Old Sewage Lagoons Abandonment and Restoration Plan

Hamlet of Arviat

Prepared By:

Nuna Burnside Engineering and Environmental Ltd.
PO Box 879 Building 764, Fred Coman Way Iqaluit NU X0A 0H0
and
15 Townline Orangeville ON L9W 3R4

Prepared for:

Hamlet of Arviat

December 2010

File No: N-O 157460

Executive Summary

The Hamlet of Arviat operates their municipal water, sewage, and solid waste facilities under the regulation of the Nunavut Water Board (NWB). In the Hamlet of Arviat there are three sewage lagoons. Two of the lagoons are no longer in use after the commissioning of the current active lagoon in 2005. The community and GN-CGS engineers indicate there is no intent to use the old lagoons again for any purpose. An Abandonment and Restoration Plan for the old lagoons has been completed as part of the conditions of the Nunavut Water Board license 3AM-ARV1015 issued to the Hamlet of Arviat on August 23, 2010.

The old lagoons are located beside the landfill and consist of two cells, Old Lagoon 1 built in 1978 and Old Lagoon 2, built sometime in the early 1990s. The lagoons stopped being used when the new active lagoon was opened in 2005. The sewage disposed of in the old lagoons came from primarily domestic sources with very little commercial and institutional sources. Sewage was unregulated and untested before discharge.

To evaluate the current conditions at the old lagoons, a site assessment was conducted in September 2010. Work included a topographic survey of the lagoons' berms and surrounding wetlands, water and sludge sampling and lagoon depth measurements.

Samples were compared to NWB guidelines and CCME (Canadian Council of Ministers of the Environment) guidelines. All water samples from the lagoons met the NWB effluent discharge criteria. Water and sludge exceeded the CCME guidelines for some metals such as iron, aluminum, copper and zinc. The results appear to be reflective of the natural overburden chemistry and is not indicative of an environmental impact.

The old lagoons should abandoned by opening a channel through the south berm of each lagoon to allow them to drain.

The channel would remain open to limit water accumulation and allow natural tundra vegetation to re-establish itself.

Table of Contents

Table of Contents (Continued)

Figures

Appendices

1.0 Introduction

Nuna Burnside Engineering and Environmental Ltd. (Nuna Burnside), was retained by Community and Government Services (CGS) of the Government of Nunavut (GN), on behalf of the Hamlet of Arviat to prepare an Abandonment and Restoration plan for two old sewage lagoons that are no longer in use. The Hamlet of Arviat operates their municipal water, sewage, and solid waste facilities under the Nunavut Water Board (NWB) License 3AM-ARV1015 (Appendix A). The licence was issued on August 23, 2010 and expires on August 31, 2015. This report fulfills a condition in Part G, Item 2 of the license.

1.1 Site Location

The Hamlet of Arviat is located within the Kivalliq Region, Nunavut, at general latitude 61°6'N and general longitude 94°3'W (Figure 1). The Community is located approximately 225 km south of Rankin Inlet and 265 km north of Churchill Manitoba. The Hamlet of Arviat is predominately residential with a few small commercial and institutional establishments. Hunting and fishing in the traditional manner is still a prime occupation for many of the inhabitants.

1.2 Site Description

The old sewage lagoons are located approximately 2.8 km south-west from the Hamlet (Figure 2). The lagoons were created as two different cells, Old Lagoon 1 being the eastern cell and Old Lagoon 2 being the western cell (Figure 3). The lagoons are located beside the community solid waste disposal site. Lagoon 2 shares its western berm with the landfill. A road separates the eastern berm of Old Lagoon 1 and the berm of the active lagoon. On the south side of the lagoons is a wetland area consisting of tundra mosses and small shrubs. The Hudson Bay shore line is located 250 m south of the lagoons.

1.3 Site History

In 1980 about one third of the community was still using honey bags for wastewater disposal. The Hamlet was working on phasing out the use of honey bags by servicing homes with sewage storage tanks and providing trucked sewage disposal. Old Lagoon 1 was built around 1978 to replace a small honey bag pit / sewage lagoon located east of the community, which was subsequently filled in. The lagoon was built using an esker as the west bank and constructed berms forming the south and east banks (AES, 1980). The facility was expanded to include a second cell (Old Lagoon 2) sometime in the 1990s. In May 2005, the current active lagoon was commissioned and sewage was no longer dumped in the two old lagoons.

The sewage disposed of in the old lagoons came from primarily domestic sources with only a small amount commercial and institutional sources, such as the local Co-op, schools and health center. Sewage was unregulated and untested before discharge.

The Hamlet, represented by the Mayor (Bob Leonard) and Senior Administration Officer (SAO) (Ed Murphy), indicate the Hamlet has no further use for the two old lagoons. Engineering staff from Community and Government Services (CGS) of the Government of Nunavut (GN) also indicate they have no future plans for the old lagoons.

1.4 Scope of Study

The purpose of this Abandonment and Restoration Plan is to ensure that the abandoned lagoons do not pose a risk to public health or the environment.

The report has been prepared based on guidance provided in “Abandonment and Restoration of Sewage Lagoons in Nunavut, Draft Review Report, FSC 2005”.

The report includes the following:

- A description of the site and existing conditions
- An assessment of existing conditions of the site including analysis of water and sludge within the old lagoons
- Recommendations for safe abandonment and restoration of the site.

2.0 Physical Setting

2.1 Adjacent Land Use

The old sewage lagoons are located adjacent to the municipal landfill on the west and the active sewage lagoon on the east. Hudson Bay is less than 1 km north-east of the site.

2.2 Topography

The topography surrounding the Hamlet of Arviat is relatively flat with a sight rise when moving inland away from Hudson Bay. Approximately 20 to 30 percent of the land is shallow ponds with depths of 1 m or less. Topographic highs are found along eskers. The old lagoons were crested by creating berms around a topographic low point.

2.3 Geology and Morphology

Local bedrock is Archean in age and generally overlain by glacial fluvial sediments. Bedrock on the peninsula where the Hamlet is located consists of tonalities, diorites and gabbros. Local bedrock is generally overlain by glacial fluvial sediments. Arviat is located in the physiographic region of the Hudson Bay lowlands, characterized by low topographic relief, occasional bedrock outcrops and glacial and glacio-fluvial overburden sediments. Boulder fields and eskers are common.

The Hamlet is located in a zone of continuous permafrost, extending from 30 m to over 100 m. The predominant local vegetation consists of mosses and lichens on rocky outcrops, with hardy grasses and sages in swampy and/or more sheltered areas.

2.4 Climate

The closest climate station to Arviat is the Rankin Inlet Airport Weather Station. The Rankin Inlet area receives an average of 18.1 cm of rainfall and 119.7 cm of snowfall per annum. Mean annual precipitation totals 29.7 cm per annum. July mean high and low temperatures are 14.9^{o}C and 5.9^{o}C, respectively. January mean high and low temperatures are -28.3^{o}C and -35.5^{o}C, respectively. Winds are generally north-west, and average 23 km/h (Rankin Inlet Weather Station, Climate Normals 1991-2000, Environment Canada, 2010).

3.0 Existing Conditions of Lagoons

The old lagoons are currently stagnant bodies of water. Water levels vary during the year depending on the amount of precipitation. The water freezes during the winter months.

Both lagoons are contained by gravel and sand berms with heights ranging from 3 to 1.5 metres above water level. The berm dividing the two cells is below water level at some points. Water drains out of the lagoons through an area of higher permeability in the berm on the north side of Old Lagoon 2. From there, water drains into wetlands and eventually discharges into Hudson Bay. The slope of the land is very gradual, approximately 3%. Figure 3 illustrates the existing conditions of the abandoned lagoons as surveyed in September 2010.

Photographs of the lagoons taken in September 2010 are provided in Appendix B.

3.1 Field Methods, Sampling and Observations

Field site visits were completed in September and November 2010 to collect data on the existing conditions of the abandoned sewage lagoons. The field work included a site survey and photographs of the lagoons, an inspection of the berms, a topographical survey of the berms and surrounding lands, water and sludge sampling and water depth measurements. Sampling locations are provided in Figure 4.

3.2 Quantity of Sludge and Water

According to a report in 2003, the lagoons have an estimated volume of 49,600 m^2 based on a 2 m working depth (FSC, 2003).

Water depths were measured in September 2010 using a boat and weighted measuring tape. The depths were used to create elevation contours of the bottom of the lagoons and an estimation of their volumes (Figure 3). The bottom of Old Lagoon 1 is approximately 2.1 m at its deepest. Old Lagoon 2 was 2.7 m at its deepest point. The two lagoons combined contained 18,500 m^3 of water in September 2010. The sludge thickness is estimated to be 0.4 m across the bottom of the inundated portions. An examination of the sludge samples indicated a component of fine sand and silt that suggest the sludge is a mixture of fine overburden being washed into the lagoons in combination with sewage organics.

3.3 Assessment Criteria

The GN defaults to using criteria for contaminants provided by the Canadian Council of Ministers of the Environment (CCME) when there are no territory specific guidelines.

Surface water samples and sludge samples were collected from each of the old lagoons in September 2010. The sampling results are included in Appendix C.

The surface water samples were analysed for metals, inorganics, microbiology and total suspended solids. The results were compared to CCME Water Quality Guidelines for Freshwater Aquatic Life (Appendix D). The results were also compared to the NWB sewage effluent discharge criteria as outlined in the license (Appendix A).

Sludge samples from the lagoons were analyzed for metals and inorganics. The results were compared to the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. The CCME standards are based on four land use categories: agricultural, residential/parkland, commercial and industrial. Since the site is far from the community and will not be used for any commercial or residential the most appropriate criteria was industrial land use. The land is assumed to be industrial land use and fine grained.

Since the sludge samples consisted of predominately organic matter with some granular material it is best described as biosolids. This can be compared to “compost”. The CCME document “Guidelines for Compost Quality, 2005” provides guidelines for acceptable qualities of parameters in final compost. The guideline classifies compost as Class A or B based on trace element concentrations. Class A compost can be used for all types of applications such as agricultural lands, residential gardens and commercial operations. Class B compost has restricted land uses. A copy of the guidelines is provided in Appendix D.

3.4 Water Quality Results

Water quality results from the lagoons indicate that the water in the old lagoons meets the NWB licence requirements for sewage discharge. Samples only exceeded the Freshwater CCME guidelines for iron and aluminum. Elevated metals including iron and aluminum is naturally characteristic of the area and is likely not a result of sewage disposed of in the lagoons. A summary of the water sampling results is provided in Table C-1, Appendix C.

3.5 Sediment /Sludge Results

The sludge samples taken from the old lagoons met all CCME compost guidelines for metals. The samples did exceed the CCME Soil Quality Guidelines for copper and zinc. Again this is likely due to naturally occurring metals in the sediment of the lagoon and not due to sewage previously deposed of in the lagoons. A summary of the sludge sampling results is provided in Table C-2, Appendix C.

3.6 Contaminant Assessment

Based on the sampling completed, the sludge and standing water in the lagoons pose very little risk to the environment. The surface water contained in the lagoons met all of the NWB discharge effluent criteria. Water samples and sludge samples did have concentrations of metals such as iron, aluminum, copper and zinc that exceeded the CCME guidelines (CCME, 2007a and 2007b).

It should be noted that the CCME guidelines are generic guidelines and do not take into account regional differences in geology, soil, or climate, nor do they account for site-specific factors that may influence bioavailability or toxicity of contaminants. The guidelines are set to account for the most sensitive receptors that may be exposed to the contaminant. Because of their conservative nature, exceedences do not necessarily mean that there is a human or environmental risk. The above noted metals are not typical contaminants for domestic sewage and appear to reflect the national overburden chemistry in the area.

There was no evidence of a significant impact to the environment in the vicinity of the lagoons, due to their historic use as receptors for Hamlet of Arviat sewage.

4.0 Abandonment and Restoration Plan

4.1 Opening Channels in the Berms

Drainage from the lagoons flows north-east towards Hudson Bay. The lagoons should be drained to local ground level by carefully excavating a location along the south berm of each lagoon, as shown in Figures 5 and 6. The excavations should be controlled so the discharge does not cause significant erosion of the wetland adjacent to the discharge points. Water should flow out of the lagoons along the natural drainage channels. Based on lagoon depth measurements a small area of the lagoons will remain below water as the elevation of parts of the lagoon area is lower than ground surface outside of the berms.

4.2 Future Land Use

The Public Health Act requires a 450 meter set-back from all sewage treatment sites. Since the lagoons for abandonment are located within 450 m of the active lagoon a complete abandonment and restoration of the lagoons would not change the land use classification of the land as it would still be within a 450 m set-back for a sewage treatment site. Taking this into consideration, the site does not need to be reclaimed to a condition suitable for other land uses. The Hamlet may consider the lagoons as an area for expansion of their active lagoon in the future, or as simply open space that is part of the 450 m setback for the active lagoon.

There is no compelling reason to cover the sewage sludge in the bottom of the lagoons, as it will naturally host tundra vegetation and poses no environmental or human health and safety concern. There is also no compelling reason to remove or level the berms after the channels have been created. As long as the berms do not act to hold back water that could rush out upon catastrophic failure of the berms, they are not an environmental or human health and safety concern. With the lagoons drained by the channels the berms can remain as the area is not suitable for any other landuse.

4.2.1 Site Security

Signs should be posted in the area of the lagoons to identify the area as an area of restoration. Driving or walking in the area of the old lagoons should be discouraged until natural tundra conditions have been re-established.

4.3 Post Abandonment Monitoring

Long term monitoring of the decommissioned lagoons is important to ensure that the lagoons are not impacting the surrounding environment. Monitoring of water quality

within the wetland attenuation zone down gradient of the lagoons will continue as part of the monitoring program for the active lagoon, however there is no need to monitor the water quality from the run off of the old lagoons once they are drained.

Annual inspections should be completed to ensure the site naturally reverts to wetland and tundra ecology. The excavated drainage channels in the berms should be inspected to ensure they continue to allow natural drainage.

5.0 Conclusions and Recommendations

Water contained in the lagoons should be carefully drained into the wetland treatment area of the current active sewage lagoon, by carefully opening a channel in the south berm of each old lagoon.

Based on water quality sampling, water released to the wetland will not be an environmental concern as it meets the NWB effluent water quality standards.

Measures should be taken control the flow of water during draining to ensure erosion of the wetland does not occur.

The channels opened in each of the lagoons should be maintained, to allow the upgradient area to drain naturally and encourage the reestablishment of natural tundra vegetation.

Signs should be posted restricting activity in the area until natural vegetation has been established.

Annual inspections should be conducted to ensure the channels stay open and the area continues to drain naturally.

Respectfully Submitted:

Stephanie Charity, P.Geo.

December 24, 2010
Date

Jim Walls, P.Geo.

REGISTERED PROFESSIONAL GEOLOGIST
J.R. WALLS
LICENSEE
NWT/NU

December 24, 2010
Date

6.0 References

AES, 1980. Sewage and Solid Waste Study, Eskimo Point, N.W.T., Associated Engineering Services Ltd, October 1980.

CCME, 2007a. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table, Updated September, 2007. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME, 2007b. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Summary Table, Updated September, 2007. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME, 2005. Guidelines for Compost, Canadian Council of Ministers of the Environment, 2005.

Environment Canada, 2010. Canadian Climate Normals 1971-2000, Rankin Inlet A Weather Station, Environment Canada. <http://climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html?StnID=1721&autofwd=1>. Accessed Sept 21, 2010.

FSC, 2003. Design Concept for Arviat Sewage Lagoon Design, prepared for the Government of Nunavut, FSC Architects & Engineers, May 2003.

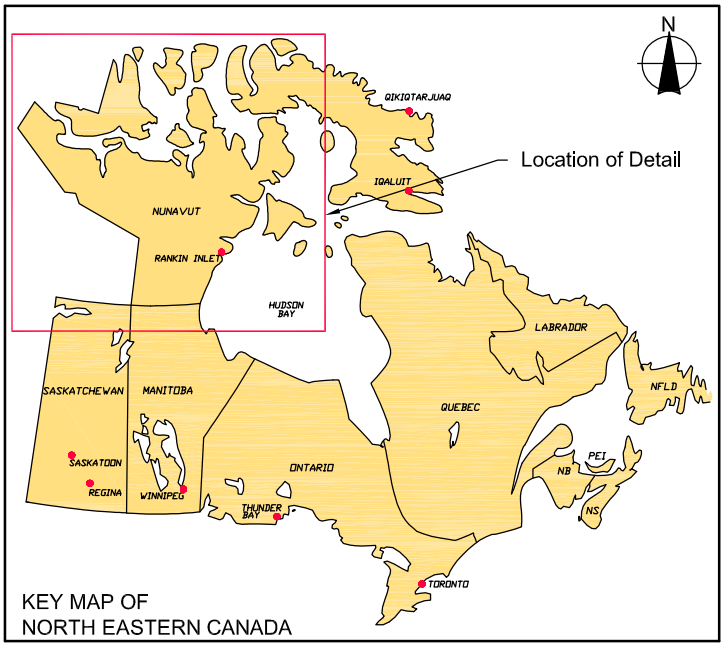
FSC, 2005. Abandonment and Restoration of Sewage Lagoons in Nunavut, Draft Review Report, FSC Architects & Engineers, January 2005.

NWB, 2010. Hamlet of Arviat Water License 3AM-ARV1015. Gjoa Haven, Nunavut. Nunavut Water Board. 23 Aug 2010.

BURNSIDE
An Aboriginal Owned Company

Figures

Map Reference:
Map Art Publishing



KEY MAP OF
NORTH EASTERN CANADA

FIGURE 1 - SITE LOCATION MAP

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

SEWAGE LAGOONS ABANDONMENT AND RESTORATION PLAN

December, 2010
Project Number: N-O157460

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SLARP 2010 SL.dwg

Plot Time: Dec 22, 2010 - 2:29pm

FIGURE 2

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

SEWAGE LAGOONS ABANDONMENT AND RESTORATION PLAN

COMMUNITY PLAN

Satellite Image Source:
Background colour satellite image obtained from Google Earth Pro.

Map Source:
Background physical features obtained from the National Topographic Database Website.

N

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Kilometres

1:50,000
December, 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

NUNA BURNSIDE

N-O15746 SLARP 2010 CP.dwg

Plot Time: Jan 12, 2011 - 4:29pm

FIGURE 3

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT
SEWAGE LAGOONS ABANDONMENT AND RESTORATION PLAN

ABANDONED SEWAGE LAGOONS

LEGEND

- WETLAND TREATMENT AREA
- FLOW DIRECTION
- 10m — GROUND SURFACE CONTOUR *(Survey by Burnside, September 2010)*
- FENCE AROUND SEWAGE LAGOONS
- 10m — INTERPRETED LAGOON BOTTOM CONTOUR *(Based on manual depth measurements by Burnside, September 2010)*

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

Map Source:
Background physical features obtained from the National Topographic Database Website.

N

0 10 20 30 40 50 60 70 80
Metres

1:1,000
December 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SLARP 2010 ABANDONED LAGOONS SP.dwg

Plot Time: Dec 22, 2010 - 2:00pm

FIGURE 4

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

SEWAGE LAGOONS ABANDONMENT AND RESTORATION PLAN

SAMPLING LOCATIONS

LEGEND

- WATER SAMPLE LOCATION
- SLUDGE SAMPLE LOCATION
- WETLAND TREATMENT AREA
- FLOW DIRECTION

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

Map Source:
Background physical features obtained from the National Topographic Database Website.

N

0 25 50 75 100 125 150 175 200

Metres

1:2,500
December, 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SLARP 2010 SAMPLING LOCATIONS.dwg

Plot Time: Dec 22, 2010-1:44pm

FIGURE 5

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT
SEWAGE LAGOONS ABANDONMENT AND RESTORATION PLAN

RESTORATION PLAN

LEGEND

- EXISTING WATER FLOW DIRECTION
- WETLAND TREATMENT AREA
- 9.0 PROPOSED LAGOON CONTOURS
- PROPOSED LAGOON WATER OUTLET FLOW DIRECTION
- FINAL WATER LEVEL
- A A CROSS SECTION ORIENTATION

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

Map Source:
Background physical features obtained from the National Topographic Database Website.

