 ug/g dry	-	11800	-	-
Chromium	5 ug/g dry	-	6	-	-
Cobalt	1 ug/g dry	-	3	-	-
Copper	5 ug/g dry	-	5	-	-
Iron	200 ug/g dry	-	6430	-	-
Lead	1 ug/g dry	-	2	-	-
Magnesium	200 ug/g dry	-	3610	-	-
Manganese	5 ug/g dry	-	80	-	-
Mercury	0.1 ug/g dry	-	0.7	-	-
Molybdenum	1 ug/g dry	-	<1	-	-
Nickel	5 ug/g dry	-	6	-	-
Potassium	200 ug/g dry	-	629	-	-
Selenium	1 ug/g dry	-	1	-	-
Silver	0.3 ug/g dry	-	<0.3	-	-
Sodium	50 ug/g dry	-	229	-	-
Thallium	1 ug/g dry	-	<1	-	-
Tin	5 ug/g dry	-	<5	-	-
Vanadium	10 ug/g dry	-	12	-	-
Zinc	20 ug/g dry	-	<20	-	-
Volatiles					
Benzene	0.02 ug/g dry	-	-	<0.02	-
Ethylbenzene	0.05 ug/g dry	-	-	<0.05	-
Toluene	0.05 ug/g dry	-	-	<0.05	-
m,p-Xylenes	0.05 ug/g dry	-	-	<0.05	-
o-Xylene	0.05 ug/g dry	-	-	<0.05	-
Xylenes, total	0.05 ug/g dry	-	-	<0.05	-
Toluene-d8	Surrogate	-	-	103%	-

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-15 SA2	MW12-15 SA3	MW12-15 SA4	MW12-15 SA5
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-01	1239202-02	1239202-03	1239202-04
	MDL/Units	Soil	Soil	Soil	Soil
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	-	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	0.66	-	-	<1.00 [1]
Acenaphthylene	0.02 ug/g dry	18.4	-	-	17.7
Anthracene	0.02 ug/g dry	5.21	-	-	19.1
Benzo [a] anthracene	0.02 ug/g dry	17.6	-	-	30.4
Benzo [a] pyrene	0.02 ug/g dry	22.2	-	-	27.6
Benzo [b] fluoranthene	0.02 ug/g dry	25.1	-	-	32.1
Benzo [g,h,i] perylene	0.02 ug/g dry	12.3	-	-	14.1
Benzo [k] fluoranthene	0.02 ug/g dry	16.8	-	-	19.8
Biphenyl	0.02 ug/g dry	<0.40 [1]	-	-	<1.00 [1]
Chrysene	0.02 ug/g dry	15.8	-	-	26.5
Dibenzo [a,h] anthracene	0.02 ug/g dry	4.00	-	-	4.97
Fluoranthene	0.02 ug/g dry	44.6	-	-	81.9
Fluorene	0.02 ug/g dry	0.73	-	-	3.07
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	12.7	-	-	14.2
1-Methylnaphthalene	0.02 ug/g dry	0.42	-	-	<1.00 [1]
2-Methylnaphthalene	0.02 ug/g dry	0.53	-	-	<1.00 [1]
Methylnaphthalene (1&2)	0.04 ug/g dry	0.95	-	-	<2.00 [1]
Naphthalene	0.01 ug/g dry	1.76	-	-	1.95
Phenanthrene	0.02 ug/g dry	0.88	-	-	11.7
Pyrene	0.02 ug/g dry	42.4	-	-	76.6
2-Fluorobiphenyl	Surrogate	65.4%	-	-	64.3%
Terphenyl-d14	Surrogate	71.2%	-	-	84.1%

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-15 SA6	MW12-15 SA8	MW12-15 SA9	MW12-15 SA11
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-05	1239202-06	1239202-07	1239202-08
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	95.7	93.0	87.5	95.8
Metals					
Antimony	1 ug/g dry	-	<1	-	<1
Arsenic	1 ug/g dry	-	<1	-	<1
Barium	1 ug/g dry	-	20	-	15
Beryllium	0.5 ug/g dry	-	<0.5	-	<0.5
Cadmium	0.5 ug/g dry	-	<0.5	-	<0.5
Calcium	200 ug/g dry	-	16600	-	23300
Chromium	5 ug/g dry	-	9	-	10
Cobalt	1 ug/g dry	-	3	-	4
Copper	5 ug/g dry	-	7	-	8
Iron	200 ug/g dry	-	6160	-	7390
Lead	1 ug/g dry	-	29	-	3
Magnesium	200 ug/g dry	-	4190	-	5140
Manganese	5 ug/g dry	-	90	-	121
Mercury	0.1 ug/g dry	-	<0.1	-	0.3
Molybdenum	1 ug/g dry	-	<1	-	<1
Nickel	5 ug/g dry	-	7	-	10
Potassium	200 ug/g dry	-	655	-	835
Selenium	1 ug/g dry	-	<1	-	<1
Silver	0.3 ug/g dry	-	<0.3	-	<0.3
Sodium	50 ug/g dry	-	276	-	281
Thallium	1 ug/g dry	-	<1	-	<1
Tin	5 ug/g dry	-	<5	-	<5
Vanadium	10 ug/g dry	-	11	-	<10
Zinc	20 ug/g dry	-	<20	-	<20
Volatiles					
Benzene	0.02 ug/g dry	<0.02	-	<0.02	-
Ethylbenzene	0.05 ug/g dry	<0.05	-	<0.05	-
Toluene	0.05 ug/g dry	<0.05	-	<0.05	-
m,p-Xylenes	0.05 ug/g dry	<0.05	-	<0.05	-
o-Xylene	0.05 ug/g dry	<0.05	-	<0.05	-
Xylenes, total	0.05 ug/g dry	<0.05	-	<0.05	-

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-15 SA6	MW12-15 SA8	MW12-15 SA9	MW12-15 SA11
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-05	1239202-06	1239202-07	1239202-08
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	106%	-	105%	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	<7	-	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	-	-	<1.00 [1]
Acenaphthylene	0.02 ug/g dry	-	-	-	15.9
Anthracene	0.02 ug/g dry	-	-	-	9.40
Benzo [a] anthracene	0.02 ug/g dry	-	-	-	23.9
Benzo [a] pyrene	0.02 ug/g dry	-	-	-	22.9
Benzo [b] fluoranthene	0.02 ug/g dry	-	-	-	28.5
Benzo [g,h,i] perylene	0.02 ug/g dry	-	-	-	12.2
Benzo [k] fluoranthene	0.02 ug/g dry	-	-	-	18.9
Biphenyl	0.02 ug/g dry	-	-	-	<1.00 [1]
Chrysene	0.02 ug/g dry	-	-	-	22.1
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	-	-	4.29
Fluoranthene	0.02 ug/g dry	-	-	-	52.0
Fluorene	0.02 ug/g dry	-	-	-	1.15
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	-	-	12.2
1-Methylnaphthalene	0.02 ug/g dry	-	-	-	<1.00 [1]
2-Methylnaphthalene	0.02 ug/g dry	-	-	-	<1.00 [1]
Methylnaphthalene (1&2)	0.04 ug/g dry	-	-	-	<2.00 [1]
Naphthalene	0.01 ug/g dry	-	-	-	2.93
Phenanthrene	0.02 ug/g dry	-	-	-	4.19
Pyrene	0.02 ug/g dry	-	-	-	55.7
2-Fluorobiphenyl	Surrogate	-	-	-	50.0%
Terphenyl-d14	Surrogate	-	-	-	64.1%

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-DUP1	MW12-14 SA1	MW12-14 SA2	MW12-14 SA4
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-09	1239202-10	1239202-11	1239202-12
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	92.4	84.9	85.4	97.4
Metals					
Antimony	1 ug/g dry	<1	<1	-	<1
Arsenic	1 ug/g dry	<1	<1	-	<1
Barium	1 ug/g dry	21	43	-	14
Beryllium	0.5 ug/g dry	<0.5	<0.5	-	<0.5
Cadmium	0.5 ug/g dry	<0.5	<0.5	-	<0.5
Calcium	200 ug/g dry	17900	16600	-	8690
Chromium	5 ug/g dry	8	7	-	5
Cobalt	1 ug/g dry	3	3	-	2
Copper	5 ug/g dry	6	10	-	<5
Iron	200 ug/g dry	7300	8320	-	8150
Lead	1 ug/g dry	8	24	-	1
Magnesium	200 ug/g dry	3860	5000	-	2730
Manganese	5 ug/g dry	82	177	-	57
Mercury	0.1 ug/g dry	<0.1	<0.1	-	<0.1
Molybdenum	1 ug/g dry	<1	<1	-	<1
Nickel	5 ug/g dry	6	7	-	<5
Potassium	200 ug/g dry	638	617	-	292
Selenium	1 ug/g dry	<1	<1	-	<1
Silver	0.3 ug/g dry	<0.3	<0.3	-	<0.3
Sodium	50 ug/g dry	256	360	-	285
Thallium	1 ug/g dry	<1	<1	-	<1
Tin	5 ug/g dry	<5	<5	-	<5
Vanadium	10 ug/g dry	<10	13	-	12
Zinc	20 ug/g dry	<20	<20	-	<20
Volatiles					
Benzene	0.02 ug/g dry	<0.02	-	-	-
Ethylbenzene	0.05 ug/g dry	<0.05	-	-	-
Toluene	0.05 ug/g dry	0.05	-	-	-
m,p-Xylenes	0.05 ug/g dry	0.31	-	-	-
o-Xylene	0.05 ug/g dry	0.12	-	-	-
Xylenes, total	0.05 ug/g dry	0.42	-	-	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-DUP1	MW12-14 SA1	MW12-14 SA2	MW12-14 SA4
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-09	1239202-10	1239202-11	1239202-12
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	105%	-	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	<7	-	-	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.40 [1]	-	<0.02	-
Acenaphthylene	0.02 ug/g dry	5.02	-	<0.02	-
Anthracene	0.02 ug/g dry	2.05	-	<0.02	-
Benzo [a] anthracene	0.02 ug/g dry	6.80	-	0.06	-
Benzo [a] pyrene	0.02 ug/g dry	7.20	-	0.05	-
Benzo [b] fluoranthene	0.02 ug/g dry	8.18	-	0.05	-
Benzo [g,h,i] perylene	0.02 ug/g dry	4.11	-	<0.02	-
Benzo [k] fluoranthene	0.02 ug/g dry	5.38	-	0.03	-
Biphenyl	0.02 ug/g dry	<0.40 [1]	-	<0.02	-
Chrysene	0.02 ug/g dry	6.47	-	0.05	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	1.35	-	<0.02	-
Fluoranthene	0.02 ug/g dry	14.0	-	0.08	-
Fluorene	0.02 ug/g dry	<0.40 [1]	-	<0.02	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	3.87	-	0.02	-
1-Methylnaphthalene	0.02 ug/g dry	<0.40 [1]	-	<0.02	-
2-Methylnaphthalene	0.02 ug/g dry	<0.40 [1]	-	<0.02	-
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.80 [1]	-	<0.04	-
Naphthalene	0.01 ug/g dry	1.09	-	<0.01	-
Phenanthrene	0.02 ug/g dry	0.84	-	<0.02	-
Pyrene	0.02 ug/g dry	15.0	-	0.08	-
2-Fluorobiphenyl	Surrogate	62.0%	-	78.2%	-
Terphenyl-d14	Surrogate	71.0%	-	51.1%	-

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-14 SA6	MW12-14 SA8	MW12-14 SA9	MW12-14 SA11
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-13	1239202-14	1239202-15	1239202-16
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	94.6	85.3	90.9	89.8
Metals					
Antimony	1 ug/g dry	-	-	<1	-
Arsenic	1 ug/g dry	-	-	<1	-
Barium	1 ug/g dry	-	-	51	-
Beryllium	0.5 ug/g dry	-	-	<0.5	-
Cadmium	0.5 ug/g dry	-	-	<0.5	-
Calcium	200 ug/g dry	-	-	14400	-
Chromium	5 ug/g dry	-	-	8	-
Cobalt	1 ug/g dry	-	-	4	-
Copper	5 ug/g dry	-	-	8	-
Iron	200 ug/g dry	-	-	7900	-
Lead	1 ug/g dry	-	-	2	-
Magnesium	200 ug/g dry	-	-	4380	-
Manganese	5 ug/g dry	-	-	114	-
Mercury	0.1 ug/g dry	-	-	<0.1	-
Molybdenum	1 ug/g dry	-	-	<1	-
Nickel	5 ug/g dry	-	-	8	-
Potassium	200 ug/g dry	-	-	838	-
Selenium	1 ug/g dry	-	-	<1	-
Silver	0.3 ug/g dry	-	-	<0.3	-
Sodium	50 ug/g dry	-	-	366	-
Thallium	1 ug/g dry	-	-	<1	-
Tin	5 ug/g dry	-	-	<5	-
Vanadium	10 ug/g dry	-	-	14	-
Zinc	20 ug/g dry	-	-	<20	-
Volatiles					
Benzene	0.02 ug/g dry	<0.02	0.07	-	0.19
Ethylbenzene	0.05 ug/g dry	<0.05	<0.05	-	8.48
Toluene	0.05 ug/g dry	<0.05	0.10	-	<0.05
m,p-Xylenes	0.05 ug/g dry	<0.05	0.35	-	0.58
o-Xylene	0.05 ug/g dry	<0.05	0.17	-	3.45
Xylenes, total	0.05 ug/g dry	<0.05	0.52	-	4.03

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-14 SA6	MW12-14 SA8	MW12-14 SA9	MW12-14 SA11
	Sample Date:	25-Sep-12	25-Sep-12	25-Sep-12	25-Sep-12
	Sample ID:	1239202-13	1239202-14	1239202-15	1239202-16
	MDL/Units	Soil	Soil	Soil	Soil
Toluene-d8	Surrogate	104%	103%	-	101%
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	<7	<7	-	18
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	-	1.19	0.07
Acenaphthylene	0.02 ug/g dry	-	-	3.62	1.28
Anthracene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Benzo [a] anthracene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Benzo [a] pyrene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Benzo [b] fluoranthene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Benzo [g,h,i] perylene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Benzo [k] fluoranthene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Biphenyl	0.02 ug/g dry	-	-	<0.40 [1]	0.07
Chrysene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Fluoranthene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Fluorene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	-	<0.40 [1]	<0.02
1-Methylnaphthalene	0.02 ug/g dry	-	-	7.63	2.05
2-Methylnaphthalene	0.02 ug/g dry	-	-	4.20	2.25
Methylnaphthalene (1&2)	0.04 ug/g dry	-	-	11.8	4.30
Naphthalene	0.01 ug/g dry	-	-	24.0	10.8
Phenanthrene	0.02 ug/g dry	-	-	<0.40	<0.02
Pyrene	0.02 ug/g dry	-	-	<0.40	<0.02
2-Fluorobiphenyl	Surrogate	-	-	64.4%	78.6%
Terphenyl-d14	Surrogate	-	-	75.0%	62.6%

