

13.0 Geotechnical Reports for Addendum – Golder Associates

A copy of the Risk Assessment and Technical Memorandums prepared by Golder Associates has been included.



March 2015

SCREENING LEVEL RISK ASSESSMENT

Grand Marais Drain near the intersection of Howard Avenue and E.C. Row Expressway in Windsor, Ontario

Submitted to:

Landmark Engineers Inc.
2280 Ambassador Drive
Windsor, Ontario
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REPORT

Report Number: 1520609-R01

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Executive Summary

A risk assessment was conducted for the property located at the southwestern corner of the intersection of E.C. Row Expressway and Howard Avenue within the approximate boundary formed by E.C. Row Expressway (eastbound lanes) to north, Grand Marais Drain to the south, Howard Avenue to the east and the associated off-ramp to the west, as shown on Figure 1, in general accordance with the requirements of *O. Reg. 153/04*. The Site is currently owned by the City of Windsor and is located within the road allowance of E.C. Row Expressway.

As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain (located along the southern portion of the Site) in order to provide adequate flood flow capacity in the drain. It is intended that the sediment removed from the drain will be placed within Geotubes which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped. There is no proposed change in the current land use.

The objectives of the RA were as follows:

- Quantitatively assess the potential risks to human and ecological receptors, if any, associated with identified COCs in the soil/sediment intended to be placed at the Site based on continued use of the Site as an E.C. Row Expressway right-of-way;
- Develop property specific standards considered to be protective of potential human and ecological receptors that are present at the Site without risk management measures in place; and
- Identify risk management measures, if necessary, to a level of detail necessary to mitigate exposures by human and ecological receptors based on the results of the RA.

The RA evaluated the following risks from the identified COCs:

- A quantitative assessment of potential human health risks was evaluated for a landscape maintenance and construction worker. The exposure pathways assessed included: direct contact with soil via ingestion, and dermal contact and inhalation of particulates.
- A quantitative evaluation of potential ecological risks was evaluated for terrestrial plants and soil invertebrates. The exposure pathways assessed included direct contact with soil and exposure by soil invertebrates and plants.

The results of the HHRA indicate that increased risks are associated with direct contact to soil/sediment by the landscape maintenance worker and construction worker in the absence of risk management measures.

The results of the ERA indicate that increased risks are associated with direct contact to soil/sediment by plants and soil invertebrates in the absence of risk management measures. Given that the Site is currently vacant, will remain vacant and will continue to be used as an E.C. Row Expressway right-of-way, the Site provides unattractive habitat to ecological receptors; therefore, it is unlikely that mammals and birds would use the Site for any prolonged period of time.



SLRA GRAND MARAIS DRAIN

The findings of the RA concluded that for the continued use of the Site as an E.C. Row Expressway right-of-way, risk management measures are required to mitigate the identified risks to human and ecological receptors if the dredged soil/sediment is to be placed on the Site.

The construction methods that will be implemented as risk management measures to decrease direct contact with the proposed dredged soil/sediment placement at the Site includes:

- The placement of clean fill soil caps, meeting the applicable Ministry of the Environment Table 3 Site Condition Standards, to block direct exposure to potentially impacted soil.

In order to control the potential exposure to impacted soils below the proposed soil cap, the following administrative controls should be implemented:

- Where work on the Site will encounter impacted soils, a Health and Safety Plan shall be developed and implemented by the contractor responsible for the work prior to commencing the work; and
- Where work on the Site will encounter impacted soils, a Soil Management Plan shall be developed and implemented by the contractor responsible for the work prior to commencing the work.

Therefore, if the risk management measures described in Section 7.2 of the RA are implemented and the Site continues to be used as an E.C. Row Expressway right-of-way, the increased risks associated with the proposed placement of dredged soil/sediment at the Site can be mitigated. However, potential human and ecological risks should be re-evaluated if future concentrations reported at the Site exceed the maximum COC concentrations assessed in the RA or significant changes to the Site use are undertaken.



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1.0 SUMMARY OF RECOMMENDATIONS / FINDINGS

1.1 Risk Assessment Objectives and Approach

Golder Associates Ltd. ("Golder") was retained by Landmark Engineers Inc. (referred to herein as "Landmark" or the "Client") to provide consulting services in support of the implementation of a sediment management strategy in a segment of the Grand Marais Drain ("Drain") near the intersection of Howard Avenue and E.C Row Expressway in Windsor, Ontario.

As part of the consulting services provided to Landmark, Golder completed a Risk Assessment (RA) for the property located at the southwestern corner of the intersection of EC Row Expressway and Howard Avenue within the approximate boundary formed by EC Row Expressway (eastbound lanes) to the north, Grand Marais Drain to the south, Howard Avenue to the east and the associated off-ramp to the west, as shown on Figure 1 (referred to hereinafter as "the Site" or "RA property"). The work is being conducted as part of the Grand Marais Drain Flood Control Improvement project, which is being managed by Landmark on behalf of the Essex Region Conservation Authority (ERCA) and the City of Windsor ("the City"). The City owns the entire property which is located on the E.C. Row Expressway right-of-way.

As part of the sediment management strategy, some accumulated sediment material will be removed from the Drain in order to provide adequate flood flow capacity in the Drain. It is intended that the sediment removed from the Drain will be placed within geosynthetic membrane containment devices ("Geotubes") which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped.

The RA was completed for due diligence purposes for the proposed placement of dredged soil/sediment on the Site. Although this RA is not intend to support the filing of a Record of Site Condition (RSC) with the Ontario Ministry of the Environment and Climate Change ("MOECC"), the RA has been prepared consistent with the spirit of *Ontario Regulation 153/04 (O. Reg. 153/04)*.

For the purposes of this RA, sediment to be dredged from the Drain and subsequently placed on the Site has been considered soil.

In order to identify contaminants of potential concern (COC) at the Site, a chemical screening process was undertaken. Initially, maximum chemical concentrations, which have been reported for samples in soil and sediment on the Site, were compared with the MOE 2011 Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium and fine textured soils (Table 3 SCS). Those chemicals that exceeded the applicable standard were retained as COCs for further evaluation.



The RA included the following assessments:

- A quantitative assessment of potential human health risks was evaluated for a landscape maintenance and construction worker. The exposure pathways assessed included: direct contact with soil via ingestion, and dermal contact and inhalation of particulates.
- A quantitative evaluation of potential ecological risks was evaluated for terrestrial plants and soil invertebrates. The exposure pathways assessed included direct contact with soil and exposure by soil invertebrates and plants.

1.1.1 Objectives of the Risk Assessment

The objectives of the RA were as follows:

- Quantitatively assess the potential risks to human and ecological receptors, if any, associated with identified COCs based on continued use of the Site as an E.C. Row Expressway right-of-way;
- Develop property specific standards (PSS) considered to be protective of potential human and ecological receptors that are present at the Site without risk management measures in place; and
- Identify risk management measures (RMM), if necessary, to a level of detail necessary to mitigate exposures by human and ecological receptors based on the results of the RA.

1.1.2 Selected Risk Assessment Approach

A standard RA approach, other than those identified in O. Reg. 153/04 Schedule C Part II, was applied. Guidance for conducting this RA was obtained from the following documents provided by the MOE:

- MOE. 2005. Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act. Dated October, 2005. Standards Development Branch.
- MOE. 2011a. Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Dated April 15, 2011. Standards Development Branch.
- MOE. 2011b. A guide to using the "Approved Model" (April 15, 2011) When Submitting a Modified Generic Risk Assessment (MGRA). Dated April 15, 2011. Ministry of the Environment.
- *Ontario Regulation 153/04 of the Environmental Protection Act.*



1.2 Deviations from Pre-Submission Form

A Pre-Submission Form pursuant to O.Reg. 153/04 was not prepared for this Site as an RSC is not intended to be filed.

1.3 Risk Assessment Standards

Proposed PSSs were developed that are protective of human and ecological health based on the continued use of the Site as an E.C. Row Expressway right-of-way. The human health standards were calculated based on meeting a target hazard quotient (HQ) of 0.2 for non-cancer effects and an incremental lifetime cancer risk (ILCR) of 1×10^{-6} for cancer effects. The ecological PSSs were derived based on meeting a target HQ of 1. The proposed PSS for the Site is provided in Table 1.1.

Table 1.1: Recommended Property Specific Standards ($\mu\text{g/g}$)

Parameter	MOE Table 3 SCS	Maximum	Minimum Human Health Based PSS	Minimum Ecological Based PSS	Proposed PSS	RMM Requirement
Acenaphthylene	0.17	<1	9.60E+00	NV	1.2	No
Anthracene	0.74	5.5	4.20E+04	76	6.6	No
Barium	670	1100	8.60E+03	3800	1320	No
Benz[a]anthracene	0.96	7.1	9.60E-01	2.47	8.5	Yes
Benzo[a]pyrene	0.3	6.6	9.60E-02	171	7.9	Yes
Benzo[b]fluoranthene	0.96	10	9.60E-01	NV	12	Yes
Benzo[k]fluoranthene	0.96	3.8	9.60E-01	36	4.6	Yes
Boron (Hot Water Soluble)	2	2.5	NV	3.8	3	No
Cadmium	1.9	45	7.90E+00	57	54	Yes
Chromium Total	160	410	2.40E+05	1197	492	No
Copper	300	210	5.60E+03	570	252	No
Dibenz[a h]anthracene	0.1	<1	9.60E-02	NV	1.2	Yes
Fluoranthene	9.6	22	5.60E+03	437	26	No
Indeno[1 2 3-cd]pyrene	0.95	4.7	9.60E-01	1.8	5.6	Yes
Lead	120	600	1.00E+03	2660	720	No
Petroleum Hydrocarbons F1	65	120	2.60E+04	608	144	No
Petroleum Hydrocarbons F2	250	3600	2.20E+04	494	4320	Yes
Petroleum Hydrocarbons F3	2500	16000	4.00E+04	4750	19200	Yes
Petroleum Hydrocarbons F4	6600	27000	4.20E+04	12540	32400	Yes
Phenanthrene	16	21	16	30	25	Yes
Polychlorinated Biphenyls	1.1	3.8	2.70E+00	78	4.6	Yes
Zinc	340	2700	4.70E+04	1520	3240	Yes



1.4 Risk Assessment Assumptions

The following assumptions were applied in the RA:

- The Site will continue to be used as an E.C. Row Expressway right-of-way.
- The Site is currently vacant and will remain vacant.
- Sediment to be dredged from the Drain and subsequently placed on the Site will be contained within Geotubes and capped with a soil cover.

1.5 Risk Management Requirements

The risk assessment identified potential risk greater than the target HQ of 0.2 and ILCR of 1×10^{-6} for human health and the target HQ of 1 for ecological health. The increased calculated risks are associated with direct contact with soil. The construction methods that will suffice as RMM to decrease direct contact with soil at the Site includes:

- The placement of clean fill soil caps, meeting the applicable Table 3 SCS, to block direct exposure to potentially impacted soil.

In order to control the potential exposure to impacted soils below the proposed soil cap, the following administrative controls should be implemented:

- Where work on the Site will encounter impacted soils, a Health and Safety Plan (HASP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work; and
- Where work on the Site will encounter impacted soils, a Soil Management Plan (SMP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work.

Details of the RMM are provided in Section 7.0.

2.0 RISK ASSESSMENT TEAM MEMBERSHIP

This RA has been prepared by a qualified RA team at Golder. The team (listed below) has the necessary expertise to complete the RA in a manner acceptable to the MOE. The following section provides a brief synopsis of the expertise and the role of each team member in the completion of the RA. The curriculum vitae for the Project team are provided in Appendix B.



Theresa Repaso-Subang – Qualified Person for Risk Assessment (QP_{RA}) and Senior Toxicologist

Ms. Theresa Repaso-Subang, B.Sc., DABT, QP_{RA}, is an Associate, Senior Toxicologist for the Toxicology and Risk Assessment Group with the Golder GTA office in Ontario. Theresa possesses the necessary technical qualifications that are relevant to this project. Theresa has demonstrated experience in overall project management, senior technical review of quantitative HHRA projects, direct experience with human health risk assessment of contaminated sites, and direct experience with contaminated sites. Theresa brings both management and technical capabilities to this project. She is an experienced project manager with a track record for meeting project budgets, allocating technical personnel, and adhering to project schedule.

Theresa graduated from the University of Guelph with an Honours B.Sc. specializing in biomedical toxicology. She is one of 40 Canadian toxicologists who are board-certified with the American Board of Toxicology. She is a member of the Society for Risk Analysis (SRA), Society for Environmental Toxicology and Chemistry (SETAC), Society for Toxicology (SOT), Society for Toxicology of Canada (STC) and International Congress of Toxicology (ICT). She is a Qualified Person for Risk Assessment as defined by O.Reg.153/04.

Theresa has over 20 years of direct experience and training in environmental and human health toxicology, and risk assessment. She has supervised more than 200 contracts (60 of which were under the Superfund program in the United States) involving professionals from a wide variety of scientific and engineering disciplines under various U.S. and Canadian regulatory frameworks.

Stephen Cioccio – Environmental Risk Assessor

Mr. Stephen Cioccio, M.Sc., joined the Golder Associates Mississauga Office as an Environmental Risk Assessor in September 2008. Mr. Cioccio has a B.Sc. in Applied Pharmaceutical Chemistry and a M.Sc. in Land Resource Science and Toxicology, both from the University of Guelph. As a member of the Toxicology and Risk Assessment Group, Mr. Cioccio's primary responsibilities include human health and ecological risk assessment, statistical and modeling calculations for the evaluation of contaminated sites and toxicological assessment of chemicals in support of emission and standards review. Mr. Cioccio was the technical lead for the human health and ecological risk assessments for the Site.

Lane Chevalier – Environmental Engineer

Mr. Lane Chevalier, P. Eng., is an Environmental Engineer with the Golder Associates Southwestern Ontario Office (Windsor location) and has over 7 years of experience in the assessment, management and remediation of contaminated sites. Mr. Chevalier has a B.A.Sc. (Hons.) in Environmental Engineering from the University of Waterloo. Mr. Chevalier was responsible for the overall project management.



3.0 PROPERTY INFORMATION, SITE PLAN AND GEOLOGICAL INTERPRETATION

3.1 Property Information

The Site is currently owned by the City and is located within the road allowance of E.C. Row Expressway. Figure 1 shows the Site location. The RA property is located at the southwestern corner of the intersection of E.C. Row Expressway and Howard Avenue within the approximate boundary formed by E.C. Row Expressway (eastbound lanes) to north, Grand Marais Drain to the south, Howard Avenue to the east and the associated off-ramp to the west, as shown on Figure 1.

The RA property is locally depressed relative to E.C. Row Expressway and the associated access ramps. The area as a whole is elevated relative to the local landscape (and inferred natural ground surface elevation) due to the elevation of the grade as part of the construction of the E.C. Row Expressway and the related access ramps. The area generally slopes to the south towards the Grand Marais Drain (understood to be a municipal drain). The Site is currently grass covered. The Site is not developed with any buildings and is generally not intended for human use except for potential access by landscape and/or maintenance City personnel.

As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain (located along the southern portion of the Site) in order to provide adequate flood flow capacity in the drain. It is intended that the sediment removed from the drain will be placed within Geotubes (geosynthetic membrane containment devices) which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped.

Previous investigations of the sediment quality in the Grand Marais Drain and previous geotechnical investigations in the vicinity of the Site have been carried out by Golder. A list of the related reports and a summary of the pertinent findings are provided below. For a more detailed description of the investigations and findings, and the associated limitations in interpreting the data, the actual reports should be consulted.

A summary of soil and sediment data collected by Golder and others is included in Appendix A. The approximate sampling locations are shown on Figure 1.

3.1.1 Historical Site Investigations

Summary of Previous Investigations

The RA relied on data reported in the following documents:

- Report number 12-1134-0179-R01 titled *"Soil and Sediment Quality Assessment, Central Grand Marais Drain, Windsor, Ontario"* prepared by Golder and dated January 2013 ("Sediment Report").
- Technical Memorandum number 1520609-TM01 titled *"Sediment Management Support, Grand Marais Drain, Windsor, Ontario"* prepared by Golder and dated March 24, 2015 ("Sediment Memo").



- Technical Memorandum number 1520609-Ph2000-TM01 titled "*Geotechnical Consultation, Proposed Retaining Walls, Grand Marais Drain, East of Canadian National Railway Tracks, City of Windsor, Ontario*" prepared by Golder and dated March 6, 2015 ("Geotechnical Memo").

Sediment Quality Assessment Report (Golder 2013)

Golder conducted an assessment of sediment quality within the Grand Marais Drain between Walker Road and Dougall Avenue in the fall/winter of 2012. The objectives of the investigation were to characterize the sediment quality in five open channel segments of the drain, estimate the approximate thickness of sediment and to provide preliminary evaluation of potential sediment management strategies for material which might require removal as part of the drain improvement activities. Two of the five drain segments evaluated were the open channel segments at the southern limit of the RA property consisting of the segment to the west of Howard Avenue and the segment to the west of on-ramp/off-ramp.

Six samples from two sampling locations (shown on Figure 2) were collected from the open channel segment of the Grand Marais Drain to the south of EC Row Expressway and west of Howard Avenue and one sample was collected from segment to the west of the on-ramp/off-ramp. The sediment material encountered at the sampling locations generally consisted of silty clay and silty sand material and the sediment accumulation was inferred to be approximately 2.1 m thick near Howard Avenue and 0.9 m thick west of the on-ramp/off-ramp. Field evidence of potential impacts (i.e., sheen on pore water and odour) was identified from each of the samples collected in this area.

The samples were submitted to Maxxam Analytics ("Maxxam") of Mississauga, Ontario under standard chain-of-custody procedures for chemical analysis. The samples were analysed for potential contaminants of concern which entailed metals listed under O.Reg. 153/04, pH, benzene, toluene, ethylbenzene and xylenes (BTEX), petroleum hydrocarbons (PHC) fractions F1 to F4, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

For evaluation of various sediment management strategies, the analytical results were compared to selected standards under the MOE O. Reg. 153/04 Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act, April 15, 2011, which included comparison to the Sediment Standards, Table 1 Standards and/or Table 3 Standards. For the purpose of this document, a summary of the exceedances of the Table 3 Standards for sediment samples collected from the segment of the Grand Marais drain at the southwest corner of the intersection of EC Row Expressway and Howard Avenue, is provided below.

Sediment

- Concentrations of various metals parameters in all seven samples exceeded the Table 3 Standards.
- Concentrations of PAHs and PHCs exceeded the Table 3 Standards in six of the seven samples.
- Concentrations of PCBs in four of the seven samples exceeded the Table 3 Standards.
- The concentrations of VOCs in all seven samples were less than the Table 3 Standards.



Sediment Quality Assessment Memo (Golder 2015)

Golder provided a technical memorandum summarizing the analytical results of samples collected by Landmark from the noted segment of the Grand Marais Drain. Landmark collected six sediment samples from four locations in within the open channel segment of the drain to west of Howard Avenue and to the west of the on-ramp/off-ramp, as shown on Figure 1. The samples were provided to Golder and subsequently submitted, under chain-of-custody procedures, to Maxxam for laboratory analysis of metals listed under O.Reg. 153/04, BTEX, PHCs, PAHs and PCBs.

For evaluation of various sediment management strategies, the analytical results as part of this subsequent sediment characterization were compared to selected standards, which included the Sediment Standards, Table 1 Standards and/or Table 3 Standards. For the purpose of this document, a summary of the exceedances of the Table 3 Standards, is provided below.

Sediment

- Concentrations of BTEX, PHC, metals and PAH parameters exceeded the MOE Table 3 Standards in all of the samples.
- Concentrations of PCBs exceeded the MOE Table 3 Standard in two of the six analysed samples.

Proposed Retaining Walls Memo (Golder 2015)

Golder provided geotechnical information including subsurface soil conditions for the proposed construction of retaining walls along the Grand Marais Drain to the immediate west of the RA property. The information was obtained from two historical geotechnical investigations as part of which boreholes were formerly advanced in the vicinity of the Site. The results of the two related investigations were summarized in the following documents:

- Golder Report Number 11-1140-0212-R01 titled, "*Geotechnical Investigation, Proposed Union Gas Undercrossing of Canadian National Railway Tracks, NPS 16 Panhandle Line, Windsor, Ontario*", dated November 2011; and
- Golder Report Number 68517/5 titled, "*Subsurface Investigation, Proposed Grand Marais Trunk Sanitary Sewer, Mark Avenue to Parent Avenue, Windsor, Ontario*", dated June 1972.

The fill materials west of the Site vary from silty clay to silty sand and contain layers with black cinders and slag fragments. The organic materials vary from black silty clay topsoil to grey silty clay containing organics, shells, and layers of peat. The surficial materials generally have a firm to very stiff consistency.

Beneath the surficial materials, silty clay till soils were encountered at elevations of approximately 182.4 m and 181.0 m. The silty clay till soils are generally very stiff in consistency to about elevation 179.0 m and are stiff to firm below this elevation.

The water level measured in temporary standpipes installed in the former boreholes varied between about elevations 176.2 m and 184.1 m. It is understood that the water level in the drain is at about elevation 180.0 m, or some 300 millimetres of water in the drain, in the area of the proposed wall.



Borehole BH-71 was completed in 1972 within the RA property, as shown on Figure 1. According to the information provided in the Record of Borehole sheet (attached), over 12 metres of fill material was encountered in the borehole which generally consisted of silty clay material with some minor layers of sand and gravel which contained black cinders and slag fragments. The fill material layer ranged in elevation from approximately 194.9 m (at surface) to 182.4 m and was generally underlain by silty clay material to borehole termination at an elevation of approximately 168.2 m.

3.1.2 Surrounding Properties

Current surrounding land uses consist of a mixture of commercial and industrial properties (including the E.C. Row Expressway Lands). The Grand Marais Drain is present along the southern limit of the RA property.

3.2 Site Plan and Hydrogeological Interpretation of Risk Assessment Property

3.2.1 Geology

The stratigraphic units encountered during the historical drilling activities in the vicinity of the Site are discussed above in section 3.1.1.

3.2.2 Hydrogeology

A brief discussion relating to the hydrogeological conditions encountered during the historical geotechnical investigations completed in the vicinity of the Site is provided above in section 3.1.1.

3.3 Contaminants of Potential Concern

3.3.1 Regulatory Criteria

The soil and sediment analytical results were compared to the generic standards provided in "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, dated April 15, 2011". The applicable standards listed below were used in assessing the soil and groundwater quality for the Site:

- Full-depth generic Table 3 SCSs in a non-potable groundwater condition for industrial property use, for medium and fine textured soil.

Potential COCs were screened against Table 3 SCS for industrial land use for medium and fine textured soils based on the following reasons:

- The full depth option is a more conservative approach;
- Land use of the Site will remain industrial;



- The Site is not a shallow soil property as defined by O. Reg. 153/04;
- Although the Site is located within 30 meters of the Drain, the Drain was constructed for the purpose of controlling surface water drainage and is therefore not considered a water body under O. Reg. 153/04;
- Based on fieldwork observations, the majority of the soil consisted of medium to fine grained soils and therefore, as per the criteria in O. Reg. 153/04, the soil at the Site is considered to be medium-fine textured; and
- The Site is not considered to be environmentally sensitive in accordance with Section 41 of O.Reg.153/04.

3.3.2 Chemical Screening Rationale

A chemical screening process was undertaken in order to identify COCs for soil and groundwater. The first step compares maximum concentrations of parameters against the Table 3 SCS. Chemicals of potential concern identified by this initial screening process were further evaluated to assess potential risks specifically to human health (as per Section 4.1.1) and potential risks specifically to ecological health (as per Section 5.1.3).

The following rationale was applied to identify COCs in soil:

- 1) If the maximum detected concentration was greater than the applicable Table 3 SCS, the parameter was retained as a COC;
- 2) If the maximum detected concentration and the maximum method detection limit (MDL) were less than the Table 3 SCS, the parameter was not retained as a COC;
- 3) If the maximum MDL was greater than the applicable Table 3 SCS, but all samples analysed were measured below the MDL and there is no known historical use of the chemical on Site, then, the parameter was not retained as a COC; and
- 4) Parameters for which there are no Table 3 SCS were evaluated further. Specifically, if all concentrations were less than the MDL, then the parameter was not considered to be present above background levels and was not retained as a COC. Otherwise, the parameter was retained as a COC.

3.3.3 Contaminants of Potential Concern - Soil

All soil data used in support of the RA are presented in Appendix A. These data are considered to be representative of the soil quality on the Site and correspond with sampling programs completed in 2012 and 2014. Locations from which the soil samples were collected are indicated on Figure 1.

For the purposes of chemical screening, the soil at the Site was considered to be comprised of a single soil stratum. Sediment concentrations from areas of the Drain that are to be dredged and placed on-Site, were also considered soil. Screening of maximum soil concentrations are found in Tables 3.1 to 3.4.



Table 3.1: Chemical Screening for VOCs in Soil

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
Acetone (2-Propanone)	µg/g	28	< 12	No	Less than Table 3 SCS
Benzene	µg/g	0.4	< 0.48	No	Less than DL *
Bromodichloromethane	µg/g	18	< 1.2	No	Less than Table 3 SCS
Bromoform	µg/g	1.7	< 1.2	No	Less than Table 3 SCS
Bromomethane	µg/g	0.05	< 1.2	No	Less than DL *
Carbon Tetrachloride	µg/g	1.5	< 1.2	No	Less than Table 3 SCS
Chlorobenzene	µg/g	2.7	< 1.2	No	Less than Table 3 SCS
Chloroform	µg/g	0.18	< 1.2	No	Less than DL *
Dibromochloromethane	µg/g	13	< 1.2	No	Less than Table 3 SCS
Dichlorobenzene, 1,2-	µg/g	8.5	1.9	No	Less than Table 3 SCS
Dichlorobenzene, 1,3-	µg/g	12	< 1.2	No	Less than Table 3 SCS
Dichlorobenzene, 1,4-	µg/g	0.84	< 1.2	No	Less than DL *
Dichloroethane, 1,1-	µg/g	21	< 1.2	No	Less than Table 3 SCS
Dichloroethane, 1,2-	µg/g	0.05	< 1.2	No	Less than DL *
Dichlorodifluoromethane	µg/g	25	< 1.2	No	Less than Table 3 SCS
Dichloroethylene, 1,1-	µg/g	0.48	< 1.2	No	Less than DL *
Dichloroethylene, 1,2-cis-	µg/g	37	< 1.2	No	Less than Table 3 SCS
Dichloroethylene, 1,2-trans-	µg/g	9.3	< 1.2	No	Less than Table 3 SCS
Dichloropropane, 1,2-	µg/g	0.68	< 1.2	No	Less than DL *
cis-1,3-Dichloropropene	µg/g	0.21	< 0.72	No	Less than DL *
trans-1,3-Dichloropropene	µg/g		< 0.96	No	Less than DL *
Ethylbenzene	µg/g	19	< 0.48	No	Less than Table 3 SCS
Ethylene Dibromide	µg/g	0.05	< 1.2	No	Less than DL *
Hexane (n)	µg/g	88	< 1.2	No	Less than Table 3 SCS
Methyl Ethyl Ketone (2-Butanone)	µg/g	88	< 12	No	Less than Table 3 SCS
Methyl Isobutyl Ketone	µg/g	210	< 12	No	Less than Table 3 SCS
Methyl t-butyl ether (MTBE)	µg/g	3.2	< 1.2	No	Less than Table 3 SCS
Methylene Chloride (Dichloromethane)	µg/g	2	< 1.2	No	Less than Table 3 SCS
Styrene	µg/g	43	< 1.2	No	Less than Table 3 SCS

**Table 3.1: Chemical Screening for VOCs in Soil**

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
Tetrachloroethane, 1,1,1,2-	µg/g	0.11	< 1.2	No	Less than DL *
Tetrachloroethane, 1,1,2,2-	µg/g	0.094	< 1.2	No	Less than DL *
Tetrachloroethylene	µg/g	21	< 1.2	No	Less than Table 3 SCS
Toluene	µg/g	78	0.52	No	Less than Table 3 SCS
Trichloroethane, 1,1,1-	µg/g	12	< 1.2	No	Less than Table 3 SCS
Trichloroethane, 1,1,2-	µg/g	0.11	< 1.2	No	Less than DL *
Trichloroethylene	µg/g	0.61	< 1.2	No	Less than DL *
Vinyl Chloride	µg/g	0.25	< 0.48	No	Less than DL *
Xylenes (Total)	µg/g	30	2.8	No	Less than Table 3 SCS
Trichlorofluoromethane	µg/g	5.8	< 1.2	No	Less than Table 3 SCS

* Detection limits were adjusted for high moisture content. This parameter was consistently measured below the detection limit in all samples collected.

Table 3.2: Chemical Screening for PHCs in Soil

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
Benzene	µg/g	0.4	< 0.48	No	Less than DL *
Toluene	µg/g	78	0.52	No	Less than Table 3 SCS
Ethylbenzene	µg/g	19	< 0.48	No	Less than Table 3 SCS
Xylenes (Total)	µg/g	30	2.8	No	Less than Table 3 SCS
Petroleum Hydrocarbons F1	µg/g	65	120	Yes	Exceeds Table 3 SCS
Petroleum Hydrocarbons F2	µg/g	250	3600	Yes	Exceeds Table 3 SCS
Petroleum Hydrocarbons F3	µg/g	2500	16000	Yes	Exceeds Table 3 SCS
Petroleum Hydrocarbons F4	µg/g	6600	27000	Yes	Exceeds Table 3 SCS

* Detection limits were adjusted for high moisture content. This parameter was consistently measured below the detection limit in all samples collected.



Table 3.3: Chemical Screening for PAHs and PCBs in Soil

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
PAHs					
Acenaphthene	µg/g	96	5	No	Less than Table 3 SCS
Acenaphthylene	µg/g	0.17	< 1	Yes	Exceeds Table 3 SCS
Anthracene	µg/g	0.74	5.5	Yes	Exceeds Table 3 SCS
Benz[a]anthracene	µg/g	0.96	7.1	Yes	Exceeds Table 3 SCS
Benzo[a]pyrene	µg/g	0.3	6.6	Yes	Exceeds Table 3 SCS
Benzo[b]fluoranthene	µg/g	0.96	10	Yes	Exceeds Table 3 SCS
Benzo[ghi]perylene	µg/g	9.6	5.2	No	Less than Table 3 SCS
Benzo[k]fluoranthene	µg/g	0.96	3.8	Yes	Exceeds Table 3 SCS
Chrysene	µg/g	9.6	9.4	No	Less than Table 3 SCS
Dibenz[a h]anthracene	µg/g	0.1	< 1	Yes	Exceeds Table 3 SCS
Fluoranthene	µg/g	9.6	22	Yes	Exceeds Table 3 SCS
Fluorene	µg/g	69	8	No	Less than Table 3 SCS
Indeno[1 2 3-cd]pyrene	µg/g	0.95	4.7	Yes	Exceeds Table 3 SCS
1-methylnaphthalene	µg/g	85	14	No	Less than Table 3 SCS
2-methylnaphthalene	µg/g		19	No	Less than Table 3 SCS
Naphthalene	µg/g	28	< 1	No	Less than Table 3 SCS
Phenanthrene	µg/g	16	21	Yes	Exceeds Table 3 SCS
Pyrene	µg/g	96	17	No	Less than Table 3 SCS
PCBs					
Polychlorinated Biphenyls (Total)	µg/g	1.1	3.8	Yes	Exceeds Table 3 SCS

Table 3.4: Chemical Screening for Metals in Soil

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
Antimony	µg/g	50	4.9	No	Less than Table 3 SCS
Arsenic	µg/g	18	14	No	Less than Table 3 SCS
Barium	µg/g	670	1100	Yes	Exceeds Table 3 SCS
Beryllium	µg/g	10	0.77	No	Less than Table 3 SCS
Boron (total)	µg/g	120	14	No	Less than Table 3 SCS
Boron (Hot Water Soluble)	µg/g	2	2.5	Yes	Exceeds Table 3 SCS



Table 3.4: Chemical Screening for Metals in Soil

Parameter	Units	MOE Table 3 SCS	Maximum	Retain for RA?	Rationale
Cadmium	<i>µg/g</i>	1.9	45	Yes	Exceeds Table 3 SCS
Chromium Total	<i>µg/g</i>	160	410	Yes	Exceeds Table 3 SCS
Chromium VI	<i>µg/g</i>	10	0.6	No	Less than Table 3 SCS
Cobalt	<i>µg/g</i>	100	15	No	Less than Table 3 SCS
Copper	<i>µg/g</i>	300	210	Yes	Exceeds Table 3 SCS
Lead	<i>µg/g</i>	120	600	Yes	Exceeds Table 3 SCS
Mercury	<i>µg/g</i>	20	0.63	No	Less than Table 3 SCS
Molybdenum	<i>µg/g</i>	40	11	No	Less than Table 3 SCS
Nickel	<i>µg/g</i>	340	180	No	Less than Table 3 SCS
Selenium	<i>µg/g</i>	5.5	2.1	No	Less than Table 3 SCS
Silver	<i>µg/g</i>	50	4.9	No	Less than Table 3 SCS
Thallium	<i>µg/g</i>	3.3	0.41	No	Less than Table 3 SCS
Vanadium	<i>µg/g</i>	86	35	No	Less than Table 3 SCS
Zinc	<i>µg/g</i>	340	2700	Yes	Exceeds Table 3 SCS
Uranium	<i>µg/g</i>	33	2.1	No	Less than Table 3 SCS

3.3.4 Contaminants of Potential Concern - Groundwater

Groundwater quality was not evaluated in this RA.

3.3.5 Summary of COCs

Table 3.5 summarizes the COCs retained for further evaluation in the RA.

Table 3.5: Summary of COCs Retained

Parameter	Units	MOE Table 3 SCS	Maximum
Barium	<i>µg/g</i>	670	1100
Boron (Hot Water Soluble)	<i>µg/g</i>	2	2.5
Cadmium	<i>µg/g</i>	1.9	45
Chromium Total	<i>µg/g</i>	160	410
Copper	<i>µg/g</i>	300	210

**Table 3.5: Summary of COCs Retained**

Parameter	Units	MOE Table 3 SCS	Maximum
Lead	$\mu\text{g/g}$	120	600
Zinc	$\mu\text{g/g}$	340	2700
Petroleum Hydrocarbons F1	$\mu\text{g/g}$	65	120
Petroleum Hydrocarbons F2	$\mu\text{g/g}$	250	3600
Petroleum Hydrocarbons F3	$\mu\text{g/g}$	2500	16000
Petroleum Hydrocarbons F4	$\mu\text{g/g}$	6600	27000
Acenaphthylene	$\mu\text{g/g}$	0.17	< 1
Anthracene	$\mu\text{g/g}$	0.74	5.5
Benz[a]anthracene	$\mu\text{g/g}$	0.96	7.1
Benzo[a]pyrene	$\mu\text{g/g}$	0.3	6.6
Benzo[b]fluoranthene	$\mu\text{g/g}$	0.96	10
Benzo[k]fluoranthene	$\mu\text{g/g}$	0.96	3.8
Dibenz[a h]anthracene	$\mu\text{g/g}$	0.1	< 1
Fluoranthene	$\mu\text{g/g}$	9.6	22
Indeno[1 2 3-cd]pyrene	$\mu\text{g/g}$	0.95	4.7
Phenanthrene	$\mu\text{g/g}$	16	21
Polychlorinated Biphenyls	$\mu\text{g/g}$	1.1	3.8

3.3.6 Sampling Program

As discussed in Section 3.1.1, characterization of environmental impacts in soil and sediment on the RA Property was been undertaken by Golder and Landmark. The data are considered representative of the quality of sediment on the Site. Based on the sediment data collected, it is inferred that the impacts identified in the drain are related to effluent from commercial and industrial properties located upstream of the Site.

The analysed parameters were selected to cover the most likely potential contaminants of concern from typical industrial and commercial operations and included metals, pH, BTEX, PHCs, VOCs, PAHs and PCBs. Samples were collected and analysed for these parameters as part of the sediment sampling activities carried out by Golder and Landmark in 2012 and 2015.

The data set is considered adequate to meet the objectives of the RA.



4.0 HUMAN HEALTH RISK ASSESSMENT

4.1 Problem Formulation

4.1.1 Identification of Contaminants of Potential Concern

For the purposes of identifying human health COCs, maximum concentrations of the COCs identified in Section 3.3 were compared to the appropriate human health component values provided in the document “*Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario*”, dated April 15, 2011 (MOE, 2011a). The details of this screening are provided in the following sections.