N

0 10 20 30 40 50 60 70 80
Metres

1:1,000
December 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SLARP 2010 RESTORATION PLAN.dwg

Plot Time: Dec. 22, 2010-1:36pm

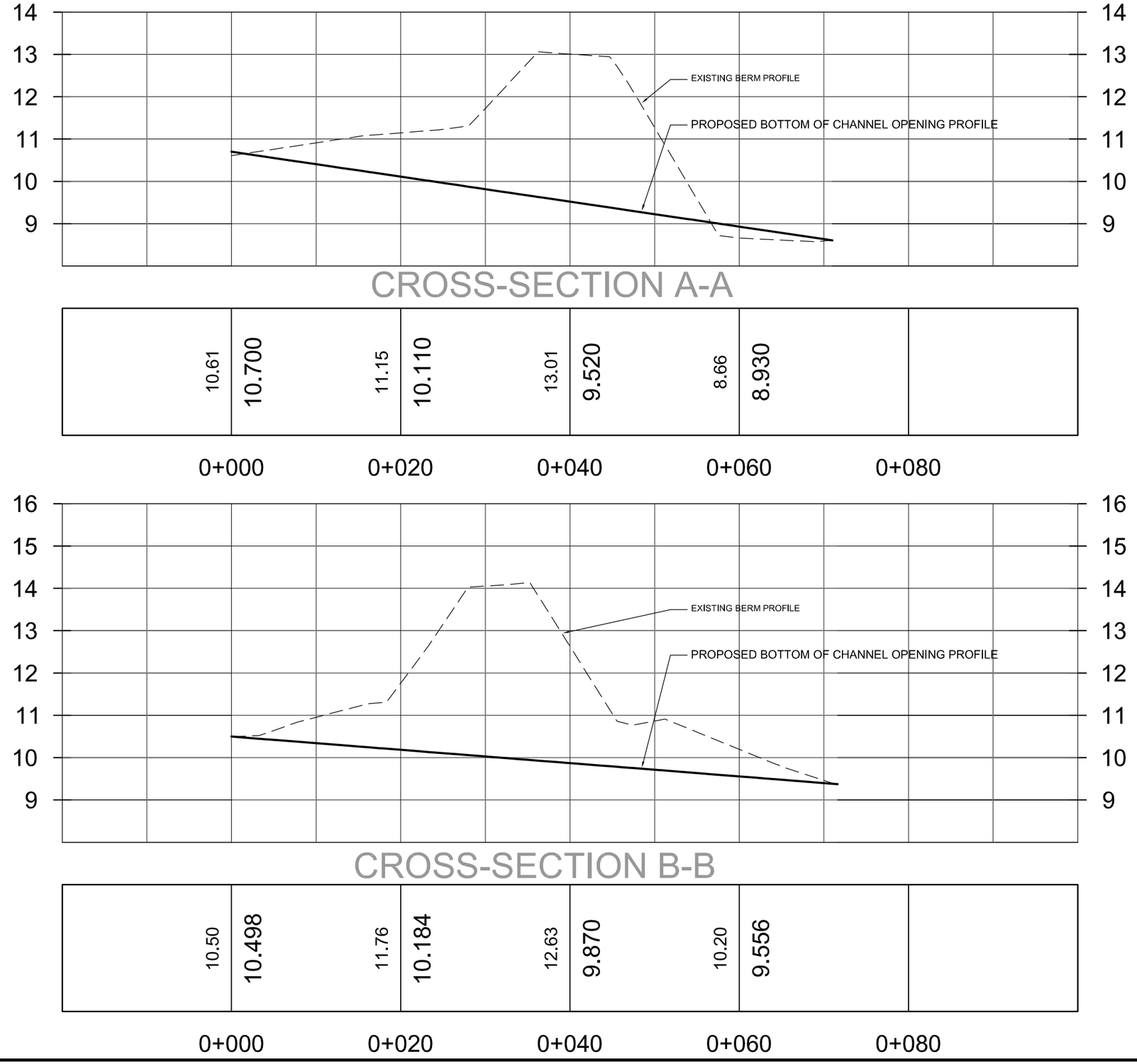


FIGURE 6

HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT
SEWAGE LAGOON ABANDONMENT & RESTORATION PLAN

RESTORATION PLAN
BERM CROSS SECTIONS

H 1:500 V 1:100
December 2010
Project Number: N-O157460

Prepared by: C. Sheppard Verified by: J. Walls

BURNSIDE

N-O15746 SLARP 2010 RESTORATION PROFILES.dwg

Plot Time: Dec 21, 2010-2:29pm

BURNSIDE
An Aboriginal Owned Company

Appendix A
Nunavut Water Board Licence

NUNAVUT WATER BOARD

WATER LICENCE NO: 3AM-ARV1015

Hamlet of Arviat, Nunavut

NUNAVUT WATER BOARD

LICENCE NO: 3AM-ARV1015

TABLE OF CONTENTS

NUNAVUT WATER BOARD

WATER LICENCE No. 3AM-ARV1015

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

HAMLET OF ARVIAT
(Licensee or Applicant)

ARVIAT, NUNAVUT X0C 0E0
(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water or dispose of waste for a period subject to restrictions and conditions contained within this Licence:

Licence Number/Type:	3AM-ARV1015 TYPE "A"
Water Management Area:	NUNAVUT 06
Location:	ARVIAT, KIVALLIQ REGION, NUNAVUT LATITUDE: 61° 06' 30" N, LONGITUDE: 94° 03' 31" W
Classification:	MUNICIPAL UNDERTAKING
Purpose:	DIRECT USE OF WATER AND DEPOSIT OF WASTE
Quantity of Water use not to Exceed:	EIGHTY-SIX THOUSAND (86,000) CUBIC METRES PER ANNUM
Date of Licence Issuance:	AUGUST 23, 2010
Expiry of Licence:	AUGUST 31, 2015

This Licence, issued and recorded at Gjoa Haven, Nunavut, includes and is subject to the annexed conditions.

Thomas Kabloona,
Nunavut Water Board
Chair

APPROVED BY:

Minister of Indian and Northern Affairs Canada

DATE LICENCE APPROVED: _____

PART A: SCOPE, DEFINITIONS AND ENFORCEMENT

1. SCOPE

a. This Licence allows for the use of Water and disposal of Waste including operation of a Water Supply Facility, Solid Waste Disposal Facility, Hazardous Waste Storage Area, Bulky Metals Area, and Sewage Disposal Facility; as well as construction and operation of a New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, upon approval by the Board, by the Hamlet of Arviat, Nunavut for a municipal undertaking (Latitude 61° 06' 30" N and Longitude 94° 03' 31" W);

b. This Licence is issued subject to conditions contained herein with respect to the taking of Water and the depositing of Waste of any type in any Waters or in any place under any conditions where such Waste or any other Waste that results from the deposits of such Waste may enter any Waters. Whenever new regulations are made or existing regulations are amended by the Governor in Council under the Act, or other statutes imposing more stringent conditions relating to the quantity, type or manner under which any such Waste may be so deposited, this Licence shall be deemed to be subject to such requirements; and

c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with all applicable legislation, guidelines and directives.

2. DEFINITIONS

In this Licence, these definitions apply and changes may be made at the discretion of the Board.

"Act" means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act;*

"Amendment" means a change to original terms and conditions of this Licence requiring correction, addition or deletion of specific terms and conditions of the Licence and/or modifications inconsistent with the terms of the set terms and conditions of the Licence;

"Analyst" means an Analyst designated by the Minister under Section 85 (1) of the Act;

"Applicant" means the Licensee;

"Appurtenant undertaking" means an undertaking in relation to which a use of Waters or a deposit of Waste is permitted by a licence issued by the Board;

"Board" means the Nunavut Water Board established under the *Nunavut Land Claims Agreement*;

"Bulky Metals Area" comprises the area and associated structures designed to contain bulky metal waste as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

"Effluent" means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant;

"Engineer" means a professional engineer registered to practice in Nunavut in accordance with the *Consolidation of Engineers and Geoscientists Act S. Nu 2008, c.2* and the *Engineering and Geoscience Professions Act S.N.W.T. 2006, c.16 Amended by S.N.W.T. 2009, c.12*;

"Final Discharge Point" in respect of an Effluent, means an identifiable discharge point of a facility beyond which the operator of the facility no longer exercises control over the quality of the Effluent;

"Freeboard" means the vertical distance between water line and the designed maximum operating height on the crest of a dam or dyke's upstream slope;

"Geotechnical Engineer" means a professional engineer registered with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists and whose principal field of specialization is with the engineering properties of earth materials in dealing with man-made structures and earthworks that will be built on a site. These can include shallow and deep foundations, retaining walls, dams, and embankments;

"Grab Sample" means a single Water or wastewater sample taken at a time and place representative of the total discharge;

"Greywater" means all liquid wastes from showers, baths, sinks, kitchens and domestic washing facilities, but does not include toilet wastes;

"Hazardous Waste" means waste classified as "hazardous" by Nunavut Territorial or Federal legislation, or as "dangerous goods" under the *Transportation of Dangerous Goods Act*;

"Hazardous Waste Storage Area" comprises the area and associated structures designed to contain Hazardous Waste as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

"Hydrocarbon Impacted Soil Storage and Treatment Facility" means an area designed to treat Petroleum Hydrocarbon-Impacted Soil, as referred to in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

"Inspector" means an Inspector designated by the Minister under Section 85 (1) of the Act;

"Licensee" means the holder of this Licence;

"Modification" means an alteration to a physical work that introduces a new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion, and changes to the operating system that are consistent with the terms of this Licence and do not require amendment;

"Monitoring Program" means a monitoring program established to collect data on surface Water and groundwater quality, Waste and Waste deposition, to assess impacts to the freshwater aquatic environment of an appurtenant undertaking;

"New Solid Waste Disposal Facility" comprises the area and associated structures designed to contain solid waste as referred to in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

"Nunavut Land Claims Agreement" (NLCA) means the *"Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*", including its preamble and schedules, and any amendments to that agreement made pursuant to it;

"Petroleum Hydrocarbon Impacted Soil" means soil in which the primary petroleum product present, as determined by laboratory analysis consistent with that described in the *Canada-Wide Standards for Petroleum Hydrocarbons in Soil*, generally consists of fuel oil, diesel fuel, gasoline and/or jet fuel;

"Sewage" means all Toilet Wastes and Greywater;

"Sewage Disposal Facilities" comprises the area, including wetland and engineered lagoon designed to contain Sewage as described in the Application for Water Licence filed by the Applicant on September 2, 2003, and illustrated in Arviat Sewage Lagoon drawings prepared by FSC Architects and Engineers for Government of Nunavut, Job No. 507-340, FSC Project No. 2003-0440-003, Submission for Tender July 11th, 2003;

"Sewage Sludge" means the semi-solid Sewage material which settles at the bottom of the Sewage lagoon;

"Solid Waste Disposal Facilities" comprises the area and associated structures designed to contain solid waste as described in the Application for Water Licence filed by the Applicant on September 2, 2003;

"Toilet Wastes" means all human excreta and associated products, but does not include Greywater;

"Waste" means, as defined in section 4 of the Act, any substance that, by itself or in combination with other substances found in Water, would have the effect of altering the quality of any Water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any Water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

"**Waste Disposal Facilities**" means all facilities designated for the disposal of Waste including the Sewage Disposal Facilities, Solid Waste Disposal Facilities, Hazardous Waste Storage Area, Bulky Metals Area, and upon approval by the Board, New Solid Waste Disposal Facility, and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

"Water" means water as defined in section 4 of the Act;

"Water Supply Facilities" comprises the area and associated intake infrastructure at the Wolf River Water Supply, as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009 and illustrated in Arviat Water Supply Filtration Upgrade drawings prepared by Dillon Consulting for Government of Nunavut Public Works and Services, Issued for Tender, April 2008, Project No. 078254; Figure 4 – Hamlet of Arviat Water Licence Submission Wolf River Water Intake drawing prepared by Nuna Burnside, December 2008, Project Number N-O15746;

"Work Plan" refers to the electronic document (letter) from Jim Walls, P.Geo., Nuna Burnside Engineering and Environmental Ltd., to Bryan Purdy, Government of Nunavut Community Government Services, Re: Work Plan to Address INAC, DFO, and NWB Licence Compliance Issues GN File 08-3025 Hamlet of Arviat, Nunavut File No. N-0 15746.1, dated June 23, 2010.

3. ENFORCEMENT

a. Failure to comply with this Licence will be a violation of the Act, subjecting the Licensee to the enforcement measures and the penalties provided for in the Act.

b. All inspection and enforcement services regarding this Licence will be provided by Inspectors appointed under the Act.

c. For the purpose of enforcing this Licence and with respect to the use of Water and deposit or discharge of Waste by the Licensee, Inspectors appointed under the Act, hold all powers, privileges and protections that are conferred upon them by the Act or by other applicable law.

PART B: GENERAL CONDITIONS

1. This Licence incorporates a previously issued Type B licence, NWB3ARV0308, to the Hamlet of Arviat, which allowed for the use of water and disposal of waste.

2. In the event of a conflict between the previously issued Type B licences and this Type A Licence, the condition of this Type A Licence prevails.

3. The Licensee shall file an annual report with the Board for review, no later than March 31st

of the year following the calendar year being reported, which shall contain the following information collected during that period:

a. Tabular summaries of all data generated under the Monitoring Program;
b. The monthly and annual quantities of freshwater obtained from all sources;
c. The monthly and annual quantities of Wastes removed for disposal from Water Supply Facilities and Waste Disposal Facilities;
d. A summary of modifications and/or major maintenance work carried out on Water Supply Facilities and Waste Disposal Facilities including all associated structures and facilities;
e. A list of unauthorized discharges and summary of follow-up actions taken;
f. Any revisions to approved plans and manuals as required by Part B, Item 12, submitted in the form of an addendum;
g. A summary of the status of implementation of the Work Plan, including an indication of the status of the funding required to carry out the Work Plan and an estimated timeframe for receipt of the necessary funding;
h. A fiscal update of the Licensee's funding commitments associated with all facilities governed by this Licence including all associated structures and facilities for the upcoming year and identifying shortfalls in such funding commitments for the previous year;
i. A summary of abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;
j. A summary of any studies, reports and plans requested by the Board that relate to Waste disposal, Water use or reclamation, and a brief description of any future studies planned; and
k. Any other details on water use or waste disposal requested by the Board by November 1st of the year being reported.

4. The Licensee shall comply with the Monitoring Program described in this Licence and any Amendments to the Monitoring Program as may be made from time to time, pursuant to the conditions of this Licence.

5. The Monitoring Program and compliance dates specified in the Licence may be modified at the discretion of the Board.

6. Metres, devices or other such methods used for measuring the volumes of Water used and Waste discharged, shall be installed, operated and maintained by the Licensee to the satisfaction of an Inspector.

7. The Licensee shall, within ninety (90) days after the first visit by the Inspector following approval of this Licence, post the necessary signs, to identify the stations of the Monitoring Program. All signage postings shall be in Inuktitut and English.

8. The Licensee shall, for all plans submitted under this Licence, include a proposed timetable for implementation. Plans submitted, cannot be undertaken without subsequent written Board approval and direction. The Board may alter or modify a plan if necessary to

achieve the legislative objectives and will notify the Licensee in writing of acceptance, rejection or alteration of the plan.

9. In the event that a plan is not found acceptable to the Board, the Licensee shall, within thirty (30) days of notification by the Board, provide a revised version to the Board, for approval in writing.

10. The Licensee shall, for all plans submitted under this Licence, implement the plan as approved by the Board in writing.

11. Every plan to be carried out pursuant to the terms and conditions of this Licence shall become a part of this Licence, and any additional terms and conditions imposed upon approval of a plan by the Board become part of this Licence. All terms and conditions of the Licence should be contemplated in the development of a plan where appropriate.

12. The Licensee shall review the plans and manuals referred to in this Licence as required by changes in operation and/or technology and revise accordingly. Revisions to the plans or manuals are to be submitted in the form of an addendum to be included with the annual report required by Part B, Item 3, complete with a revisions list detailing where significant content changes are made.

13. The Licensee shall ensure a copy of this Licence is maintained at the municipal office and at the site of operation at all times.

14. Any communication with respect to this Licence shall be made in writing to the attention of:

Manager of Licensing
Nunavut Water Board
P. O. Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369
Email: licensing@nunavutwaterboard.org

15. Any notice made to an Inspector shall be made in writing to the attention of:

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4295
Fax: (867) 979-6445

16. The Licensee shall submit one (1) paper copy and one (1) electronic copy of all reports, studies, and plans to the Board or as otherwise requested by the Board. Reports or studies submitted to the Board by the Licensee shall include an executive summary in English and

Inuktitut.

17. The Licensee shall ensure that any document(s) or correspondence submitted by the Licensee to the Board, is received by the Board and maintain on file a copy of the acknowledgment of receipt issued by the Manager of Licensing.

18. This Licence is assignable as provided for in Section 44 of the Act.

19. The expiry or cancellation of this Licence does not relieve the Licensee from any obligation imposed by the Licence, or any other regulatory requirement.

20. The Licensee shall file a Water Licence Renewal Application with the Board no later than September 1, 2014.

PART C: CONDITIONS APPLYING TO WATER USE AND MANAGEMENT

1. The Licensee shall obtain all freshwater from Wolf River at Monitoring Program Station ARV-1 as otherwise approved by the Board in writing.

2. The annual quantity of water used for all purposes shall not exceed eighty-six thousand (86, 000) cubic metres per annum, or as otherwise approved by the Board in writing.

3. The Licensee shall equip all water intake hoses with a screen of an appropriate mesh size to ensure that fish are not entrained and shall withdraw Water at a rate such that fish do not become impinged on the screen.

4. The Licensee shall submit to the Board for approval in writing by December 31, 2010, as-built drawings stamped and signed by an Engineer confirming compliance with the DFO guideline "Freshwater Intake End of Pipe Fish Screen Guideline". The drawings shall include information regarding the operating capacity of the pump used and the intake screen size.

5. The Licensee shall not remove any material from below the ordinary high water mark of any Water body.

6. The Licensee shall not cause erosion to the banks of any body of Water and shall provide necessary controls to prevent such erosion.

7. Sediment and erosion control measures shall be implemented prior to and maintained during construction and operation to prevent entry of sediment into Water.

8. The Licensee shall submit to the Board for review by December 31, 2010, the Water balance assessment for Wolf River and an assessment of the potential effects of drawdown of Wolf River on the aquatic environment. The assessment shall include recommended mitigation measures and an implementation schedule.

9. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL AND MANAGEMENT

1. The Licensee shall direct all Sewage to the Sewage Disposal Facility.

2. All Effluent discharged from the Sewage Disposal Facilities at Monitoring Program Station ARV-4 shall not exceed the following Effluent quality limits, or as otherwise approved by the Board in writing:

Parameter	Maximum Concentration of any Grab Sample
Fecal Coliform	1×10^4 CFU/dl
BOD_5	80 mg/l
Total Suspended Solids	100 mg/l
Oil and Grease	No visible sheen
pH	Between 6 and 9

3. A Freeboard limit of 1.0 metre, or as recommended by a qualified Geotechnical Engineer and as approved by the Board in writing, shall be maintained at all dams, dyke or structures intended to contain, withhold, divert or retain Water or Wastes.

4. The Licensee shall provide at least ten (10) days notification to an Inspector, prior to initiating any planned discharges from any Waste Disposal Facility.

5. The Licensee shall submit to the Board for approval in writing by December 31, 2010, a Sewage Disposal Facility Report. The Report shall include:

   a. As-built drawings and design plans of the Sewage Disposal Facility (including the lagoon and wetland) signed and stamped by an Engineer;
   b. A preliminary discharge and wetland hydrology assessment;
   c. The results of an inspection by a Geotechnical Engineer of the Sewage Disposal Facility lagoon including its berms and an evaluation of the impact of sewage seepage through the lagoon berms on the environment;
   d. An evaluation of the long term impacts of the Sewage Disposal Facility on the environment;
   e. A Sludge Management Plan that addresses sludge assessment and disposal methods. The Plan shall be incorporated in to the Sewage Disposal Facility Operations and Maintenance Manual referred to in Part F Item 1b;
   f. Recommended measures to optimize the Sewage Disposal Facility; and
   g. A schedule for implementing recommended measures.

6. The Licensee shall, prior to commissioning of the New Solid Waste Disposal Facility, or as otherwise approved by the Board in writing:

a. Dispose of and contain all non-Hazardous, non-bulky metal, solid Waste at the Solid Waste Disposal Facility;
b. Dispose of and contain all bulky metal Waste at the Bulky Metals Area; and
c. Segregate and securely store all hazardous materials and Hazardous Waste within the Hazardous Waste Storage Area in a manner as to prevent the deposit of deleterious substances into any Water, until such a time that the materials have been removed for proper disposal at a licensed facility.

7. The Licensee shall not open burn plastics, wood treated with preservatives, electric wire, styrofoam, asbestos or painted wood to prevent the deposition of Waste materials of incomplete combustion and/or leachate from contaminated ash residual, from impacting any surrounding Waters, or as otherwise approved by the Board in writing.

8. The Licensee shall maintain records of all Waste removed from site and records of confirmation of proper disposal of removed Waste. These records shall be made available to an Inspector upon request.

9. The Licensee shall store and contain all Petroleum Hydrocarbon Impacted Soil in a manner as to prevent the deposit of deleterious substances into any Water.

10. The Licensee shall submit to the Board for approval in writing, at least sixty (60) days prior to the commissioning of a Hydrocarbon Impacted Soil Storage and Treatment Facility, a Hydrocarbon Impacted Soil Storage and Treatment Facility Management Plan including proposed Effluent quality limits for Monitoring Program Station ARV-10.

11. The Licensee shall dispose of all Effluent from contaminated soil areas and the Hydrocarbon Impacted Soil Storage and Treatment Facility, that exceed Effluent quality limits approved by the Board in Part D Item 14 (c) and Part D Item 10 respectively, off site at a licensed hazardous waste facility, or as otherwise approved by the Board in writing.

12. The discharge locations for all treated Effluents from the Hydrocarbon Impacted Soil Storage and Treatment Facility and contaminated soil areas shall be located at a minimum of thirty one (31) metres from the ordinary high water mark of any Water body and where direct or indirect flow into a Water body is not possible and no additional impacts are created.

13. The Licensee shall, prior to the removal of any treated soil from the Hydrocarbon Impacted Soil Storage and Treatment Facility, obtain written documentation from the Government of Nunavut Environmental Protection Service, confirming that the soils have been treated in accordance with the Government of Nunavut's "*Environmental Guideline for Contaminated Site Remediation, 2009"* for its intended use.

14. The Licensee shall submit to the Board for approval in writing by December 31, 2010, a Solid Waste Management Report. The Report shall include:

a. As-built drawings of the Solid Waste Disposal Facility, Hazardous Waste Storage Area, and Bulky Metals Area, signed and stamped by an Engineer;
b. Capacity assessment of the Solid Waste Disposal Facility;
c. An inventory and assessment of contaminated soil and water at the Solid Waste Disposal Facility, Bulky Metals Area, and Hazardous Waste Storage Area, and a plan for the treatment and disposal of contaminated soil and water including proposed Effluent quality limits for Monitoring Program Station ARV-11;
d. Recommendations for Water and wastewater containment, treatment, and drainage control. This Plan shall be incorporated into the Solid Waste Disposal Facility Operations and Maintenance Plan referred to in Part F Item 2d.
e. Recommended measures to optimize solid waste management; and
f. A schedule for implementing recommended measures.

