



AGNICO EAGLE
MELIADINE

Meliadine Gold Project
NWB water license 2BB-1424
2017 Annual Report

Prepared for:

Nunavut Water Board, Kivalliq Inuit Association

Prepared by:

Agnico Eagle Mines Limited – Meliadine Division

March 31, 2018

Prepared By:



Oleksiy Chernoloz
Environmental Compliance Counselor
alex.chernoloz@agnicoeagle.com
819-759-3555 x8136

Approved By:



Jessica Huza
Environment General Supervisor - Nunavut Service Group
jessica.huza@agnicoeagle.com
819-856-5097

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SECTION 1 • INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) is developing the Meliadine Gold Project (the Project), located approximately 25 kilometres (km) north of Rankin Inlet, and 80 km southwest of Chesterfield Inlet in the Kivalliq Region of Nunavut. The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine.

As required under Part B Item 6 of Type B Water License 2BB-MEL1424, this report documents the water management and monitoring activities at the mine site for the year.

SECTION 2 • REPORTING DATA

a. The daily, monthly and annual quantities in cubic metres of all freshwater obtained from Meliadine Lake at Monitoring Stations MEL-1 and MEL-2

Daily freshwater consumption details can be found in Appendix A. The monthly average, monthly total and annual water usage volumes are summarized in Table 1.1 below; a total of 18,229 m³ or 17% of the authorized amount (290 m³/ day ~ 106,000 m³/ year) was consumed in 2017.

Table 2-1 Monthly and annual quantities of freshwater in m³, obtained from Meliadine lake at monitoring stations MEL-1 and MEL-2 in 2017.

	January	February	March	April	May	June	July	August	September	October	November	December	2017 Total
Water withdrawn, m ³	947	996	1,554	1,759	2,835	2,829	935	1,036	1,139	1,532	1,387	1,280	18,229
Authorized withdrawal, m ³	8,990	8,120	8,990	8,700	8,990	8,700	8,990	8,990	8,700	8,990	8,700	8,990	105,850

b. The daily, monthly and annual quantities, in cubic metres, of Mine water pumped from the underground

The daily, monthly, and annual flow volume quantities, in cubic meters (m³), of mine water pumped from underground to surface during 2017 are summarized in Appendix B. The monthly and annual flow volumes are summarized in Table 2-2 below.

Table 2-2 2017 Monthly and Annual flow volumes of underground mine water pumped to surface

	January	February	March	April	May	June	July	August	September	October	November	December	2017 Total
Water pumped, m ³	-	-	-	-	1,169	1,706	3,124	5,457	640	-	-	-	12,097

c. An estimate of the current volume of waste rock and ore stockpiled on site

Crushed run-of-mine material was placed in several stockpiles on site; three piles of screened material (0-30 mm, 0-50 mm and 0-200 mm) contained 11,300 m³, 12,500 m³ and 8,400 m³ respectively, unscreened pile contained approximately 15,000 m³ for a total of approximately 47,200 m³ of waste rock. No waste rock was placed into the waste rock storage facility in 2017.

A total of 1,738 tonnes of ore was produced in 2017 during the process of the mine development; as of December 31, 2017 the total ore stockpile on site is approximately 46,000 t.

d. Tabular summary of all data generated under the Monitoring Program, Part J.

In accordance with Part J, item 1 of the License, Agnico maintained the following sampling stations MEL-1, MEL-2, MEL-6, MEL-7, and MEL-8. Tabular summary of all data gathered under Part J of the License is presented in Appendix C.

e. A summary of modification and/or major maintenance work carried out on the Water Supply Facilities, Bulk Fuel Storage Facility, Bermed Fuel Containment Facilities, and Wastewater Treatment Facility, including all associated structures, and an outline of any work anticipated for the next year.

In 2017, modifications were undertaken at the fuel farm and the STP.

Following April 8, 2017 release of approximately 30,000 L of diesel fuel from Tank 18 at the Meliadine Tank Farm, an extensive containment and clean-up operation commenced. Contaminated soil was placed in the landfarm; contaminated snow was stored in newly built so-called snow cell within P-area. The snow cell is a bermed rectangular containment, lined with impermeable liner between two layers of geotextile. The snow cell was built entirely within P-Area; therefore its construction did not increase the disturbed area. Design drawing of the snow cell is provided in Appendix D. In September 2017 contaminated melted water from the snow cell was treated using AquaSweep™ oil separator. Treated water was discharged into CP1.

Following the repeated exceedances of the fecal coliform limit at the exploration STP (sampling station MEL-7), it was decided to suspend the release of the effluent into the environment, and to undertake an extensive maintenance and upgrade programs. [Those exceedances are discussed in detail in the following section f.] Starting November 15, 2017 all sewage from the exploration

camp, was trucked to the main camp STP for treatment to facilitate the maintenance and upgrade of the exploration STP.

Maintenance of the STP included: complete de-sludging of Biodisk, Bionest and grease trap, major clean-up of equalization tanks, replacement of UV lights.

Upgrade of the STP included: installation of the distribution system at the entry of the grease trap and jet mixers in the equalization tanks.

The decision to restart the discharge of the effluent from the exploration STP into the environment will be taken in 2018 in agreement with regulators. It will be based on testing data, showing consistent treatment process, producing compliant effluent. Until then, all effluent from the exploration camp will continue to be treated at the main camp STP.

Anticipated 2018 work includes decommissioning of the exploration fuel tank farm. The fuel tanks are being emptied and are expected to be removed in 2018. After removal of the tanks, the remediation of the area will commence, which is planned to be completed in 2019.

f. A list of unauthorized discharges and a summary of follow-up actions taken

The summary of unauthorized discharges at Meliadine under the license 2BB-1424 in 2017 and follow-up actions taken is provided below. Unauthorized discharges/ exceedances fell into two categories: spills of oil and fuel from the machinery, and exceedances in effluent limits from the exploration STP.

1. Spills of fuel and hydraulic fluid:

- a. On April 8th 2017 a Diesel spill of approximately 30,000 liters occurred at the fuel tank storage facility at the Meliadine project. Following the spill, immediate efforts were put into the containment and clean-up of the spill. Agnico Eagle retained SWAT Consulting Inc. to guide the clean-up and restoration efforts. Mitigation measures included the extensive sampling program and delineation of the spill, excavation of approximately 577 m³ of contaminated soil and its placement in the license B landfarm, excavation of 1,271 m³ of contaminated snow and its placement in the snow cell (see the description in the section e.), installation of the HDPE liner along the wall of the excavation to act as a barrier for fuel contamination. Fuel tanks in the fuel farm are being drawn down to allow the fuel farm decommissioning in 2018 and commencement of the full-scale remediation with planned completion in 2019.
- b. On July 25th 2017, a mobile equipment operator was moving sea-cans using a HYSTER (mobile equipment capable of manipulating sea-cans). The HYSTER tipped during operation, which resulted in the equipment rolling over off the road on the tundra. Upon tipping, approximately 150 liters of hydraulic oil, as well as 100 liters of diesel

fuel spilled from the HYSTER on ground. To contain the leaked fuel/ hydraulic oil and to prevent the spread of contamination, a trench was excavated and spill containment pads mobilized. Spill cleanup involved excavation of approximately 210 m³ of contaminated soil down to permafrost and its placement in the License B landfarm. A total of 8 soil samples were collected and sent for analysis; once the results were confirmed to meet CCME soil quality standard, the excavated area was backfilled and straw logs were placed in the direction of drainage to prevent the potential TSS contamination of Meliadine Lake.

- c. On December 3rd 2017 a diesel spill of approximately 7,500 liters occurred at the Meliadine exploration camp gen set (generator). At approximately 20:00 the spill was noticed by the night security personnel and was immediately reported to the Site Services and Environment departments. The source of the spill was controlled and investigation and remediation efforts commenced. As of December 31st 2017, approximately 1,230 L of spilled diesel was collected and a total of 692 m³ of soil was excavated from the downstream slope (facing the lake), and placed in the Type A water license landfarm. It is expected that the contamination plume is present under the exploration camp gensets. Additional mitigation measures included placement of HDPE liner to prevent the migration of contaminants towards the lake, placement of slotted culvert to collect the contaminants from the liner, placement of observation wells and piezometers, and backfill of the excavated area. Planned additional mitigation includes relocation of gensets and associated infrastructure in the summer of 2018, excavation of contaminated soil and its placement in the landfarm for treatment, collection of the soil samples and backfill of the excavation.

2. Exceedances of the STP effluent limits

Agnico is monitoring the quality of the effluent by collecting and sending for analysis samples of the effluent every week. As the result of this monitoring campaign, in 2017 Agnico detected several instances of exceedance of the effluent limits, set forth in the License; all those instances were reported to the GN, INAC/AANDC, NIRB, ECCC and investigated:

- a. On March 13th 2017 a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results were received on March 21st 2017; the fecal coliforms were measured at 7000 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the Water License 2BB-MEL1424 (the License).
- b. On May 1st 2017 a sample from MEL-07 (STP effluent) was collected and sent for analysis. Lab results, received on May 11th 2017, showed an exceedance of "Total Oil and Grease" (license limit = 5 mg/L, result = 6.1 mg/L). In response to the incident, the grease trap was cleaned, and fitted with the distribution system.
- c. On June 26th 2017, a sample from Mel-07 (STP effluent) was collected and sent for analysis. The results were received on July 6th 2017; the pH was measured at 5.67, outside of the permitted range of 6-9.5 set forth in the License. The investigation

concluded that logistical challenge led to the shortage of the standard pH adjustment agent (soda ash) on site, and it was replaced with caustic soda; dosing adjustments caused temporary drop in pH. Soda ash shortage was resolved and pH returned in normal range.

- d. On July 24th 2017, a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results were received on August 1st 2017; the fecal coliforms were measured at 2600 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the License.
- e. On September 25th 2017, a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results were received on September 29th 2017; the fecal coliforms were measured at 4200 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the License.
- f. On October 30th 2017, a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results were received on November 7th 2017; the fecal coliforms were measured at 1100 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the License.
- g. On November 7th 2017, a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results were received on November 14th 2017; the fecal coliforms were measured at 14000 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the License.
- h. On November 13th 2017, a sample from MEL-07 (STP effluent) was collected and sent for analysis. The results showed that fecal coliforms were measured at 2300 CFU/100 mL, which exceeds the permitted discharge limit of 1000 CFU/100 mL set forth in the License.

To identify the underlying causes of the effluent limit exceedances, in Q2 2017, Agnico hired two dedicated water treatment technicians to look over the daily operation and maintenance activities. In addition, in June 2017, Agnico retained a third party engineering firm (Hatch). Consultants from Hatch visited the site between July 3rd and July 6th 2017, inspected the STP, and provided Agnico with recommendations on how to improve the effluent quality. Based on the report by Hatch (issued on September 1st 2017) and internal expertise, Agnico began planning for implementation of the main key recommendations provided by the Hatch report. As discussed in the previous section e., starting November 15th 2017 all sewage from the exploration camp, was trucked to the main camp STP for treatment to facilitate the maintenance (de-sludging of Biodisk, Bionest and grease trap, major clean-up of equalization tanks, replacement of UV lights) and upgrade (installation of the distribution system at the entry of the grease trap and jet mixers in the equalization tanks) of the exploration STP. This maintenance and upgrade program was completed in November – December 2017; Agnico personnel resumed the monitoring of the performance of the system via regular sampling

and analysis, preparing to resume the discharge after receiving consistently compliant effluent.

At the time of submission of 2016 annual report, the investigation into the causes of oil and grease spill, occurred on December 5th 2016 was ongoing; this investigation concluded in March 2017. The follow up report, provided in Appendix E, did not identify with certainty the cause of the spill and suggested that human error lead to incorrect waste disposal.

As reported in previous annual reports, starting 2015, rising levels of chloride and ammonia were observed in small ponds downstream of P1 pond. The trend was reported in a letter submitted to the NWB and KIA on March 17, 2016. In response to this trend and to contain and manage the runoff from freshet, in 2016 Agnico built four temporary water containment dikes (DP1-A, DP1-B, DP2-A, DP3-A), creating three containment ponds (P1 Containment Area, P2 Containment Area, and P3 Containment Area), collectively known as P-Area. Subsequently, in 2016-2017, three evaporators, drainage ditches water pumping system were installed within P-Area.

In 2017 active sampling continued in affected area; sampling results from 2017 are compared to post-July 2016 results in Figures 1, 2 and 3. Prior to August 2016 samples were analyzed by two separate laboratories (ALS and MultiLab), and since August 2016, laboratory analysis was conducted by Maxxam Analytics Inc. Because of this change of laboratories and analytical detection methods they employed, it is not possible to directly compare the results from all three laboratories; therefore, historical trends for water quality after August 2016 are based on the data from Maxxam Analytics Inc. only.

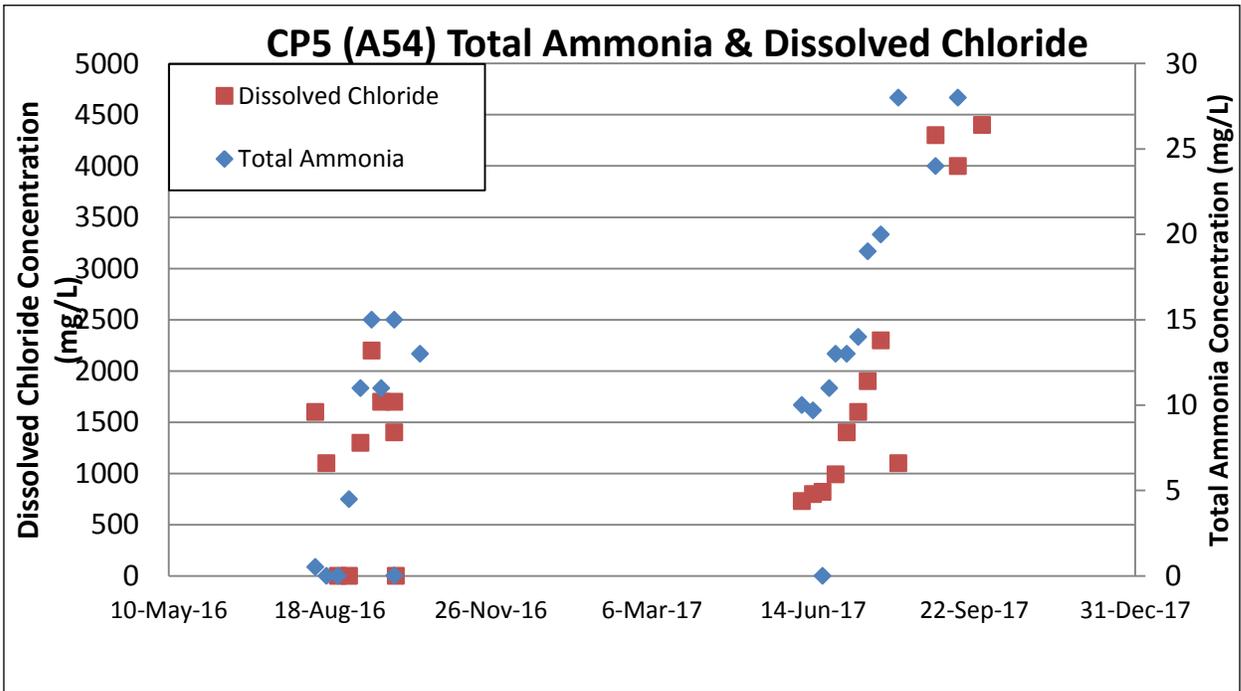


Figure 1: Chloride and ammonia concentrations in CP5 (A54), August 2016 – December 2017.