Maximum soil concentrations of the COCs identified in Section 3.3 were further screened against the soil components for Table 3 SCSs full depth medium and fine textured soil, non-potable ground water for industrial / commercial / community land. The component values are described below and the comparison is provided in Table 4.1..

- The **S2 Risk** component value is a soil concentration based on an exposure scenario where an adult outdoor worker (long-term) may come into contact with contaminated soil via ingestion and dermal contact.
- The **S3 Risk** component value is a soil concentration based on an exposure scenario where an adult worker (short-term) may come into contact with contaminated soil via ingestion and dermal contact during excavations.
- The **Outdoor Air** component value is a soil concentration based on the potential for volatile organics to migrate from soil to outdoor air and be inhaled by adult outdoor workers (long-term). This component value does not account for inhalation in a trench by an adult worker (short-term).



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Table 4.1: Screening of Maximum Concentrations in Soil for the Human Health Risk Assessment.

Parameter	Units	S2 Risk	S3 Risk	Outdoor Air	Maximum	Retain for HHRA?	Rationale
Acenaphthylene	µg/g	9.6	360	96	<1	No	Below component values
Anthracene	µg/g	42000	420000	NV	5.5	No	Below component values
Barium	µg/g	32000	8600	NV	1100	No	Below component values
Benz[a]anthracene	µg/g	0.96	36	330	7.1	Yes	Exceeds S2 component value
Benzo[a]pyrene	µg/g	0.096	3.6	170	6.6	Yes	Exceeds S2 and S3 component values
Benzo[b]fluoranthene	µg/g	0.96	36	2000	10	Yes	Exceeds S2 component value
Benzo[k]fluoranthene	µg/g	0.96	36	2100	3.8	Yes	Exceeds S2 component value
Boron (Hot Water Soluble)	µg/g	NV	NV	NV	2.3	No	Not relevant to human health
Cadmium	µg/g	7.9	7.9	NV	45	Yes	Exceeds S2 and S3 component values
Chromium Total	µg/g	240000	240000	NV	410	No	Below component values
Copper	µg/g	5600	5600	NV	210	No	Below component values
Dibenz[a h]anthracene	µg/g	0.096	3.6	430	<1	Yes	Exceeds S2 component value
Fluoranthene	µg/g	9.6	360	2500	22	Yes	Exceeds S2 component value
Indeno[1 2 3-cd]pyrene	µg/g	0.96	36	4000	4.7	Yes	Exceeds S2 component value
Lead	µg/g	1000	1000	NV	600	No	Below component values
Petroleum Hydrocarbons F1	µg/g	47000	100000	26000	120	No	Below component values
Petroleum Hydrocarbons F2	µg/g	22000	48000	25000	3600	No	Below component values
Petroleum Hydrocarbons F3	µg/g	40000	260000	NV	16000	No	Below component values
Petroleum Hydrocarbons F4	µg/g	42000	400000	NV	27000	No	Below component values
Phenanthrene	µg/g	NV	NV	NV	21	Yes	No component value
Polychlorinated Biphenyls	µg/g	2.7	4.1	120	3.8	Yes	Exceeds S2 component value
Zinc	µg/g	47000	47000	NV	2700	No	Below component values



The COCs that exceeded the soil component values and the pathways for which they were considered in the HHRA are provided in Table 4.2. It is noted that acenaphthylene, anthracene, barium, total chromium, copper, lead, PHC fractions F1 to F4 and zinc met the human health soil component values and were not evaluated further in the HHRA. The MOE does not provide human health component values for phenanthrene; therefore phenanthrene will be assessed qualitatively in Section 4.4.1.4. Hot water soluble boron is not relevant to human health and was only retained for the ecological risk assessment.

Table 4.2: Contaminants of Concern that Exceed Soil Component Values and Their Respective Pathways in the Human Health Risk Assessment

Contaminant of Concern	of	Direct Contact ¹ and Inhalation of Particulates
Benzo(a)anthracene ²		Exceeds S2
Benzo(a)pyrene ²		Exceeds S2 and S3
Benzo(b)fluoranthene ²		Exceeds S2
Benzo(g,h,i)perylene ²		Meets component values, retained for additive effects
Benzo(k)fluoranthene ²		Exceeds S2
Cadmium		Exceeds S2 and S3
Chrysene ²		Meets component values, retained for additive effects
Dibenzo(a,h)anthracene ²		Exceeds S2
Fluoranthene		Exceeds S2
Indeno(1,2,3-cd)pyrene ²		Exceeds S2
Phenanthrene		Exceeds S2
Polychlorinated Biphenyls		Exceeds S2

¹ Includes incidental ingestion and dermal contact.

² Additive effects were considered for these carcinogenic PAHs for the direct contact pathway.

4.1.2 Human Health Conceptual Site Model

The CSM identifies all potential exposure pathways between COCs and human receptors. The CSM for the human health RA is presented as Figure 2. A human health CSM with RMMs in place is provided in Figure 3.

The RA has been prepared to evaluate the use of the Site as a sediment storage area. The RA property is locally depressed relative to EC Row Expressway and the associated access ramps making it a good location to place the dredged sediment. As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain. It is intended that the sediment removed from the drain will be placed within Geotubes which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped.



Given that the Site is currently vacant, will remain vacant and will continue to be used as an E.C. Row Expressway right-of-way, the human receptors evaluated in the HHRA include construction workers and landscape maintenance workers. A more detailed discussion on the exposure pathways for receptors that may spend time at the Site (including rationale for those pathways that are incomplete or complete but do not require quantitative assessment) is provided in Section 4.2.2.

4.1.3 Human Health Risk Assessment Objectives

The objectives of the HHRA were as follows:

- Quantitatively and qualitatively assess the potential risks to human receptors, if any, associated with identified COCs based on continued use of the Site as an E.C. Row Expressway right-of-way;
- Develop PSS considered to be protective of potential human receptors that are present at the Site without risk management measures in place; and
- Identify risk management measures, if necessary, to a level of detail necessary to mitigate exposures by human receptors based on the results of the RA.

4.2 Exposure Assessment

4.2.1 Receptor Characteristics

Receptor characteristics and exposure factors are summarized in the tables in each receptor subsection. These assumptions comprise receptor-specific characteristics such as body weight, ingestion rates, body surface areas and other relevant exposure factors.

On-site human receptors were selected based on the continued use of the Site as an E.C. Row Expressway right-of-way, potential exposure frequency, and potential sensitivity to identified COCs. Selected receptors include a landscape maintenance worker and a construction worker.

4.2.1.1 Landscape Maintenance Worker

The landscape maintenance worker was assumed to be an adult who works on the Site maintaining grassed areas and carrying out winter snow and ice clearing activities. This receptor was assumed to spend 9.8 hours per day for 5 days a week for 39 weeks a year (MOE, 2011a) at the Site. The exposure factors for the landscape maintenance worker are provided in Table 4.3.

**Table 4.3: Characteristics and Exposure Factors for the Landscape Maintenance Worker Receptor**

Characteristics	Units	Adult	Reference
Age	yr	≥20	(MOE, 2011a)
Body weight (BW)	kg	70.7	(MOE, 2011a)
Rate of incidental soil ingestion ($R_{\text{ing-soil}}$)	kg/day	0.0001	(MOE, 2011a)
Rate of inhalation (R_{inh})	m ³ /hr	1.5	(MOE, 2011a)
Skin surface area (head, hands and forearms) (SA)	cm ²	3400	(MOE, 2011a)
Concentration of PM ₁₀ in air	µg/m ³	100	(MOE, 2011a)
Fraction of PM ₁₀ deposited	unitless	0.6	(MOE, 2011a)
Exposure time (ET)	hr/day	9.8	(MOE, 2011a)
Exposure frequency (EF)	days/yr	195	(MOE, 2011a)
Exposure duration (ED)	yr	56	(MOE, 2011a)
Averaging time (AT)	yr	56	(MOE, 2011a)
Dermal Exposure	events/day	1	(MOE, 2011a)

4.2.1.2 Construction Worker

The construction worker was assumed to be an adult who may work on an intermittent basis on the Site. The construction worker was considered to be at the Site for 195 days per year (MOE, 2011a). Within this 195-day exposure frequency, this receptor was considered to spend two weeks (or 10 days per year) within an excavation trench and 185 days per year at ground surface. The construction worker was considered to spend a total of 1.5 years at the Site (MOE, 2011a). Incidental dermal contact exposure to groundwater was assumed to involve the head, hands and forearms only. The exposure factors for the construction worker are provided in Table 4.4.

Table 4.4: Characteristics and Exposure Factors for the Construction Worker Receptor

Characteristics	Units	Adult	Reference
Age	yr	≥20	(MOE, 2011a)
Body weight (BW)	kg	70.7	(MOE, 2011a)
Rate of incidental soil ingestion ($R_{\text{ing-soil}}$)	kg/day	0.0001	(MOE, 2011a)
Rate of inhalation (R_{inh})	m ³ /hr	1.5	(MOE, 2011a)
Skin surface area (head, hands and forearms) (SA)	cm ²	3400	(MOE, 2011a)
Concentration of PM ₁₀ in air	µg/m ³	100	(MOE, 2011a)
Fraction of PM ₁₀ deposited	unitless	0.6	(MOE, 2011a)



Table 4.4: Characteristics and Exposure Factors for the Construction Worker Receptor

Characteristics	Units	Adult	Reference
Exposure Factor			
Exposure time (ET)	hr/day	9.8	(MOE, 2011a)
Exposure frequency – at ground surface (EF)	days/yr	185	(MOE, 2011a)
Exposure frequency – in a trench (EF)	days/yr	10	(MOE, 2011a)
Exposure duration (ED)	yr	1.5	(MOE, 2011a)
Averaging time (AT)	yr	56	(MOE, 2011a)
Dermal exposure	events/day	1	(MOE, 2011a)

NA = not applicable; the female construction worker was assessed for the inhalation of trench air pathway only.

4.2.2 Pathway Analysis

This section provides the exposure pathways that were evaluated for the receptors considered in this RA.:

Table 4.5: Potential Human Health Exposure Pathways

Media	Exposure Route	Pathway	Retained	Rationale
Soil	Dermal Contact	Dermal contact with soil	Yes	Soil COCs were identified and must be evaluated based on direct contact.
	Inhalation	Inhalation of re-entrained soil & dusts	Yes	
	Ingestion	Incidental ingestion of soil	Yes	
		Uptake into plants and consumption of plants	No	There are no plants or animals on the Site that are used for consumption.
	Uptake into animals and consumption of animals	No		
Air	Inhalation	Inhalation of compounds in indoor air	No	There are no proposed buildings at the Site. The soil COCs that are volatile met the soil to outdoor air component values.
		Inhalation of compounds in outdoor air	No	
Groundwater	Ingestion	Potable water source	No	Groundwater quality was not evaluated in this RA.
		Incidental ingestion	No	
	Dermal Contact	Dermal Contact with groundwater	No	
	Inhalation	Inhalation of	No	



Table 4.5: Potential Human Health Exposure Pathways

Media	Exposure Route	Pathway	Retained	Rationale
		groundwater while bathing		
Surface Water	Ingestion	Incidental Ingestion of surface water while swimming/wading	No	Surface water quality was not evaluated in this RA.
	Dermal Contact	Dermal contact with surface water while swimming of wading		

Based on this assessment, the only potentially complete exposure pathway is direct contact with soil.

4.2.3 Bioavailability and Relative Absorption Factors

4.2.3.1 Bioaccessibility

Bioavailability factors can be used to estimate the actual amount of a chemical taken up by a human receptor. The detection of COCs in various environmental media does not necessarily reflect the actual concentrations available to biological systems and therefore may not reflect the “toxicologically-relevant” exposure concentration. When a person ingests a chemical in soil, some portion (from 0-100%) of the total amount of chemical concentration will be absorbed by the body. For oral exposure, this portion of the chemical absorbed from the matrix (e.g., soil) is deemed to be “bioavailable” (i.e., that fraction of the administered dose that reaches the systemic circulation *in vivo*) (Oomen, et al., 2002). The “bioaccessible” fraction represents the maximum amount of contaminant that has been released from the soil matrix and is therefore potentially available for transport across the intestinal epithelium.

4.2.3.2 Relative Absorption Factors

The concept of relative bioavailability allows for corrections to be made for the matrix to which a receptor is exposed. For example, TRVs are often based on studies in which exposure occurs via contaminated water or food. Chemicals in soil are typically much less bioavailable than in water or food. This lower availability in soil relates to the potential binding of the chemical to the inorganic and/or organic matrix of the soil. In addition, where contamination has been present in soil for an extended period of time, sorption tends to be greater than in recently-contaminated soil. Consequently, when comparing exposure from soil ingestion to TRVs generated from exposure to chemicals in water or food, some correction for relative bioavailability is generally accepted as being reasonable.



The RAFs provided by the MOE (2011a) for ingestion and dermal absorption were adopted for use in this HHRA.

Table 4.6: Relative Absorption Factors used in the HHRA

Chemical Parameter	GI Absorption Factor	Dermal Absorption Factor
Benz[a]anthracene	1.00	0.13
Benzo[a]pyrene	1.00	0.13
Benzo[b]fluoranthene	1.00	0.13
Benzo[ghi]perylene	1.00	0.13
Benzo[k]fluoranthene	1.00	0.13
Cadmium	1.00	0.01
Chrysene	1.00	0.13
Dibenz[a h]anthracene	1.00	0.13
Fluoranthene	1.00	0.13
Indeno[1 2 3-cd]pyrene	1.00	0.13
Phenanthrene	1.00	0.13
Polychlorinated Biphenyls	1.00	0.14

4.2.4 Exposure Estimates

This section provides an overview of the calculations used to estimate exposures for each of the applicable exposure pathways. The maximum concentrations for the COCs in soil have been used to estimate exposures. To account for exposure from above-ground and below-ground work activities (i.e., trench activities for the construction worker), exposure was calculated for both types of activities and summed to obtain a total exposure.

Incidental Ingestion of Soil

$$\text{Dose (mg/kg} \cdot \text{day)} = \frac{C_s \times R_{\text{ing(s)}} \text{RAF}_{\text{ing}} \times EF \times ED}{BW \times AT}$$

Where:

C_s = maximum concentration of chemical in soil (mg/kg);

$R_{\text{ing(s)}}$ = incidental soil ingestion rate (kg/day);

RAF_{ing} = relative absorption factor for ingestion (unitless);

EF = exposure frequency (day/yr);

ED = exposure duration (yr);

BW = body weight (kg); and

AT = averaging time (yr)

= $ED \times 365$ days/yr for non-carcinogenic effects; 56 or 76 yr $\times 365$ days/yr for carcinogenic effects.



Inhalation of Soil Particulates

$$Dose(mg/kg \cdot day) = \frac{C_s \times R_{inh} \times RAF_{inh} \times C_{PM_{10}} \times F_{PM_{10}} \times CF \times ET \times EF \times ED}{BW \times AT}$$

Where:

C_s = maximum concentration of chemical in soil (mg/kg);

R_{inh} = inhalation rate (m³/hr);

RAF_{inh} = relative absorption factor for inhalation (unitless);

$C_{PM_{10}}$ = concentration of PM₁₀ in air (µg/m³);

$F_{PM_{10}}$ = fraction of PM₁₀ that is deposited (unitless);

CF = conversion factor (10⁻⁹ kg/µg);

ET = exposure time (hr/day);

EF = exposure frequency (day/yr);

ED = exposure duration (yr);

BW = body weight (kg); and

AT = averaging time (yr)

= ED × 365 days/yr for non-carcinogenic effects; 56 yrs × 365 days/yr for carcinogenic effects

Dermal Contact with Soil

$$DAD(mg/kg \cdot day) = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$$

Where:

DAD = dermally absorbed dose (mg/kg/day);

DA_{event} = absorbed dose per event (mg/cm²-event), see below for derivation;

EF = exposure frequency (day/yr);

ED = exposure duration (yr);

EV = event frequency (events/day);

SA = skin surface area available for contact (cm²);

BW = body weight (kg); and

AT = averaging time (yr)

= ED × 365 days/yr for non-carcinogenic effects, 56 or 76 yr × 365 days/yr for carcinogenic effects.

$$DA_{event} = C_s \times CF \times AF \times RAF_{der}$$

Where:

C_s = maximum concentration of chemical in soil (mg/kg);

CF = conversion factor (10⁻⁶ kg/mg)

AF = adherence factor (mg/cm²-event); and

RAF_{der} = relative absorption factor for dermal contact (unitless).



The calculated exposure estimates for the landscape maintenance worker and construction worker are presented in Tables 4.7 and 4.8, respectively.

Table 4.7: Calculated Exposure Estimates (mg/kg-day) – Landscape Maintenance Worker

Exposure Pathway	Direct Contact With Soil	Inhalation of Soil Particulates
Non-cancer Exposure Rates		
Cadmium	3.6E-05	3.0E-07
Polychlorinated Biphenyls	5.6E-06	2.5E-08
Fluoranthene	3.1E-05	1.5E-07
Phenanthrene	3.0E-05	1.4E-07
Cancer Exposure Rates		
Cadmium	3.6E-05	3.0E-07
Benz[a]anthracene	1.0E-05	4.7E-08
Benzo[a]pyrene	9.4E-06	4.4E-08
Benzo[b]fluoranthene	1.4E-05	6.7E-08
Benzo[ghi]perylene	7.4E-06	3.5E-08
Benzo[k]fluoranthene	5.4E-06	2.5E-08
Chrysene	1.3E-05	6.3E-08
Dibenz[a h]anthracene	1.4E-06	6.7E-09
Indeno[1 2 3-cd]pyrene	6.7E-06	3.1E-08
TOTAL PAH	6.8E-05	3.2E-07
Polychlorinated Biphenyls	5.6E-06	2.5E-08

Table 4.8: Calculated Exposure Estimates (mg/kg-day) – Construction Worker

Non-cancer Exposure Rates		
Cadmium	3.6E-05	3.0E-07
Polychlorinated Biphenyls	NA	NA
Fluoranthene	NA	NA
Phenanthrene	3.0E-05	1.4E-07
Cancer Exposure Rates		
Cadmium	9.11E-07	8.03E-09
Benz[a]anthracene	2.7E-07	1.3E-09
Benzo[a]pyrene	2.5E-07	1.2E-09

**Table 4.8: Calculated Exposure Estimates (mg/kg-day) – Construction Worker**

Cancer Exposure Rates		
Benzo[b]fluoranthene	3.8E-07	1.8E-09
Benzo[ghi]perylene	2.0E-07	9.3E-10
Benzo[k]fluoranthene	1.4E-07	6.8E-10
Chrysene	3.6E-07	1.7E-09
Dibenz[a h]anthracene	3.8E-08	1.8E-10
Indeno[1 2 3-cd]pyrene	1.8E-07	8.4E-10
TOTAL PAH	1.8E-06	8.5E-09
Polychlorinated Biphenyls	NA	NA

NA – chemical meets applicable S3 component value.

4.3 Toxicity Assessment

The toxicity or hazard assessment phase of the HHRA involves the characterization of the potential adverse health effects of COCs and estimation of concentrations that can be received by human receptors without resulting in adverse health effects. It provides a basis for the interpretation of exposure estimates. The toxicity assessment considers possible modes of toxicity associated with different routes and durations of exposure, and sensitive receptors.

4.3.1 Nature of Toxicity (Hazard Assessment)

Toxicity assessment involves the classification of the potential toxic effects of COCs. Toxicity assessment is conducted for all COCs and considers possible modes of toxicity associated with different routes and durations of exposure, and sensitive receptors. The toxicity assessment provides an estimate of how much chemical exposure may occur without unacceptable health effects occurring from lifetime exposure (or a significant portion of lifetime), and provides a basis to interpret predicted exposure rates.

Regulatory agencies (such as the MOE) classify contaminants based on their mode of action (i.e., threshold *versus* non-threshold substances). For substances exhibiting a threshold for toxicity, an acceptable level of exposure at or below which no adverse effects are anticipated is established. For non-threshold substances, any level of exposure is assumed to theoretically pose a potential risk, and a slope factor is used to predict risks from estimated exposures. Carcinogenic substances which act through a mechanism involving damage to the genetic material (i.e., DNA) are usually considered to be non-threshold substances.

Several organizations have developed classification systems based on the carcinogenic properties of chemicals. The MOE provides chemical classifications based on the US EPA's databases (e.g., IRIS). The classification systems for the US EPA (2012) and the International Agency for Research on Cancer (IARC, 2012) are presented in Table 4.9. The classifications for the COCs at the Site are provided in Table 4.10.



Table 4.9: Carcinogenicity Classification Systems

IARC ¹	US EPA ²	Description
Group 1	Group A	Human carcinogen
Group 2A	Group B	Probable human carcinogen
	B1	Limited human evidence available
	B2	Inadequate human evidence, sufficient animal evidence
Group 2B	Group C	Possible human carcinogen
Group 3	Group D	Unclassifiable as to human carcinogenicity
Group 4	Group E	Probably not carcinogenic to humans

¹ International Agency for Research on Cancer (IARC, 2012)

² US EPA – Integrated Risk Information System (USEPA, 2012)

Table 4.10: Carcinogenicity Classification of Contaminants of Concern

Contaminant of Concern	IARC Classification	US EPA Classification	Assessed as a Carcinogen?
Benzo(a)anthracene	Group 2B	Group B2	Yes
Benzo(a)pyrene	Group 1	Group B2	Yes
Benzo(b)fluoranthene	Group 2B	Group B2	Yes
Benzo(g,h,i)perylene	Group 3	Group D	Yes
Benzo(k)fluoranthene	Group 2B	Group B2	Yes
Cadmium	Group 1	Inhalation = Group B1	Yes*
Chrysene	Group 2B	Group B2	Yes
Dibenzo(a,h)anthracene	Group 2A	Group B2	Yes
Fluoranthene	Group 3	Group D	No**
Indeno(1,2,3-cd)pyrene	Group 2B	Group B2	Yes
Phenanthrene	Group 3	Group D	No
Polychlorinated Biphenyls	Group 2A	Group B2	Yes

** Inhalation of soil particulate pathway only

** Although toxicity equivalent factors are provided for these PAHs by the MOE (2011a), the US EPA (2012) and/or IARC (2012) does not consider them to be carcinogenic; therefore, they were not assessed as carcinogens.



Where the MOE (2011a) has provided a carcinogenic TRV but not a non-carcinogenic TRV for a COC, the COC was assessed as a carcinogen only. The following g COCs were assessed as carcinogens only:

- Benzo(a)anthracene;
- Benzo(a)pyrene;
- Benzo(b)fluoranthene;
- Benzo(g,h,i)perylene;
- Benzo(k)fluoranthene;
- Chrysene;
- Dibenzo(a,h)anthracene; and
- Indeno(1,2,3-cd)pyrene.

4.3.2 Toxicological Reference Values

Chemicals may exhibit different toxicological mechanisms of action depending on the route of exposure (i.e., ingestion, inhalation, dermal). Different TRVs are often provided for oral and inhalation exposure routes. In this RA, preference was given to pathway-specific TRVs; however, if TRVs were not available for each route of exposure, the TRV for oral exposure was adopted where applicable. In this RA, pathway-specific TRVs were used for ingestion and inhalation pathways. In the absence of dermal TRVs, ingestion TRVs were adopted for dermal exposure. For compounds where the mechanism of action is specific to the route of exposure, this application of the TRVs is not scientifically defensible, and was not used. COCs were not assessed for pathways where the MOE (2011a) has not provided a TRV.

4.3.3 Dose-Response Assessment

The dose-response assessment identifies the TRVs used in the HHRA. All TRVs were adopted based on accepted values provided in MOE (2011a). However, the MOE (2011a) does not provide TRVs for all COCs identified at the Site. COCs that do not have TRVs are discussed in further detail below. Table 4.10 provides a list of the TRVs and their toxicological endpoints used in the HHRA.

Polychlorinated Biphenyls

The US EPA (2012) provides a range of carcinogenic TRVs for PCBs. The oral TRV selected for use in the HHRA (i.e., $2 \text{ (mg/kg-day)}^{-1}$) is the upper-bound slope factor for high risk and persistence PCBs. This selection was based on the following criteria for use:

- Food chain exposure;
- Sediment or soil ingestion;
- Dust or aerosol inhalation;
- Dermal exposure, if an absorption factor has been applied;
- Presence of dioxin-like, tumor-promoting, or persistent congeners; and
- Early-life exposure (all pathways and mixtures).

The upper-bound estimate provides assurance that risk is not likely to be underestimated. Because there is the potential for higher sensitivity in early life stages, the high risk tier was selected for use in the HHRA.



Table 4.10: Human Health Toxicity Reference Values

Non-Carcinogens						
Contaminant of Concern	Oral Reference Dose (mg/kg/day)	Toxicological Endpoint	Source	Inhalation Reference Concentration (mg/m ³)	Toxicological Endpoint	Source
Cadmium	3.20E-05	Unavailable	modified from CalEPA 2006	NA	-	-
Fluoranthene	4.00E-02	Nephropathy, increased liver weights, hematological alterations, and clinical effects	IRIS 1993	NV	-	-
Phenanthrene	NV	-	-	NV	-	-
Polychlorinated Biphenyls	2.00E-05	Immunological; Increased liver weight and decreases in IgG and IgM immunoglobulin response to sheep red blood cell challenge	ATSDR 2000; WHO CICAD 2003	5.00E-04	Marginal effects	RIVM 2001

Carcinogens				
Contaminant of Concern	Oral Slope Factor (mg/kg/day) ⁻¹	Source	Inhalation Unit Risk (mg/m ³) ⁻¹	Source
Benzo(a)anthracene	7.30E-01	Kalberlah <i>et al.</i> 1995; IRIS 1994	1.10E-01	Kalberlah <i>et al.</i> 1995; CalEPA ATH 2005/1993
Benzo(a)pyrene	7.30E+00	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Benzo(b)fluoranthene	7.30E-01	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Benzo(g,h,i)perylene	7.30E-02	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Benzo(k)fluoranthene	7.30E-01	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Cadmium	NV	-	9.80E+00	Health Canada 1996
Chrysene	7.30E-02	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Dibenzo(a,h)anthracene	7.30E+00	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Indeno(1,2,3-cd)pyrene	7.30E-01	Kalberlah <i>et al.</i> 1995; IRIS 1994	NA	-
Polychlorinated Biphenyls	2.00E+00	IRIS 1997; CalEPA DW 2007; CalEPA ATH 1999, 2005	1.00E-01	IRIS 1997

NA = Not applicable; this exposure pathway was not relevant for this COC.

NV = No value.



Inhalation reference concentrations for all receptors were converted to inhalation reference doses and inhalation unit risks were converted to inhalation slope factors. Equations are given as follows:

Landscape Worker and Construction Worker

$$\text{Inhalation RfD (mg/kg} \cdot \text{day)} = \text{RfC} \times \frac{R_{inh}}{BW}$$

Where:

- RfD = reference dose (mg/kg/day);
- RfC = inhalation reference concentration (mg/m³);
- R_{inh} = inhalation rate (20 m³/day); and
- BW = body weight (kg).

$$\text{Inhalation SF (mg/kg} \cdot \text{day)}^{-1} = \text{IUR} \times \frac{BW}{R_{inh}}$$

Where:

- SF = slope factor (mg/kg/day)⁻¹;
- IUR = inhalation unit risk (mg/m³)⁻¹;
- BW = body weight (kg); and
- R_{inh} = inhalation rate (20 m³/day).

4.4 Risk Characterization

4.4.1 Interpretation of Health Risks

Risk characterization is the final step in the RA process, during which the exposure and toxicity assessments are integrated. The process of risk characterization conducted in this RA reflects the conservative approach used to generate risk estimates. The process and interpretation of these steps are discussed in the following sections.

4.4.1.1 Quantitative Interpretation of Health Risks

The risk characterization stage of the HHRA process compares the exposures estimated for each of the receptors with the identified toxicity values to determine if site-related exposures are above the identified limits. Because of the differences in the biological mechanisms of action between non-carcinogenic and carcinogenic chemicals, the potential hazards/risks are determined differently. The characterization of hazards associated with exposure to non-carcinogenic chemicals and the risks associated with exposure to carcinogenic chemicals on the Site are presented in the following sections.



4.4.1.2 Quantifying Hazards for Non-Carcinogenic Chemicals

For non-carcinogenic chemicals, the potential for exposures to result in adverse human health effects is based on the ratio between the estimated exposure and the health-based TRV. This ratio is called the *Hazard Quotient* (HQ) and is calculated as shown below. The HQ provides an indication of whether estimated exposures are large enough to be of concern for human health. A HQ of less than 1 indicates that exposures would not be expected to result in adverse human health effects. Because of the conservative assumptions used by regulatory agencies in the development of toxicity values, HQ values greater than 1.0 do not mean that adverse human health effects will occur, but the likelihood that an adverse effect will occur increases as the HQ value rises above 1.0.

$$HQ = \frac{EE}{TRV}$$

Where:

- HQ = Hazard Quotient (unitless)
- EE = Exposure Estimate (mg/kg/day)
- TRV = chemical-specific toxicological reference value (mg/kg/day)

Because this assessment has considered only exposures from site-related sources, the HQ benchmark of 0.2 recommended by the MOE for assessing site-related exposures has been used. The HQ values calculated for each chemical for the identified receptors are presented in Table 4.11 and Table 4.12.

With the exception of direct contact with cadmium and PCBs in soil, the HQs for the landscape maintenance worker are below the target HQ of 0.2 and are considered acceptable (Table 4.11). There may be unacceptable risk to the landscape maintenance worker from direct contact with cadmium and PCBs in soil; therefore RMMs described in Section 7.0 are required to block direct contact with soil.

Table 4.11: Calculated Hazard Quotients – Landscape Maintenance Worker

Exposure Pathway	Direct Contact With Soil ¹	Inhalation of Soil Particulates
Cadmium	1.13E+00	3.50E-02
Fluoranthene	7.8E-04	3.7E-06
Polychlorinated Biphenyls	2.8E-01	1.8E-04

Numbers in bold font are greater than MOE target HQ.

¹ Incidental ingestion and dermal contact

With the exception of direct contact with cadmium in soil, the HQs for the construction worker are below the target HQ of 0.2 and are considered acceptable (Table 4.12). Soil concentrations for fluoranthene and polychlorinated biphenyls met the Table 3 S3 component values. Given that the Table 3 S3 component values are considered protective of the construction worker exposure scenario, hazard quotients were not calculated. There may be unacceptable risk to the construction worker from direct contact with cadmium in soil; therefore RMMs described in Section 7.0 are required to block direct contact with soil.

**Table 4.12: Calculated Hazard Quotients – Construction Worker**

Exposure Pathway	Direct Contact With Soil ¹	Inhalation of Soil Particulates
Cadmium	1.13E+00	3.50E-02
Fluoranthene	NA	NA
Polychlorinated Biphenyls	NA	NA

Numbers in bold font are greater than MOE target HQ.

NA = not applicable; this exposure pathway was not applicable for these chemicals.

¹ Incidental ingestion and dermal contact

4.4.1.3 Quantifying Risks for Carcinogenic Chemicals

Carcinogenic chemicals are generally considered to elicit health effects via a non-threshold mechanism. This means that there is no dose below which an adverse effect will not occur. Any exposure to a carcinogen is considered to be associated with some level of risk. The probability of developing cancer as a result of environmental exposure to a carcinogenic substance is expressed as the ILCR and is calculated using the equation below.

$$ILCR = LADD \times CSF$$

Where:

ILCR = Incremental Lifetime Cancer Risk (Unitless)

LADD = Lifetime Averaged Daily Dose (mg/kg/day)

CSF = Cancer Slope Factor (mg/kg/day)⁻¹

The ILCR associated with exposure to the identified COCs to the human receptors on-Site are shown in Table 4.13 and Table 4.14. For each exposure pathway, the MOE considers an acceptable cancer risk to be one in a million (1×10^{-6}) (MOE, 2005).

The ILCRs for the landscape maintenance worker are greater than the target of 1×10^{-6} for the following pathways and COCs (Table 4.13):

- Direct contact with soil:
 - Benzo(a)anthracene;
 - Benzo(a)pyrene;
 - Benzo(b)fluoranthene;
 - Benzo(k)fluoranthene;
 - Dibenzo(a,h)anthracene;
 - Indeno(1,2,3-cd)pyrene; and
 - Polychlorinated Biphenyls.
- Inhalation of Soil Particulates:
 - Cadmium.



There are unacceptable risks for the landscape maintenance worker from direct contact with PAHs and PCBs in soil and inhalation of soil particulates (*i.e.*, dust) of cadmium in outdoor air sourced from soil. The RMMs described in Section 7.0 are required to limit direct contact with soil.

Table 4.13: Calculated Incremental Lifetime Cancer Risks – Landscape Maintenance Worker

Exposure Pathway	Direct Contact With Soil ¹	Inhalation of Soil Particulates
Cadmium	NA	1.0E-05
Benz[a]anthracene	7.4E-06	1.8E-08
Benzo[a]pyrene	6.9E-05	1.7E-07
Benzo[b]fluoranthene	1.0E-05	2.6E-08
Benzo[ghi]perylene	5.4E-07	1.3E-09
Benzo[k]fluoranthene	3.9E-06	9.8E-09
Chrysene	9.8E-07	2.4E-09
Dibenz[a h]anthracene	1.0E-05	2.6E-08
Indeno[1 2 3-cd]pyrene	4.9E-06	1.2E-08
Total PAH ²	1.1E-04	2.6E-07
Polychlorinated Biphenyls	1.1E-05	8.9E-09

Numbers in bold font are greater than MOE target ILCR.

NA = not applicable; this exposure pathway was not applicable for these chemicals.

¹ Incidental ingestion and dermal contact

² Sum of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene; benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene.

The ILCRs for the construction worker are greater than the target of 1×10^{-6} for the following pathways and COCs (Table 4.13):

- Direct contact with soil:
 - Benzo(a)pyrene.

Soil concentrations for polychlorinated biphenyls met the Table 3 S3 component values. Given that the Table 3 S3 component values are considered protective of the construction worker exposure scenario, incremental lifetime cancer risk were not calculated. There are unacceptable risks for the construction worker from direct contact with PAHs in soil. The RMMs described in Section 7.0 are required to limit direct contact with soil.

**Table 4.14: Calculated Incremental Lifetime Cancer Risks – Construction Worker**

Exposure Pathway	Direct Contact With Soil ¹	Inhalation of Soil Particulates
Cadmium	NA	2.8E-07
Benz[a]anthracene	2.0E-07	4.9E-10
Benzo[a]pyrene	1.8E-06	4.5E-09
Benzo[b]fluoranthene	2.8E-07	6.9E-10
Benzo[ghi]perylene	1.4E-08	3.6E-11
Benzo[k]fluoranthene	1.1E-07	2.6E-10
Chrysene	2.6E-08	6.5E-11
Dibenz[a h]anthracene	2.8E-07	6.9E-10
Indeno[1 2 3-cd]pyrene	1.3E-07	3.2E-10
Total PAH ²	2.9E-06	7.1E-09
Polychlorinated Biphenyls	NA	NA

Numbers in bold font are greater than MOE target ILCR.

NA = not applicable; this exposure pathway was not applicable for these chemicals.

¹ Incidental ingestion and dermal contact

² Sum of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene; benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene.

4.4.1.4 Qualitative Interpretation of Health Risks

The MOE does not provide human health component values or TRVs for the PAH phenanthrene. The US EPA (2012) considers phenanthrene to be unclassifiable as to human carcinogenicity. The MOE Table 3 SCS for phenanthrene (16 µg/g) is based on the protection of plants and soil invertebrates. Although a quantitative assessment of potential risk associated with exposure to phenanthrene could not be completed due to the lack of adequate toxicity information, the Site will ultimately contain RMM, described in Section 7.0, which will limit direct contact with dredged sediments and soils.



4.4.1.5 Development of Human Health Property Specific Standards

The human health standards were calculated assuming continued use of the Site as an E.C. Row Expressway right-of-way. The major exposure pathways are:

- Direct contact (including incidental ingestion, dermal contact and inhalation of soil particulates) with COCs in soil.