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-13 SA3	MW12-13 SA4	-	-
	Sample Date:	25-Sep-12	25-Sep-12	-	-
	Sample ID:	1239202-17	1239202-18	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	82.0	82.5	-	-
Metals					
Antimony	1 ug/g dry	-	<1	-	-
Arsenic	1 ug/g dry	-	<1	-	-
Barium	1 ug/g dry	-	46	-	-
Beryllium	0.5 ug/g dry	-	<0.5	-	-
Cadmium	0.5 ug/g dry	-	<0.5	-	-
Calcium	200 ug/g dry	-	57200	-	-
Chromium	5 ug/g dry	-	10	-	-
Cobalt	1 ug/g dry	-	3	-	-
Copper	5 ug/g dry	-	6	-	-
Iron	200 ug/g dry	-	6750	-	-
Lead	1 ug/g dry	-	23	-	-
Magnesium	200 ug/g dry	-	5080	-	-
Manganese	5 ug/g dry	-	140	-	-
Mercury	0.1 ug/g dry	-	3.3	-	-
Molybdenum	1 ug/g dry	-	<1	-	-
Nickel	5 ug/g dry	-	9	-	-
Potassium	200 ug/g dry	-	1020	-	-
Selenium	1 ug/g dry	-	<1	-	-
Silver	0.3 ug/g dry	-	<0.3	-	-
Sodium	50 ug/g dry	-	727	-	-
Thallium	1 ug/g dry	-	<1	-	-
Tin	5 ug/g dry	-	<5	-	-
Vanadium	10 ug/g dry	-	20	-	-
Zinc	20 ug/g dry	-	27	-	-
Volatiles					
Benzene	0.02 ug/g dry	44.2	107	-	-
Ethylbenzene	0.05 ug/g dry	15.4	23.7	-	-
Toluene	0.05 ug/g dry	135	199	-	-
m,p-Xylenes	0.05 ug/g dry	78.6	215	-	-
o-Xylene	0.05 ug/g dry	31.1	80.9	-	-
Xylenes, total	0.05 ug/g dry	110	296	-	-

Certificate of Analysis

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-13 SA3	MW12-13 SA4	-	-
	Sample Date:	25-Sep-12	25-Sep-12	-	-
	Sample ID:	1239202-17	1239202-18	-	-
	MDL/Units	Soil	Soil	-	-
Toluene-d8	Surrogate	98.9%	90.6%	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	238	18700	-	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	14.2	-	-
Acenaphthylene	0.02 ug/g dry	-	180	-	-
Anthracene	0.02 ug/g dry	-	66.8	-	-
Benzo [a] anthracene	0.02 ug/g dry	-	36.7	-	-
Benzo [a] pyrene	0.02 ug/g dry	-	33.2	-	-
Benzo [b] fluoranthene	0.02 ug/g dry	-	21.5	-	-
Benzo [g,h,i] perylene	0.02 ug/g dry	-	18.4	-	-
Benzo [k] fluoranthene	0.02 ug/g dry	-	14.6	-	-
Biphenyl	0.02 ug/g dry	-	34.9	-	-
Chrysene	0.02 ug/g dry	-	37.6	-	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	5.42	-	-
Fluoranthene	0.02 ug/g dry	-	61.0	-	-
Fluorene	0.02 ug/g dry	-	87.2	-	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	12.6	-	-
1-Methylnaphthalene	0.02 ug/g dry	-	308	-	-
2-Methylnaphthalene	0.02 ug/g dry	-	580	-	-
Methylnaphthalene (1&2)	0.04 ug/g dry	-	889	-	-
Naphthalene	0.01 ug/g dry	-	1750	-	-
Phenanthrene	0.02 ug/g dry	-	141	-	-
Pyrene	0.02 ug/g dry	-	106	-	-
2-Fluorobiphenyl	Surrogate	-	65.9%	-	-
Terphenyl-d14	Surrogate	-	69.2%	-	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g						
Metals									
Antimony	ND	1	ug/g						
Arsenic	ND	1	ug/g						
Barium	ND	1	ug/g						
Beryllium	ND	0.5	ug/g						
Cadmium	ND	0.5	ug/g						
Calcium	ND	200	ug/g						
Chromium	ND	5	ug/g						
Cobalt	ND	1	ug/g						
Copper	ND	5	ug/g						
Iron	ND	200	ug/g						
Lead	ND	1	ug/g						
Magnesium	ND	200	ug/g						
Mercury	ND	0.1	ug/g						
Manganese	ND	5	ug/g						
Molybdenum	ND	1	ug/g						
Nickel	ND	5	ug/g						
Potassium	ND	200	ug/g						
Selenium	ND	1	ug/g						
Silver	ND	0.3	ug/g						
Sodium	ND	50	ug/g						
Thallium	ND	1	ug/g						
Tin	ND	5	ug/g						
Vanadium	ND	10	ug/g						
Zinc	ND	20	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Biphenyl	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.30*		*ug/g*		*97.4*	*50-140*			
Surrogate: Terphenyl-d14	*1.01*		*ug/g*		*75.9*	*50-140*			
Volatiles									
Benzene	ND	0.02	ug/g						
Ethylbenzene	ND	0.05	ug/g						
Toluene	ND	0.05	ug/g						
m,p-Xylenes	ND	0.05	ug/g						
o-Xylene	ND	0.05	ug/g						

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Xylenes, total	ND	0.05	ug/g						
Surrogate: Toluene-d8	*8.37*		*ug/g*		*105*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g dry	ND				40	
Metals									
Antimony	19.9	1	ug/g dry	17.4			12.9	30	
Arsenic	ND	1	ug/g dry	ND			0.0	30	
Barium	55.9	1	ug/g dry	50.5			10.2	30	
Beryllium	ND	0.5	ug/g dry	ND			0.0	30	
Cadmium	1.89	0.5	ug/g dry	1.72			9.5	30	
Calcium	3080	200	ug/g dry	2740			11.7	30	
Chromium	44.7	5	ug/g dry	41.0			8.7	30	
Cobalt	8.9	1	ug/g dry	8.5			4.6	30	
Copper	51.9	5	ug/g dry	51.1			1.6	30	
Iron	20600	200	ug/g dry	19100			7.5	30	
Lead	51.8	1	ug/g dry	52.1			0.5	30	
Magnesium	5970	200	ug/g dry	5560			7.1	30	
Mercury	0.665	0.1	ug/g dry	0.669			0.6	35	
Manganese	293	5	ug/g dry	278			5.2	30	
Molybdenum	ND	1	ug/g dry	ND			0.0	30	
Nickel	27.3	5	ug/g dry	26.2			4.3	30	
Potassium	1540	200	ug/g dry	1450			6.3	30	
Selenium	ND	1	ug/g dry	ND			0.0	30	
Silver	ND	0.3	ug/g dry	ND			0.0	30	
Sodium	663	50	ug/g dry	721			8.4	30	
Thallium	ND	1	ug/g dry	ND			0.0	30	
Tin	5.8	5	ug/g dry	5.5			4.4	30	
Vanadium	31.7	10	ug/g dry	30.4			4.4	30	
Zinc	441	20	ug/g dry	413			6.4	30	
Physical Characteristics									
% Solids	85.3	0.1	% by Wt.	82.5			3.4	25	
Semi-Volatiles									
Acenaphthene	0.774	0.40	ug/g dry	0.656			16.6	40	
Acenaphthylene	21.2	0.40	ug/g dry	18.4			14.1	40	
Anthracene	4.69	0.40	ug/g dry	5.21			10.5	40	
Benzo [a] anthracene	20.9	0.40	ug/g dry	17.6			16.9	40	
Benzo [a] pyrene	27.4	0.40	ug/g dry	22.2			20.8	40	
Benzo [b] fluoranthene	32.0	0.40	ug/g dry	25.1			24.4	40	
Benzo [g,h,i] perylene	14.2	0.40	ug/g dry	12.3			14.3	40	
Benzo [k] fluoranthene	18.1	0.40	ug/g dry	16.8			7.5	40	
Biphenyl	ND	0.40	ug/g dry	ND				40	GEN07
Chrysene	19.0	0.40	ug/g dry	15.8			18.6	40	
Dibenzo [a,h] anthracene	4.70	0.40	ug/g dry	4.00			16.0	40	
Fluoranthene	51.3	0.40	ug/g dry	44.6			13.9	40	
Fluorene	0.790	0.40	ug/g dry	0.732			7.6	40	
Indeno [1,2,3-cd] pyrene	14.7	0.40	ug/g dry	12.7			15.1	40	
1-Methylnaphthalene	ND	0.40	ug/g dry	0.420			0.0	40	
2-Methylnaphthalene	ND	0.40	ug/g dry	0.527			0.0	40	
Naphthalene	0.358	0.20	ug/g dry	1.76			133.0	40	QR-04
Phenanthrene	0.779	0.40	ug/g dry	0.879			12.1	40	
Pyrene	49.0	0.40	ug/g dry	42.4			14.4	40	
Surrogate: 2-Fluorobiphenyl	*1.04*		*ug/g dry*	*ND*	*61.1*	*50-140*			
Surrogate: Terphenyl-d14	*1.12*		*ug/g dry*	*ND*	*66.1*	*50-140*			
Volatiles									
Benzene	ND	0.02	ug/g dry	ND				50	
Ethylbenzene	ND	0.05	ug/g dry	ND				50	

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Toluene	ND	0.05	ug/g dry	ND				50	
m,p-Xylenes	ND	0.05	ug/g dry	ND				50	
o-Xylene	ND	0.05	ug/g dry	ND				50	
Surrogate: Toluene-d8	*8.86*		*ug/g dry*	*ND*	*106*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	185	7	ug/g	ND	92.4	80-120			
Metals									
Antimony	55.9		ug/L	7.0	97.9	70-130			
Arsenic	43.4		ug/L	ND	88.3	70-130			
Barium	70.0		ug/L	20.2	99.7	70-130			
Beryllium	50.1		ug/L	0.12	99.9	70-130			
Cadmium	46.0		ug/L	0.69	90.7	70-130			
Calcium	2080		ug/L	1090	99.1	70-130			
Chromium	63.1		ug/L	16.4	93.3	70-130			
Cobalt	51.1		ug/L	3.4	95.4	70-130			
Copper	66.3		ug/L	20.4	91.7	70-130			
Iron	9040		ug/L	7640	140	70-130			QS-02
Lead	63.7		ug/L	20.8	85.8	70-130			
Magnesium	3300		ug/L	2220	107	70-130			
Mercury	1.79	0.1	ug/g	0.669	75.0	72-128			
Manganese	56.5		ug/L	19.8	73.4	70-130			
Molybdenum	42.9		ug/L	0.3	85.3	70-130			
Nickel	58.3		ug/L	10.5	95.6	70-130			
Potassium	1610		ug/L	579	103	70-130			
Selenium	45.4		ug/L	0.3	90.2	70-130			
Silver	39.0		ug/L	0.07	77.9	70-130			
Sodium	4400		ug/L	288	411	70-130			QS-02
Thallium	55.8		ug/L	0.1	111	70-130			
Tin	49.0		ug/L	2.2	93.6	70-130			
Vanadium	57.9		ug/L	12.1	91.6	70-130			
Zinc	222		ug/L	165	114	70-130			
Semi-Volatiles									
Acenaphthene	0.147	0.02	ug/g	ND	88.2	50-140			
Acenaphthylene	0.170	0.02	ug/g	ND	102	50-140			
Anthracene	0.148	0.02	ug/g	ND	88.7	50-140			
Benzo [a] anthracene	0.144	0.02	ug/g	ND	86.4	50-140			
Benzo [a] pyrene	0.141	0.02	ug/g	ND	84.6	50-140			
Benzo [b] fluoranthene	0.126	0.02	ug/g	ND	75.8	50-140			
Benzo [g,h,i] perylene	0.145	0.02	ug/g	ND	87.3	50-140			
Benzo [k] fluoranthene	0.134	0.02	ug/g	ND	80.5	50-140			
Biphenyl	0.189	0.02	ug/g	ND	113	50-140			
Chrysene	0.153	0.02	ug/g	ND	91.7	50-140			
Dibenzo [a,h] anthracene	0.161	0.02	ug/g	ND	96.6	50-140			
Fluoranthene	0.137	0.02	ug/g	ND	82.3	50-140			
Fluorene	0.176	0.02	ug/g	ND	106	50-140			
Indeno [1,2,3-cd] pyrene	0.161	0.02	ug/g	ND	96.4	50-140			
1-Methylnaphthalene	0.111	0.02	ug/g	ND	66.9	50-140			
2-Methylnaphthalene	0.122	0.02	ug/g	ND	73.3	50-140			
Naphthalene	0.129	0.01	ug/g	ND	77.4	50-140			
Phenanthrene	0.146	0.02	ug/g	ND	87.5	50-140			
Pyrene	0.150	0.02	ug/g	ND	90.2	50-140			
Surrogate: 2-Fluorobiphenyl	*1.17*		*ug/g*		*88.1*	*50-140*			
Volatiles									

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 09-Oct-2012
Order Date:27-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzene	3.94	0.02	ug/g	ND	98.5	60-130			
Ethylbenzene	3.62	0.05	ug/g	ND	90.5	60-130			
Toluene	4.61	0.05	ug/g	ND	115	60-130			
m,p-Xylenes	7.21	0.05	ug/g	ND	90.1	60-130			
o-Xylene	3.82	0.05	ug/g	ND	95.5	60-130			

Qualifier Notes:

Sample Qualifiers :

1 : Elevated detection limit because of dilution required due to high target analyte concentration.

QC Qualifiers :

GEN07 : Elevated detection limit because of dilution required due to high target analyte concentration.

QR-04 : Duplicate results exceeds RPD limits due to non-homogeneous matrix.