15. Licensee shall implement measures to ensure hazardous materials and/or leachate from the Waste Disposal Facilities does not enter Water.

16. Licensee shall, annually between the months of June and September, undertake a geotechnical inspection to be carried out by a Geotechnical Engineer that takes into account all facilities intended to contain, withhold, divert or retain Water or Wastes. The inspection shall be conducted in accordance with the Canadian Dam Safety Guidelines, where applicable.

17. The Licensee shall, within sixty (60) days of completion of the geotechnical inspection referred to in Part D, Item 16, submit to the Board for review, the Geotechnical Engineer's inspection Report. The Licensee shall include a cover letter outlining an implementation plan to address the recommendations of the Geotechnical Engineer.

18. The Licensee shall maintain and operate all Water Supply Facilities and Waste Disposal Facilities in such a manner as to prevent structural failure.

PART E: CONDITIONS APPLYING TO MODIFICATIONS AND CONSTRUCTION

1. The Licensee shall, at least sixty (60) days prior to construction of the New Solid Waste Disposal Facility and/or the Hydrocarbon Impacted Soil Storage and Treatment Facility, or any dams, dykes or structures intended to contain, withhold, divert or retain Water or Wastes, submit to the Board, for approval in writing, final design Plans and construction drawings signed and stamped by an Engineer.

2. The Licensee shall obtained approval from the Board in writing prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain Water or Wastes.

3. The Licensee may, without written approval from the Board, carry out Modifications provided that such Modifications are consistent with the terms of this Licence and the following requirements are met:

a. The Licensee has notified the Board in writing of such proposed Modifications at least sixty (60) days prior to beginning the Modifications to include:
   i. A description of the facilities and/or works to be constructed;
   ii. The proposed location of the structure(s);
   iii. Identification of any potential impacts to the receiving environment;
   iv. A description of any monitoring required, including sampling locations, parameters measured and frequencies of sampling;
   v. Schedule for construction;
   vi. Drawings of engineered structures signed and stamped by an Engineer; and
   vii. Proposed sediment and erosion control measures.
b. The proposed Modifications do not place the Licensee in contravention of the Licence or the Act;
c. The Board has not, within sixty (60) days following notification of the proposed Modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and
d. The Board has not rejected the proposed Modifications;

4. Modifications for which any of the conditions referred to above have not been met can be carried out only with approval from the Board in writing.

5. The Licensee shall provide as-built plans and drawings of the construction and/or Modifications referred to in Part E of this Licence within ninety (90) days of completion of the Construction or Modification. These plans and drawings shall be signed and stamped by an Engineer.

PART F: CONDITIONS APPLYING TO OPERATIONS AND MAINTENACE

1. The Licensee shall, within sixty (60) days following Board approval of the Sewage Disposal Facility Report referred to in Part D, Item 5, submit to the Board, for approval in writing, a revision to the Plan entitled "Sewage Treatment Facility Operation and Maintenance (O&M) Plan, Hamlet of Arviat" May 2009, revised May 2010, to address the following:

   a. Requirements of the Licence;
   b. Sludge Management Plan referred to in Part D Item 5e; and
   c. Results of the Sewage Disposal Facility Report referred to in Part D Item 5.

2. The Licensee shall, within sixty (60) days following Board approval of the Solid Waste Disposal Facility Report referred to in Part D Item 14, submit to the Board, for approval in writing, a revision to the Plan entitled "Solid Waste Management Facility Operation and Maintenance (O&M) Plan, Hamlet of Arviat" January 2009, revised May 2010, to address the following:

   a. Requirements of the Licence;
   b. Bulky Waste Management Plan;

c. Hazardous Waste Management Plan including Hazardous Waste containment and segregation measures, and procedures for the movement of Hazardous Waste;
d. Recommendations for Water and wastewater containment, treatment, and drainage control as referred to in Part D Item 14(d); and
e. Results of the Solid Waste Disposal Facility Report referred to in Part D Item 14.

3. The Licensee shall, at least three (3) months prior to commissioning the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, submit to the Board, for approval in writing, a revised Solid Waste Management Facility Operations and Maintenance (O&M) Plan referred to in Part F Item 2 to address the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility.

4. The Licensee shall, in preparation of the revised plan referred to in Part F, Item 3, consult Environment Canada for guidance related to Petroleum Hydrocarbon Impacted Soils storage and treatment facility design, siting, operation, monitoring, sampling and analytical methods, decommissioning and closure, as well as record keeping and reporting.

5. The Licensee shall, by December 31, 2010, submit to the Board for review, an Addendum to the approved Plan entitled "Environmental Emergency Contingency Plan, Hamlet of Arviat" May 2009, revised May 2010, to address reviewers' comments including the following:

   a. Procedures for the movement of Hazardous Waste;
   b. Contact information for the Government of Nunavut Department of Environment Manager of Pollution; and
   c. Detailed information regarding clean-up methods/procedures for spills on Water or ice.

6. If, during the period of this Licence, an unauthorized discharge of Waste and or Effluent occurs, or if such discharge is foreseeable, the Licensee shall:

   a. Employ as required, the approved Environmental Emergency Contingency Plan referred to in Part F Item 5;
   b. Report the incident immediately via the 24-Hour Spill Reporting Line (867) 920-8130 and to the Inspector at (867) 975-4295; and
   c. For each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain, clean up and restore the spill site.

PART G: CONDITIONS APPLYING TO ABANDONMENT, RESTORATION AND CLOSURE

1. The Licensee shall, by December 31, 2010, submit to the Board, for review, an interim Abandonment and Restoration Plan for the Solid Waste Disposal Facility, Bulky Metals Area, Hazardous Waste Storage Area and any contaminated sites identified in the Solid Waste Management Report referred to in Part D Item 14 (c). The Plan shall incorporate, where applicable, the appropriate sections described in Part G Item 3.

2. The Licensee shall, by December 31, 2010, submit to the Board, for approval in writing, a Final Abandonment and Restoration Plan for the two abandoned sewage lagoons. The Plan shall incorporate, where applicable, the appropriate sections described in Part G Item 3.

3. The Licensee shall, at least six (6) months prior to abandoning any facilities or upon submission of final design drawings for the construction of new facilities to replace existing ones, submit to the Board, for approval in writing, a Final Abandonment and Restoration Plan for the facilities being decommissioned. The Plan shall incorporate, where applicable, information on the following:

    a. Water intake facilities;
    b. The water treatment and waste disposal sites and facilities;
    c. Former dump sites;
    d. Petroleum and chemical storage areas;
    e. Any site affected by waste spills;
    f. Leachate prevention;
    g. An implementation and completion schedule;
    h. Maps delineating all disturbed areas, and site facilities;
    i. Consideration of altered drainage patterns;
    j. Type and source of cover materials;
    k. Future area use;
    l. Hazardous Wastes; and
    m. A proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

4. The Licensee shall carry out progressive reclamation of any Water Supply Facilities and Waste Disposal Facilities no longer required for the Licensee's operations.

5. In order to promote growth of vegetation and the needed microclimate for seed deposition, all disturbed surfaces shall be prepared by ripping, grading, or scarifying the surface to conform to the natural topography.

6. The Licensee shall, prior to the use of reclaimed soils that have been contaminated by hydrocarbons, or soils referred to in Part D, Item 14(c), consult with the Government of Nunavut, Department of Environment and obtain written confirmation that the soil meets

the objectives as outlined in the Government of Nunavut's *Environmental Guideline for Contaminated Site Remediation*, March 2009 (Revised).

7. The Licensee shall complete the restoration work within the time schedule specified in an approved Abandonment and Restoration Plan, or as subsequently revised and approved by the Board in writing.

8. The Licensee shall complete all restoration work prior to the expiry of this Licence.

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

1. The Licensee shall maintain Monitoring Program Stations at the following locations:

Station Number	Description	Frequency	Status
ARV-1	Raw water supply at Wolf River prior to treatment.	Monthly	Active (Volume)
ARV-2a	Effluent from the discharge point of the Solid Waste Disposal Facility.	Quality Monthly during the months of May to August and prior to discharge of accumulated impacted water. Acute Toxicity Annually	Active (Quality and Acute Toxicity)
ARV-2b	Effluent from the discharge point of the New Solid Waste Disposal Facility.	Quality Monthly during the months of May to August and prior to discharge of accumulated impacted water. Acute Toxicity Annually	Active (Quality and Acute Toxicity)
ARV-3	Raw Sewage at truck offload point.	Monthly	Not active

ARV-4	Effluent from the discharge point of the Sewage Disposal Facility (end of Wetland).	Quality Monthly during the months of May to August. Acute Toxicity Annually	Active (Quality and Acute Toxicity)
ARV-5	Discharge from the Bulky Metal Waste Area.	Monthly during periods of observed flow.	New (Quality)
ARV-6	Discharge from the Hazardous Waste Storage Area.	Monthly during periods of observed flow.	New (Quality)
ARV-7	Water level in Wolf River.	Monthly during periods of open water.	New (Water level)
ARV-8	Water level in Sewage Disposal Facility lagoon.	Monthly during thawed conditions.	New (Sewage level)
ARV-9	Sewage Sludge removed from the Sewage Disposal Facility.	Monthly	New (Volume)
ARV-10	Effluent from the Final Discharge Point of the Hydrocarbon Impacted Soil Storage and Treatment Facility	To be determined in accordance with Part D Item 10	New (To be determined in accordance with Part D Item 10)
ARV-11	Effluent discharge from dewatering contaminated soil areas.	To be determined in accordance with Part D Item 14 (c)	New (To be determined in accordance with Part D Item 14 (c))

2. The Licensee shall, by December 31, 2010, maintain a water level Monitoring Program Station (ARV-7) at Wolf River.

3. The Licensee shall, by December 31, 2010, maintain a lagoon level Monitoring Program Station (ARV-8) at the Sewage Disposal Facility.

4. The Licensee shall provide the GPS co-ordinates (in degrees, minutes and seconds of latitude and longitude) of all locations where sources of Water are utilized for all purposes and at all Monitoring Program Stations.

5. The Licensee shall confirm the locations and GPS coordinates for all Monitoring Program Stations referred to in Part H Item 1 with an Inspector.

6. The Licensee shall determine the locations and GPS coordinates of any additional Monitoring Program Stations required for any new Waste Disposal Facilities with an Inspector.

7. The Licensee shall measure and record in cubic metres, the monthly and annual quantities of Water extracted for all purposes at Monitoring Program Station ARV-1.

8. The Licensee shall carry out, at a minimum, weekly inspections at Monitoring Program Stations ARV-2a, ARV-5, ARV-6, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, from May to August inclusive, to identify Effluent or Water flow in order to fulfill the monitoring requirements of Part H, Item 9. A record of inspections shall be retained and made available to an Inspector upon request.

9. The Licensee shall sample monthly at Monitoring Program Stations ARV-2a, ARV-4, ARV-5, ARV-6, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, during the months of May to August, inclusive. Samples shall be analyzed for the following parameters:

BOD_5	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Ammonia Nitrogen
Nitrate – Nitrite	Oil and Grease (visual)
Total Phenols	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Arsenic	Total Cadmium
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	Total Phosphorous

10. The Licensee shall conduct the following acute toxicity tests at Monitoring Program Stations ARV-2a and ARV-4, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, once annually between June and September, approximately mid-way through the discharge period:

    a. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout (Reference Method EPS 1/RM/13), July 1990, published by the Department of the Environment, as amended in December 2000, and as may be further amended from time to time
    b. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna (Reference Method EPS 1/RM/14), July 1990, published by the Department of the Environment, as amended in December 2000, and as may be further amended from time to time.

11. The Licensee shall, when flow volumes at Monitoring Program Stations ARV- 2a, ARV-2b and ARV-4 are not sufficient to conduct the tests required by Part H Item 10, collect samples upstream where adequate flow volume exists.

12. The Licensee shall record water elevation monthly, during open water at Monitoring Program Station ARV-7.

13. The Licensee shall record water elevations monthly during thawed conditions at Monitoring Program Station ARV-8.

14. The Licensee shall measure and record in cubic metres the monthly and annual quantities of Sewage sludge removed from the Sewage Disposal Facility at Monitoring Program Station ARV-9.

15. The Licensee shall submit to the Board for review, by December 31, 2010 a revision to the approved Plan entitled "Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan, Hamlet of Arviat" May 2009, revised May 2010, to address the following:

    a. All monitoring requirements listed under Part H of the Licence;
    b. A covering letter from an accredited laboratory confirming acceptance of the Quality Assurance/ Quality Control (QA/QC) Plan for analyses to be performed under this Licence as required under Part H, Item 17.

16. The Licensee shall, at least six (60) days prior to commissioning the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, submit to the Board, for approval in writing, a revision to the Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan, referred to in Part H Item 15, to address the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility.

17. The Licensee shall annually review the QA/QC Plan referred to in Part H, Item 15 and modify it as necessary. The revised QA/QC Plan shall be submitted to the Board for review, accompanied by a current approval letter from an accredited lab and shall meet the standards as set out in Part H, Item 20 and Part H, Item 21 of the Licence.

18. The Licensee shall measure and record the volume of all contaminated soil, from all locations entering the Hydrocarbon Impacted Soil Storage and Treatment Facility.

19. The Licensee shall assess and record the concentration of Petroleum Hydrocarbon Impacted Soil entering any Hydrocarbon Impacted Soil Storage and Treatment Facility from all sources, as per the CCME *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil, User Guide, January 2008*.

20. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board.

21. All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.

22. The Licensee shall include all of the data and information required by the Monitoring Program in the Licensee's Annual Report, as required per Part B, Item 3(a) or as otherwise requested by an Inspector.

23. Modifications to the Monitoring Program may be made only upon written request and subsequent approval of the Board in writing.

provide the findings with recommendations by December 31, 2010[85] as well as the commitments outlined in the Licensee's Work Plan.[86]

Specifically, Part D Item 5 of the Licence requires the Licensee to submit to the Board for approval in writing by December 31, 2010 a Sewage Disposal Facility Report. The Report shall include:

a. As-built drawings and design plans of the Sewage Disposal Facility (including the lagoon and wetland) signed and stamped by an Engineer;
b. A preliminary discharge and wetland hydrology assessment;
c. The results of an inspection by a Geotechnical Engineer of the Sewage Disposal Facility lagoon including its berms and an evaluation of the impact of sewage seepage through the lagoon berms on the environment;
d. An evaluation of the long term impacts of the Sewage Disposal Facility on the environment;
e. A Sludge Management Plan that addresses sludge assessment and disposal methods. The Plan shall be incorporated in to the Sewage Disposal Facility Operations and Maintenance Manual;
f. Recommended measures to optimize the Sewage Disposal Facility; and
g. A schedule for implementing recommended measures.

Solid Waste including Bulky Metal Waste and Hazardous Waste

As identified by INAC[87] at the Hearing, the Hamlet operates a Bulky Metal Waste Area and Hazardous Waste Storage area in addition to the Solid Waste Disposal Facility, and these areas are not addressed in the expired licence NWB3ARV0308. To address this issue, the Board requires the Licensee as a condition in Part D Item 6 of the Licence to, unless otherwise approved by the Board in writing:

a. Dispose of and contain all non-hazardous, non-bulky metal, solid waste at the Solid Waste Disposal Facility;
b. Dispose of and contain all bulky metal waste at the Bulky Metals Area; and
c. Segregate and securely store all hazardous materials and Hazardous Waste within the Hazardous Waste Storage Area in a manner as to prevent the deposit of deleterious substances into any water, until such a time that the materials have been removed for proper disposal at a licensed facility.

To address the issues presented by parties regarding solid waste disposal including management of contaminated soils[88], and runoff management[89], the Board accepts the Licensee's request to include conditions in the Licence to conduct studies and provide the

[85] Transcript, Jim Walls, Nuna Burnside, at p. 35-36, lines 22-11.
[86] Exhibits 3 and 4, Work Plan to Address INAC, DFO and NWB License Compliance Issues, from Jim Walls to Bryan Purdy, dated June 23, 2010.
[87] Transcript, Ian Parsons, INAC, at p. 76 -77, lines 15-8
[88] Transcript, Ian Parson, INAC, at p. 76-77, lines 21-2 and Paula Smith, INAC, at p. 92-93, lines 26-13.
[89] Transcript, Ian Parsons, INAC, at p. 76, lines 5-8 and Paula Smith, EC, at p. 92, lines 10-23.

BURNSIDE
An Aboriginal Owned Company

Appendix B
Photographs

Old sewage lagoons, looking north.
Date: 9/10/2010

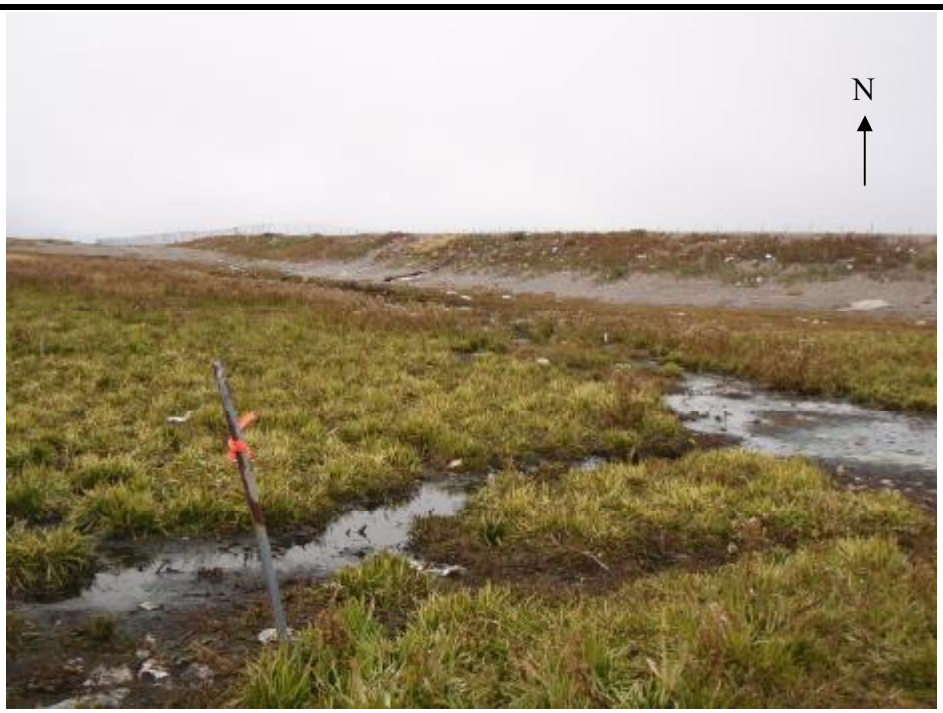
Old sewage lagoons, looking west from road to active sewage lagoon.
Date: 9/10/2010

Looking west along the south side of south berm of old sewage lagoons.
Date: 9/10/10

South-east corner of Old Lagoon 1, looking west.
Date: 9/10/2010

Looking east along the road that goes to active sewage lagoon, abandoned lagoons on right.
Date: 9/10/2010

Looking north towards berm of Old Lagoon 2 from the wetland.
Date: 9/10/2010



Wetland treatment area, looking north towards the berm of old lagoons.
Date: 9/10/2010

BURNSIDE
An Aboriginal Owned Company

Appendix C
Sample Results and Certificates of Analysis

Table C 1 Summary of Water Quality Analysis Abandoned Sewage Lagoons

Parameter	Unit	Detection Limits (Sept)	CCME Standards (Fresh water)	NWB Effluent Quality Limits	9/10/2010 Old Sewage Lagoon 1	9/10/2010 Old Sewage Lagoon 2
Colour	TCU	5			110	86
Electrical Conductivity	S/cm	2			523	324
pH	N/A	-		6 - 9	7.95	7.73
Turbidity	NTU	0.5			6.7	4.7
Total Suspended Solids	mg/L	10		100	<10	<10
Alkalinity (as CaCO3)	mg/L	5			161	83
Bicarbonate (as CaCO3)	mg/L	5			161	83
Total Hardness (as CaCO3)	mg/L	10			81	52
Ammonia as N	mg/L	0.02			20.9	7.64
Nitrate as N	mg/L	0.05			<0.05	0.67
Nitrite as N	mg/L	0.05			<0.05	0.12
Calcium	mg/L	0.05			19.3	12.5
Chloride	mg/L	0.1			60.9	38.6
Fluoride	mg/L	0.05			0.21	0.15
Magnesium	mg/L	0.05			7.91	4.99
Orthophosphate as P	mg/L	0.1			<0.1	<0.1
Potassium	mg/L	0.05			12.1	8.48
Reactive Silica	mg/L	0.05			9.25	7.02
Sodium	mg/L	0.05			47.3	29.9
Sulphate	mg/L	0.1			11.2	10.3
Total Dissolved Solids	mg/L	20			294	200
Total Organic Carbon	mg/L	0.5			28.7	23.9
Total Phosphorus	mg/L	0.05			1.96	1.93
$BOD_{(5)}$	mg/L	1		80	7.2	<6
Fecal Coliforms	MPN/100mL	3			1500	<3
Aluminum	mg/L	0.004	0.1		**0.142**	**0.234**
Arsenic	mg/L	0.003	0.005		0.004	<0.003
Barium	mg/L	0.002			0.011	0.007
Boron	mg/L	0.01			0.108	0.082
Cadmium	mg/L	0.002	0.00054-0.00004[1]		<0.002	<0.002
Chromium Total	mg/L	0.003			<0.003	<0.003
Copper	mg/L	0.003	0.002-0.004[1]		0.009	0.067
Iron	mg/L	0.01	0.30		**2.15**	**1.31**
Lead	mg/L	0.002	0.001-0.007[1]		<0.002	<0.002
Manganese	mg/L	0.002			0.266	0.052
Mercury	mg/L	0.0001	0.000026		<0.0001	<0.0001
Molybdenum	mg/L	0.002	0.073		<0.002	<0.002
Nickel	mg/L	0.003	0.025-0.15[1]		<0.003	<0.003
Selenium	mg/L	0.004	0.001		<0.004	<0.004
Silver	mg/L	0.002	0.0001		<0.002	<0.002
Strontium	mg/L	0.005			0.107	0.057
Thallium	mg/L	0.006	0.0008		<0.006	<0.006
Titanium	mg/L	0.002			0.003	0.004
Uranium	mg/L	0.002			<0.002	<0.002
Vanadium	mg/L	0.002			<0.002	<0.002
inc	mg/L	0.005	0.03		0.006	0.013