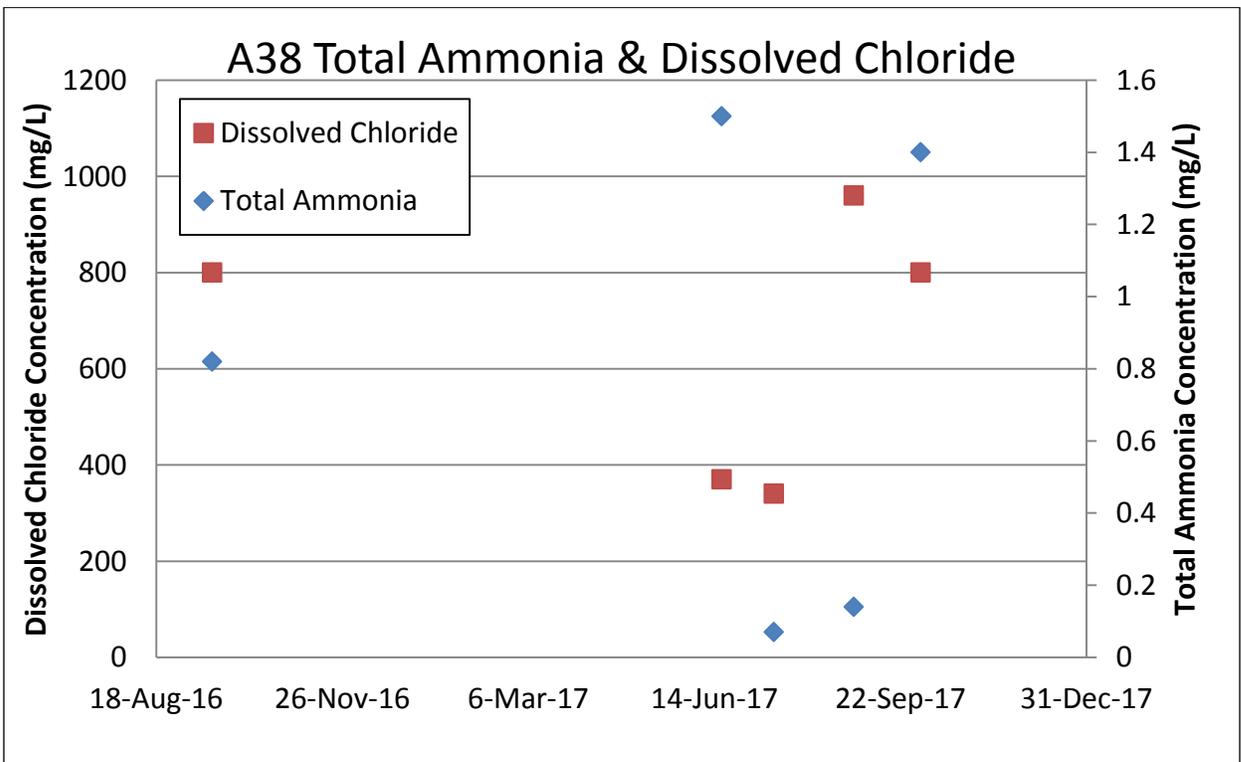


Figure 2: Chloride and ammonia concentrations in A38, August 2016 – December 2017.

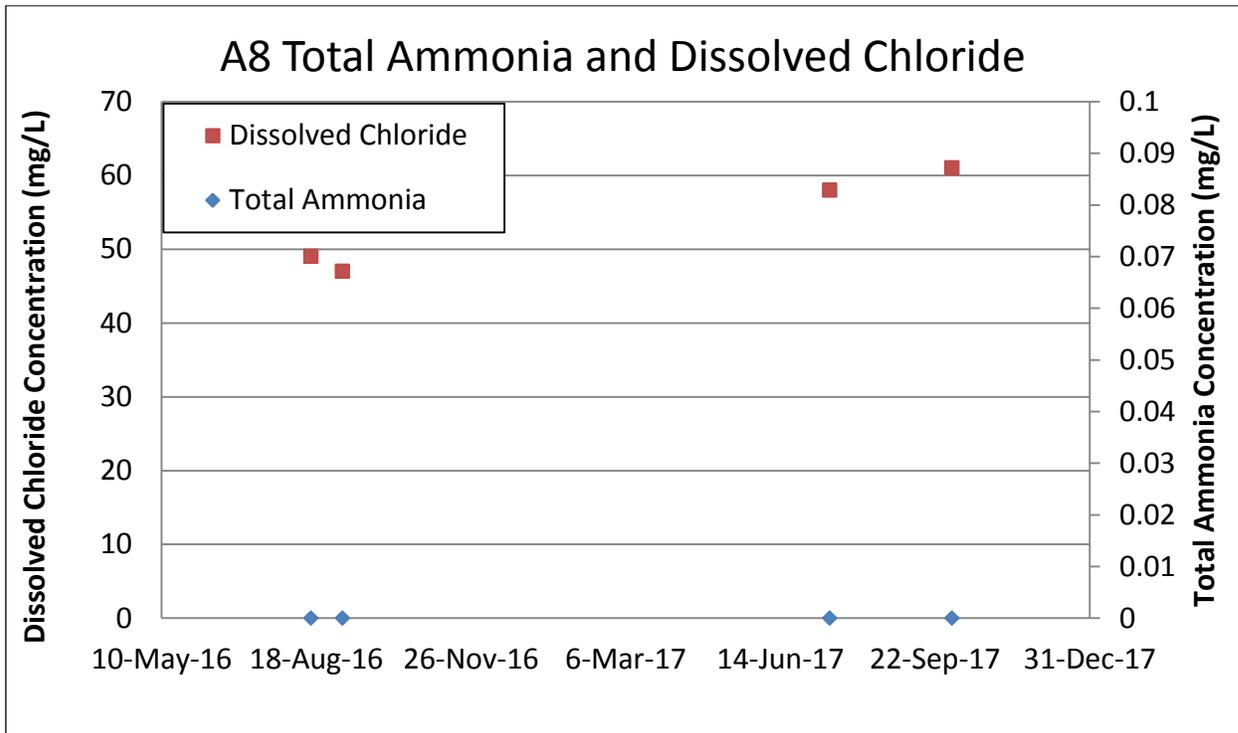


Figure 3: Chloride and ammonia concentrations in A8, August 2016 – December 2017.

CP5 (formerly Lake A54) showed a decreasing trend in median concentrations of chloride from 2016 to until late-August 2017 and increase after August 2017. Median CP5 chloride concentration post-July 2016 was 1,600 mg/L (range: 1,100 – 2,200 mg/L) and prior to late-August 2017 was 1,300 mg/L (range: 730 – 2300 mg/L). Following August 2017, the median chloride concentration at CP5 increased to 4,300 mg/L (range: 4000 – 4400 mg/L).

Lake A38 results had minimal change in chloride levels from 2016 (800 mg/L) to 2017 (median 590 mg/L, range: 340 – 960 mg/L). The concentration of chloride in A8 saw a modest increase from approximately 48 mg/L (range 47-49 mg/L) in August 2016 to approximately 60 mg/L (range: 59 – 61 mg/L) in 2017.

Ammonia concentrations in CP5 followed similar trends to chloride. The median 2016 post-July ammonia concentration at CP5 was 7.8 mg/L (range: 0.39 – 15 mg/L) compared to the median value during the period prior to late-August 2017 of 13 mg/L (range: 10 – 20 mg/L). For the period following August 2017, the median ammonia concentrations at CP5 increased to 28 mg/L (range: 24 – 28 mg/L). In Lake A38 in August 2016, the ammonia concentration was 0.77 mg/L compared to a median of 0.8 mg/L (range: 0.07 – 1.4 mg/L) during 2017. In Lake A8, ammonia concentrations were below the analytical detection limit of 0.01 mg/L in both 2016 and 2017.

Toxicity of ammonia increases with temperature and pH. At CP5, median temperature and pH values in 2017 were 11.7 °C (range: 4.90 – 16.3 °C) and 7.69 (range: 7.49 – 7.89). Relative to 2016 median temperature and pH values at CP5 of 11.4 °C (range: 5.5 – 16.5 °C) and 7.59 (range: 7.39 – 7.67), temperature and pH exhibited no change from 2016 to 2017 at CP5. At CP5, both temperature and pH followed a decreasing trend as the 2017 season progressed. Thus, suggesting that parameters impacting ammonia toxicity decreased as ammonia concentrations increased. At A38, median temperature and pH values in 2017 were 14.7 °C (range: 12.1 – 15.6 °C) and 7.79 (range: 7.67 – 7.94). Relative to September 2016 temperature and pH values at A38 of 5.5 °C and 7.81, pH exhibits no change and temperature appears to increase from 2016 to 2017 at A38. However, as the 2016 measurement was taken on September 17 and 2017 measurements extend only until August 28, no direct comparison is possible and the increase is likely reflective only of the timing of measurements. At A38, temperature decreased over the season and pH showed no directional trend.

The impact of contact water with elevated chloride and ammonia levels is localized. Contact water was contained and prevented from migration into proximal water bodies. Chloride and ammonia in the fish bearing Lake A8 did not exceed the CCME guidelines and in fact ammonia level there was below the detection limit (0.01 mg/L).

- g. Any revisions to the Spill Contingency Plan, Site Water Management Plan, Used Water Management Plan, Waste Management Plan, Waste Rock and Ore Storage Plan, Landfill and Landfarm Management Plans, Abandonment and Restoration Plan, as required by Part B, Item 12, submitted in the form of an Addendum**

In late 2017 - early 2018 Agnico undertook a thorough revision of the management plans, associated with Type A and Type B water licenses. Following management plans, pertaining to 2BB-MEL1424 license, were updated:

- a. Landfarm Management Plan;
- b. Landfill Management Plan;
- c. Used Water Management Plan;
- d. Waste water treatment plan.

Other plans of similar nature were amalgamated with Type A license plans to ensure consistency of management on site, including:

- a. Incinerator Management Plan;
- b. Quality Assurance/ Quality Control Plan;
- c. Spill Contingency Plan.

Please find amended and updated management plans in Appendix F.

- h. An updated estimate of the current Meliadine West Gold Project restoration and liability, as required under Part B, Item 3, based upon the results of the restoration research, project development monitoring, and any modifications to the site plan**

A permanent closure and reclamation financial security cost estimate was prepared in March 2015 to cover the closure and reclamation of all Project facilities using the RECLAIM Version 7.0. It was incorporated to the Preliminary Closure and Reclamation Plan (March 2015) prepared as part of the Type B Water License 2015 Annual Report. This closure cost was approved and incorporated into Part B of Water License 2BB-MEL1424. There have been no changes to the closure and reclamation plan since then. The restoration liability and financial security are still adequate.

- i. A summary of drilling/trenching activities and progressive reclamation of drill/trench sites**

In 2017, Agnico Eagle completed a total of 53 surface drilling holes with a total length of 15,867 m. No trenches were created during the year.

Progressive reclamation of drill sites is completed in accordance with the Exploration Closure and Reclamation Management plan, using the following procedure:

- Casing is pulled out if possible. If not, casing is cut off at or below ground level;
- Water and drill cuttings are disposed of at least 31 meter away from any water body where direct flow to the water body is not possible.

Agnico in collaboration with the research team of the College of Agriculture and Bioresources of the University of Saskatchewan developed a multi-year comprehensive soil restoration program for drilling sites at Meliadine. Field studies are expected to commence in the summer of 2018.

- j. Report all artesian flow occurrences as required under Part F, Item 6**

In 2017, Agnico Eagle completed a total of 53 surface drilling holes; no artesian flows were encountered.

- k. A description of all progressive and/or final reclamation work undertaken, including photographic records of site conditions before, during and after completion of operations**

Drill site reclamation is completed after the completion of the drilling program. The drilling sites are inspected after the drilling to ensure that no waste is present and that the casings are removed or cut to ground level. All the conversion holes were cemented for the first 5m, the hydrogeology holes were partly or completely cemented.

Comprehensive drill site remediation study in collaboration with the University of Saskatchewan is expected to commence in the summer of 2018.

i. A summary of any specific studies or reports requested by the Board, and a brief description of any future studies planned or proposed

No specific studies were requested by the Board in 2017.

In 2017 Agnico retained the National Research Council Canada (NRC) to undertake the contaminated soil assessment in the landfarm. NRC performed a feasibility study to determine the potential for biodegradation of the diesel contamination by indigenous microorganisms, present in the soil. The study developed recommendations for bioremediation to address soil contamination with petroleum hydrocarbons. Full text of the study is provided in Appendix G

Within the scope of this license, the drill site restoration study, as described in the section i., is expected to commence in 2018.

m. A summary of public consultation/participation, describing consultation with local organizations and residents of the nearby communities, if any were conducted

In 2017 Agnico held 64 public consultations with the public, related to Meliadine Project, including meetings, presentations, information sessions, site tours etc. The consultation log is provided in Appendix H.

n. Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

No other details on water use or water disposal were requested by the Board by November 1, 2017.

Appendix A
2017 Daily Freshwater Usage

Daily Water Withdrawals at Meliadine in 2017

Date	Type A	Type B	Total	Date	Type A	Type B	Total	Date	Type A	Type B	Total
1-Jan-2017	0	47.2	47.2	1-Feb-2017	0	33.5	33.5	1-Mar-2017	0	32.5	32.5
2-Jan-2017	0	18.2	18.2	2-Feb-2017	0	26.2	26.2	2-Mar-2017	0	33.8	33.8
3-Jan-2017	0	14.2	14.2	3-Feb-2017	0	29.1	29.1	3-Mar-2017	0	31.9	31.9
4-Jan-2017	0	21.6	21.6	4-Feb-2017	0	28.1	28.1	4-Mar-2017	0	31.3	31.3
5-Jan-2017	0	18.2	18.2	5-Feb-2017	0	30.6	30.6	5-Mar-2017	0	35.6	35.6
6-Jan-2017	0	20.2	20.2	6-Feb-2017	0	41.4	41.4	6-Mar-2017	0	43.4	43.4
7-Jan-2017	0	26.2	26.2	7-Feb-2017	0	41.2	41.2	7-Mar-2017	0	52.9	52.9
8-Jan-2017	0	20.2	20.2	8-Feb-2017	0	33.0	33.0	8-Mar-2017	0	42.5	42.5
9-Jan-2017	0	15.4	15.4	9-Feb-2017	0	42.5	42.5	9-Mar-2017	0	33.3	33.3
10-Jan-2017	0	5.2	5.2	10-Feb-2017	0	30.4	30.4	10-Mar-2017	0	48.7	48.7
11-Jan-2017	0	12.6	12.6	11-Feb-2017	0	32.3	32.3	11-Mar-2017	0	60.4	60.4
12-Jan-2017	0	4.2	4.2	12-Feb-2017	0	41.0	41.0	12-Mar-2017	0	43.9	43.9
13-Jan-2017	0	2.7	2.7	13-Feb-2017	0	45.7	45.7	13-Mar-2017	0	54.9	54.9
14-Jan-2017	0	42.6	42.6	14-Feb-2017	0	22.5	22.5	14-Mar-2017	0	44.4	44.4
15-Jan-2017	0	42.6	42.6	15-Feb-2017	0	38.9	38.9	15-Mar-2017	0	51.5	51.5
16-Jan-2017	0	53.4	53.4	16-Feb-2017	0	32.5	32.5	16-Mar-2017	0	54.3	54.3
17-Jan-2017	0	31.0	31.0	17-Feb-2017	0	40.1	40.1	17-Mar-2017	0	50.7	50.7
18-Jan-2017	0	80.4	80.4	18-Feb-2017	0	35.9	35.9	18-Mar-2017	0	65.4	65.4
19-Jan-2017	0	48.9	48.9	19-Feb-2017	0	30.8	30.8	19-Mar-2017	0	43.9	43.9
20-Jan-2017	0	48.9	48.9	20-Feb-2017	0	37.7	37.7	20-Mar-2017	0	42.1	42.1
21-Jan-2017	0	41.3	41.3	21-Feb-2017	0	37.8	37.8	21-Mar-2017	96	36.5	132.5
22-Jan-2017	0	40.6	40.6	22-Feb-2017	0	37.9	37.9	22-Mar-2017	96	62.7	158.7
23-Jan-2017	0	28.1	28.1	23-Feb-2017	0	36.6	36.6	23-Mar-2017	96	60.2	156.2
24-Jan-2017	0	28.2	28.2	24-Feb-2017	0	38.2	38.2	24-Mar-2017	0	70.9	70.9
25-Jan-2017	0	43.8	43.8	25-Feb-2017	0	37.5	37.5	25-Mar-2017	0	42.9	42.9
26-Jan-2017	0	23.8	23.8	26-Feb-2017	0	42.3	42.3	26-Mar-2017	0	48.4	48.4
27-Jan-2017	0	34.8	34.8	27-Feb-2017	0	34.9	34.9	27-Mar-2017	0	61.4	61.4
28-Jan-2017	0	28.9	28.9	28-Feb-2017	0	37.5	37.5	28-Mar-2017	0	61.4	61.4
29-Jan-2017	0	32.1	32.1					29-Mar-2017	0	51.8	51.8
30-Jan-2017	0	32.2	32.2					30-Mar-2017	0	73.6	73.6
31-Jan-2017	0	39.1	39.1					31-Mar-2017	0	86.6	86.6
Total Jan	0	946.8	946.8	Total Feb	0.0	995.7	995.7	Total March	288.0	1554.1	1842.1