QS-02 : Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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p: 1-800-749-1947
e: paracel@paracellabs.com
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Nº 94614

Page 1 of 2

Client Name: Geofirma
Contact Name: Sean Sterling
Address: 1 Raymond Street Ottawa, ON
Telephone: 613-232-2525

Project Reference: 11-200-11
Quote #
PO #
Email Address: ssterling@geofirma.ca

TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 1239202

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	BTEX/F1	Grain size					
1	MW12-15 SA2 BAG856	soil		1	25-Sep-12				✓							-	1X	250	mL	-
2	MW12-15 SA3 BAG857			1						✓	✓						↓			
3	MW12-15 SA4 BAG858			2										✓		-	1X	120	mL	+ 1 vial
4	MW12-15 SA5 BAG859			1					✓							-	1X	250	mL	-
5	MW12-15 SA6 BAG860			2										✓		-	1X	120	mL	+ 1 vial
6	MW12-15 SA8 BAG861			1						✓	✓					-	1X	250	mL	-
7	MW12-15 SA9 BAG862			2										✓		-	1X	120	mL	+ 1 vial
8	MW12-15 SA10			1											✓	-	1X	250	mL	-
9	MW12-15 SA11 BAG863			1					✓	✓	✓						↓			
10	MW12-DUP1 BAG864	↓		4					✓	✓	✓			✓		-	1X	120	mL	+ 2X 250 mL + 1 vial

Comments: heavily contaminated samples (coal tar)
* Grain size analyses not required. Keep samples on hold instead per Sean - MC

Method of Delivery: Paracel

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Brooks	T. Dcouse	MC	MC
Date/Time: 26-SEP-12 / 14:10	Date/Time: 26/09/12 3:30 PM	Date/Time: Sept 26/12 5:25	Date/Time: Sept 27/12 1:22
	Temperature: _____ °C	Temperature: 18.9 °C	pH Verified [ ] By: N/A

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(Lab Use Only)
Nº 94613

Page 2 of 2

Client Name: Geofirma	Project Reference: 11-200-11	TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Contact Name: Sean Sterling	Quote #	
Address: 1 Raymond St, Ottawa, ON	PO #	Date Required:
Telephone: 613-232-2525	Email Address: ssterling@geofirma.ca	

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 1239202

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	grain size	BTEX/F1	Required Analyses
1	MW12-14 SA1 BAG 865	Soil		1	25-Sep-12					✓	✓					-1x250mL-
2	MW12-14 SA2 BAG 866	↓		1	↓				✓							↓
3	MW12-14 SA4 BAG 867			1						✓	✓					
4	MW12-14 SA5 -			1										✓		
5	MW12-14 SA6 BAG 868			2											✓	-1x120mL+1vial-
6	MW12-14 SA8 BAG 869			2											✓	- ↓
7	MW12-14 SA9 BAG 870			1						✓	✓	✓				-1x250mL-
8	MW12-14 SA11 BAG 871			1						✓					✓	-1x250mL+1vial
9	MW12-13 SA3 BAG 872			2											✓	-1x120mL+1vial
10	MW12-13 SA4 BAG 873	↓		2	↓					✓	✓	✓			✓	-1x250mL+1vial

Comments: Heavily contaminated samples (coal tar)

Method of Delivery: Paracel

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Broeders	M. Scouse	MC	MC
Date/Time: 26-SEP-12/14:10	Date/Time: 26/09/12 3:36pm	Date/Time: Sept 26/12 5:25	Date/Time: Sept 27/12 1:22
	Temperature: ____°C	Temperature: 18.4 °C	pH Verified [ ] By: N/A

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Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 4629

Report Date: 5-Oct-2012
Order Date: 26-Sep-2012
Order #: 1239209

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1239209-01	MW12-16 SA2
1239209-02	MW12-16 SA5
1239209-03	MW12-16 SA6
1239209-04	MW12-16 SA7
1239209-05	MW12-16 SA9
1239209-06	MW12-16 SA10
1239209-07	MW12-DUP2

Approved By: 

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 8260 - P&T GC-MS	28-Sep-12	3-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	28-Sep-12	3-Oct-12
Mercury	EPA 7471A - CVAA, digestion	28-Sep-12	28-Sep-12
Metals	EPA 6020 - Digestion - ICP-MS	28-Sep-12	29-Sep-12
PAHs by GC-MS, standard scan	EPA 8270 - GC-MS, extraction	27-Sep-12	2-Oct-12
Solids, %	Gravimetric, calculation	28-Sep-12	28-Sep-12

PARACEL LABORATORIES LTD.

Order #: 1239209

Certificate of Analysis

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-16 SA2	MW12-16 SA5	MW12-16 SA6	MW12-16 SA7
	Sample Date:	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12
	Sample ID:	1239209-01	1239209-02	1239209-03	1239209-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	79.3	94.5	91.8	92.6
Metals					
Antimony	1 ug/g dry	<1	<1	-	-
Arsenic	1 ug/g dry	<1	<1	-	-
Barium	1 ug/g dry	385	48	-	-
Beryllium	0.5 ug/g dry	<0.5	<0.5	-	-
Cadmium	0.5 ug/g dry	<0.5	<0.5	-	-
Calcium	200 ug/g dry	38100	60000	-	-
Chromium	5 ug/g dry	12	9	-	-
Cobalt	1 ug/g dry	3	6	-	-
Copper	5 ug/g dry	8	15	-	-
Iron	200 ug/g dry	11100	8870	-	-
Lead	1 ug/g dry	47	7	-	-
Magnesium	200 ug/g dry	11000	5350	-	-
Manganese	5 ug/g dry	249	185	-	-
Mercury	0.1 ug/g dry	0.2	<0.1	-	-
Molybdenum	1 ug/g dry	<1	<1	-	-
Nickel	5 ug/g dry	7	15	-	-
Potassium	200 ug/g dry	1200	976	-	-
Selenium	1 ug/g dry	<1	<1	-	-
Silver	0.3 ug/g dry	<0.3	<0.3	-	-
Sodium	50 ug/g dry	210	175	-	-
Thallium	1 ug/g dry	<1	<1	-	-
Tin	5 ug/g dry	<5	<5	-	-
Vanadium	10 ug/g dry	21	13	-	-
Zinc	20 ug/g dry	30	21	-	-
Volatiles					
Benzene	0.02 ug/g dry	0.35	-	0.05	-
Ethylbenzene	0.05 ug/g dry	0.73	-	0.08	-
Toluene	0.05 ug/g dry	0.75	-	0.20	-
m,p-Xylenes	0.05 ug/g dry	1.30	-	0.36	-
o-Xylene	0.05 ug/g dry	0.43	-	0.13	-
Xylenes, total	0.05 ug/g dry	1.73	-	0.50	-
Toluene-d8	Surrogate	101%	-	104%	-

Certificate of Analysis

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-16 SA2	MW12-16 SA5	MW12-16 SA6	MW12-16 SA7
	Sample Date:	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12
	Sample ID:	1239209-01	1239209-02	1239209-03	1239209-04
	MDL/Units	Soil	Soil	Soil	Soil
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	30	-	<7	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	0.81	<0.02	-	<0.02
Acenaphthylene	0.02 ug/g dry	8.88	0.04	-	<0.02
Anthracene	0.02 ug/g dry	8.08	0.02	-	<0.02
Benzo [a] anthracene	0.02 ug/g dry	20.4	0.09	-	<0.02
Benzo [a] pyrene	0.02 ug/g dry	9.94	0.04	-	<0.02
Benzo [b] fluoranthene	0.02 ug/g dry	27.6	0.13	-	<0.02
Benzo [g,h,i] perylene	0.02 ug/g dry	10.2	0.05	-	<0.02
Benzo [k] fluoranthene	0.02 ug/g dry	14.2	0.10	-	<0.02
Biphenyl	0.02 ug/g dry	0.47	<0.02	-	<0.02
Chrysene	0.02 ug/g dry	18.7	0.12	-	<0.02
Dibenzo [a,h] anthracene	0.02 ug/g dry	4.56	<0.02	-	<0.02
Fluoranthene	0.02 ug/g dry	49.3	0.13	-	<0.02
Fluorene	0.02 ug/g dry	3.00	<0.02	-	<0.02
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	11.4	0.06	-	<0.02
1-Methylnaphthalene	0.02 ug/g dry	1.44	<0.02	-	<0.02
2-Methylnaphthalene	0.02 ug/g dry	1.09	<0.02	-	<0.02
Methylnaphthalene (1&2)	0.04 ug/g dry	2.53	<0.04	-	<0.04
Naphthalene	0.01 ug/g dry	2.01	0.01	-	<0.01
Phenanthrene	0.02 ug/g dry	27.1	0.06	-	<0.02
Pyrene	0.02 ug/g dry	40.3	0.11	-	<0.02
2-Fluorobiphenyl	Surrogate	98.4%	76.0%	-	70.9%
Terphenyl-d14	Surrogate	85.7%	53.5%	-	61.0%

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-16 SA9	MW12-16 SA10	MW12-DUP2	-
	Sample Date:	26-Sep-12	26-Sep-12	26-Sep-12	-
	Sample ID:	1239209-05	1239209-06	1239209-07	-
	MDL/Units	Soil	Soil	Soil	-
Physical Characteristics					
% Solids	0.1 % by Wt.	85.7	86.0	95.6	-
Metals					
Antimony	1 ug/g dry	<1	-	<1	-
Arsenic	1 ug/g dry	<1	-	<1	-
Barium	1 ug/g dry	22	-	58	-
Beryllium	0.5 ug/g dry	<0.5	-	<0.5	-
Cadmium	0.5 ug/g dry	<0.5	-	<0.5	-
Calcium	200 ug/g dry	11100	-	62000	-
Chromium	5 ug/g dry	5	-	10	-
Cobalt	1 ug/g dry	3	-	7	-
Copper	5 ug/g dry	6	-	15	-
Iron	200 ug/g dry	7890	-	10100	-
Lead	1 ug/g dry	2	-	11	-
Magnesium	200 ug/g dry	3500	-	6170	-
Manganese	5 ug/g dry	73	-	201	-
Mercury	0.1 ug/g dry	<0.1	-	<0.1	-
Molybdenum	1 ug/g dry	<1	-	<1	-
Nickel	5 ug/g dry	6	-	16	-
Potassium	200 ug/g dry	480	-	1140	-
Selenium	1 ug/g dry	<1	-	<1	-
Silver	0.3 ug/g dry	<0.3	-	<0.3	-
Sodium	50 ug/g dry	369	-	199	-
Thallium	1 ug/g dry	<1	-	<1	-
Tin	5 ug/g dry	<5	-	<5	-
Vanadium	10 ug/g dry	11	-	14	-
Zinc	20 ug/g dry	<20	-	23	-
Volatiles					
Benzene	0.02 ug/g dry	-	<0.02	<0.02	-
Ethylbenzene	0.05 ug/g dry	-	<0.05	<0.05	-
Toluene	0.05 ug/g dry	-	<0.05	0.09	-
m,p-Xylenes	0.05 ug/g dry	-	<0.05	0.19	-
o-Xylene	0.05 ug/g dry	-	<0.05	0.08	-
Xylenes, total	0.05 ug/g dry	-	<0.05	0.27	-

Certificate of Analysis

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-16 SA9	MW12-16 SA10	MW12-DUP2	-
	Sample Date:	26-Sep-12	26-Sep-12	26-Sep-12	-
	Sample ID:	1239209-05	1239209-06	1239209-07	-
	MDL/Units	Soil	Soil	Soil	-
Toluene-d8	Surrogate	-	104%	103%	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	<7	9	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	-	<0.02	-
Acenaphthylene	0.02 ug/g dry	-	-	0.02	-
Anthracene	0.02 ug/g dry	-	-	<0.02	-
Benzo [a] anthracene	0.02 ug/g dry	-	-	0.05	-
Benzo [a] pyrene	0.02 ug/g dry	-	-	<0.02	-
Benzo [b] fluoranthene	0.02 ug/g dry	-	-	0.07	-
Benzo [g,h,i] perylene	0.02 ug/g dry	-	-	0.03	-
Benzo [k] fluoranthene	0.02 ug/g dry	-	-	0.05	-
Biphenyl	0.02 ug/g dry	-	-	<0.02	-
Chrysene	0.02 ug/g dry	-	-	0.07	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	-	<0.02	-
Fluoranthene	0.02 ug/g dry	-	-	0.06	-
Fluorene	0.02 ug/g dry	-	-	<0.02	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	-	0.03	-
1-Methylnaphthalene	0.02 ug/g dry	-	-	<0.02	-
2-Methylnaphthalene	0.02 ug/g dry	-	-	<0.02	-
Methylnaphthalene (1&2)	0.04 ug/g dry	-	-	<0.04	-
Naphthalene	0.01 ug/g dry	-	-	0.01	-
Phenanthrene	0.02 ug/g dry	-	-	0.03	-
Pyrene	0.02 ug/g dry	-	-	0.05	-
2-Fluorobiphenyl	Surrogate	-	-	87.8%	-
Terphenyl-d14	Surrogate	-	-	62.2%	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g						
Metals									
Antimony	ND	1	ug/g						
Arsenic	ND	1	ug/g						
Barium	ND	1	ug/g						
Beryllium	ND	0.5	ug/g						
Cadmium	ND	0.5	ug/g						
Calcium	ND	200	ug/g						
Chromium	ND	5	ug/g						
Cobalt	ND	1	ug/g						
Copper	ND	5	ug/g						
Iron	ND	200	ug/g						
Lead	ND	1	ug/g						
Magnesium	ND	200	ug/g						
Mercury	ND	0.1	ug/g						
Manganese	ND	5	ug/g						
Molybdenum	ND	1	ug/g						
Nickel	ND	5	ug/g						
Potassium	ND	200	ug/g						
Selenium	ND	1	ug/g						
Silver	ND	0.3	ug/g						
Sodium	ND	50	ug/g						
Thallium	ND	1	ug/g						
Tin	ND	5	ug/g						
Vanadium	ND	10	ug/g						
Zinc	ND	20	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Biphenyl	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.30*		*ug/g*		*97.4*	*50-140*			
Surrogate: Terphenyl-d14	*1.01*		*ug/g*		*75.9*	*50-140*			
Volatiles									
Benzene	ND	0.02	ug/g						
Ethylbenzene	ND	0.05	ug/g						
Toluene	ND	0.05	ug/g						
m,p-Xylenes	ND	0.05	ug/g						
o-Xylene	ND	0.05	ug/g						