BOLD - indicates exceedence of CCME standards

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Updated 2007

[1] Value depends on water hardness, see CCME Guidelines

Table C 2 Summary of Analysis Sewage Lagoon Sludge

Parameter	Unit	Reported Detection Limits	Guidelines			Old Lagoon 1	Old Lagoon 2
			CCME Class A Compost	CCME Class B Compost	CCME Industrial	9/9/2010	9/9/2010
Antimony	g/g	0.8				1.40	2.80
Arsenic	g/g	1	1300	7500	12	3.00	3.00
Barium	g/g	2			2000	140.00	89.00
Beryllium	g/g	0.5				<0.5	<0.5
Boron	g/g	5				10.00	12.00
Boron	g/g	0.1				2.62	3.96
Cadmium	g/g	0.5	21000		22	1.60	1.10
Chromium	g/g	2			87	19	17
Cobalt	g/g	0.5	3400	15000		3.90	4.40
Copper	g/g	1	40000	-	91	**273**	**251**
Lead	g/g	1	15000	50000	600	45.00	20.00
Molybdenum	g/g	0.5	500	2000		2.80	3.30
Nickel	g/g	1	6200	18000	50	13.00	13.00
Selenium	g/g	0.4	200	1400	2.9	2.50	1.80
Silver	g/g	0.2				5.80	4.80
Thallium	g/g	0.4			1	<0.4	<0.4
Uranium	ug/g	0.5			300	1.10	1.60
Vanadium	g/g	1			130	13.0	18.0
inc	g/g	5	70000	185000	360	**533**	**369**
Chromium, Hexavalent	g/g	0.2			1.4	<0.2	<0.2
Cyanide, Free	g/g	0.05			8	<0.05	<0.05
Mercury	g/g	0.01	80	500	50	1.00	0.41
Electrical Conductivity	mS/cm	0.002				0.70	1.56
Sodium Adsorption Ratio	N/A	N/A				1.63	1.70
pH	pH Units					6.36	6.09
Chloride	g/g	2				83	161
Nitrate Nitrite	g/g	1				<1	<1

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Industrial Land Use, Subsurface, Fine Grained
Guidelines for Compost Quality, CCME 2005

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg 153 Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	BW-1 1988754
C6 - C10 (F1)	g/L		25	<25
C6 - C10 (F1 minus BTEX)	g/L		25	<25
C>10 - C16 (F2)	g/L		100	<100
C>10 - C16 (F2 minus Naphthalene)	g/L		100	<100
C6 - C16 (F1 F2)	g/L		100	<100
C>16 - C34 (F3)	g/L		100	<100
C>16 - C34 (F3 minus PAHs)	g/L		100	<100
C>34 - C50 (F4)	g/L		100	<100
C>16 - C50 (F3 F4)	g/L		100	<100
Gravimetric Heavy Hydrocarbons	g/L		500	NA

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988754
The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 PAHs in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	BW-1 1988754
Naphthalene	g/L		0.12	<0.12
Acenaphthylene	g/L		0.11	<0.11
Acenaphthene	g/L		0.10	<0.10
Fluorene	g/L		0.09	<0.09
Phenanthrene	g/L		0.10	<0.10
Anthracene	g/L		0.07	<0.07
Fluoranthene	g/L		0.12	<0.12
Pyrene	g/L		0.12	<0.12
Benzo(a)anthracene	g/L		0.08	<0.08
Chrysene	g/L		0.05	<0.05
Benzo(b)fluoranthene	g/L		0.05	<0.05
Benzo(k)fluoranthene	g/L		0.06	<0.06
Benzo(a)pyrene	g/L		0.01	<0.01
Indeno(1,2,3-cd)pyrene	g/L		0.03	<0.03
Dibenzo(a,h)anthracene	g/L		0.09	<0.09
Benzo(g,h,i)perylene	g/L		0.06	<0.06
2-and 1-methyl Napthalene	g/L		0.20	<0.20
Surrogate	**Unit**	**Acceptable Limits**		
Chrysene-d12	%	60-130		97

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	BW-1 1988754
Dichlorodifluoromethane	g/L		0.20	20
Chloromethane	g/L		0.40	<0.40
Vinyl Chloride	g/L		0.17	<0.17
Bromomethane	g/L		0.20	<0.20
Chloroethane	g/L		0.20	<0.20
Trichlorofluoromethane	g/L		0.40	17
Acetone	g/L		1.0	<1.0
1,1 Dichloroethylene	g/L		0.30	<0.30
Methylene Chloride	g/L		0.30	<0.30
trans- 1,2-dichloroethylene	g/L		0.20	<0.20
Methyl tert-butyl ether	g/L		0.20	<0.20
1,1-Dichloroethane	g/L		0.30	<0.30
Methyl Ethyl Ketone	g/L		1.0	<1.0
cis- 1,2-Dichloroethylene	g/L		0.20	<0.20
Chloroform	g/L		0.20	<0.20
1,2 - Dichloroethane	g/L		0.20	<0.20
1,1,1-Trichloroethane	g/L		0.30	<0.30
Carbon Tetrachloride	g/L		0.20	<0.20
Benzene	g/L		0.20	<0.20
1,2-Dichloropropane	g/L		0.20	<0.20
Trichloroethylene	g/L		0.20	<0.20
Bromodichloromethane	g/L		0.20	<0.20
cis-1,3-Dichloropropene	ug/L		0.20	<0.20
Methyl Isobutyl Ketone	g/L		1.0	<1.0
trans-1,3-Dichloropropene	g/L		0.30	<0.30
1,1,2-Trichloroethane	g/L		0.20	<0.20
Toluene	g/L		0.20	<0.20
2-Hexanone	g/L		0.30	<0.30
Dibromochloromethane	g/L		0.10	<0.10
Ethylene Dibromide	g/L		0.20	<0.20
Tetrachloroethylene	g/L		0.20	<0.20
1,1,1,2-Tetrachloroethane	g/L		0.10	<0.10
Chlorobenzene	g/L		0.10	<0.10

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	BW-1 1988754
Ethylbenzene	g/L		0.10	<0.10
m & p-Xylene	g/L		0.20	<0.20
Bromoform	g/L		0.10	<0.10
Styrene	g/L		0.10	<0.10
1,1,2,2-Tetrachloroethane	g/L		0.10	<0.10
o-Xylene	g/L		0.10	<0.10
1,3-Dichlorobenzene	g/L		0.10	<0.10
1,4-Dichlorobenzene	g/L		0.10	<0.10
1,2-Dichlorobenzene	g/L		0.10	<0.10
1,2,4-Trichlorobenzene	g/L		0.30	<0.30
1,3-Dichloropropene (Cis Trans)	g/L		0.30	<0.30
Xylene Mixture (Total)	g/L		0.20	<0.20
n-Hexane	g/L		0.20	<0.20
Surrogate	**Unit**	**Acceptable Limits**		
Toluene-d8	% Recovery	60-130		100
4-Bromofluorobenzene	% Recovery	70-130		92

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	LF-1 1988705	LF-2 1988707	LF-3 1988716	SL-Wet1 1988725	SL-Wet2 1988736	SL-Wet3 1988742	SL-Wet4 1988748
Aluminum	mg/L		0.004	<0.004	0.006	0.004	0.059	0.033	0.054	0.143
Arsenic	mg/L		0.003	<0.003	0.003	0.003	0.007	0.005	0.006	0.011
Barium	mg/L		0.002	0.045	0.041	0.035	0.006	0.007	0.009	0.015
Boron	mg/L		0.010	0.736	0.805	0.773	0.179	0.176	0.162	0.230
Cadmium	mg/L		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	mg/L		0.05	283	225	169	15.9	20.9	24.4	12.0
Chromium	mg/L		0.003	<0.003	0.006	0.006	0.008	0.006	0.005	0.007
Copper	mg/L		0.003	<0.003	<0.003	<0.003	0.012	0.006	0.011	0.027
Iron	mg/L		0.010	<0.010	0.074	0.020	0.503	1.41	1.28	2.55
Potassium	mg/L		0.05	20.8	30.6	37.5	15.6	14.8	14.7	21.7
Magnesium	mg/L		0.05	24.5	42.1	43.1	8.66	15.9	17.7	9.76
Mercury	mg/L		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	mg/L		0.002	0.045	0.216	0.226	0.226	0.412	0.461	0.274
Molybdenum	mg/L		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium	mg/L		0.05	82.5	171	204	75.5	111	110	94.2
Nickel	mg/L		0.003	<0.003	0.003	<0.003	0.004	0.003	0.005	0.006
Total Phosphorus	mg/L		0.05	1.57	0.34	0.20	0.98	1.56	1.45	4.54
Lead	mg/L		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium	mg/L		0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Silver	mg/L		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Strontium	mg/L		0.005	2.54	1.71	1.31	0.142	0.237	0.214	0.111
Thallium	mg/L		0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Titanium	mg/L		0.002	0.008	0.007	0.006	0.003	0.002	0.003	0.005
Uranium	mg/L		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium	mg/L		0.002	<0.002	<0.002	<0.002	0.004	0.003	0.003	0.006
inc	mg/L		0.005	0.007	0.013	0.009	0.007	<0.005	<0.005	0.022
Fluoride	mg/L		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.50
Chloride	mg/L		0.10	114	267	334	120	204	186	140
Nitrite as N	mg/L		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho phosphate as P	mg/L		0.10	<0.10	<0.10	<0.10	1.53	1.71	0.55	2.33
Bromide	mg/L		0.05	1.42	2.63	2.58	<0.05	1.16	<0.05	<0.05
Nitrate as N	mg/L		0.05	<0.05	0.81	<0.05	1.00	0.30	0.39	0.40
Sulphate	mg/L		0.10	650	518	469	18.4	37.3	26.6	11.5

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	LF-1 1988705	LF-2 1988707	LF-3 1988716	SL-Wet1 1988725	SL-Wet2 1988736	SL-Wet3 1988742	SL-Wet4 1988748
pH	pH Units		NA	7.90	8.03	8.27	7.89	7.82	7.84	8.18
Ammonia as N	mg/L		0.02	<0.02	1.23	0.26	36.5	25.7	18.3	71.9
Total Organic Carbon	mg/L		0.5	36.5	25.8	26.5	28.3	21.0	22.7	61.4
Electrical Conductivity	uS/cm		2	1750	2040	2070	793	1020	957	1030
Total Dissolved Solids	mg/L		20	1440	1520	1450	368	496	484	436
Saturation pH				6.59	6.53	6.70	7.70	7.52	7.43	7.53
% Difference/ Ion Balance			0.1	3.6	3.8	5.6	0.6	4.5	3.6	3.8
Total Hardness (as CaCO3)	mg/L		10	808	735	599	75	118	134	70
Langlier Index				1.31	1.50	1.57	0.19	0.30	0.41	0.65
Carbonate (as CaCO3)	mg/L		5	<5	<5	<5	<5	<5	<5	<5
Bicarbonate (as CaCO3)	mg/L		5	252	322	263	193	186	200	306
Turbidity	NTU		0.5	0.9	3.3	1.6	3.1	4.1	5.2	20.0
Alkalinity (as CaCO3)	mg/L		5	252	322	263	193	186	200	306
Hydroxide (as CaCO3)	mg/L		5	<5	<5	<5	<5	<5	<5	<5
Reactive Silica	mg/L		0.05	15.9	8.84	9.34	12.3	11.4	8.67	14.2
Colour	TCU		5	30	55	49	107	100	131	209

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899

PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

Chromium VI & TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	LF-1 1988705
Chromium VI	mg/L		0.005	<0.005
Total Suspended Solids	mg/L		10	288

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

Chromium VI, Phenols & TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	LF-2 1988707	LF-3 1988716
Chromium VI	mg/L		0.005	<0.005	<0.005
Phenols	mg/L		0.001	0.002	0.001
Total Suspended Solids	mg/L		10	21	<10

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	SL-Wet1 1988725	SL-Wet2 1988736	SL-Wet3 1988742	SL-Wet4 1988748
Total Suspended Solids	mg/L		10	44	<10	<10	78

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 Metals & Inorganics in Soil - Table 1

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	Old Lagoon 1-Soil 1988833	Old Lagoon 2-Soil 1988834	Active Lagoon 1988835
Antimony	g/g	1.0	0.8	1.4	2.8	2.1
Arsenic	g/g	17	1	3	3	1
Barium	g/g	210	2	140	89	56
Beryllium	g/g	1.2	0.5	<0.5	<0.5	<0.5
Boron	g/g		5	10	12	<5
Boron (Hot Water Extractable)	g/g		0.10	2.62	3.96	0.88
Cadmium	g/g	1.0	0.5	1.6	1.1	<0.5
Chromium	g/g	71	2	19	17	14
Cobalt	g/g	21	0.5	3.9	4.4	2.6
Copper	g/g	85	1	273	251	171
Lead	g/g	120	1	45	20	9
Molybdenum	g/g	2.5	0.5	2.8	3.3	1.2
Nickel	g/g	43	1	13	13	9
Selenium	g/g	1.9	0.4	2.5	1.8	3.0
Silver	g/g	0.42	0.2	5.8	4.8	2.7
Thallium	g/g	2.5	0.4	<0.4	<0.4	<0.4
Uranium	ug/g		0.5	1.1	1.6	0.9
Vanadium	g/g	91	1	13	18	13
inc	g/g	160	5	533	369	242
Chromium, Hexavalent	g/g	2.5	0.2	<0.2	<0.2	<0.2
Cyanide, Free	g/g	0.12	0.05	<0.05	<0.05	<0.05
Mercury	g/g	0.23	0.01	1.00	0.41	0.31
Electrical Conductivity (2:1)	mS/cm	0.57	0.002	0.703	1.56	0.792
Sodium Adsorption Ratio (2:1)	N/A	2.4	N/A	1.63	1.70	2.38
pH, 2:1 CaCl2 Extraction	pH Units			6.36	6.09	5.51
Chloride (2:1)	g/g	330	2	83	161	94
Nitrate Nitrite	g/g	61	1	<1	<1	<1

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)

1988833-1988835 EC, SAR, Chloride & Nitrate/Nitrite were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the extract obtained from the 2:1 leaching procedure (2 parts 0.01M CaCl2:1 part soil).

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 Metals in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
Antimony	g/g	1.0	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	g/g	17	1	3	1	2	1	2	4	2
Barium	g/g	210	2	26	35	31	31	22	23	21
Beryllium	g/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	g/g		5	<5	<5	<5	<5	<5	<5	<5
Cadmium	g/g	1.0	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	g/g	71	2	11	15	13	12	8	15	9
Cobalt	g/g	21	0.5	2.7	3.9	3.2	3.2	2.4	2.7	2.4
Copper	g/g	85	1	11	10	18	9	7	6	9
Lead	g/g	120	1	4	4	9	5	4	3	3
Molybdenum	g/g	2.5	0.5	0.7	<0.5	0.6	<0.5	<0.5	1.0	0.5
Nickel	g/g	43	1	6	9	8	7	5	7	5
Selenium	g/g	1.9	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	g/g	0.42	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	g/g	2.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	ug/g		0.5	1.2	1.4	1.0	1.3	0.9	0.9	1.2
Vanadium	g/g	91	1	14	18	14	16	12	13	14
inc	g/g	160	5	25	34	54	20	159	125	31

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

Phenols in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
Phenols, Total	mg/kg		1	<1	<1	<1	<1	<1	<1	<1

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

(P & T) BTEX - Soil (GC/MS)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
Benzene	g/g	0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	g/g	0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ethylbenzene	g/g	0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
m & p-Xylene	g/g		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	g/g		0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylene Mixture (Total)	g/g	0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Surrogate	Unit	Acceptable Limits								
Toluene-d8	% Recovery	60-130		113	106	112	94	100	113	99
4-Bromofluorobenzene	% Recovery	70-130		115	103	109	122	120	104	113

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)
1988818-1988845 Results are based on the dry weight of the soil.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg 153 Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	ARV-2 1988848
C6 - C10 (F1)	g/L		25	<25
C6 - C10 (F1 minus BTEX)	g/L		25	<25
C>10 - C16 (F2)	g/L		100	<100
C>10 - C16 (F2 minus Naphthalene)	g/L		100	<100
C6 - C16 (F1 F2)	g/L		100	<100
C>16 - C34 (F3)	g/L		100	<100
C>16 - C34 (F3 minus PAHs)	g/L		100	<100
C>34 - C50 (F4)	g/L		100	<100
C>16 - C50 (F3 F4)	g/L		100	<100
Gravimetric Heavy Hydrocarbons	g/L		500	NA

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988848
The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil (PAHs Incl.)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
C6 - C10 (F1)	g/g		5	<5	11	<5	<5	<5	<5	<5
C6 - C10 (F1 minus BTEX)	g/g		5	<5	11	<5	<5	<5	<5	<5
C>10 - C16 (F2)	g/g		10	1200	3400	240	130	<10	<10	<10
C>10 - C16 (F2 minus Naphthalene)	g/g		10	1200	3400	240	130	<10	<10	<10
C>16 - C34 (F3)	g/g		50	430	1800	9100	130	26000	32000	24000
C>16 - C34 (F3 minus PAHs)	g/g		50	430	1800	9100	130	26000	32000	24000
C>34 - C50 (F4)	g/g		50	<50	<50	730	79	4800	6000	4400
Gravimetric Heavy Hydrocarbons	g/g		50	NA	NA	NA	NA	NA	NA	NA
Moisture Content	%		0.1	7.2	8.4	4.2	3.0	7.5	2.2	6.3

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988818-1988845 Results are based on sample dry weight.
The C6-C10 fraction is calculated using toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
Total C6 - C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 PAHs in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
Naphthalene	g/g		0.03	<0.03	0.04	0.04	<0.03	0.03	<0.03	0.05
Acenaphthylene	g/g		0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthene	g/g		0.03	<0.03	0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Fluorene	g/g		0.02	0.02	0.15	<0.02	<0.02	<0.02	<0.02	<0.02
Phenanthrene	g/g		0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	g/g		0.02	<0.02	0.03	<0.02	<0.02	0.02	<0.02	<0.02
Pyrene	g/g		0.02	0.02	0.06	0.03	<0.02	0.04	0.02	0.03
Benzo(a)anthracene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.21	0.11	0.14
Chrysene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.11	0.07	0.10
Benzo(b)fluoranthene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.07	0.05	0.04
Benzo(k)fluoranthene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02
Benzo(a)pyrene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.13	0.09	0.07
Indeno(1,2,3-cd)pyrene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.05	0.03	0.03
Dibenz(a,h)anthracene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(g,h,i)perylene	g/g		0.02	<0.02	<0.02	<0.02	<0.02	0.08	0.05	0.04
2-and 1-methyl Naphthalene	g/g		0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
Surrogate	Unit	Acceptable Limits								
Chrysene-d12	%	60-130		79	89	100	93	89	95	89

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard
1988818-1988845 Results are based on the dry weight of the soil.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Reg. 153 PAHs in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	ARV-2 1988848
Naphthalene	g/L		0.12	<0.12
Acenaphthylene	g/L		0.11	<0.11
Acenaphthene	g/L		0.10	<0.10
Fluorene	g/L		0.09	<0.09
Phenanthrene	g/L		0.10	<0.10
Anthracene	g/L		0.07	<0.07
Fluoranthene	g/L		0.12	<0.12
Pyrene	g/L		0.12	<0.12
Benzo(a)anthracene	g/L		0.08	<0.08
Chrysene	g/L		0.05	<0.05
Benzo(b)fluoranthene	g/L		0.05	<0.05
Benzo(k)fluoranthene	g/L		0.06	<0.06
Benzo(a)pyrene	g/L		0.01	<0.01
Indeno(1,2,3-cd)pyrene	g/L		0.03	<0.03
Dibenzo(a,h)anthracene	g/L		0.09	<0.09
Benzo(g,h,i)perylene	g/L		0.06	<0.06
2-and 1-methyl Napthalene	g/L		0.20	<0.20
Surrogate	**Unit**	**Acceptable Limits**		
Chrysene-d12	%	60-130		98

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	ARV-2 1988848
Dichlorodifluoromethane	g/L		0.80	<0.80
Chloromethane	g/L		1.60	<1.60
Vinyl Chloride	g/L		0.68	<0.68
Bromomethane	g/L		0.80	<0.80
Chloroethane	g/L		0.80	<0.80
Trichlorofluoromethane	g/L		1.60	<1.60
Acetone	g/L		4.0	<4.0
1,1 Dichloroethylene	g/L		1.20	<1.20
Methylene Chloride	g/L		1.20	<1.20
trans- 1,2-dichloroethylene	g/L		0.80	<0.80
Methyl tert-butyl ether	g/L		0.80	<0.80
1,1-Dichloroethane	g/L		1.20	<1.20
Methyl Ethyl Ketone	g/L		4.0	<4.0
cis- 1,2-Dichloroethylene	g/L		0.80	<0.80
Chloroform	g/L		0.80	<0.80
1,2 - Dichloroethane	g/L		0.80	<0.80
1,1,1-Trichloroethane	g/L		1.20	<1.20
Carbon Tetrachloride	g/L		0.80	<0.80
Benzene	g/L		0.80	<0.80
1,2-Dichloropropane	g/L		0.80	<0.80
Trichloroethylene	g/L		0.80	<0.80
Bromodichloromethane	g/L		0.80	<0.80
cis-1,3-Dichloropropene	ug/L		0.80	<0.80
Methyl Isobutyl Ketone	g/L		4.0	<4.0
trans-1,3-Dichloropropene	g/L		1.20	<1.20
1,1,2-Trichloroethane	g/L		0.80	<0.80
Toluene	g/L		0.80	<0.80
2-Hexanone	g/L		1.20	<1.20
Dibromochloromethane	g/L		0.40	<0.40
Ethylene Dibromide	g/L		0.80	<0.80
Tetrachloroethylene	g/L		0.80	<0.80
1,1,1,2-Tetrachloroethane	g/L		0.40	<0.40
Chlorobenzene	g/L		0.40	<0.40

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	ARV-2 1988848
Ethylbenzene	g/L		0.40	<0.40
m & p-Xylene	g/L		0.80	<0.80
Bromoform	g/L		0.40	<0.40
Styrene	g/L		0.40	<0.40
1,1,2,2-Tetrachloroethane	g/L		0.40	<0.40
o-Xylene	g/L		0.40	<0.40
1,3-Dichlorobenzene	g/L		0.40	<0.40
1,4-Dichlorobenzene	g/L		0.40	<0.40
1,2-Dichlorobenzene	g/L		0.40	<0.40
1,2,4-Trichlorobenzene	g/L		1.20	<1.20
1,3-Dichloropropene (Cis Trans)	g/L		1.20	<1.20
Xylene Mixture (Total)	g/L		0.80	<0.80
n-Hexane	g/L		0.80	<0.80
Surrogate	**Unit**	**Acceptable Limits**		
Toluene-d8	% Recovery	60-130		99
4-Bromofluorobenzene	% Recovery	70-130		92

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988848 Dilution factor=4
The sample was diluted because the sample was foamy. The reporting detection limit has been corrected for the dilution factor used.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

PCBs (soil)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Soil

Parameter	Unit	G / S	RDL	BW-P1-A 1988818	BW-P1-B 1988823	BW-P2-A 1988827	BW-P2-B 1988830	HW-1 1988837	HW-2 1988842	HW-3 1988845
PCBs	g/g		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate	Unit	Acceptable Limits								
Decachlorobiphenyl	%	60-130		97	120	80	90	63	82	89

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard
1988818-1988845 Results are based on the dry weight of soil extracted.