Total Q1 288.0 3496.6 **3784.6**

Date	Type A	Type B	Total	Date	Type A	Type B	Total	Date	Type A	Type B	Total
1-Apr-17	48.0	59.0	107.0	1-May-17	32.7	47.2	79.9	1-Jun-17	43.7	66.3	110.0
2-Apr-17	11.0	60.7	71.7	2-May-17	24.2	52.5	76.8	2-Jun-17	55.2	122.4	177.5
3-Apr-17	97.0	70.4	167.4	3-May-17	36.5	61.7	98.2	3-Jun-17	36.4	74.3	110.7
4-Apr-17	14.0	56.2	70.2	4-May-17	23.6	101.1	124.7	4-Jun-17	45.5	55.1	100.7
5-Apr-17	15.0	48.9	63.9	5-May-17	35.8	102.5	138.3	5-Jun-17	64.9	107.7	172.7
6-Apr-17	16.0	33.5	49.5	6-May-17	22.8	107.3	130.1	6-Jun-17	42.8	99.3	142.1
7-Apr-17	19.0	76.9	95.9	7-May-17	26.6	111.4	138.0	7-Jun-17	27.9	213.7	241.6
8-Apr-17	13.0	50.5	63.5	8-May-17	52.8	129.9	182.6	8-Jun-17	46.9	204.5	251.5
9-Apr-17	14.0	34.5	48.5	9-May-17	23.1	179.7	202.8	9-Jun-17	50.0	96.2	146.2
10-Apr-17	17.0	45.5	62.5	10-May-17	32.0	139.4	171.4	10-Jun-17	31.7	126.8	158.5
11-Apr-17	17.0	47.5	64.5	11-May-17	30.8	124.1	154.9	11-Jun-17	46.1	77.6	123.7
12-Apr-17	20.0	34.8	54.8	12-May-17	2.4	118.1	120.5	12-Jun-17	46.3	83.1	129.3
13-Apr-17	12.0	28.0	40.0	13-May-17	25.4	117.4	142.8	13-Jun-17	37.6	43.0	80.6
14-Apr-17	18.0	46.9	64.9	14-May-17	34.3	116.0	150.3	14-Jun-17	41.1	79.0	120.1
15-Apr-17	24.7	71.7	96.4	15-May-17	31.2	71.9	103.1	15-Jun-17	35.8	177.1	212.9
16-Apr-17	18.0	42.2	60.2	16-May-17	60.8	47.6	108.3	16-Jun-17	64.5	75.4	139.9
17-Apr-17	22.4	39.3	61.7	17-May-17	32.5	30.5	63.0	17-Jun-17	50.0	82.2	132.2
18-Apr-17	17.6	42.0	59.6	18-May-17	27.2	34.9	62.2	18-Jun-17	54.7	79.5	134.2

Daily Water Withdrawals at Meliadine in 2017

19-Apr-17	16.1	72.3	88.4	19-May-17	28.0	51.1	79.1	19-Jun-17	51.4	131.7	183.1
20-Apr-17	36.1	65.6	101.7	20-May-17	38.3	68.1	106.4	20-Jun-17	67.1	104.2	171.2
21-Apr-17	0.0	48.8	48.8	21-May-17	33.5	103.9	137.4	21-Jun-17	66.0	78.7	144.8
22-Apr-17	19.5	82.8	102.3	22-May-17	34.8	105.8	140.6	22-Jun-17	63.3	116.1	179.4
23-Apr-17	20.5	71.5	91.9	23-May-17	39.2	88.7	127.9	23-Jun-17	73.0	127.6	200.6
24-Apr-17	22.8	84.9	107.8	24-May-17	33.8	91.9	125.7	24-Jun-17	63.0	46.4	109.4
25-Apr-17	18.3	73.9	92.2	25-May-17	48.7	110.3	158.9	25-Jun-17	71.2	80.1	151.3
26-Apr-17	19.8	70.3	90.1	26-May-17	37.5	90.8	128.3	26-Jun-17	71.7	79.8	151.6
27-Apr-17	0.0	109.9	109.9	27-May-17	35.0	102.2	137.2	27-Jun-17	43.0	54.2	97.1
28-Apr-17	50.6	77.5	128.1	28-May-17	32.2	56.8	89.1	28-Jun-17	42.8	44.3	87.1
29-Apr-17	22.7	55.5	78.2	29-May-17	47.1	96.4	143.4	29-Jun-17	66.5	56.9	123.4
30-Apr-17	35.6	57.4	93.0	30-May-17	39.5	109.5	149.0	30-Jun-17	56.2	46.0	102.2
				31-May-17	38.7	66.2	104.9				
Total April	675.7	1758.9	2434.7	Total May	1040.8	2834.9	3875.7	Total June	1556.3	2829.4	4385.7
								Total Q2	3272.8	7423.2	10696.1

Date	Type A	Type B	Total	Date	Type A	Type B	Total	Date	Type A	Type B	Total
1-Jul-17	94.5	33.4	127.9	1-Aug-17	107.1	25.1	132.2	1-Sep-17	63.0	35.6	98.6
2-Jul-17	62.9	33.2	96.2	2-Aug-17	121.3	28.1	149.5	2-Sep-17	63.5	35.4	98.9
3-Jul-17	68.2	32.5	100.6	3-Aug-17	74.0	37.1	111.1	3-Sep-17	77.5	31.0	108.5
4-Jul-17	52.2	27.0	79.3	4-Aug-17	102.5	27.0	129.5	4-Sep-17	71.0	31.6	102.6
5-Jul-17	87.3	32.4	119.7	5-Aug-17	70.3	28.2	98.5	5-Sep-17	178.5	34.7	213.2
6-Jul-17	43.8	38.0	81.8	6-Aug-17	60.0	33.5	93.5	6-Sep-17	71.0	33.1	104.1
7-Jul-17	58.6	36.1	94.7	7-Aug-17	84.6	29.5	114.1	7-Sep-17	61.0	35.1	96.1
8-Jul-17	53.8	19.2	73.0	8-Aug-17	78.5	26.6	105.1	8-Sep-17	89.0	35.7	124.7
9-Jul-17	43.3	29.0	72.3	9-Aug-17	94.9	36.5	131.4	9-Sep-17	68.0	27.2	95.2
10-Jul-17	65.1	31.9	97.0	10-Aug-17	83.0	30.8	113.8	10-Sep-17	62.0	44.9	106.9
11-Jul-17	48.7	25.6	74.3	11-Aug-17	78.5	36.0	114.5	11-Sep-17	70.0	78.2	148.2
12-Jul-17	99.5	23.2	122.7	12-Aug-17	109.5	28.6	138.1	12-Sep-17	76.5	93.6	170.1
13-Jul-17	65.0	26.9	91.9	13-Aug-17	91.0	49.1	140.1	13-Sep-17	65.0	34.0	99.0
14-Jul-17	58.0	33.3	91.3	14-Aug-17	99.0	26.2	125.2	14-Sep-17	77.4	37.3	114.7
15-Jul-17	62.0	30.1	92.1	15-Aug-17	81.5	28.3	109.8	15-Sep-17	61.5	33.6	95.1
16-Jul-17	72.0	27.4	99.4	16-Aug-17	84.0	29.6	113.6	16-Sep-17	65.0	25.9	90.9
17-Jul-17	56.7	27.3	84.0	17-Aug-17	77.7	35.1	112.7	17-Sep-17	73.0	32.5	105.5
18-Jul-17	65.2	34.8	100.0	18-Aug-17	90.6	39.6	130.2	18-Sep-17	67.0	32.8	99.8
19-Jul-17	55.0	32.3	87.3	19-Aug-17	64.3	25.3	89.6	19-Sep-17	71.2	25.7	96.8
20-Jul-17	61.0	25.9	86.9	20-Aug-17	112.6	34.2	146.8	20-Sep-17	95.5	33.0	128.6
21-Jul-17	74.8	27.3	102.1	21-Aug-17	93.0	48.2	141.1	21-Sep-17	56.0	28.6	84.6
22-Jul-17	67.8	25.1	92.9	22-Aug-17	64.0	45.8	109.8	22-Sep-17	80.8	30.8	111.6
23-Jul-17	84.2	34.0	118.2	23-Aug-17	100.4	38.5	138.9	23-Sep-17	101.0	25.8	126.8
24-Jul-17	67.4	37.2	104.6	24-Aug-17	99.7	36.3	136.0	24-Sep-17	62.2	26.8	89.0
25-Jul-17	97.8	30.2	128.0	25-Aug-17	106.0	32.7	138.7	25-Sep-17	85.4	32.4	117.7
26-Jul-17	86.2	27.4	113.6	26-Aug-17	61.0	36.8	97.8	26-Sep-17	73.1	25.3	98.4
27-Jul-17	71.2	29.5	100.7	27-Aug-17	74.2	30.5	104.7	27-Sep-17	58.3	38.6	96.9
28-Jul-17	108.4	26.2	134.6	28-Aug-17	96.5	33.0	129.6	28-Sep-17	64.5	21.9	86.4
29-Jul-17	72.0	34.8	106.8	29-Aug-17	78.7	39.9	118.6	29-Sep-17	80.5	37.3	117.8
30-Jul-17	113.3	29.5	142.8	30-Aug-17	63.4	27.7	91.1	30-Sep-17	70.2	100.8	171.0
31-Jul-17	73.6	34.3	107.9	31-Aug-17	70.6	31.8	102.4				
Total July	2189.4	935.3	3124.7	Total Aug	2672.5	1035.6	3708.1	Total Sept	2258.5	1139.3	3397.7
								Total Q3	7120.4	3110.1	10230.5

Daily Water Withdrawals at Meliadine in 2017

Date	Type A	Type B	Total	Date	Type A	Type B	Total	Date	Type A	Type B	Total	
1-Oct-17	63.6	28.0	91.6	1-Nov-17	66.0	33.0	99.0	1-Dec-17	73.5	55.5	129.0	
2-Oct-17	76.0	41.5	117.5	2-Nov-17	77.0	61.0	138.0	2-Dec-17	81.0	73.0	154.0	
3-Oct-17	67.1	36.9	104.0	3-Nov-17	75.0	60.9	135.9	3-Dec-17	109.0	89.4	198.4	
4-Oct-17	75.8	36.0	111.8	4-Nov-17	72.0	58.2	130.2	4-Dec-17	57.0	74.9	131.9	
5-Oct-17	79.3	26.8	106.1	5-Nov-17	80.5	52.5	133.0	5-Dec-17	79.0	31.5	110.5	
6-Oct-17	62.7	23.4	86.1	6-Nov-17	68.0	59.5	127.5	6-Dec-17	83.0	37.8	120.8	
7-Oct-17	63.0	26.3	89.3	7-Nov-17	72.0	66.0	138.0	7-Dec-17	86.3	58.6	144.9	
8-Oct-17	58.0	28.2	86.2	8-Nov-17	68.0	20.9	88.9	8-Dec-17	79.0	47.5	126.5	
9-Oct-17	70.9	31.1	102.0	9-Nov-17	87.8	25.1	112.9	9-Dec-17	81.6	41.3	122.9	
10-Oct-17	53.0	393.4	446.4	10-Nov-17	94.4	39.8	134.2	10-Dec-17	81.8	50.2	132.0	
11-Oct-17	67.8	119.6	187.4	11-Nov-17	88.6	44.4	133.0	11-Dec-17	97.0	60.5	157.5	
12-Oct-17	60.1	23.4	83.5	12-Nov-17	88.2	51.4	139.7	12-Dec-17	65.0	30.0	95.0	
13-Oct-17	66.6	28.8	95.4	13-Nov-17	77.2	49.5	126.7	13-Dec-17	85.0	60.3	145.3	
14-Oct-17	61.0	21.3	82.3	14-Nov-17	82.5	29.4	111.9	14-Dec-17	85.8	53.6	139.4	
15-Oct-17	62.0	26.7	88.7	15-Nov-17	78.5	47.2	125.7	15-Dec-17	58.7	37.2	95.9	
16-Oct-17	59.5	22.2	81.7	16-Nov-17	78.9	33.2	112.1	16-Dec-17	51.0	48.6	99.6	
17-Oct-17	77.5	26.4	103.9	17-Nov-17	77.5	27.4	104.9	17-Dec-17	49.9	40.1	90.0	
18-Oct-17	64.8	25.8	90.6	18-Nov-17	73.3	43.6	116.9	18-Dec-17	52.2	36.6	88.9	
19-Oct-17	67.1	76.0	143.1	19-Nov-17	103.4	33.7	137.0	19-Dec-17	40.0	33.7	73.7	
20-Oct-17	63.0	31.6	94.6	20-Nov-17	74.0	47.9	121.8	20-Dec-17	33.0	64.3	97.3	
21-Oct-17	76.8	24.8	101.6	21-Nov-17	88.0	30.5	118.5	21-Dec-17	27.0	5.9	32.9	
22-Oct-17	61.0	29.3	90.3	22-Nov-17	40.5	54.2	94.7	22-Dec-17	21.0	22.5	43.5	
23-Oct-17	79.0	54.0	133.0	23-Nov-17	62.0	17.4	79.4	23-Dec-17	19.0	40.1	59.1	
24-Oct-17	54.0	30.3	84.3	24-Nov-17	66.0	54.8	120.8	24-Dec-17	25.0	27.1	52.1	
25-Oct-17	82.4	26.9	109.3	25-Nov-17	66.0	57.3	123.3	25-Dec-17	23.0	17.9	40.9	
26-Oct-17	73.3	29.0	102.3	26-Nov-17	69.0	45.2	114.2	26-Dec-17	20.0	28.9	48.9	
27-Oct-17	68.4	43.4	111.8	27-Nov-17	72.0	47.8	119.8	27-Dec-17	19.0	20.2	39.2	
28-Oct-17	67.5	52.3	119.8	28-Nov-17	92.5	112.2	204.7	28-Dec-17	21.0	27.2	48.2	
29-Oct-17	67.0	67.1	134.1	29-Nov-17	79.0	49.3	128.3	29-Dec-17	21.0	23.7	44.7	
30-Oct-17	82.7	51.8	134.5	30-Nov-17	77.0	33.7	110.7	30-Dec-17	21.0	18.7	39.7	
31-Oct-17	81.0	49.3	130.3					31-Dec-17	18.0	23.9	41.9	
Total Oct	2111.9	1531.5	3643.4	Total Nov	2294.7	1387.1	3681.8	Total Dec	1663.8	1280.4	2944.3	
									Total Q4	6070.5	4199.0	10269.5