The PSSs, calculated using the equation below, are risk-based and are assumed to be protective of human health. For non-carcinogenic COCs a MOE target HQ of 0.2 was used. For carcinogenic COCs a MOE target ILCR of 1.0×10^{-6} was used.

$$PSS = \frac{TRL \times C}{Risk\ Estimate}$$

Where:

- PSS = Property Specific Standard ($\mu\text{g/g}$ or $\mu\text{g/L}$);
- TRL = Target Risk Level (0.2 or 1×10^{-6}) (unitless);
- C = Maximum Concentration ($\mu\text{g/g}$ or $\mu\text{g/L}$); and
- Risk Estimate = Calculated HQ or ILCR corresponding with Maximum Concentration (unitless).

Human health standards are presented for all pathways without RMMs.

The human health standards for each human exposure scenario are provided in Table 4.15. The final proposed PSS are provided in Table 4.16.

Table 4.15: Calculated Human Health Risk Based Concentrations for Direct Contact with Soil ($\mu\text{g/g}$).

Contaminant of Concern	Construction Worker	Landscape Maintenance Worker	Minimum Human Health Based Concentration
Non-cancer Assessment			
Cadmium	7.9E+00	7.9E+00	7.9E+00
Fluoranthene	NA	5.6E+03	5.6E+03
Polychlorinated Biphenyls	NA	2.7E+00	2.7E+00
Cancer Assessment			
Benzo(a)anthracene	NA	9.6E-01	9.6E-01
Benzo(a)pyrene	3.6E+00	9.6E-02	9.6E-02
Benzo(b)fluoranthene	NA	9.6E-01	9.6E-01
Benzo(k)fluoranthene	NA	9.6E-01	9.6E-01
Dibenzo(a,h)anthracene	NA	9.6E-02	9.6E-02
Indeno(1,2,3-cd)pyrene	NA	9.6E-01	9.6E-01
Cadmium	1.6E+02	4.4E+00	4.4E+00
Polychlorinated Biphenyls	NA	3.4E-01	3.4E-01

NA = not applicable; this exposure pathway was not applicable for these chemicals.



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Table 4.16: Final Human Health Risk Based Concentrations (µg/g)

Contaminant of Concern	Maximum Concentration	Final Human Health Standard	Proposed PSS (Max + 20%)	RMM Requirement	Rationale for Risk Management Measure
Acenaphthylene	<1	9.6E+00	1.2	No	-
Anthracene	5.5	4.2E+04	6.6	No	-
Barium	1100	8.6E+03	1320	No	-
Benzo(a)anthracene	7.1	9.6E-01	8.5	Yes	Limit Direct Contact
Benzo(a)pyrene	6.6	9.6E-02	7.9	Yes	Limit Direct Contact
Benzo(b)fluoranthene	10	9.6E-01	12	Yes	Limit Direct Contact
Benzo(k)fluoranthene	3.8	9.6E-01	4.6	Yes	Limit Direct Contact
Cadmium	45	7.9E+00	54	Yes	Limit Direct Contact
Chromium Total	410	2.4E+05	492	No	-
Copper	210	5.6E+03	252	No	-
Dibenzo(a,h)anthracene	<1	9.6E-02	1.2	Yes	Limit Direct Contact
Fluoranthene	22	5.6E+03	26	No	-
Indeno(1,2,3-cd)pyrene	4.7	9.6E-01	5.6	Yes	Limit Direct Contact
Lead	570	1.0E+03	600	No	-
Petroleum Hydrocarbon F1	120	2.6E+04	144	No	-
Petroleum Hydrocarbon F2	3600	2.2E+04	4320	No	-
Petroleum Hydrocarbon F3	16000	4.0E+04	19200	No	-
Petroleum Hydrocarbon F4	27000	4.2E+04	32400	No	-
Phenanthrene	21	16	25	Yes	Limit Direct Contact
Polychlorinated Biphenyls	3.8	2.7E+00	4.6	Yes	Limit Direct Contact
Zinc	2700	4.7E+04	3240	No	-



4.4.2 Special Considerations for Environmentally Sensitive Area

The RA property is not considered environmentally sensitive.

4.4.3 Interpretation of Off-Site Health Risks

Current surrounding land uses consist of a mixture of commercial and industrial properties (including the E.C. Row Expressway Lands). The Site will ultimately be capped with a soil cover, limiting dust erosion to the surrounding properties.

4.4.4 Discussion of Uncertainty

A range of “standard” exposure factors were used in the RA, in conjunction with the maximum soil concentrations of COCs to derive risk estimates for the assessed exposure scenarios. The major sources of uncertainty associated with the RA are briefly described below.

- **Exposure point concentrations:** The maximum concentrations of each COC were considered to be the exposure point concentrations for the human receptors assessed in this RA. This is considered to be a conservative approach, and may overestimate risks in some cases.
- **Literature-derived RAFs:** This RA did not involve the collection and analysis of samples for the purpose of determining site-specific bioaccessibility for the COCs. The literature-derived values cited likely represent solubilization of chemicals from soil rather than true bioavailability. These values are considered to have a greater degree of uncertainty compared to site-specific values. However, in the absence of site-specific data, these values are considered to be reasonable for use in this HHRA.
- **Toxicity Reference Values:** The TRVs used in this RA (and TRVs in general) are generally based on the most sensitive endpoints, with the application of safety factors to protect sensitive subpopulations. The uncertainty associated with TRVs is highly dependent on the number of studies available, and whether the key study was based on humans (low uncertainty) or small mammals (high uncertainty). When few studies are available, and the studies available are conducted using animals as test organisms, several types of safety factors must be applied to account for this uncertainty (e.g., factors for inter- and intraspecies sensitivity).

Risk estimates generated under these combinations of assumptions are thought to provide “reasonable maximum” values that will be protective for potential exposures at the Site.



5.0 ECOLOGICAL RISK ASSESSMENT

A study of the potential ecological effects associated with COC concentrations at the Site is part of the initial step in the ecological risk assessment (ERA), which included the following components:

- Description of the current and proposed environmental setting, including habitat types, and species likely to be present, based on Site conditions;
- Description of contaminants known or suspected to exist at the Site and the reasonable maximum exposure concentrations present in each medium;
- Contaminant fate and transport mechanisms that might exist;
- Mechanisms of ecotoxicity associated with contaminants and categories of ecological receptors that may be affected;
- Relevant exposure pathways that might exist at the Site; and
- The availability of relevant TRVs for extrapolation to the ecological receptors based on conservative assumptions that are protective of wildlife populations.

5.1 Problem Formulation

5.1.1 Ecological Risk Assessment Objectives

The primary objectives of the ERA include the following:

- Quantitatively assess the potential risks, if any, associated with identified COCs in surface soil to ecological receptors based on continued land use as an E.C. Row Expressway right-of-way;
- Develop PSSs considered to be protective of the potential ecological receptors that are present at the Site without risk management measures in place; and,
- Identify risk management measures, if necessary, to mitigate exposures by ecological receptors based on the results of the ERA.

5.1.2 Ecological Conceptual Site Model

The ecological CSM without the incorporation of RMM is provided in Figure 4. The ecological CSM with the incorporation of RMM is provided in Figure 5.

The RA has been prepared to evaluate the use of the Site as a sediment storage area. The RA property is locally depressed relative to EC Row Expressway and the associated access ramps making it a good location to place the dredged sediment. As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain (located along the southern portion of the Site) in order to provide adequate flood flow capacity in the drain. It is intended that the sediment removed from the drain will be placed within Geotubes which are proposed to be located within the RA property (Figure 1). Once in place,



the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped.

Given that the Site is currently vacant, will remain vacant and will continue to be used as an E.C. Row Expressway right-of-way, the Site provides unattractive habitat to ecological receptors. In order to account for this less than desirable habitat, the Modified Ecological Protection (MEP) approach as described in MOE, 2011b) was used. The MEP is an option available within the modified generic risk assessment process in Ontario that uses less stringent ecotoxicity values to develop PSS. The use of the MEP option will allow for the maintenance or establishment of natural habitat; habitat that is not comparable in quality to habitat in an uncontaminated setting but instead is habitat comprising of assemblages of species that are adapted or less sensitive to the COCs at the property.

Under the MEP option, mammals and birds are removed from the CSM. Therefore, no protection is provided for those ecological receptors under the MEP option. However, this is considered appropriate for the Site, given its size and location.

For plants and soil organisms, the MEP option utilizes a multiplier (1.9 x industrial component value) that is equivalent to the 75th percentile value for each dose-response data set (developed for generic model values using the CCME protocol weight-of-evidence procedure where resulting no observable effect concentration (NOEC) and lowest observed effect concentration (LOEC) data are ranked and ranked percentiles are determined for each data point (MOE, 2011b). In following this procedure, the 2011 MOE Table 3 plants and soil organism component value for industrial/commercial land use is multiplied by 1.9.

Ecological receptors that may be present on the RA property may be exposed to COCs via contact with surface soils. Based on the identified ecological receptors, the COCs and the relevant environmental media (i.e., surface soil), the ERA evaluated the following exposure pathways:

- Direct contact with soil by soil invertebrates; and
- Direct contact with soil by terrestrial vegetation;

5.1.3 Contaminants of Concern for Ecological Receptors

Based on this chemical screening against the Table 3 SCS, several chemicals in soil were retained for further consideration in the RA.

For the purposes of identifying COCs related specifically to ecological receptors that may be at the RA property, maximum concentrations of the COCs that exceeded these standards were then compared to the ecological component values provided in the document "*Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario*", dated April, 2011 (MOE, 2011a). The details of this screening are provided in the following sections.



5.1.3.1 COCs for Ecological Health – Soil

Soil COCs identified in Section 3.3 were further screened against the ecological component values for the Table 3 for industrial/commercial land use, for medium to fine textured soil.

Screening of maximum soil concentrations against ecological Table 3 component values is shown in Table 5.1.

Table 5.1: Screening of Maximum Concentrations in Soil against Ecological Component Values

Parameter	Units	Plants & Soil Org. (MEP)	Maximum	Retain for ERA?	Rationale
Acenaphthylene	µg/g	NV	<1	No	Meets MEP
Anthracene	µg/g	76	5.5	No	Meets MEP
Barium	µg/g	3800	1100	No	Meets MEP
Benz[a]anthracene	µg/g	2.47	7.1	Yes	Exceeds MEP
Benzo[a]pyrene	µg/g	171	6.6	No	Meets MEP
Benzo[b]fluoranthene	µg/g	NV	10	No	Meets MEP
Benzo[k]fluoranthene	µg/g	36	3.8	No	Meets MEP
Boron (Hot Water Soluble)	µg/g	3.8	2.5	No	Meets MEP
Cadmium	µg/g	57	45	No	Meets MEP
Chromium Total	µg/g	1197	410	No	Meets MEP
Copper	µg/g	570	210	No	Meets MEP
Dibenz[a h]anthracene	µg/g	NV	<1	No	Meets MEP
Fluoranthene	µg/g	437	22	No	Meets MEP
Indeno[1 2 3-cd]pyrene	µg/g	1.8	4.7	Yes	Exceeds MEP
Lead	µg/g	2660	600	No	Meets MEP
Petroleum Hydrocarbons F1	µg/g	608	120	No	Meets MEP
Petroleum Hydrocarbons F2	µg/g	494	3600	Yes	Exceeds MEP
Petroleum Hydrocarbons F3	µg/g	4750	16000	Yes	Exceeds MEP
Petroleum Hydrocarbons F4	µg/g	12540	27000	Yes	Exceeds MEP
Phenanthrene	µg/g	30	21	No	Meets MEP
Polychlorinated Biphenyls	µg/g	78	3.8	No	Meets MEP
Zinc	µg/g	1520	2700	Yes	Exceeds MEP

Soil COCs with reported concentrations below their respective ecological component values are considered to pose an acceptable risk to receptors on the RA property and were not carried forward for further evaluation. Contaminants of concern that exceeded the ecological component values were carried forward and assessed for the exposure pathway for which it exceeded. If no component value was available for a COC, the COC was not carried forward in the ERA as no TRV was available.



5.1.4 Discussion of Data Quality

The data used for the ERA (as described in Section 3.0) is sufficient to meet the objectives of the ERA, in consideration of the discussion provided in Section 3.0.

5.2 Receptor Characterization

The Site is currently a vacant lot and is found in the E.C. Row Expressway right-of-way. Potential terrestrial ecological receptors were identified based on ecological habitat both on- and off-Site. In general, the Site provides relatively unattractive habitat for ecological receptors. Mammals and birds are not likely present on the Site or would use the Site because of the limited suitable habitat and the lack of ecological corridors (i.e., properties adjacent to the Site are developed for commercial land uses and also provide limited ecological habitat).

Terrestrial receptor groups considered valued ecological components (VECs) in the ERA are listed below:

- **Earthworm species:** Canadian worm (*Aporrectodea tuberculata*), Octagonal-tail worm (*Dendrobaena octaedra*) and Dew worm (*Lumbricus terrestris*);
- **Plant species:** Ornamental garden species, such as red maple, flowering dogwood, black-eyed susan and aster).

5.3 Exposure Assessment

5.3.1 Pathway Analysis

Exposure pathways to contaminated surface soil evaluated in this assessment include:

- Direct contact with soil by soil invertebrates (i.e., earthworms); and
- Direct contact with soil by terrestrial vegetation.

Several exposure pathways to COCs in soil were not evaluated in the assessment. The pathways and rationale for their exclusion from the assessment are provided below:

- **Uptake of soil dust particles by plants:** Based on the physical characteristics of the Site, there is limited opportunity for wind erosion of soil and suspension of dust particles. In addition, the transfer factors necessary to evaluate foliar uptake are often lacking.
- **Uptake of soil vapour by plants:** As outlined above, soil vapour in ambient air is not expected to be significant.



5.3.2 Exposure Estimates

5.3.2.1 Exposure Point Concentrations

As per MOE guidance, the maximum concentrations of COCs in soil were conservatively used as the exposure point concentrations in soil. The exposure concentrations used in the assessment for the Site are provided in Table 5.2.

Table 5.2: Soil Exposure Point Concentrations for the ERA

Parameter	Units	Maximum
Benz[a]anthracene	$\mu\text{g/g}$	7.1
Indeno[1 2 3-cd]pyrene	$\mu\text{g/g}$	4.7
Petroleum Hydrocarbons F2	$\mu\text{g/g}$	3600
Petroleum Hydrocarbons F3	$\mu\text{g/g}$	16000
Petroleum Hydrocarbons F4	$\mu\text{g/g}$	27000
Zinc	$\mu\text{g/g}$	2700

5.3.2.2 Exposure Factors

Exposure factors for mammalian and avian receptors were not compiled, as these receptors have not been retained for the ERA.

5.3.2.3 Concentrations in Food/Prey Items

Concentrations in prey/food items were not modelled, as mammals and birds were not retained in the RA.

5.3.2.4 Exposure Equations

For plants and soil invertebrates, the exposure estimate is simply the maximum concentration of the COC in soil. For birds and mammals, an exposure estimate was not calculated as they were not retained as receptors in the RA.

5.4 Hazard Assessment

The TRVs used to characterize risks to ecological health are provided in Table 5.3 for plants & soil invertebrates. No COCs were identified for mammals and birds; therefore a hazard assessment was not undertaken for these receptors.

**Table 5.3: Direct Soil Contact Values for Protection of Plants and Soil Invertebrates**

Parameter	Toxicological Benchmark (mg/kg)	MEP Benchmark (mg/kg)	Source
Benz[a]anthracene	1.3	2.47	MOE, 2011a
Indeno[1 2 3-cd]pyrene	0.95	1.8	MOE, 2011a
Petroleum Hydrocarbons F2	260	494	MOE, 2011a
Petroleum Hydrocarbons F3	2500	4750	MOE, 2011a
Petroleum Hydrocarbons F4	6600	12540	MOE, 2011a
Zinc	800	1520	MOE, 2011a

MEP Benchmark = Toxicological Benchmark x 1.9

5.5 Risk Characterization

To characterize risks, the total estimated exposure to the COC was compared to the TRV for the COC as shown in the equation below:

$$HQ = \frac{Exposure}{TRV} \quad (2)$$

Where:

HQ = hazard quotient (unitless);
 Exposure = total estimated exposure to COC (mg/kg); and
 TRV = toxicity reference value (mg/kg).

If the HQ was greater than one (1) for a particular species and COC, then this species was considered to be potentially exposed to unacceptable levels of this COC on the Site.

5.5.1 Quantitative Interpretation of Ecological Risks

5.5.1.1 Plants and Soil Invertebrates

The calculated HQs for COCs for plants and soil invertebrates are provided in Table 5.4.

Table 5.4: Hazard Quotients for Uptake of COCs in Soil by Plants and Soil Invertebrates

Parameter	Maximum Concentration (mg/kg)	MEP Benchmark (mg/kg)	HQ (Unitless)
Benz[a]anthracene	7.1	2.47	2.9
Indeno[1 2 3-cd]pyrene	4.7	1.8	2.6
Petroleum Hydrocarbons F2	3600	494	7.3
Petroleum Hydrocarbons F3	16000	4750	3.4
Petroleum Hydrocarbons F4	27000	12540	2.2
Zinc	2700	1520	1.8



Values in bold exceed target HQ of 1

The HQs for the plants and earthworms exceed a HQ of 1 (Table 5.4). An HQ greater than 1 does not necessarily indicate that there are risks to plants and soil invertebrates because of the inherent conservatism in the risk assessment process. For example, the toxicological benchmarks used in the calculation of HQs may significantly overestimate risks to plants and soil invertebrates due to the nature of the toxicity tests used to derive the benchmarks. This is because in most cases the benchmarks are based on laboratory studies in which soils are amended with a bioavailable form of the chemical. The soils at the Site are weathered, and therefore, the bioavailability and toxicity of chemicals in these soils is likely less than that for amended soils used to derive the toxicological benchmarks. Furthermore, many of the toxicity tests are performed in containers. Toxicity can be as much as 2-fold higher in studies conducted in containers because plant roots and soil invertebrates cannot avoid the contaminated soil as they do under field conditions (Moradi *et al.*, 2009). Toxicity also tends to be greater in plants grown in containers because the plants are typically grown under ideal conditions. The hardiness of plants in the natural environment is not reflected in these tests. In addition, benchmarks are typically derived from tests using species not likely to be present on the Site (i.e., crops and species of earthworms not native to Ontario) and which are typically more sensitive than species likely to be found on developed Sites in Ontario. In addition to the conservative nature of the benchmarks used in the toxicity assessment, maximum concentrations were used in the exposure assessment. Plant roots and soil invertebrates will avoid contaminated soil (Menon, *et al.*, 2007; Lukkari & Haimi, 2005; Sousa, *et al.*, 2008); so actual exposure is likely much lower than the maximum concentrations used in the assessment.

Based on the identified risks to the ecological receptors, RMMs are required for the proposed land use of the Site. The RMMs proposed for the Site are discussed in Section 7.0.

5.5.2 Qualitative Interpretation of Ecological Risks

Ecological risks were quantitatively assessed; therefore no qualitative assessment was undertaken.

5.5.3 Special Consideration for Environmentally-Sensitive Area

The Site is not classified as a sensitive site.

5.5.4 Interpretation of Off-Site Ecological Risks

Current surrounding land uses consist of a mixture of commercial and industrial properties (including the EC Row Expressway Lands). The Site will ultimately be capped with a soil cover, limiting dust erosion to the surrounding properties.

5.5.5 Ecological Property Specific Standards

The ecological risk based concentrations for each chemical retained for quantitative evaluation in the ERA are provided in Table 5.5. The final PSS for the Site are also listed in this table.



Table 5.5: Ecological PSS for Direct Contact with Soil (µg/g)

Parameter	Units	Maximum Concentration	Final Ecological Standard	Proposed PSS (Max + 20%)	RMM Requirement	Rationale for Risk Management Measure
Acenaphthylene	µg/g	<1	NV	1.2	No	-
Anthracene	µg/g	5.5	76	6.6	No	-
Barium	µg/g	1100	3800	1320	No	-
Benz[a]anthracene	µg/g	7.1	2.47	8.5	Yes	Limit Direct Contact
Benzo[a]pyrene	µg/g	6.6	171	7.9	No	-
Benzo[b]fluoranthene	µg/g	10	NV	12	No	-
Benzo[k]fluoranthene	µg/g	3.8	36	4.6	No	-
Boron (Hot Water Soluble)	µg/g	2.5	3.8	3	No	-
Cadmium	µg/g	45	57	54	No	-
Chromium Total	µg/g	410	1197	492	No	-
Copper	µg/g	210	570	252	No	-
Dibenz[a h]anthracene	µg/g	<1	NV	1.2	No	-
Fluoranthene	µg/g	22	437	26	No	-
Indeno[1 2 3-cd]pyrene	µg/g	4.7	1.8	5.6	Yes	Limit Direct Contact
Lead	µg/g	600	2660	720	No	-
Petroleum Hydrocarbons F1	µg/g	120	608	144	No	-
Petroleum Hydrocarbons F2	µg/g	3600	494	4320	Yes	Limit Direct Contact
Petroleum Hydrocarbons F3	µg/g	16000	4750	19200	Yes	Limit Direct Contact
Petroleum Hydrocarbons F4	µg/g	27000	12540	32400	Yes	Limit Direct Contact
Phenanthrene	µg/g	21	30	25	No	-
Polychlorinated Biphenyls	µg/g	3.8	78	4.6	No	-
Zinc	µg/g	2700	1520	3240	Yes	Limit Direct Contact



5.5.6 Discussion of Uncertainty

Uncertainties related to the exposure and toxicity assessments of the ERA, and the potential implications that these uncertainties may have on the interpretation of risks are provided below:

5.5.6.1 Exposure Assessment

The maximum concentrations of COCs were used as the exposure point concentrations in soil in the ERA. This is a conservative approach for mammals and birds. For example, the CCME (1996) recommends the use of a "reasonable maximum exposure" concentration, specifically, the 95% upper confidence limit of the mean concentration as the exposure point concentration in soil. Use of maximum soil concentrations potentially overestimates exposure and risk to mammals and birds. The use of maximum measured concentrations as exposure point concentrations, while still conservative as it assumes that the maximum concentration occurs across the Site, is considered more appropriate for terrestrial plants and soil organisms as they occupy the Site 100% of the time.

The ERA also evaluated potential risks in the absence of risk management measures. However, soils/sediment to be dredged from the Drain and placed on-Site will be contained within Geotubes and covered by a clean soil cap, limiting direct exposure to ecological receptors.

5.5.6.2 Toxicity Assessment

Toxicity benchmarks are based on laboratory studies in which soils are amended with a bioavailable form of the chemical. The soils at the Site are likely weathered, and therefore, the bioavailability and toxicity of the chemicals are likely less than that for amended soils used to derive the toxicity benchmarks. Furthermore, for plants and earthworms, many of the toxicity studies are performed in containers. It has been demonstrated that toxicity can be up to 2-fold higher in studies conducted in containers because plant roots and earthworms cannot avoid the contaminated soil as they do under field conditions. Toxicity also tends to be greater in plants grown in containers because the plants are typically grown under ideal conditions.

6.0 CONCLUSIONS / RECOMMENDATIONS

An RA was conducted for the property located at southwestern corner of the intersection of EC Row Expressway and Howard Avenue within the approximate boundary formed by EC Row Expressway (eastbound lanes) to north, Grand Marais Drain to the south, Howard Avenue to the east and the associated off-ramp to the west, as shown on Figure 1, in general accordance with the requirements of *O. Reg. 153/04*. The Site is currently owned by the City and is located within the road allowance of EC Row Expressway.



As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain (located along the southern portion of the Site) in order to provide adequate flood flow capacity in the drain. It is intended that the sediment removed from the drain will be placed within Geotubes which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped. There is no proposed change in the current land use.

The objectives of the RA were as follows:

- Quantitatively assess the potential risks to human and ecological receptors, if any, associated with identified COCs in the soil/sediment intended to be placed at the Site based on continued use of the Site as an E.C. Row Expressway right-of-way;
- Develop property specific standards considered to be protective of potential human and ecological receptors that are present at the Site without risk management measures in place; and
- Identify risk management measures, if necessary, to a level of detail necessary to mitigate exposures by human and ecological receptors based on the results of the RA.

The RA evaluated the following risks from the identified COCs:

- A quantitative assessment of potential human health risks was evaluated for a landscape maintenance and construction worker. The exposure pathways assessed included: direct contact with soil via ingestion, and dermal contact and inhalation of particulates.
- A quantitative evaluation of potential ecological risks was evaluated for terrestrial plants and soil invertebrates. The exposure pathways assessed included direct contact with soil and exposure by soil invertebrates and plants.

The RA assumed that the soils/sediments were exposed at surface and human and ecological receptors can potentially come in contact with identified COCs via incidental ingestion, dermal contact and inhalation of particulates. This is a conservative approach given that the soils/sediments are placed in Geotubes and covered by a soil cap that meets the Table 3 SCSs.

In the absence of risk management measures, the results of the HHRA indicate that increased risks are associated with direct contact soil/sediment by the landscape maintenance worker and construction worker. The results of the ERA indicate that increased risks are associated with direct contact soil/sediment by plants & soil invertebrates. Given that the Site is currently vacant, will remain vacant and will continue to be used as an E.C. Row Expressway right-of-way, the Site provides unattractive habitat to ecological receptors; therefore, it is unlikely that mammals and birds would use the site for any prolonged period of time.

The findings of the RA conclude that for the continued use of the Site as an E.C. Row Expressway right-of-way, risk management measures are required to mitigate the identified risks to human and ecological receptors if the dredged soil/sediment is to be placed on the Site.



The construction methods that will be implemented as risk management measures to decrease direct contact with the proposed dredged soil/sediment placement at the Site includes:

- The placement of clean fill soil caps, meeting the applicable Table 3 SCS, to block direct exposure to potentially impacted soil.

In order to control the potential exposure to impacted soils below the proposed soil cap, the following administrative controls should be implemented:

- Where work on the Site will encounter impacted soils, a Health and Safety Plan (HASP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work; and,
- Where work on the Site will encounter impacted soils, a Soil Management Plan (SMP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work.

Therefore, if the risk management measures described in Section 7.2 are implemented and the Site continues to be used as an E.C. Row Expressway right-of-way, the increased risks associated with the proposed placement of dredged soil/sediment at the Site can be mitigated. However, potential human and ecological risks should be re-evaluated if future concentrations reported at the Site exceed the maximum COC concentrations assessed in the RA or significant changes to the Site use are undertaken.

6.1 Recommended Standards

Proposed PSSs that are protective of human and ecological health were developed based on the continued use of the Site as an E.C. Row Expressway right-of-way. The human health standards were calculated based on meeting a target HQ of 0.2 for non-cancer effects and a target ILCR of 1×10^{-6} for cancer effects. The ecological PSSs were calculated based on meeting a target HQ of 1. Risks were calculated without RMMs. The human health and ecological standards listed in Table 6.1 represent the lowest calculated standard without RMMs from the above mentioned tables. The proposed PSSs for the Site are provided in Table 6.1 and represent the maximum measured concentration plus 20% to account for sampling and laboratory analytical variability. The proposed PSS in 6.1 also take into account any required RMM.

Table 6.1: Recommended Soil Property Specific Standards (µg/g)

Parameter	MOE Table 3 SCS	Maximum	Minimum Human Health Based PSS	Minimum Ecological Based PSS	Proposed PSS	RMM Requirement
Acenaphthylene	0.17	<1	9.60E+00	NV	1.2	No
Anthracene	0.74	5.5	4.20E+04	76	6.6	No
Barium	670	1100	8.60E+03	3800	1320	No
Benz[a]anthracene	0.96	7.1	9.60E-01	2.47	8.5	Yes
Benzo[a]pyrene	0.3	6.6	9.60E-02	171	7.9	Yes
Benzo[b]fluoranthene	0.96	10	9.60E-01	NV	12	Yes
Benzo[k]fluoranthene	0.96	3.8	9.60E-01	36	4.6	Yes



Table 6.1: Recommended Soil Property Specific Standards (µg/g)

Parameter	MOE Table 3 SCS	Maximum	Minimum Human Health Based PSS	Minimum Ecological Based PSS	Proposed PSS	RMM Requirement
Boron (Hot Water Soluble)	2	2.5	NV	3.8	3	No
Cadmium	1.9	45	7.90E+00	57	54	Yes
Chromium Total	160	410	2.40E+05	1197	492	No
Copper	300	210	5.60E+03	570	252	No
Dibenz[a h]anthracene	0.1	<1	9.60E-02	NV	1.2	Yes
Fluoranthene	9.6	22	5.60E+03	437	26	No
Indeno[1 2 3-cd]pyrene	0.95	4.7	9.60E-01	1.8	5.6	Yes
Lead	120	600	1.00E+03	2660	720	No
Petroleum Hydrocarbons F1	65	120	2.60E+04	608	144	No
Petroleum Hydrocarbons F2	250	3600	2.20E+04	494	4320	Yes
Petroleum Hydrocarbons F3	2500	16000	4.00E+04	4750	19200	Yes
Petroleum Hydrocarbons F4	6600	27000	4.20E+04	12540	32400	Yes
Phenanthrene	16	21	16	30	25	Yes
Polychlorinated Biphenyls	1.1	3.8	2.70E+00	78	4.6	Yes
Zinc	340	2700	4.70E+04	1520	3240	Yes

7.0 RISK MANAGEMENT PLAN

The RA property is locally depressed relative to EC Row Expressway and the associated access ramps. The area as a whole is elevated relative to the local landscape (and inferred natural ground surface elevation) due to the elevation of the grade as part of the construction of the EC Row Expressway and the related access ramps. The area generally slopes to the south towards the Grand Marais Drain (understood to be a municipal drain). The Site is currently grass covered. The Site is not developed with any buildings and is generally not intended for human use except for potential access by landscape and/or maintenance personnel.

As part of the drain improvement program, some accumulated sediment material will be removed from the Grand Marais Drain (located along the southern portion of the Site) in order to provide adequate flood flow capacity in the drain. It is intended that the sediment removed from the drain will be placed within Geotubes which are proposed to be located within the RA property (Figure 1). Once in place, the Geotubes will be covered with a sufficient soil and/or granular isolation cap and the area will be suitably landscaped.

This section outlines the basic components of a risk management plan (RMP) required for the Site, based on the findings of the RA, which demonstrated increased risks to human health and the environment from potential direct contact with contaminants found in the dredged soil/sediment to be placed on Site.



The construction methods that will suffice as RMMs for the Site includes:

- The placement of clean fill soil caps, meeting the applicable Table 3 SCS, to block direct exposure to potentially impacted soil.

In order to control the potential exposure to impacted soils below the proposed soil cap, the following administrative controls should be implemented:

- Where work on the Site will encounter impacted soils, a Health and Safety Plan (HASP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work; and
- Where work on the Site will encounter impacted soils, a Soil Management Plan (SMP) shall be developed and implemented by the contractor responsible for the work prior to commencing the work.

Details of the RMM are provided in Section 7.2.

7.1 Risk Management Performance Objectives

The risk management performance objectives are required to ensure that the estimated risks are managed to meet the acceptable hazard quotient of 0.2 and incremental lifetime cancer risk of 1×10^{-6} for human health; and for ecological receptors, ecotoxicity HQ reduced to less than or equal to 1.

In order to meet the requirements, RMM are required for the Site:

- To block direct contact exposure by human and ecological receptors to impacted dredged soil/sediment to be placed at the Site.

The proposed RMMs will limit unacceptable exposure to the human and ecological receptors through control of the relevant exposure pathways. The use of soil cap barriers to control the direct contact with soil pathway will effectively eliminate this exposure pathway to human and ecological receptors located at ground surface. For those receptors that may be exposed to soils beneath barriers (e.g. construction worker), the use of administrative (e.g., a health and safety plan) and engineered controls (e.g., personal protective equipment) will also effectively reduce the direct contact with soil exposure pathway.

7.2 Risk Management Measures

The following RMM are required at the Site to mitigate the calculated increased risks to human and ecological receptors from exposure to contaminants in dredged soil/sediment to be placed at the Site.



7.2.1 Shallow Soil Cap Barrier

The shallow soil cap described below is consistent with the shallow soil cap barrier RMM described in the MOE's Approved Tier II Model (MOE, 2011c) and is considered a suitable RMM to block potential direct exposure to dredged soil/sediment to be placed at the Site.

The shallow soil cap risk management measure consists of:

- a) capping of the impacted soils/sediments contained within the geotubes with a minimum of 0.5 meters of unimpacted soil (soil meeting the Table 3 SCS) immediately on top of the geotubes;
- b) Inspection and maintenance of the capping according to a program to ensure the continuing integrity of the capping, including:
 - a. at least semi-annual (spring and fall) inspections of the capping;
 - b. the noting of any deficiencies in the capping observed during the inspection or any other time;
 - c. the repair forthwith of any such deficiencies; and
 - d. the recording of inspections, deficiencies and repairs in a log book maintained by or on behalf of the owner of the RA property from time to time.
- c) Inspection and maintenance, as described above, with respect to any fencing on the RA property so long as fencing is required because the RA property or any part thereof is not being used or developed; and
- d) Ongoing and perpetual maintenance of the capping by the owner of the RA property from time to time.

7.2.2 Health and Safety Plans

Where work on the Site will encounter impacted soils beneath the cap, a HASP shall be developed and implemented by the contractor responsible for the work prior to commencing the work. The HASP shall be developed for the Site and implemented during all intrusive activities potentially in contact with or exposing COCs identified on the Site or portions of the Site and a copy shall be maintained on the Property for the duration of all intrusive activities. This HASP shall meet the following requirements:

- 1) The HASP shall be prepared by a competent person having knowledge of sound occupational health and safety practices pertaining to exposures to contaminants including metals; and
- 2) The HASP shall prescribe engineered controls and/or personal protective equipment to reduce dermal contact, incidental ingestion and/or inhalation of particulates by workers to the contaminants of concern.



7.2.3 Soil Management Plan

Potentially impacted soil removed from the Site should be managed in accordance with Ontario Regulation 347. In the event that contaminated materials are removed from the Site, materials will be hauled by licensed contractors to facilities holding approvals or permits, as required, to accept these materials. Materials confirmed to be waste will be disposed of at an MOE-approved facility. Prior to the identification of disposal options, a Qualified Person shall collect samples for waste characterization testing of materials intended for removal or disposal. Samples will be analyzed by Toxicity Characteristic Leaching Procedure (TCLP) for comparison to Schedule 4 leachate quality criteria as listed under O. Reg. 347. TCLP analysis will include all parameters on Schedule 4 that are reasonably expected to be present based on the source location of these materials within the Site, taking into account the previous characterization work as documented in the Risk Assessment applicable to the source area.

Should hazardous waste be generated during construction, registration as a waste generator outlined in Ontario Regulation 347 will be required and shall be undertaken by the site owner or its designated agent.

Waste characterization results for soil to be disposed from the Site and manifests for shipments of wastes to a licensed waste receiver will be retained on Site.

7.3 Duration of Risk Management Measures

It is proposed that the risk management measures provided herein remain in place as long as the impacted soils/sediments remain at the Site. If there is a change in land use, the RA should be revised to reflect new RMM required for the proposed land use, if necessary.

8.0 LIMITATIONS AND USE OF THIS REPORT

This report has been prepared for the use of Landmark Engineers Inc., the City of Windsor and the Essex Region Conservation Authority. This report provides a risk assessment for the property located at southwestern corner of the intersection of EC Row Expressway and Howard Avenue within the approximate boundary formed by EC Row Expressway (eastbound lanes) to the north, Grand Marais Drain to the south, Howard Avenue to the east and the associated off-ramp to the west, in Windsor, Ontario, as shown on Figure 1. Any use of this report by a third party is prohibited and without the prior permission of Golder. No assurance is made regarding the accuracy and completeness of these data. Golder Associates Ltd. disclaims responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

The report is based on data and information collected during investigation programs conducted by Golder Associates Ltd. and others. Golder Associates Ltd. has reliance on the previous data and information provided by Landmark Engineers Inc. It is based solely on the conditions on the subject Site encountered at the time of these Site investigations.



The assessment of the environmental conditions and hazards at this Site has been made using the results of chemical analysis of discrete soil and sediment samples from a limited number of locations. The Site conditions between sampling locations have been inferred based on conditions observed at test locations. Subsurface conditions will vary between and beyond sample locations. Additional study, including further subsurface investigation, can reduce the inherent uncertainties associated with this type of study. However, it may not be possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a Site may be impacted and remain undetected.

The services performed as described in this report were conducted in a manner consistent with the level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

The content of this report is based on information collected during Site investigations, our present understanding of the Site conditions, and our professional judgment in light of such information at the time of this report. This report provides a professional opinion and, therefore, no warranty is either expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

The findings and conclusions of the RA are valid only as of the date of the report. If the proposed land use for the Site changes, risk assessment and site remediation requirements should be re-evaluated, and as warranted, an updated RA should be performed.