Certified By: Jordy Takewaki

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	Old Lagoon 1-Water 1988850	Old Lagoon 2-Water 1989165	SL-1 1989172
Aluminum	mg/L		0.004	0.142	0.234	0.256
Arsenic	mg/L		0.003	0.004	<0.003	<0.003
Barium	mg/L		0.002	0.011	0.007	0.006
Boron	mg/L		0.010	0.108	0.082	0.162
Cadmium	mg/L		0.002	<0.002	<0.002	<0.002
Calcium	mg/L		0.05	19.3	12.5	7.10
Chromium	mg/L		0.003	<0.003	<0.003	<0.003
Copper	mg/L		0.003	0.009	0.009	0.067
Iron	mg/L		0.010	2.15	1.31	0.455
Potassium	mg/L		0.05	12.1	8.48	17.9
Magnesium	mg/L		0.05	7.91	4.99	2.96
Mercury	mg/L		0.0001	<0.0001	<0.0001	<0.0001
Manganese	mg/L		0.002	0.266	0.052	0.047
Molybdenum	mg/L		0.002	<0.002	<0.002	<0.002
Sodium	mg/L		0.05	47.3	29.9	54.3
Nickel	mg/L		0.003	0.004	<0.003	<0.003
Total Phosphorus	mg/L		0.05	1.96	1.93	7.23
Lead	mg/L		0.002	<0.002	<0.002	<0.002
Selenium	mg/L		0.004	<0.004	<0.004	<0.004
Silver	mg/L		0.002	<0.002	<0.002	<0.002
Strontium	mg/L		0.005	0.107	0.057	0.022
Thallium	mg/L		0.006	<0.006	<0.006	<0.006
Titanium	mg/L		0.002	0.003	0.004	0.005
Uranium	mg/L		0.002	<0.002	<0.002	<0.002
Vanadium	mg/L		0.002	<0.002	<0.002	<0.002
inc	mg/L		0.005	0.006	0.013	0.060
Fluoride	mg/L		0.05	0.21	0.15	0.42
Chloride	mg/L		0.10	60.9	38.6	55.8
Nitrite as N	mg/L		0.05	<0.05	0.12	<0.05
Ortho phosphate as P	mg/L		0.10	<0.10	<0.10	<0.10
Bromide	mg/L		0.05	0.19	0.15	<0.05
Nitrate as N	mg/L		0.05	<0.05	0.67	<0.05

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	Old Lagoon 1-Water 1988850	Old Lagoon 2-Water 1989165	SL-1 1989172
Sulphate	mg/L		0.10	11.2	10.3	11.1
pH	pH Units		NA	7.95	7.73	7.90
Ammonia as N	mg/L		0.02	20.9	7.64	49.7
Total Organic Carbon	mg/L		0.5	28.7	23.9	113
Electrical Conductivity	uS/cm		2	523	324	737
Total Dissolved Solids	mg/L		20	294	200	298
Saturation pH				7.72	8.20	7.95
% Difference/ Ion Balance			0.1	2.7	1.1	0.6
Total Hardness (as CaCO3)	mg/L		10	81	52	30
Langlier Index				0.23	-0.47	-0.05
Carbonate (as CaCO3)	mg/L		5	<5	<5	<5
Bicarbonate (as CaCO3)	mg/L		5	161	83	253
Turbidity	NTU		0.5	6.7	4.7	23.0
Alkalinity (as CaCO3)	mg/L		5	161	83	253
Hydroxide (as CaCO3)	mg/L		5	<5	<5	<5
Reactive Silica	mg/L		0.05	9.25	7.02	14.7
Colour	TCU		5	110	86	208

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T434896

PROJECT NO: N-015746

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

TSS (Water)

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE T PE: Water

Parameter	Unit	G / S	RDL	Old Lagoon 1-Water 1988850	Old Lagoon 2-Water 1989165	SL-1 1989172
Total Suspended Solids	mg/L		10	<10	<10	156

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 10T434896

PROJECT NO: N-015746

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4 1 2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANAL SIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Antimony	1.0	1.4
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Cadmium	1.0	1.6
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Copper	85	273
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Electrical Conductivity (2:1)	0.57	0.703
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Mercury	0.23	1.00
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Molybdenum	2.5	2.8
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Selenium	1.9	2.5
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Silver	0.42	5.8
1988833	Old Lagoon 1-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	inc	160	533
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Antimony	1.0	2.8
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Cadmium	1.0	1.1
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Copper	85	251
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Electrical Conductivity (2:1)	0.57	1.56
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Mercury	0.23	0.41
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Molybdenum	2.5	3.3
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Silver	0.42	4.8
1988834	Old Lagoon 2-Soil	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	inc	160	369
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Antimony	1.0	2.1
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Copper	85	171
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Electrical Conductivity (2:1)	0.57	0.792
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Mercury	0.23	0.31
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Selenium	1.9	3.0
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	Silver	0.42	2.7
1988835	Active Lagoon	T1(All)	O. Reg. 153 Metals & Inorganics in Soil - Table 1	inc	160	242

R.J. BURNSIDE & ASSOCIATES LTD
ATTN: STEPHANIE CHARITY / JIM WALLS
292 SPEEDVALE AVE., WEST
UNIT #7
GUELPH ON N1H 1C4
Phone: 519-823-4995

Date Received: 13-SEP-10
Report Date: 22-SEP-10 15:38 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L930600
Project P.O. #: NOT SUBMITTED
Job Reference: N-015746
Legal Site Desc:
C of C Numbers:

Paul Nicolas
Account Manager

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L930600-1 ARV-2							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:35							
Matrix: WASTE WATER							
Nitrate + Nitrite							
Anions scan (IC)							
Nitrite-N	<0.25		0.25	mg/L		14-SEP-10	R1467253
Nitrate-N	<0.25		0.25	mg/L		14-SEP-10	R1467253
Sulfate	475		2.5	mg/L		14-SEP-10	R1467253
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.35		0.35	mg/L		15-SEP-10	
Miscellaneous Parameters							
Ammonia as N	13.3		0.050	mg/L		21-SEP-10	R1473786
Biochemical Oxygen Demand	<6.0		6.0	mg/L	13-SEP-10	18-SEP-10	R1470801
Conductivity	2630		0.40	umhos/cm		13-SEP-10	R1465201
Fecal Coliforms	38		3	MPN/100mL		16-SEP-10	R1470203
Mercury (Hg)-Total	<0.000050		0.000050	mg/L	17-SEP-10	17-SEP-10	R1473006
Phenols (4AAP)	0.0020		0.0010	mg/L	15-SEP-10	15-SEP-10	R1467205
Total Oil and Grease	<1.0		1.0	mg/L	16-SEP-10	17-SEP-10	R1470248
Total Suspended Solids	8.0		5.0	mg/L		16-SEP-10	R1469793
pH	8.21		0.10	pH units		13-SEP-10	R1465201
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.0095		0.0050	mg/L	14-SEP-10	14-SEP-10	R1466569
Antimony (Sb)-Total	0.00410		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Arsenic (As)-Total	0.00482		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Barium (Ba)-Total	0.0458		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Boron (B)-Total	1.34		0.010	mg/L	14-SEP-10	14-SEP-10	R1466569
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	14-SEP-10	14-SEP-10	R1466569
Calcium (Ca)-Total	230		0.10	mg/L	14-SEP-10	14-SEP-10	R1466569
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Chromium (Cr)-Total	<0.0010		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569
Cobalt (Co)-Total	0.00051		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Copper (Cu)-Total	0.00149		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Iron (Fe)-Total	0.529		0.020	mg/L	14-SEP-10	14-SEP-10	R1466569
Lead (Pb)-Total	0.000145		0.000090	mg/L	14-SEP-10	14-SEP-10	R1466569
Lithium (Li)-Total	0.0318		0.0020	mg/L	14-SEP-10	14-SEP-10	R1466569
Magnesium (Mg)-Total	49.0		0.010	mg/L	14-SEP-10	14-SEP-10	R1466569
Manganese (Mn)-Total	0.599		0.00030	mg/L	14-SEP-10	14-SEP-10	R1466569
Molybdenum (Mo)-Total	0.00036		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Nickel (Ni)-Total	<0.0020		0.0020	mg/L	14-SEP-10	14-SEP-10	R1466569
Phosphorus (P)-Total	0.56		0.20	mg/L	14-SEP-10	14-SEP-10	R1466569
Potassium (K)-Total	44.0		0.020	mg/L	14-SEP-10	14-SEP-10	R1466569
Rubidium (Rb)-Total	0.0375		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Selenium (Se)-Total	<0.0010		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569
Silicon (Si)-Total	4.79		0.050	mg/L	14-SEP-10	14-SEP-10	R1466569
Silver (Ag)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Sodium (Na)-Total	243		0.030	mg/L	14-SEP-10	14-SEP-10	R1466569
Strontium (Sr)-Total	1.66		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Thorium (Th)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Tin (Sn)-Total	0.00022		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Titanium (Ti)-Total	0.00299		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Tungsten (W)-Total	<0.0010		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L930600-1 ARV-2							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:35							
Matrix: WASTE WATER							
Total Metals by ICP-MS							
Uranium (U)-Total	0.00063		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Vanadium (V)-Total	0.00061		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Zinc (Zn)-Total	0.0160		0.0050	mg/L	14-SEP-10	14-SEP-10	R1466569
Zirconium (Zr)-Total	0.00043		0.00040	mg/L	14-SEP-10	14-SEP-10	R1466569
L930600-2 ARV-4							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:15							
Matrix: WASTE WATER							
Nitrate + Nitrite							
Anions scan (IC)							
Nitrite-N	0.284		0.050	mg/L		14-SEP-10	R1467253
Nitrate-N	1.23		0.050	mg/L		14-SEP-10	R1467253
Sulfate	6.99		0.50	mg/L		14-SEP-10	R1467253
Nitrate+Nitrite							
Nitrate and Nitrite as N	1.51		0.071	mg/L		15-SEP-10	
Miscellaneous Parameters							
Ammonia as N	28.2		0.050	mg/L		21-SEP-10	R1473786
Biochemical Oxygen Demand	65.0		6.0	mg/L	13-SEP-10	18-SEP-10	R1470801
Conductivity	1020		0.40	umhos/cm		13-SEP-10	R1465201
Fecal Coliforms	2100		3	MPN/100mL		16-SEP-10	R1470203
Mercury (Hg)-Total	<0.000050		0.000050	mg/L	17-SEP-10	17-SEP-10	R1473006
Phenols (4AAP)	<0.01	DLM	0.010	mg/L	15-SEP-10	15-SEP-10	R1467205
Total Oil and Grease	1.3		1.0	mg/L	16-SEP-10	17-SEP-10	R1470248
Total Suspended Solids	169		5.0	mg/L		16-SEP-10	R1469793
pH	8.12		0.10	pH units		13-SEP-10	R1465201
Total Metals by ICP-MS							
Aluminum (Al)-Total	0.325		0.0050	mg/L	14-SEP-10	14-SEP-10	R1466569
Antimony (Sb)-Total	0.00033		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Arsenic (As)-Total	0.0107		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Barium (Ba)-Total	0.0349		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Beryllium (Be)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Bismuth (Bi)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Boron (B)-Total	0.254		0.010	mg/L	14-SEP-10	14-SEP-10	R1466569
Cadmium (Cd)-Total	0.000092		0.000010	mg/L	14-SEP-10	14-SEP-10	R1466569
Calcium (Ca)-Total	22.7		0.10	mg/L	14-SEP-10	14-SEP-10	R1466569
Cesium (Cs)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Chromium (Cr)-Total	0.0018		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569
Cobalt (Co)-Total	0.00229		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Copper (Cu)-Total	0.0394		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Iron (Fe)-Total	5.90		0.020	mg/L	14-SEP-10	14-SEP-10	R1466569
Lead (Pb)-Total	0.00152		0.000090	mg/L	14-SEP-10	14-SEP-10	R1466569
Lithium (Li)-Total	0.0067		0.0020	mg/L	14-SEP-10	14-SEP-10	R1466569
Magnesium (Mg)-Total	14.4		0.010	mg/L	14-SEP-10	14-SEP-10	R1466569
Manganese (Mn)-Total	0.349		0.00030	mg/L	14-SEP-10	14-SEP-10	R1466569
Molybdenum (Mo)-Total	0.00080		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Nickel (Ni)-Total	0.0088		0.0020	mg/L	14-SEP-10	14-SEP-10	R1466569
Phosphorus (P)-Total	5.81		0.20	mg/L	14-SEP-10	14-SEP-10	R1466569
Potassium (K)-Total	24.7		0.020	mg/L	14-SEP-10	14-SEP-10	R1466569
Rubidium (Rb)-Total	0.0279		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Selenium (Se)-Total	<0.0010		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569
Silicon (Si)-Total	6.32		0.050	mg/L	14-SEP-10	14-SEP-10	R1466569

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L930600-2 ARV-4							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:15							
Matrix: WASTE WATER							
Total Metals by ICP-MS							
Silver (Ag)-Total	0.00025		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Sodium (Na)-Total	116		0.030	mg/L	14-SEP-10	14-SEP-10	R1466569
Strontium (Sr)-Total	0.323		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Thallium (Tl)-Total	<0.00010		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Thorium (Th)-Total	0.00032		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Tin (Sn)-Total	0.00082		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Titanium (Ti)-Total	0.0196		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Tungsten (W)-Total	<0.0010		0.0010	mg/L	14-SEP-10	14-SEP-10	R1466569
Uranium (U)-Total	0.00044		0.00010	mg/L	14-SEP-10	14-SEP-10	R1466569
Vanadium (V)-Total	0.00470		0.00020	mg/L	14-SEP-10	14-SEP-10	R1466569
Zinc (Zn)-Total	0.0241		0.0050	mg/L	14-SEP-10	14-SEP-10	R1466569
Zirconium (Zr)-Total	0.00199		0.00040	mg/L	14-SEP-10	14-SEP-10	R1466569
L930600-3 OLD LAGOON 1							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 14:45							
Matrix: WASTE WATER							
Miscellaneous Parameters							
Biochemical Oxygen Demand	7.2		6.0	mg/L	13-SEP-10	18-SEP-10	R1470801
Fecal Coliforms	1500		3	MPN/100mL		16-SEP-10	R1470183
L930600-4 OLD LAGOON 2							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 14:30							
Matrix: WASTE WATER							
Miscellaneous Parameters							
Biochemical Oxygen Demand	<6.0		6.0	mg/L	13-SEP-10	18-SEP-10	R1470801
Fecal Coliforms	<3		3	MPN/100mL		16-SEP-10	R1470183
L930600-5 SL-1							
Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 15:00							
Matrix: WASTE WATER							
Miscellaneous Parameters							
Biochemical Oxygen Demand	420		6.0	mg/L	13-SEP-10	18-SEP-10	R1470801
Fecal Coliforms	15000		3	MPN/100mL		16-SEP-10	R1470183

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Numbe	Client ID	Qualifier	Description
L930600-1	ARV-2	EHR	Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted For Sample Matrix Effects

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS5-IC-WP	Water	Anions scan (IC)	EPA 300.1 IC
This analysis is carried out using procedures adapted from EPA Method 300.1 "Determination of Inorganic Anions in Drinking Water by Ion Chromatography".			
BOD-WP	Water	Biochemical Oxygen Demand (BOD)	APHA 5210 B
The sample is incubated for 5 days at 20 degrees Celcius. Comparison of dissolved oxygen content at the beginning and end of incubation provides a measure of biochemical oxygen demand. If carbonaceous BOD is requested, TCMP is added to the sample to chemically inhibit nitrogenous oxygen demand. If soluble BOD is requested, the sample is filtered prior to analysis. Surface waters have a DL of 1 mg/L. Effluents are diluted according to their history and will have a sample DL of 6 mg/L or greater, depending on the dilutions used.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
FC-MPN-WP	Water	Fecal Coliform	APHA 9221A-C
The Most Probable Number (MPN) method is based on the Multiple Tube Fermentation technique. The results of examination of replicate tubes and dilutions of a sample are reported after confirmations specific to total coliform, fecal coliform and E. coli are performed. Results are reported in MPN/100 mL for water and MPN/gram for food and solid samples.			
HG-T-CVAF-WP	Water	Mercury Total	EPA245.7 V2.0
Mercury in filtered and unfiltered waters is oxidized with Bromine monochloride and analyzed by cold-vapour atomic fluorescence spectrometry.			
MET-T-L-MS-WP	Water	Total Metals by ICP-MS	U.S. EPA 200.8-TL
Total Metals by ICP-MS: This analysis is carried out using sample preparation procedures adapted from Standard Methods for the examination of Water and Wastewater Method 3030E and analytical procedures adapted from U.S EPA Method 200.8 for analyis of metals by inductively coupled-mass spectrometery.			
NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F
Ammonia - Colourimeric using Salicylate-nitroprusside and hypochlorite, in an alkaline phosphate buffer.			
NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
OGG-IR-WP	Water	Total Oil and Grease	APHA METHOD 5520C
PH-WP	Water	pH	APHA 4500H
pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
PHENOLS-4AAP-WT	Water	Phenols (4AAP)	EPA 9066
An automated method is used to distill the sample. The distillate is then buffered to pH 9.4 which reacts with 4AAP and potassium ferricyanide to form a red complex which is measured colorimetrically.			
SOLIDS-TOTSUS-WP	Water	Total Suspended Solids	APHA 2540
The residue retained by a prepared 1.5 um Whatman 934-AH glass microfibre filter dried at 105 degrees C.			

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

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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
WP	ALS LABORATORY GROUP - WINNIPEG, MANITOBA, CANADA
WT	ALS LABORATORY GROUP - 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.

Legend:

Limit	99% Confidence Interval (Laboratory Control Limits)
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
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	10-SEP-10 11:35	13-SEP-10 12:52	0.25	73	hours	EHTR-FM
	2	10-SEP-10 11:15	13-SEP-10 12:52	0.25	74	hours	EHTR-FM
Anions and Nutrients							
Anions scan (IC)							
	1	10-SEP-10 11:35	14-SEP-10 15:19	48	100	hours	EHTR
	2	10-SEP-10 11:15	14-SEP-10 15:19	48	100	hours	EHTR
Bacteriological Tests							
Fecal Coliform							
	1	10-SEP-10 11:35	13-SEP-10 08:54	48	69	hours	EHTR
	2	10-SEP-10 11:15	13-SEP-10 08:54	48	70	hours	EHTR
	3	10-SEP-10 14:45	13-SEP-10 14:59	48	72	hours	EHTR
	4	10-SEP-10 14:30	13-SEP-10 14:59	48	72	hours	EHTR
	5	10-SEP-10 15:00	13-SEP-10 14:59	48	72	hours	EHTR
Aggregate Organics							
Biochemical Oxygen Demand (BOD)							
	1	10-SEP-10 11:35	13-SEP-10 08:48	48	69	hours	EHTR
	2	10-SEP-10 11:15	13-SEP-10 08:48	48	70	hours	EHTR
	3	10-SEP-10 14:45	13-SEP-10 08:48	48	66	hours	EHTR
	4	10-SEP-10 14:30	13-SEP-10 08:48	48	66	hours	EHTR
	5	10-SEP-10 15:00	13-SEP-10 08:48	48	66	hours	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L930600 were received on 13-SEP-10 11:34.