Appendix B
2017 Volumes of Mine Water Pumped from Underground

Date	UDG to Surface (m3)										
1-Jan-2017	0.0	1-Feb-2017	0.0	1-Mar-2017	0.0	1-Apr-2017	0.0	1-May-2017	0.0	1-Jun-2017	139.0
2-Jan-2017	0.0	2-Feb-2017	0.0	2-Mar-2017	0.0	2-Apr-2017	0.0	2-May-2017	0.0	2-Jun-2017	129.0
3-Jan-2017	0.0	3-Feb-2017	0.0	3-Mar-2017	0.0	3-Apr-2017	0.0	3-May-2017	0.0	3-Jun-2017	79.2
4-Jan-2017	0.0	4-Feb-2017	0.0	4-Mar-2017	0.0	4-Apr-2017	0.0	4-May-2017	0.0	4-Jun-2017	68.3
5-Jan-2017	0.0	5-Feb-2017	0.0	5-Mar-2017	0.0	5-Apr-2017	0.0	5-May-2017	0.0	5-Jun-2017	81.4
6-Jan-2017	0.0	6-Feb-2017	0.0	6-Mar-2017	0.0	6-Apr-2017	0.0	6-May-2017	0.0	6-Jun-2017	93.4
7-Jan-2017	0.0	7-Feb-2017	0.0	7-Mar-2017	0.0	7-Apr-2017	0.0	7-May-2017	0.0	7-Jun-2017	149.6
8-Jan-2017	0.0	8-Feb-2017	0.0	8-Mar-2017	0.0	8-Apr-2017	0.0	8-May-2017	0.0	8-Jun-2017	150.9
9-Jan-2017	0.0	9-Feb-2017	0.0	9-Mar-2017	0.0	9-Apr-2017	0.0	9-May-2017	0.0	9-Jun-2017	24.3
10-Jan-2017	0.0	10-Feb-2017	0.0	10-Mar-2017	0.0	10-Apr-2017	0.0	10-May-2017	0.0	10-Jun-2017	0.0
11-Jan-2017	0.0	11-Feb-2017	0.0	11-Mar-2017	0.0	11-Apr-2017	0.0	11-May-2017	12.0	11-Jun-2017	107.5
12-Jan-2017	0.0	12-Feb-2017	0.0	12-Mar-2017	0.0	12-Apr-2017	0.0	12-May-2017	29.6	12-Jun-2017	38.6
13-Jan-2017	0.0	13-Feb-2017	0.0	13-Mar-2017	0.0	13-Apr-2017	0.0	13-May-2017	51.5	13-Jun-2017	75.5
14-Jan-2017	0.0	14-Feb-2017	0.0	14-Mar-2017	0.0	14-Apr-2017	0.0	14-May-2017	60.0	14-Jun-2017	59.0
15-Jan-2017	0.0	15-Feb-2017	0.0	15-Mar-2017	0.0	15-Apr-2017	0.0	15-May-2017	72.6	15-Jun-2017	10.3
16-Jan-2017	0.0	16-Feb-2017	0.0	16-Mar-2017	0.0	16-Apr-2017	0.0	16-May-2017	14.6	16-Jun-2017	0.0
17-Jan-2017	0.0	17-Feb-2017	0.0	17-Mar-2017	0.0	17-Apr-2017	0.0	17-May-2017	87.6	17-Jun-2017	0.0
18-Jan-2017	0.0	18-Feb-2017	0.0	18-Mar-2017	0.0	18-Apr-2017	0.0	18-May-2017	82.9	18-Jun-2017	0.0
19-Jan-2017	0.0	19-Feb-2017	0.0	19-Mar-2017	0.0	19-Apr-2017	0.0	19-May-2017	33.9	19-Jun-2017	0.0
20-Jan-2017	0.0	20-Feb-2017	0.0	20-Mar-2017	0.0	20-Apr-2017	0.0	20-May-2017	0.0	20-Jun-2017	0.0
21-Jan-2017	0.0	21-Feb-2017	0.0	21-Mar-2017	0.0	21-Apr-2017	0.0	21-May-2017	0.0	21-Jun-2017	0.0
22-Jan-2017	0.0	22-Feb-2017	0.0	22-Mar-2017	0.0	22-Apr-2017	0.0	22-May-2017	0.0	22-Jun-2017	0.0
23-Jan-2017	0.0	23-Feb-2017	0.0	23-Mar-2017	0.0	23-Apr-2017	0.0	23-May-2017	0.0	23-Jun-2017	0.0
24-Jan-2017	0.0	24-Feb-2017	0.0	24-Mar-2017	0.0	24-Apr-2017	0.0	24-May-2017	30.0	24-Jun-2017	0.0
25-Jan-2017	0.0	25-Feb-2017	0.0	25-Mar-2017	0.0	25-Apr-2017	0.0	25-May-2017	78.2	25-Jun-2017	0.0
26-Jan-2017	0.0	26-Feb-2017	0.0	26-Mar-2017	0.0	26-Apr-2017	0.0	26-May-2017	52.0	26-Jun-2017	0.0
27-Jan-2017	0.0	27-Feb-2017	0.0	27-Mar-2017	0.0	27-Apr-2017	0.0	27-May-2017	0.0	27-Jun-2017	0.0
28-Jan-2017	0.0	28-Feb-2017	0.0	28-Mar-2017	0.0	28-Apr-2017	0.0	28-May-2017	149.4	28-Jun-2017	0.0
29-Jan-2017	0.0			29-Mar-2017	0.0	29-Apr-2017	0.0	29-May-2017	132.3	29-Jun-2017	0.0
30-Jan-2017	0.0			30-Mar-2017	0.0	30-Apr-2017	0.0	30-May-2017	135.1	30-Jun-2017	500.0
31-Jan-2017	0.0			31-Mar-2017	0.0			31-May-2017	147.7		
Total Jan	0.0	Total Feb	0.0	Total March	0.0	Total April	0.0	Total May	1169.3	Total June	1706.0

Total Q1 0.0

Total Q2 2875.3

Date	UDG to Surface (m3)										
1-Jul-2017	0.0	1-Aug-2017	0.0	1-Sep-2017	21.3	1-Oct-2017	0.0	1-Nov-2017	0.0	1-Dec-2017	0.0
2-Jul-2017	0.0	2-Aug-2017	400.9	2-Sep-2017	25.0	2-Oct-2017	0.0	2-Nov-2017	0.0	2-Dec-2017	0.0
3-Jul-2017	0.0	3-Aug-2017	257.6	3-Sep-2017	9.7	3-Oct-2017	0.0	3-Nov-2017	0.0	3-Dec-2017	0.0
4-Jul-2017	0.0	4-Aug-2017	105.3	4-Sep-2017	159.2	4-Oct-2017	0.0	4-Nov-2017	0.0	4-Dec-2017	0.0
5-Jul-2017	0.0	5-Aug-2017	20.3	5-Sep-2017	47.4	5-Oct-2017	0.0	5-Nov-2017	0.0	5-Dec-2017	0.0
6-Jul-2017	0.0	6-Aug-2017	11.6	6-Sep-2017	0.0	6-Oct-2017	0.0	6-Nov-2017	0.0	6-Dec-2017	0.0
7-Jul-2017	0.0	7-Aug-2017	3.8	7-Sep-2017	0.0	7-Oct-2017	0.0	7-Nov-2017	0.0	7-Dec-2017	0.0
8-Jul-2017	0.0	8-Aug-2017	0.2	8-Sep-2017	0.0	8-Oct-2017	0.0	8-Nov-2017	0.0	8-Dec-2017	0.0
9-Jul-2017	0.0	9-Aug-2017	0.0	9-Sep-2017	0.0	9-Oct-2017	0.0	9-Nov-2017	0.0	9-Dec-2017	0.0
10-Jul-2017	0.0	10-Aug-2017	89.1	10-Sep-2017	8.9	10-Oct-2017	0.0	10-Nov-2017	0.0	10-Dec-2017	0.0
11-Jul-2017	0.0	11-Aug-2017	228.5	11-Sep-2017	53.3	11-Oct-2017	0.0	11-Nov-2017	0.0	11-Dec-2017	0.0
12-Jul-2017	0.0	12-Aug-2017	247.2	12-Sep-2017	54.0	12-Oct-2017	0.0	12-Nov-2017	0.0	12-Dec-2017	0.0
13-Jul-2017	0.0	13-Aug-2017	245.9	13-Sep-2017	33.5	13-Oct-2017	0.0	13-Nov-2017	0.0	13-Dec-2017	0.0
14-Jul-2017	0.0	14-Aug-2017	0.0	14-Sep-2017	31.3	14-Oct-2017	0.0	14-Nov-2017	0.0	14-Dec-2017	0.0
15-Jul-2017	0.0	15-Aug-2017	2032.2	15-Sep-2017	30.7	15-Oct-2017	0.0	15-Nov-2017	0.0	15-Dec-2017	0.0
16-Jul-2017	0.0	16-Aug-2017	229.6	16-Sep-2017	28.2	16-Oct-2017	0.0	16-Nov-2017	0.0	16-Dec-2017	0.0
17-Jul-2017	0.0	17-Aug-2017	139.4	17-Sep-2017	0.0	17-Oct-2017	0.0	17-Nov-2017	0.0	17-Dec-2017	0.0
18-Jul-2017	0.0	18-Aug-2017	0.8	18-Sep-2017	52.5	18-Oct-2017	0.0	18-Nov-2017	0.0	18-Dec-2017	0.0
19-Jul-2017	0.0	19-Aug-2017	0.0	19-Sep-2017	30.9	19-Oct-2017	0.0	19-Nov-2017	0.0	19-Dec-2017	0.0
20-Jul-2017	0.0	20-Aug-2017	0.0	20-Sep-2017	21.8	20-Oct-2017	0.0	20-Nov-2017	0.0	20-Dec-2017	0.0
21-Jul-2017	0.0	21-Aug-2017	22.4	21-Sep-2017	32.5	21-Oct-2017	0.0	21-Nov-2017	0.0	21-Dec-2017	0.0
22-Jul-2017	0.0	22-Aug-2017	0.0	22-Sep-2017	0.0	22-Oct-2017	0.0	22-Nov-2017	0.0	22-Dec-2017	0.0
23-Jul-2017	0.0	23-Aug-2017	190.0	23-Sep-2017	0.0	23-Oct-2017	0.0	23-Nov-2017	0.0	23-Dec-2017	0.0
24-Jul-2017	0.0	24-Aug-2017	251.9	24-Sep-2017	0.0	24-Oct-2017	0.0	24-Nov-2017	0.0	24-Dec-2017	0.0
25-Jul-2017	0.0	25-Aug-2017	166.2	25-Sep-2017	0.0	25-Oct-2017	0.0	25-Nov-2017	0.0	25-Dec-2017	0.0
26-Jul-2017	0.0	26-Aug-2017	15.6	26-Sep-2017	0.0	26-Oct-2017	0.0	26-Nov-2017	0.0	26-Dec-2017	0.0
27-Jul-2017	0.0	27-Aug-2017	99.2	27-Sep-2017	0.0	27-Oct-2017	0.0	27-Nov-2017	0.0	27-Dec-2017	0.0
28-Jul-2017	0.0	28-Aug-2017	195.0	28-Sep-2017	0.0	28-Oct-2017	0.0	28-Nov-2017	0.0	28-Dec-2017	0.0
29-Jul-2017	0.0	29-Aug-2017	188.8	29-Sep-2017	0.0	29-Oct-2017	0.0	29-Nov-2017	0.0	29-Dec-2017	0.0
30-Jul-2017	294.2	30-Aug-2017	202.4	30-Sep-2017	0.0	30-Oct-2017	0.0	30-Nov-2017	0.0	30-Dec-2017	0.0
31-Jul-2017	2830.0	31-Aug-2017	113.1			31-Oct-2017	0.0			31-Dec-2017	0.0
Total July	3124.2	Total Aug	5457.1	Total Sept	640.3	Total Oct	0.0	Total Nov	0.0	Total Dec	0.0

Total Q3 9221.6

Total Q4 0.0

Appendix C
2017 Tabular Summary of Monitoring Data

Sampling Station MEL-06 / MEL-16 (G2)

Waterbody : H19		Specific Criteria	MERC Criteria	CCME	2017			
Year	6/24/2017				7/24/017	8/23/2017	9/13/2017	
Date Sampled								
Lab Reference					B7D6320	B7G3631	B7I6940	B7K4224
LAB					Maxxam	Maxxam	Maxxam	Maxxam
Field Measurements								
GPS Coordinates					0538840-6990498	0538840-6990498	0538840-6990498	0538840-6990498
Water Temperature	oC				-	-	12.9	9.4
pH	pH units				-	-	7.8	8.1
Conductivity	(mS/cm)				-	-	0.329	0.1542
Parameters								
Bicarb. Alkalinity (calc. as CaCO3)	mg/L				28	31	33	35
Carb. Alkalinity (calc. as CaCO3)	mg/L				<1.0	<1.0	<1.0	<1.0
Total Ammonia-N	mg/L	ent18 Grab sample		Table (field pH/ field Temp)	<0.01	<0.01	<0.01	<0.01
Conductivity	umhos/cm				74	84	88	110
Total Dissolved Solids (TDS)	mg/L	1400			48	58	66	92
Free Cyanide (Cn)	mg/L		0.010				<0.0010	0.0013
Total Kjeldahl Nitrogen (TKN)	mg/L				0.23	0.21	0.33	0.25
Dissolved Organic Carbon (DOC)	mg/L				3.9	4.9	5	-
Total Organic Carbon (TOC)	mg/L				4.6	4.7	5.3	5.1
Orthophosphate (P)	mg/L				<0.010	<0.010	<0.0010	<0.010
pH	pH units	6.0 to 9.5		6.5-9.0 (long term)	7.51	7.71	7.75	7.78
Total Phosphorus (P)	mg/L	ent4.0 Grab sample		ultra-oligotrophic <4 ug/L (or	0.010	0.005	0.009	0.005
Total Suspended Solids (TSS)	mg/L	ent30 Grab	ent30 Grab	Maximum increase of 25 mg/L	1	1	<10	2
Dissolved Sulphate (SO4)	mg/L				<1.0	1.3	<1.0	1.8
Total Cyanide (Cn)	mg/L	ent1 Grab	0.010			<0.0050	<0.0050	<0.0050
Turbidity	NTU			Maximum increase of 8 NTUs	0.6	1.5	0.6	0.5
Alkalinity (Total as CaCO3)	mg/L				28	32	34	35
Dissolved chloride (Cl)	mg/L			640 mg/L (short term); 120 mg/L (long term)	4.6	5.2	6.1	11
Nitrite (as N)	mg/L			60 mg/L NO2-N (long term)	<0.010	<0.010	<0.010	<0.010
Nitrate (as N)	mg/L			550 mg/L (short term); 13 mg/L (long term)	<0.10	<0.10	<0.10	<0.10
Nitrite-Nitrate (as N)	mg/L				<0.10	<0.10	<0.10	<0.10
Radium-226	Bq/L							
Total Oil & Grease								
Mercury (Hg)-Total	mg/L			0.026 ug/L (long term) (or 0.0001 mg/L)	<0.00001	<0.00001	<0.00001	<0.00001
Dissolved Mercury (Hg)	mg/L				<0.00001	<0.00001	<0.00001	<0.00001
Total Hardness (CaCO3)	mg/L				26.6	31.6	43	-
Total Aluminium (Al)	mg/L	ent3 Grab sample		5 ug/L (0.005 mg/L) if pH < 6.5	0.0154	0.0114	0.0087	0.0125
Total Antimony (Sb)	mg/L				<0.00050	<0.00050	<0.00050	<0.00050
Total Arsenic (As)	mg/L	ent0.6 Grab sample		5 ug/L (long term) (or 0.005 mg/L)	<0.00118	0.00099	0.00107	0.00094
Total Barium (Ba)	mg/L				0.0147	0.0148	0.016	0.0209
Total Beryllium (Be)	mg/L				<0.00010	<0.00010	<0.00010	<0.00010
Total Boron (B)	mg/L			29 mg/L (short term); 1.5 mg/L (long term)	<0.050	<0.050	<0.050	<0.050
Total Cadmium (Cd)	mg/L			1 ug/L or 0.001 mg/L (short term)	<0.000010	<0.000010	<0.000010	<0.000010
Total Chromium (Cr)	mg/L				<0.0010	<0.0010	<0.0010	<0.0010
Total Copper (Cu)	mg/L	ent0.4 Grab sample		if hardness 0 to < 82 mg/L, then 300 ug/L (long term) (or 0.3 mg/L)	0.00107	0.00102	0.00092	0.00104
Total Iron (Fe)	mg/L				0.286	0.092	0.146	0.094
Total Lead (Pb)	mg/L	ent0.4 Grab	ent0.4 Grab	hardness is 0 to ≤ 60 mg/L, then 100 ug/L (long term) (or 0.01 mg/L)	<0.00020	<0.00020	<0.00020	<0.00020
Total Lithium (Li)	mg/L				<0.0020	<0.0020	<0.0020	<0.0020
Total Manganese (Mn)	mg/L				0.014	0.0072	0.0106	0.0139
Total Molybdenum (Mo)	mg/L			73 ug/L (long term) (or 0.073 ug/L)	<0.0010	<0.0010	<0.0010	<0.0010
Total Nickel (Ni)	mg/L	ent1.0 Grab	ent1.0 Grab	hardness is 0 to ≤ 60 mg/L, then 100 ug/L (long term) (or 0.01 mg/L)	0.0014	<0.0010	<0.0010	<0.0010
Total Selenium (Se)	mg/L			1 ug/L (long term) (or 0.001 mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Total Silver (Ag)	mg/L				<0.000020	<0.000020	<0.000020	<0.000020
Total Strontium (Sr)	mg/L				0.0485	0.0567	0.061	0.0737
Total thallium (Tl)	mg/L			0.8 ug/L (long term) (or 0.0001 mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
Total Tin (Sn)	mg/L				<0.0050	<0.0050	<0.0050	<0.0050
Total Titanium (Ti)	mg/L				<0.0050	<0.0050	<0.0050	<0.0050
Total Uranium	mg/L			33 ug/L (short term) (or 0.033 ug/L)	<0.00010	<0.00010	<0.00010	<0.00010
Total Vanadium	mg/L				<0.0050	<0.0050	<0.0050	<0.0050
Total Zinc	mg/L	ent0.8 Grab sample		30 ug/L (long term) (or 0.03 mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
Total Calcium	mg/L				8.91	10.5	14.9	14.6
Total Magnesium	mg/L				1.04	1.3	1.42	1.76
Total Potassium	mg/L				0.838	1.19	1.16	1.18
Total Sodium	mg/L				1.9	2.33	2.53	2.71
Dissolved Hardness					27.7	29	41.4	-
Dissolved Aluminum (Al)	mg/L				0.0052	0.0051	0.0054	0.004
Dissolved Antimony (Sb)	mg/L				<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L		0.010		0.0009	0.00086	0.00084	0.00076
Dissolved Barium (Ba)	mg/L				0.0147	0.0137	0.016	0.0197
Dissolved Beryllium (Be)	mg/L				<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Boron (B)	mg/L				<0.050	<0.050	<0.050	<0.050
Dissolved Cadmium (Cd)	mg/L				<0.000010	<0.000010	<0.000010	<0.000010
Dissolved Chromium (Cr)	mg/L				<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Copper (Cu)	mg/L		0.010		0.00076	0.0008	0.00087	0.00079