If new information is discovered in future work, including excavations, borings, or other studies, or the land use or design concept change, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.



9.0 REFERENCES

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Report Signature Page

Handwritten signature of Stephen Cioccio in blue ink.

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Lane Chevalier, B.A.Sc. (Hons), P.Eng.
Environmental Engineer

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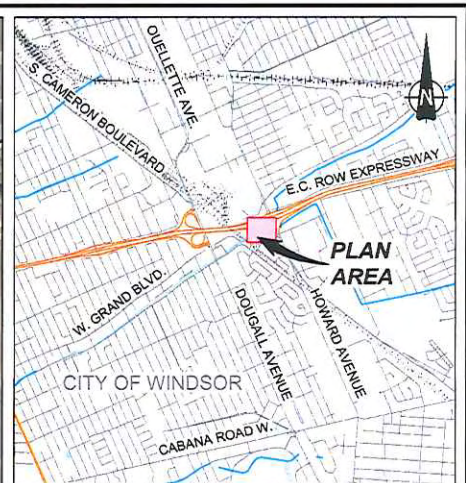
Theresa Repaso-Subang, B.Sc. (Hons), DABT, QP_{RA}
Associate - Toxicology and Risk Assessment

SC/TRS/rb/lag

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FIGURES



KEY PLAN

- LEGEND**
- SEDIMENT SAMPLE (Previous Investigation 12-1134-0179)
 - SEDIMENT SAMPLE - APPROXIMATE LOCATION (Sample Collected By Landmark Engineers Inc.)
 - ⊕ BOREHOLE (Previous Investigation 68517-5)

REFERENCE

DRAWING BASED ON 2013 AERIAL IMAGE FROM THE COUNTY OF ESSEX INTERACTIVE WEB MAPPING SITE, BY PERMISSION; AND CANMAP STREETFILES V2008.4.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
ALL LOCATIONS ARE APPROXIMATE.

PROJECT GRAND MARAIS DRAIN FLOOD CONTROL IMPROVEMENT
SEDIMENT MANAGEMENT SITE SPECIFIC RISK ASSESSMENT
CITY OF WINDSOR, ONTARIO

TITLE LOCATION PLAN

PROJECT No.	1520609	FILE No.	1520609-3000-R01001
CADD	DMB	Apr. 20/15	SCALE AS SHOWN REV.
CHK'D			

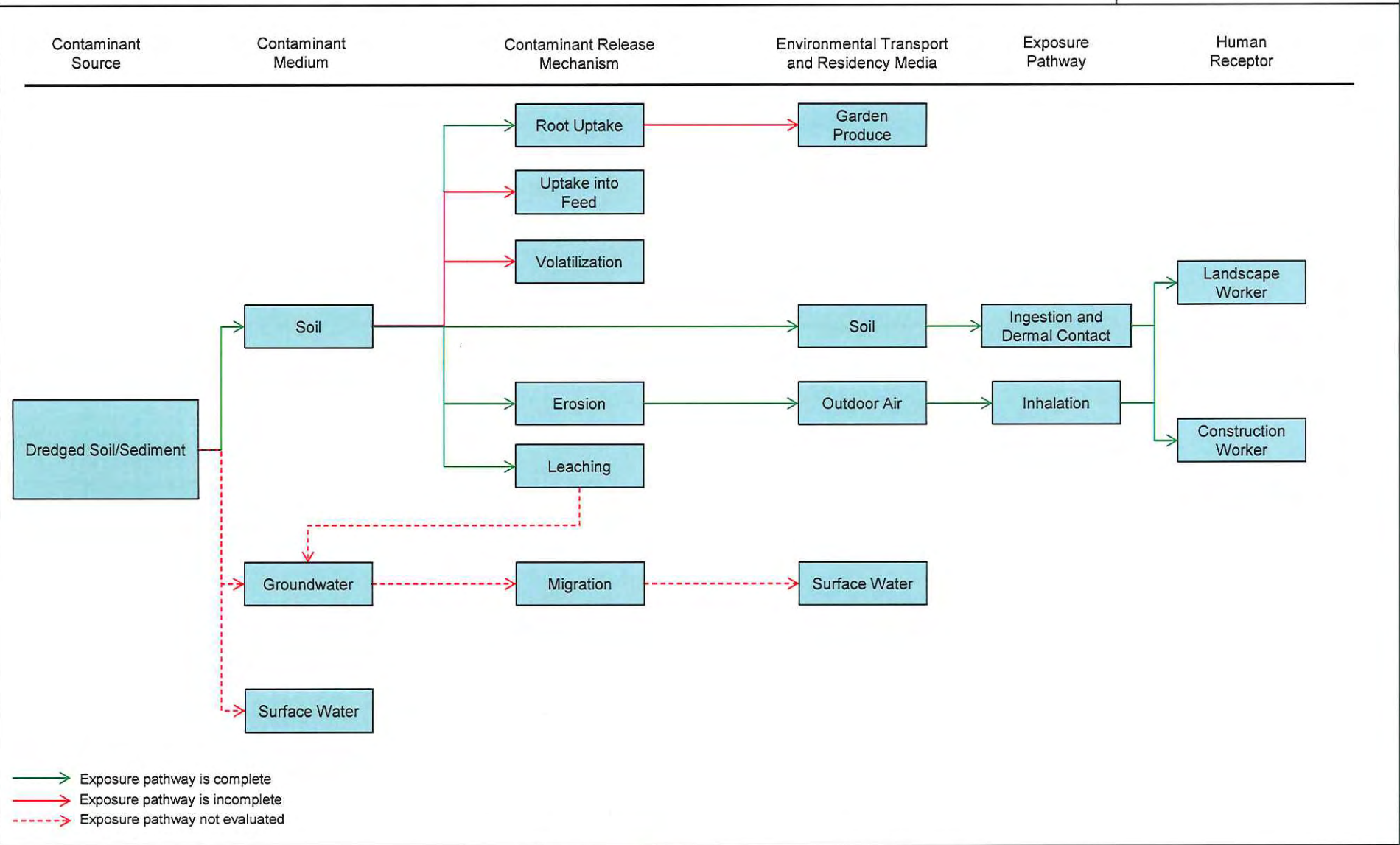


FIGURE 1

Drawing file: 1520609-3000-R01001.dwg Apr. 20, 2015 - 11:14am

Conceptual Site Model for Human Receptors – No Risk Management Measures

FIGURE 2



Date: March 2015

Project Number: 1520609

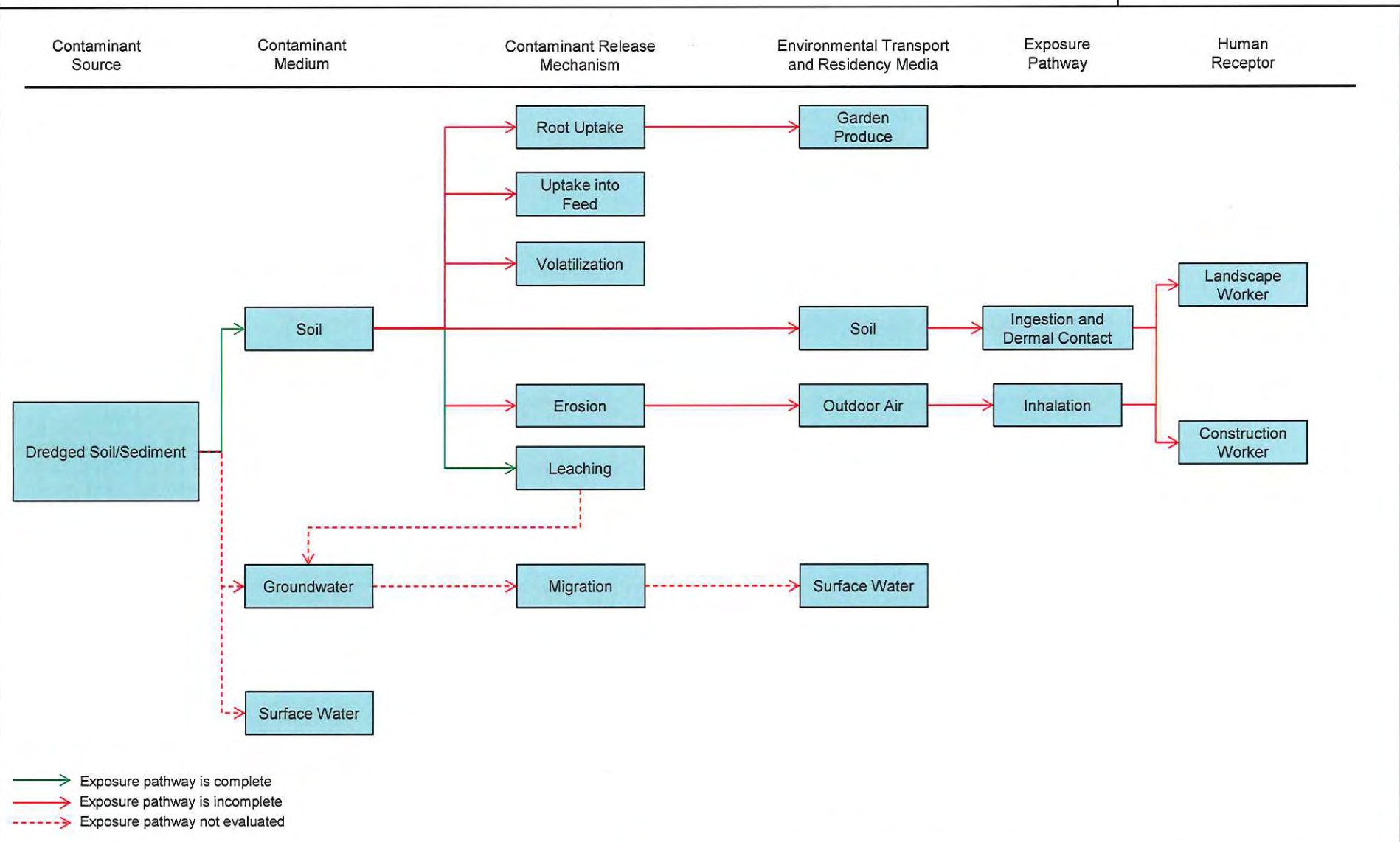


CAD: SC

CKD: TRS

Conceptual Site Model for Human Receptors – With Risk Management Measures

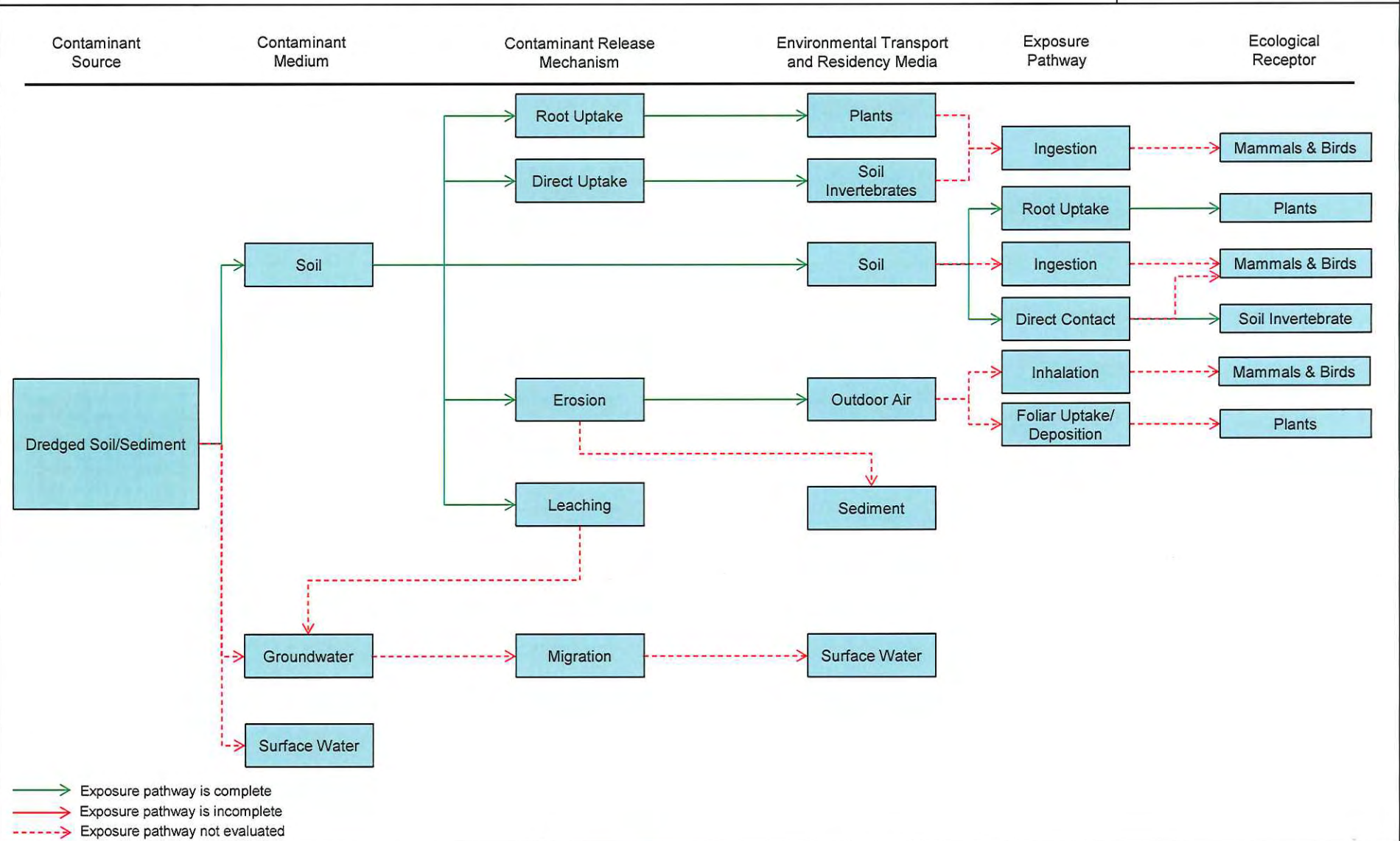
FIGURE 3



Date: March 2015		CAD: SC
Project Number: 1520609		CKD: TRS

Conceptual Site Model for Ecological Receptors – No Risk Management Measures

FIGURE 4



Date: March 2015

Project Number: 1520609

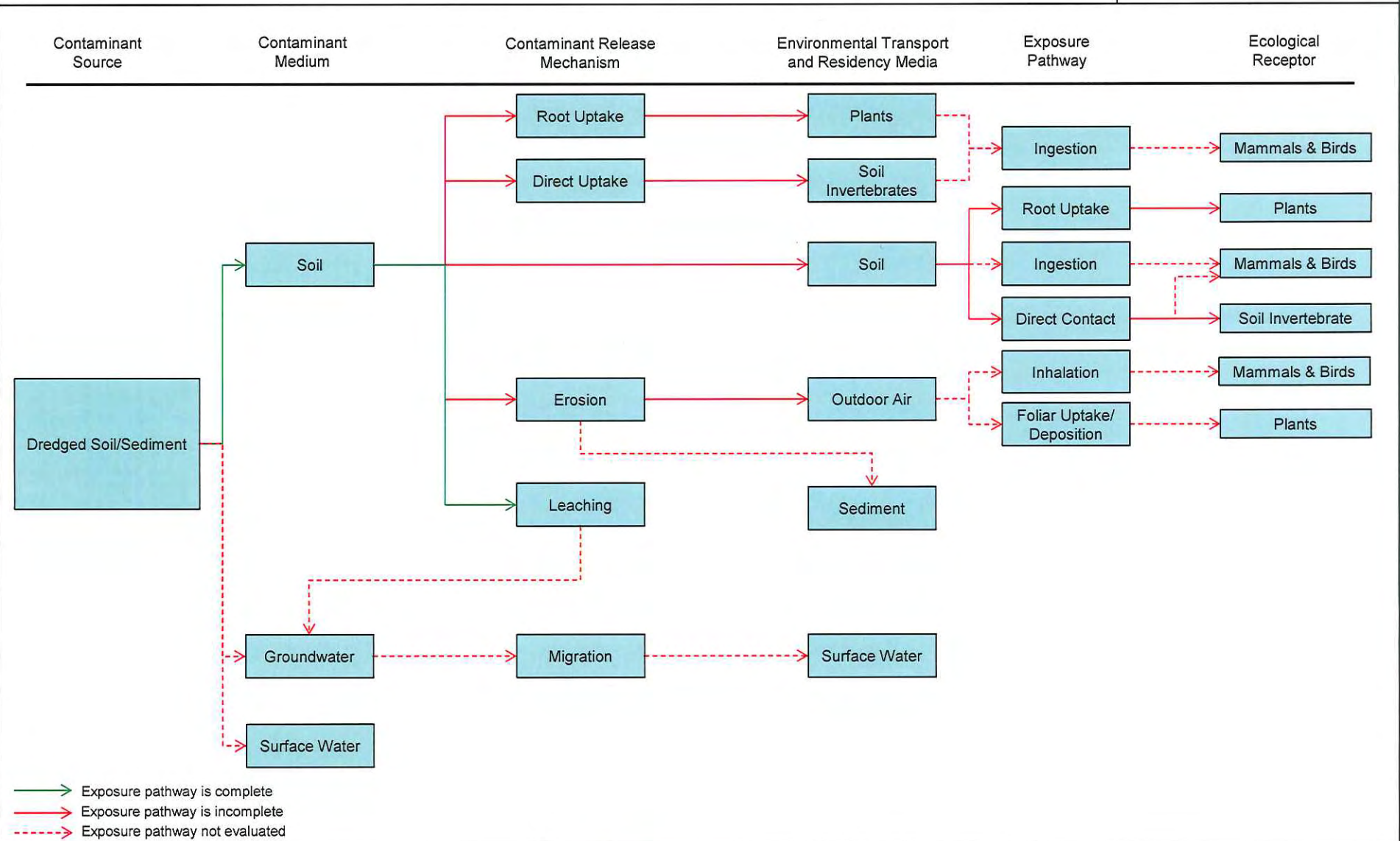


CAD: SC

CKD: TRS

Conceptual Site Model for Ecological Receptors – With Risk Management Measures

FIGURE 5



Date: March 2015

Project Number: 1520609



CAD: SC

CKD: TRS



APPENDIX A

Summary of Data from Previous Reports

Table I
Analytical Results for Metals and Inorganics in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SS-A1	SS-A2	SS-B1	SS-B2
Sample Date:			3-Dec-14	3-Dec-14	3-Dec-14	3-Dec-14
Sample Location:			Upper	Lower	Upper	Lower
Parameter	Units	MOE Table 3 Standards				
Antimony	µg/g	50	4.2	2.4	4.6	4.6
Arsenic	µg/g	18	11	14	11	11
Barium	µg/g	670	820	410	1100	1000
Beryllium	µg/g	10	0.73	0.73	0.75	0.77
Boron (Hot Water Soluble)	µg/g	2	2.3	1.9	1.7	1.8
Cadmium	µg/g	1.9	17	3.8	13	40
Chromium	µg/g	160	280	160	410	350
Chromium VI	µg/g	10	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/g	100	9.1	9.4	9.7	9.5
Copper	µg/g	300	110	72	100	130
Lead	µg/g	120	480	240	570	560
Mercury	µg/g	20	0.29	0.14	0.30	0.48
Molybdenum	µg/g	40	4.5	3.6	4.0	4.8
Nickel	µg/g	340	120	72	160	140
Selenium	µg/g	5.5	1.1	0.83	1.1	1.5
Silver	µg/g	50	1.1	0.52	0.93	1.8
Thallium	µg/g	3.3	0.38	0.32	0.38	0.41
Vanadium	µg/g	86	34	32	35	35
Zinc	µg/g	340	1400	520	2100	2100
Boron (Total)	µg/g	120	13	11	12	14
Uranium	µg/g	33	1.6	1.2	1.6	2.0

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table I
Analytical Results for Metals and Inorganics in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:		SS-C	SS-D	SD-301A	SD-301B	
Sample Date:		3-Dec-14	3-Dec-14	23-Oct-12	23/10/2012	
Sample Location:		N/A	N/A	0 to 0.15	0.30 to 0.38	
Parameter	Units	MOE Table 3 Standards				
Antimony	µg/g	50	3.4	3.9	1.9	3
Arsenic	µg/g	18	6.2	8.7	4.3	7.3
Barium	µg/g	670	410	480	360	300
Beryllium	µg/g	10	0.36	0.53	0.25	0.45
Boron (Hot Water Soluble)	µg/g	2	1.2	2.2	1.3	1.7
Cadmium	µg/g	1.9	17	28	12	14
Chromium	µg/g	160	130	130	130	93
Chromium VI	µg/g	10	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/g	100	6.1	10	4.7	15
Copper	µg/g	300	110	140	73	190
Lead	µg/g	120	210	210	130	170
Mercury	µg/g	20	0.37	0.46	0.22	0.26
Molybdenum	µg/g	40	5.0	11	7.6	6
Nickel	µg/g	340	51	58	50	44
Selenium	µg/g	5.5	0.84	1.5	0.73	1
Silver	µg/g	50	0.52	1.4	0.27	4.9
Thallium	µg/g	3.3	0.18	0.29	0.14	0.2
Vanadium	µg/g	86	17	26	13	21
Zinc	µg/g	340	840	1100	600	940
Boron (Total)	µg/g	120	7.5	10	5.1	8.4
Uranium	µg/g	33	1.2	2.1	0.85	1.3

Notes

--	Not analyzed or not applicable.
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µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
Table to be read in conjunction with accompanying report.	

Table I
Analytical Results for Metals and Inorganics in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:		SD-301C	SD-302A	SD-302B	SD-302C	SD-401	
Sample Date:		23/10/2012	23-Oct-12	23-Oct-12	23-Oct-12	23-Oct-12	
Sample Location:		2.03 to 2.13	0.15	0.30 to 0.41	2.03 to 2.13	0 to 0.30	
Parameter	Units	MOE Table 3 Standards					
Antimony	µg/g	50	5.3	3.2	1.8	4.9	4.6
Arsenic	µg/g	18	10	10	5.8	9.3	11
Barium	µg/g	670	350	510	390	420	420
Beryllium	µg/g	10	0.55	0.5	0.35	0.48	0.65
Boron (Hot Water Soluble)	µg/g	2	2.5	1.3	1.1	2	1.3
Cadmium	µg/g	1.9	22	45	20	37	11
Chromium	µg/g	160	440	250	130	380	290
Chromium VI	µg/g	10	0.5	<0.2	<0.2	0.6	<0.2
Cobalt	µg/g	100	7.9	13	9.7	9.4	8.1
Copper	µg/g	300	150	210	120	120	110
Lead	µg/g	120	600	280	150	510	490
Mercury	µg/g	20	0.44	0.63	0.29	0.48	0.27
Molybdenum	µg/g	40	4.8	5.9	3.8	4.9	3.5
Nickel	µg/g	340	180	81	45	180	130
Selenium	µg/g	5.5	1.2	2.1	0.83	1.2	1
Silver	µg/g	50	0.99	2.2	2.1	1.7	1.3
Thallium	µg/g	3.3	0.27	0.16	0.18	0.096	0.26
Vanadium	µg/g	86	24	22	15	21	28
Zinc	µg/g	340	2200	1600	800	2700	1400
Boron (Total)	µg/g	120	8.8	7.3	6.1	6.6	6.9
Uranium	µg/g	33	1.6	1.7	1.1	1.8	1.6

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table II
Analytical Results for Petroleum Hydrocarbons and BTEX in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SS-A1	SS-A2	SS-B1	SS-B2
Sample Date:			3-Dec-14	3-Dec-14	3-Dec-14	3-Dec-14
Sample Depth (mbgs):			Upper	Lower	Upper	Lower
Parameter	Units	MOE Table 3 Standards				
Benzene	µg/g	0.4	<0.020	<0.020	<0.020	<0.040
Toluene	µg/g	78	0.051	0.054	0.036	<0.040
Ethylbenzene	µg/g	19	0.024	<0.020	<0.020	<0.040
Total Xylenes	µg/g	30	0.42	0.19	0.36	0.35
PHC F1 (C6 - C10)	µg/g	65	120	38	58	89
PHC F2 (>C10 - C16)	µg/g	250	2500	430	1600	3600
PHC F3 (>C16 - C34)	µg/g	2500	14000	3800	11000	16000
PHC F4 (>C34 - C50)	µg/g	6600	2700	750	2100	3300
PHC F4 Gravimetric (>C50)	µg/g	6600	--	--	--	--

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard
mbgs	Metres below ground surface.
	Xylenes (Total) represents the sum of p+m- and o-xylenes.
	PHC F1 (C6-10) values do not include BTEX.
	Table to be read in conjunction with accompanying report.

Table II
Analytical Results for Petroleum Hydrocarbons and BTEX in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SS-C	SS-D	SD-301A	SD-301B
Sample Date:			3-Dec-14	3-Dec-14	24-Oct-12	24-Oct-12
Sample Depth (mbgs):			N/A	N/A	0 to 0.15	0.30 to 0.38
Parameter	Units	MOE Table 3 Standards				
Benzene	µg/g	0.4	<0.020	<0.040	<0.16	<0.24
Toluene	µg/g	78	0.034	<0.040	0.43	<0.24
Ethylbenzene	µg/g	19	<0.020	<0.040	<0.16	<0.24
Total Xylenes	µg/g	30	<0.040	0.11	<0.16	<0.24
PHC F1 (C6 - C10)	µg/g	65	18	<20	<20	<30
PHC F2 (>C10 - C16)	µg/g	250	960	520	59	140
PHC F3 (>C16 - C34)	µg/g	2500	16000	11000	2000	4900
PHC F4 (>C34 - C50)	µg/g	6600	9400	5900	860	2100
PHC F4 Gravimetric (>C50)	µg/g	6600	27000	16000	3000	7100

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
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	Xylenes (Total) represents the sum of p+m- and o-xylenes.
	PHC F1 (C6-10) values do not include BTEX.
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Table II
Analytical Results for Petroleum Hydrocarbons and BTEX in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SD-301C	SD-302A	SD-302B	SD-302C	SD-401
Sample Date:			24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	23-Oct-12
Sample Depth (mbgs):			2.03 to 2.13	0.15	0.30 to 0.41	2.03 to 2.13	0 to 0.30
Parameter	Units	MOE Table 3 Standards					
Benzene	µg/g	0.4	<0.40	<0.060	<0.48	<0.40	<0.020
Toluene	µg/g	78	0.52	0.19	<0.48	<0.40	0.1
Ethylbenzene	µg/g	19	<0.40	0.11	<0.48	<0.40	<0.020
Total Xylenes	µg/g	30	2.2	0.27	<0.48	2.8	0.15
PHC F1 (C6 - C10)	µg/g	65	79	<30	<30	97	32
PHC F2 (>C10 - C16)	µg/g	250	3500	160	340	10000	970
PHC F3 (>C16 - C34)	µg/g	2500	37000	7300	13000	71000	8100
PHC F4 (>C34 - C50)	µg/g	6600	10000	7000	4600	9300	1600
PHC F4 Gravimetric (>C50)	µg/g	6600	--	20000	--	--	--

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Xylenes (Total) represents the sum of p+m- and o-xylenes.
	PHC F1 (C6-10) values do not include BTEX.
	Table to be read in conjunction with accompanying report.

Table III
Analytical Results for Volatile Organic Compounds in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:		SD-301A	SD-301B	SD-301C	SD-302A	SD-302B	SD-302C	SD-401	
Sample Date:		24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	23-Oct-12	
Sample Depth (mbgs):		0 to 0.15	0.30 to 0.38	2.03 to 2.13	0.15	0.30 to 0.38	2.03 to 2.13	0 to 0.30	
Parameter	Units	MOE Table 3 Standards							
Acetone	µg/g	28	<4.0	<6.0	<10	<1.5	<12	<10	<0.50
Benzene	µg/g	0.4	<0.16	<0.24	<0.40	<0.060	<0.48	<0.40	<0.020
Bromodichloromethane	µg/g	18	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Bromoform	µg/g	1.7	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Bromomethane	µg/g	0.05	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Carbon Tetrachloride	µg/g	1.5	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Chlorobenzene	µg/g	2.7	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Chloroform	µg/g	0.18	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Dibromochloromethane	µg/g	13	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,2-Dichlorobenzene	µg/g	8.5	<0.40	<0.60	<1.0	<0.15	<1.2	1.9	0.28
1,3-Dichlorobenzene	µg/g	12	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,4-Dichlorobenzene	µg/g	0.84	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,1-Dichloroethane	µg/g	21	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,2-Dichloroethane	µg/g	0.05	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,1-Dichloroethylene	µg/g	0.48	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Cis-1,2-Dichloroethylene	µg/g	37	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Trans-1,2-Dichloroethylene	µg/g	9.3	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,2-Dichloropropane	µg/g	0.68	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Cis-1,3-Dichloropropylene	µg/g	0.21	<0.24	<0.36	<0.60	<0.090	<0.72	<0.60	<0.030
Trans-1,3-Dichloropropylene	µg/g	0.21	<0.32	<0.48	<0.80	<0.12	<0.96	<0.80	<0.040
1,3-Dichloropropylene (Total)	µg/g	0.21	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Ethylbenzene	µg/g	19	<0.16	<0.24	<0.40	0.11	<0.48	<0.40	<0.020
Ethylene Dibromide	µg/g	0.05	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Methyl Ethyl Ketone	µg/g	88	<4.0	<6.0	<10	<1.5	<12	<10	<0.50
Methylene Chloride	µg/g	2	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Methyl Isobutyl Ketone	µg/g	210	<4.0	<6.0	<10	<1.5	<12	<10	<0.50
Methyl-t-Butyl Ether	µg/g	3.2	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Styrene	µg/g	43	<0.40	<0.60	<1.0	0.18	<1.2	<1.0	<0.050
1,1,1,2-Tetrachloroethane	µg/g	0.11	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,1,2,2-Tetrachloroethane	µg/g	0.094	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Toluene	µg/g	78	0.43	<0.24	0.52	0.19	<0.48	<0.40	0.1
Tetrachloroethylene	µg/g	21	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,1,1-Trichloroethane	µg/g	12	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
1,1,2-Trichloroethane	µg/g	0.11	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Trichloroethylene	µg/g	0.61	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Vinyl Chloride	µg/g	0.25	<0.16	<0.24	<0.40	<0.060	<0.48	<0.40	<0.020
m-Xylene & p-Xylene	µg/g	--	<0.16	<0.24	0.87	0.16	<0.48	1	0.11
o-Xylene	µg/g	--	<0.16	<0.24	1.3	0.11	<0.48	1.7	0.036
Xylenes (Total)	µg/g	30	<0.16	<0.24	2.2	0.27	<0.48	2.8	0.15
Dichlorodifluoromethane	µg/g	25	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Hexane(n)	µg/g	88	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050
Trichlorofluoromethane	µg/g	5.8	<0.40	<0.60	<1.0	<0.15	<1.2	<1.0	<0.050

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
mbgs	Metres below ground surface. Table to be read in conjunction with accompanying report.

Table IV
Analytical Results for Polycyclic Aromatic Hydrocarbons in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:		SS-A1	SS-A2	SS-B1	SS-B2
Sample Date:		3-Dec-14	3-Dec-14	3-Dec-14	3-Dec-14
Sample Depth (mbgs):		Upper	Lower	Upper	Lower
Parameter	Units	MOE Table 3 Standards			
Acenaphthene	µg/g	96	0.67	0.10	0.40
Acenaphthylene	µg/g	0.17	0.10	0.072	0.47
Anthracene	µg/g	0.74	5.5	<0.010	1.0
Benzo(a)anthracene	µg/g	0.96	1.4	0.47	1.4
Benzo(a)pyrene	µg/g	0.3	0.96	0.45	1.3
Benzo(b/j)fluoranthene	µg/g	0.96	1.9	0.73	2.1
Benzo(ghi)perylene	µg/g	9.6	0.78	0.35	0.98
Benzo(k)fluoranthene	µg/g	0.96	0.54	0.27	0.79
Chrysene	µg/g	9.6	2.2	0.6	2.1
Dibenzo(a,h)anthracene	µg/g	0.1	0.16	0.066	0.22
Fluoranthene	µg/g	9.6	2.9	1.6	5.2
Fluorene	µg/g	69	1.1	0.22	1.0
Indeno(1,2,3-cd)pyrene	µg/g	0.95	0.79	0.37	0.72
1-Methylnaphthalene	µg/g	85	3.3	0.46	1.6
2-Methylnaphthalene	µg/g	85	3.9	0.38	1.8
Methylnaphthalene (Total)	µg/g	85	7.1	0.84	3.4
Naphthalene	µg/g	28	<0.40	0.10	<0.40
Phenanthrene	µg/g	16	5.5	1.4	4.6
Pyrene	µg/g	96	2.4	1.3	3.9

Notes

–	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table IV
Analytical Results for Polycyclic Aromatic Hydrocarbons in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SS-C	SS-D	SD-301A	SD-301B
Sample Date:			3-Dec-14	3-Dec-14	24-Oct-12	24-Oct-12
Sample Depth (mbgs):			N/A	N/A	0 to 0.15	0.30 to 0.38
Parameter	Units	MOE Table 3 Standards				
Acenaphthene	µg/g	96	3.8	2.0	0.53	<1.0
Acenaphthylene	µg/g	0.17	0.25	0.6	0.11	<1.0
Anthracene	µg/g	0.74	1.8	1.5	1.2	2
Benzo(a)anthracene	µg/g	0.96	1.3	2.1	5.1	7.1
Benzo(a)pyrene	µg/g	0.3	1.2	1.5	4.2	6.6
Benzo(b/j)fluoranthene	µg/g	0.96	2.0	2.3	5.2	10
Benzo(ghi)perylene	µg/g	9.6	1.0	0.99	2.9	5.2
Benzo(k)fluoranthene	µg/g	0.96	0.59	0.77	1.6	3.8
Chrysene	µg/g	9.6	1.8	2.4	6	9.4
Dibenzo(a,h)anthracene	µg/g	0.1	0.22	0.22	0.58	<1.0
Fluoranthene	µg/g	9.6	3.9	5.6	15	22
Fluorene	µg/g	69	1.9	1.4	0.62	<1.0
Indeno(1,2,3-cd)pyrene	µg/g	0.95	0.78	0.8	3.1	4.7
1-Methylnaphthalene	µg/g	85	2.2	2.7	0.18	<1.0
2-Methylnaphthalene	µg/g	85	2.2	2.8	0.26	<1.0
Methylnaphthalene (Total)	µg/g	85	4.4	5.5	0.44	<1.4
Naphthalene	µg/g	28	<0.30	0.31	0.29	<1.0
Phenanthrene	µg/g	16	6.3	7.5	7.6	11
Pyrene	µg/g	96	4.0	3.4	11	17

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

**Table IV
Analytical Results for Polycyclic Aromatic Hydrocarbons in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario**

Sample Identification:		SD-301C	SD-302A	SD-302B	SD-302C	SD-401	
Sample Date:		24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	23/10/2012	
Sample Depth (mbgs):		2.03 to 2.13	0.15	0.30 to 0.41	2.03 to 2.13	0 to 0.30	
Parameter	Units	MOE Table 3 Standards					
Acenaphthene	µg/g	96	<1.0	0.53	<1.0	5	<1.0
Acenaphthylene	µg/g	0.17	<1.0	0.24	<1.0	<1.0	<1.0
Anthracene	µg/g	0.74	1.7	1.1	<1.0	3.3	<1.0
Benzo(a)anthracene	µg/g	0.96	3.8	4.7	1.9	2.1	<1.0
Benzo(a)pyrene	µg/g	0.3	2.7	3.6	1.7	1.4	<1.0
Benzo(b/j)fluoranthene	µg/g	0.96	4.2	4.8	3.1	2.1	<1.0
Benzo(ghi)perylene	µg/g	9.6	2	2.5	1.5	1	<1.0
Benzo(k)fluoranthene	µg/g	0.96	1.5	1.5	<1.0	<1.0	<1.0
Chrysene	µg/g	9.6	5	5.9	3.2	2.2	<1.0
Dibenzo(a,h)anthracene	µg/g	0.1	<1.0	0.51	<1.0	<1.0	<1.0
Fluoranthene	µg/g	9.6	11	13	6	6.4	1.6
Fluorene	µg/g	69	1.6	0.61	<1.0	8	<1.0
Indeno(1,2,3-cd)pyrene	µg/g	0.95	1.5	2.5	1.3	<1.0	<1.0
1-Methylnaphthalene	µg/g	85	2.4	0.29	<1.0	14	<1.0
2-Methylnaphthalene	µg/g	85	3	0.38	<1.0	19	<1.0
Methylnaphthalene (Total)	µg/g	85	5.4	0.67	<1.4	33	<1.4
Naphthalene	µg/g	28	<1.0	0.49	<1.0	<1.0	<1.0
Phenanthrene	µg/g	16	8.5	6.1	3.4	21	2
Pyrene	µg/g	96	8.6	10	5	6	1.5

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table V
Analytical Results for Polychlorinated Biphenyls in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:			SS-A1	SS-A2	SS-B1	SS-B2
Sample Date:			3-Dec-14	3-Dec-14	3-Dec-14	3-Dec-14
Sample Depth (mbgs):			Upper	Lower	Upper	Lower
Parameter	Units	MOE Table 3 Standards				
Aroclor 1016	ug/g		--	--	--	--
Aroclor 1221	ug/g		--	--	--	--
Aroclor 1232	ug/g		--	--	--	--
Aroclor 1242	ug/g	--	0.057	0.056	0.21	0.15
Aroclor 1248	ug/g	--	<0.010	<0.010	<0.10	<0.10
Aroclor 1254	ug/g	--	0.26	0.25	1.3	0.81
Aroclor 1260	ug/g	--	0.10	0.085	0.47	0.76
Aroclor 1262	ug/g	--	--	--	--	--
Aroclor 1268	ug/g	--	--	--	--	--
Total PCB	ug/g	1.1	0.41	0.4	2.0	1.7

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

**Table V
Analytical Results for Polychlorinated Biphenyls in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario**

Sample Identification:		SS-C	SS-D	SD-301A	SD-301B
Sample Date:		3-Dec-14	3-Dec-14	24-Oct-12	24-Oct-12
Sample Depth (mbgs):		N/A	N/A	0 to 0.15	0.30 to 0.38
Parameter	Units	MOE Table 3 Standards			
Aroclor 1016	ug/g		--	--	<0.020
Aroclor 1221	ug/g		--	--	<0.020
Aroclor 1232	ug/g		--	--	<0.020
Aroclor 1242	ug/g	--	0.19	0.27	<0.020
Aroclor 1248	ug/g	--	<0.020	<0.020	<0.020
Aroclor 1254	ug/g	--	0.38	0.45	0.79
Aroclor 1260	ug/g	--	0.33	0.39	0.89
Aroclor 1262	ug/g	--	--	--	<0.020
Aroclor 1268	ug/g	--	--	--	<0.020
Total PCB	ug/g	1.1	0.9	1.1	1.7

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table V
Analytical Results for Polychlorinated Biphenyls in Sediment Samples
Screening Level Risk Assessment
Central Grand Marais Drain
Windsor, Ontario

Sample Identification:		SD-301C	SD-302A	SD-302B	SD-302C	SD-401	
Sample Date:		24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	23/10/2012	
Sample Depth (mbgs):		2.03 to 2.13	0.15	0.30 to 0.41	2.03 to 2.13	0 to 0.30	
Parameter	Units	MOE Table 3 Standards					
Aroclor 1016	ug/g		<0.10	<0.10	<0.020	<0.20	<0.10
Aroclor 1221	ug/g		<0.10	<0.10	<0.020	<0.20	<0.10
Aroclor 1232	ug/g		<0.10	<0.10	<0.020	<0.20	<0.10
Aroclor 1242	ug/g	--	0.29	<0.10	0.14	0.94	0.25
Aroclor 1248	ug/g	--	<0.10	<0.10	<0.020	<0.20	<0.10
Aroclor 1254	ug/g	--	1.3	0.44	0.23	1.8	0.66
Aroclor 1260	ug/g	--	0.86	0.82	0.45	1	0.49
Aroclor 1262	ug/g	--	<0.10	<0.10	<0.020	<0.20	<0.10
Aroclor 1268	ug/g	--	<0.10	<0.10	<0.020	<0.20	<0.10
Total PCB	ug/g	1.1	2.5	1.3	0.82	3.8	1.4

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/g	Micrograms per gram.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for industrial/commercial/community property use for medium to fine textured soil (April 15, 2011).
21	Concentration exceeding the MOE Table 3 Standard.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.