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.

BURNSIDE
An Aboriginal Owned Company

Appendix D
CCME Guidelines

Canadian Water Quality Guidelines for the Protection of Aquatic Life

SUMMARY TABLE

Update 7.0
September 2007

Summary of Canadian water quality guidelines for the protection of aquatic life.

	Freshwater		Marine	
Parameter[a]	**Concentration (µg·L^{-1})**	**Date[b]**	**Concentration (µg·L^{-1})**	**Date[b]**
Acenaphthene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Acridine [See Polycyclic aromatic hydrocarbons (PAHs)]				
Aldicarb	1[c]	1993	0.15[c]	1993
Aldrin + Dieldrin[d]	~~0.004~~[e,f]	1987		
Aluminium[d]	5–100[g]	1987		
Ammonia (total)	see factsheet	2001		
Ammonia (un-ionized)	19[h]	2001		
Aniline	2.2[i]	1993	Insufficient data	1993
Anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Arsenic[j]	5.0[k]	1997	12.5[c]	1997
Atrazine	1.8[i]	1989		
Benz*(a)*anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Benzene[j]	370[c, k]	1999	110[c]	1999
Benzo*(a)*pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]				
2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane [See DDT (total)]				
Bromacil	5.0[c,i]	1997	Insufficient data	1997
Bromoform [See Halogenated methanes, Tribromomethane]				
Bromoxynil	5.0[i]	1993	Insufficient data	1993
Cadmium	0.017[c,l]	1996	0.12[i]	1996
Captan	1.3[c]	1991		
Carbaryl	0.20[i]	1997	0.32[c,i]	1997
Carbofuran	1.8[i]	1989		
Carbon tetrachloride [See Halogenated methanes, Tetrachloromethane]				
Chlordane[d]	~~0.006~~[e,f]	1987		
Chlorinated benzenes				
Monochlorobenzene	1.3[c,k]	1997	25[c,k]	1997
1,2-Dichlorobenzene	0.70[c,k]	1997	42[c,k]	1997
1,3-Dichlorobenzene	150[c,k]	1997	Insufficient data[k]	1997
1,4-Dichlorobenzene	26[c,k]	1997	Insufficient data[k]	1997
1,2,3-Trichlorobenzene	8.0[c,k]	1997	Insufficient data[k]	1997
1,2,4-Trichlorobenzene	24[c,k]	1997	5.4[c,k]	1997
1,3,5-Trichlorobenzene[d]	Insufficient data[k]	1997	Insufficient data[k]	1997

Continued.

Parameter[a]	Freshwater		Marine	
	Concentration ($\mu g \cdot L^{-1}$)	Date[b]	Concentration ($\mu g \cdot L^{-1}$)	Date[b]
Chlorinated benzenes—Continued				
1,2,3,4-Tetrachlorobenzene	1.8[c,k]	1997	Insufficient data[k]	1997
1,2,3,5-Tetrachlorobenzene[d]	Insufficient data[k]	1997	Insufficient data[k]	1997
1,2,4,5-Tetrachlorobenzene[d]	Insufficient data[k]	1997	Insufficient data[k]	1997
Pentachlorobenzene	6.0[c,k]	1997	Insufficient data[k]	1997
Hexachlorobenzene[d]	Insufficient data[e,f,k]	1997	Insufficient data[k]	1997
Chlorinated ethanes				
1,2-Dichloroethane	100[c,i]	1991	Insufficient data	1991
1,1,1-Trichloroethane	Insufficient data	1991	Insufficient data	1991
1,1,2,2-Tetrachloroethane	Insufficient data	1991	Insufficient data	1991
Chlorinated ethenes				
1,1,2-Trichloroethene (Tichloroethylene; TCE)	21[c,i]	1991	Insufficient data	1991
1,1,2,2-Tetrachloroethene (Tetrachloroethylene; PCE)	111[c,i]	1993	Insufficient data	1993
Chlorinated methanes [See Halogenated methanes]				
Chlorinated phenols[d]				
Monochlorophenols	7	1987		
Dichlorophenols	0.2	1987		
Trichlorophenols	18	1987		
Tetrachlorophenols	1	1987		
Pentachlorophenol (PCP)	0.5	1987		
Chlorine, reactive [See Reactive chlorine species]				
Chloroform [See Halogenated methanes, Trichloromethane]				
4-Chloro-2-methyl phenoxy acetic acid [See MCPA]				
Chlorothalonil	0.18[c]	1994	0.36[c]	1994
Chlorpyrifos	0.0035	1997	0.002[c]	1997
Chromium				
Trivalent chromium (Cr(III))	8.9[c,k]	1997	56[c,k]	1997
Hexavalent chromium (Cr(VI))	1.0[k]	1997	1.5[k]	1997
Chrysene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Colour	Narrative	1999	Narrative	1999
Copper[d]	2–4[m]	1987		
Cyanazine	2.0[c,i]	1990		
Cyanide[d]	5 (as free CN)	1987		
DDAC (Didecyl dimethyl ammonium chloride)	1.5[c]	1999	Insufficient data	1999
DDT (total)[d] (2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane; dichloro diphenyl trichloroethane)	~~0.001~~[e,f]	1987		
Debris (litter/settleable matter)			Narrative[c]	1996

Continued.

	Freshwater		Marine	
Parameter[a]	**Concentration ($\mu g \cdot L^{-1}$)**	**Date[b]**	**Concentration ($\mu g \cdot L^{-1}$)**	**Date[b]**
Deltamethrin	0.0004	1997	Insufficient data	1997
Deposited bedload sediment [See Total particulate matter]				
Dibromochloromethane [See Halogenated methanes]				
Dicamba	10[c,i]	1993		
Dichlorobenzene [See Chlorinated benzenes]				
Dichlorobromomethane [See Halogenated methanes]				
Dichloro diphenyl trichloroethane [See DDT (total)]				
Dichloroethane [See Chlorinated ethanes]				
Dichloroethylene [See Chlorinated ethanes, 1,2-Dichloroethane]				
Dichloromethane [See Halogenated methanes]				
Dichlorophenols [See Chlorinated phenols]				
2,4-Dichlorophenoxyacetic acid [see Phenoxy herbicides]				
Diclofop-methyl	6.1	1993		
Didecyl dimethyl ammonium chloride [See DDAC]				
Diethylene glycol [See Glycols]				
Di(2-ethylhexyl) phthalate [See Phthalate esters]				
Diisopropanolamine (DIPA)[aa]	1600[c]	2005	Insufficient data	2005
Dimethoate	6.2[c]	1993	Insufficient data	1993
Di-*n*-butyl phthalate [See Phthalate esters]				
Di-*n*-octyl phthalate [See Phthalate esters]				
Dinoseb	0.05	1992		
Dissolved gas supersaturation	Narrative	1999	Narrative	1999
Dissolved oxygen	5500–9500[k,n]	1999	>8000 and Narrative[c,k]	1996
Endosulfan[d]	0.02	1987		
Endrin[d]	~~0.0023~~[e,f]	1987		
Ethylbenzene[j]	90[c,k]	1996	25[c,k]	1996
Ethylene glycol [See Glycols]				
Fluoranthene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Fluorene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Glycols				
Ethylene glycol	192 000[k]	1997	Insufficient data	1997
Diethylene glycol	Insufficient data[k]	1997	Insufficient data	1997
Propylene glycol	500 000[k]	1997	Insufficient data	1997
Glyphosate	65[c]	1989		

Continued

Parameter[a]	Freshwater		Marine	
	Concentration ($\mu g \cdot L^{-1}$)	Date[b]	Concentration ($\mu g \cdot L^{-1}$)	Date[b]
Halogenated methanes				
Monochloromethane (Methyl chloride)[d]	Insufficient data	1992	Insufficient data	1992
Dichloromethane (Methylene chloride)	98.1[c,i]	1992	Insufficient data	1992
Trichloromethane (Chloroform)	1.8[c,i]	1992	Insufficient data	1992
Tetrachloromethane (Carbon tetrachloride)	13.3[c,i]	1992	Insufficient data	1992
Monobromomethane (Methyl bromide)[d]	Insufficient data	1992	Insufficient data	1992
Tribromomethane (Bromoform)[d]	Insufficient data	1992	Insufficient data	1992
Dibromochloromethane[d]	Insufficient data	1992	Insufficient data	1992
Dichlorobromomethane[d]	Insufficient data	1992	Insufficient data	1992
HCBD [See Hexachlorobutadiene (HCBD)]				
Heptachlor (Heptachlor epoxide)[d]	~~0.01~~[e,f]	1987		
Hexachlorobenzene [See Chlorinated benzenes]				
Hexachlorobutadiene (HCBD)	1.3[c, k]	1999		
Hexachlorocyclohexane (Lindane)[d]	0.01	1987		
Hypochlorous acid [See Reactive chlorine species]				
Imidacloprid[aa]	0.23[c]	2007	0.65[c]	2007
Inorganic fluorides	120[c]	2002		
3-Iodo-2-propynyl butyl carbamate [See IPBC]				
IPBC (3-Iodo-2-propynyl butyl carbamate)	1.9[c]	1999		
Iron[d]	300	1987		
Lead[d]	1–7[c]	1987		
Lindane [See Hexachlorocyclohexane]				
Linuron	7.0[c]	1995	Insufficient data	1995
MCPA (4-Chloro-2-methyl phenoxy acetic acid; 2-methyl-4-chloro phenoxy acetic acid)	2.6[c]	1995	4.2[c]	1995
Mercury[v]				
Inorganic Mercury[v]	0.026	2003	0.016[c,w]	2003
Methylmercury[v]	0.004[c,w]	2003		
Methyl bromide [See Halogenated methanes, Monobromomethane]				
Methyl chloride [See Halogenated methanes, Monochloromethane]				
2-Methyl-4-chloro phenoxy acetic acid [See MCPA]				
Methylene chloride [See Halogenated methanes, Dichloromethane]				
Methyl *tertiary*-butyl ether [See MTBE]				
Metolachlor	7.8[c]	1991		
Metribuzin	1.0[c]	1990		
Molybdenum[j]	73[c]	1999		
Monobromomethane [See Halogenated methanes]				
Monochloramine [See Reactive chlorine species]				

Continued.

	Freshwater		Marine	
Parameter[a]	**Concentration ($\mu g \cdot L^{-1}$)**	**Date**[b]	**Concentration ($\mu g \cdot L^{-1}$)**	**Date**[b]
Monochlorobenzene [See Chlorinated benzenes]				
Monochloromethane [See Halogenated methanes]				
Monochlorophenols [See Chlorinated phenols]				
MTBE (methyl *tertiary*-butyl ether)	10 000[c]	2003	5 000[c]	2003
Naphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Nickel[d]	25–150[p]	1987		
Nitrate	13 000[c,u,y]	2003	16 000[c,u,y]	2003
Nitrite[d]	60[z]	1987		
Nonylphenol and its ethoxylates	1.0[c,t]	2002	0.7[c,t]	2002
Nutrients	Guidance Framework[x]	2004	Guidance Framework [aa,bb]	2007
Organotins				
Tributyltin	0.008[c]	1992	0.001[c]	1992
Tricyclohexyltin	Insufficient data	1992	Insufficient data	1992
Triphenyltin	0.022[c,i]	1992	Insufficient data	1992
Oxygen, dissolved [See Dissolved oxygen]				
PAHs [See Polycyclic aromatic hydrocarbons (PAHs)]				
PCBs [See Polychlorinated biphenyls (PCBs)(total)]				
PCE [See Chlorinated ethenes, 1,1,2,2-Tetrachloroethene]				
PCP [See Chlorinated phenols, Pentachlorophenol]				
Pentachlorobenzene [See Chlorinated benzenes]				
Pentachlorophenol [See Chlorinated phenols]				
Permethrin[aa]	0.004[c]	2006	0.001[c]	2006
pH[d]	6.5–9	1987	7.0–8.7 and Narrative	1996
Phenanthrene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Phenols (mono- & dihydric)	4.0[k]	1999		
Phenoxy herbicides[d, q]	4.0	1987		
Phosphorus	Guidance Framework[x]	2004	Guidance Framework[bb]	2007
Phthalate esters				
Di-*n*-butyl phthalate	19[c]	1993	Insufficient data	1993
Di(2-ethylhexyl) phthalate	16[c]	1993	Insufficient data	1993
Di-*n*-octyl phthalate	Insufficient data	1993	Insufficient data	1993
Picloram	29[c]	1990		
Polychlorinated biphenyls (PCBs) (total)[d]	~~0.001~~[e,f]	1987	~~0.01~~[e,f]	1991

Continued.

	Freshwater		Marine	
Parameter[a]	**Concentration (µg·L^{-1})**	**Date**[b]	**Concentration (µg·L^{-1})**	**Date**[b]
Polycyclic aromatic hydrocarbons (PAHs)				
Acenaphthene	5.8[c]	1999	Insufficient data	1999
Acridine	4.4[c]	1999	Insufficient data	1999
Anthracene	0.012[c]	1999	Insufficient data	1999
Benz*(a)*anthracene	0.018[c]	1999	Insufficient data	1999
Benzo*(a)*pyrene	0.015[c]	1999	Insufficient data	1999
Chrysene	Insufficient data	1999	Insufficient data	1999
Fluoranthene	0.04[c]	1999	Insufficient data	1999
Fluorene	3.0[c]	1999	Insufficient data	1999
Naphthalene	1.1[c]	1999	1.4[c]	1999
Phenanthrene	0.4[c]	1999	Insufficient data	1999
Pyrene	0.025[c]	1999	Insufficient data	1999
Quinoline	3.4[c]	1999	Insufficient data	1999
Propylene glycol [See Glycols]				
Pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]				
Quinoline [See Polycyclic aromatic hydrocarbons (PAHs)]				
Reactive chlorine species (hypochlorous acid and monochloramine)	0.5 and Narrative	1999	0.5 and Narrative	1999
Salinity			≤10% fluctuation[c]	1996
Selenium[d]	1.0	1987		
Silver[d]	0.1	1987		
Simazine	10	1991		
Streambed substrate [See Total particulate matter]				
Styrene	72[c]	1999		
Sulfolane[aa]	50 000[c]	2005	Insufficient data	2005
Suspended sediments [See Total particulate matter]				
TCE [See Chlorinated ethenes, 1,1,2-Trichloroethene]				
Tebuthiuron	1.6[c]	1995	Insufficient data	1995
Temperature	Narrative[s]	1987	Not to exceed ±1°C and Narrative[c]	1996
Tetrachlorobenzene [See Chlorinated benzenes]				
Tetrachloroethane [See Chlorinated ethanes]				
Tetrachloroethene [See Chlorinated ethenes]				
Tetrachloroethylene [See Chlorinated ethenes, 1,1,2,2-Tetrachloroethene]				

Continued.

Parameter[a]	Freshwater		Marine	
	Concentration ($\mu g \cdot L^{-1}$)	Date[b]	Concentration ($\mu g \cdot L^{-1}$)	Date[b]
Tetrachloromethane [See Halogenated methanes]				
Tetrachlorophenols [See Chlorinated phenols]				
Thallium[j]	0.8	1999		
Toluene	2.0[c,j,k]	1996	215[c,k]	1996
Total particulate matter				
Deposited bedload sediment	Insufficient data	1999	Insufficient data	1999
Streambed substrate	Narrative	1999	Narrative	1999
Suspended sediments	Narrative	1999	Narrative	1999
Turbidity	Narrative	1999	Narrative	1999
Toxaphene[d]	~~0.008~~[e,f]	1987		
Triallate	0.24[e]	1992		
Tribromomethane [See Halogenated methanes]				
Tributyltin [See Organotins]				
Trichlorobenzene [See Chlorinated benzenes]				
Trichloroethane [See Chlorinated ethanes]				
Trichloroethene [See Chlorinated ethenes]				
Trichloroethylene [See Chlorinated ethenes, 1,1,2-Trichloroethene]				
Trichloromethane [See Halogenated methanes]				
Trichlorophenols [See Chlorinated phenols]				
Tricyclohexyltin [See Organotins]				
Trifluralin	0.20[i]	1993		
Triphenyltin [See Organotins]				
Turbidity [See Total particulate matter]				
Zinc[d]	30	1987		

[a] Unless otherwise indicated, supporting documents are available from the National Guidelines and Standards Office, Environment Canada.

[b] The guidelines dated 1987 have been carried over from *Canadian Water Quality Guidelines* (CCREM 1987) and no fact sheet was prepared. The guidelines dated 1989 to 1997 were developed and initially published in CCREM 1987 as appendixes on the date indicated. They are published as fact sheets in this document. Other guidelines dated 1997 and those dated 1999 are published for the first time in this document.

[c] Interim guideline.

[d] No fact sheet created. For more information on this guideline, please refer to *Canadian Water Quality Guidelines* (CCREM 1987).

[e] This guideline (originally published in *Canadian Water Quality Guidelines* [CCREM 1987 + Appendixes] in 1987 or 1991 [PCBs in marine waters]) is no longer recommended and the value is withdrawn. A water quality guideline is not recommended. Environmental exposure is predominantly via sediment, soil, and/or tissue, therefore, the reader is referred to the respective guidelines for these media.

[f] This substance meets the criteria for Track 1 substances under the national CCME Policy for the Management of Toxic Substances (PMTS) (i.e., persistent, bioaccumulative, primarily the result of human activity, and CEPA-toxic or equivalent), and should be subject to virtual elimination strategies. Guidelines can serve as action levels or interim management objectives towards virtual elimination.

[g] Aluminium guideline= 5 $\mu g \cdot L^{-1}$ at pH <6.5
= 100 $\mu g \cdot L^{-1}$ at pH ≥6.5

[h] Ammonia guideline: Expressed as µg unionized ammonia·L^{-1}. This would be equivalent to 15.2 µg ammonia-nitrogen·L^{-1}. Guideline for total ammonia is temperature and pH dependent, please consult factsheet for more information.

[i] Guideline value slightly modified from CCREM 1987 + Appendixes due to re-evaluation of the significant figures.

[j] The technical document for the guideline is available from the Ontario Ministry of the Environment.

[k] Substance has been re-evaluated since CCREM 1987 + Appendixes. Either a new guideline has been derived or insufficient data existed to derive a new guideline.

[l]Cadmium guideline = $10^{\{0.86[\log(\text{hardness})] - 3.2\}}$.

[m]Copper guideline = 2 $\mu g \cdot L^{-1}$ at a water hardness of 0–120 $mg \cdot L^{-1}$ (soft to medium) as $CaCO_3$
= 3 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 4 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[n]Dissolved oxygen for warm-water biota: early life stages = 6000 $\mu g \cdot L^{-1}$
other life stages = 5500 $\mu g \cdot L^{-1}$
for cold-water biota: early life stages = 9500 $\mu g \cdot L^{-1}$
other life stages = 6500 $\mu g \cdot L^{-1}$

[o]Lead guideline = 1 $\mu g \cdot L^{-1}$ at a water harness of 0–60 $mg \cdot L^{-1}$ (soft) as $CaCO_3$
= 2 $\mu g \cdot L^{-1}$ at a water harness of 60–120 $mg \cdot L^{-1}$ (medium) as $CaCO_3$
= 4 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 7 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[p]Nickel guideline = 25 $\mu g \cdot L^{-1}$ at a water harness of 0–60 $mg \cdot L^{-1}$ (soft) as $CaCO_3$
= 65 $\mu g \cdot L^{-1}$ at a water harness of 60–120 $mg \cdot L^{-1}$ (medium) as $CaCO_3$
= 110 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 150 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[q]The guideline of 4.0 $\mu g \cdot L^{-1}$ for phenoxy herbicides is based on data for ester formulations of 2,4-dichlorophenoxyacetic acid.

[r]The technical document for the guideline is available from British Columbia Ministry of Environment, Lands and Parks.

[s]Temperature: (for more information, see CCREM 1987)

Thermal Stratification: Thermal additions to receiving waters should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to the addition of heat from artificial origins.

Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded.

Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

[t]Expressed on a TEQ basis using NP TEFs, see Table 2 in factsheet.

[u]For protection from direct toxic effects; the guidelines do not consider indirect effects due to eutrophication.

[v]May not prevent accumulation of methylmercury in aquatic life, therefore, may not protect wildlife that consume aquatic life; see factsheet for details. Consult also the appropriate Canadian Tissue Residue Guideline for the Protection of Wildlife Consumers of Aquatic Biota.

[w]May not fully protect higher trophic level fish; see factsheet for details.

[x]Canadian Guidance Framework for Phosphorus is for developing phosphorus guidelines (does not provide guidance on other freshwater nutrients). It provides Trigger Ranges for Total Phosphorus (see Guidance Framework for Phosphorus factsheet):

ultra-oligotrophic <4 $\mu g \cdot L^{-1}$
oligotrophic 4-10 $\mu g \cdot L^{-1}$
mesotrophic 10-20 $\mu g \cdot L^{-1}$
meso-eutrophic 20-35 $\mu g \cdot L^{-1}$
eutrophic 35-100 $\mu g \cdot L^{-1}$
hyper-eutrophic >100 $\mu g \cdot L^{-1}$

[y]Guidelines are expressed in μg nitrate$\cdot L^{-1}$. These values are equivalent to 2900 μg nitrate-nitrogen$\cdot L^{-1}$, and 3600 μg nitrate-nitrogen$\cdot L^{-1}$, for freshwater and marine respectively.

[z]Guideline is expressed as μg nitrite-nitrogen$\cdot L^{-1}$. This value is equivalent to 197 μg nitrite$\cdot L^{-1}$.