Sampling Station MEL-06 / MEL-16 (G2)

Dissolved Iron (Fe)	mg/L			0.115	0.0386	0.0564	0.0245
Dissolved Lead (Pb)	mg/L	0.010		<0.00020	<0.00020	<0.00020	<0.00020
Dissolved Lithium (Li)	mg/L			<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Manganese (Mn)	mg/L			0.0025	0.0012	0.0022	0.0034
Dissolved Molybdenum (Mo)	mg/L			<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Nickel (Ni)	mg/L	0.020		<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Selenium (Se)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Silver (Ag)	mg/L			<0.000020	<0.000020	<0.000020	<0.000020
Dissolved Strontium (Sr)	mg/L			0.0504	0.0517	0.0617	0.0692
Dissolved Thallium (Tl)	mg/L			<0.000010	<0.000010	<0.000010	<0.000010
Dissolved Tin (Tl)	mg/L			<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Titanium (Ti)	mg/L			<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Uranium (U)	mg/L			<0.00010	<0.00010	<0.00010	<0.00010
Dissolved Vanadium (V)	mg/L			<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Zinc (Zn)	mg/L	0.010		<0.0050	<0.0050	<0.0050	<0.0050
Calcium (Ca)-Dissolved	mg/L			9.3	9.65	14	13.2
Magnesium (Mg)-Dissolved	mg/L			1.08	1.2	1.57	1.74
Potassium (K)-Dissolved	mg/L			0.872	0.947	1.25	1.19
Sodium (Na)-Dissolved	mg/L			1.97	2.18	2.73	2.87
Reactive Silica (Si)	mg/L			0.55	0.097	0.19	0.32

Sampling Station MEL-7 (Explo STP)

Station: STP-FINAL (MEL-7)	January					February			
DATE	1/4/2017	1/9/2017	1/18/2017	1/23/2017	1/30/2017	2/6/2017	2/13/2017	2/20/2017	2/27/2017
Ammonia as N (mg/L)	18	32	41	62	44	44	50	38	49
Biochemical Oxygen Demand	50	30	30	14	35	21	39	14	9
Kjeldahl nitrogen	18	39	54	63	46	52	47	39	47
pH	7.28	7.19	7.33	7.62	7.01	7.25	7.42	7.25	7.39
Phosphorus (P)-Total	13	13	12	15	15	14	13	13	14
Total Suspended Solids	8	14	9	9	13	10	10	6	4
Transmittance %	36	25	25	20	25	20	26	29	27
Nitrite-N	3.57	0.971	3.9	2.27	2.16	1.13	1.34	2.36	2.72
Nitrate-N	22.8	23.6	19.7	16.2	30.7	24.1	17.4	19.1	16.2
Nitrate and Nitrite as N	26.4	24.6	23.6	18.5	32.8	25.3	18.8	21.5	18.9
Oil & Grease-(IR)	0.9	0.9	0.5	1.1	<0.50	1.3	<0.50	1.5	0.7
Total Nitrogen (N)	-	-	-	-	-	-	-	-	-
Total Chemical Oxygen Demand (COD)	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	-	-	-	-	-	-	-
Atypical	45000	220	4000	610	*	7900	12000	>20000	2500
Fecal Coliforms (CFU/100mL)	2	<2	<2	48	*	<2	2	<2	<2
Heterotrophic Plate Count (AAHB) (CFU/100mL)	12,000	>30000	>3000	>3000	*	>3000	26,000	>3000	11,400
Total Coliforms (CFU/100mL)	<1000	180	100	210	*	500	9000	***	600

Station: STP-FINAL (MEL-7)	March				April					
DATE	3/6/2017	3/13/2017	3/23/2017	3/27/2017	4/3/2017	4/12/2017	4/20/2017	4/24/2017	4/27/2017	
Ammonia as N (mg/L)	40.0	64.0	37.0	29.00	26	12	9	9	17	
Biochemical Oxygen Demand	43.0	43.0	8.0	14.0	48	7	13	30		
Kjeldahl nitrogen	43.00	63	36.00	29.00	26	15	12	15	24	
pH	7.3	7.54	7.07	7.14	7.02	7.09	6.83	6.97	7.5	
Phosphorus (P)-Total	12.0	14	12.0	14.0	13	12	12	12	12	
Total Suspended Solids	5.0	13	3.0	7.0	8	5	4	7	4	
Transmittance %	29.0	27	38.0	32.0	32	40	39	39	39	
Nitrite-N	2.47	1.98	4.95	1.29	1.93	2.52	2.94	1.95	2.23	
Nitrate-N	17.1	6.1	30.6	23.5	25.2	27.7	24.8	20.1	20.8	
Nitrate and Nitrite as N	19.6	8.06	35.50	24.70	27.2	30.2	27.8	22	23	
Oil & Grease-(IR)	0.5	2.7	<0.50	0.8	<0.50	<0.5	<0.50	0.9	0.9	
Total Nitrogen (N)	-	-	-	-	-	-	-	-	-	
Total Chemical Oxygen Demand (COD)	-	-	-	-	-	-	-	-	-	
Total Dissolved Solids	-	-	-	-	-	-	-	-	-	
Alkalinity	-	-	-	-	-	-	-	-	-	
Atypical	330	>200000	240	2100	38,000	7,000	1400	3200	<10	
Fecal Coliforms (CFU/100mL)	<2	7,000.0	<10	<2	<2	100	<2	<2	<2	
Heterotrophic Plate Count (AAHB) (CFU/100mL)	9,300	>30000	-	11,800.0	>30000	>30000	20,600.00	>20000	36	
Total Coliforms (CFU/100mL)	40	-	50.0	1,500.0	3,000	10,000	5900	2800	<10	

Station: STP-FINAL (MEL-7)	May						June			
DATE	5/1/2017	5/8/2017	5/15/2017	5/18/2017	5/22/2017	5/29/2017	6/5/2017	6/12/2017	6/19/2017	6/26/2017
Ammonia as N (mg/L)	18	21	18	21	50	13	12	11	11	20
Biochemical Oxygen Demand	23	26	11	44	54	17	11	17	12	51
Kjeldahl nitrogen	21	19	21	42	46	14	15	18	15	19
pH	7.61	7.35	7.07	7.15	7.43	7	7.05	7.24	7.19	5.67
Phosphorus (P)-Total	13	13	14	13	16	14	12	11	11	12
Total Suspended Solids	5	6	5	4	4	5	13	4	3	4
Transmittance %	37	37	34	34	25	38	39	46	48	48
Nitrite-N	2.39	2.56	0.49	7.08	8.6	2.31	0.96	6.78	3.99	2.81
Nitrate-N	19	17.8	33.2	37.6	43	36.9	30.5	31.5	20.6	36.2
Nitrate and Nitrite as N	21.4	20.4	33.7	44.7	51.6	39.3	31.4	38.3	24.5	39
Oil & Grease-(IR)	6.1	<0.50	1.7	1.3	<0.50	<0.50	1.1	1.2	0.6	<0.50
Total Nitrogen (N)	-	-	-	-	-	-	-	-	-	-
Total Chemical Oxygen Demand (COD)	-	69	73	73	-	-	62	53	55	51
Total Dissolved Solids	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	130	91	80	-	-	47	68	68	3.6
Atypical	27000	14100	6100	not reported	9700	240	>200000	17500	55000	420
Fecal Coliforms (CFU/100mL)	<2	2	<2	<2	<2	<2	<2	<10	<2	<2
Heterotrophic Plate Count (AAHB) (CFU/100mL)	24,000	25,600	24,800.00	6,000.00	>30000	17,700.00	>30000	36,000	>30000	19,500
Total Coliforms (CFU/100mL)	42,000	< 100	800	not reported	1000	50	Not reported	300	1000	60

Station: STP-FINAL (MEL-7)	July						August			
DATE	7/3/2017	7/10/2017	7/17/2017	7/20/2017	7/24/2017	7/31/2017	8/7/2017	8/14/2017	8/21/2017	8/28/2017
Ammonia as N (mg/L)	11	11	0.03	17	17	16	14	12	14	22
Biochemical Oxygen Demand	20	12	12	29	23	19	58	10	20	38
Kjeldahl nitrogen	14	14	16	18	17	16	18	19	13	23
pH	6.94	7.27	6.92	6.84	7.41	6.99	6.72	7.01	7.42	7.38
Phosphorus (P)-Total	11	9.6	9	11	10	12	13	12	12	12
Total Suspended Solids	<10	5	2	3	5	4	6	2	4	<10
Transmittance %	48	51	43	47	40	42	38	44	41	40
Nitrite-N	2.12	1.68	1.41	1.8	1.95	2.72	2.7	2.27	1.25	1.68
Nitrate-N	21.4	22.5	24.7	27.4	9.43	24.2	20.2	24.1	18.1	17.7
Nitrate and Nitrite as N	23.5	24.2	-	29.2	11.4	26.9	22.9	26.4	19.3	19.4
Oil & Grease-(IR)	<0.50	1.3	<1	1.4	0.5	<0.50	0.9	1.4	1.3	0.6
Total Nitrogen (N)	-	-	-	-	-	-	-	-	-	-
Total Chemical Oxygen Demand (COD)	57	46	78	51	71	71	70	59	57	62
Total Dissolved Solids	-	-	-	-	-	-	-	-	-	-
Alkalinity	46	67	55	44	130	63	50	48	80	110
Atypical	250	1470	130000	1860	29 000	1400	38	5800	100	800

Sampling Station MEL-7 (Explo STP)

Fecal Coliforms (CFU/100mL)	<2	2	<10	<2	2600	<2	<2	<2	<2	<2
Heterotrophic Plate Count (AAHB) (CFU/100mL)	12,000.00	8,800	>6000	8,000.00	> 30 000	11,200.00	35,000.00	14,000.00	9,000.00	8,600.00
Total Coliforms (CFU/100mL)	>800	80	<10	18	12 000	230	5	400	200	<100

Station: STP-FINAL (MEL-7)	September					October				
	DATE	9/4/2017	9/11/2017	9/18/2017	9/25/2017	10/2/2017	10/10/2017	10/16/2017	10/19/2017	10/24/2017
Ammonia as N (mg/L)	21	19	11	16	33	38	38	30	34	34
Biochemical Oxygen Demand	3	3	10	7	14	38	17	43	28	6
Kjeldahl nitrogen	21	20	14	19	33	38	40	32	34	33
pH	7.72	7.63	7.55	7.22	7.65	7.45	7.57	7.44	7.88	7.61
Phosphorus (P)-Total	13	14	9.5	11	12	10	9	12	11	11
Total Suspended Solids	2	2	15	5	7	5	2	11	11	4
Transmittance %	39	38	35	38	31	40	31	-	27	39
Nitrite-N	0.56	0.386	0.449	0.411	0.606	2.49	2.73	1.11	1.01	0.32
Nitrate-N	13.5	11.1	13.1	20.4	19.5	22.2	17.9	14.7	16.2	27.3
Nitrate and Nitrite as N	14.1	11.5	13.6	20.8	20.1	24.7	20.6	15.8	17.2	27.6
Oil & Grease-(IR)	0.9	1.1	0.9	2.2	1.1	<0.50	2.4	1.6	<0.50	<0.50
Total Nitrogen (N)	-	-	-	-	-	-	-	-	-	-
Total Chemical Oxygen Demand (COD)	63	60	74	62	81	59	69	-	-	60
Total Dissolved Solids										
Alkalinity	120	130	100	92	140	130	180	-	190	110
Atypical	45000	32000	200	19000	>2000000	26000	Hold time exceedance	190000	-	29000
Fecal Coliforms (CFU/100mL)	120	<10	<10	4200	>60	14	Hold time exceedance	230	-	1100
Heterotrophic Plate Count (AAHB) (CFU/100mL)	>30000	>30000	20,200	30,000.00	>300,000	27700	Hold time exceedance	150,000	-	>30000
Total Coliforms (CFU/100mL)	<1000	<1000	200	16000	***	22000	Hold time exceedance	290000	-	20000

Station: STP-FINAL (MEL-7)	November		December				
	DATE	11/7/2017	11/13/2017	12/4/2017	12/12/2017	12/14/2017	12/18/2017
Ammonia as N (mg/L)	28	26	-	-	-	-	-
Biochemical Oxygen Demand	18	19	-	-	-	-	-
Kjeldahl nitrogen	29	27	-	-	-	-	-
pH	7.69	7.63	-	-	-	-	-
Phosphorus (P)-Total	10	9.7	-	-	-	-	-
Total Suspended Solids	12	18	-	-	-	-	-
Transmittance %	28	28	-	-	-	-	-
Nitrite-N	0.484	0.417	-	-	-	-	-
Nitrate-N	6.28	12.6	-	-	-	-	-
Nitrate and Nitrite as N	6.77	13	-	-	-	-	-
Oil & Grease-(IR)	<0.50	0.7	-	-	-	-	-
Total Nitrogen (N)	-	-	-	-	-	-	-
Total Chemical Oxygen Demand (COD)	100	90	-	-	-	-	-
Total Dissolved Solids							
Alkalinity	210	160	-	-	-	-	-
Atypical	7200000	7500000	950	30	170	180	
Fecal Coliforms (CFU/100mL)	14000	2300	20	<2	<2	<10	
Heterotrophic Plate Count (AAHB) (CFU/100mL)	>200000	5000000	4,300	450	500.00	209	
Total Coliforms (CFU/100mL)	2800000	1500000	30	90	70	90	

Sampling Station MEL-8 / MEL-18 (B5)