APPENDIX B

Curriculum Vitae



Golder Associates Ltd. – Mississauga

Ms. Theresa Repaso-Subang, B.Sc., DABT, QPRA

In 1990, Ms. Theresa Repaso-Subang graduated from the University of Guelph with an Honours B.Sc. specializing in biomedical toxicology. She has 17 years of direct experience and training in environmental and human health toxicology, and risk assessment. She is one of 40 Canadian toxicologists who are board-certified with the American Board of Toxicology. She is a member of the Society for Risk Analysis, Society for Environmental Toxicology and Chemistry, Society of Toxicology and Society for Toxicology of Canada.

Education

*B.Sc. Specialization:
Biomedical Toxicology
(Hons), University of
Guelph, 1990*

Certifications

*Diplomate of American
Board of Toxicology,
2004*

During the 10 years with Conestoga-Rovers & Associates, she provided a leadership role in the design and conduct of site-specific risk assessment under various U.S. regulatory programs including CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act or Superfund), RCRA (Resource Conservation and Recovery Act), state-lead and voluntary agency programs. Ms. Repaso-Subang provided expert advice, technical expertise and training in the areas of environmental & human health toxicology, risk assessment and risk management for their staff across the United States.

Ms. Repaso-Subang carried out over 200 quantitative risk assessments, 60 of which were under the Superfund program in the United States. She has completed numerous risk assessment projects for a range of environmental programs in the United States and in Canada related to chemical disposal sites, incinerators, landfills, operating plant sites, production practices and chemical spills. Using her knowledge of toxicology, she has developed several exposure models to address key issues in toxicology, human health and environmental risk assessment. To carry out quantitative risk assessments under the regulatory frameworks in the United States and Canada, she has applied several environmental fate and uptake models to estimate human exposure to environmental impacts in soil, ground water, surface water, sediments and biota. She is very familiar with environmental fate and/or exposure models as per the US EPA Soil Screening Level Guidance (1996), the US EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (2001), the American Society for Testing and Materials Standard Guide for Risk-Based Correction Action Applied at Petroleum Release Sites, and the Johnson & Ettinger model to evaluate vapour intrusion models into buildings. Ms. Repaso-Subang has assessed the uptake of various pesticides and PCBs in sediments and surface water by fish, the bioavailability of chemicals in soils and subsequent root and/or foliage uptake by plants (including homegrown garden vegetables).

Ms. Repaso-Subang developed health-based objectives to be applied as remediation levels or screening benchmarks for numerous sites. In addition, she performed critical reviews of risk assessments prepared by both US EPA and state agencies.

As a member of the GlobalTox team of environmental professionals, Ms. Repaso-Subang provided scientific leadership and direction to technical staff. She designed, conducted and managed numerous risk assessments under the



1996 Guidelines and under Ontario Regulation 153/04. She is the project manager and team coordinator for reviews of RAs under the 1996 Guidelines and, for reviews of PSFs and RAs under the O.Reg.153/04 on behalf of the MOE from 2002 to 2007. She has been actively involved in a number of occupational health investigations, environmental and civil litigation cases.

Employment History

Golder Associates Ltd. – Mississauga, Ontario

Team Leader, Toxicology and Risk Assessment Group (2007)

Qualified Person for risk assessment under O.Reg. 153/04 of Ontario's Environmental Protection Act. She has 18 years experience in the fields of human health and ecological risk assessment, environmental impact assessment, environmental modelling and site assessment. She is responsible for senior project direction/review and project management role in environmental risk projects. Her responsibilities also include business development and marketing initiatives as well as staff management including work allocation, team building, mentoring and performance reviews.

GlobalTox International Consultants Inc. – Guelph, Ontario

Assistant Manager – Toxicology and Risk Assessment Division (2006 to 2007)

Her responsibilities include administrative and technical functions, business development and marketing initiatives. Her staff management responsibilities include work allocation, team building, mentoring and performance reviews. Her technical responsibilities include project direction, senior review and project management role on projects.

GlobalTox International Consultants Inc. – Guelph, Ontario

Senior Risk Assessment Specialists / Toxicology (2002 to 2007)

Completion of risk assessments in accordance with the Ontario Regulation 153/04 and for assessing human health risks associated with soil, air and water-borne contaminants as required by the MOE. Responsible for coordinating a multi-disciplinary team approach (human health, ecological, hydrogeological and site characterization) to the review of brownfield risk assessments under contract to the MOE. Completion of risk assessments in accordance with federal guidelines for Health and Environment Canada as well as other public sector clients. Responsible also for project management, senior review, supervision of technical staff and business development initiatives.

Golder Associates Ltd. – Mississauga, Ontario

Senior Risk Assessor/Toxicologist (2000 to 2002)

Completed site-specific risk assessments in accordance with the MOE Guidelines. Completed third-party peer reviews in accordance with MOE Guidelines. Liaison with clients and regulatory agencies. Project management, budgeting, supervision of technical staff and business development responsibilities.

***Conestoga-Rovers & Associates – Waterloo, Ontario****Risk Assessment Specialists / Toxicologist (1990 to 2000)*

Manager of risk assessment projects for contaminated sites including inactive industrial landfills and/or municipal landfills, sludge lagoons and operating facilities.

Assessed and modeled human and ecological exposure and risk. Developed conceptual site exposure models for human health and ecological risk assessment. Provided chemical-specific toxicological information as related to environmental fate and potential adverse health effects. Assessment of a suite of contaminants including chlorinated solvents (i.e., trichloroethene, perchloroethene and other ethylene compounds), polycyclic aromatic hydrocarbons, PCBs, other volatiles, semi-volatiles, pesticides and metals. Critiqued human health and ecological assessments prepared by U.S. EPA and state agencies. Prepared proposals and work plans for completion of human health and ecological assessments. Developed risk-based levels in media for use in remediation. Experienced with Canadian regulatory frameworks related to risk assessment (i.e., CCME, Ontario, Quebec, and British Columbia). Completion of risk assessments, varying in complexity from screening level to more detailed and comprehensive level, consistent with various U.S. regulatory frameworks including U.S. EPA, CERCLA or Superfund, Resource and Conservation and Recovery Act (RCRA), ASTM RBCA tiered framework, various U.S. state agencies and state voluntary action programs. Presented project information to clients and legal counsel.



PROJECT EXPERIENCE – REGULATORY

Working knowledge of provincial, national and international environmental regulations and guidelines related to completion of risk assessments.

PROJECT EXPERIENCE – SCIENTIFIC / TOXICOLOGY

Reviewed, interpreted and summarized available literature on animal models for safety and nutritional assessment of whole foods while considering novel foods, genetically modified foods, nutritional quality, and biomarkers of beneficial and adverse health effects. Completed under contract to Health Canada Bureau of Chemical Safety Food Directorate Health Products and Food Branch.

Prepared toxicity profile for arsenic in drinking water for Teck Cominco Ltd.

Review of particle size ranges relevant to quantitative risk assessment under contract to Health Canada.

Development of a unified risk ranking scheme to prioritize contaminated sites under \$250K under contract to Health Canada.

Development of Two-Tiered De Minimus Screening Levels for Air under contract to the MOE.

Review of current governmental and non-governmental approaches in evaluating chemical mixtures in a quantitative risk assessment under contract to Health Canada.

Review of current governmental and non-governmental approaches of exposure amortization in cancer risk assessments under contract to Health Canada.

Management and technical responsibilities in the reviews of Pre-Submission Forms (PSFs) and Risk Assessments that are submitted to the MOE Standards Development Branch for review under the processes described in O. Reg. 153/04.

Comprehensive reviews of site-specific risk assessments that are submitted to the MOE Standards Development Branch for review under the processes described in the MOE Guidelines.

Developed a 2-day training course and training manual on Human Health Risk Assessment for the MOE Standards Development Branch.

Reviewed, evaluated and interpreted toxicological data for hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide for development of air quality standard.



Prepared chemical-specific fact sheets for Health Canada on 4-chloro-3-methylphenol, 2,4-dinitrophenol, n-butyl alcohol, and methyl isobutyl ketone. Reviewed, evaluated and interpreted animal toxicity data including available toxicity studies pertaining to acute, sub-chronic, chronic, developmental/reproductive, carcinogenic, mutagenic effects to prepare toxicological fact sheets for above noted chemicals.

On behalf of the Region of Waterloo, reviewed the toxicological basis of available health-based drinking water guidelines for 1,4-dioxane.

Completed hazard assessment of polychlorinated terphenyls for the World Health Organization (WHO) including review and summary of animal and human toxicity, bioaccumulation potential, environmental fate and potential for long-range transport.

Completed site-specific risk assessments in accordance with provincial (i.e. Ontario, Quebec, British Columbia) and federal guidance.

Completed various screening level human health and ecological risk assessments.

Developed conceptual models for human health and ecological assessments. Prepared work plans for human health and ecological assessments.

Completed Baseline Risk Assessments Under CERCLA, RCRA and State programs (i.e., Florida, Illinois, Indiana, Kentucky, Massachusetts, Michigan, Minnesota, New Jersey, New York, and Ohio).

Completed site-specific risk assessments under state voluntary cleanup program (i.e., Illinois and Ohio). For example, alternative cleanup objectives were calculated for over 10,000 tons of staged soil at an anonymous site in Illinois, impacted with dry cleaning solvents. There was significant cost savings over previously agreed remedial action plan.

Provided technical leadership in the completion of a Maximum Concentration Level Assessment (MCLA) in support of a Certificate of Approval for Air Permit for a titanium-containing compound used as a coating on automotive parts. The MCLA included collection of physical-chemical property data, air quality standards from other jurisdictions, occupational exposure limits and toxicological information for each chemical. Since insufficient data on the main compound was available, the manufacturing process was examined to identify the transformation product. Toxicological data was available on the transformation product and was used to identify the target air concentration for this compound.

Provided technical leadership in the completion of a Maximum Concentration Level Assessment (MCLA) in support of a Certificate of Approval for Air Permit for 16 chemicals used in paints, primers, rinses and cleaners for the automotive industry. The MCLA included collection of physical-chemical property data, air quality standards from other jurisdictions, occupational exposure limits and toxicological information for each chemical. When insufficient toxicological information was available, structure-activity relationships were used to identify surrogate chemicals.



Provided technical leadership in the completion of a Maximum Concentration Level Assessment (MCLA) in support of a Certificate of Approval for Air Permit for nitrogen gas. The MCLA included collection of physical-chemical property data, air quality standards from other jurisdictions, occupational exposure limits and toxicological information.

Conceptual and practical knowledge of Probabilistic Risk Assessments.

Critically reviewed, evaluated and interpreted toxicology data for constituents of an industrial coolant (ECOCOOL 4016) used in an industrial plant located in Guelph, Ontario. The water distribution system of the plant was impacted by an industrial coolant as a result of "backwash flow".

Conducted toxicological profiling including environmental fate and transport as well as health effects for numerous compounds, including those without any USEPA established health-based criteria. Examples are as follows: benzothiazole compounds reported in soil and groundwater at a Uniroyal Plant in Louisiana; 1,2,4- and 1,3,5-trimethylbenzenes reported in soil due to a leaking underground storage tank for a site in Illinois; and a polydimethylsiloxane (PDMS) product known as Syltherm 800 in groundwater for the Former Dart Industries in New Jersey.

Conducted literature search and developed site-specific surface water quality criteria. Examples are as follows: formaldehyde for a facility in London, Ontario; benzothiazole compounds reported in groundwater for a Uniroyal Plant in Louisiana; chlordane in an unnamed tributary for a former Velsicol plant in Illinois; and aquatic toxicity of cordite, nitrocellulose and nitroglycerin.

Developed health-based cleanup objectives for lead using the USEPA "Integrated Exposure Uptake Biokinetic Model for Lead (IEUBK Model)" for residential settings and using the TRW Adult Equation for non-residential settings. Examples are as follows: Cannelton Industries Site (a 75-acre former leather tannery site) located in Sault Ste. Marie, Michigan; Ramona Park Battery Casing Area (a 5.5-acre inactive landfill) located in Michigan; two operating plants for General Motors Corporation located in Michigan; and Commercial Oil Services Superfund Site (7 sludge lagoons contaminated with PCBs, VOCs, SVOCs and metals), Ohio.

Derived soil cleanup levels for total petroleum hydrocarbons (TPH), applying Risk-Based Corrective Action (RBCA) approach. Examples are as follows: coal tar in soil and groundwater (Former Minneapolis Gas Works, Minnesota); 3 operating wood treating facilities (Bell Lumber and Pole, Minnesota; Brown Wood, Kentucky; Bell Pole, British Columbia); LUST Investigation (Coit Road, Ohio) and retail gas stations.

Developed Risk-Based Ranking Scheme for approximately 200 properties owned and/or operated by Ontario Hydro Services Company (OHSC), now known as HydroOne.



Provided toxicology support.
In-house training of toxicology and risk assessment related issues.
Organize and compile toxicity data, regulatory limits, and applicable or relevant and appropriate requirements (ARARs) from USEPA databases particularly, Integrated Risk Information System (IRIS) database.

PROJECT EXPERIENCE – COMMUNICATIONS

On behalf of the City of Kitchener, developed a background sheet for distribution to the public related to a multi-million dollar construction/remediation project of coal tar impacted area.

On behalf of Regional Municipality of Peel, developed a fact sheet for distribution to workers who may be exposed to bottom ash. The Regional Municipality of Peel recycles bottom ash resulting from the burning of waste at KMS Peel by using it as a surface covering material at the Caledon Sanitary Landfill.

Proficiency in writing reports, data summaries, technical memoranda, correspondence and proposals for internal purposes and agency submittal.

Prepared statement of qualification brochures for company-wide marketing of risk assessment services.

Prepared company-wide quality system (GlobalTox) and quality system for internal use within the risk assessment group (GlobalTox and Conestoga-Rovers & Associates)

Contacted and worked with numerous groups of people including municipal, provincial and federal governments, property managers, property owners, clients, contractors and academic facilities.

Created and presented information in the form of summaries, reports, marketing pamphlets and Power Point slide shows.

Trained clients and MOE staff on elements of Human Health Risk Assessment.

PROJECT EXPERIENCE – QUANTITATIVE SITE-SPECIFIC RISK ASSESSMENTS

Risk assessment for a site being developed for commercial use
Guelph

Risk assessment completed under Ontario Regulation 153/04 for a site being developed for commercial use in Guelph 2006. Designated as the Qualified Person for Risk Assessment (QPRA) as per Ontario Regulation 153/04 for the project, and is the overall project manager and senior technical lead in the design and implementation of the overall approach applied in the RA.



Risk assessment for a site being developed for recreational use
Burlington

Risk assessment completed under Ontario Regulation 153/04 for a site being developed for recreational use in Burlington. 2006. Designated as the Qualified Person for Risk Assessment (QPRA) as per Ontario Regulation 153/04 for the project, and is the overall project manager and senior technical lead in the design and implementation of the overall approach applied in the RA.

Human Health Risk assessment
Toronto

Human Health Risk assessment completed under Ontario Regulation 153/04 for a property being developed as a long-term care facility in Toronto. 2006. Senior technical lead responsible for the design and implementation of the overall approach applied in the human health RA and is responsible for all aspects of the human health RA.

Site-specific human health risk assessment for a DFO site, 2005
Slate Islands, Lake Superior

Conducted quantitative RA to address metal and PHC contamination present at a DFO site. Human health RA addressed DFO workers, seasonal residents and recreational users. Senior technical lead in the design and implementation of the overall approach applied in the human health RA including the development of the conceptual site model (CSM), and is the responsible for all aspects of the human health RA.

Residential properties impacted with arsenic

Site-Specific Risk Assessment was completed for several residential properties impacted with arsenic as a result of its historical use as an herbicide at an upgradient source. December 2002 to June 2005. The objectives were to identify the likely absence of potential human health risks; determine if a comprehensive SSRA is required, and if so, help define the scope of the SSRA; and develop risk management strategies and mitigation options for the properties, if warranted.

Occupational risk assessment for processed bottom ash on behalf of the Regional Municipality of Peel, November 2004.

The Regional Municipality of Peel recycles bottom ash resulting from the burning of waste at KMS Peel by using it as a surface covering material at the Caledon Sanitary Landfill. Reviewed data from recent samples of the bottom ash, and used this information to evaluate potential for risks to workers at the landfill.

Site-specific human risk assessment for proposed gas station. 2004

Conducted an exposure and hazard assessment for construction workers, landscape workers and convenience store employees.

Assessment of potential risks to nursing infants

Assessment of potential risks to nursing infants associated with occupational exposures of lactating mothers to lindane. May 2004. The assessment evaluated dermal and inhalation exposures of lactating mothers (who handle seeds treated with lindane based products), and resultant exposures to nursing infants.



Proposed gas station and convenience store

A Site-Specific Risk Assessment was completed for a proposed gas station and convenience store. April 2004. The project objectives were to 1) identify the likely presence/absence of potential human and ecological health risks associated with the present Site use and the anticipated future use, 2) identify any data gaps, and 3) develop risk management strategies and mitigation options, if warranted. The scope of work included a review and analysis of data, completion of a risk assessment and preparation of a draft and final report. The data review and analysis was completed to identify data gaps in order to facilitate the smooth completion of the risk assessment. Based on this review additional sampling was conducted to profile the vertical and horizontal extent of contamination. The risk assessment included a problem formulation, exposure assessment, toxicity assessment and risk characterization. As part of the problem formulation, a number of chemicals of potential concern were identified in soil and groundwater including: inorganics, volatile organic compounds, PAHs, phenols and total petroleum hydrocarbons. Human receptors included Site construction workers, landscape workers and convenience store employees. Completed human exposure pathways included 1) direct soil contact via incidental ingestion, dermal contact and inhalation of dusts, 2) direct contact with ground water via ingestion and dermal contact and 3) inhalation of indoor and outdoor vapours. Exposure level calculations and risk characterization was conducted with the use of a number of models, including USEPA Version 3.0 of the Johnson and Ettinger (J&E) Model and the Risk-Integrated Software for Clean-ups (RISC) Version 4. Deliverables included a draft report describing the results of the additional investigations and the findings of the risk assessment and a final report. The final report incorporated the client's comments, as appropriate, and provided recommendations regarding the risk management measures required in the design and construction of the convenience store to support the conclusions reached in the risk assessment.

Cardinal Health Facility

Evaluated the potential for, and significance of, exposure to etoposide residue by a future worker assuming post-restoration conditions at the Cardinal Health Facility. October 2003. Cardinal Health operated an encapsulation facility, located in Windsor, Ontario, whereby an etoposide was processed for various pharmaceutical companies. Cardinal ceased operations thereafter, equipment and building decontamination and restoration activities were carried out, in compliance with the Containment Facility – Site Restoration and Equipment Decommissioning Plan (Cardinal Health, 2003a), and completed on September 26, 2003.

Site-specific risk assessment of glycol impacts at a former de-icing area for a local airport, July – August 2001

Assessment of ethylene glycol and degradation products (acetaldehyde, acetic acid, methanol and ethanol) in soil and groundwater.



Proposed watermain works of the Laurier Avenue rehabilitation project
Ottawa, Ontario

Site-specific risk assessment focused only on potential exposures and risk to human receptors associated with the proposed watermain works of the Laurier Avenue rehabilitation project located in Ottawa, Ontario. June 2001. A short-term risk evaluation assessed COPCs above the applicable CCME and MOE guidelines, including polycyclic aromatic hydrocarbons (PAHs), fuel-related compounds and metals. A short-term risk evaluation resulting from environmental site conditions was carried out associated with the proposed watermain upgrade of the construction project for the Laurier Avenue Bridge. The short-term risk evaluation focused on the COPCs identified in the fill material, and it was carried out to determine the potential presence or absence of risks to construction workers during construction activities and possibly to pedestrians within the publicly accessible areas. The significant exposure pathway for the construction workers involved in the watermain works was identified to be through direct contact potentially impacted fill material. Pedestrians within publicly accessible areas maybe exposed via inhalation of fugitive dusts/particulates emanating from the open excavation. It was concluded that the proposed watermain upgrade at the site does not pose a human health risk to the general public who may be exposed indirectly to fugitive dust/particulates emanating from the open excavation. In addition, it was concluded that potential direct contact with soils by future construction workers does not pose a health concern for a continuous working period less than or equal to 80 days. This in combination with good dust suppression program, soil management program and a health and safety program would minimize exposure to potentially impacted fill material and thereby, reduce potential risks.

Site-specific risk assessment for a municipally-owned greenspace, May 2001
Hamilton, Ontario

Assessment of soil impacted with polycyclic aromatic hydrocarbons (PAHs).

Site-specific risk assessment for the former Plastimet Site, May 2001
Hamilton, Ontario

Assessment of soil contamination including dioxins and furans, fuel-related compounds and metals for a former industrial property that is being redeveloped to an active parkland.

Site-specific risk assessment for a facility in Trenton, April 2001
Ontario

Assessment of 2,4,6-trinitrotoluene and related compounds in soil as a result of historical munitions operations at the site. In addition, assessed trichloroethene and degradation products in groundwater and potential impact to receptors on site. Evaluated potential migration to indoor air using the Johnson & Ettinger Model (1991).



Site-specific risk assessment of lead in soil for recreational lands, March 2001
Pembroke, Ontario

Assessment of lead in soils for a property that is planned to be redeveloped for recreational purposes. The subject site included a 4.1-acre parcel of recreational land that is planned to be redeveloped for a hotel/convention complex. Previous investigations undertaken at the site indicated that certain areas have imported fill material that has concentrations of lead and zinc above the MOE Table B generic criteria. The intent of the supplemental site investigations including surficial soil sampling was to further define the extent of the area of heavy metal impacts on the site and to characterize the potential subsurface environmental impacts associated with the proposed development of the Site. The quantitative risk assessment indicates that the site conditions are acceptable in terms of risk for current and future park users as well as future construction workers, future hotel visitor and future hotel workers.

Site-specific Risk Assessment for active manufacturing facility, Steelcraft Manufacturing Facility, Feb. 1999/2000
Blue Ash, Ohio

Assessed potential risks and hazards associated with potential exposures of adult industrial workers and, off-site residents and industrial workers to VOCs (including TCE and tetrachloroethene) in soil, groundwater and surface water. The manufacturing facility covered over 30 acres with historical operations dating back to the 1940s. Successful negotiations with the Ohio Voluntary Action Program (VAP) regarding the classification ("Class B") of groundwater beneath the site. The Class B designation for groundwater indicates that the groundwater is not a potable drinking water source. As a result, exposure scenarios evaluated in the SSRA included groundwater vapour into indoor air of the existing manufacturing facility, and the indoor air of nearby residents and nearby industrial facilities. Use of Ohio EPA VAP Guidelines. The site successfully received a No Further Action (NFA) letter under the OEPA VAP.

Launch Complex-34
Florida

Site-Specific Risk Assessment for the Launch Complex-34 site, the former Apollo launch site, in Cape Canaveral Air Station (CCAS) located in Florida. 1999/2000.

Site-specific Risk Assessment for industrial facility, Bell Canada, October 1998
Montreal, Quebec

Determination of potential risk to human health and the environment posed by the residual soil and groundwater contamination.

Site-Specific Risk Assessment of Polycyclic Aromatic Hydrocarbons (PAHs) in CN Rail Lands, September 1998
City of Barrie, Ontario

Assessed PAHs in soil, groundwater, sediments and surface water. Evaluated potential impact to human health and the environment given current and future anticipated land use.

Site-specific Risk Assessment for commercial property, May 1998
Montreal, Quebec

Determination of potential risk to human health and the environment posed by the residual soil contamination.



Site-specific Risk Assessment for proposed firehall site, January 1997
Toronto, Ontario

Assessment of potential hazards associated with volatiles in soil in the context of land development as a firehall.

Human Health and Ecological Risk Assessment for a 210-acre former disposal site, Former Fairchild Republic site, 1996
Hagerstown, Maryland

The former disposal site received solid waste, construction and demolition debris, and industrial/commercial wastes. As part of the Supplemental Remedial Investigation and Feasibility Study (SRI/SFS), the risk assessment assessed potential risks to adult industrial workers, construction workers, and nearby residents to VOCs, SVOCs, pesticides and metals in surface soil, subsurface soil, groundwater, sediment and surface water. The ecological risk assessment evaluated the potential risks to invertebrates in the unnamed creek, which receives discharge from the site. Use of the USEPA RAGS and Region III guidelines.

Site-specific Risk Assessment for Groundwater beneath an Industrial facility, August 1995
Toronto, Ontario

Assessment of potential hazards associated with chlorinated organics in groundwater in the context of continued industrial/commercial use of the property. Use of USEPA Risk Assessment Guidance for Superfund (RAGS).

Detailed Human Health Risk Assessment for active industrial facility, Occidental Chemical Corporation, October 1995
Kenton, Ohio

Assessed potential risks and hazards associated with potential exposures of adult industrial workers, construction workers, and nearby residents to VOCs, SVOCs, and metals in surface soil, subsurface soil, air, groundwater, surface water and sediments. As part of the RCRA (Resource Conservation and Recovery Act) Facility Investigation (RFI) and Corrective Measure Study (CMS), a risk analysis was completed for each of the 70 suspected Solid Waste Management Unit (SWMU), Area of Concern (AOC) and Additional Area of Concern (AAOC). The RFI identified only one AAOC as requiring corrective measures that involved excavation of approximately 50 yd³ of soil. The RFI/CMS was successfully accepted by OEPA.

Detailed Human and Ecological Risk Assessment for former lagoon site, 1994-1995
Hamptonburg, Orange County, New York

Assessed potential risks and hazards associated with potential exposures of nearby residents, trespassers and recreational users to a suite of contaminants including volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in soil, groundwater, surface water and sediments. The 29-acre inactive property contained 6 lagoons that were historically used for disposal of wastewater. Use of USEPA Risk Assessment Guidance for Superfund (RAGS) and NYSDEC guidelines.



Detailed Human and Ecological Risk Assessment for chemical manufacturing plant, 1994-1995
Harriman, Orange County, New York

The chemical plant which has been operational since 1942 produced bulk pharmaceutical chemicals, hydrogels, pyridine-based industrial chemical intermediates. Assessed potential risks and hazards associated with potential exposures of adult workers (including industrial and construction workers), recreational users and future hypothetical residents to a suite of contaminants including VOCs, SVOCs, PCBs, PAHs, and metals in soil, groundwater, air, surface water and sediments. The active plant produced bulk pharmaceutical chemicals, hydrogels, and pyridine-based industrial chemical intermediates. The detailed quantitative risk assessment also evaluated pyridine-based tentatively identified compounds in response to NYSDEC comments. Use of USEPA RAGS and NYSDEC guidelines.

Detailed Ecological Risk Assessment for an abandoned industrial sludge lagoon, Willow Run Sludge Lagoon, 1993
Ypsilanti Township, Michigan

Assessed potential risks to the ecological receptors associated with potential exposures to PCBs and metals in soil, air, surface water and sediments.

Site-specific Risk Assessment for chemical manufacturing facility, FMC Corporation, 1992
Middleport, New York

Assessed potential risks and hazards associated with potential exposures of nearby residents, trespassers, and adult workers to arsenic, lead and chlorinated pesticides in soil, surface water and sediments in seven (7) off-site areas. The task included toxicological review of published literature related to bioavailability of arsenic, lead and chlorinated pesticides adhered to soil. Use of New York State Department of Environmental Conservation (NYSDEC) guidelines.

Site-specific Risk Assessment for plastic molding operation, Former Dart Industries Facility, 1990-1992
North Smithfield, Rhode Island

Assessed potential risk and hazard associated with potential exposures of recreational users and adult workers to PCBs and Total Petroleum Hydrocarbon (TPH) in soil, groundwater and surface water. Developed alternative soil cleanup levels for PCBs and TPH based on site-specific modeling and risk analysis, and successfully negotiated with Rhode Island Department of Environmental Management (RIDEM). A higher TPH cleanup level of 1900 ppm, instead of the state generic criterion of 100 ppm, was applied to soil at the site based on site-specific modeling and risk analysis.

Site-specific Human Health Risk Assessment for industrial/commercial property, Caldwell Systems Inc.
Lenoir, North Carolina

Assessed potential risks and hazards associated with potential exposures of adult industrial workers and construction workers to VOCs, SVOCs and metals in soil and subsurface soils. The risk assessment evaluated over 100 soil samples from several investigations completed on site to determine and aid in the selection of appropriate removal or remedial action alternatives. Use of USEPA RAGS.

Human Health Risk Assessment for Novak Farm site
Chenango County, New York

Assessed potential risks and hazards associated with potential exposures of site workers, visitors, and future hypothetical residents to VOCs, SVOCs, and PCBs in surface soil, subsurface soil, groundwater, surface water and ambient air. Use of USEPA RAGS.



Human Health Risk Assessment for anonymous 90-acre plastic manufacturing facility located in Frewsburg, New York. Assessed potential risks and hazards associated with potential exposures of trespassers, nearby residents and recreational users to VOCs (including TCE, vinyl chloride, 1, 2-DCE and BTEX), PCBs and metals in soil, sediment, surface water, and groundwater. Use of NYSDEC guidelines.

PROJECT EXPERIENCE – MINE SITES

Provision of expert advice and toxicology consulting services to Gartner Lee for the Human Health Risk Assessment of fish consumption from Giauque Lake, Discovery Gold Mine site, Yellowknife, Northwest Territories. January 2007. The Discovery Mine site has undergone significant remediation to mitigate human and ecological impacts from the more than one million tonnes of metal contaminated mine tailings deposited on the site during mining operations from the mid-1940s through late 1960s. The human health risk assessment focused on potential consumption of fish from Giauque Lake which was impacted by mercury during the mining operations.

Provision of expert opinion and recommendations to Health Canada and the Nova Scotia Department of Health and Protection regarding the assessment and management of four sites within the Nova Scotia's gold mining districts. August 2006. The gold mine tailing sites included Montague Gold Mines (Mitchell Brook), Goldenville, Lake Catcha and the Wine Harbour area. Based on the information provided by the NSDOHP, expert opinion and recommendations related to the need for additional site characterization, human health risk assessment and risk management were provided.

Site-specific risk assessment for the former Caland Mine Pelletizing plant property located in Atikokan, Ontario. October 2001. The Ministry of Northern Development and Mines (MNDM) presently owns the subject property but that the Township of Atikokan proposes to take ownership of this property. Though there are no conceptual designs or definitive plans for the subject property, the Township intends to rezone and redevelop the site for industrial/commercial uses. The SSRA was to determine whether there are potential future human and ecological health risks associated with substances released from the former pelletizing plant. The chemicals of potential concern (COPCs) included arsenic and cadmium in soil, groundwater, vegetation, sediment and surface water.

PROJECT EXPERIENCE – SCREENING LEVEL RISK ASSESSMENTS (SLRAS)

SLRA completed for an industrial facility located in Huron Park, Ontario as part of a Severance Application for the Site. The SLRA evaluated the potential human and ecological risks associated with chlorinated solvents in groundwater beneath the Site. August 2007.



SLRA for TPH, BTEX, PAHs, and metals at three generating stations for Ontario Power Generation (OPG). November to April 2001.

SLRA for PCBs, TPH, and arsenic at the Sidney Transmission Station facility located in the City of Quinte West (near Trenton), Ontario. November 2004.

SLRA for BTEX and TPH as part of an indoor air investigation at a twenty-storey building with two levels of underground parking. The subject property is presently owned by the Standard Life Assurance Company (Standard Life) however, Public Works Government Services Canada (PWGSC) is leasing a portion of the building. The renewal of the lease by PWGSC is dependent upon the findings of the SSRA.

SLRA of TPH, BTEX, PAHs, SAR, and EC for the Development of the Uptown Waterloo Lands, Ontario. April 2000. An assessment of potential hazards associated with contaminants above the MOE Table A generic criteria to humans and the environment in the context of proposed commercial redevelopment of the Uptown Waterloo lands.

SLRA for lead, firing range in Campbellford, Ontario. November 1999. Assessment of potential lead impact to soil, groundwater and surface water as a result of the use of property as a firing range.

SLRA of chlorinated organics (including vinyl chloride and trichloroethene) during subsurface investigation, Litton Systems Canada, Etobicoke, Ontario. December 1997. Assessment of potential hazards associated with chlorinated organics in soil and groundwater in the context of continued industrial/commercial use of the property.