[aa]Supporting documents are available from the Canadian Council of Ministers of the Environment at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125

[bb]The Canadian Guidance Framework for the Management of Nearshore Marine Systems is for developing nutrient (phosphorus and nitrogen) guidelines for nearshore marine systems. Refer to factsheet for details

Reference

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

Reference listing:

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated September, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

Environment Canada
National Guidelines and Standards Office
351 St. Joseph Blvd.
Gatineau, Quebec, K1A 0H3
Phone: (819) 953-1550
Facsimile: (819) 956-5602
E-mail: ceqg-rcqe@ec.gc.ca
Internet: http://www.ec.gc.ca/ceqg-rcqe

For additional copies, contact:

CCME Documents
Toll Free: (800) 805-3025
www.ccme.ca

Aussi disponible en français

Excerpt from Publication No. 1299; ISBN 1-896997-34-1

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health

SUMMARY TABLES

Update 7.0
September 2007

Table 1. Canadian Soil Quality Guidelines (mg·kg^{-1}).

Substance[y]	Year revised/ released[a]	Land Use and Soil Texture							
		Agricultural[*]		Residential/ parkland[*]		Commercial[*]		Industrial[*]	
		Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine
Arsenic (inorganic)	1997	12[b]		12[b]		12[b]		12[b]	
Barium	2003	750[c]		500[c]		2000[c]		2000[c]	
Benzene									
Surface[w]	2004	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]
Subsoil[w]	2004	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]
Surface[x]	2004	0.0095[t,u]	0.0068[t,u]	0.0095[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]
Subsoil[x]	2004	0.011[t,u]	0.0068[t,u]	0.011[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]	0.030[t,u]	0.0068[t,u]
Benzo*(a)*pyrene	1997	0.1[e]		0.7[f]		0.7[f]		0.7[f]	
Cadmium	1999	1.4[b]		10[g]		22[b]		22[b]	
Chromium									
Total chromium	1997	64[b]		64[b]		87[b]		87[b]	
Hexavalent chromium (VI)	1999	0.4[h]		0.4[h]		1.4[h]		1.4[h]	
Copper	1999	63[b]		63[b]		91[b]		91[b]	
Cyanide (free)	1997	0.9[b]		0.9[b]		8.0[b]		8.0[b]	
DDT (total)	1999	0.7[i]		0.7[i]		12[i, j]		12[i, j]	
Diisopropanolamine (DIPA)[z]	2006	180[b]		180[b]		180[b]		180[b]	
Ethylbenzene									
Surface	2004	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Subsoil	2004	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Ethylene glycol	1999	960[k]		960[k]		960[k]		960[k]	
Lead	1999	70[b]		140[b]		260[b]		600[b]	
Mercury (inorganic)	1999	6.6[b]		6.6[b]		24[b]		50[b]	
Naphthalene	1997	0.1[d]		0.6[h]		22[h]		22[h]	
Nickel	1999	50[l]		50[l]		50[l]		50[l]	
Nonylphenol (and its ethyloxylates)	2002	5.7[p]		5.7[p]		14[p]		14[p]	
Pentachlorophenol	1997	7.6[b]		7.6[b]		7.6[b]		7.6[b]	
Phenol	1997	3.8[b]		3.8[b]		3.8[b]		3.8[b]	
Polychlorinated biphenyls (PCBs)	1999	0.5[m]		1.3[l]		33[j,l]		33[j,l]	
Polychlorinated dibenzo-*p*-dioxins/ dibenzofurans (PCDD/Fs)	2002	4 ng TEQ·kg^{-1} [q]		4 ng TEQ·kg^{-1} [q]		4 ng TEQ·kg^{-1} [r]		4 ng TEQ·kg^{-1} [s]	
Propylene glycol	2006	Insufficient information[v]		Insufficient information[v]		Insufficient information[v]		Insufficient information[v]	
Selenium	2007	1[b]		1[b]		2.9[b]		2.9[b]	

Continued

Substance	Year revised/ released[a]	Land Use and Soil Texture							
		Agricultural*		Residential/ parkland*		Commercial*		Industrial*	
		Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine
Sulfolane[z]	2006	0.8[b]		0.8[b]		0.8[b]		0.8[b]	
Tetrachloroethylene	1997	0.1[e]		0.2[f]		0.5[f]		0.6[f]	
Thallium	1999	1[n]		1[o]		1[o]		1[o]	
Toluene									
Surface	2004	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Subsoil	2004	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Trichloroethylene	2006	0.01[b,u]		0.01[b,u]		0.01[b,u]		0.01[b,u]	
Uranium[z]	2007	23[t]		23[t]		33[t]		300[t]	
Vanadium	1997	130[l]		130[l]		130[i]		130[i]	
Xylenes									
Surface	2004	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Subsoil	2004	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Zinc	1999	200[l]		200[l]		360[l]		360[l]	

Notes: SQG_E = soil quality guideline for environmental health; SQG_{HH} = soil quality guideline for human health.

*For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a]Guidelines released in 1997 were originally published in the working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited, and reprinted here. Guidelines revised/released in 1999 are published here for the first time (see Table 2).

[b]Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use, derived in accordance with the soil protocol (CCME 1996; 2006). The corresponding interim soil quality criterion (CCME 1991) is superseded by the soil quality guideline.

[c]Data are insufficient/inadequate to calculate an SQG_{EH}, a provisional SQG_{HH}, an SQG_E, or a provisional SQG_E. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use (see table 2).

[d]Data are sufficient and adequate to calculate only a provisional SQG_E. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[e]Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[f]Data are sufficient and adequate to calculate an SQG_{EH} and a provisional SQG_E. Both are less than corresponding interim soil quality criterion (CCME 1991). Therefore the soil quality guideline supersedes the interim soil quality criterion for this land use.

[g]The soil–plant–human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g., adopt the agricultural guideline as objective). The off-site migration check should be recalculated accordingly.

[h]Data are sufficient and adequate to calculate only a provisional SQG_E, which is less than the existing interim soil quality criterion (CCME 1991). Therefore the provisional soil quality guideline supersedes the interim soil quality criterion for this land use.

[i]Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the SQG_E becomes the soil quality guideline.

[j]In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary, or tertiary consumers, the soil and food ingestion guideline is recommended as the SQG_E.

[k]Data are sufficient and adequate to calculate only a provisional SQG_E.

[l]Data are sufficient and adequate to calculate only an SQG_E, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the SQG_E becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[m]Data are sufficient and adequate to calculate only an SQG_E, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[n]Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is equal to the SQG_E and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[o]Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is less than the SQG_E and thus becomes the soil quality guideline for this land use.

[p]Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for these substances, therefore, the SQG_E becomes the soil quality guideline.

[q]Data are sufficient and adequate to calculate only a provisional SQG_{HH}, which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional SQG_{HH} becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[r]Data are sufficient and adequate to calculate only a provisional SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the provisional SQG_{HH} becomes the soil quality guideline.

[s]Data are sufficient and adequate to calculate only an SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the SQG_{HH} becomes the soil quality guideline.

[t]Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use.

[u]This guideline value may be less than the common limit of detection in some jurisdictions. Contact jurisdictions for guidance.

[v]Data are sufficient and adequate to calculate only a preliminary SQG_{FWAL} (Soil Quality Guideline for freshwater aquatic life). This value is 6,210 $mg \cdot kg^{-1}$. See accompanying factsheet for further information.

[w]10^{-5} Incremental Risk

[x]10^{-4} Incremental Risk

[y]Unless otherwise indicated, supporting documents are available from the National Guidelines and Standards Office, Environment Canada.

[z]Supporting documents are available from the Canadian Council of Ministers of the Environment at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125

References

CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

———. 1996. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [A summary of the protocol appears in Canadian environmental quality guidelines, Chapter 7, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

———. 1997. Recommended Canadian soil quality guidelines. CCME, Winnipeg.

———. 2006. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [The protocol is available online through the CCME website at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125]

Table 2. Interim remediation criteria for soil (mg·kg^{-1}) that have not yet been replaced by Canadian Soil Quality Guidelines[1].

Parameter	Year released	Land use			
		Agricultural	Residential/ parkland	Commercial	Industrial
General Parameters					
Conductivity [dS/m]	1991	2	2	4	4
pH	1991	6 to 8	6 to 8	6 to 8	6 to 8
Sodium adsorption ratio	1991	5	5	12	12
Inorganic Parameters					
Antimony	1991	20	20	40	40
Beryllium	1991	4	4	8	8
Boron (hot water soluble)	1991	2			
Cobalt	1991	40	50	300	300
Fluoride (total)	1991	200	400	2000	2000
Molybdenum	1991	5	10	40	40
Silver	1991	20	20	40	40
Sulphur (elemental)	1991	500			
Tin	1991	5	50	300	300
Monocyclic Aromatic Hydrocarbons					
Chlorobenzene	1991	0.1	1	10	10
1,2-Dichlorobenzene	1991	0.1	1	10	10
1,3-Dichlorobenzene	1991	0.1	1	10	10
1,4-Dichlorobenzene	1991	0.1	1	10	10
Styrene	1991	0.1	5	50	50
Phenolic Compounds					
Chlorophenols[a] (each)	1991	0.05	0.5	5	5
Nonchlorinated[b] (each)	1991	0.1	1	10	10
Polycyclic Aromatic Hydrocarbons (PAHs)					
Benzo*(a)*anthracene	1991	0.1	1	10	10
Benzo*(b)*fluoranthene	1991	0.1	1	10	10
Benzo*(k)*fluoranthene	1991	0.1	1	10	10
Dibenz*(a,h)*anthracene	1991	0.1	1	10	10
Indeno(1,2,3-c,d)pyrene	1991	0.1	1	10	10
Phenanthrene	1991	0.1	5	50	50
Pyrene	1991	0.1	10	100	100
Chlorinated Hydrocarbons					
Chlorinated aliphatics[c] (each)	1991	0.1	5	50	50
Chlorobenzenes[d] (each)	1991	0.05	2	10	10
Hexachlorobenzene	1991	0.05	2	10	10
Hexachlorocyclohexane	1991	0.01	—	—	—
Miscellaneous Organic Parameters					
Nonchlorinated aliphatics (each)	1991	0.3	—	—	—
Phthalic acid esters (each)	1991	30			
Quinoline	1991	0.1			
Thiophene	1991	0.1			

[1]**Notes:**

All values are in $mg \cdot kg^{-1}$ unless otherwise stated.

Guidelines released in 1991 were published in "Interim Canadian Environmental Quality Criteria for Contaminated Sites" (CCME, 1991).

These interim remediation criteria are considered generally protective of human and environmental health and were based on experience and professional judgement.

These interim criteria (CCME, 1991) should only be used when soil quality guidelines based on the CCME soil protocol (CCME, 1996; 2006) have not yet been developed for a given chemical. Also, because the interim remediation criteria were not developed using the soil protocol and its integral checks, they cannot be modified through the site specific remediation objective procedure.

[a]Chlorophenols include
chlorophenol isomers (ortho, meta, para)
dichlorophenols (2,6- 2,5- 2,4- 3,5- 2,3- 3,4-)
trichlorophenols (2,4,6- 2,3,6- 2,4,5- 2,3,4- 3,4,5-)
tetrachlorophenols (2,3,5,6- 2,3,4,5- 2,3,4,6-)

[b]Nonchlorinated phenolic compounds include
2,4-dimethylphenol
2,4-dinitrophenol
2-methyl 4,6-dinitrophenol
nitrophenol (2-,4-)
phenol
cresol

[c]Aliphatic chlorinated hydrocarbons include
chloroform
dichloroethane (1,1- 1,2-), dichloroethene (1,1- 1,2-)
dichloromethane
1,2-dichloropropane, 1,2-dichloropropene (cis and trans)
1,1,2,2-tetrachloroethane, tetrachloroethene
carbon tetrachloride
trichloroethane (1,1,1- 1,1,2-), trichloroethene

[d]Chlorobenzenes include
all trichlorobenzene isomers
all tetrachlorobenzene isomers
pentachlorobenzene

References

CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

———. 1996. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [A summary of the protocol appears in Canadian environmental quality guidelines, Chapter 7, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

———. 2006. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [The protocol is available online through the CCME website at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125]

Reference listing:

Canadian Council of Ministers of the Environment. 2007. Canadian soil quality guidelines for the protection of environmental and human health: Summary tables. Updated September, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

Environment Canada
National Guidelines and Standards Office
351 boul. St. Joseph
Gatineau, Quebec, K1A 0H3
Phone: (819) 953-1550
Facsimile: (819) 956-5602
E-mail: ceqg-rcqe@ec.gc.ca
Internet: http://www.ec.gc.ca/ceqg-rcqe

For additional copies, contact:

CCME Documents
Toll Free: (800) 805-3025
Internet: http://www.ccme.ca

Aussi disponible en français.

Excerpt from Publication No. 1299; ISBN 1-896997-34-1

CCME

Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Guidelines for Compost Quality

PN 1340

Canadian Council of Ministers of the Environment

The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards, practices, and legislation.

Canadian Council of Ministers of the Environment
123 Main St., Suite 360
Winnipeg, Manitoba R3C 1A3
Ph: (204) 948-2090 Fax: (204) 948-2125

For additional copies, contact:

CCME Documents
Toll free: 1 (800) 805-3025
www.ccme.ca

Aussi disponible en français

La présente publication est également offerte en français sous le titre *Lignes directrices pour la qualité du compost.* PN 1341

ISBN 1-896997-60-0

Abstract

The benefits of compost to aid plant growth and add stability and fertility to soils are well demonstrated. Based on these attributes, the composting industry in Canada has become a vibrant industry that continues to grow in size and strength.

In order to ensure a consistent, high quality product that is safe for all uses, early in the 1990s CCME established a committee to develop quality guidelines for compost that is sold or given away. CCME, the Bureau de normalization du Québec (BNQ) and the Canadian Food Inspection Agency (CFIA) agreed to coordinate efforts and developed compost standards that provide a significant level of consistency, while being flexible enough to accommodate different (e.g. regional) interests and issues. This joint effort led to the development of the first edition of the CCME Compost Quality Guidelines in 1996.

Since 1996, the industry has grown to what it is today. During that growth, new science and technologies have improved our understanding of composting and compost. Thus, a revision to the 1996 guidelines was necessary. These revised guidelines reflect our new understanding while still providing the same level of protection that was intended in the first version.

The CCME Guidelines for Compost Quality are based on the following four criteria for product safety and quality: foreign matter, maturity, pathogens, and trace elements. The guidelines attempt to integrate the concept that exposure is an integral part of risk by establishing two grades of material (Category A - unrestricted and Category B - restricted). The guidelines will help protect public health and the environment and help composting continue to develop as an important resource/waste management solution.

Table of Contents

Glossary

aerated static pile: a heap of compostable materials formed to promote the aerobic decomposition of the organic matter. Ventilation is either provided by passive or forced aeration, rather than through frequent agitation (turning). French: ***tas statique aéré***

biosolids: organic product obtained from the physico-chemical and/or biological treatment of wastewater. Biosolids result from primary wastewater treatment (primary biosolids), or from secondary wastewater treatment (secondary biosolids), and these two types of biosolids are often combined (mixed biosolids). These biosolids can be derived from the treatment of either municipal wastewater or industrial wastewater. French: ***biosolides***

compost: solid mature product resulting from composting. French: ***compost***

composting: managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase. French: ***compostage***

contaminant: element, compound, substance, organism, or form of energy which through its presence or concentration causes an adverse effect on the natural environment or impairs human use of the environment. French: ***contaminant***

foreign matter: any matter over 2 mm in dimension that results from human intervention and has organic or inorganic components such as metal, glass, synthetic polymers (for example plastic and rubber) and that may be present in the compost but excluding mineral soil, woody material and pieces of rock. French: ***corps étranger***

in-vessel composting: diverse group of composting methods in which composting materials are contained in a reactor vessel; the purpose is to maintain optimal conditions for composting. French: ***compostage en milieu fermé***

mature: term used to designate a compost that, when used as an organic soil conditioner, does not have phytotoxic effects arising from, for example, nitrogen immobilization or anaerobioses. NOTE — The opposite of "mature" is immature. French: ***mature***

micronutrient: plant nutrient (for example boron, copper, molybdenum, manganese, iron and zinc) required in lesser quantities than major (for example nitrogen, phosphorus and potassium) and secondary (for example calcium and magnesium) plant nutrients, having essential physiological functions in plant metabolism. French: ***oligoélément***

municipal biosolids: biosolids obtained from municipal wastewater pretreated to remove gravel and coarse solid waste. French: ***biosolides municipaux***

municipal solid waste (MSW): solid non-hazardous refuse that originates from residential, industrial, commercial, institutional, demolition, land clearing, or construction sources. French: ***déchets solides municipaux***

pathogens: organisms, including some bacteria, viruses, fungi, and parasites, that are capable of producing an infection or disease in a susceptible human, animal, or plant host. French: ***organismes pathogènes***

sharp foreign matter: any foreign matter over a 3 mm dimension that may cause damage or injury to humans and animals during or resulting from its intended use. NOTE — Sharp foreign matter may consist of, but is not limited to, the following: metallic objects or pieces of metallic objects, for example utensils, fixtures, electrical wiring, pins, needles, staples, nails, bottle caps; glass and porcelain or pieces of glass and porcelain, for example, containers, dishes, glass panes, electric light bulbs and tubes, mirrors. French: ***corps étranger tranchant***

source separation: separation of wastes into specific types of material at the point of generation. French: ***tri à la source***

thermophilic phase: biological phase in the composting process characterized by the presence of micro-organisms which grow optimally in a temperature range of 45°C to 75°C. French: ***phase thermophilic***

trace element: chemical element present in compost at a very low concentration. French: ***élément trace***

volatile solids: solids in water or other liquids that are lost on ignition of dry solids, generally above 500°C. French: ***solides volatils***

windrow: elongated piles of triangular or trapezoidal cross-section that are turned in order to aerate and blend the material. French: ***andain***

yard waste: vegetative matter resulting from gardening, horticulture, landscaping, or land clearing operations and includes materials such as tree and shrub trimmings, plant remains, grass clippings, and chipped trees. French: ***résidus de jardin***

Acronyms

AAFC	Agriculture and Agri-Food Canada
BNQ	Bureau de normalisation du Québec
CCC	Composting Council of Canada
CCME	Canadian Council of Ministers of the Environment
CFIA	Canadian Food Inspection Agency
CRIQ	Centre de recherche industrielle du Québec
MPN	most probable number
MSW	municipal solid waste
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
SCC	Standards Council of Canada

Preface

Guidelines for Compost Quality, 2005, is published by the Canadian Council of Ministers of the Environment (CCME) and replaces the previous version – *Guidelines for Compost Quality*, 1996.

This document was prepared by the CCME Compost Guidelines Task Group. Membership of the Task Group was representative of provincial, territorial, and federal governments.

Compost Guidelines Task Group

Barry Friesen, Chair	Nova Scotia Environment and Labour
Jack Bryden	British Columbia Ministry of Water, Land and Air Protection
Gordon Dinwoodie	Alberta Environment
Jim Ferguson	Manitoba Conservation
Marc Hébert	Ministère de du Développement durable, de l'Environnement et des Parcs
Brad Guglietti	Ontario Ministry of the Environment
Ken Hall	Northwest Territories Resources, Wildlife and Economic Development
Dennis Jackson	Environment Canada
Don Jardine	Prince Edward Island Environment and Energy
Heather Valsangar	New Brunswick Environment and Local Government
Pat Paslawski	Yukon Environment
Marie Ryan	Newfoundland and Labrador Environment and Conservation
Kim Yee	Saskatchewan Environment
Anjanette Tomac	CCME Secretariat

Acknowledgements

The Compost Guidelines Task Group acknowledges the following individuals and organizations that have contributed to the production of these guidelines:

Sylvain Allard	Bureau de normalisation du Québec
Susan Antler	Composting Council of Canada
Ian Gardiner	Canadian Food Inspection Agency
Kate Billingsley	Canadian Food Inspection Agency

Section 1

Introduction

Canadians have long understood that organic matter, when composted, is a valuable product. Compost provides many benefits, returning nutrients and organic matter to the soil, making it a valuable amendment for landscaping, horticulture, and agriculture.

In 1996, CCME developed guidelines for compost products, at a time when the composting industry was still relatively young. Since then, many industries and municipalities have implemented large-scale composting operations.

By setting standards for the quality of compost material, the guidelines helped protect public health and the environment, as well as ensured that compost products were used beneficially. The composting industry also benefited since the guidelines helped secure compost as a beneficial soil amendment, increased the demand for organic materials, and encouraged source separation of organic wastes. In short, the guidelines helped organic materials to be regarded as a resource.

As is often necessary, updates to guidelines and standards are necessary in order to recognize advances in new technologies and science. This 2005 revision is meant to reflect these advances and to provide even better use of organic resources in Canada and to protect the environment and human health.

1.1 Background

Several standard-setting organizations across Canada are mandated to regulate compost and write standards concerning compost. These include the federal government, provincial and territorial governments, and the Bureau de normalisation du Québec (BNQ), acting on behalf of the Standards Council of Canada (SCC)[1].

Within the federal government, the Canadian Food Inspection Agency (CFIA) regulates compost when it is sold either as a soil amendment or as a product with plant nutrient claims under the *Fertilizers Act*. The provinces and territories regulate the disposal and beneficial use of wastes on land, and therefore, the production and use of compost. In its role, acting on behalf of the SCC, the BNQ establishes voluntary industry standards for adoption by the SCC and endorses products that meet their standards.

Since 1993, CCME, BNQ and CFIA have aimed to coordinate efforts in an attempt to develop compost standards that provide a significant level of national consistency, while being flexible enough to accommodate different interest (e.g., regional) and issues.