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Xylenes, total	ND	0.05	ug/g						
Surrogate: Toluene-d8	*8.37*		*ug/g*		*105*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g dry	ND				40	
Metals									
Antimony	19.9	1	ug/g dry	17.4			12.9	30	
Arsenic	ND	1	ug/g dry	ND			0.0	30	
Barium	55.9	1	ug/g dry	50.5			10.2	30	
Beryllium	ND	0.5	ug/g dry	ND			0.0	30	
Cadmium	1.89	0.5	ug/g dry	1.72			9.5	30	
Calcium	3080	200	ug/g dry	2740			11.7	30	
Chromium	44.7	5	ug/g dry	41.0			8.7	30	
Cobalt	8.9	1	ug/g dry	8.5			4.6	30	
Copper	51.9	5	ug/g dry	51.1			1.6	30	
Iron	20600	200	ug/g dry	19100			7.5	30	
Lead	51.8	1	ug/g dry	52.1			0.5	30	
Magnesium	5970	200	ug/g dry	5560			7.1	30	
Mercury	0.665	0.1	ug/g dry	0.669			0.6	35	
Manganese	293	5	ug/g dry	278			5.2	30	
Molybdenum	ND	1	ug/g dry	ND			0.0	30	
Nickel	27.3	5	ug/g dry	26.2			4.3	30	
Potassium	1540	200	ug/g dry	1450			6.3	30	
Selenium	ND	1	ug/g dry	ND			0.0	30	
Silver	ND	0.3	ug/g dry	ND			0.0	30	
Sodium	663	50	ug/g dry	721			8.4	30	
Thallium	ND	1	ug/g dry	ND			0.0	30	
Tin	5.8	5	ug/g dry	5.5			4.4	30	
Vanadium	31.7	10	ug/g dry	30.4			4.4	30	
Zinc	441	20	ug/g dry	413			6.4	30	
Physical Characteristics									
% Solids	85.3	0.1	% by Wt.	82.5			3.4	25	
Semi-Volatiles									
Acenaphthene	0.774	0.40	ug/g dry	0.656			16.6	40	
Acenaphthylene	21.2	0.40	ug/g dry	18.4			14.1	40	
Anthracene	4.69	0.40	ug/g dry	5.21			10.5	40	
Benzo [a] anthracene	20.9	0.40	ug/g dry	17.6			16.9	40	
Benzo [a] pyrene	27.4	0.40	ug/g dry	22.2			20.8	40	
Benzo [b] fluoranthene	32.0	0.40	ug/g dry	25.1			24.4	40	
Benzo [g,h,i] perylene	14.2	0.40	ug/g dry	12.3			14.3	40	
Benzo [k] fluoranthene	18.1	0.40	ug/g dry	16.8			7.5	40	
Biphenyl	ND	0.40	ug/g dry	ND				40	GEN07
Chrysene	19.0	0.40	ug/g dry	15.8			18.6	40	
Dibenzo [a,h] anthracene	4.70	0.40	ug/g dry	4.00			16.0	40	
Fluoranthene	51.3	0.40	ug/g dry	44.6			13.9	40	
Fluorene	0.790	0.40	ug/g dry	0.732			7.6	40	
Indeno [1,2,3-cd] pyrene	14.7	0.40	ug/g dry	12.7			15.1	40	
1-Methylnaphthalene	ND	0.40	ug/g dry	0.420			0.0	40	
2-Methylnaphthalene	ND	0.40	ug/g dry	0.527			0.0	40	
Naphthalene	0.358	0.20	ug/g dry	1.76			133.0	40	QR-04
Phenanthrene	0.779	0.40	ug/g dry	0.879			12.1	40	
Pyrene	49.0	0.40	ug/g dry	42.4			14.4	40	
Surrogate: 2-Fluorobiphenyl	*1.04*		*ug/g dry*	*ND*	*61.1*	*50-140*			
Surrogate: Terphenyl-d14	*1.12*		*ug/g dry*	*ND*	*66.1*	*50-140*			
Volatiles									
Benzene	ND	0.02	ug/g dry	ND				50	
Ethylbenzene	ND	0.05	ug/g dry	ND				50	

Certificate of Analysis

Report Date: 05-Oct-2012

Client: **Geofirma Engineering Ltd.**

Order Date:26-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Toluene	ND	0.05	ug/g dry	ND				50	
m,p-Xylenes	ND	0.05	ug/g dry	ND				50	
o-Xylene	ND	0.05	ug/g dry	ND				50	
Surrogate: Toluene-d8	*8.86*		*ug/g dry*	*ND*	*106*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	185	7	ug/g	ND	92.4	80-120			
Metals									
Antimony	55.9		ug/L	7.0	97.9	70-130			
Arsenic	43.4		ug/L	ND	88.3	70-130			
Barium	70.0		ug/L	20.2	99.7	70-130			
Beryllium	50.1		ug/L	0.12	99.9	70-130			
Cadmium	46.0		ug/L	0.69	90.7	70-130			
Calcium	2080		ug/L	1090	99.1	70-130			
Chromium	63.1		ug/L	16.4	93.3	70-130			
Cobalt	51.1		ug/L	3.4	95.4	70-130			
Copper	66.3		ug/L	20.4	91.7	70-130			
Iron	9040		ug/L	7640	140	70-130			QS-02
Lead	63.7		ug/L	20.8	85.8	70-130			
Magnesium	3300		ug/L	2220	107	70-130			
Mercury	1.79	0.1	ug/g	0.669	75.0	72-128			
Manganese	56.5		ug/L	19.8	73.4	70-130			
Molybdenum	42.9		ug/L	0.3	85.3	70-130			
Nickel	58.3		ug/L	10.5	95.6	70-130			
Potassium	1610		ug/L	579	103	70-130			
Selenium	45.4		ug/L	0.3	90.2	70-130			
Silver	39.0		ug/L	0.07	77.9	70-130			
Sodium	4400		ug/L	288	411	70-130			QS-02
Thallium	55.8		ug/L	0.1	111	70-130			
Tin	49.0		ug/L	2.2	93.6	70-130			
Vanadium	57.9		ug/L	12.1	91.6	70-130			
Zinc	222		ug/L	165	114	70-130			
Semi-Volatiles									
Acenaphthene	0.147	0.02	ug/g	ND	88.2	50-140			
Acenaphthylene	0.170	0.02	ug/g	ND	102	50-140			
Anthracene	0.148	0.02	ug/g	ND	88.7	50-140			
Benzo [a] anthracene	0.144	0.02	ug/g	ND	86.4	50-140			
Benzo [a] pyrene	0.141	0.02	ug/g	ND	84.6	50-140			
Benzo [b] fluoranthene	0.126	0.02	ug/g	ND	75.8	50-140			
Benzo [g,h,i] perylene	0.145	0.02	ug/g	ND	87.3	50-140			
Benzo [k] fluoranthene	0.134	0.02	ug/g	ND	80.5	50-140			
Biphenyl	0.189	0.02	ug/g	ND	113	50-140			
Chrysene	0.153	0.02	ug/g	ND	91.7	50-140			
Dibenzo [a,h] anthracene	0.161	0.02	ug/g	ND	96.6	50-140			
Fluoranthene	0.137	0.02	ug/g	ND	82.3	50-140			
Fluorene	0.176	0.02	ug/g	ND	106	50-140			
Indeno [1,2,3-cd] pyrene	0.161	0.02	ug/g	ND	96.4	50-140			
1-Methylnaphthalene	0.111	0.02	ug/g	ND	66.9	50-140			
2-Methylnaphthalene	0.122	0.02	ug/g	ND	73.3	50-140			
Naphthalene	0.129	0.01	ug/g	ND	77.4	50-140			
Phenanthrene	0.146	0.02	ug/g	ND	87.5	50-140			
Pyrene	0.150	0.02	ug/g	ND	90.2	50-140			
Surrogate: 2-Fluorobiphenyl	*1.17*		*ug/g*		*88.1*	*50-140*			
Volatiles									

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzene	3.94	0.02	ug/g	ND	98.5	60-130			
Ethylbenzene	3.62	0.05	ug/g	ND	90.5	60-130			
Toluene	4.61	0.05	ug/g	ND	115	60-130			
m,p-Xylenes	7.21	0.05	ug/g	ND	90.1	60-130			
o-Xylene	3.82	0.05	ug/g	ND	95.5	60-130			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Oct-2012
Order Date:26-Sep-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

QC Qualifiers :

GEN07 : Elevated detection limit because of dilution required due to high target analyte concentration.

QR-04 : Duplicate results exceeds RPD limits due to non-homogeneous matrix.

QS-02 : Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Page 1 of 1

Client Name: Geofirma	Project Reference: 11-200-11	TAT: [✓] Regular [ ] 3 Day
Contact Name: Sean Sterling	Quote #	[ ] 2 Day [ ] 1 Day
Address: 1 Raymond St, Ottawa	PO #	Date Required:
Telephone: 613-232-2525	Email Address: ssterling@geofirma.ca	

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 123209

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PAH	BTEX/F1	metals (ICP) + Hg	moisture		Required Analyses
1	MW12-16 SA2 BAG 874	soil		2	26-Sep-12		✓	✓	✓		-	1x250mL + 1 vial - ✓
2	MW12-16 SA5 BAG 875	"		1			✓		✓		-	1x250mL - ✓
3	MW12-16 SA6 BAG 876			2				✓			-	1x120mL + 1 vial ✓
4	MW12-16 SA7 BAG 877			1			✓				-	1x250mL - ✓
5	MW12-16 SA9 BAG 878			1					✓			✓
6	MW12-16 SA10 BAG 879	↓		2	↓			✓			-	1x120mL + 1 vial ✓
7	MW12-DUP2 BAG 880	"		4			✓	✓	✓		-	1x120mL + 2x250mL + 1 vial ✓
8												
9												
10												

Comments:

Method of Delivery: Paracel

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Vanessa Scharf	T. Scouse	MC	MC
Date/Time: 26-Sep-12 1443	Date/Time: 26/09/12 3:30 PM	Date/Time: Sept 26/12 5:25	Date/Time: Sept 27/12 2:15
	Temperature: ____°C	Temperature: 15.8 °C	pH Verified [ ] By: N/A

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Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 93812

Report Date: 11-Oct-2012
Order Date: 2-Oct-2012
Order #: 1240076

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1240076-01	MW12-02
1240076-02	OW116A
1240076-03	OW116B
1240076-04	MW12-06
1240076-05	OW110A

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

Report Date: 11-Oct-2012

Order Date:2-Oct-2012

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	5-Oct-12	6-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	5-Oct-12	6-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	10-Oct-12	11-Oct-12

Certificate of Analysis

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-02	OW116A	OW116B	MW12-06
	Sample Date:	01-Oct-12	01-Oct-12	01-Oct-12	01-Oct-12
	Sample ID:	1240076-01	1240076-02	1240076-03	1240076-04
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene-d8	Surrogate	95.0%	112%	111%	110%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Biphenyl	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Chrysene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Fluorene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	<0.05	0.06	0.07	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	<0.10	0.11	<0.10
Naphthalene	0.05 ug/L	<0.05	0.30	0.77	0.29
Phenanthrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Pyrene	0.01 ug/L	0.01	<0.01	<0.01	0.02
2-Fluorobiphenyl	Surrogate	93.0%	83.3%	81.2%	84.3%
Terphenyl-d14	Surrogate	82.5%	84.0%	77.8%	79.9%

Certificate of Analysis

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	OW110A	-	-	-
	Sample Date:	01-Oct-12	-	-	-
	Sample ID:	1240076-05	-	-	-
	MDL/Units	Water	-	-	-
Volatiles					
Benzene	0.5 ug/L	<0.5	-	-	-
Ethylbenzene	0.5 ug/L	<0.5	-	-	-
Toluene	0.5 ug/L	<0.5	-	-	-
m,p-Xylenes	0.5 ug/L	<0.5	-	-	-
o-Xylene	0.5 ug/L	<0.5	-	-	-
Xylenes, total	0.5 ug/L	<0.5	-	-	-
Toluene-d8	Surrogate	111%	-	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	-	-	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	-	-	-
Acenaphthylene	0.05 ug/L	<0.05	-	-	-
Anthracene	0.01 ug/L	<0.01	-	-	-
Benzo [a] anthracene	0.01 ug/L	<0.01	-	-	-
Benzo [a] pyrene	0.01 ug/L	<0.01	-	-	-
Benzo [b] fluoranthene	0.05 ug/L	<0.05	-	-	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	-	-	-
Benzo [k] fluoranthene	0.05 ug/L	<0.05	-	-	-
Biphenyl	0.05 ug/L	<0.05	-	-	-
Chrysene	0.05 ug/L	<0.05	-	-	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	-	-	-
Fluoranthene	0.01 ug/L	<0.01	-	-	-
Fluorene	0.05 ug/L	<0.05	-	-	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	-	-	-
1-Methylnaphthalene	0.05 ug/L	<0.05	-	-	-
2-Methylnaphthalene	0.05 ug/L	0.09	-	-	-
Methylnaphthalene (1&2)	0.10 ug/L	0.13	-	-	-
Naphthalene	0.05 ug/L	0.21	-	-	-
Phenanthrene	0.05 ug/L	<0.05	-	-	-
Pyrene	0.01 ug/L	<0.01	-	-	-
2-Fluorobiphenyl	Surrogate	103%	-	-	-
Terphenyl-d14	Surrogate	77.9%	-	-	-

Certificate of Analysis

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*18.9*		*ug/L*		*94.6*	*50-140*			
Surrogate: Terphenyl-d14	*15.0*		*ug/L*		*75.1*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*36.0*		*ug/L*		*112*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*30.6*		*ug/L*	*ND*	*95.6*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1790	25	ug/L	ND	89.6	68-117			
Semi-Volatiles									
Acenaphthene	3.89	0.05	ug/L	ND	77.8	50-140			
Acenaphthylene	4.50	0.05	ug/L	ND	90.0	50-140			
Anthracene	4.44	0.01	ug/L	ND	88.8	50-140			
Benzo [a] anthracene	4.11	0.01	ug/L	ND	82.3	50-140			
Benzo [a] pyrene	3.56	0.01	ug/L	ND	71.2	50-140			
Benzo [b] fluoranthene	4.53	0.05	ug/L	ND	90.6	50-140			
Benzo [g,h,i] perylene	3.58	0.05	ug/L	ND	71.5	50-140			
Benzo [k] fluoranthene	4.95	0.05	ug/L	ND	99.0	50-140			
Biphenyl	3.72	0.05	ug/L	ND	74.4	50-140			
Chrysene	4.71	0.05	ug/L	ND	94.3	50-140			
Dibenzo [a,h] anthracene	4.71	0.05	ug/L	ND	94.2	50-140			
Fluoranthene	3.78	0.01	ug/L	ND	75.7	50-140			
Fluorene	3.92	0.05	ug/L	ND	78.3	50-140			
Indeno [1,2,3-cd] pyrene	4.13	0.05	ug/L	ND	82.5	50-140			
1-Methylnaphthalene	4.88	0.05	ug/L	ND	97.5	50-140			
2-Methylnaphthalene	4.49	0.05	ug/L	ND	89.8	50-140			
Naphthalene	4.07	0.05	ug/L	ND	81.4	50-140			
Phenanthrene	4.34	0.05	ug/L	ND	86.8	50-140			
Pyrene	4.20	0.01	ug/L	ND	83.9	50-140			
Surrogate: 2-Fluorobiphenyl	*20.4*		*ug/L*		*102*	*50-140*			
Volatiles									
Benzene	22.1	0.5	ug/L	ND	55.3	50-140			
Ethylbenzene	39.6	0.5	ug/L	ND	98.9	50-140			
Toluene	28.6	0.5	ug/L	ND	71.5	50-140			
m,p-Xylenes	85.3	0.5	ug/L	ND	107	50-140			
o-Xylene	43.0	0.5	ug/L	ND	107	50-140			