Waterbody		Site Specific Criteria	MMER Criteria	CCME	2017		
Year							
Date Sampled	6/24/2017				7/24/2017	8/23/2017	
Maxxam ID	B7D6320				B7G3631	R4693472	
LAB	Maxxam	Maxxam	Maxxam				
Field Measurements							
Coordinates					0538261-6988535	0538261-6988535	0538261-6988535
Water Temperature	oC				-	-	-
pH	pH units				-	-	-
Conductivity	(mS/cm)				-	-	-
Parameters							
Bicarb. Alkalinity (calc. as CaCO3)	mg/L				31	36	37
Carb. Alkalinity (calc. as CaCO3)	mg/L				<1.0	<1.0	<1.0
Total Ammonia-N	mg/L	14 Effluent 18 Grab sample		Table (field pH/ field Temp)	0.01	<0.01	<0.01
Conductivity	umhos/cm				130	150	150
Total Dissolved Solids (TDS)	mg/L	1400			106	118	120
Free Cyanide (Cn)	mg/L		0.010				<0.0010
Total Kjeldahl Nitrogen (TKN)	mg N/L				0.2	0.19	0.31
Dissolved Organic Carbon (DOC)	mg/L				3.4	4.2	4.3
Total Organic Carbon (TOC)	mg/L				3.9	4.4	4.5
Orthophosphate (P)	mg/L				<0.010	<0.010	<0.010
pH	pH units	6.0 to 9.5		6.5-9.0 (long term)	7.58	7.71	7.82
Total Phosphorus (P)	mg/L	2.0 Effluent 4.0 Grab sample		ultra-oligotrophic <4 ug/L (or 0.004 mg/L) or oligotrophic 4-10 (0.004 to 0.01 mg/L)	0.009	0.006	0.009
Total Suspended Solids (TSS)	mg/L	15 Effluent 30 Grab sample	15 Effluent 30 Grab sample	Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).	<1	2	<10
Dissolved Sulphate (SO4)	mg/L				3.2	4.4	4.7
Total Cyanide (Cn)	mg/L	0.5 Effluent 1 Grab sample	0.010		<0.0050	<0.0050	<0.0050
Turbidity				Maximum increase of 8 NTUs from background levels for a short term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period).			
Free Cyanide (Cn)	NTU				0.5	0.3	<0.0010
Alkalinity (Total as CaCO3)	mg/L				32	36	37
Dissolved chloride (Cl)	mg/L			640 mg/L (short term); 120 mg/L (long term)	17	20	21
Nitrite (as N)	mg/L			60 mg/L NO2-N (long term)	<0.010	<0.010	<0.010
Nitrate (as N)	mg/L			550 mg/L (short term); 13 mg/L (long term)	<0.10	<0.10	<0.10
Nitrite-Nitrate (as N)	mg/L				<0.10	<0.10	<0.10
Radium-226	Bq/L						
Total Oil & Grease							
Mercury (Hg)	mg/L			0.026 ug/L (long term) (or 0.00026 mg/L)	<0.00001	<0.00001	<0.00001
Dissolved Mercury (Hg)	mg/L				<0.00001	<0.00001	<0.00001
Hardness (as CaCO3)	mg/L				47.3	52	66
Aluminum (Al)-Total	mg/L	2 Effluent 3 Grab sample		5 ug/L (0.005 mg/L) if pH < 6.5 ; 100 ug/L (0.1 mg/L) if pH ≥ 6.5	0.0053	0.0048	0.0036
Antimony (Sb)-Total	mg/L				<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	mg/L	0.3 Effluent 0.6 Grab sample		5 ug/L (long term) (or 0.005 mg/L)	0.00122	0.00155	0.00157
Barium (Ba)-Total	mg/L				0.0157	0.0144	0.0146
Beryllium (Be)-Total	mg/L				<0.00010	<0.00010	<0.00010
Boron (B)-Total	mg/L			29 mg/L (short term); 1.5 mg/L (long term)	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	mg/L			1 ug/L or 0.001 mg/L (short term) ; 0.09 ug/L or 0.00009 mg/L (long term)	<0.000010	<0.000010	<0.000010

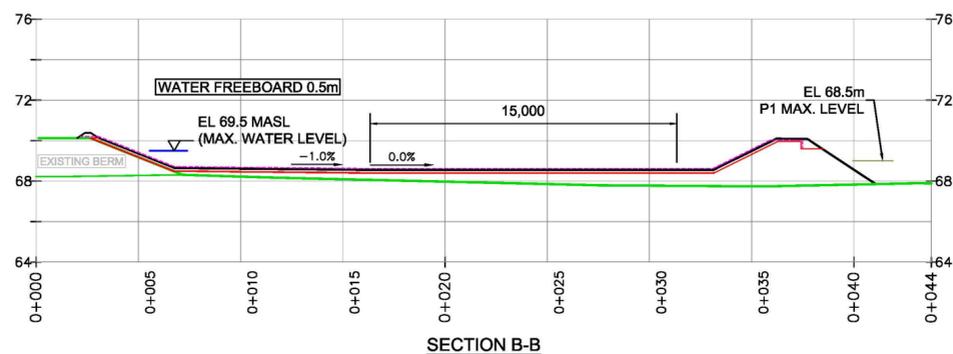
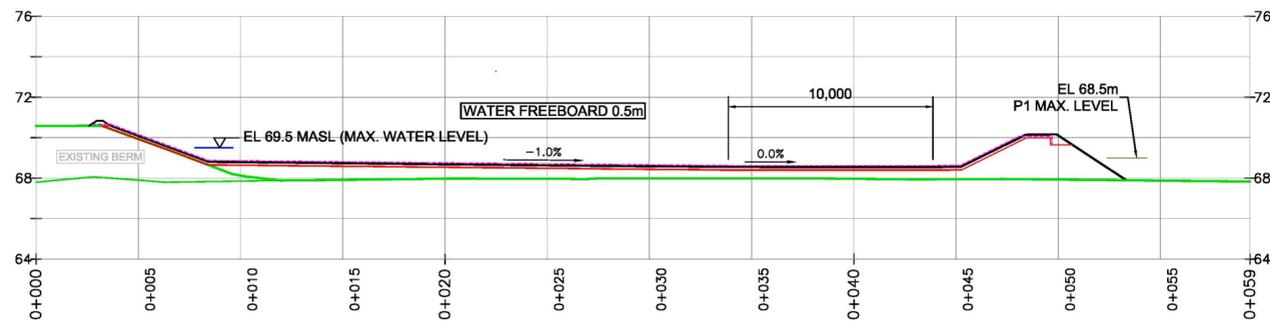
Sampling Station MEL-8 / MEL-18 (B5)

Chromium (Cr)-Total	mg/L				<0.0010	<0.0010	<0.0010
Copper (Cu)-Total	mg/L	0.2 Effluent 0.4 Grab sample		if hardness 0 to < 82 mg/L, the CWQG is 2 µg/L (or 0.002 mg/L) ; if hardness >180 mg/L, the CWQG is 4 µg/L (or 0.004 mg/L)	0.00053	0.00062	0.00065
Iron (Fe)-Total	mg/L			300 ug/L (long term) (or 0.3mg/L)	0.116	0.054	0.07
Lead (Pb)-Total	mg/L	0.2 Effluent 0.4 Grab sample	0.2 Effluent 0.4 Grab sample	hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L (or 0.001 mg/L) At hardness >180 mg/L, the CWQG is 7 µg/L (or 0.007mg/L)	<0.00020	<0.00020	<0.00020
Lithium (Li)-Total	mg/L				0.0032	0.0033	0.0036
Manganese (Mn)-Total	mg/L				0.0163	0.0097	0.0122
Molybdenum (Mo)-Total	mg/L			73 ug/L (long term) (or 0.073 mg/L)	<0.0010	<0.0010	<0.0010
Nickel (Ni)-Total	mg/L	0.5 Effluent 1.0 Grab sample	0.5 Effluent 1.0 Grab sample	hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L (or 0.025 mg/L) hardness >180 mg/L, the CWQG is 150 µg/L (or 0.15 mg/L)	<0.0010	<0.0010	<0.0010
Selenium (Se)-Total	mg/L			1 ug/L (long term) (or 0.001 mg/L)	<0.00010	<0.00010	<0.00010
Silver (Ag)-Total	mg/L				<0.000020	<0.000020	<0.000020
Strontium (Sr)-Total	mg/L				0.095	0.104	0.11
Thallium (Tl)-Total	mg/L			0.8 ug/L (long term) (or 0.0008 mg/L)	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total	mg/L				<0.0050	<0.0050	<0.0050
Titanium (Ti)-Total	mg/L				<0.0050	<0.0050	<0.0050
Uranium (U)-Total	mg/L			33 ug/L (short term) (or 0.033 mg/L); 15 ug/L (long term) (or 0.015 mg/L)	<0.00010	<0.00010	<0.00010
Vanadium (V)-Total	mg/L				<0.0050	<0.0050	<0.0050
Zinc (Zn)-Total	mg/L	0.4 Effluent 0.8 Grab sample		30 ug/L (long term) (or 0.03 mg/L)	<0.0050	<0.0050	<0.0050
Calcium (Ca)-Total	mg/L				15.6	17	22.1
Magnesium (Mg)-Total	mg/L				2.01	2.29	2.63
Potassium (K)-Total	mg/L				0.964	1.07	1.23
Sodium (Na)-Total	mg/L				3.78	4.53	5.03
Dissolved Hardness (CaCO3)	mg/L				49.1	51.2	63.4
Dissolved Aluminium (Al)	mg/L				0.0042	0.0035	<0.0030
Dissolved Antimony (Sb)	mg/L				<0.00050	<0.00050	<0.00050
Dissolved Arsenic (As)	mg/L		0.010		0.001	0.00129	0.00143
Dissolved Barium (Ba)	mg/L				0.0156	0.0139	0.0151
Dissolved Beryllium (Be)	mg/L				<0.00010	<0.00010	<0.00010
Dissolved Boron (B)	mg/L				<0.050	<0.050	<0.050
Dissolved Cadmium (Cd)	mg/L				<0.000010	<0.000010	<0.000010
Dissolved Chromium (Cr)	mg/L				<0.0010	<0.0010	<0.0010
Dissolved Copper (Cu)	mg/L		0.010		0.00049	0.00063	0.00062
Dissolved Iron (Fe)	mg/L				0.0708	0.0212	0.035
Dissolved Lead (Pb)	mg/L		0.010		<0.00020	<0.00020	<0.00020
Dissolved Lithium (Li)	mg/L				0.0033	0.0035	0.0036
Dissolved Manganese (Mn)	mg/L				0.0065	0.0021	0.0025
Dissolved Molybdenum (Mo)	mg/L				<0.0010	<0.0010	<0.0010
Dissolved Nickel (Ni)	mg/L		0.020		<0.0010	<0.0010	<0.0010
Dissolved Selenium (Se)	mg/L				<0.00010	<0.00010	<0.00010
Dissolved Silver (Ag)	mg/L				<0.000020	<0.000020	<0.000020
Dissolved Strontium (Sr)	mg/L				0.0981	0.105	0.11
Dissolved thallium (Tl)	mg/L				<0.000010	<0.000010	<0.000010
Dissolved Tin (Sn)	mg/L				<0.0050	<0.0050	<0.0050
Dissolved titanium (Ti)	mg/L				<0.0050	<0.0050	<0.0050
Dissolved Uranium (U)	mg/L				<0.00010	<0.00010	<0.00010
Dissolved Vanadium	mg/L				<0.0050	<0.0050	<0.0050
Dissolved Zinc	mg/L		0.010		<0.0050	<0.0050	<0.0050
Dissolved Calcium (Ca)	mg/L				16.3	16.6	21
Magnesium (Mg)-Dissolved	mg/L				2.06	2.37	2.7
Dissolved Potassium (K)	mg/L				0.99	1.09	1.34
Sodium (Na)-Dissolved	mg/L				3.91	4.38	5.25
Reactive Silica (Si)	mg/L				0.51	0.53	0.61

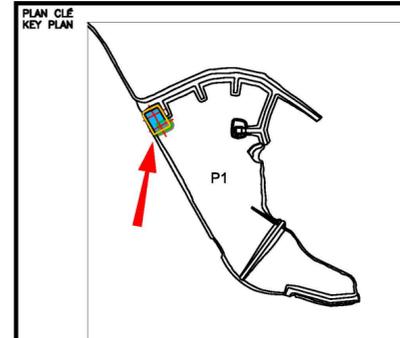
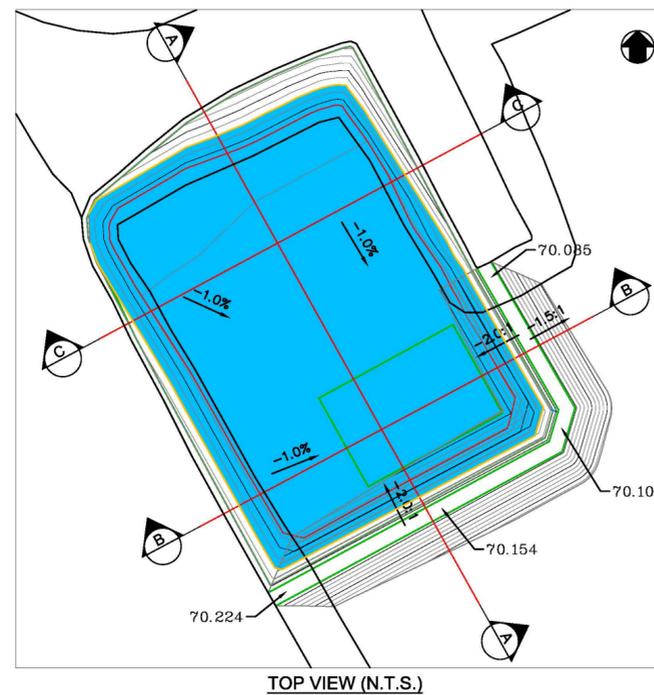
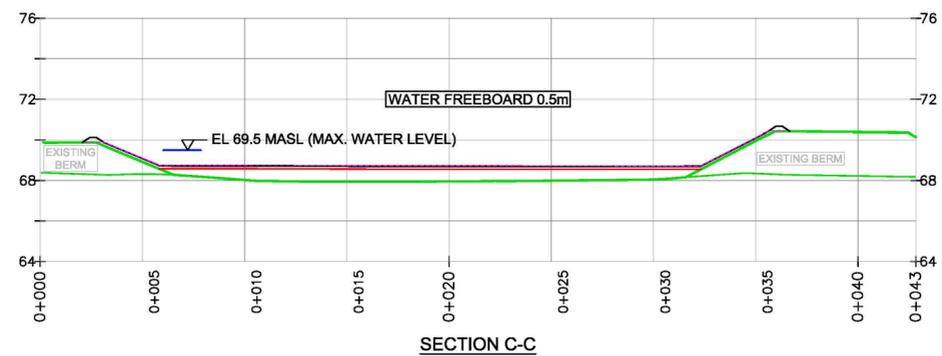
- not analyzed

BOLD - exceeds one or more guidelines

Appendix D
As-built Report for Snow Cell



LEGEND:
 — ORIGINAL GROUND
 - - - FINE FILL
 — LINERS



NOTES GÉNÉRALES / GENERAL NOTES

**POUR APPROBATION
FOR APPROVAL**
 AGNICO EAGLE DATE : 2017-05-24

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DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG



REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
2	2017-05-24	ISSUED FOR APPROBATION	J.C.	T.L.	M.R.J.
1	2017-05-10	ISSUED FOR APPROBATION	J.C.	T.L.	M.R.J.