[1] The SCC coordinates voluntary industry standardization activities in Canada and represents Canada in the International Organization for Standardization (ISO). Four standard-development organizations are accredited by the SCC, one of which is the BNQ. Within the SCC, BNQ is primarily responsible for standardizing fertilization, organic fertilizers, and soil supplements. As such, the BNQ is the only standard-writing organization of the SCC accredited to write industry standards for compost.

CCME produced its first Guidelines for Compost Quality in 1996. In 2003, CCME directed the Compost Guidelines Task Group to review the 1996 CCME Compost Guidelines since the Canadian voluntary standard (BNQ) was also being revised. The BNQ public consultations and standard revisions have led to the development of these revised CCME Guidelines for Compost Quality.

1.2 Objectives

The objectives of *Guidelines for Compost Quality* are to:

- Protect public health and the environment across the country;
- Promote harmonization with the Canadian Food Inspection Agency (CFIA) and Bureau de normalisation du Québec (BNQ);
- Encourage source separation of municipal solid waste (MSW) to produce a high quality compost product;
- Produce compost standards that are consistent across the country, while accommodating different interests and issues;
- Incorporate the experience of industry and regulators in applying the guidelines and to ensure that the national guidelines reflect new science and technology advances;
- Discourage the application of untreated organic wastes to land; and,
- Ensure consumer confidence through consistent nationwide product quality standards.

1.3 Scope and Applicability

These guidelines apply to compost produced from any organic feedstock as determined by regulatory agencies. They apply to compost that is sold, given away or used on-site. Specific definitions and regulatory information on on-site composting can be obtained from federal, provincial and territorial authorities.

These guidelines do not apply to compost-based products, e.g., potting soil mixes, although jurisdictions may wish to apply or modify the guidelines for these products.

Due to the diversity of regulatory approaches that exists in Canada, these guidelines generally apply to the quality of compost rather than the composting process. Jurisdictions will develop individual siting and operating guidelines to accommodate jurisdictional needs.

In response to special concerns, a jurisdiction may decrease or increase the number of parameters to be analyzed based on monitoring data, changes in the waste stream or

processing techniques, effectiveness of source separation programs, or the potential presence of toxic substances.

These guidelines only come into effect if adopted, in whole or in part, by an authority having jurisdiction. Where this guideline has been adopted, in whole or in part, by an authority having jurisdiction, it is subject to any restrictions or conditions added by the regulatory authority.

Readers of this guideline are advised to check with the federal, provincial, or territorial authority having jurisdiction to establish whether this guideline applies in their area of interest.

Section 2

Product Safety and Exposure

Products must be safe for sale or use. However, by the same token, "safety" (or "risk") is the function of exposure. When assessing the safety of a product, exposure must also be considered; if there is no exposure there can be no "risk". Ultimately, exposure is a function of the quantity, the intended use, and the users of a product. The question then becomes whether a product is "safe enough" for "use as intended". It should be recognized that a product may be safe for one type of use and user, but not for another use in which the product may be further exposed to the public, water, environment, or plants in the food chain. These guidelines attempt to integrate the concept that exposure is an integral part of the risk by establishing different grades of material (Category A - unrestricted and Category B - restricted) on the basis of safety.

Section 3

Compost Product Guidelines

These compost guidelines are based on the following four criteria for product safety: foreign matter, maturity, pathogens and trace elements.

The standards for compost quality are summarized in this section. For additional information on the limits recommended, please refer to the "Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria]".

3.1 Categories

Two compost categories have been developed for trace element concentrations and sharp foreign matter. These categories (A and B) are based on the end use of the compost material.

Unrestricted Use

Category A – Compost that can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other businesses.

Category A criteria for trace elements are achievable using best source separated MSW feedstock or municipal biosolids, or pulp and paper mill biosolids, or manure.

Restricted Use

Category B – Compost that has a restricted use because of the presence of sharp foreign matter or higher trace element content. Category B compost may require additional control when deemed necessary by a province or territory.

Please note that for a compost to meet the unrestricted use category, it must meet the unrestricted (Category A) requirements for all trace elements and sharp foreign matter. If the compost fails one criterion of the guideline for unrestricted use but meets the criteria for restricted (Category B) use, then it is classified as a Category B product. Products that do not meet the criteria for either Category A or B must be used or disposed of appropriately.

3.2 Trace Elements

Trace elements, for example, mercury, cadmium, lead, may be present in raw materials from which compost products are produced. Excessive accumulation in soils over the long term may result in toxicity to plants, animals and humans. However, copper, cobalt, molybdenum and zinc (and possibly nickel and selenium) are plant micronutrients, and

their presence may be useful in compost. Also arsenic, cobalt, chromium, copper, molybdenum, nickel, selenium, and zinc are micronutrients required by animals and humans (Webber and Singh, 1995). Cadmium, mercury and lead are of no known value to either plants or animals. Compost applied repeatedly in large quantities to land without monitoring trace element concentrations could theoretically cause adverse effects on human health or the environment over the long term.

The concentrations of trace elements in finished compost (Category A and B) and the cumulative additions to soil (Category B) shall not exceed those levels provided in Table 1 as calculated on a dry weight basis.

Background information about trace elements are provided in Annexes A and B.

Table 1 **Concentrations of Trace Elements in Compost and Cumulative Trace Element Additions to Soil**

	CATEGORY A	CATEGORY B	
Trace Elements* **	Maximum Concentration within Product (mg/kg dry weight)	Maximum Concentration within Product* (mg/kg dry weight)	Maximum Cumulative Additions to Soil* (kg/ha)
Essential or beneficial to plants or animals			
Arsenic (As)	13	75	15
Cobalt (Co)	34	150	30
Chromium (Cr)	210	**	**
Copper (Cu)	400	**	**
Molybdenum (Mo)	5	20	4
Nickel (Ni)	62	180	36
Selenium (Se)	2	14	2.8
Zinc (Zn)	700	1850	370
Other			
Cadmium (Cd)	3	20	4
Mercury (Hg)	0.8	5	1
Lead (Pb)	150	500	100

* These concentrations are the existing standards under the Canadian Food Inspection Agency's Standards for Metals in Fertilizers and Supplements, September 1997 (Trade Memorandum T-4-93).

** Limits for copper and chromium are not established in the Trade Memorandum. Calculated in the same manner as limits for the other nine elements, the trace element additions to soil for chromium and copper would be: chromium = 210 kg/ha and copper = 150 kg/ha for the trace element concentrations within the compost product , chromium = 1060 mg/kg and copper = 757 mg/kg. Details of these calculations are in the "Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413-200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria".

*** Concentrations of other elements may eventually be regulated in certain provinces to accommodate regional and national concerns.

3.3 Foreign Matter in Compost

Foreign matter detracts from good quality compost. As most compost feedstocks and products contain foreign matter, the following quality criteria are important to protect human health, and to be an incentive for source separation of residuals or sorting out of foreign matter in the final product.

a) Sharp Foreign Matter

Category A - Compost shall not contain any sharp foreign matter of dimension greater than 3 mm per 500 ml.

Category B - Compost shall have a sharp foreign matter content less than or equal to three (3) pieces of sharp foreign matter per 500 ml, and the maximum dimension of the sharp foreign matter shall be 12.5 mm. However, this compost shall not be used in pastures, parks or for residential purposes.

b) Other Foreign matter

Category A - Compost shall contain no more than one (1) piece of foreign matter greater than 25 mm in any dimension per 500 ml.

Category B - Compost shall contain no more than two (2) pieces of foreign matter greater than 25 mm in any dimension per 500 ml.

3.4 Maturity/Stability of Compost

Characteristics of mature and stable compost include biostabilization and humus formation. Guidelines for compost maturity are necessary as unstable/immature product has the potential to cause adverse effects on plants when applied in large amounts or attract vectors, such as flies, and to cause odours.

Compost shall be mature and stable at the time of sale and distribution. To be considered mature and stable, a compost shall be cured for a minimum of 21 days and meet one of the following three requirements:

a) the respiration rate is less than, or equal to, 400 milligrams of oxygen per kilogram of volatile solids (or organic matter) per hour; or,

b) the carbon dioxide evolution rate is less than, or equal to, 4 milligrams of carbon in the form of carbon dioxide per gram of organic matter per day; or,

c) the temperature rise of the compost above ambient temperature is less than 8 °C .

3.5 Pathogens in Compost

As pathogenic organisms may be present in the compost feedstock, the compost itself may also contain pathogenic organisms and, as a result, may pose a risk to human health. To adequately reduce these health risks, the compost shall conform to the criteria outlined in either a) or b) depending on the feedstock source.

a) When compost contains ***only yard waste*** the following criteria shall be met:

1. The compost shall undergo the following treatment or other process recognized as equivalent by the relevant province or territory.

   Using in-vessel composting method, the material shall be maintained at operating conditions of 55°C or greater for three days.

   Using the windrow composting method, the material shall attain a temperature of 55°C or greater for at least 15 days during the composting period. Also, during the high temperature period, the windrow shall be turned at least five times.

   Using the aerated static pile composting method, the material will be maintained at operating conditions of 55°C or greater for three days. The preferable practice is to cover the pile with an insulating layer of material, such as cured compost or wood chips, to ensure that all areas of the feed material are exposed to the required temperature.

   OR

2. Organism content shall meet the following:

   Fecal coliforms[2] < 1000 most probable number (MPN)/g of total solids calculated on a dry weight basis,

   AND

   No *Salmonella* sp. with a detection level < 3 MPN/4g total solids calculated on a dry weight basis.

---

[2] Preliminary research suggests that some composts may have high fecal coliform counts due to bacteria of environmental origin and not of fecal origin. Thus, fecal coliforms may not be a reliable indicator of pathogen levels under all circumstances. In cases where high levels of fecal coliforms are suspected to be due to environmental contamination, additional analysis for *Escherichia coli* should be conducted. Use of *Escherichia coli* content as a direct indicator of pathogen levels is not yet supported by all regulatory agencies in Canada, but it may be used to help verify the reason for the high fecal coliform levels.

b) When compost contains ***other feedstock***, the following criteria shall be met:

1. Undergo a treatment (described in a),

   AND

2. Organism content shall meet the following:

   Fecal coliforms < 1000 MPN / g of total solids calculated on a dry weight basis,

   OR

   No *Salmonella* sp. with a detection level < 3 MPN / 4g total solids calculated on a dry weight basis.

3.6 Organic Contaminants in Compost

Organic chemicals enter waste streams from a variety of industrial and domestic sources. While many degrade or volatilize during waste collection, treatment (including composting) and storage, some of these organic chemicals persist.

Some compost feedstocks may contain trace amounts of persistent[3] or bio-accumulating organic contaminants, such as dioxins, furans, pesticides, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH) or herbicides (e.g. clopyralid). The manufacturer should pay special attention to raw materials that might contain such contaminants. To this effect, it is recommended that the composting of raw materials with high contents of these contaminants be avoided.

However, given the low content of dioxin and furans in compost feedstock (Webber, 1996) and in composts produced in Canada (Groeneveld and Hébert, 2004), routine analysis under the CCME Guidelines is not considered necessary. The same also applies to PCB and PAH. For specific sampling requirements in each province or territory, contact the provincial or territorial authority having jurisdiction.

[3] The term "persistent" is used to indicate resistance to transformation (i.e. breakdown or degradation) in the environment. A compound is considered persistent in soil or aquatic systems when its half-life (T ½) or its time for 50% decline or disappearance is greater than 180 days.

Section 4

Sampling and Analytical Methods for Testing Compost Quality

The following documents can be used as a basis for sampling and analytical test methods.

CAN/BNQ 0413-200-2005 – Organic Soil Conditioners – Composts. (Amendements organiques – Composts.)

CAN/BNQ 0413-210-2005 – Organic Soil Conditioners – Composts – Determination of Foreign Matter Content – Sieving Method. (Amendements organiques – Composts – Détermination de la teneur en corps étrangers – Méthode granulométrique.)

CAN/BNQ 0413-210-2005 – Organic Soil Conditioners – Composts – Determination of Respiration Rate – Respirometric Method. (Amendements organiques – Composts – Détermination du taux de respiration – Méthode respirométrique.)

These publications are available at the Bureau de normalisation du Québec (BNQ).

Bureau de normalisation du Québec
Customer Service
333, rue Franquet
Sainte-Foy (Québec) G1P 4C7
Telephone: (418) 652-2238
Toll-free: 1 800 386-5114
Fax: (418) 652-2292
E-mail: bnqinfo@bnq.qc.ca
http://www.bnq.qc.ca/

CENTRE D'EXPERTISE EN ANALYSE ENVIRONNEMENTALE DU QUÉBEC, Dénombrement des salmonelles ; méthode par tubes multiples. MA. 700 – Sal-tm 1.0, Ministère de l'Environnement du Québec, 2003, 19 p.
http://www.ceaeq.gouv.qc.ca/methodes/pdf/MA700Saltm10.pdf

Compost sampling and analysis protocols can also be found in *Test Methods for the Examination of Composting and Compost* (TMECC).

US COMPOSTING COUNCIL RESEARCH AND EDUCATION FOUNDATION (CCREF), and UNITED STATES DEPARTMENT OF AGRICULTURE (USDA), *Test Methods for the Examination of Composting and Compost*.
http://www.tmecc.org/tmecc/

Maximum Acceptable Trace Element Contents in Category A Compost — No Net Degradation and Best Achievable Approach Concepts[4]

The **no net degradation** and the **best achievable approach** concepts are two different concepts that were considered for the determination of the maximum acceptable trace element contents in **Category A** compost.

The **no net degradation** concept referred to in *An International Survey of Composting Criteria* (Waste Conversion Incorporated, 1992) requires that the use of compost not change the regional background levels of trace elements in the receiving soils. In the *Review and recommendations for Canadian interim environmental quality criteria for contaminated sites* (1991), Environment Canada defines **background level** as "the concentration of a chemical substance occurring in a media removed from the influence of industrial activity at a specific site and in an area considered to be relatively unaffected by industrial activity."

The **no net degradation** concept generally recognizes that the maximum acceptable trace element contents in compost should be established by taking the arithmetic mean of measured background levels in a defined region and adding three standard deviations from the mean. For ***normal distributions***, 99 % of all trace element content results for samples from a region considered to be uninfluenced by industrial activities shall be below these maximum acceptable contents.

At the time of the first edition of this guideline (1996), measurements of background levels of trace elements were available only for the agricultural soils of Alberta, Ontario and Québec. Requirements based on the **no net degradation** concept were thus established using the highest values of background levels of soils obtained from these three provinces.

The **best achievable approach** concept favours the use of the best available technology to produce an end product. This concept is based on the fact that the best available technology (such as source separation) to produce the desired end product should be used to establish the requirements for maximum acceptable trace element contents in compost.

At the time of the first edition of this guideline (1996), data based on the **best achievable approach** concept was available in British Columbia's *Production and Use of Compost Regulation* (1993). The data specified in this regulation were derived from municipal solid waste residue and source separation management programs. In 2004, numbers for Cu and Zn were derived to allow composting of other feedstocks. For Cu, the value was raised from 100 to 400 mg/kg in order to allow composting of hog manure and municipal biosolids. Environmental justifications of trace element contents are found in Hébert and

[4] Adapted from Bureau de normalisation du Québec (2005)

Groeneveld (2003). For Zn, the concentration limit was raised from 500 to 700 mg/kg to allow composting of poultry and hog manure, and vermicomposting. The limits for poultry manure were based on CRIQ (1994) database values for manure and manure composts. It is important to note that both the **no net degradation** approach and the **best achievable technology** standards are policy-based criteria for compost products and are not based on risk assessment associated with local soil quality.

The following table presents maximum acceptable trace element contents for **Category A** compost established using the highest value derived from **no net degradation** and **best achievable approach** concepts.

Table 2 Maximum Acceptable Trace Element Contents for Category A Compost Using the Highest Value Derived from No Net Degradation and Best Achievable Approach Concepts.

Trace Element	Mean of Background Levels + 3 Standard Deviations			*No Net Degradation* Concept (1996)	*Best Achievable Approach* Concept	Maximum Acceptable Trace Element Content in Category A Compost
	Alberta	Ontario[1]	Québec[2]			
As		10		10	13[3]	13
Cd	1.6	3	2.5	3	2.6[3]	3
Co	14	25	34	34	26[3]	34
Cr	30	50	121	121	210[3]	210
Cu	29	60	48	60	400[4]	400
Hg	0.1	0.15	0.09	0.15	0.8[3]	0.8
Mo		2		2	5[5]	5
Ni	36	60	62	62	50[3]	62
Pb	20	150	68	150	150[5]	150
Se		2		2	2[5]	2
Zn	124	500	144	500	700[5]	700

NOTE — All results are expressed in milligrams per kilogram (dry weight basis).

1. Reference: Ontario Ministry of the Environment, 1989
2. Reference: Giroux, Rompré, Carrier, Audesse & Lemieux, 1992
3. Reference: British Columbia, 1993
4. Reference: Hébert and Groeneveld, 2003
5. Reference: Centre de recherche industrielle du Québec, 1994

Annex B

Maximum Acceptable Trace Element Contents in Category B Compost as outlined in Trade Memorandum T-4-93 [5]

Maximum acceptable trace element contents for **Category B** compost ensure that the cumulative trace element additions to soil will not exceed the requirements shown in the table below, assuming a wet basis annual application rate of 11,000 kg/hm² (1 hm^2 = 10,000 m^2 = 1 ha) of compost at 60% moisture content (equivalent to an oven-dried mass of 4,400 kg/hm^2 containing up to 5% total nitrogen) for a period of 45 years.

No maximum trace element content for Cu or Cr was retained for **Category B**, which corresponds to the absence of values indicated in "Trade Memorandum T-4-93" (CFIA, 1997).

Note that these values, except for As and Pb, are lower than «Exceptional quality» criteria derived by US EPA (1995) for municipal biosolids compost from a risk-based analysis.

Table 3 Maximum Acceptable Trace Element Contents for Category B Compost

Trace Element	Maximum Cumulative Trace Element Addition to Soils* Based on *Table I* in "Trade Memorandum T-4-93", kg/hm^2 (kg/ha)	Maximum Acceptable Trace Element Content in Type *B* Compost Based on *Table II* in "Trade Memorandum T-4-93", mg/kg (dry weight basis)
Arsenic (As)	15	75*
Cadmium (Cd)	4	20
Cobalt (Co)	30	150
Lead (Pb)	100	500
Mercury (Hg)	1	5
Molybdenum (Mo)	4	20
Nickel (Ni)	36	180
Selenium (Se)	2.8	14
Zinc (Zn)	370	1,850

* The maximum arsenic content in a compost in milligrams per kilogram is calculated as follows:

$$\frac{15\ \mathrm{kg/hm^2}}{4400\ \mathrm{kg/hm^2 a} \times 45\ \mathrm{a} \times 1\ \mathrm{g/1000\ mg} \times 1\ \mathrm{kg/1000\ g}}$$

[5] Adapted from Bureau de normalisation du Québec (2005)

References

British Columbia. (1993, November 19). Waste Management Act: Production and Use of Compost Regulation. *British Columbia Regulation 334/94*, p. 15

Bureau de normalisation du Québec. (2005) CAN/BNQ 0413-200-2005 – Organic Soil Conditioners – Composts. (Amendements organiques – Composts.)

Canadian Food Inspection Agency. (1997, September). Standards for Metals in Fertilizers and Supplements, Trade Memorandum T-4-93.

Centre de recherche industrielle du Québec. (1994, May). Caractérisation de certains composts commerciaux disponibles au Québec. *Technical report No. RDQ-94-026*, Sainte-Foy, Québec, p. 19.

Environment Canada, Water Quality Branch. (1991). Review and recommendations for Canadian interim environmental quality criteria for contaminated sites. *Study No. 197, Scientific Series*, Ottawa.

Giroux, M., M. Rompré, D. Carrier, P. Audesse and M. Lemieux. (1992, December) Caractérisation de la teneur en métaux lourds totaux et disponibles des sols du Québec. *Agrosol*, Sainte-Foy, Québec, volume 5, number 2, pp. 46 to 55.

Groeneveld, È. And M. Hébert. (2004, September). Dioxines, furannes, BPC et HAP dans les composts de l'est du Canada. *Vecteur Environnement*. pp. 47-52.

Hébert et Groeneveld. 2003. *Impacts of modifying the copper limit of the Canadian compost standard* novembre 2003, 9 p. Ministère du Développement durable, de l'Environnement et des Parcs du Québec.

Ontario Ministry of the Environment, Air Resources Branch. (1989, March) Upper Limit of Normal Contaminant Guidelines for Phytotoxicology Samples, Phytotoxicology Section, (ARB-138-88). 7 p.

"Support Document for Compost Quality Criteria [National Standard of Canada CAN/BNQ 0413200, Canadian Council of Ministers of the Environment (CCME) Guidelines and Agriculture and Agri-Food Canada (AAFC) Criteria]", Final Version (1996, March).

US EPA. (1995, September). A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule, United States Environmental Protection Agency, Office of Wastewater Management, EPA/832-B-93-005, 144 p.

Waste Conversion Incorporated. (1992, August). An International Survey of Composting Criteria, Ottawa, (Contract No. KE144-1-6173, internal report pre-pared for Environment Canada) p. 6.

Webber, M.. (1996). Compilation, Review and Evaluation of Organic Contaminants in Compost and Compost Feedstock Materials. Burlington, Water Technology International Corporation.

Webber, M. and S.S. Singh. (1995) Contamination of Agricultural Soils. In D.F. Acton and L.J. Gregorich (Eds.), *The Health of Our Soils: Toward Sustainable Agriculture in Canada*. (chap. 9). Centre for Land and Biological Resources Research, Research Branch, Agriculture and Agri-Food Canada. http://res2.agr.gc.ca/publications/hs/chap09_e.htm