Certificate of Analysis

Report Date: 11-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Page 1 of 1

Client Name: Geofirma Engineering	Project Reference: 11-200-11	TAT: [X] Regular [ ] 3 Day
Contact Name: Sean Sterling	Quote # City of Ottawa	[ ] 2 Day [ ] 1 Day
Address: 1 Raymond St. Suite 204 Ottawa ON	PO #	Date Required:
Telephone: 613-232-2525	Email Address: ssterling@geofirma.com	

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Required Analyses

Paracel Order Number: 1240076

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	PAH	PHC-FI	BTEX				
1	MW12-02 BAG 882	GW		3	1-OCT-12	11:05								X	X	X				✓
2	OW116A BAG 883	↓		↓		11:18								X	X	X				✓
3	OW116B BAG 884					11:32								X	X	X				✓
4	MW12-06 BAG 885					12:08								X	X	X				✓
5	OW110A BAG 886	↓		↓		12:56								X	X	X				✓
6																				
7																				
8																				
9																				
10																				

Comments: may have high levels of contamination

Method of Delivery: Pick up

Relinquished By (Print & Sign): Melanie Brooks	Received by Driver/Depot: JCouse	Received at Lab: SUNEEPORN	Verified By: MC
Date/Time: 2-OCT-12 18:30	Date/Time: 02/10/12 10:00 AM	Date/Time: OCT 02,2012 10.45	Date/Time: Oct 2/12 11:29
	Temperature: ____ °C	Temperature: 9.1 °C	pH Verified [ ] By: N/A

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Certificate of Analysis

Geofirma Engineering Ltd.
1 Raymond St., Suite 200
Ottawa, ON K1R 1A2
Attn: Jean Francois Dion

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/191 Lees Ave
Custody: 4317

Report Date: 5-Nov-2012
Order Date: 29-Oct-2012
Order #: 1244020

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1244020-01	OW507b
1244020-02	OW507c
1244020-03	FB

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	2-Nov-12	3-Nov-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	2-Nov-12	3-Nov-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	30-Oct-12	31-Oct-12

Certificate of Analysis

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/191 Lees Ave

	Client ID:	OW507b	OW507c	FB	-
	Sample Date:	29-Oct-12	29-Oct-12	29-Oct-12	-
	Sample ID:	1244020-01	1244020-02	1244020-03	-
	MDL/Units	Water	Water	Water	-
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	-
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	-
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	-
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	-
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	-
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	-
Toluene-d8	Surrogate	92.6%	96.6%	94.9%	-
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	0.25	<0.05	-
Acenaphthylene	0.05 ug/L	<0.05	0.77	<0.05	-
Anthracene	0.01 ug/L	<0.01	0.03	<0.01	-
Benzo [a] anthracene	0.01 ug/L	<0.01	<0.01	<0.01	-
Benzo [a] pyrene	0.01 ug/L	<0.01	<0.01	<0.01	-
Benzo [b] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	-
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	-
Biphenyl	0.05 ug/L	<0.05	0.18	<0.05	-
Chrysene	0.05 ug/L	<0.05	<0.05	<0.05	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	-
Fluoranthene	0.01 ug/L	<0.01	<0.01	<0.01	-
Fluorene	0.05 ug/L	<0.05	0.08	<0.05	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	-
1-Methylnaphthalene	0.05 ug/L	0.06	0.05	<0.05	-
2-Methylnaphthalene	0.05 ug/L	0.15	0.05	<0.05	-
Methylnaphthalene (1&2)	0.10 ug/L	0.21	0.10	<0.10	-
Naphthalene	0.05 ug/L	0.26	0.08	<0.05	-
Phenanthrene	0.05 ug/L	<0.05	0.06	<0.05	-
Pyrene	0.01 ug/L	0.04	0.03	<0.01	-
2-Fluorobiphenyl	Surrogate	85.1%	65.1%	65.1%	-
Terphenyl-d14	Surrogate	96.1%	89.0%	100%	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*16.1*		*ug/L*		*80.5*	*50-140*			
Surrogate: Terphenyl-d14	*23.6*		*ug/L*		*118*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*30.9*		*ug/L*		*96.7*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Project Description: 11-200-11/191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*31.4*		*ug/L*	*ND*	*98.1*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1710	25	ug/L	ND	85.5	68-117			
Semi-Volatiles									
Acenaphthene	5.30	0.05	ug/L	ND	106	50-140			
Acenaphthylene	5.80	0.05	ug/L	ND	116	50-140			
Anthracene	5.48	0.01	ug/L	ND	110	50-140			
Benzo [a] anthracene	4.94	0.01	ug/L	ND	98.8	50-140			
Benzo [a] pyrene	5.24	0.01	ug/L	ND	105	50-140			
Benzo [b] fluoranthene	3.96	0.05	ug/L	ND	79.1	50-140			
Benzo [g,h,i] perylene	5.32	0.05	ug/L	ND	106	50-140			
Benzo [k] fluoranthene	3.82	0.05	ug/L	ND	76.3	50-140			
Biphenyl	5.79	0.05	ug/L	ND	116	50-140			
Chrysene	4.45	0.05	ug/L	ND	89.0	50-140			
Dibenzo [a,h] anthracene	5.10	0.05	ug/L	ND	102	50-140			
Fluoranthene	4.91	0.01	ug/L	ND	98.1	50-140			
Fluorene	5.08	0.05	ug/L	ND	102	50-140			
Indeno [1,2,3-cd] pyrene	5.18	0.05	ug/L	ND	104	50-140			
1-Methylnaphthalene	4.61	0.05	ug/L	ND	92.3	50-140			
2-Methylnaphthalene	4.93	0.05	ug/L	ND	98.5	50-140			
Naphthalene	4.50	0.05	ug/L	ND	89.9	50-140			
Phenanthrene	5.79	0.05	ug/L	ND	116	50-140			
Pyrene	6.08	0.01	ug/L	ND	122	50-140			
Surrogate: 2-Fluorobiphenyl	*15.0*		*ug/L*		*75.1*	*50-140*			
Volatiles									
Benzene	30.8	0.5	ug/L	ND	77.0	50-140			
Ethylbenzene	35.5	0.5	ug/L	ND	88.8	50-140			
Toluene	33.0	0.5	ug/L	ND	82.6	50-140			
m,p-Xylenes	70.6	0.5	ug/L	ND	88.2	50-140			
o-Xylene	37.6	0.5	ug/L	ND	94.0	50-140			

Certificate of Analysis

Report Date: 05-Nov-2012
Order Date:29-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/191 Lees Ave

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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p: 1-800-749-1947
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Nº 4317

Page 1 of 1

Client Name: Geofirma Eng Ltd	Project Reference: 11-20-11	TAT: [x] Regular [ ] 3 Day
Contact Name: JF Dean	Quote # City of Ottawa.	[ ] 2 Day [ ] 1 Day
Address:	PO #	Date Required:
Telephone: 613-290-4005	Email Address: JFDion@Geofirma.Com	

Criteria: [ ] O. Reg. 153/04 Table __ [x] O. Reg. 153/11 (Current) Table 3 [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 1244020

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	Required Analyses: PAH	Btex F1 PHC								
1	OW507b BAH195	GW		3	29-Oct-12		X	X								✓
2	OW507c BAH196	↓		↓	↓		X	X								✓
3	FB BAH 197.	↓		↓	↓		X	X								✓
4																
5																
6																
7																
8																
9																
10																

Comments: City of Ottawa job per JF. SC.

Method of Delivery: Pick up

Relinquished By (Print & Sign): JF Dion	Received by Driver/Depot: T Deluse	Received at Lab: SUNEEPORN	Verified By:
Date/Time: 29-Oct-10:00 Am	Date/Time: 29/10/12 10:39 AM	Date/Time: Oct 29 2012 11:20	Date/Time: Oct 29/12
	Temperature: ___ °C	Temperature: 16.6 °C	pH Verified [ ] By: N/A

11:55a

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e: paracel@paracellabs.com
www.paracellabs.com

Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 94611

Report Date: 16-Nov-2012
Order Date: 5-Oct-2012
Revised Report **Order #: 1240349**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1240349-01	MW12-14
1240349-02	E-006
1240349-03	MW19-17
1240349-04	OW112B

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	11-Oct-12	11-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	11-Oct-12	11-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	16-Oct-12	16-Oct-12

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-14	E-006	MW19-17	OW112B
	Sample Date:	05-Oct-12	05-Oct-12	05-Oct-12	05-Oct-12
	Sample ID:	1240349-01	1240349-02	1240349-03	1240349-04
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	110	<0.5	<0.5	695
Ethylbenzene	0.5 ug/L	657 [1]	<0.5	<0.5	644
Toluene	0.5 ug/L	45.5	<0.5	<0.5	2030
m,p-Xylenes	0.5 ug/L	168	<0.5	<0.5	965
o-Xylene	0.5 ug/L	692 [1]	<0.5	<0.5	494
Xylenes, total	0.5 ug/L	860 [1]	<0.5	<0.5	1460
Toluene-d8	Surrogate	94.5%	104%	101%	104%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<1250
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Acenaphthylene	0.05 ug/L	19.0	<0.05	<0.05	127
Anthracene	0.01 ug/L	<1.00 [2]	<0.01	<0.01	3.46
Benzo [a] anthracene	0.01 ug/L	<1.00 [2]	<0.01	<0.01	<2.00 [2]
Benzo [a] pyrene	0.01 ug/L	<1.00 [2]	<0.01	<0.01	<2.00 [2]
Benzo [b] fluoranthene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Benzo [g,h,i] perylene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Benzo [k] fluoranthene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Biphenyl	0.05 ug/L	<5.00 [2]	<0.05	<0.05	19.7
Chrysene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Dibenzo [a,h] anthracene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
Fluoranthene	0.01 ug/L	<1.00 [2]	<0.01	<0.01	<2.00 [2]
Fluorene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	20.1
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	<10.0 [2]
1-Methylnaphthalene	0.05 ug/L	38.8	0.06	0.12	312
2-Methylnaphthalene	0.05 ug/L	37.6	0.08	0.17	212
Methylnaphthalene (1&2)	0.10 ug/L	76.4	0.13	0.29	524
Naphthalene	0.05 ug/L	631	0.25	0.91	2560
Phenanthrene	0.05 ug/L	<5.00 [2]	<0.05	<0.05	18.4
Pyrene	0.01 ug/L	<1.00 [2]	<0.01	<0.01	5.09
2-Fluorobiphenyl	Surrogate	80.4%	83.0%	83.6%	66.2%
Terphenyl-d14	Surrogate	88.0%	99.5%	99.7%	60.9%

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*18.7*		*ug/L*		*93.5*	*50-140*			
Surrogate: Terphenyl-d14	*19.8*		*ug/L*		*98.9*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*28.1*		*ug/L*		*87.8*	*50-140*			

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*29.5*		*ug/L*	*ND*	*92.2*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1670	25	ug/L	ND	83.6	68-117			
Semi-Volatiles									
Acenaphthene	3.82	0.05	ug/L	ND	76.5	50-140			
Acenaphthylene	4.16	0.05	ug/L	ND	83.2	50-140			
Anthracene	3.33	0.01	ug/L	ND	66.6	50-140			
Benzo [a] anthracene	3.54	0.01	ug/L	ND	70.8	50-140			
Benzo [a] pyrene	3.12	0.01	ug/L	ND	62.4	50-140			
Benzo [b] fluoranthene	3.78	0.05	ug/L	ND	75.6	50-140			
Benzo [g,h,i] perylene	3.78	0.05	ug/L	ND	75.6	50-140			
Benzo [k] fluoranthene	4.43	0.05	ug/L	ND	88.7	50-140			
Biphenyl	3.89	0.05	ug/L	ND	77.8	50-140			
Chrysene	3.74	0.05	ug/L	ND	74.8	50-140			
Dibenzo [a,h] anthracene	4.75	0.05	ug/L	ND	95.1	50-140			
Fluoranthene	3.47	0.01	ug/L	ND	69.3	50-140			
Fluorene	3.66	0.05	ug/L	ND	73.3	50-140			
Indeno [1,2,3-cd] pyrene	4.11	0.05	ug/L	ND	82.3	50-140			
1-Methylnaphthalene	4.82	0.05	ug/L	ND	96.3	50-140			
2-Methylnaphthalene	4.44	0.05	ug/L	ND	88.8	50-140			
Naphthalene	4.17	0.05	ug/L	ND	83.4	50-140			
Phenanthrene	4.18	0.05	ug/L	ND	83.7	50-140			
Pyrene	4.07	0.01	ug/L	ND	81.3	50-140			
Surrogate: 2-Fluorobiphenyl	*19.7*		*ug/L*		*98.6*	*50-140*			
Volatiles									
Benzene	48.2	0.5	ug/L	ND	120	50-140			
Ethylbenzene	27.1	0.5	ug/L	ND	67.8	50-140			
Toluene	36.8	0.5	ug/L	ND	92.1	50-140			
m,p-Xylenes	77.6	0.5	ug/L	ND	97.0	50-140			
o-Xylene	43.8	0.5	ug/L	ND	109	50-140			

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:5-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

Sample Qualifiers :

2 : Elevated detection limit because of dilution required due to high target analyte concentration.

1 : This result exceeds the calibration range of the instrument. The result may be biased low.

Sample Data Revisions

None

Work Order Revisions / Comments:

Revision 1 - this report includes revised client Sample ID's.

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Page 1 of 4

Client Name: Geofirma	Project Reference: 11-200-11	TAT: [✓] Regular [ ] 3 Day
Contact Name: Sean Sterling	Quote # City of Ottawa	[ ] 2 Day [ ] 1 Day
Address: 1 Raymond St, Suite 200	PO #	
Telephone: 613-232-2525	Email Address: ssterling@geofirma.com	Date Required:

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 1240349

Required Analyses

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	PHC - F1	BTEX					
1	MW12-14 BAG 976 (watery)	~~Soil~~		3	5-OCT-12	9:40			✓					✓	✓					✓
2	E-006 BAG 977	↓		↓	↓	10:36			✓					✓	✓					✓
3	MW12-19 BAG 978					11:35			✓					✓	✓					✓
4	OW112B BAG 979					10:00			✓					✓	✓					✓
5																				
6																				
7																				
8																				
9																				
10																				

Comments: May be contaminated with coal tar

Method of Delivery: Pick up

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Vanessa Schart Vanessa Schart	T. Krause	SUMEEPGRN	M/C
Date/Time:	Date/Time: 05/10/12 2:48 PM	Date/Time: OCT 05 2012 03:57	Date/Time: Oct 5/12 5:16
	Temperature: ____ °C	Temperature: 19.9 °C	pH Verified [ ] By: N/A

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e: paracel@paracellabs.com

www.paracellabs.com

Certificate of Analysis

Geofirma Engineering Ltd.

Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 94612

Report Date: 15-Oct-2012
Order Date: 4-Oct-2012
Order #: 1240284

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1240284-01	MW12-11
1240284-02	MW12-12
1240284-03	OW122C
1240284-04	OW122B
1240284-05	BH001
1240284-06	MW12-07

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	10-Oct-12	10-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	10-Oct-12	10-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	12-Oct-12	12-Oct-12

Certificate of Analysis

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-11	MW12-12	OW122C	OW122B
	Sample Date:	04-Oct-12	04-Oct-12	04-Oct-12	04-Oct-12
	Sample ID:	1240284-01	1240284-02	1240284-03	1240284-04
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene-d8	Surrogate	86.7%	84.6%	87.4%	87.1%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
Semi-Volatiles					
Acenaphthene	0.05 ug/L	2.72	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	59.2	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	5.02	<0.01	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	3.38	<0.01	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	3.10	<0.01	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	3.24	<0.05	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	1.30	<0.05	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	1.25	<0.05	<0.05	<0.05
Biphenyl	0.05 ug/L	3.94	<0.05	<0.05	<0.05
Chrysene	0.05 ug/L	3.24	<0.05	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	0.57	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	6.14	<0.01	<0.01	<0.01
Fluorene	0.05 ug/L	12.6	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	1.32	<0.05	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	98.5	<0.05	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	7.73	<0.05	<0.05	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	106	<0.10	<0.10	<0.10
Naphthalene	0.05 ug/L	91.1	<0.05	0.84	0.63
Phenanthrene	0.05 ug/L	13.1	<0.05	<0.05	<0.05
Pyrene	0.01 ug/L	11.9	<0.01	<0.01	<0.01
2-Fluorobiphenyl	Surrogate	81.2%	86.0%	89.4%	86.8%
Terphenyl-d14	Surrogate	79.6%	101%	109%	117%

Certificate of Analysis

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	BH001	MW12-07	-	-
	Sample Date:	04-Oct-12	04-Oct-12	-	-
	Sample ID:	1240284-05	1240284-06	-	-
	MDL/Units	Water	Water	-	-
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	-	-
Ethylbenzene	0.5 ug/L	<0.5	<0.5	-	-
Toluene	0.5 ug/L	<0.5	<0.5	-	-
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	-	-
o-Xylene	0.5 ug/L	<0.5	<0.5	-	-
Xylenes, total	0.5 ug/L	<0.5	<0.5	-	-
Toluene-d8	Surrogate	85.1%	87.1%	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	-	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Acenaphthylene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Anthracene	0.01 ug/L	<0.05 [1] [2]	<0.01	-	-
Benzo [a] anthracene	0.01 ug/L	<0.05 [1] [2]	<0.01	-	-
Benzo [a] pyrene	0.01 ug/L	<0.05 [1] [2]	<0.01	-	-
Benzo [b] fluoranthene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Benzo [k] fluoranthene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Biphenyl	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Chrysene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Fluoranthene	0.01 ug/L	<0.05 [1] [2]	<0.01	-	-
Fluorene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
1-Methylnaphthalene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
2-Methylnaphthalene	0.05 ug/L	<0.25 [1] [2]	<0.05	-	-
Methylnaphthalene (1&2)	0.10 ug/L	<0.50 [1] [2]	<0.10	-	-
Naphthalene	0.05 ug/L	<0.25 [1] [2]	0.15	-	-
Phenanthrene	0.05 ug/L	<0.25 [1] [2]	0.08	-	-
Pyrene	0.01 ug/L	0.07 [1] [2]	<0.01	-	-
2-Fluorobiphenyl	Surrogate	-	88.3%	-	-
Terphenyl-d14	Surrogate	-	108%	-	-

Certificate of Analysis

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*24.8*		*ug/L*		*124*	*50-140*			
Surrogate: Terphenyl-d14	*21.0*		*ug/L*		*105*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*28.1*		*ug/L*		*87.8*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*29.5*		*ug/L*	*ND*	*92.2*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

Report Date: 15-Oct-2012

Order Date:4-Oct-2012

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1670	25	ug/L	ND	83.6	68-117			
Semi-Volatiles									
Acenaphthene	3.95	0.05	ug/L	ND	79.0	50-140			
Acenaphthylene	3.76	0.05	ug/L	ND	75.1	50-140			
Anthracene	3.78	0.01	ug/L	ND	75.5	50-140			
Benzo [a] anthracene	3.93	0.01	ug/L	ND	78.6	50-140			
Benzo [a] pyrene	3.28	0.01	ug/L	ND	65.7	50-140			
Benzo [b] fluoranthene	4.11	0.05	ug/L	ND	82.1	50-140			
Benzo [g,h,i] perylene	4.22	0.05	ug/L	ND	84.3	50-140			
Benzo [k] fluoranthene	5.32	0.05	ug/L	ND	106	50-140			
Biphenyl	3.97	0.05	ug/L	ND	79.3	50-140			
Chrysene	3.98	0.05	ug/L	ND	79.7	50-140			
Dibenzo [a,h] anthracene	5.61	0.05	ug/L	ND	112	50-140			
Fluoranthene	3.99	0.01	ug/L	ND	79.8	50-140			
Fluorene	4.08	0.05	ug/L	ND	81.6	50-140			
Indeno [1,2,3-cd] pyrene	4.86	0.05	ug/L	ND	97.1	50-140			
1-Methylnaphthalene	5.25	0.05	ug/L	ND	105	50-140			
2-Methylnaphthalene	4.55	0.05	ug/L	ND	91.0	50-140			
Naphthalene	4.29	0.05	ug/L	ND	85.8	50-140			
Phenanthrene	4.38	0.05	ug/L	ND	87.6	50-140			
Pyrene	4.48	0.01	ug/L	ND	89.6	50-140			
Surrogate: 2-Fluorobiphenyl	*24.7*		*ug/L*		*124*	*50-140*			
Volatiles									
Benzene	48.2	0.5	ug/L	ND	120	50-140			
Ethylbenzene	27.1	0.5	ug/L	ND	67.8	50-140			
Toluene	36.8	0.5	ug/L	ND	92.1	50-140			
m,p-Xylenes	77.6	0.5	ug/L	ND	97.0	50-140			
o-Xylene	43.8	0.5	ug/L	ND	109	50-140			

Certificate of Analysis

Report Date: 15-Oct-2012
Order Date:4-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

Sample Qualifiers :

1 : Elevated Reporting Limit due to matrix interference.

2 : Surrogates not available due to extract dilution.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Head Office
300-2319 St. Laurent Blvd.
Ottawa, Ontario K1G 4J8
p: 1-800-749-1947
e: paracel@paracellabs.com
www.paracellabs.com

Chain of Custody
(Lab Use Only)
Nº 94612

Page 1 of 1

Client Name: Geofirma	Project Reference: 11-200-11	TAT: ✓ Regular | | 3 Day
Contact Name: Sean Sterling	Quote #	| | 2 Day | | 1 Day
Address: 2 1 Raymond street Suite 200 Ottawa	PO #	
Telephone: 613-232-7525	Email Address: ssterling@geofirma.com	Date Required:

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 1240284

Required Analyses

	Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	PHC - F1	BTEX					
1	MW12-11	BAG936	GW		3	4-OCT-12				✓					✓	✓					
2	MW12-12	BAG937	↓		3	↓				✓					✓	✓					
3	OW122C	BAG938			3					✓					✓	✓					
4	OW122B	BAG939			3					✓					✓	✓					
5	BH001	BAG940			3					✓					✓	✓					
6	MW12-07	BAG941	↓		3	↓				✓					✓	✓					
7																					
8																					
9																					
10																					

Comments: may contain contaminated samples (coal tar)

Method of Delivery: Paracel

Relinquished By (Print & Sign): Vanessa Schaf / Vanessa Schaf	Received by Driver/Depot: T. Krause	Received at Lab: MC
Date/Time: 4-OCT-12 12:53	Date/Time: 04/10/12 4:37 PM	Date/Time: Oct 4/12 5:30
	Temperature: ____ °C	Temperature: 16.2 °C
		Verified By: MC
		Date/Time: Oct 4/12 16:25
		pH Verified [ ] By: N/A

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300-2319 St. Laurent Blvd.
Ottawa, Ontario K1G 4J8
p: 1-800-749-1947
e: paracel@paracellabs.com
www.paracellabs.com

Certificate of Analysis

Geofirma Engineering Ltd.
Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 5004

Report Date: 16-Nov-2012
Order Date: 3-Oct-2012
Revised Report **Order #: 1240186**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1240186-01	MW12-19
1240186-02	MW12-03
1240186-03	MW12-04
1240186-04	OW109A
1240186-05	MW12-18
1240186-06	MW12-01
1240186-07	OW116C
1240186-08	MW12-05

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	5-Oct-12	9-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	5-Oct-12	8-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	11-Oct-12	12-Oct-12

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-19	MW12-03	MW12-04	OW109A
	Sample Date:	03-Oct-12	03-Oct-12	03-Oct-12	03-Oct-12
	Sample ID:	1240186-01	1240186-02	1240186-03	1240186-04
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene-d8	Surrogate	100%	102%	102%	102%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	0.10	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	0.03	<0.01	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	0.09	<0.01	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	0.05	<0.01	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	0.09	<0.05	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Biphenyl	0.05 ug/L	0.07	<0.05	<0.05	0.05
Chrysene	0.05 ug/L	0.08	<0.05	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	0.09	<0.01	<0.01	<0.01
Fluorene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	0.06	<0.05	0.06	0.10
2-Methylnaphthalene	0.05 ug/L	0.08	<0.05	0.08	0.14
Methylnaphthalene (1&2)	0.10 ug/L	0.14	0.11	0.14	0.24
Naphthalene	0.05 ug/L	0.24	<0.05	0.10	0.29
Phenanthrene	0.05 ug/L	0.11	<0.05	<0.05	<0.05
Pyrene	0.01 ug/L	0.11	<0.01	<0.01	<0.01
2-Fluorobiphenyl	Surrogate	90.1%	86.8%	86.9%	84.3%
Terphenyl-d14	Surrogate	85.6%	95.5%	85.3%	103%

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-18	MW12-01	OW116C	MW12-05
	Sample Date:	03-Oct-12	03-Oct-12	03-Oct-12	03-Oct-12
	Sample ID:	1240186-05	1240186-06	1240186-07	1240186-08
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene-d8	Surrogate	102%	104%	103%	101%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	0.02	<0.01	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	0.09	<0.01	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	0.04	<0.01	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	0.09	<0.05	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	0.10	<0.05	<0.05	<0.05
Biphenyl	0.05 ug/L	0.05	<0.05	<0.05	<0.05
Chrysene	0.05 ug/L	0.06	<0.05	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	0.12	<0.01	<0.01	<0.01
Fluorene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	0.09	<0.05	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	0.09	<0.05	0.05	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	0.18	<0.10	<0.10	<0.10
Naphthalene	0.05 ug/L	0.18	<0.05	0.30	0.09
Phenanthrene	0.05 ug/L	0.20	<0.05	<0.05	<0.05
Pyrene	0.01 ug/L	0.12	<0.01	<0.01	<0.01
2-Fluorobiphenyl	Surrogate	107%	80.8%	79.0%	82.2%
Terphenyl-d14	Surrogate	95.9%	85.8%	87.1%	87.6%

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*18.4*		*ug/L*		*92.2*	*50-140*			
Surrogate: Terphenyl-d14	*17.3*		*ug/L*		*86.6*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*36.0*		*ug/L*		*112*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*30.6*		*ug/L*	*ND*	*95.6*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1790	25	ug/L	ND	89.6	68-117			
Semi-Volatiles									
Acenaphthene	3.75	0.05	ug/L	ND	75.0	50-140			
Acenaphthylene	1.60	0.05	ug/L	ND	32.1	50-140			
Anthracene	3.22	0.01	ug/L	ND	64.5	50-140			
Benzo [a] anthracene	3.59	0.01	ug/L	ND	71.8	50-140			
Benzo [a] pyrene	3.43	0.01	ug/L	ND	68.6	50-140			
Benzo [b] fluoranthene	3.67	0.05	ug/L	ND	73.4	50-140			
Benzo [g,h,i] perylene	3.21	0.05	ug/L	ND	64.2	50-140			
Benzo [k] fluoranthene	3.98	0.05	ug/L	ND	79.6	50-140			
Biphenyl	4.05	0.05	ug/L	ND	80.9	50-140			
Chrysene	3.74	0.05	ug/L	ND	74.7	50-140			
Dibenzo [a,h] anthracene	3.66	0.05	ug/L	ND	73.2	50-140			
Fluoranthene	3.54	0.01	ug/L	ND	70.8	50-140			
Fluorene	4.18	0.05	ug/L	ND	83.7	50-140			
Indeno [1,2,3-cd] pyrene	3.35	0.05	ug/L	ND	67.0	50-140			
1-Methylnaphthalene	4.66	0.05	ug/L	ND	93.2	50-140			
2-Methylnaphthalene	4.05	0.05	ug/L	ND	81.0	50-140			
Naphthalene	3.64	0.05	ug/L	ND	72.9	50-140			
Phenanthrene	3.93	0.05	ug/L	ND	78.6	50-140			
Pyrene	3.91	0.01	ug/L	ND	78.1	50-140			
Surrogate: 2-Fluorobiphenyl	*18.0*		*ug/L*		*89.8*	*50-140*			
Volatiles									
Benzene	22.1	0.5	ug/L	ND	55.3	50-140			
Ethylbenzene	39.6	0.5	ug/L	ND	98.9	50-140			
Toluene	28.6	0.5	ug/L	ND	71.5	50-140			
m,p-Xylenes	85.3	0.5	ug/L	ND	107	50-140			
o-Xylene	43.0	0.5	ug/L	ND	107	50-140			

Certificate of Analysis

Report Date: 16-Nov-2012
Order Date:3-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

Revision 1 - this report includes revised client Sample ID's.