SLRA of chlorinated organics (including trichloroethene) in groundwater, Allan Bradley, Cambridge, Ontario. February 1997. Evaluation of the technical basis of the MOE Table A generic criteria and their applicability to the site.



PROJECT EXPERIENCE – CRITICAL REVIEWS

Under contract with the Ontario Ministry of the Environment (MOE), coordinator of a multidisciplinary team (human health, ecological, hydrogeological and site characterization) in the comprehensive reviews of risk assessments submitted to the MOE under the Ontario Regulation 153/04. Scientific lead in the reviews of the human health component. October 2004 to present.

Retained by Ontario Power Generation Inc. to review the Human Health and Ecological Risk Assessment Report, prepared by Intrinsik Science for Lake Gibson Reservoir, Thorold, ON. June 2007.

Retained by O'Connor Associates Environmental Inc. to carry out a review of environmental site assessment reports related to environmental conditions at the Minden Transformer Station (TS) and the wetland property located in the vicinity of Bright, Ontario. The Subject Site includes the fenced TS, the area outside the fenced TS and the 18-acre of wetland property located west of the TS. The review was to assist in the preparation of an opinion letter evaluating possible strategies that would be feasible given the environmental conditions at the Site. These strategies/options include risk assessment, risk management, remediation and/or a combination of options. February 2007.

Reviewed air modeling report prepared by Conestoga-Rovers & Associates (CRA) which examined changes in air emissions and other potential environmental issues related to a proposal to use used tires as feedstock to a cement kiln. Work completed for the Resource Recovery Fund Board Inc., Nova Scotia. December 2006 to January 2007.



Independent peer review of technical reports submitted to the Region of Halton as part of the Environmental Assessment (EA) requirements pursuant to Ontario Regulation 116/01 for Electricity projects under the Ontario Environmental Assessment Act. Completed peer reviews for submissions of EA reports by Pristine Power and TransCanada for proposed construction of two (2) electricity-generating facilities in the area. October 2006 to February 2007.

Retained by Health Canada ("HC") and the Nova Scotia Department of Health Promotion and Protection (NSDOHPP) to provide expert opinion/recommendations regarding the assessment and management of four sites within the Nova Scotia's gold mining districts. Critically reviewed environmental reports and available analytical data, and provided recommendations on whether a quantitative HHRA is necessary to determine management options for the sites and potential risk management options. June 2006.

On behalf of the Sudbury Soils Working Group, provided an independent review of the computational model applied by the SARA Group in the human health risk assessment component of the Sudbury Soils Study. March 2006.

Independent review of the human health risk assessment completed on hexabromocyclododecane (HBCD) previously done by the European Chemicals Bureau. Albemarle and the larger group of industries that it belongs to, the Bromine Science and Environmental Forum (BSEF), disagree with some of the outcomes of the ECB report. The ECB report was submitted to Health Canada and Environment Canada for review.

Peer review of the human health risk assessment component of the CH2MHILL Report Entitled: "Site-Specific Risk Assessment for General Motors of Canada Limited, Locomotive Division Facility, 2021 Oxford Street East, London, ON". October 2004.

Peer review of the SSRA prepared by Cantox Environmental Inc. for a property located in Toronto, Ontario that is scheduled for immediate redevelopment as a commercial retail outlet. The property has reported chlorinated solvents in groundwater. June 2004.

Peer review of the SSRA for the HCISPA Development Property located in Hawkesbury, Ontario. Critically reviewed environmental reports and available analytical data, and provided recommendations. March 2004.



Peer review of the SSRA for the petroleum hydrocarbon impacted soils in a residential property located in St. Catharines. Critically reviewed environmental reports and available analytical data, and provided recommendations. October 2003.

Peer Review of the SSRA for a former manufacturing facility for small engines which has since been subdivided. The target parameters in soil and groundwater included petroleum hydrocarbons (including LNAPL), BTEX, chlorinated organics within the shallow soil zone and PCBs. May 2002.

Peer Review of the SSRA for a former manufacturing facility for small engines which has since been subdivided. The target parameters in soil and groundwater included petroleum hydrocarbons (including LNAPL), BTEX, chlorinated organics within the shallow soil zone and PCBs. May 2002.

Peer Review of the SSRA for a property owned and operated by TransCanada Pipelines Ltd. The chemical of potential concern is PCBs reported in sediments of a nearby creek. April 2002.

Third Party Peer Review of the Site-Specific Risk Assessment for a former agricultural land located in the Township of Grenville, Ontario. February 2001.

Third Party Peer Review of the Site-Specific Risk Assessment for a proposed arena development of the Western Fair Grounds, London, Ontario. August 2000.

Performed critical reviews of risk assessments prepared by both the United States Environmental Protection Agency (USEPA) and state agencies. June 1990 to March 2000.

Peer Review of the environmental site investigations and assessment for Southside High School located in Elmira, New York. The environmental site investigation and assessment was completed by the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC). December 2000.

Peer review of the environmental site assessment activities including site-specific risk assessment, Dura Industries Facility, Brantford, Ontario. April 1999.



Critical review of the Baseline Risk Assessment (including both human health and ecological risk assessment) for the Arlington Blending and Packaging site, a Superfund site, located in Tennessee. Soils and groundwater at the site have been impacted by VOCs, pesticides (lindane, chlordane, simazine, aldrin, and endrin ketone) and pentachlorophenol. Conestoga-Rovers & Associates was originally retained by the potentially responsible parties (PRP) to review the Remedial Investigation (RI)/Feasibility Study (FS) prepared by USEPA Region IV. During the public comment period for USEPA's proposed plan, Conestoga-Rovers & Associates (CRA) implemented a supplemental site investigation to address deficiencies in USEPA's RI/FS. The findings of the supplemental investigation and comments generated by CRA resulted in recharacterization of the site soils and groundwater with resultant agency changes for various cleanup criteria.

Critical review of the Baseline Risk Assessment (including both human health and ecological risk assessment) for the MIG/Dewane Landfill, a Superfund site, located in Boone County, Illinois. The RA was completed by another consultant, on behalf of Illinois EPA, and was premised on ultraconservative residential land use assumptions in addition to application of conservative exposure factor assumptions. The review identified numerous deficiencies in the RA and resulted in the subsequent completion of a SSRA.

Critical review of the Baseline Risk Assessment prepared by USEPA, for the former 75-acre tannery site along the St. Mary River, Cannelton Industries Site, Sault Ste. Marie, Michigan. For 50 years, the tannery processed animal hides, primarily cowhides. The review identified numerous deficiencies in the RA and resulted in the subsequent completion of a Site-specific Human Health Risk Assessment. Assessed potential risks and hazards associated with potential exposures of adult industrial workers, construction workers, trespassers, and future hypothetical residents on site to VOCs, SVOCs, pesticides, PCBs and metals (primarily chromium and lead) in surface soil, subsurface soils and air. The SSRA evaluated the site following a sectorwise approach (6 sectors in total) due to the size of the site, variable chemistry and variable anticipated future land use for different portions of the site. Use of USEPA RAGS. Applied the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) Model to derive risk-based level for lead in soil under residential settings. Also, applied the USEPA Technical Review Workgroup (TRW) to derive site-specific risk-based levels for lead in soil under non-residential settings.



PROJECT EXPERIENCE – CLEANUP CRITERIA DEVELOPMENT

Development of site-specific soil criteria for dicyclopentadiene, manganese, nickel, zinc and petroleum hydrocarbon fractions for NOVA Chemicals located in Red Deer, Alberta. The site-specific soil criteria were derived consistent with the CCME 2000 Protocols for the Derivation of Environmental and Human health Soil Quality Guidelines

Development of site-specific criteria for ethylene glycol and degradation products at a former de-icing area for a local airport.

Development of site-specific criteria for 2,4,6-trinitrotoluene and other related compounds in soil as a result of historical munitions operations at the site.

Development of site-specific ambient water quality guideline for formaldehyde in the Thames River, 3M Canada Company, London, Ontario. June 1998. Evaluation of the technical basis of the interim Provincial Water Quality Objectives (PWQO) for formaldehyde and its applicability to the site, and the development of site-specific ambient water quality guideline for formaldehyde based on instream mixing calculation.

Development of site-specific criteria for arsenic, GSW, Hamilton, Ontario. April 1998.

Developed site-specific criteria for arsenic following MOE methodology in the context of continued industrial use of the site.

Development of site-specific screening levels for pesticides as part of a Phase II Environmental Site Assessment, Stanley Creek, Ontario. June 1997. Developed site-specific screening levels for pesticides (including thiabendazole, dicamba, diquat, paraquat, bravo, maneb, thiram, lindane, cobex, 2,4-D, MCPA, and others) following USEPA (Region III and Region IX) and Ontario framework.

Development of site-specific remediation criteria for the Bioremediation Pilot Project, Contained Waste Final Disposal, Uniroyal Chemical Ltd., Elmira, Ontario. April 1997. Development of site-specific remediation criteria following MOE methodology for exposure pathways that are appropriate and applicable to the site, given current and anticipated future land use.

Development of site-specific criteria for TPH, Ultramar Property, Port Stanley, Ontario. October 1996. Developed site-specific criteria for TPH in soil based on appropriate and applicable exposure pathway, consistent with MOE approach and methodology.

Developed site-specific alternative cleanup objective for an anonymous site, East Peoria, Illinois. Calculated alternative cleanup objectives for over 10,000 tons of staged soil impacted with dry cleaning solvents with significant cost savings over previously agreed remedial action plan. The treated soil was subsequently used as on-site backfill as part of a negotiated remedy. Use of Illinois Voluntary Action Program guidelines (follows ASTM RBCA approach).



Developed site-specific risk-based criteria for benzothiazole compounds reported in soil and groundwater at the Uniroyal Plant located in Louisiana.

Developed site-specific risk-based criteria for 1,2,4-and 1,3,5-trimethylbenzene reported in soil and groundwater for ChemRex Inc. facility located in Chicago Heights, Illinois.

Developed site-specific risk-based criteria for a polydimethylsiloxane product known as Syltherm 800 in groundwater for the Former Dart Industries, located in New Jersey.

Developed site-specific risk-based criteria for PCBs, VOCs and SVOCs reported in soil at the Commercial Oil Services site located in Oregon, Ohio. The site collected and recycled waste oil for resale from 1969 to 1985 when the owners declared bankruptcy and operations ceased. The site consisted of 7 surface impoundments and 45 aboveground storage tanks (ASTs). The lagoons contain approximately 75,000 cubic yards of waste oil sludges with elevated levels of PCB compounds ranging from 30 to 160 mg/kg. The derivation of soil cleanup levels was part of the task to implement the requirements of the Action Memorandum and the Consent Decree issued by USEPA requiring that all tanks and lagoons on the site be closed and that an engineered cell meeting TSCA and RCRA requirements be constructed on site to contain solidified/stabilized waste sludges and contents.

Developed site-specific risk-based criteria for tentatively identified compounds (TICs) reported in soil at the Fisher Calo site located in Indiana.

Developed site-specific risk-based criteria for cutting oils and mineral oil products reported in soil as part of the Leaking Underground Storage Tank (LUST) Investigation at two MascoTech Plants located in Michigan. These criteria were subsequently accepted by the Michigan Department of Environmental Quality (MDEQ).

Developed site-specific risk-based criteria for lead using the USEPA "Integrated Exposure Uptake Biokinetic Model for Lead" (IEUBK Model) for residential settings and using the TRW Adult Equation for nonresidential settings. Example sites include Cannelton Industries site (75-acre former leather tannery Superfund site) located in Sault Ste. Marie, Michigan; Ramona Park Battery Casing Area (5.5-acre inactive landfill) located in Michigan; two General Motors Corporation sites located in Michigan; Commercial Oil Services site (included 7 sludge lagoons) located in Ohio; and J.I. Case located in Washington.



PROJECT EXPERIENCE – OTHER RISK-BASED APPLICATIONS

Development and implementation of a risk-based property ranking system for 200 of the 1600 properties owned and/or operated by HydroOne (formerly known as Ontario Hydro Services Company or OHSC) throughout Ontario, 1999/2000. The scope of the project included evaluation of publicly available state-of-the-art property ranking systems; development of a risk-based ranking system suited to HydroOne; ranking of the selected 200 priority sites; and sensitivity testing of the risk-based ranking system. The risk-based ranking system developed for HydroOne integrated risk assessment and risk management principles in current decision making. The risk-based ranking system is a scoring system based on the following property-specific information: contaminant mobility and toxicity, contaminant concentration, contaminant quantity, distance to receptor, land use/receptor sensitivity, and number of receptors. The risk-based ranking system developed for HydroOne was not intended to provide a quantitative property-specific risk assessment. Rather, its objective is to provide a scientifically defensible screening tool to characterize environmental risks associated with each property, and to provide a relative ranking of properties presenting similar environmental risk(s), through an assessment of property-specific information provided to Conestoga-Rovers by HydroOne. As a result, the risk-based ranking system developed by Conestoga-Rovers will aid corporate environmental management decisions to focus remedial and/or site management activities by HydroOne.

Developed a site-specific indicator parameter list (SSIPL) for purposes of groundwater monitoring for a 65-acre Miami County Incinerator site, Troy, Ohio. 1998. There are four aquifers beneath the site and extensive groundwater database was developed over the years as a result of previous field investigations and groundwater monitoring activities. As part of the groundwater monitoring activities following the fifth year after the groundwater extraction system has been operational, a site-specific indicator parameter list was developed to reduce the number of chemicals analyzed for monitoring purposes and thus, reduce cost. A systematic risk-based approach was applied to identify chemicals for inclusion in the SSIPL based on the following selection criteria: prevalence, toxicity and exceedance of drinking water limits and/or risk-based criteria.

Developed a site-specific indicator parameter list (SSIPL) for purposes of groundwater monitoring for an eleven-acre Summit National Superfund site, Deerfield Township, Ohio. 1998. There are four aquifers beneath the site and extensive groundwater database was developed over the years as a result of previous field investigations and groundwater monitoring activities. As part of the groundwater monitoring activities, a site-specific indicator parameter list was developed consistent with the requirements of the Consent Order with the USEPA and OEPA. Chemicals were included in the SSIPL based on the exceedance of $1.0E-06$ risk and/or a hazard quotient of 1.0.



TRAINING

Environmental Risk Management

Institute of Risk Management, Toronto, ON, 1996

Analyzing Risks: Science, Assessment and Management

Harvard School of Public Health, Boston, MA, 1998

Cleanup of Contaminated Sites, Guideline Best Practices and Pitfalls to Avoid

Ontario Ministry of the Environment, Toronto, ON, 2000

Mid-America Toxicology Course, Kansas City, Missouri

2003

Building the Scientific Foundation for Mixtures Joint Toxicity and Risk Assessment Meeting, Atlanta, Georgia

2005

Monte Carlo Analysis and Probability-Bounds Analysis, Probabilistic Modeling, Washington, D.C.

2005

Development and Interpretation of Toxicokinetic Data for Risk on Safety Assessment, XI**International Congress of Toxicology Conference, Montreal, Canada**

2007

PROFESSIONAL AFFILIATIONS

Society for Risk Analysis (2002)

Society for Environmental Toxicology and Chemistry (2002)

Society of Toxicology (2002)

Society of Toxicology of Canada (2005)

International Congress of Toxicology (2007)

PUBLICATIONS

Other

Repaso-Subang, T., Phillipps, K. and Brecher, R.W. (2002). Chapter on the "Hazard Assessment of Polychlorinated Terphenyls (PCTs)" to the report "Health Risks of Persistent Organic Pollutants from Long Range Transboundary Air Pollution". Prepared for the World Health Organization (WHO)/United Nations Economic Commission for Europe (UNECE). Participated at the Fifth Meeting of the Joint UNECE/WHO-ECEH Task Force to discuss above, held on May 13 and 14, 2002 in Bonn, Germany.

Repaso-Subang, T., Phillipps, K.A., Hatton, E. and Brecher, R.W. (2005). Review of Existing Approaches for the Risk Assessment of Chemical Mixtures. Prepared



for Health Canada.

Repaso-Subang, T., Phillipps, K.A., Brecher, R.W., Roest, N., and Richardson, M. (2006). Review of Cancer Amortization in Risk Assessment. Prepared for Health Canada.

Repaso-Subang, T., Pearson, R.G., Phillipps, K.A., Hatton, E., Brecher, R.W., Roest, N., and Richardson, M. (2006). Development of a Risk-Based Ranking Scheme for Small-Scale Contaminated Sites. Prepared for Health Canada.

**Education**

M.Sc. Land Resource Science with Toxicology, University of Guelph, Guelph, Ontario, 2012

B.Sc. Tech. (Hons) Applied Pharmaceutical Chemistry Co-op, University of Guelph, Guelph, Ontario, 2006

Certifications

First Aid and CPR, June 22, 2011

Languages

English – Fluent

Golder Associates Ltd. – Mississauga***Environmental Risk Assessor***

Mr. Stephen Cioccio has been an Environmental Risk Assessor at Golder Associates' Mississauga office for over five years. As a member of the Toxicology and Risk Assessment Group, Mr. Cioccio's primary responsibilities include data compilation, statistical calculations, modelling of contaminant uptake by selected pathways, exposure assessment, toxicity characterization and risk calculations for human health and ecological risk assessment of contaminated sites.

Mr. Cioccio has completed numerous risk assessments for a variety of clients in various sectors since joining Golder. These include: risk assessments for regulatory submissions under Ontario Regulation 153/04; due diligence risk assessments for land transactions; and, exposure risk assessments included in environmental assessments for power and mining projects. Mr. Cioccio's main focus has been on human health and ecological risk assessment for brownfield redevelopment. He has been involved in the redevelopment of former gas stations, manufacturing facilities, marine transfer stations and drycleaners into parkland, residential and mixed residential/commercial land use. He has completed risk assessments for sites with various chemicals of concern in both soil and groundwater including metals, petroleum hydrocarbons, volatile organic compounds, polychlorinated biphenyls and polycyclic aromatic hydrocarbons.

Prior to joining Golder, he completed an undergraduate degree in Applied Pharmaceutical Chemistry, Co-op, at the University of Guelph. The degree focused on organic and analytical chemistry, with courses in pharmacology as well as environmental, human and biochemical toxicology. He has completed an M.Sc. degree in Land Resource Science with a focus on toxicology and bioavailability at the University of Guelph. His thesis evaluated the effectiveness of rendering a Nickel impacted agricultural field alkaline with dolomitic limestone to reduce the uptake of nickel into soybean and oat.

Employment History***Golder Associates Ltd. – Mississauga, Ontario***

Environmental Risk Assessor (2008 to Present)

Data compilation, interpretation and analysis in support of environmental and toxicological risk evaluations and assessments; general technical support.

University of Guelph – Guelph, Ontario

Research Assistant (May 2006 to October 2006)

Collected field samples and analyzed them for trace metal concentration, designed and executed greenhouse experiments using soybeans to determine how trace metals compete for uptake into plant roots and worked as part of a team to aid various graduate students with their ongoing research.



McNeil Consumer Healthcare – Guelph, Ontario

Quality Systems Associate (September 2005 to December 2005)

Gained excellent multitasking and problem solving skills as an active member of the Document Control Group as new problems arose daily that needed to be solved quickly. Developed exceptional attention to detail by implementing a variety of documents including SOPs, Test Procedures and Process Orders, and took part in organizing a company wide Good Manufacturing Practice Awareness Campaign and developed the campaign's slogan, "Form an Alliance with Compliance".

Sigma Genosys – Oakville, Ontario

DNA Synthesis/QC Technician (August 2004 to January 2005)

Ran daily start up protocols for all instruments and robots used in lab and maintained all reagents required to operate them, purified synthetic DNA from previous day's production run, performed multiple QC tests, including gel electrophoresis, OD counts using the UV spectrophotometer and interpretation of MALDI -TOF mass-spec data, and developed and ran weekly calibration protocols for liquid handling robots.

Agriculture and Agri-Food Canada – Harrow, Ontario

Virus Indexing Laboratory Technician (January 2004 to May 2004)

Collected, prepared and tested fruit tree tissue samples for the presence of virus using Enzyme Linked Immunosorbent Assay, maintained and developed new databases to facilitate with the organization of the virus test results.



PROJECT EXPERIENCE – BROWNFIELDS

Bayside Development Project
Toronto, Ontario

Golder was retained to prepare a risk assessment under Ontario Regulation 153/04. Proposed land use for the Site is multi-storey, mixed residential/commercial. Major responsibilities included providing technical support for the human health and ecological risk assessment. This project involved coordination with the site investigation and remediation team as well as CAD and GIS to adequately characterize the site conditions. Specific tasks included data management and analysis, preparation and submission of a Pre-Submission Form to the MOE, creating and updating calculation spreadsheets with guidance from senior team members, calculating risks to human and ecological receptors, modeling of volatile contaminants in soil and groundwater, report writing and responding to MOE comments.

Batawa Development Corporation
Batawa, Ontario

Golder was retained to complete a risk assessment under Ontario Regulation 153/04 for the redevelopment of a property located in Eastern Ontario. The proposed land use is mixed residential/commercial. The property owner has proposed to retrofit the existing on-Site building to accommodate commercial and multi-storey residential units. Major responsibilities included providing technical support for the human health and ecological risk assessment. Specific tasks included data management, modeling of volatile contaminants in soil and groundwater, calculating risks to human and ecological receptors, and report writing.

ShawCor
Hamilton, Ontario

Prepared a human health and ecological risk assessment under Ontario Regulation 153/04. The site was being redeveloped from former industrial to commercial use. Contaminants of concern included chlorinated solvents, PAHs, PHCs and metals in soil and groundwater. Risk management measures were recommended to reduce potential exposure at the site.

Cooksville Four Corners
Mississauga, Ontario

Completed a Tier II risk assessment on a former gas station being converted into a parkette. The RA evaluated potential risks to construction workers that may have come into contact with impacted soils during site re-development.

Canada Square
Toronto, Ontario

Completed an Ontario Regulation 153/04 human health and ecological risk assessment for the redevelopment of an industrial/commercial site to a public park on Toronto's waterfront. As the Site was located within 30 metres of Lake Ontario, potential effects to the aquatic environment as a result of groundwater seepage to the lake was evaluated. A risk management plan was developed to limit impacted soil exposure to receptors that may frequent the park. Risk management measures included using both clean fill soil caps and hardscaped surfaces in the design of the park.

Belfield
Toronto, Ontario

Prepared an Ontario Regulation 153/04 pre-submission form and a Tier II risk assessment for re-development of a former industrial site to a church.



Bay Port Development
Midland, Ontario

Human Health and Ecological Risk Assessment for a proposed residential development on the shores of Georgian Bay under Ontario Regulation 153/04. The RA evaluated the potential risks for human and ecological receptors considering a stratified soil approach. Responsibilities included human and ecological receptor identification; exposure pathway identification; and a qualitative risk characterization using the proposed environmental control measures.

Industrial/Commercial Site
Burlington, Ontario

Completed an ecological risk assessment for an industrial/commercial site under Ontario Regulation 153/04. Evaluated risks to aquatic receptors that could be exposed to PHCs in groundwater migrating off the site to a downgradient surface water body. Developed property specific standards that are protective of aquatic ecological receptors and identified risk management measures based on the results of the assessment.

PROJECT EXPERIENCE – TRANSPORTATION

Former Kodak Site
Toronto, Ontario

Golder was retained by Metrolinx to revise the Ontario Regulation 153/04 risk assessment previously prepared by another consultant. Construction of a light rail vehicle storage, maintenance facility and bus terminal is planned for the Site. Project work included incorporating additional analytical data into the risk assessment report and updating the report as per Ministry of the Environment comments.

PROJECT EXPERIENCE – REAL ESTATE

Medical Centre
Stratford, Ontario

Completed an Ontario Regulation 153/04 risk assessment for a medical facility with VOC contamination in soil and groundwater and hydrocarbon contamination in groundwater. Soil vapour sampling was conducted in support of the HHRA to facilitate the evaluation of vapour migration from soil/groundwater to indoor/outdoor air. Vapour transport modeling was conducted using the J&E Model and RISC. A literature search was conducted to identify toxicity benchmarks for VOCs in groundwater for effects on plants. A degradation assessment for the chlorinated solvents in groundwater was included in the estimation of risks to human health and the environment. Risk management measures were proposed.

Truck Yard
Hamilton, Ontario

Completed a human health and ecological risk assessment under Ontario Regulation 153/04 intended to support the filing of a Record of Site Condition ("RSC") for the property based on continued industrial/commercial land use.

Retail Plaza Dry Cleaner
Scarborough, Ontario

Conducted a due diligence human health and ecological risk assessment on behalf of a property management firm. The contaminants of concern are VOCs in soil and groundwater. The RA used soil vapour, sub-slab vapour and indoor air data to determine potential risks associated with vapour migration to indoor air.



PROJECT EXPERIENCE – PROPERTY TRANSFER

Hancock Nursery
Mississauga, Ontario

A Phase II Environmental Site Assessment was undertaken on behalf of the City of Mississauga for the purchase of a former nursery. The intended re-development of the site is to a public park. Results of the Phase II ESA indicted increased concentrations of pesticides in soil and localised petroleum hydrocarbons in groundwater. As a result, remedial excavation of impacted soils and in-situ remediation of groundwater was completed.

Loreland
Mississauga, Ontario

Involved in the preparation of a phase II environmental site assessment, a due diligence risk assessment for a property transaction. Contaminants of concern included PAHs and select metals. The Site was being converted from a former industrial property into a municipal works yard.

**Glass Products
Manufacturer**
Rexdale, Ontario

Golder was retained by Guardian to conduct a due diligence Phase II ESA and risk assessment in preparation of a possible property transaction. Phase II project work included compilation of analytical and field data, data analyses and preparation of figures. Risk assessment project work included technical support on the human health risk assessment. Specific tasks included calculations, vapour intrusion modeling and reporting.

PROJECT EXPERIENCE – MINING

**NICO Cobalt-Gold-
Bismuth-Copper
Project**
NWT, Canada

Technical lead for the terrestrial wildlife risk assessment component of the Environmental Assessment for a proposed open pit mine in the Northwest Territories. Responsibilities include component management and preparation of deliverables. The risk assessment included the assessment of health risks due to construction, operation, and closure of the mine due to metals-impacted environmental media.

Xstrata Copper
Timmins, Ontario

Assessed the need for sediment remediation downstream of the former Kidd Metallurgical site as part of the overall Closure plan for the site. Ecological risk assessment was used to determine what risks were present for both terrestrial and aquatic receptors. Based on marginal predicted risks and upstream sources of contaminants, the recommended option was to leave sediments in place.

**Former Uranium Mine
Sites**
Bancroft, Ontario

Conducted ecological risk assessments (terrestrial and aquatic) for several former uranium mines in northern Ontario. The assessments included extensive environmental sampling campaigns to characterize conventional and radiological impacts to soil, groundwater, surface water and sediments. Plant, fish and small mammal tissues were also collected in support of the risk assessments. An assessment of both non-radiological metals and radionuclides, including uranium and its degradation products was performed. The results of sediment toxicity testing with benthic invertebrates were used as a line of evidence in a weight of evidence approach to characterize risks to benthic invertebrates from contaminated sediments. The risk assessments will be used to inform future management strategies for the sites ensuring the protection of the environment.



Former Uranium Mine Sites
Bancroft, Ontario

Completed field work and technical reports associated with environmental due diligence for obtaining and documenting multi-disciplinary supporting information for the licensing by the CNSC of a decommissioned uranium mine. The field investigations included groundwater and soil investigations of mine and tailings areas as well as surface-water monitoring.

PROJECT EXPERIENCE – PIPELINES

Pipeline Compressor Stations
Ontario, Canada

Completed field work and technical reports for environmental assessments involving soil investigations and groundwater monitoring programs to address and summarize issues of potential environmental concern at numerous compressor stations. The work is completed to manage environmental risks under the provision of regulatory standards.

Pipeline Compressor Stations
Ontario, Canada

Assessed ecological risks due to PCBs, PHCs and metals in creek sediments related to historic discharges from a three pipelines compressor stations under Ontario Regulation 153/04. Risks due to PCBs were assessed through a field program to assess the environmental concentrations to which biota could be exposed, the concentrations in fish tissues in order to provide a measure of the biological availability of PCBs from sediments and direct toxicity testing using benthic invertebrates to assess potential toxicity of PCBs. Ecological risks due to PHCs were assessed through sediment bioassay tests. Ecological risks due to metals was conducted through comparison of metal concentrations in sediments to effects data from laboratory toxicity tests using sediments collected at metals-contaminated sites in Ontario, conducted by the MOE using the MOE sediment bioassay protocol.

PROJECT EXPERIENCE – WASTE

Toronto Public Health
Ontario, Canada

Comparison of two proposed mixed waste technologies to reduce the amount of mixed waste entering a landfill. A Pre-Screening Health Determinants decision tool was developed to aid in the assessment. The Pre-Screening decision tool was designed to prioritize site and technology options on the basis of their potential impacts on determinants of health consistent with those identified in the HIA Screening Tool for the Toronto Public Health. The Pre-Screening Health Determinants decision tool is intended to help narrow the number of technologies and sites by eliminating those options that are not compatible with the objectives and requirements of the study.

Eastview Landfill
Guelph, Ontario

Conducted a risk assessment for the potential re-development of a closed landfill site and bufferlands into a park. Included a human health risk assessment based on environmental exposure as well as consideration of health and safety risks associated with landfill infrastructure.



PROJECT EXPERIENCE – POWER

Ontario Power Generation
Darlington, Ontario

Conducted an assessment of potential thermal effects on round whitefish from once-through cooling water at the Darlington Nuclear Generating Station. The assessment considered reference values from empirical studies on round whitefish embryos together with detailed temperature data. The assessment found that temperatures that could adversely affect larval development were confined to the immediate area of the diffuser, and that no measurable effects on populations were likely to occur.

Sithe Global
Ontario, Canada

Human Health and Ecological Risk Assessment for a proposed 350 MW natural gas peaking station. Modeled air concentrations based on predicted emissions were compared to health-based air concentration benchmarks to determine potential health risks to neighbouring communities and habitats. Responsibilities included identification and risk calculations for ecological receptors.

Northland Power
Ontario, Canada

Human Health and Ecological Risk Assessment for a proposed 850 MW combined cycle, natural gas-fired electricity generating station. Modeled air concentrations based on predicted emissions, as well as ambient air quality, were compared to health-based air concentration benchmarks to determine potential health risks to neighbouring communities and habitats. Responsibilities included identification of potential receptors, risk calculations and presentation of results at a public open house.

PROJECT EXPERIENCE – OIL & GAS

Oil Sands Expansion
Alberta, Canada

Completed literature review and information sheets on potential water quality issues raised by regulators during EIA review. The information sheets will be used by Senior consultants throughout the course of the public hearings regarding the potential mine expansion.

Former Gas Station
Niagara Falls, Ontario

Participated in a Ontario Regulation 153/04 risk assessment for a former gas station with PHC and BTEX impacts in soil and groundwater. Completed the human health and ecological assessment calculations including chemical screening, exposure pathway identification, chemical modelling, exposure assessment, toxicity assessment and risk characterization.

PROJECT EXPERIENCE – AIR QUALITY

Ontario, Canada

A review of the toxicological basis of the O. Reg. 419/05 ambient air quality criteria (AAQC) for nickel was carried out on behalf of Vale Inco. A review of the available jurisdictional air standards for these metals was conducted to determine whether the toxicological basis of the draft AAQCs proposed in the Ontario Regulation are consistent with those of other jurisdictions. This review included a summary of the study design, methodology, and endpoints used to derive the jurisdictional standards.



PROJECT EXPERIENCE – RISK ASSESSMENT - SITE SPECIFIC GUIDELINE DEVELOPMENT

**Shamrock - City of
London**
Ontario, Canada

Conducted literature and Internet search for established toxicological data for the herbicide Trifluralin. A conceptual site model (CSM) was developed to identify potential receptors and routes of exposure to Trifluralin. Site specific guidelines were established based on risk calculations using the toxicological and CSM data.

PROFESSIONAL AFFILIATIONS

Member, Society of Environmental Toxicology and Chemistry

PUBLICATIONS

Conference Proceedings

Cioccio, Stephen, Beverley Hale and Tereza Dan. 2007. *Port Colborne Field Trial of Limestone and Manganese Application to Agricultural Land to Reduce Nickel Toxicity in Field Crops*. Mining and the Environment Conference, October. Sudbury, Canada.

Other

Cioccio, S. 2008 Evaluation of Dolomitic Limestone Applications to Nickel Contaminated Land to Mitigate Nickel Uptake in Field Crops. Presented at the Golder Associates Site Investigation and Remediation Technical Network Conference, Calgary AB, November 2008

Cioccio, S. and B. Hale. 2008 Limestone Application to Agricultural Land in Port Colborne Ontario to Reduce Nickel Toxicity of Crops. Presented at the 5th SETAC World Conference, Sydney Australia, August 2008.

Cioccio, S. and B. Hale. 2007. Does the CaCl₂ Extractable Ni from Field Soil Relate to Phytotoxicity? Poster presented at the SETAC North America 28th Annual Meeting, Milwaukee WI, November 2007.



Education

*B.A.Sc. (Honours), Co-operative Program
Environmental Engineering,
University of Waterloo,
Waterloo, Ontario, 2008*

Languages

French – Fluent

English – Fluent

Golder Associates Ltd. – Windsor

Environmental Consultant

Lane is an Environmental Consultant with over five years of experience in the environmental engineering field. He is experienced in; managing and conducting Phase I and Phase II Environmental Site Assessments (ESAs) and remediations on a variety of active and vacant industrial, commercial, public properties; conducting designated substance identification and management; and the operation and maintenance of small drinking water treatment systems and in-situ remedial technology applications.

Lane has written and compiled detailed reports for senior review outlining and interpreting environmental site investigation findings and recommending subsequent courses of action.

Currently, Lane's responsibilities relate primarily to the project management, implementation and reporting of various ESAs and environmental compliance related projects.

Employment History

Golder Associates Ltd. – Windsor, Ontario

Environmental Consultant / Project Manager (2011 to Present)

Manage, coordinate and conduct environmental investigation and reporting activities at multiple sites in southern Ontario, including active and inactive heavy industrial and commercial facilities. Implement procedures and work programs to satisfy requirements of applicable provincial and federal environmental regulations, such as Ontario Regulation 153/04, Records of Site Condition (O.Reg. 153/04), under the Environmental Protection Act. Develop work proposals and budgets for anticipated project activities, and continuously track and compare costs and work progress to facilitate timely and profitable project completion.

SNC-Lavalin Environment (formerly Aqua Terre Solutions Inc.) – Toronto, Ontario

Engineer-In-Training/Environmental Scientist (2009 to 2011)

Manage, coordinate and conduct environmental investigation and reporting activities and associated, regulatory approved, contaminant management plans at multiple sites in southern Ontario, including a bulk fuels distribution facility and various retail fuel facilities for a major petroleum client. Implement procedures and work programs to satisfy requirements of applicable provincial and federal environmental regulations, such as Ontario Regulation 153/04, Records of Site Condition (O.Reg. 153/04), under the Environmental Protection Act. Identify and select contractors and prepare associated contracts to complete required work programs. Liaise with clients to continuously ensure expectations are met or exceeded. Act as mentor to junior staff. Assist senior management with business development initiatives, including promoting further available services to existing clients and providing positive business exposure to potential clients. Ensure applicable in-house and client health and safety protocols and procedures are identified and initiated during project planning stages, and are implemented and



observed by all staff throughout project execution.

Aqua Terre Solutions Inc. – Toronto, Ontario

Field Technician/Environmental Scientist (2008 to 2009)

Completed a variety of environmental field investigations, sampling activities, data interpretation and the preparation of related reports. Performed numerous sampling techniques and collected samples of a variety of media, including: designated substances, groundwater, surface water, potable water, soil, sediment and air. Assisted with the operation, monitoring and maintenance of several types of soil and groundwater remediation technologies.

Algonquin Power Systems Inc. – Oakville, Ontario

Environmental Engineering Assistant (2007 to 2007)

Assisted with air emissions database management and associated regulatory reporting for landfill-gas-to-energy facilities.

Hydro One Networks Inc. – Toronto, Ontario

Co-Op Student (2006 to 2006)

Designed and configured a semi-automated spreadsheet in order to determine the available storage capacities in existing transformer stations, to minimize the quantity and complexity of required new facilities.