REVISIONS

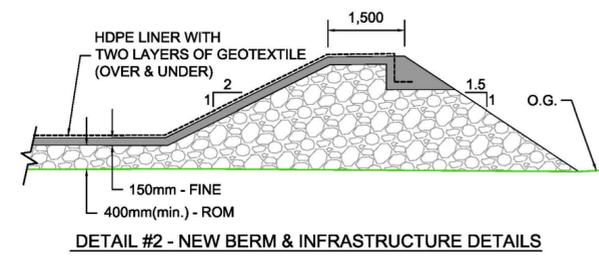
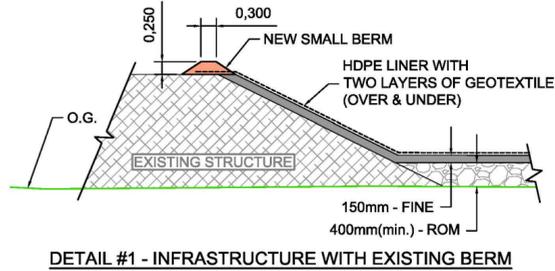
TITRE / TITLE
 AGNICO-EAGLE - MELIADINE DIVISION
 695 - WATER MANAGEMENT
 230 - EARTH WORK
 PLAN, SECTION & DETAILS
 SNOW CONTAINMENT

DESSINÉ PAR DRAWN BY	JOCELYN CRETE	DATE 2017-05-04
VÉRIFIÉ PAR CHECKED BY	THOMAS LEPINE	2017-05-08
APPROUVÉ PAR APPROVED BY	MICHEL JULIEN	2017-05-08

ECHELLE
SCALE N/A DATE 2017-05-04

NO. DESSIN DRAWING NO.	65-695-230-001	
NO. PROJET PROJECT NO.	65	REVISION 2
		FEUILLE / SHEET 1 / 1

- NOTES FOR CONSTRUCTION**
- 1) This cell is for temporary storage of contaminated snow during summer 2017. Depending on its performance and condition, it could be used for other usages beyond summer 2017. If so, the liner need to be weighted to prevent liner lift up.
 - 2) Placement of snow will have to be done carefully to avoid damage to the liner.
 - 3) Water level in the snow containment cell should be maintained 0.5 m below the minimum liner elevation.
 - 4) The maximum elevation of P1 pond should be adjusted to prevent water inflow in the snow all and should not exceed the elevation 68.5 MASL.
 - 5) Geotextile : TEXEL 160E (or equivalent) placed with an overlap of 0.3m between each width. Needleponched nonwoven short staple fibers geotextile; polypropylene made
 - 6) Liner : HDPE 1.5mm, TYPE SOLMAX 460 (or equivalent) placed with proper overlap to allow welding to take place. The installer is to provide detailed QC information describing the placement and welding.



Appendix E

Follow-up Report on December 6, 2016 Oil and Grease Spill

2016-12-05 Sewage Treatment Plant Exceedance

Spill description:

On December 5th, a sample of Sewage Treatment Plant (STP) effluent, MEL-7, was collected at 6:30 AM and submitted for water quality analysis as per the Water License 2BB-MEL1424. Upon receiving the water quality results, a value of 75 mg/L was measured in the effluent exceeding the maximum effluent quality limit for Oil and Grease of 5 mg/L.

Spill cause:

Due to the lag time between the sample collection and the receipt of the analytical results, it was not known that an exceedance had occurred until several days later. Upon discussions with the Environmental Technician, no visible sheen in the sample was observed when the sample was collected. In addition, the routine monitoring of the STP indicated that all key parameters were within normal operating range.

Once the exceedance was known, the following steps were taken in order to investigate the cause:

1. Reviewed the STP operational data for the time period where the exceedance occurred. No abnormal operating parameters were noted.
2. Identified potential sources on site which could have contributed to the oil and grease loading to the STP. Most likely sources include the STP (from maintenance activities such as greasing mechanical components), the kitchen, or the laundry rinse water.

None of the above mentioned actions, as part of the investigation, led to the identification of the root cause for the exceedance. It is also possible that the incident occurred as the result of human error leading to incorrect waste disposal.

As such, the follow-up measures are planned:

1. Increase awareness at site with respect to correct waste management practices.
2. Educate site personnel on the STP with regards to the oil and grease limitations.

Spill response:

No spill response was completed as the exceedance was not noticed until the analytical results were received several days later.

Appendix F
Updated Management Plans



AGNICO EAGLE

MELIADINE GOLD PROJECT

Landfarm Management Plan

March 2018

Version 4

EXECUTIVE SUMMARY

Agnico Eagle Mines Limited (Agnico Eagle) is developing the Meliadine Gold Project (Project), located approximately 25 kilometres (km) north of Rankin Inlet, and 80 km southwest of Chesterfield Inlet in the Kivalliq Region of Nunavut. The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine.

This document presents the Landfarm Management Plan for the Project and forms a component of the documentation produced for the Type B Water Licence Application. The Plan describes the design features and operational procedures for the landfarm to be constructed at the Project for the storage and treatment of petroleum hydrocarbon contaminated soils.

On-site storage and remediation has been established as the preferred method for treatment of light petroleum hydrocarbon contaminated soil that may be generated on the proposed mine site. The landfarm is designed to receive soils, rock, snow, and ice contaminated with petroleum hydrocarbons. This will include light hydrocarbons such as diesel and gasoline being treated in the landfarm.

The landfarm is located in the former “fuel bladders” containment behind the fuel farm. It consists of a lined basin structure that can hold approximately 2,500 cubic meter of light petroleum product contaminated soil. The landfarm has an impervious liner and no impacts on shallow groundwater are anticipated. Water accumulating in the landfarm will be discharged directly to the receiving environment, if the discharge criteria from Licence 2BB-MEL1424 part D, item 15, is met. The water will go through the EVAC water filtration for TSS and petroleum removal prior to releasing the water to the environment. If the water meets the criteria for discharge, the water will be released West of the road on the West side of the landfarm.

A report of landfarm activities will be prepared annually by the Environment Department indicating the volume of material added to the facility, amount of material removed and disposed of or re-use location, all analysis results, volume and type of nutrient addition, visual inspection results, and volume of contact water pumped.

Soils contaminated with light end petroleum hydrocarbons will require an estimated three full summer seasons for complete remediation. When remediated, the soils will be removed from the facility and can be used for construction purpose, such as part of the cover of the Tailings Storage Facility or stacked in the Waste Rock Storage Facility.

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DOCUMENT CONTROL

Version	Date	Section	Page	Revision	Author
1	April 2015			First version of the Landfarm Management Plan	John Witteman, Env. Consultant, Agnico Eagle
2	February 2015	All		Operational revision for the year 2014	Meliadine Environmental department
3	March 2017	All		Operational revision for the year 2017	Meliadine Environmental department
4	February 2018	1.1, 2.1, 2.3.1	1, 3, 6	-Approximate volume of material adjusted to 2200 m3	Meliadine Environmental department
		2.1	4	-Added "Due to increased volume of material placement in 2017, transfer of material from the 2BB landfarm to the 2AM landfarm will likely be required to ensure appropriate decontamination"	
		2.3.1	6	-Added "At this time, no additional contaminated soil is being deposited into the 2BB landfarm; the 2AM landfarm has been commissioned and is operational."	
		3.2.1	9	-Corrected residual capacity of landfarm to 300m3 - Added "In-house wet chemistry and portable VOC monitoring" for spill excavation assessments	
		3.1	8	- Antifreeze removed from list of acceptable contaminants for landfarm disposal	
		1.3	2	-Added reference to Oil Pollution Emergency Plan	

ACRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
BTEX	benzene, toluene, ethylbenzene, and xylene
CP1	Collection Pond 1
GN	Government of Nunavut
NWB	Nunavut Water Board
PHC	Petroleum hydrocarbons
Project	Meliadine Gold Project
RMMS	Responsible Mining Management System
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

SECTION 1 • INTRODUCTION

1.1 Project History

Agnico Eagle Mines Limited (Agnico Eagle) is developing the Meliadine Gold Project (Project), located approximately 25 kilometres (km) north of Rankin Inlet, and 80 km southwest of Chesterfield Inlet in the Kivalliq Region of Nunavut. Situated on the western shore of Hudson Bay, the proposed Project site is located on a peninsula between the east, south, and west basins of Meliadine Lake (63°1'23.8" N, 92°13'6.42"W), on Inuit Owned Lands. The Project is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine. The proposed mine will produce approximately 12.1 million tonnes (Mt) of ore, 31.8 Mt of waste rock, 7.4 Mt of overburden waste, and 12.1 Mt of tailings. There are four phases to the development of Tiriganiaq: just over 4 years construction (Q4 Year -5 to Year -1), 8 years mine operation (Year 1 to Year 8), 3 years closure (Year 9 to Year 11), and post-closure (Year 11 onwards).

The Landfarm Management Plan (Plan) focuses on minimizing the waste footprint on-site, and maximizing remediation potential through implementation best practices.

During the advanced exploration phase of the Project, the Nunavut Water Board (NWB) approved amendment #6 to Water Licence 2BB-MEL1424, which allowed the operation of light PHC soil stockpile. This approval supported using a landfarm developed inside a bermed and lined area previously used to store fuel bladders. Soil contaminated with light PHC is being deposited in this bermed and lined area for treatment. To date, there is approximately 2200 cubic meters (m³) of contaminated soil being treated. This quantity resulted from inadvertent spills that occurred during the advanced exploration phase of the Project. Some or all of this material will be transferred to the landfarm for the proposed mine upon its completion and commissioning.

When possible, materials contaminated with heavy hydrocarbons (e.g. hydraulic fluid, grease), are to be segregated, packaged, and shipped south for treatment and/or disposal.

1.2 Objectives

On-site storage and remediation has been established as the preferred method for treatment of light PHC contaminated soil that may be generated at the proposed mine. Specifically, remediation through landfarming has been identified as the primary treatment option and, as such, the focus of this Plan is the management of contaminated soil.

This Plan is a component of the Responsible Mining Management System (RMMS)¹. The objectives of this Plan are to:

- provide an overview of the actual contaminated soil management at the Project;
- describe the physical setting, location, and design criteria of the landfarm;
- define acceptable types of contaminated soils to be placed in the landfarm and conditions for removal of treated soil;
- define operating procedures and monitoring requirements for the landfarm; and
- describe contingency options for alternate treatment/storage of PHC contaminated soil.

1.3 Related Documents

Spill prevention is the first stage in the contaminated soil management for the Project. Documents containing information related to this Plan are submitted as part of the Type A and B Water Licenses and include:

- Spill Contingency Plan;
- Environmental Management and Protection Plan; and
- Risk Management and Emergency Response Plan.

There is also a related Oil Pollution Emergency Plan (Agnico Eagle 2017), which is specific to spills at Agnico Eagle's Itivia Oil Handling Facility located in Rankin Inlet. The Oil Handling Facility is located on the shore of Melvin Bay, which is part of Hudson Bay. The Oil Pollution Emergency Plan was prepared as a requirement of Canadian Shipping Act and associated regulations. It will be submitted to Transport Canada for approval prior to any shipping related to the development of the proposed mine.

1.4 Spill Prevention

Similar to the waste management philosophy, Agnico Eagle actively works towards minimizing spills through the implementation of suitable plans and work procedures. Plans developed from the environmental impact study address the management of spills on land, ice, water, and into the marine environment. When spills do occur, the goal is to limit the spread of the spill, and then manage contaminated material resulting from the spill. The Spill Contingency Plan describes spill prevention measures.

¹ The RMMS is described in the Environmental Management and Protection Plan.

SECTION 2 • LANDFARM DESIGN

2.1 Background

In the event of a spill, on-site storage and remediation is the most practical and efficient method in handling contaminated soil, particularly in an isolated location such as the Project. Any PHC contaminated soils generated during the construction, operation, and closure phases will be adequately managed. Soils contaminated with light PHCs, such as diesel, will be treated on-site in a landfarm. This method involves spreading and placing the contaminated soil within a containment area to promote conditions favorable for the volatilization and aerobic microbial degradation of hydrocarbons.

When possible, materials contaminated with heavy hydrocarbons (e.g. hydraulic fluid, grease), are to be segregated, packaged, and shipped south for treatment and/or disposal.

There are currently PHC contaminated soils stored on-site in the 2BB-MEL1424 Landfarm (approximately 2200 m³), resulting from spills that occurred during the exploration and pre-construction phase. This material will be moved to the Water License A landfarm facility progressively to facilitate remediation. This volume has been accounted for in the design of the future facility.

A landfarm options analysis prepared for Agnico Eagle by Golder (2007) identified factors relevant to landfarming in the north. These include environmental factors and physical properties of the soil that affect microbial growth and rates of biodegradation, such as temperature, pH, soil moisture, nutrient content, salinity, and soil particle size.

Although rates of biodegradation decline with temperature, landfarming is still a feasible technique in Arctic climates as demonstrated by the Meadowbank landfarm. Degradation in the north is typically restricted because microbial activity stops between 0 to -5 degrees Celsius (°C) limiting biodegradation to the months of June to September². Nevertheless, degradation was reported at 90% over two summers on Resolution Island (Paudyn et al. 2008).

It is estimated that soils contaminated with light-end PHCs would require three full summer seasons for complete remediation. When remediated, the soils will be removed from the facility and can be used for construction purposes such as part of the cover of the Tailings Storage Facility (TSF) or stacked in the Waste Rock Storage Facility (WRSF). Based on a remediation period of three seasons, it would be possible to close the Licence B landfarm facility on the third year following the start of construction and usage of the Licence A landfarm facility.

*Due to increased volume of material placement in 2017, transfer of material from the 2BB landfarm to the 2AM landfarm will likely be required to ensure appropriate decontamination.

² Even though bioremediation ceases below -5°C, volatilization of the PHCs does continue but at a much slower rate.

2.2 Location

The overall site plan showing the main infrastructure for the Project, including the landfarm, is shown in Figure 2-1. The area is located within the Fuel farm and drilling core storage. The pad is located north of the service road leading to the exploration camp.

2.2.1 Proximity of Surface Water

The landfarm is located just off of the exploration Fuel Farm pad. It is located at the most elevated point of the local topographical area. Meliadine Lake is located approximately 620 m north-east and Lake H-20 is approximately 311 m north-west of the landfarm area. On the other side of the road, south of the landfarm, Lake J3 is located at approximately 265 m.



Figure 2-1 Main Infrastructure for the Meliadine Project, including the Landfarm

2.2.2 Proximity of Groundwater

In the Project area, the groundwater within the active layer is estimated to reach 1.5 m in October. The active layer begins to form in July when temperatures largely remain above 0°C, and deepens to a maximum in October. The shallow groundwater in the area of the landfarm flows towards Meliadine Lake, located approximately 620 m from the landfarm.

To prevent movement of contaminants from the landfarm facility into the groundwater and the surrounding environment, the Meliadine Landfarm has an impervious liner.

2.3 Design

The Landfarm was originally designed as a lined containment to hold PHC fuel bladders for exploration purposes. In 2016, the edges of the landfarm containment were resloped and locations of exposed liner were recovered to ensure protection. The contaminated material placed in the Landfarm can include light hydrocarbons such as diesel and gasoline. The design volume of the Landfarm is based on the allowances for the materials being treated at Meadowbank during operation, as described below.

2.3.1 Soil Volume Requirements

Remediation of the existing contaminated soil in the Licence B Landfarm is expected to be completed in 2017 or 2018. The total capacity of the Landfarm is approximately 2,500 m³ and the actual quantity of contaminated soil being remediated is approximately 2,200 m³. The estimated remaining capacity for future contaminated material represents approximately 300 m³, which should be sufficient according to the estimated volume for the pre-development period (Table 2-1), until the decontamination activity from the Water License 2BB landfarm is transferred to the Water License 2AM landfarm.

At this time, no additional contaminated soil is being deposited into the 2BB landfarm; the 2AM landfarm has been commissioned and is operational.

Table 2-1 Estimated Volume of Petroleum Hydrocarbon Contaminated Soil and Ice/Snow to be Managed

Project Phase	Volume of PHC Soil/Rock (m ³)	Annual PHC Snow/Ice (m ³)
Pre-development (2 years)	350 (175 per year)	
Construction (3 years)	1,050 (350 per year)	
Operations (7 years)	2,450 (350 per year)	
Closure & Reclamation (2 years)	700 (350 per year)	500 per year
Total	4,970	

It is estimated that soils contaminated with light-end PHCs would require three full summer seasons for complete remediation (Agnico Eagle, 2008). When remediated, the soils will be removed from the Landfarm and used on-site, placed in the WRSF or used as cover at the TSF.