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Head Office
300-2319 St. Laurent Blvd.
Ottawa, Ontario K1G 4J8
p: 1-800-749-1947
e: paracel@paracellabs.com
www.paracellabs.com

Chain of Custody
(Lab Use Only)
Nº 5004

Page 1 of 1

Client Name: Geofirma Engineering
Contact Name: Sean Sterling
Address: 1 Raymond St. Suite 200 Ottawa ON
Telephone: 613-232-2525

Project Reference: 11-200-11
Quote # City of Ottawa
PO #
Email Address: ssterling@geofirma.com

TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 1240186

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PAH	PHC-F1	BTEX								
1	MW12-21 BAG 908	GW		3	3-OCT-12		X	X	X								✓
2	MW12-03 BAG 909						X	X	X								✓
3	MW12-04 BAG 910						X	X	X								✓
4	OW109A BAG 911						X	X	X								✓
5	MW12-20 BAG 912						X	X	X								✓
6	MW12-01 BAG 913						X	X	X								✓
7	OW116C BAG 914						X	X	X								✓
8	MW12-05 BAG 915	↓		↓	↓		X	X	X								✓
9																	
10																	

Comments: may contain high concentrations

Method of Delivery: Pick up

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Brooks	T. Brouse	SUNEEPORN	M
Date/Time: 3-OCT-12 / 14:00	Date/Time: 03/10/12 3:56 PM	Date/Time: OCT 03, 2012 07:13	Date/Time: Oct 3/12 6:06
	Temperature: ____ °C	Temperature: 17.9 °C	pH Verified [ ] By: N/A

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Ottawa, Ontario K1G 4J8
p: 1-800-749-1947
e: paracel@paracellabs.com

www.paracellabs.com

Certificate of Analysis

Geofirma Engineering Ltd.

Suite 200, 1 Raymond St.
Ottawa, ON K1R 1A2
Attn: Sean Sterling

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 93814/3

Report Date: 12-Oct-2012
Order Date: 2-Oct-2012
Order #: 1240110

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1240110-01	E115-Deep
1240110-02	MWD1
1240110-03	MW12-15
1240110-04	MW12-08
1240110-05	MW12-13
1240110-06	MWD2
1240110-07	MW12-09
1240110-08	MW12-10
1240110-09	MW12-16
1240110-10	OW112A
1240110-11	MWD3

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	5-Oct-12	6-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	5-Oct-12	6-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	9-Oct-12	11-Oct-12

Certificate of Analysis

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	E115-Deep	MWD1	MW12-15	MW12-08
	Sample Date:	02-Oct-12	02-Oct-12	02-Oct-12	02-Oct-12
	Sample ID:	1240110-01	1240110-02	1240110-03	1240110-04
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene-d8	Surrogate	110%	112%	111%	109%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.05	0.19	<0.05
Anthracene	0.01 ug/L	<0.01	<0.01	0.05	<0.01
Benzo [a] anthracene	0.01 ug/L	<0.01	<0.01	0.23	<0.01
Benzo [a] pyrene	0.01 ug/L	<0.01	<0.01	0.19	<0.01
Benzo [b] fluoranthene	0.05 ug/L	<0.05	<0.05	0.21	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	0.08	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	0.12	<0.05
Biphenyl	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Chrysene	0.05 ug/L	<0.05	<0.05	0.22	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	<0.01	<0.01	0.42	0.02
Fluorene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	0.09	<0.05
1-Methylnaphthalene	0.05 ug/L	<0.05	<0.05	0.09	<0.05
2-Methylnaphthalene	0.05 ug/L	<0.05	<0.05	0.12	0.06
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	<0.10	0.21	<0.10
Naphthalene	0.05 ug/L	<0.05	<0.05	0.38	0.12
Phenanthrene	0.05 ug/L	<0.05	<0.05	0.06	<0.05
Pyrene	0.01 ug/L	<0.01	<0.01	0.45	0.03
2-Fluorobiphenyl	Surrogate	88.5%	87.9%	107%	97.8%
Terphenyl-d14	Surrogate	76.5%	91.8%	91.8%	90.6%

Certificate of Analysis

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-13	MWD2	MW12-09	MW12-10
	Sample Date:	02-Oct-12	02-Oct-12	02-Oct-12	02-Oct-12
	Sample ID:	1240110-05	1240110-06	1240110-07	1240110-08
	MDL/Units	Water	Water	Water	Water
Volatiles					
Benzene	0.5 ug/L	775	6390	18600	307
Ethylbenzene	0.5 ug/L	3760	2180	1860	2580
Toluene	0.5 ug/L	958	1210	3850	275
m,p-Xylenes	0.5 ug/L	4120	2480	2250	1530
o-Xylene	0.5 ug/L	2460	1640	1400	1010
Xylenes, total	0.5 ug/L	6580	4120	3650	2540
Toluene-d8	Surrogate	108%	107%	87.6%	113%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	5520	5550	52200000	1340
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	36.3 [2]
Acenaphthylene	0.05 ug/L	<50.0 [1] [2]	77.3 [2]	60.8 [2]	48.3 [2]
Anthracene	0.01 ug/L	11.7 [2]	19.9 [2]	11.7 [2]	7.12 [2]
Benzo [a] anthracene	0.01 ug/L	<10.0 [1] [2]	<10.0 [1] [2]	<10.0 [1] [2]	<5.00 [1] [2]
Benzo [a] pyrene	0.01 ug/L	<10.0 [1] [2]	<10.0 [1] [2]	<10.0 [1] [2]	<5.00 [1] [2]
Benzo [b] fluoranthene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Benzo [g,h,i] perylene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Benzo [k] fluoranthene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Biphenyl	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Chrysene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Dibenzo [a,h] anthracene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
Fluoranthene	0.01 ug/L	21.2 [2]	24.6 [2]	15.0 [2]	12.0 [2]
Fluorene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	25.1 [2]
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<50.0 [1] [2]	<50.0 [1] [2]	<50.0 [1] [2]	<25.0 [1] [2]
1-Methylnaphthalene	0.05 ug/L	163 [2]	277 [2]	132 [2]	247 [2]
2-Methylnaphthalene	0.05 ug/L	240 [2]	301 [2]	212 [2]	295 [2]
Methylnaphthalene (1&2)	0.10 ug/L	404 [2]	578 [2]	344 [2]	542 [2]
Naphthalene	0.05 ug/L	800 [2]	981 [2]	1210 [2]	1680 [2]
Phenanthrene	0.05 ug/L	53.9 [2]	69.0 [2]	<50.0 [1] [2]	45.5 [2]
Pyrene	0.01 ug/L	30.4 [2]	40.8 [2]	23.1 [2]	19.3 [2]

Certificate of Analysis

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	MW12-16	OW112A	MWD3	-
	Sample Date:	02-Oct-12	02-Oct-12	02-Oct-12	-
	Sample ID:	1240110-09	1240110-10	1240110-11	-
	MDL/Units	Water	Water	Water	-
Volatiles					
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	-
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	-
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	-
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	-
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	-
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	-
Toluene-d8	Surrogate	115%	115%	115%	-
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	0.07	0.08	-
Acenaphthylene	0.05 ug/L	0.14	0.23	0.23	-
Anthracene	0.01 ug/L	0.03	0.09	0.11	-
Benzo [a] anthracene	0.01 ug/L	<0.01	0.15	0.20	-
Benzo [a] pyrene	0.01 ug/L	<0.01	0.09	0.12	-
Benzo [b] fluoranthene	0.05 ug/L	<0.05	0.08	0.10	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	-
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	0.08	-
Biphenyl	0.05 ug/L	<0.05	<0.05	<0.05	-
Chrysene	0.05 ug/L	<0.05	0.12	0.17	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	-
Fluoranthene	0.01 ug/L	0.05	0.10	0.14	-
Fluorene	0.05 ug/L	<0.05	0.12	0.12	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	-
1-Methylnaphthalene	0.05 ug/L	0.19	0.23	0.27	-
2-Methylnaphthalene	0.05 ug/L	0.20	0.30	0.34	-
Methylnaphthalene (1&2)	0.10 ug/L	0.39	0.53	0.61	-
Naphthalene	0.05 ug/L	0.76	0.46	0.47	-
Phenanthrene	0.05 ug/L	0.10	0.34	0.43	-
Pyrene	0.01 ug/L	0.06	0.21	0.28	-
2-Fluorobiphenyl	Surrogate	86.7%	101%	98.1%	-
Terphenyl-d14	Surrogate	78.3%	79.0%	75.7%	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*18.9*		*ug/L*		*94.6*	*50-140*			
Surrogate: Terphenyl-d14	*15.0*		*ug/L*		*75.1*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*36.0*		*ug/L*		*112*	*50-140*			

Certificate of Analysis

Report Date: 12-Oct-2012

Client: **Geofirma Engineering Ltd.**

Order Date:2-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND				30	
Volatiles									
Benzene	ND	0.5	ug/L	ND				30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	ND	0.5	ug/L	ND				30	
m,p-Xylenes	ND	0.5	ug/L	ND				30	
o-Xylene	ND	0.5	ug/L	ND				30	
Surrogate: Toluene-d8	*30.6*		*ug/L*	*ND*	*95.6*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1790	25	ug/L	ND	89.6	68-117			
Semi-Volatiles									
Acenaphthene	3.89	0.05	ug/L	ND	77.8	50-140			
Acenaphthylene	4.50	0.05	ug/L	ND	90.0	50-140			
Anthracene	4.44	0.01	ug/L	ND	88.8	50-140			
Benzo [a] anthracene	4.11	0.01	ug/L	ND	82.3	50-140			
Benzo [a] pyrene	3.56	0.01	ug/L	ND	71.2	50-140			
Benzo [b] fluoranthene	4.53	0.05	ug/L	ND	90.6	50-140			
Benzo [g,h,i] perylene	3.58	0.05	ug/L	ND	71.5	50-140			
Benzo [k] fluoranthene	4.95	0.05	ug/L	ND	99.0	50-140			
Biphenyl	3.72	0.05	ug/L	ND	74.4	50-140			
Chrysene	4.71	0.05	ug/L	ND	94.3	50-140			
Dibenzo [a,h] anthracene	4.71	0.05	ug/L	ND	94.2	50-140			
Fluoranthene	3.78	0.01	ug/L	ND	75.7	50-140			
Fluorene	3.92	0.05	ug/L	ND	78.3	50-140			
Indeno [1,2,3-cd] pyrene	4.13	0.05	ug/L	ND	82.5	50-140			
1-Methylnaphthalene	4.88	0.05	ug/L	ND	97.5	50-140			
2-Methylnaphthalene	4.49	0.05	ug/L	ND	89.8	50-140			
Naphthalene	4.07	0.05	ug/L	ND	81.4	50-140			
Phenanthrene	4.34	0.05	ug/L	ND	86.8	50-140			
Pyrene	4.20	0.01	ug/L	ND	83.9	50-140			
Surrogate: 2-Fluorobiphenyl	*20.4*		*ug/L*		*102*	*50-140*			
Volatiles									
Benzene	22.1	0.5	ug/L	ND	55.3	50-140			
Ethylbenzene	39.6	0.5	ug/L	ND	98.9	50-140			
Toluene	28.6	0.5	ug/L	ND	71.5	50-140			
m,p-Xylenes	85.3	0.5	ug/L	ND	107	50-140			
o-Xylene	43.0	0.5	ug/L	ND	107	50-140			

Certificate of Analysis

Report Date: 12-Oct-2012
Order Date:2-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

Sample Qualifiers :

1 : Elevated detection limit because of dilution required due to high target analyte concentration.

2 : Surrogates not available due to extract dilution.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Nº 93814
Page 1 of 2

Client Name: Geofirma Engineering	Project Reference: 11-200-11	TAT: [X] Regular	[ ] 3 Day
Contact Name: Sean Sterling	Quote # City of Ottawa		[ ] 2 Day [ ] 1 Day
Address: 1 Raymond St. Suite 200 Ottawa ON	PO #	Date Required:	
Telephone: 613-232-2525	Email Address: ssterling@geofirma.com		

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 1240110

	Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	PAH	PHC-F1	BTEX				
1	E115-Deep	BAG887	GW		3	2-OCT-12									X	X	X				/
2	MW01	BAG888	↓		↓	↓									X	X	X				/
3	MW12-15	BAG889													X	X	X				/
4	MW12-08	BAG890													X	X	X				/
5	MW12-13	BAG891													X	X	X				/
6	MW02	BAG892													X	X	X				/
7	MW12-09	BAG893													X	X	X				/
8	MW12-10	BAG894													X	X	X				/
9	MW12-16	BAG895													X	X	X				/
10	OW12A	BAG896	↓		↓	↓									X	X	X				/

Comments:

Method of Delivery: Pick-up

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Brooks	T. Louse	SUNEEPORN	MC
Date/Time: 2-OCT-12 14:35	Date/Time: 02/10/12 3:46PM	Date/Time: OCT 03, 2012 04:30	Date/Time: Oct 2/12 5:33
	Temperature: ____ °C	Temperature: 16.1 °C	pH Verified [ ] By: N/A

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Nº 93813

Client Name: Geofirma Engineering	Project Reference: 11-200-11	TAT: [X] Regular [ ] 3 Day
Contact Name: Sean Sterling	Quote #	[ ] 2 Day [ ] 1 Day
Address:	PO #	
Telephone: 613-232-2525	Email Address: ssterling@geofirma.com	Date Required:

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 1240110

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP/MS	Hg	CrVI	B (HWS)	PAH	PHC-F1	BTEX				
1	MW03 BAG 897	GW		3	2-OCT-12									X	X	X				/
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				

Comments:

Method of Delivery: Pick up

Relinquished By (Print & Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Melanie Breaks	A. BLOUSE	SUNBYPORN	
Date/Time: 2-OCT-12 14:35	Date/Time: 02/10/12 3:46pm	Date/Time: OCT 03 2012 04:30	Date/Time: Oct 2/12 5:33
	Temperature: _____ °C	Temperature: 15.6 °C	pH Verified [ ] By: N/A

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Certificate of Analysis

Geofirma Engineering Ltd.
1 Raymond St., Suite 200
Ottawa, ON K1R 1A2
Attn: Jean Francois Dion

Phone: (613) 232-2525
Fax: (613) 232-7149

Client PO: 45064625
Project: 11-200-11/ 191 Lees Ave
Custody: 2573

Report Date: 25-Oct-2012
Order Date: 9-Oct-2012
Revised Report **Order #: 1241065**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1241065-01	~~OW111A~~ OW111B

Approved By:

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
BTEX	EPA 624 - P&T GC-MS	12-Oct-12	14-Oct-12
CCME PHC F1	CWS Tier 1 - P&T GC-FID	12-Oct-12	14-Oct-12
PAHs by GC-MS, standard scan	EPA 625 - GC-MS, extraction	16-Oct-12	16-Oct-12

PARACEL LABORATORIES LTD.