Stantec Consulting Ltd. – Windsor, Ontario

Engineer-In-Training/Junior Inspector (2004 to 2006)

Gained municipal engineering experience while acting as a third-party inspector for road reconstruction and resurfacing activities, water line installation, trunk sanitary and storm sewer installation and bridge construction activities. Participated in design initiatives for water and waste-water collection systems and associated treatment facilities.



PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**Various Industrial and
Commercial Sites**
Ontario, Canada

Managed, coordinated and conducted numerous Phase I and II ESAs throughout Ontario. Duties included project management, preparation of cost estimates for senior review, historical research, site reconnaissance, conducting field work programs involving soil sampling, installation of groundwater monitoring wells, collection of groundwater samples, data evaluation and preparation of reports, and liaison with site representatives and subcontractors.
Supervised groundwater monitoring well installations. Completed monitoring well development and subsequent sampling.



PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT



**Various Bulk and
Retail Fuel Facilities**
Various, Canada

Managed, coordinated and conducted Phase II ESA activities for various sites involving the installation of numerous groundwater quality monitoring wells to characterize on-site groundwater quality and potential influence from off-site sources. Supervised well installation activities, conducted subsequent monitoring well development and water quality sampling. Carried out groundwater sampling using various techniques including low-flow sampling (peristaltic and/or bladder pumps). Conducted various hydrogeological test including rapid bail-down tests, bail-down tests and radius of influence monitoring.

Managed, coordinated and conducted field investigations, data interpretation, and reporting activities for multiple projects involving groundwater and surface water sampling; potable water system operation and oversight; borehole drilling, test pitting, remedial excavation, and associated soil sampling; and monitoring well installation. Contaminants of concern have included: petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, herbicides, pesticides, polychlorinated biphenyls, metals and other inorganics, and microbiological parameters. Safely implemented various work programs on provincial and municipal roadways through the acquisition of applicable permits and the implementation of comprehensive health and safety programs.

Provided project management assistance, while supervising and directing remediation contractors retained to complete remedial excavations of petroleum hydrocarbon impacted soil at multiple former retail fuel facilities, in order to restore the sites to acceptable environmental conditions prior to property transfer or site redevelopment.

Provided project management and coordination relating to the operation of regulated small drinking water systems located at various 'posted' and 'non-posted' service station facilities throughout Ontario, for activities including: system monitoring and maintenance, water sampling, and ensuring applicable compliance and reporting obligations were fulfilled. Conducted associated site operator/attendant training for related water and sewage system infrastructure operation and maintenance activities and completed subsequent compliance audits to ensure adherence to procedures.

Supervised and conducted biostimulation injections and trend monitoring for indicator parameters of the natural attenuation of hydrocarbon impacts at various petroleum hydrocarbon impacted former retail fuel sites.

Undertook maintenance, performance monitoring, and evaluation of various remedial technologies, including: soil-vapour-extraction and air-sparge systems, pump and treat systems, in-situ biostimulation, and in-situ submerged oxygen-injecting curtain systems at active and decommissioned retail fuel facilities.

Completed monitoring and sampling of a portable granular activated carbon water treatment system, installed to treat effluent water used for a leak-test of a large above ground fuel storage tank, before discharging into municipal sewers at an operating petroleum distribution terminal, following tank repairs.

Completed air sampling programs at multiple industrial facilities for various contaminants, including: volatile organic compounds, tetraethyl lead, and silica.



TRAINING

Communication Basics

Golder U (Internal), 2012

Conceptual Site Models

Golder U (Internal), 2012

Transportation of Dangerous Goods

2006

Site Supervisor Training

Construction Safety Association of Ontario, Toronto, Ontario, 2010

Standard First-Aid Level C CPR

Red Cross, Windsor, 2012

Confined Space Awareness, Fall Awareness and Petroleum Oriented Safety Training

Toronto, Ontario, 2010

PROFESSIONAL AFFILIATIONS

Professional Engineers Ontario

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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Mississauga, Ontario, L5N 7K2
Canada
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DATE May 6, 2015**PROJECT No.** 1520609-TM02**TO** Dan Krutsch, P.Eng.
Landmark Engineers Inc.**CC** Mr. John Henderson, P.Eng.
Essex Region Conservation Authority**FROM** Lane Chevalier, P.Eng.**EMAIL** Lane_Chevalier@golder.com**GRAND MARAIS DRAIN IMPROVEMENTS
FILTRATE WATER ANALYTICAL RESULTS
WINDSOR, ONTARIO**

Golder Associates Ltd. ("Golder") was retained by Landmark Engineers Inc. (referred to herein as "Landmark" or the "Client") to provide consulting services in support of the implementation of a sediment management strategy for a segment of the Grand Marais Drain ("Drain") near the intersection of Howard Avenue and E.C. Row Expressway in Windsor, Ontario (referred to hereinafter as "the Site"). The work is being conducted as part of the Grand Marais Drain Flood Control Improvement project, which is being managed by Landmark on behalf of the Essex Region Conservation Authority (ERCA) and the City of Windsor ("the City").

Background and Scope of Work

It is understood that, in March 2015, Landmark collected a sample of the sediment material from the open segment of the Grand Marais Drain immediately west of Howard Avenue and south of EC Row Expressway in the area where the sediment removal activities have been proposed and that the sample was shipped to Trimatrix Laboratories, Inc. ("Trimatrix") of Grand Rapids, Michigan. The sediment sample was then placed within the Geotube™ material (which is being proposed for use as sediment containment at the Site) and the filtrate water passing through the Geotube™ material was collected for analysis of the following parameters listed under Ontario Regulation (O.Reg.) 153/04: metals, volatile organic compounds (VOCs), petroleum hydrocarbon (PHC) fractions F1 to F4, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). The analyses were performed by Trimatrix and ALS Environmental Laboratories of London, Ontario.

Selection of Criteria/Standards

Following the proposed hydraulic dredging of the sediment material and placement in Geotubes™ at the Site, a relatively rapid dewatering of the Geotubes™ is expected to occur and related water from this process may enter the Grand Marais Drain at the Site. The Grand Marais Drain is understood to be a municipal drain. Consequently, the noted analytical results were compared to City of Windsor Storm Water By-Law criteria



(By-Law Number 11446 passed May 17, 1993, amended July 22, 2002). We have also provided the Ontario Ministry of the Environment (MOE) Table 3 non-potable groundwater criteria for comparison purposes, where no related Storm Water By-Law criterion is available.

Filtrate Water Results

Sediment material which is impacted to a similar degree as that being removed as part of the proposed sediment removal activities is expected to continue to remain in place within the Grand Marais Drain upstream and downstream of the area proposed to be dredged and relocated into the Geotubes™. Based on the remaining presence of impacted sediment in the drain, it is inferred that the filtrate water from the Geotubes™ would not be expected to have a significant impact on the water quality in the drain.

Further details are included in the attached tables. The laboratory Certificates of Analysis are also attached.

We trust that this information is sufficient for your present purposes. If we can be of additional assistance in this regard, please contact the undersigned directly.



Lane Chevalier, P.Eng.
Environmental Engineer



Keith G. Lesarge, M.Sc., P.Geo.
Principal, Senior Environmental Scientist

LC/JC/KGL/ap/rm

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Table I
Analytical Results for Metals and Inorganics in Filtrate Water Samples
Grand Marais Drain
Windsor, Ontario

Sample Identification:				Filtrate	
Sample Date:				26-Mar-2015	
Parameter	Units	MOE Table 3 Standards	City of Windsor Storm Water By-Law	Reporting Limit	
Antimony	µg/L	20000	--	1.0	<1.0
Aluminum	µg/L	--	5000	--	--
Ammonias (Unionized)	µg/L	--	200	--	--
Arsenic	µg/L	1900	500	1.0	2.3
Barium	µg/L	29000	500	10	220
Beryllium	µg/L	67	--	1.0	<1.0
Boron	µg/L	45000	--	50	150
Cadmium	µg/L	2.7	100	0.20	0.35
Chlorine	µg/L	--	1000	--	--
Chromium	µg/L	810	1000	1.0	3.1
Chromium VI	mg/L	140	--	1.0	<1.0
Cobalt	µg/L	66	--	1.0	2.6
Copper	µg/L	87	1000	1.0	4.1
Cyanide	µg/L	66	100	--	--
Fluoride	µg/L	400	1000	--	--
Iron	µg/L	--	5000	--	--
Lead	µg/L	25	1000	5.0	<5.0
Manganese	µg/L	--	1000	--	--
Mercury	µg/L	2.8	1.0	0.20	<0.20
Molybdenum	µg/L	9200	--	1.0	13
Nickel	µg/L	490	1000	1.0	5.0
Phosphorus	µg/L	--	1000	--	--
Selenium	µg/L	63	1000	1.0	1.3
Silver	µg/L	1.5	1000	0.20	<0.20
Sulphate	µg/L	--	150000	--	--
Thallium	µg/L	510	--	1.0	<1.0
Tin	µg/L	--	1000	--	--
Uranium	µg/L	420	--	5.0	<5.0
Vanadium	µg/L	250	--	1.0	1.4
Zinc	µg/L	1100	1000	10	22

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/L	Micrograms per Litre.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial/Commercial/Community Property Use for medium to fine textured soil (April 15, 2011).
Storm Water By-Law	By-Law Number 11446, A By-Law to Prohibit, Regulate and Inspect the Discharge of Sewage into the Municipal Sewerage System in the City of Windsor, May 17, 1993, amended July 22, 2002.
21	Concentration exceeding the MOE Table 3 Standard.
21	Concentration exceeding the City of Windsor Storm Water By-Law.
	Table to be read in conjunction with accompanying report.

Table II
Analytical Results for Volatile Organic Compounds in Filtrate Water Samples
Grand Marais Drain
Windsor, Ontario

Sample Identification:				Filtrate	
Parameter	Units	MOE Table 3 Standards	City of Windsor Storm Water By-Law	Reporting Limit	Sample Date: 26-Mar-2015
Acetone	µg/L	130000	--	5.0	7.7
Benzene	µg/L	430	--	1.0	<1.0
Bromodichloromethane	µg/L	85000	--	1.0	<1.0
Bromoform	µg/L	770	--	1.0	<1.0
Bromomethane	µg/L	56	--	1.0	<1.0
Carbon Tetrachloride	µg/L	8.4	--	1.0	<1.0
Chlorobenzene	µg/L	630	--	1.0	<1.0
Chloroform	µg/L	22	--	1.0	<1.0
Dibromochloromethane	µg/L	82000	--	1.0	<1.0
1,2-Dibromoethane	µg/L	0.83	--	1.0	<1.0
1,2-Dichlorobenzene	µg/L	9600	--	1.0	<1.0
1,3-Dichlorobenzene	µg/L	9600	--	1.0	<1.0
1,4-Dichlorobenzene	µg/L	67	--	1.0	<1.0
Dichlorodifluoromethane	µg/L	4400	--	1.0	<1.0
1,1-Dichloroethane	µg/L	3100	--	1.0	<1.0
1,2-Dichloroethane	µg/L	12	--	1.0	<1.0
1,1-Dichloroethylene	µg/L	17	--	1.0	<1.0
Cis-1,2-Dichloroethylene	µg/L	17	--	1.0	<1.0
Trans-1,2-Dichloroethylene	µg/L	17	--	1.0	<1.0
1,2-Dichloropropane	µg/L	140	--	1.0	<1.0
Cis-1,3-Dichloropropylene	µg/L	45	--	1.0	<1.0
Trans-1,3-Dichloropropylene	µg/L	45	--	1.0	<1.0
Ethylbenzene	µg/L	2300	--	1.0	<1.0
Hexane	µg/L	520	--	1.0	<1.0
Methyl-t-Butyl Ether	µg/L	1400	--	1.0	<1.0
Methylene Chloride	µg/L	5500	--	1.0	<1.0
2-Butanone (MEK)	µg/L	1500000	--	5.0	<5.0
4-Methyl-2-pentanone (MIBK)	µg/L	580000	--	5.0	<5.0
Styrene	µg/L	9100	--	1.0	<1.0
1,1,1,2-Tetrachloroethane	µg/L	28	--	1.0	<1.0
1,1,2,2-Tetrachloroethane	µg/L	15	--	1.0	<1.0
Tetrachloroethylene	µg/L	17	--	1.0	<1.0
Toluene	µg/L	18000	--	1.0	<1.0
1,1,1-Trichloroethane	µg/L	6700	--	1.0	<1.0
1,1,2-Trichloroethane	µg/L	30	--	1.0	<1.0
Trichloroethylene	µg/L	17	--	1.0	<1.0
Trichlorofluoromethane	µg/L	2500	--	1.0	<1.0
Vinyl Chloride	µg/L	1.7	--	1.0	<1.0
m-Xylene & p-Xylene	µg/L	--	--	2.0	<2.0
o-Xylene	µg/L	--	--	1.0	<1.0
Total Xylenes	µg/L	4200	--	3.0	<3.0

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/L	Micrograms per Litre.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial/Commercial/Community Property Use for medium to
Storm Water By-Law	By-Law Number 11446, A By-Law to Prohibit, Regulate and Inspect the Discharge of Sewage into the Municipal Sewerage System in the City of Windsor, May 17, 1993, amended July 22, 2002.
21	Concentration exceeding the MOE Table 3 Standard.
21	Concentration exceeding the City of Windsor Storm Water By-Law.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.

Table III
Analytical Results for Petroleum Hydrocarbons and BTEX in Filtrate Water Samples
Grand Marais Drain
Windsor, Ontario

Sample Identification:				Filtrate	
Sample Date:				26-Mar-2015	
Parameter	Units	MOE Table 3 Standards	City of Windsor Storm Water By-Law	Reporting Limit	
Benzene	µg/L	430	--	0.20	<1.0
Toluene	µg/L	18000	--	0.20	<1.0
Ethylbenzene	µg/L	2300	--	0.20	<1.0
Total Xylenes	µg/L	4200	--	0.40	<3.0
F1 (C6-C10) - BTEX	µg/L	750	--	25	<25
F2 (C10-C16)	µg/L	150	--	100	350
F3 (C16-C34)	µg/L	500	--	250	<250
F4 (C34-C50)	µg/L	500	--	250	<250

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/L	Micrograms per Litre
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial/Commercial/Community Property Use for medium to fine textured soil (April 15, 2011).
Storm Water By-Law	By-Law Number 11446, A By-Law to Prohibit, Regulate and Inspect the Discharge of Sewage into the Municipal Sewerage System in the City of Windsor, May 17, 1993, amended July 22, 2002.
21	Concentration exceeding the MOE Table 3 Standard.
21	Concentration exceeding the City of Windsor Storm Water By-Law.
	Xylenes (Total) represents the sum of p+m- and o-xylenes.
	PHC F1 (C6-10) values do not include BTEX.
	PHC F2 (>C10-C16) values do not include Naphthalene.
	PHC F3 (>C16-C34) values do not include PAHs.
	Table to be read in conjunction with accompanying report.

Table IV
Analytical Results for Polychlorinated Biphenyls in Filtrate Water Samples
Grand Marais Drain
Windsor, Ontario

Sample Identification:				Filtrate	
Parameter	Units	MOE Table 3 Standards	City of Windsor Storm Water By-Law	Reporting Limit	Sample Date:
					26-Mar-2015
PCB-1016	µg/L	--	--	0.20	<0.20
PCB-1221	µg/L	--	--	0.20	<0.20
PCB-1232	µg/L	--	--	0.20	<0.20
PCB-1242	µg/L	--	--	0.20	<0.20
PCB-1248	µg/L	--	--	0.20	<0.20
PCB-1254	µg/L	--	--	0.20	<0.20
PCB-1260	µg/L	--	--	0.20	<0.20

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/L	Micrograms per Litre.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial/Commercial/Community Property Use for Storm Water By-Law Number 11446, A By-Law to Prohibit, Regulate and Inspect the Discharge of Sewage into the Municipal Sewerage System in the City of Windsor, May 17, 1993, amended July 22, 2002.
21	Concentration exceeding the MOE Table 3 Standard.
21	Concentration exceeding the City of Windsor Storm Water By-Law.
	Table to be read in conjunction with accompanying report.

Table V
Analytical Results for Polycyclic Aromatic Hydrocarbons in Filtrate Water Samples
Grand Marais Drain
Windsor, Ontario

Sample Identification:				Filtrate	
Sample Date:				26-Mar-2015	
Parameter	Units	MOE Table 3 Standards	City of Windsor Storm Water By-Law	Reporting Limit	
Acenaphthene	µg/L	1700	--	0.50	<0.50
Acenaphthylene	µg/L	1.8	--	0.50	<0.50
Anthracene	µg/L	2.4	--	0.50	<0.50
Benzo(a)anthracene	µg/L	4.7	--	0.50	<0.50
Benzo(a)pyrene	µg/L	0.81	--	0.50	<0.50
Benzo(b)fluoranthene	µg/L	0.75	--	0.50	<0.50
Benzo(k)fluoranthene	µg/L	0.4	--	0.50	<0.50
Benzo(ghi)perylene	µg/L	0.2	--	0.50	<0.50
Chrysene	µg/L	1.0	--	0.50	<0.50
Dibenzo(a,h)anthracene	µg/L	0.52	--	0.50	<0.50
Fluoranthene	µg/L	130	--	0.50	<0.50
Fluorene	µg/L	400	--	0.50	<0.50
Indeno(1,2,3-cd)pyrene	µg/L	0.2	--	0.50	<0.50
1-Methylnaphthalene	µg/L	1800	--	0.50	<0.50
2-Methylnaphthalene	µg/L	1800	--	0.50	<0.50
Naphthalene	µg/L	6400	--	0.50	<0.50
Phenanthrene	µg/L	580	--	0.50	<0.50
Pyrene	µg/L	68	--	0.50	<0.50

Notes

--	Not analyzed or not applicable.
<	Less than reported detection limit as indicated.
µg/L	Micrograms per Litre.
MOE Table 3 Standards	Ministry of the Environment Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Industrial/Commercial/Community Property Use for
Storm Water By-Law	By-Law Number 11446, A By-Law to Prohibit, Regulate and Inspect the Discharge of Sewage into the Municipal Sewerage System in the City of
21	Concentration exceeding the MOE Table 3 Standard.
21	Concentration exceeding the City of Windsor Storm Water By-Law.
mbgs	Metres below ground surface.
	Table to be read in conjunction with accompanying report.



April 09, 2015

WATERSOLVE, LLC
Attn: Doug Walker
5031 68th St. SE
Calendonia, MI 49316

Project: Filtrate Project

Dear Doug Walker,

Enclosed is a copy of the laboratory report for the following work order(s) received by TriMatrix Laboratories:

Work Order	Received	Description
1503390	03/26/2015	Laboratory Services

This report relates only to the sample(s) as received. Test results are in compliance with the requirements of the National Environmental Laboratory Accreditation Program (NELAP) and/or one of the following certification programs:

ACLASS DoD-ELAP/ISO17025 (#ADE-1542); Arkansas DEP (#88-0730/13-049-0); Florida DEP (#E87622-24); Georgia EPD (#E87622-24); Illinois DEP (#200026/003329); Kansas DPH (#E-10302); Kentucky DEP (#0021); Louisiana DEP (#103068); Michigan DPH (#0034); Minnesota DPH (#491715); New York ELAP (#11776/48855); North Carolina DNRE (#659); Virginia DCLS (#460153/2592); Wisconsin DNR (#999472650); USDA Soil Import Permit (#P330-12-00236).

Any qualification or narration of results, including sample acceptance requirements and test exceptions to the above referenced programs, is presented in the Statement of Data Qualifications and Project Technical Narrative sections of this report. Estimates of analytical uncertainties and certification documents for the test results contained within this report are available upon request.

If you have any questions or require further information, please do not hesitate to contact me.

Sincerely,

James D. McFadden
Project Chemist



PROJECT TECHNICAL NARRATIVE(s)

Polychlorinated Biphenyls (PCBs) by EPA Method 8082A

Narrative: Due to sample volumes, batch matrix quality control (QC) was not performed for this analysis. A Method Blank and Laboratory Control Sample comprise the batch QC.

Analysis: USEPA-8082A

Sample/Analyte: 1503390-01 Filtrate



PROJECT TECHNICAL NARRATIVE(s)

Semivolatile Organic Compounds by EPA Method 8270C

Narrative: Due to sample volumes, batch matrix quality control (QC) was not performed for this analysis. A Method Blank and Laboratory Control Sample comprise the batch QC.

Analysis: USEPA-8270C

Sample/Analyte: 1503390-01 Filtrate

Narrative: Manual integration was required on the analytes listed below. All manual integrations were performed and reviewed in accordance with TriMatrix laboratory policy.

Analysis: USEPA-8270C

Sample/Analyte: 1503390-01 Filtrate

Naphthalene



PROJECT TECHNICAL NARRATIVE(s)

Total Metals by EPA 6000/7000 Series Methods

Narrative: Due to sample matrix-related Internal Standard failure, the sample was reanalyzed at dilution. The RL for this analyte has been elevated.

Analysis: USEPA-6020A

Sample/Analyte:	1503390-01 Filtrate	Lead
	1503390-01 Filtrate	Uranium

Narrative: The CRL recovery for this analyte was outside of the laboratory control limits.

Analysis: USEPA-6020A

5D08026-CRL1	Antimony
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STATEMENT OF DATA QUALIFICATIONS

Volatile Organic Compounds by EPA Method 8260B

Qualification: The corresponding CCV for this analytical batch had a recovery exceeding the upper control limit of the method. A positive result for this analyte in any associated samples are considered estimated. Non-detectable results are not qualified.

Analysis: USEPA-8260B

Sample/Analyte: 1503390-01

Filtrate

Bromomethane



STATEMENT OF DATA QUALIFICATIONS

Total Metals by EPA 6000/7000 Series Methods

Qualification: The LCS recovery exceeded the upper control limit. Positive results for this analyte in all samples in the associated QC batch are considered estimated. Non-detectable results are not qualified.

Analysis: USEPA-6020A

Sample/Analyte: 1503390-01

Filtrate

Antimony



STATEMENT OF DATA QUALIFICATIONS

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Qualification: The MS and/or MSD recovery was outside the laboratory or method control limit.

Analysis: USEPA-7196A

Sample/Analyte: 1503390-01

Filtrate

Chromium, Hexavalent



ANALYTICAL REPORT

Client: **WATERSOLVE, LLC**
 Project: Filtrate Project
 Client Sample ID: **Filtrate**
 Lab Sample ID: **1503390-01**
 Matrix: Water
 Unit: ug/L
 Dilution Factor: 1
 QC Batch: 1502849

Work Order: **1503390**
 Description: Laboratory Services
 Sampled: 03/26/15 10:00
 Sampled By: Doug Walker
 Received: 03/26/15 12:00
 Prepared: 03/30/15 12:06 By: ALK
 Analyzed: 04/02/15 16:39 By: MSZ
 Analytical Batch: 5D03016

Polychlorinated Biphenyls (PCBs) by EPA Method 8082A

CAS Number	Analyte	Analytical Result	RL
12674-11-2	PCB-1016	<0.20	0.20
11104-28-2	PCB-1221	<0.20	0.20
11141-16-5	PCB-1232	<0.20	0.20
53469-21-9	PCB-1242	<0.20	0.20
12672-29-6	PCB-1248	<0.20	0.20
11097-69-1	PCB-1254	<0.20	0.20
11096-82-5	PCB-1260	<0.20	0.20

<i>Surrogates:</i>	<i>% Recovery</i>	<i>Control Limits</i>
<i>Decachlorobiphenyl</i>	<i>81</i>	<i>52-139</i>
<i>Tetrachloro-m-xylene</i>	<i>78</i>	<i>26-118</i>



ANALYTICAL REPORT

Client:	WATERSOLVE, LLC	Work Order:	1503390
Project:	Filtrate Project	Description:	Laboratory Services
Client Sample ID:	Filtrate	Sampled:	03/26/15 10:00
Lab Sample ID:	1503390-01	Sampled By:	Doug Walker
Matrix:	Water	Received:	03/26/15 12:00
Unit:	ug/L	Prepared:	03/27/15 07:00 By: DLV
Dilution Factor:	1	Analyzed:	03/31/15 03:17 By: DLV
QC Batch:	1502874	Analytical Batch:	5C31010

Volatile Organic Compounds by EPA Method 8260B

CAS Number	Analyte	Analytical Result	RL
67-64-1	Acetone	7.7	5.0
71-43-2	Benzene	<1.0	1.0
75-27-4	Bromodichloromethane	<1.0	1.0
75-25-2	Bromoform	<1.0	1.0
*74-83-9	Bromomethane	<1.0	1.0
56-23-5	Carbon Tetrachloride	<1.0	1.0
108-90-7	Chlorobenzene	<1.0	1.0
67-66-3	Chloroform	<1.0	1.0
124-48-1	Dibromochloromethane	<1.0	1.0
106-93-4	1,2-Dibromoethane	<1.0	1.0
95-50-1	1,2-Dichlorobenzene	<1.0	1.0
541-73-1	1,3-Dichlorobenzene	<1.0	1.0
106-46-7	1,4-Dichlorobenzene	<1.0	1.0
75-71-8	Dichlorodifluoromethane	<1.0	1.0
75-34-3	1,1-Dichloroethane	<1.0	1.0
107-06-2	1,2-Dichloroethane	<1.0	1.0
75-35-4	1,1-Dichloroethene	<1.0	1.0
156-59-2	cis-1,2-Dichloroethene	<1.0	1.0
156-60-5	trans-1,2-Dichloroethene	<1.0	1.0
78-87-5	1,2-Dichloropropane	<1.0	1.0
10061-01-5	cis-1,3-Dichloropropene	<1.0	1.0
10061-02-6	trans-1,3-Dichloropropene	<1.0	1.0
100-41-4	Ethylbenzene	<1.0	1.0
110-54-3	Hexane	<10	10
1634-04-4	Methyl tert-Butyl Ether	<1.0	1.0
75-09-2	Methylene Chloride	<1.0	1.0
78-93-3	2-Butanone (MEK)	<5.0	5.0
108-10-1	4-Methyl-2-pentanone (MIBK)	<5.0	5.0
100-42-5	Styrene	<1.0	1.0

Continued on next page

*See Statement of Data Qualifications



ANALYTICAL REPORT

Client:	WATERSOLVE, LLC	Work Order:	1503390
Project:	Filtrate Project	Description:	Laboratory Services
Client Sample ID:	Filtrate	Sampled:	03/26/15 10:00
Lab Sample ID:	1503390-01	Sampled By:	Doug Walker
Matrix:	Water	Received:	03/26/15 12:00
Unit:	ug/L	Prepared:	03/27/15 07:00 By: DLV
Dilution Factor:	1	Analyzed:	03/31/15 03:17 By: DLV
QC Batch:	1502874	Analytical Batch:	5C31010

Volatile Organic Compounds by EPA Method 8260B (Continued)

CAS Number	Analyte	Analytical Result	RL
630-20-6	1,1,1,2-Tetrachloroethane	<1.0	1.0
79-34-5	1,1,2,2-Tetrachloroethane	<1.0	1.0
127-18-4	Tetrachloroethene	<1.0	1.0
108-88-3	Toluene	<1.0	1.0
71-55-6	1,1,1-Trichloroethane	<1.0	1.0
79-00-5	1,1,2-Trichloroethane	<1.0	1.0
79-01-6	Trichloroethene	<1.0	1.0
75-69-4	Trichlorofluoromethane	<1.0	1.0
75-01-4	Vinyl Chloride	<1.0	1.0
179601-23-1	Xylene, Meta + Para	<2.0	2.0
95-47-6	Xylene, Ortho	<1.0	1.0
1330-20-7	Xylene (Total)	<3.0	3.0

Surrogates:	% Recovery	Control Limits
<i>Dibromofluoromethane</i>	100	85-118
<i>1,2-Dichloroethane-d4</i>	105	87-122
<i>Toluene-d8</i>	97	85-113
<i>4-Bromofluorobenzene</i>	97	82-110



ANALYTICAL REPORT

Client:	WATERSOLVE, LLC	Work Order:	1503390
Project:	Filtrate Project	Description:	Laboratory Services
Client Sample ID:	Filtrate	Sampled:	03/26/15 10:00
Lab Sample ID:	1503390-01	Sampled By:	Doug Walker
Matrix:	Water	Received:	03/26/15 12:00
Unit:	ug/L	Prepared:	03/31/15 10:14 By: ALK
Dilution Factor:	1	Analyzed:	04/03/15 13:17 By: ASC
QC Batch:	1502854	Analytical Batch:	5D06015

Semivolatile Organic Compounds by EPA Method 8270C

CAS Number	Analyte	Analytical Result	RL
83-32-9	Acenaphthene	<0.50	0.50
208-96-8	Acenaphthylene	<0.50	0.50
120-12-7	Anthracene	<0.50	0.50
56-55-3	Benzo(a)anthracene	<0.50	0.50
50-32-8	Benzo(a)pyrene	<0.50	0.50
205-99-2	Benzo(b)fluoranthene	<0.50	0.50
207-08-9	Benzo(k)fluoranthene	<0.50	0.50
191-24-2	Benzo(g,h,i)perylene	<0.50	0.50
218-01-9	Chrysene	<0.50	0.50
53-70-3	Dibenz(a,h)anthracene	<0.50	0.50
206-44-0	Fluoranthene	<0.50	0.50
86-73-7	Fluorene	<0.50	0.50
193-39-5	Indeno(1,2,3-cd)pyrene	<0.50	0.50
91-57-6	2-Methylnaphthalene	<0.50	0.50
90-12-0	1-Methylnaphthalene	<0.50	0.50
91-20-3	Naphthalene	<0.50	0.50
85-01-8	Phenanthrene	<0.50	0.50
129-00-0	Pyrene	<0.50	0.50

<i>Surrogates:</i>	<i>% Recovery</i>	<i>Control Limits</i>
<i>2-Fluorophenol</i>	<i>24</i>	<i>20-70</i>
<i>Phenol-d6</i>	<i>20</i>	<i>18-45</i>
<i>Nitrobenzene-d5</i>	<i>71</i>	<i>31-123</i>

Continued on next page



ANALYTICAL REPORT

Client:	WATERSOLVE, LLC	Work Order:	1503390
Project:	Filtrate Project	Description:	Laboratory Services
Client Sample ID:	Filtrate	Sampled:	03/26/15 10:00
Lab Sample ID:	1503390-01	Sampled By:	Doug Walker
Matrix:	Water	Received:	03/26/15 12:00
Unit:	ug/L	Prepared:	03/31/15 10:14 By: ALK
Dilution Factor:	1	Analyzed:	04/03/15 13:17 By: ASC
QC Batch:	1502854	Analytical Batch:	5D06015

Semivolatile Organic Compounds by EPA Method 8270C (Continued)

<i>Surrogates (Continued):</i>	<i>% Recovery</i>	<i>Control Limits</i>
<i>2-Fluorobiphenyl</i>	<i>63</i>	<i>25-113</i>
<i>2,4,6-Tribromophenol</i>	<i>46</i>	<i>30-121</i>
<i>o-Terphenyl</i>	<i>64</i>	<i>42-125</i>



ANALYTICAL REPORT

Client: **WATERSOLVE, LLC**
 Project: Filtrate Project
 Client Sample ID: **Filtrate**
 Lab Sample ID: **1503390-01**
 Matrix: Water

Work Order: **1503390**
 Description: Laboratory Services
 Sampled: 03/26/15 10:00
 Sampled By: Doug Walker
 Received: 03/26/15 12:00

Total Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Time Analyzed	By	QC Batch
*Antimony	<1.0	1.0	ug/L	1	USEPA-6020A	04/08/15 14:37	MSM	1502842
Arsenic	2.3	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Barium	220	10	ug/L	10	USEPA-6020A	04/08/15 12:30	DSC	1502842
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020A	04/08/15 14:37	MSM	1502842
Boron	150	50	ug/L	5	USEPA-6020A	04/08/15 14:36	MSM	1502842
Cadmium	0.35	0.20	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Chromium	3.1	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Cobalt	2.6	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Copper	4.1	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Lead	<5.0	5.0	ug/L	5	USEPA-6020A	04/08/15 11:07	DSC	1502842
Molybdenum	13	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Mercury	<0.20	0.20	ug/L	1	USEPA-7470A	04/02/15 17:58	CKD	1502917
Nickel	5.0	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Selenium	1.3	1.0	ug/L	1	USEPA-6020A	04/08/15 15:02	MSM	1502842
Silver	<0.20	0.20	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Thallium	<1.0	1.0	ug/L	5	USEPA-6020A	04/08/15 11:07	DSC	1502842
Uranium	<5.0	5.0	ug/L	5	USEPA-6020A	04/08/15 11:07	DSC	1502842
Vanadium	1.4	1.0	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842
Zinc	22	10	ug/L	1	USEPA-6020A	04/08/15 10:55	DSC	1502842

*See Statement of Data Qualifications



ANALYTICAL REPORT

Client: **WATERSOLVE, LLC**
 Project: Filtrate Project
 Client Sample ID: **Filtrate**
 Lab Sample ID: **1503390-01**
 Matrix: Water

Work Order: **1503390**
 Description: Laboratory Services
 Sampled: 03/26/15 10:00
 Sampled By: Doug Walker
 Received: 03/26/15 12:00

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Time Analyzed	By	QC Batch
*Chromium, Hexavalent	<0.0010	0.0010	mg/L	1	USEPA-7196A	03/26/15 13:52	LMA	1502924

*See Statement of Data Qualifications



PRETREATMENT SUMMARY PAGE

Client: **WATERSOLVE, LLC**
Project: **Filtrate Project**

Pretreatment	Lab Sample ID	Batch	By	Date & Time Prepared
USEPA-3020A Metals Digestion	1503390-01	1502842	ARB	03/31/15 08:00
USEPA-3510C Liquid-Liquid Extraction	1503390-01	1502849	ALK	03/30/15 12:06
		1502854	ALK	03/31/15 10:14
USEPA-3665A/3660B Sulfuric Acid/Sulfur Cleanup	1503390-01	5C31066	ALK	03/31/15 12:00
USEPA-7470A Mercury Digestion	1503390-01	1502917	JBA	04/01/15 13:00



CASH CLIENTS - LONDON
ATTN: TriMatrix Laboratories, Jim McFadden
5560 Corporate Exchange Ct
Grand Rapids MI 49512

Date Received: 31-MAR-15
Report Date: 08-APR-15 14:58 (MT)
Version: FINAL

Client Phone: 616-976-4544

Certificate of Analysis

Lab Work Order #: L1593446
Project P.O. #: NOT SUBMITTED
Job Reference: GRAND MARAIS DRAIN
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 07-APR-15 11:51



[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 309 Exeter Road Unit #29, London, ON N6L 1C1 Canada | Phone: +1 519 652 6044 | Fax: +1 519 652 0671
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
F1-F4-511-CALC-WT	Water	F1-F4 Hydrocarbon Calculated Parameters	CCME CWS-PHC DEC-2000 - PUB# 1310-L

Analytical methods used for analysis of CCME Petroleum Hydrocarbons have been validated and comply with the Reference Method for the CWS PHC.

In cases where results for both F4 and F4G are reported, the greater of the two results must be used in any application of the CWS PHC guidelines and the gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.

In samples where BTEX and F1 were analyzed, F1-BTEX represents a value where the sum of Benzene, Toluene, Ethylbenzene and total Xylenes has been subtracted from F1.

In samples where PAHs, F2 and F3 were analyzed, F2-Naphth represents the result where Naphthalene has been subtracted from F2. F3-PAH represents a result where the sum of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene has been subtracted from F3.

Unless otherwise qualified, the following quality control criteria have been met for the F1 hydrocarbon range:

1. All extraction and analysis holding times were met.
2. Instrument performance showing response factors for C6 and C10 within 30% of the response factor for toluene.
3. Linearity of gasoline response within 15% throughout the calibration range.

Unless otherwise qualified, the following quality control criteria have been met for the F2-F4 hydrocarbon ranges:

1. All extraction and analysis holding times were met.
2. Instrument performance showing C10, C16 and C34 response factors within 10% of their average.
3. Instrument performance showing the C50 response factor within 30% of the average of the C10, C16 and C34 response factors.
4. Linearity of diesel or motor oil response within 15% throughout the calibration range.