Order #: 1241065

Certificate of Analysis

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625

Project Description: 11-200-11/ 191 Lees Ave

	Client ID:	~~OW111A~~	-	-	-
	Sample Date:	09-Oct-12	-	-	-
	Sample ID:	1241065-01	OW111B	-	-
	MDL/Units	Water	-	-	-
Volatiles					
Benzene	0.5 ug/L	34.3	-	-	-
Ethylbenzene	0.5 ug/L	6.9	-	-	-
Toluene	0.5 ug/L	1.0	-	-	-
m,p-Xylenes	0.5 ug/L	3.4	-	-	-
o-Xylene	0.5 ug/L	3.7	-	-	-
Xylenes, total	0.5 ug/L	7.1	-	-	-
Toluene-d8	Surrogate	97.1%	-	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	-	-	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	-	-	-
Acenaphthylene	0.05 ug/L	0.80	-	-	-
Anthracene	0.01 ug/L	0.02	-	-	-
Benzo [a] anthracene	0.01 ug/L	0.04	-	-	-
Benzo [a] pyrene	0.01 ug/L	<0.01	-	-	-
Benzo [b] fluoranthene	0.05 ug/L	<0.05	-	-	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	-	-	-
Benzo [k] fluoranthene	0.05 ug/L	<0.05	-	-	-
Biphenyl	0.05 ug/L	0.11	-	-	-
Chrysene	0.05 ug/L	<0.05	-	-	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	-	-	-
Fluoranthene	0.01 ug/L	0.06	-	-	-
Fluorene	0.05 ug/L	0.07	-	-	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	-	-	-
1-Methylnaphthalene	0.05 ug/L	2.50	-	-	-
2-Methylnaphthalene	0.05 ug/L	0.36	-	-	-
Methylnaphthalene (1&2)	0.10 ug/L	2.86	-	-	-
Naphthalene	0.05 ug/L	2.24	-	-	-
Phenanthrene	0.05 ug/L	0.11	-	-	-
Pyrene	0.01 ug/L	0.09	-	-	-
2-Fluorobiphenyl	Surrogate	95.8%	-	-	-
Terphenyl-d14	Surrogate	99.1%	-	-	-

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Biphenyl	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*18.7*		*ug/L*		*93.5*	*50-140*			
Surrogate: Terphenyl-d14	*19.8*		*ug/L*		*98.9*	*50-140*			
Volatiles									
Benzene	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: Toluene-d8	*31.2*		*ug/L*		*97.3*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	589	25	ug/L	576			2.2	30	
Volatiles									
Benzene	13.6	0.5	ug/L	11.7			15.4	30	
Ethylbenzene	ND	0.5	ug/L	ND				30	
Toluene	2.53	0.5	ug/L	2.52			0.4	30	
m,p-Xylenes	214	0.5	ug/L	188			13.1	30	
o-Xylene	39.4	0.5	ug/L	35.5			10.3	30	
Surrogate: Toluene-d8	*31.3*		*ug/L*	*ND*	*97.8*	*50-140*			

Certificate of Analysis

Client: **Geofirma Engineering Ltd.**

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1760	25	ug/L	ND	88.0	68-117			
Semi-Volatiles									
Acenaphthene	3.82	0.05	ug/L	ND	76.5	50-140			
Acenaphthylene	4.16	0.05	ug/L	ND	83.2	50-140			
Anthracene	3.33	0.01	ug/L	ND	66.6	50-140			
Benzo [a] anthracene	3.54	0.01	ug/L	ND	70.8	50-140			
Benzo [a] pyrene	3.12	0.01	ug/L	ND	62.4	50-140			
Benzo [b] fluoranthene	3.78	0.05	ug/L	ND	75.6	50-140			
Benzo [g,h,i] perylene	3.78	0.05	ug/L	ND	75.6	50-140			
Benzo [k] fluoranthene	4.43	0.05	ug/L	ND	88.7	50-140			
Biphenyl	3.89	0.05	ug/L	ND	77.8	50-140			
Chrysene	3.74	0.05	ug/L	ND	74.8	50-140			
Dibenzo [a,h] anthracene	4.75	0.05	ug/L	ND	95.1	50-140			
Fluoranthene	3.47	0.01	ug/L	ND	69.3	50-140			
Fluorene	3.66	0.05	ug/L	ND	73.3	50-140			
Indeno [1,2,3-cd] pyrene	4.11	0.05	ug/L	ND	82.3	50-140			
1-Methylnaphthalene	4.82	0.05	ug/L	ND	96.3	50-140			
2-Methylnaphthalene	4.44	0.05	ug/L	ND	88.8	50-140			
Naphthalene	4.17	0.05	ug/L	ND	83.4	50-140			
Phenanthrene	4.18	0.05	ug/L	ND	83.7	50-140			
Pyrene	4.07	0.01	ug/L	ND	81.3	50-140			
Surrogate: 2-Fluorobiphenyl	*19.7*		*ug/L*		*98.6*	*50-140*			
Volatiles									
Benzene	33.2	0.5	ug/L	ND	83.1	60-130			
Ethylbenzene	42.9	0.5	ug/L	ND	107	60-130			
Toluene	35.2	0.5	ug/L	ND	87.9	60-130			
m,p-Xylenes	88.8	0.5	ug/L	ND	111	60-130			
o-Xylene	46.0	0.5	ug/L	ND	115	60-130			

Certificate of Analysis

Report Date: 25-Oct-2012
Order Date:9-Oct-2012

Client: **Geofirma Engineering Ltd.**

Client PO: 45064625 Project Description: 11-200-11/ 191 Lees Ave

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

Revision 1 - This report includes an updated client Sample ID.

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.

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Client Name: Geofirma Eng LTD	Project Reference: 11-200-11
Contact Name: JF Dion	Quote #
Address:	PO # City of OTTAWA
Telephone: 613-290-4005	Email Address: JFDion@Geofirma.Com

TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [X] O. Reg. 153/11 (Current) Table 3 [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 1241065

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken: Date	Sample Taken: Time	Btex + F1	PAH									
1	OW1116 BAH006	GW		3	9-Oct-12	13:30	X	X									✓
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: COURIER

Relinquished By (Print & Sign): JF Dion	Received by Driver/Depot:	Received at Lab: SUNREP OAN	Verified By: MC
Date/Time: 9-Oct-12 14:38	Date/Time:	Date/Time: OCT 09, 2012 04.10	Date/Time: Oct 9/12 4:56
	Temperature: ____ °C	Temperature: 19.7 °C	pH Verified [ ] By: N/A

APPENDIX E

MOE Well Records

Ontario — Ministry of the Environment

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A135005

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of ottawa	C/O Brad Carew		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W. 5 Fl.	ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Lees Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA.	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	447591	5029485		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Blk	Asphalt	gravel	Hard.	0	.31
Brn	Sand	Fill	Soft	.31	2.44
Gry	Sand.	Silt	moist, Hard.	2.44	4.88

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	3'	Flushmount/Concrete.	
.3'	3.1	3/8 Bentonite chips	
3.1	4.88	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☑ Other, *specify* Direct push

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
4.03	plastic	.368	0	3.35

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
4.82	plastic	10	3.35	4.88

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Kind of Water	
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	4.88	8.25

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12-13 on my

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Shad Soil Sampling	7291

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1G6	wrecords@shadsoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9057649304	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2012/08/28

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: YYYY MM DD

Date Work Completed: 2012/08/25

Ministry Use Only

Audit No. Z 156921

Received

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Contractor's Copy

Ontario — Ministry of the Environment

Measurements recorded in: [x] Metric [ ] Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A185004

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	[ ] Well Constructed by Well Owner
City of Ottawa	c/o Brad Carew		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W. 5 FL	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Leos Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	447608	5029440		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Blk	Asphalt	Gravel	Hard.	0	.31
Brwn	Sand	gravel	Layered, soft.	.31	3.1
Brwn	Sand	Silt.	Layered, soft.	3.1	6.1
Grey	Sand.	silt.	moist.	6.1	8.53
Grey	clay	silt, gravel.	moist, Hard.	8.53	9.14

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	.31	Flushmount/concrete	
.31	7.32	3/8" Bentonite chips	
7.32	9.14	sand	

Method of Construction

[ ] Cable Tool [ ] Diamond
[x] Rotary (Conventional) [ ] Jetting
[ ] Rotary (Reverse) [ ] Driving
[ ] Boring [ ] Digging
[ ] Air percussion
[ ] Other, *specify* _____

Well Use

[ ] Public [ ] Commercial [ ] Not used
[ ] Domestic [ ] Municipal [ ] Dewatering
[ ] Livestock [x] Test Hole [x] Monitoring
[ ] Irrigation [ ] Cooling & Air Conditioning
[ ] Industrial
[ ] Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.2	plastic	.39	0	7.62

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.03	plastic	10	7.62	9.14

Status of Well

[ ] Water Supply
[ ] Replacement Well
[x] Test Hole
[ ] Recharge Well
[ ] Dewatering Well
[x] Observation and/or Monitoring Hole
[ ] Alteration (Construction)
[ ] Abandoned, Insufficient Supply
[ ] Abandoned, Poor Water Quality
[ ] Abandoned, other, *specify* _____
[ ] Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Kind of Water	Hole Diameter Depth From	Hole Diameter Depth To	Hole Diameter (cm/in)
[ ] Gas	[ ] Fresh [ ] Untested [ ] Other, *specify*	0	9.14	10.92
[ ] Gas	[ ] Fresh [ ] Untested [ ] Other, *specify*			
[ ] Gas	[ ] Fresh [ ] Untested [ ] Other, *specify*			

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Samplers	7211

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9059761493104	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2012 09 28

Results of Well Yield Testing

After test of well yield, water was:
[ ] Clear and sand free
[ ] Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? [ ] Yes [ ] No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12-14 on Map

Comments:

Well owner's information package delivered: [ ] Yes [ ] No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2012 09 28

Ministry Use Only

Audit No. Z 156922

Received

Contractor's Copy

Ontario — Ministry of the Environment

Well Tag No. *(Place Sticker and/or Print Below)* A135003

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☑ Metric ☐ Imperial

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of Ottawa	C/O Brad Carew		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurie Ave W 5 FL	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Lees Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	447535	5029481		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Blk	Asphalt	Gravel	Fill.	0	.31
Brwn	Sand	gravel	Layered Soft.	.31	2.44
Brwn	Sand	s. lt.	Layered soft	2.44	6.1
Gy	Sand	s. lt.	soft, wet.	6.1	8.99

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	.31	Flush mount / concrete	
.31	7.16	3/8" Bentonite Chips	
7.16	8.99	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☒ Other, *specify* Direct push

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
4.03	plastic	.368	0	7.47

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
4.82	plastic	10	7.47	8.99

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	☐ Gas	Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	8.99	8.25

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12-15 on Map

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Sampling	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1G6	wrecords@stratasoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9057649304	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2012/09/28

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No		2012/09/25

Ministry Use Only

Audit No. Z 156920

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Contractor's Copy

Ontario — Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A135006

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of	Ottawa c/o Brad Carew		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W. 5th Fl	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Loos Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA.	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	447651	5029946 3		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brwn	Topsoil	Sand.	Loose, soft.	0	.61
Brwn	Sand.	gravel.	Loose, soft.	.61	3.1
Brwn	Sand	gravel.	Hard dense.	3.1	6.1
Grey	Sand	silt, clay	moist, Layered.	6.1	9.14

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	7.32	3/8" Bentonite chips	
7.32	9.14	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☒ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, *specify* _____

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
4.05	plastic	.368	0	7.62

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
4.82	plastic	10	7.62	9.14

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Kind of Water	
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	9.14	10.92

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW 12-16 on Map

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Samplers Inc.	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9057649930	Beatty, Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3161		2012 09 28

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: _____

Date Work Completed: 2012 09 25

Ministry Use Only

Audit No. Z 156955

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Contractor's Copy

Ontario — Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A135000

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of Ottawa	C/O Brad Carew		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W 5 Fl.	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Lees Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	445750	5029418		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brwn	Topsoil	Sand	Soft Loose	0	.61
Brwn	Sand.	gravel.	Soft. Layered.	.61	6.1
Gry	Silt	clay	Soft Layered	6.1	7.62
Gry	clay	Silt.	no sd.	7.62	8.53
Gry	Till.		Hard.	8.53	8.84

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	7.01	3/8 Bentonite chips	
7.01	8.84	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☒ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, *specify* _____

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.2	plastic	.39	0	7.32

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.03	plastic	10	7.32	8.84

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Kind of Water	
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	8.84	10.2

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Shad Soil Sampling	7141

Business Address (Street Number/Name)	Municipality
2-147 Wurtemburg West Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@shadsoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
905 764 9393	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2011 2009 28

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down		Recovery	
	Time *(min)*	Water Level *(m/ft)*	Time *(min)*	Water Level *(m/ft)*
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12 - MW17 on Map

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2011 2009 24

Ministry Use Only

Audit No. Z 156918

Received

Contractor's Copy

Ontario — Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A135002

5-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of Ottawa	C/O Brad Caron		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W. 5th Fl	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Legg Avenue			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates NAD 83	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
	18	447517	5029450		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brn	Topsoil	Sand	Sandy, Loose.	0	.61
Brn	Sand.	gravel	Layered Sands.	.61	3.66
Gry	Silty sand.	clay	Sandy.	3.66	6.1
Gry	clay	Silty Sand.	moist, sandy.	6.1	8.84

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	7.01	3/8" Bentonite chips	
7.01	8.84	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☒ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, *specify* _____

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.2	plastic	.39	0	7.32

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.03	plastic	10	7.32	8.84

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh	Untested	Other, specify
	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	8.84	10.92

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12 from 18 on Map

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Survey	2411

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1G6	wrecords@stratasoil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9057649304	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2012/09/28

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No		2012/09/24

Ministry Use Only

Audit No. Z156917

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Contractor's Copy

Ontario — Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A135001

S-13085

Well Record

Regulation 903 Ontario Water Resources Act

Page _____ of _____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
City of Ottawa	C/o Brad Caron		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
110 Laurier Ave W. 5th Fl.	Ottawa	ON	K1P1J1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
191 Lees Avenue.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA.	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	18	445745	5029419		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brwn	Topsoil	Sand.	Soft, Loose.	0	.61
Brwn	Sand.	~~cobbles~~. gravel.	soft.	.61	4.57
Gry	Clay	silt	Layered. Soft.	4.57	7.62

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used *(Material and Type)*	Volume Placed (m^3/ft^3)
0	5.79	3/8" Bentonite chips	
5.79	7.62	Sand.	

Method of Construction

☐ Cable Tool ☐ Diamond
☒ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☐ Other, *specify* _____

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☒ Test Hole ☒ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify* _____

Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth (m/ft) From	Depth (m/ft) To
5.2	plastic	.39	0	6.1

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.03	plastic	10	6.1	7.62

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* _____
☐ Other, *specify* _____

Water Details

Water found at Depth (m/ft)	Kind of Water	
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify* _____
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify* _____
☐ Gas	☐ Fresh ☐ Untested	☐ Other, *specify* _____

Hole Diameter

Depth (m/ft) From	To	Diameter *(cm/in)*
0	7.62	10.92

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* _____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping _____ hrs + _____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Draw Down Water Level *(m/ft)*	Recovery Time *(min)*	Recovery Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.

Labelled MW12 2019 on Map

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Sampling	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1G6	wrecords@stratas oil.com

Bus. Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
9056769930	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		2019/09/28

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No		2019/09/24

Ministry Use Only

Audit No. Z 156919

Received

Contractor's Copy