F1-HS-511-WT	Water	F1-O.Reg 153/04 (July 2011)	E3398/CCME TIER 1-HS
--------------	-------	-----------------------------	----------------------

Fraction F1 is determined by analyzing by headspace-GC/FID.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

F2-F4-511-WT	Water	F2-F4-O.Reg 153/04 (July 2011)	MOE DECPH-E3398/CCME TIER 1
--------------	-------	--------------------------------	-----------------------------

Fractions F2, F3 and F4 are determined by liquid/liquid extraction with a solvent. The solvent recovered from the extracted sample is dried and treated to remove polar material. The extract is then analyzed by GC/FID.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L1593446

Report Date: 08-APR-15

Page 1 of 2

Client: CASH CLIENTS - LONDON
 5560 Corporate Exchange Ct
 Grand Rapids MI 49512

Contact: TriMatrix Laboratories, Jim McFadden

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F1-HS-511-WT	Water							
Batch	R3168058							
WG2059513-1	CVS							
F1 (C6-C10)			98.4		%		80-120	02-APR-15
WG2059513-2	MB							
F1 (C6-C10)			<25		ug/L		25	02-APR-15
Surrogate: 3,4-Dichlorotoluene			102.8		%		60-140	02-APR-15
F2-F4-511-WT	Water							
Batch	R3169210							
WG2063916-1	CVS							
F2 (C10-C16)			111.6		%		80-120	02-APR-15
F3 (C16-C34)			109.4		%		80-120	02-APR-15
F4 (C34-C50)			113.9		%		80-120	02-APR-15
WG2063916-2	CVS							
F2 (C10-C16)			111.7		%		80-120	02-APR-15
F3 (C16-C34)			107.7		%		80-120	02-APR-15
F4 (C34-C50)			112.5		%		80-120	02-APR-15
WG2063743-2	LCS							
F2 (C10-C16)			99.0		%		65-135	02-APR-15
F3 (C16-C34)			98.8		%		65-135	02-APR-15
F4 (C34-C50)			113.9		%		65-135	02-APR-15
WG2063743-1	MB							
F2 (C10-C16)			<100		ug/L		100	02-APR-15
F3 (C16-C34)			<250		ug/L		250	02-APR-15
F4 (C34-C50)			<250		ug/L		250	02-APR-15
Surrogate: 2-Bromobenzotrifluoride			92.5		%		60-140	02-APR-15

Quality Control Report

Workorder: L1593446

Report Date: 08-APR-15

Page 2 of 2

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

DATE July 24, 2015**PROJECT** 1520609-TM01**TO** Dave Killen, P.Eng.
Landmark Engineers Inc.**CC** Theresa Repaso-Subang**FROM** James Cullen, P.Geo., P.Eng.**EMAIL** jcullen@golder.com**RESPONSE TO MOECC COMMENTS ON THE GRAND MARAIS DRAIN SCREENING LEVEL RISK ASSESSMENT**

As per your request of July 14, 2015, please see below our response to MOECC comments on the Grand Marais Drain screening level risk assessment relating to:

- a) The need for an Environmental Compliance Approval (ECA) or some other instrument for sediment management and addressing/monitoring the filtrate released from the proposed use of Geotubes at the Site;
- b) Proposed monitoring program to assess the soil cover on the dewatered sediment in the Geotubes (and rationale if monitoring is deemed unnecessary); and
- c) A contingency plan, including appropriate measures in the event of failure of the soil cover used as a risk management measure (RMM) for the dewatered sediment at the Site.

Item (a)

Based on the Golder sediment sampling program and laboratory analytical results, the contaminated sediment in the Grand Marais Drain is considered a non-hazardous waste. Golder understands that the proponent for the sediment removal program in the Grand Marais Drain is proposing to use Geotubes for sediment dewatering and that the dewatered sediment is to be left in place on the same property and covered with a soil cap as described in the screening level risk assessment. Golder understands that the proponent is proposing to use Geotubes for sediment dewatering and is considering to return the filtrate from the dewatered sediment via an existing drainage swale to the Grand Marais Drain and to monitor water quality in accordance with the City of Windsor Sewer Use By-Law 11446.

Based on a review of the information provided by the proponent for the use of Geotubes at the site, an example of an appropriate regulatory instrument for the proposed sediment management and filtrate monitoring program is the existing Environmental Compliance Approval (ECA) 1428-8ADGZH of Geo-Dredging and Dewatering Solutions, a copy of which is included as Attachment A. This ECA is considered to be applicable to the proposed management of non-hazardous waste at the site, including contaminated and uncontaminated sediments.



Based on a review of the information provided by the proponent with regard to the proposed cationic polymer and filtrate analytical results from pilot tests of the dewatered sediment, we recommend that the proponent addresses Items 7.1 and 7.2 in the ECA to minimize the potential for adverse effect to the natural environment or impairment of water quality at the site. In addition to the equipment and reporting requirements described in ECA 1428-8ADGZH, it is recommended that the proponent consider providing supplemental filtration of the effluent from the Geotube containment area before it returns to the Grand Marais Drain. The purpose of the supplemental filtration would be to reduce suspended solids, dissolved metal, dissolved petroleum hydrocarbon, or residual polymer concentrations that may be present in the effluent. The supplemental filtration of the effluent could be accomplished through the use of one of the following items:

- i) Installation of a rock check-dam with a core filter consisting of clear sand and liquid-phase granular activated carbon in the existing drainage swale downstream of the Geotube containment area; or
- ii) Pumping of the effluent from the Geotube containment area through two liquid-phase granular activated carbon vessels connected in series prior to discharging to the existing drainage swale that returns to the Grand Marais Drain.

Depending on the regulatory response to the project notification requirements described in Item 19.1(b) of ECA1428-8ADGZH, it may be possible to add one of the above supplemental filtration items as a mitigative measure to address Items 7.1 and 7.2 in the ECA, or alternatively a separate mobile ECA for liquid-phase activated carbon filtration could be obtained from a suitable contractor and would need to be described in the project notification requirements. We note that the analytical monitoring requirements in Item 8.1 of the ECA for the effluent returning to the Grand Marais Drain will need to be agreed upon with the lead regulatory agency.

Golder understands that the dry tonnage of sediment to be removed and stored at the site is approximately 386 tonnes, which is subject to change however it would need to be finalized for the project notification requirements described in Item 19.1(b) of the ECA.

Items (b) and (c)

As noted on page 50 of the Golder screening level risk assessment, the proposed soil cap for the dewatered sediments and associated inspection and maintenance program is described as follows:

“Shallow Soil Cap Barrier

The shallow soil cap described below is consistent with the shallow soil cap barrier RMM described in the MOE’s Approved Tier II Model (MOE, 2011c) and is considered a suitable RMM to block potential direct exposure to dredged soil/sediment to be placed at the Site.

The shallow soil cap risk management measure consists of:

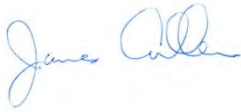
- a) capping of the impacted soils/sediments contained within the geotubes with a minimum of 0.5 meters of unimpacted soil (soil meeting the Table 3 SCS) immediately on top of the geotubes;
- b) Inspection and maintenance of the capping according to a program to ensure the continuing integrity of the capping, including:
 - a. at least semi-annual (spring and fall) inspections of the capping;
 - b. the noting of any deficiencies in the capping observed during the inspection or any other time;
 - c. the repair forthwith of any such deficiencies; and

- d. the recording of inspections, deficiencies and repairs in a log book maintained by or on behalf of the owner of the RA property from time to time.
- c) Inspection and maintenance, as described above, with respect to any fencing on the RA property so long as fencing is required because the RA property or any part thereof is not being used or developed; and
- d) Ongoing and perpetual maintenance of the capping by the owner of the RA property from time to time”.

We note that Item 19.1(b)(xi) in the attached ECA can be used to describe the location of the dewatered sediments, and Items 21.0 and 23.2 of the ECA regarding inspections and reporting can be used to document the annual inspections of the soil cap on the dewatered sediments.

We trust this sufficiently addresses the requested response items for the MOECC comments on the Grand Marais Drain screening level risk assessment.

Sincerely,



James Cullen, P.Geo., P.Eng.
Senior Environmental Engineer

Attachment A: Copy of Certificate of Approval 1428-8ADGZH for Geo-Dredging and Dewatering Solutions

JC/TRS/jc

n:\active\other office projects\2015\1520609\1520609 tech memo 24july2015.docx

ATTACHMENT A

**COPY OF CERTIFICATE OF APPROVAL 1428-8ADGZH
FOR GEO-DREDGING AND DEWATERING SOLUTIONS**

Fax Télécopie



Date/December 15, 2010 Time/Heure 11:41 am Fax/Télécopieur 613 628-5978

To/A
Kevin Bossy
Biskop Water Technologies

From/De	Ministry of the Environment Environmental Assessment and Approvals Branch 2 St. Clair Avenue West 12th Floor Toronto ON M4V 1L5	Ministère de l'Environnement Direction des évaluations environnementales et des autorisations 2, avenue St. Clair Ouest 12e étage Toronto ON M4V 1L5
---------	--	---

Name/Nom Bonnie Wilkinson

Telephone/Téléphone 416 314-8316

Fax/Télécopieur 416 314-8452

Pages to follow/Pages à suivre 18

Message

As requested, a copy of the approved Waste Management System Certificate of Approval (#1426-SADGZH). The original will be sent in the mail

Sincerely,



Bonnie Wilkinson

This facsimile may contain PRIVILEGED and CONFIDENTIAL INFORMATION only for use by the Addressee named above. If you are not the intended recipient of this facsimile or the employee or agent responsible for delivering it to the intended recipient, you are hereby notified that any dissemination or copying of this facsimile is strictly prohibited. If you have received this facsimile in error, please immediately notify us by telephone. Thank you.

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PROVISIONAL CERTIFICATE OF APPROVAL
WASTE MANAGEMENT SYSTEM
NUMBER 1426-8ADGZH
Issue Date: December 14, 2010

1770888 Ontario Inc.
c/o Geo-Dredging and Dewatering Solutions
110-B Bonnechere St W Eganville
Bonnechere Valley, Ontario
K0J 1T0

You have applied in accordance with Section 27 of the Environmental Protection Act for approval of:

a waste management system serving:

Province of Ontario,

through the operation of a mobile waste processing site comprising of a trailer-mounted polymer injection system and Geotubes[®] (details in the attached Schedule "B") to dewater the following types of non-hazardous waste:

domestic sewage wastes, mine tailings, pulp and paper biosolids, contaminated sediments, uncontaminated sediments.

For the purpose of this Provisional Certificate of Approval and the terms and conditions specified below, the following definitions apply:

DEFINITIONS

"**Agricultural waste**" is as defined in *Ontario Regulation 347, R.R.O. 1990, as amended;*

"**Certificate**" means this Provisional Certificate of Approval for a waste processing site, including Schedules "A" and "B", issued in accordance with Section 27 of the *Act*;

"**Director**" means any person(s) designated pursuant to Section 5 of the *Act* for the purposes of administering Part V of the *Act*;

"**District Manager**" means the *Ministry's* District Manager responsible for the geographic area in which the *waste management system* is to be operated;

"**Domestic sewage wastes**" for the purpose of this *Certificate* includes waste activated sludge, aerobically digested solids, anaerobically digested solids and hauled sewage (seepage);

"EPA" or "Act" means the Environmental Protection Act, R.S.O. 1990, c.E.-19, as amended;

"Ministry" or "MOE" means the Ontario Ministry of the Environment;

"O. Reg. 347" or "Regulation 347" means Ontario Regulation 347 (General-Waste Management Regulation), R.R.O. 1990, made under the EPA, as amended;

"Owner" or "Company" means any person that is responsible for the establishment or operation of the waste management system at a site being approved by this Certificate, and includes 1770888 Ontario Inc. operating as Geo-Dredging and Dewatering Solutions.

"OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c.O.40, as amended;

"PA" means the Pesticides Act, R.S.O. 1990, CHAPTER P.11;

"Provincial Officer" means any person designated by the Minister as a provincial officer pursuant to section 5 of the OWRA or section 5 of the Act or section 17 of PA;

"Site" means the location where the waste is present/generated and where it is to be processed by the waste management system;

"Trained Personnel" knowledgeable regarding the terms, conditions and requirements of this Certificate and any other applicable Certificate of Approval (i.e. a site's Section 27 EPA Certificate of Approval), relevant environmental legislation and regulations, site operations, contingency plans, emergency procedures, and relevant health, safety and environmental concerns pertaining to waste management and disposal; and

"Waste Management System" means the items listed in Schedule "B" that are approved to operate at a site pursuant to this Certificate.

You are hereby notified that this approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1.0 Built, etc. in Accordance

- 1.1 Except as otherwise provided by these conditions, the waste management system and site set-up shall be designed and operated in accordance with this Certificate and with the supporting information submitted to the Ministry as part of the application listed in Schedule "A" and Schedule "B".
- 1.2 This Certificate allows for the operation of a Geotube[®] dewatering system which consists of a trailer-mounted polymer injection system and up to three (3) Geotubes[®].
- 1.3 In the event that the Company proposes to operate the additional Geotubes[®] or equipment different than approved in this Certificate and listed in Schedule "B", the Company shall apply to the Director for an amendment to this Certificate. An increase in the number of Geotubes[®] will increase the Financial Assurance required.

2.0 Compliance

- 2.1 The *Company* shall ensure compliance with all the conditions of this *Certificate* and shall ensure that any person authorized to carry out work on or operate any aspect of the *waste management system* is notified of this *Certificate* and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.
- 2.1 Any person authorized to carry out work on or operate any aspect of the *waste management system* shall comply with the conditions of this *Certificate*.

3.0 Interpretation

- 3.1 Where there is a conflict between a provision of any document, including the application, referred to in this *Certificate*, and the conditions of this *Certificate*, the conditions in this *Certificate* shall take precedence.
- 3.2 Where there is a conflict between the application and a provision in any documents listed in Schedule "A", the application shall take precedence, unless it is clear that the purpose of the document was to amend the application and that the *Ministry* approved the amendment.
- 3.3 Where there is a conflict between any two documents listed in Schedule "A", other than the application, the document bearing the most recent date shall take precedence.
- 3.4 The requirements of this *Certificate* are severable. If any requirement of this *Certificate*, or the application of any requirement of this *Certificate* to any circumstance, is held invalid or unenforceable, the application of such requirement to other circumstances and the remainder of this *Certificate* shall not be affected thereby.

4.0 Other Legal Obligations

- 4.1 The issuance of, and compliance with the conditions of, this *Certificate* does not:
- (a) relieve any person of any obligation to comply with any provision of any applicable statute, regulation or other legal requirement; or
 - (b) limit in any way the authority of the *Ministry* to require certain steps be taken or to require the *Owner* to furnish any further information related to compliance with this *Certificate*.

5.0 Change of Owner

- 5.1 The *Owner* shall notify the *Director* in writing within 30 days of the occurrence of any changes:
- (a) change of *Owner / Company* name;
 - (b) change of address, or address of new *Owner*;
 - (c) change of partners where the *Owner* is or at any time becomes a partnership, and a copy of the most recent registration registered under the *Business Names Act* shall be

included in the notification to the Director;

- (d) change of name of the corporation where the *Owner* is or at any time becomes a corporation, and a copy of the most current "Initial Notice of Notice of Change" (Form 1, 2 or O. Reg 189, R.R.O. 1980, as amended from time to time), filed under the *Corporation Information Act* shall be included in the notification to the *Director*.

5.2 In the event of any change in ownership of the *waste management system*, the *Company* shall forthwith notify in writing the succeeding owner of the existence of this *Certificate*, and provide the successor with an up-to-date copy of this *Certificate* and a copy of such notice shall forthwith be forwarded to the *Director*.

6.0 Inspections

6.1 No person shall hinder or obstruct a *Provincial Officer* in the performance of their duties, including any and all inspections authorized by the *OWRA* or *EPA* of any place to which this *Certificate* relates, and without limiting the foregoing to:

- (a) enter upon the premises where the *waste management system* is located, or the location where the records required by the conditions of this *Certificate* are kept;
- (b) have access to, inspect, and copy any records required by the conditions of this *Certificate*;
- (c) inspect the practices, procedures, or operations required by the terms conditions of this *Certificate*; and
- (d) sample and monitor for the purposes of assessing compliance with the conditions of this *Certificate* or the *EPA*, the *OWRA* or the *PA*.

6.2 (a) The *Owner* shall, forthwith upon request of the *Director*, *District Manager*, or *Provincial Officer*, furnish any information requested by such persons with respect to compliance with this *Certificate*, including but not limited to, any records required to be kept under this *Certificate*; and

(b) The receipt of any information by the *Ministry* or the failure of the *Ministry* to prosecute any person or to require any person to take any action, under this *Certificate* or under any statute, regulation or other legal requirement, in relation to the information, shall not be construed as:

- (i) an approval, waiver, or justification by the *Ministry* of any act or omission of any person that contravenes any term or condition of this *Certificate* or any statute, regulation or other legal requirement; or
- (ii) acceptance by the *Ministry* of the information's completeness or accuracy.

7.0 Adverse Effects

7.1 The *waste management system* shall be constructed, assembled, operated and maintained in

an environmentally safe manner which ensures the health and safety of all persons and minimizes adverse effects on the natural environment.

- 7.2 The *Owner* shall take steps to minimize and ameliorate any adverse effect on the natural environment or impairment of water quality resulting from the *waste management system*, including such accelerated or additional monitoring as may be necessary to determine the nature and extent of the effect or impairment.
- 7.3 Despite an *Owner* or any other person fulfilling any obligations imposed by this *Certificate*, the person remains responsible for any contravention of any other condition of this *Certificate* or any applicable statute, regulation, or other legal requirement resulting from any act or omission that caused the adverse effect to the natural environment or impairment of water quality.

8.0 Wastewater / Effluent Discharges

- 8.1 All wastewater or effluent must be discharged in accordance with the *OWRA*, any Certificate of Approval issued under Section 53 of the *OWRA*, and any applicable Municipal Sewer Use By-Law(s).

9.0 Discharges to the Atmosphere

- 9.1 The *Owner* shall not operate the *waste management system* unless all air approvals under Section 9 of the *Act*, where applicable, have been obtained and fully complied with.

10.0 Financial Assurance

- 10.1 Within twenty (20) days of the issuance of this *Certificate* the *Owner* shall provide to the *Director* Financial Assurance, as defined in Section 131 of the *Act*, in the amount of sixty thousand dollars (\$60,000.00) for use of up to three (3) Geotubes[®] in the Province of Ontario. This Financial Assurance shall be in a form and amount acceptable to the *Director* and shall provide sufficient funds for the analysis, transportation, *waste management system* clean-up, monitoring and disposal of all quantities of waste on-site at any one time.
- 10.2 No processing, collection or transportation operations shall be carried out in the *waste management system*, unless the *Ministry* has received and approved the appropriate amount of financial assurance as outlined in Condition 10.1 above.
- 10.3 The amount of financial assurance is subject to review at any time by the *Director* and may be amended at his/her discretion.
- 10.4 In the event that the financial assurance is scheduled to expire or notice is received that it will not be renewed and a replacement in a form satisfactory to the *Director* is not received at least sixty (60) calendar days before the expiry or the renewal date the *Owner* shall replace it with a cash deposit.
- 10.5 The financial assurance may be used for any expenses incurred by her Majesty the Queen in Right of Ontario, including cash deposits made under this condition or payment under Part

XII of the *Act* related to any waste management activity of the *Owner* or its successors and assignees.

11.0 Copy of Certificate

11.1 A copy of this *Certificate*, in its entirety and including all Notices of Amendment, if any, shall be with the *waste management system* at the sites where use of the *waste management system* is to occur, pursuant to this *Certificate*.

12.0 Approved Wastes

12.1 The operation of this *waste management system* is limited to the processing of non-hazardous waste including *domestic sewage wastes*, pulp and paper biosolids, contaminated sediments, uncontaminated sediments.

12.2 (a) Prior to waste being processed by the *waste management system*, all documentation that contains the required waste characterization shall be inspected by *Trained Personnel*.

(b) If physically possible, prior to waste being processed by the *waste management system*, the waste shall be visually inspected by *Trained Personnel*, to ensure that the *waste management system* is approved to process that type of waste.

13.0 Wastes Exempt from Part V of the Act

13.1 Prior to processing of any waste at the waste generator's site or contaminated site, the *Company* shall determine the type of waste to be received for processing in the *waste management system* (in accordance with Condition 12.2). Notwithstanding Condition 12.1, if the waste to be received is *agricultural waste*, mill tailings from a mine or any other waste that is exempt from Part V of the *Act* and *O.Reg. 347* (exemptions as defined in *O.Reg. 347*), the conditions of this *Certificate* do not apply (except for the conditions under sections 7.0 and 8.0 of this *Certificate*).

14.0 Approved Sites

14.1 (a) The *waste management system* shall only be operated at a site where the waste has been generated unless the site is a waste disposal site that has a Certificate of Approval under Section 27 of the *Act* to receive, store and process waste from other generators/sites, or a Certificate of Approval under Section 55 of the *OWRA* where sewage, as defined in *OWRA*, is received, stored and treated.

(b) If the *waste management system* is operated at a waste disposal site that has a Certificate of Approval under Section 27 of the *Act*, the Certificate of Approval for

the waste disposal site must approve the type of waste and the type of waste processing undertaken by the *waste management system*.

(c) Operation of the *waste management system* at a waste disposal site or at an *OWRA* approved site is subject to the site's Part V or *OWRA* approvals' restrictions.

14.2 When the *waste management system* is operated at a waste disposal site that has approval under Section 27 of the *Act* for the operation of the *waste management system*. Conditions 14.1, 19.1 and 19.2 are not applicable. The *Company* shall comply with all conditions of approval for the waste disposal site as they relate to the operation of the *waste management system*. Should there be discrepancies between the conditions of this *Certificate* and those of the Certificate of Approval for the waste disposal site where the *waste management system* is operating, the conditions of the latter shall take precedence.

15.0 Operating Period

15.1 The *Owner* shall not operate the *waste management system* at a *site* for a period exceeding thirteen (13) consecutive calendar months. If the *waste management system* requires another freeze-thaw cycle (another approximate 13 months) at the *site*, the *Owner* shall obtain written approval from the *District Manager*.

16.0 Containment Areas

16.1 The coagulants/flocculants drums shall be stored within a containment system with a sufficient containment area to hold a minimum of 110% of the drums' storage capacity.

16.2 The *Company* shall ensure the Geotubes[®] are located within an impermeable area that provides adequate and sufficient containment, and as described in Items 1 and 2 of Schedule "A" of this *Certificate*.

17.0 Effluent and Dewatered Solids Handling

17.1 The *Company* shall ensure that liquid effluent generated by the *waste management system* is collected and/or directed back to the source or a storage area at the *site* in accordance with a *site*'s Certificate of Approval issued under Section 27 of the *Act* or in accordance with the *OWRA* approval. Effluent that is discharged to the natural environment or a sanitary sewer must be done in accordance with Condition 8.1 of this *Certificate*.

17.2 The *Company* should request and receive written confirmation from the owner of the *site* and/or of the waste to be processed in the *waste management system*, that all dewatered solid wastes generated at the *site* from the *waste management system* will either remain at the *site* or be transported from the *site* by an approved waste transportation system, as defined under *O. Reg. 347* for disposal, further processing at a waste disposal site approved to receive such waste, or for land application at a site approved to receive such waste.

17.3 No waste as defined by *O. Reg. 347* shall be transported in the *waste management system*.

18.0 Identification, Signs, Security

18.1 The *waste management system* shall be clearly marked with the following information being displayed (where possible):

- (a) *Company* name; and
- (b) this *Certificate* number.

18.2 The *Company* shall install and maintain a sign at the main entrance/exit to the *site* where the *waste management system* is to be stored / located / operated, on which the following information is legibly displayed:

- (a) name of the *Company*;
- (b) this *Certificate* number;
- (c) normal hours of operation;
- (d) telephone number to which complaints may be directed;
- (e) twenty-four hour emergency telephone number (if different from above);
- (f) a warning against unauthorized access; and
- (g) a warning against dumping at the site.

18.3 The *Company* shall ensure that the *site* at which the *waste management system* is operated is fenced, gated and maintained in a secure manner, such that unauthorized persons cannot enter the *site*.

18.4 Different signage and security arrangements must be approved in writing by the *District Manager* prior to the operation of the *waste management system* at the *site*.

19.0 Notification Requirements

Pre-Operation District Office Notification

19.1 (a) The *Company* shall notify the *District Manager*, in writing, of its intent to operate the *waste management system* at a *site* in the *District Manager's* area of jurisdiction. The notification shall be submitted no less than ten (10) business days prior to operation of the *waste management system*.

(b) The notification shall include, but not be limited to, the following information:

- i. address of the *site* at which the *Company* intends to operate;
- ii. name of the owner of the waste to be processed by the *waste management system*;
- iii. Certificate of Approval numbers (i.e. for this *waste management system*, for the *site* if applicable)
- iv. description of the Geotubes[®] and coagulant/flocculant (include the MSDS) to be used;

- v. *site* plan for the location where the *Company* intends to operate, including property boundaries, buildings, placement of *waste management system* on the *site*, containment and drainage area design to be used, usage of properties adjacent to *site*, location of overnight storage of equipment (i.e. trailer mounted polymer injection system and coagulant/flocculant drums), *site* fencing and access control;
 - vi. details on any records review, *site* visits and interviews undertaken as part of the *site* characterization and a description of the waste to be processed, including testing data obtained to characterize the waste, the name, address and telephone number of the testing laboratory utilized for the characterization;
 - vii. any sampling and testing protocols proposed to characterize the waste, dewatered solids or effluent from the *site*, including the name, address and telephone number of the testing laboratory utilized for the required characterization;
 - viii. proposed volume of waste to be processed;
 - ix. proposed procedure for the visual waste inspection required by this *Certificate*;
 - x. anticipated date of the commencement and the completion of the *waste management system* operation at the *site*;
 - xi. destination(s) of the dewatered solids and effluent processed/generated by the *waste management system* ;
 - xii. a copy of the municipal notification.
- (c) The *Company* shall provide to the *District Manager* any additional information that the *District Manager* may require. This information must be submitted within a time period acceptable to the *District Manager*.
- (d) Should the *District Manager* require additional information, the *Company* shall not allow the *waste management system* to be located or operated at the *site* until the *District Manager* has provided, written concurrence of all required additional information.
- (e) The *District Manager* may delete any of the items required in the notification list included in Condition 19.1 (b), or shorten the minimum time period necessary for the notification submission, referred to in Condition 19.1 (a).

Pre-Operation Municipal Notification

- 19.2 A copy of the notification referred to in Condition 19.1 above shall also be submitted to the clerk of the municipality in which the *Company* intends to operate the *waste management system* or to such other municipal officer that the clerk designates in writing. The notification shall be submitted a minimum of ten (10) business days prior to the date of commencement of the operation. Should the services be provided to a municipality, notification of the municipal clerk is not required.

20.0 Complaint Notification

- 20.1 (a) Upon receipt a complaint regarding the operation of the *waste management system* at a *site*, the *Company* shall initiate appropriate steps to determine all possible causes of the complaint. If the operation of this *waste management system* is determined to be the likely cause of the complaint, the *Company* shall proceed to take the necessary actions to eliminate the cause of the complaint and shall:
- i. notify the *District Manager* (or the MOE Spills Action Centre if after office hours) within 24 hours; and
 - ii. forward a formal reply to the complainant.
- (b) The notification to the *District Manager* (or the MOE Spills Action Centre if after office hours) shall contain the following information:
- i. name, address and the telephone number of the complainant;
 - ii. time and date of the complaint;
 - iii. direction of the wind at the time of the complaint;
 - iv. details of the complaint; and
 - v. actions proposed to remediate the cause of the complaint.
- (c) The *Company* shall prepare and submit to the *District Manager* a report written within one (1) week of the complaint date, listing the actions taken to resolve the complaint and any recommendations for remedial measures, and managerial or operational changes to reasonably avoid the re-occurrence of similar incidents.

21.0 Inspections

- 21.1 The *Company* shall have *trained personnel* inspect the *waste management system* being operated at a *site* (at a minimum of once each month) to ensure that there are no deficiencies present.
- 21.2 Any deficiencies that might negatively impact the environment detected during these regular inspections shall be promptly corrected.

22.0 Emergency Response & Contingency Measures

- 22.2 (a) The *Company* shall promptly take all necessary steps to contain and clean up any spills which have resulted from the operation of the *waste management system* to minimize impact on the natural environment.
- (b) The *Company* shall ensure that all spills (as defined in Part X of the *Act*) are reported to the MOE Spills Action Centre (1-800-268-6060 or 416-325-3000) and other persons specified in Section 92 of the *Act*.

- (c) All wastes resulting from an emergency situation shall be managed and disposed of in accordance with the Act and O.Reg. 347.
- (d) The Company shall record the nature of the emergency situation and the measures taken to contain the environmental impact of the emergency situation and to prevent its recurrence.

23.0 Reporting

Operating Logs

- 23.1 The Company shall ensure that a record of operation of the *waste management system* at a site is maintained weekly in written or electronic format, which contains a record of the following information:
- (a) date of record;
 - (b) progress of waste processing (dewatering) including, but not limited to the amount of waste received by the *waste management system*;
 - (c) results of testing or monitoring activities undertaken;
 - (d) results of inspections required by Condition 21.1 and 21.2 including the name and the signature of the *Trained Personnel* conducting the inspection;
 - (e) details on any emergency situations or spills which have occurred during the operation of the *waste management system* at the site;
 - (f) details on any complaints resulting from the operation of the *waste management system* at the site.

Final Report

- 23.2 (a) Within thirty (30) days of completion of the operation of the *waste management system* at a site, the Company shall prepare a final report and submit it to the appropriate *District Manager*. The report shall include, but not be limited to the following information:
- i. reference to the notification referred to in Condition 19.1 and 19.2;
 - ii. confirmation of actual date when the processing by the *waste management system* commenced and the date when the processing was completed;
 - iii. the amount of waste that was processed by the *waste management system*;
 - iv. the amount of effluent and dewatered solids that were generated by the *waste management system*;
 - v. total volume and type of coagulants/flocculants used;
 - vi. final destination of the effluent and dewatered solids;
 - vii. Analysis of effluent and dewatered solids retained;
 - viii. records of any emergency situations and spills that occurred during the operation of the *waste management system*;

- ix. records of any complaints that were received by the *Company* as a result of the operation of the *waste management system* at the *site*.

SCHEDULE "A"

This Schedule "A" forms part of Provisional Certificate of Approval No. 1426-8ADGZH

1. Application for a Certificate of Approval for a Waste Disposal Site dated June 16, 2010 and signed by Kevin Bossy, CEO, including Technical Brief [dated April 2010] prepared by McIntosh Perry Consulting Engineers Ltd.
2. E-mail dated October 18, 2010 [5:08 PM] from Mark Friddle, McIntosh Perry Consulting Engineers to B. Wilkinson, MOE re: containment of Geotubes[®] at a site and drainage design.
3. E-mail dated November 9, 2010 [2:15 PM] from Mark Friddle, McIntosh Perry Consulting Engineers to B. Wilkinson, MOE re: additional info.

SCHEDULE "B"

This Schedule "B" forms part of Provisional Certificate of Approval No. 1426-8ADGZH

Components of the Waste Management System:

1. Trailer-mounted polymer injection system consisting of a mounting frame on which the dosing equipment (which has a sample port) is installed and a main-header (from the dredger/pumper to the Geotube^{*}) which has a diameter of 6 inches and is equipped with a knife valve at both the inlet and the outlet. The electrical supply for this system is provided by a portable generator or a line source electrical supply at the site. Schematic diagram showing the components is found in Schedule "A", Item 1.
2. Geotube^{*} container of varying sizes (up to a maximum of 3 individual Geotubes) - manufactured by Tencate Geosynthetics North America and is an engineered textile.
3. Vehicle used for transporting items 1 & 2 above.

The reasons for the imposition of these terms and conditions are as follows:

Conditions under 1.0 are included to ensure that the *waste management system* is operated in accordance with the application and supporting documentation submitted by the *Company*, and not in a manner which the *Director* has not been asked to consider.

Conditions under 2.0, 3.0, 4.0, 7.0, 8.0, 9.0 are included to clarify the legal rights and responsibilities of the *Company*.

Conditions under 5.0 are included to ensure that the *waste management system* is operated under the corporate name which appears on the application form submitted for this approval and to ensure that the *Director* is informed of any changes.

Conditions under 6.0 are included to ensure that the appropriate *Ministry* staff have ready access to information regarding the operations of the *waste management system* which are approved under this *Certificate*, and to the locations at which the *waste management system* operate. The Conditions are supplementary to the powers afforded a *Provincial Officer* pursuant to the *EPA*, the *OWRA* and the *PA*, as amended.

Conditions under 10.0 are included to ensure that sufficient funds are available to the *Ministry* to clean up a site at which the *waste management system* operated in the event that the *Company* or owner of the *site* / waste is unable or unwilling to do so.

Condition 11.1 is included to ensure that conditions of this *Certificate* are shared with the *site* or waste owners at which the *waste management system* is operated or used for processing, as well as with the operator(s) of the *waste management system*.

Condition 12.1 is included to specify the type of waste that may be received by the *waste management system* for processing (as requested in the application).

Condition 12.2 is included to ensure the *Company* recognizes the type of waste that is to be received by the *waste management system* so as to ensure compliance with this *Certificate*.

Condition 13.1 is included to make it clear that wastes that are defined as exempt under the *EPA* are permitted to be processed in the *waste management system* and are also exempt from the conditions of this *Certificate* (but as always, the *Company* shall take steps to minimize adverse effects).

Conditions under 14.0 and 15.0 are included to ensure that the location of the operation of the *waste management system* does not become a permanent waste disposal site as such operation was not considered by the *Director* under this approval. In addition Condition 14.2 is included to clarify which conditions do not apply when the *waste management system* is operated at a waste disposal site that has approval under Section 27 of the *Act* for operation

of a such *waste management system*, and to clarify that the *waste management system* shall not operate at a waste disposal site that has approval under Section 27 of the Act that does not permit operation of such a *waste management system*.

Conditions under 16.0 are included to ensure that operations related to the pumping, polymer mixing and processing of wastes by the *waste management system* are done so in a manner which does not result in a nuisance or a hazard to the health and safety of the environment or people.

Conditions under 17.0 are included to ensure that the wastes generated by waste management system are handled according to the application by the *Company*, the *Act* and the relevant regulations.

Conditions under 18.0 are included to require the *Company* to provide visible identification for the *waste management system* as an authorized waste management facility and for inspection purposes.

Conditions under 19.0 are included to require notification of the *District Office* and the local municipal officials of the *Company's* intent to operate the *waste management system* in their area of jurisdiction and to allow for additional requirements to be placed on the *Company* in order to address concerns specific to the proposed operation of the *waste management system*.

Conditions under 20.0 are included to ensure that the *District Office* is informed of any complaints with respect to the operation of the *waste management system*, which would indicate problems with the operation of the waste management or non-compliance with the *Act*. Condition 20.1 (c) is also included to ensure that any complaints regarding the *waste management system* operations are responded to in a timely manner.

Conditions under 21.0 are included to ensure that the *waste management system* does not have any deficiencies that may create an adverse effect or result in a hazard to the health and safety of any person or the natural environment.

Conditions under 22.0 are included to ensure that spills are reported, and to minimize the environmental impact of any spills that may occur during the operation of the *waste management system*.

Conditions under 23.0 are included to require the *Company* to create and retain records for a minimum period so that the environmental impact and subsequent compliance with the *Act*, the regulations and this *Certificate* can be verified.

In accordance with Section 139 of the Environmental Protection Act, R.S.O. 1990, Chapter E-19, as amended, you may by written notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act, provides that the Notice requiring the hearing shall state:

1. The portions of the approval or each term or condition in the approval in respect of which the hearing is required, and,
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The Certificate of Approval number;
6. The date of the Certificate of Approval;
7. The name of the Director;
8. The municipality within which the works are located;

and the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto, Ontario
M5G 1E5

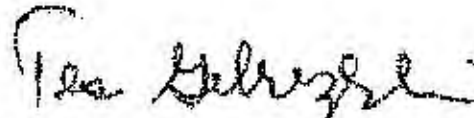
AND

The Director
Section 39, *Environmental Protection Act*
Ministry of the Environment
2 St. Clair Avenue West, Floor 12A
Toronto, Ontario
M4V 1L5

* Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 314-4600, Fax: (416) 314-4306 or www.ert.gov.on.ca

The above noted waste management system is approved under Section 39 of the Environmental Protection Act, and is subject to the Regulations made thereunder.

DATED AT TORONTO this 14th day of December, 2010



Tesfaye Gebrezghi, P.Eng.
Director
Section 39, *Environmental Protection Act*

BW/

c/ District Manager, MOE Ottawa
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