SECTION 3 • LANDFARM OPERATION AND MANAGEMENT

Agnico Eagle will be responsible for managing and implementing the Landfarm operation plan. Operation and monitoring of the Landfarm as well as determining the training requirements for personnel will be the responsibility of the Environment department.

3.1 Acceptable Landfarm Material

3.1.1 Contaminants

The Landfarm facility will only treat and/or store light PHC contaminated soils that have been generated through mine related activities at the Project. Material from the Hamlet of Rankin Inlet or other sites will not be accepted without approval from the NWB, In-Indigenous and Northern Affairs Canada, Water Resources Inspectors, and the Kivalliq Inuit Association.

The following products are acceptable for treatment in the Landfarm if used on-site and has resulted in contamination of soil:

- diesel fuel;
- gasoline;
- aviation fuel (Jet A);
- hydraulic oil;
- other light oil (e.g., engine oil, lubricating oil); and

In the event that the contaminant source is unknown, soil samples will be analyzed for PHCs and possibly additional contaminants prior to placement in the Landfarm. These additional parameters could include BTEX , PAH, total metals, oil and grease, and volatile organic compounds. Analysis for additional compounds will be determined by the Environment Department on a case-by-case basis. Concentrations of contaminants will be compared to the site background values (for metals) and/or criteria in the Government of Nunavut (GN) *Guidelines for Contaminated Site Remediation* (GN 2009). If this analysis indicates soil contamination above background or GN guidelines for any substance not approved for landfarming (i.e., non-PHC contaminants), the spill material will not be placed in the Landfarm. This is to ensure that PHC contaminated soils are not contaminated with other products.

Spills of non-PHC material (e.g., solvents) will be placed in drums and stored on-site for shipment south to approved facilities during shipping season.

3.1.2 Grain Size

Bioremediation of very coarse-grained larger soil material is inhibited as it does not readily retain moisture. However, volatilization will occur more rapidly (SAIC 2006). It has been noted that this material likely contains lower concentrations of contaminants due to a lower volume and surface

area ratio, and can typically be screened out prior to landfarming (SAIC 2006). As a result, soils and rock material with grain size less than 2.5 centimetres (cm) will be segregated from larger-grained material, where possible. This will occur at the spill location or in the landfarm using a screen sieve, should it prove necessary. The two soil fractions will be treated separately in the Landfarm when possible.

3.2 Contaminated Soil Additions

3.2.1 Spill Excavation

Soil contaminated with the above-described petroleum hydrocarbon materials will be excavated and transported to the Landfarm facility in dump trucks or other available means of transportation. Care will be exercised to ensure that the entire spill is excavated (verified by olfactory, visual, in-house wet chemistry, portable VOC monitor or sampling if necessary, by the Environment department) and that none of the contaminated material is lost during transport.

3.2.2 Placement in the Landfarm

As above, larger coarse material (rocks) will be separated from the finer material (sand and gravel) in the Landfarm when possible and assessed visually for PHC staining and product. If the material is saturated it will be spread to allow volatilization in the designated area of the landfarm.

Materials identified as acceptable in the Landfarm will be dispersed as space permits. A record will be kept by the on-site Environmental department of the amount of contaminated soil placed in the Landfarm and the location of each load within it.

3.3 Contaminated Snow

Petroleum hydrocarbon contaminated snow and ice will be placed in a designated area of the Landfarm and treated as contact water after snowmelt. After snowmelt, the water will be pumped through the site's EVAC water treatment system. The treated water will be discharged in the environment, if discharge criteria are met, as prescribed in the License 2BB-MEL1424.

3.4 Remediation

Remediation of fine grained PHC contaminated soil in landfarms occurs naturally through volatilization and aerobic microbial degradation. Soil aeration and nutrient amendment are recognized as methods of improving rates of remediation. While it is recognized that pH, salinity, moisture content, and microbial population density also contribute to rates of degradation, these factors will not be explicitly investigated or managed unless remediation rates are too slow to allow meeting targets set for closure.

3.4.1 Absorbent Materials

Coarse-grained soils are not readily bio-remediated, but concentrations of PHC contaminants may still be reduced through volatilization. Oil absorbent pads will be used to help remove visible product from coarse-grained material. Used absorbent materials will be incinerated or packed in Quatrex bags with oily rags and shipped south for treatment in an approved facility.

3.4.2 Aeration

Natural aeration would occur with material sparsely placed in the Landfarm, if possible. The goal will be to mechanically aerate the soil with earth-moving equipment. The soil will be run through a gravel separator to separate the large rock from the smaller grained materials. Following this, the material will be turned over to promote aeration to allow the PHC to volatilize.

3.4.3 Soil Moisture

Prior to turning over the soil, site personnel will ensure that the soil has sufficient moisture to prevent generation of significant dust. It will be equally necessary to ensure soil is not overly saturated. If soil is too dry, non-contaminated water from within the Landfarm containment area will be used as a moisture source. If no accumulated water is available, freshwater will be used.

3.5 Removal of Soil From the Landfarm

3.5.1 Government of Nunavut Remediation Guidelines

The following parameters will be measured and compared with the GN industrial remediation criteria to determine whether PHC contaminated soil has been adequately remediated:

- benzene, toluene, ethylbenzene and xylene (BTEX); and
- petroleum hydrocarbon fractions 1 - 4.

The GN remediation criteria are characterized for agricultural/wildlife, residential/parkland, commercial, and industrial land uses. At the Project, remediation to agricultural/wildlife criteria is targeted; however, if these criteria cannot be met, industrial criteria will be followed.

The GN remediation criteria for coarse-grained soils and Licence 2BB-MEL1424 Part D, item 15 criteria will be applied. Table 3-1 presents the applicable Tier 1 criteria for coarse-grained soil, assuming agricultural/wildlife or industrial land uses.

Table 3-1 Summary of Relevant GN Tier 1 Soil Remediation Criteria for Surface Soil (mg/kg)

	Land Use Criteria (mg/kg)	
	Agricultural/Wildlife	Industrial
Benzene	0.03	0.03
Toluene	0.37	0.37
Ethylbenzene	0.082	0.082
Xylene	11	11
PHC Fraction 1	30	320
PHC Fraction 2	150	260
PHC Fraction 3	300	1,700
PHC Fraction 4	2,800	3,300

mg/kg = milligram per kilogram

3.5.2 Sampling and Analysis

Landfarm soils will be sampled bi-annually, at the earliest possible time and at the end of the summer season, to determine if remediation objectives have been met. Representative composite samples will be taken to estimate remaining PHC concentrations. For each sub cell (Figure 3-1), two composite samples will be collected, one consisting of three surface sub-samples and the other from three sub-samples at 1 m depth. Sub-samples will be taken approximately 3.3 m apart, and will be taken randomly in the sub-cell.

Sample collection will follow the QAQC protocols established for the Project which includes collecting one (1) duplicate for every ten (10) samples.

After two seasons of treatment in the Landfarm, degradation rates will be assessed to estimate the total remediation time required for PHC contaminated soil under these conditions. If remediation to GN guidelines is feasible within the life-of-mine timeframe, Landfarm operations will continue with aeration. If rates of degradation are not sufficient through this method, alternative options will be further investigated as described in Section 4.2.

2016 LANDFARM SAMPLING

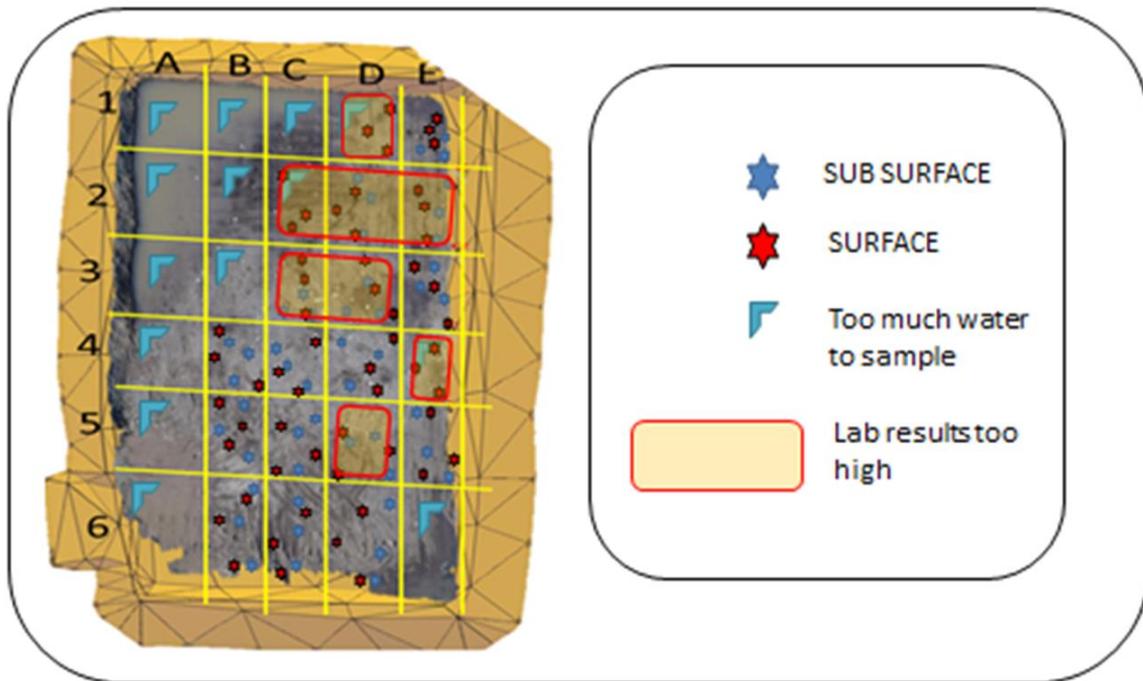


Figure 3-1 Licence 2BB-MEL1424 grid and sampling example

3.5.3 Soil Removal

Coarse-grained soils will be assessed near the end of the summer season by the Environment department technicians for PHC product and odour. A photoionization detector (PID) may be employed to assist in petroleum-based vapour detection. When PHC odours are no longer detected, the material will be removed to the WRSF, or used at the TSF for cover material.

When analysis of the fine-grained material at the end of a season indicates that concentrations of contaminants are below GN guidelines, the appropriate section of soil suitable for removal from the facility is completed. Interim monitoring may also be conducted of the headspace with a portable instrument (e.g., flame ionization detector), however, prior to any material removal, samples will be confirmed to be of suitable quality by an accredited laboratory beforehand.

When remediated, the soils will be removed from the facility and can be used for construction purposes such as normal overburden (i.e., part of the cover of the TSF) or stacked in the WRSF.

3.6 Water Management

Since the Landfarm facility is uncovered to facilitate natural weathering, water accumulating inside the bermed area may come into contact with contaminated material.

3.6.1 Snow Management

Non-contaminated snow will be removed as much as possible during winter to minimize the quantity of spring melt inside the berm. Care will be taken to ensure contaminated snow/soil is not disturbed by leaving a base layer of snow of no less than 10 cm in place. Following snowmelt, any contaminated product left from winter spill clean-up operations could be padded up.

3.6.2 Water Management

While, the Landfarm will have an impermeable liner, visual inspections by the Environment department will be conducted for seepage of contact water coming through the perimeter berm, or the accumulation of water within the containment berm. This will be conducted on a weekly basis starting after freshet and continuing until October when water is likely to be present. In the event of water accumulation or seepage, the ponded water will be pumped through the site's oil-water separator (EVAC by Ci.Agent) to remove PHC residue and will be analyzed for BTEX, lead, and oil and grease prior to discharge to the environment, only if discharge criteria from the Water Licence 2BB-MEL1424 part D, item 15, are met (Table 3-2).

Table 3-2 Licence 2BB-MEL1424 Part D, Item 15 STP

Licence 2BB-MEL-1424	
Criteria limits (ug/L)	
Benzene	370
Ethylbenzene	2
Toluene	90
Lead	1
Oil & Grease	15,000 and no visible sheen
Phenols	20

3.7 Landfarm Closure and Reclamation

After removal of all remediated soil and prior to closure and reclamation of the Licence B Landfarm, the berm and base will be sampled on a 10 m grid to determine if these soils are free from PHC contamination. Results of this analysis will be compared to GN and CCME criteria set out in Table 3-1. No excavation will be necessary if the agricultural/wildlife criteria are met. If industrial criteria are used, the Landfarm will be covered with a 2 m thick layer of waste rock, or other suitable material used for reclamation. The surrounding berm will be breached to avoid water accumulation on the landfarm.

3.8 Summary of Activities

A summary of Landfarm activities including monitoring of the physical condition is provided in Table 3-3. An annual report will be prepared indicating the volume of material added to the facility, amount of material removed, disposal or reuse location, all analysis results, volume and type of nutrient addition, visual inspection results, and volume of contact water pumped. This information will be appended to Agnico Eagle's NWB Annual Report.

Table 3-3 Summary of Landfarm Activities, Analyses, and Records

Activity	Analysis	Frequency of Analysis	Record
Excavation of spill and transport of contaminated material to landfarm.	If unsure of full excavation - F1-F4, BTEX If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs	As needed	Date, time and location of spill and excavation; estimated volume of spill; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable. Any evidence of remaining product
Soil aeration	NA	As possible	Date and time of the aeration; location; soil condition (moisture, odour, granulometrie, etc.)
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4, BTEX (laboratory)	Vapour – as needed; Laboratory – Bi-annually	Date and time; location; odour; laboratory report
Soil removal from landfarm	Removal subject to meeting GN criteria	Once GN criteria are met	Date and time; location; quantity of soil removed; final location
Ponded contact water	Table 3-2 – as specified in Water Licence 2BB-mel1424 Part D, Item 15	Prior to any dewatering; if re-used in landfarm, no sampling necessary	Date and time, location, laboratory report, in Annual Report
Seepage	Visual inspection; Table 3-2 – as specified in Water Licence 2BB-mel1424 Part D, Item 15	Weekly during summer	Location, extent, approximate depth, evidence of sheen
Identification of maintenance requirements	Visual inspection of landfarm	Twice over the summer	Inspected areas; condition of berm and base; previously unidentified safety concerns

SECTION 4 • CONTINGENCY OPTIONS

This section describes the contaminated soil management plan, should a large spill event occur, and if Landfarm treatment proves not successful.

4.1 Large Spill Event

A large spill event producing a quantity of soil that cannot be contained in the Landfarm is unlikely because the Landfarm is designed to hold sufficiently more contaminated soil than as is expected to be produced (see Table 2-1). Nevertheless, in this event, soils will be placed in a temporary storage area selected to avoid drainage of contaminated material. A temporary stockpile area would be set up in another location as approved by the NWB. As space becomes available, the soil would be transferred to the landfarm. The previously described spill prevention measures intend to minimize the potential of this scenario occurring.

4.2 Alternate Treatment Options

Should Landfarm treatment not perform as anticipated in which the rates of degradation are not sufficient to meet GN Tier 1 criteria within the life-of-mine and the anticipated closure period, the following alternative treatment options will be considered. Implementation will only occur once a detailed protocol and revised plan is approved by the NWB.

4.2.1 Soil Amendment

Since pH, salinity, moisture content, and microbial population density all affect rates of biodegradation by microbes, these factors may be monitored and adjusted through soil amendments if they are not found to be optimal (SAIC 2006). In addition, the dispersion of soil could be repeated to maximize air exposure if space in the Landfarm allows.

4.2.2 Tier 2 – Modified-Criteria Approach

According to the GN *Environmental Guideline for Contaminated Site Remediation* (GN 2009), in cases where site conditions, land uses, receptors, or exposure pathways are different from those assumed in the development of the Tier 1 criteria, modified criteria may be permitted. This process requires the collection of site-specific information on exposure and risk estimates, and is subject to GN approval. For this Project, landfarmed soils are to be encapsulated in a WRSF rather than used in surface applications, as assumed in Tier 1, reducing the likelihood of exposure to any remaining contamination. Therefore, the Tier 2 approach could be warranted if Tier 1 criteria cannot be met. Any consideration for this approach would be based on soil sampling results and science based information.

4.2.3 Direct Placement in Waste Rock Storage Facility or on Tailings Storage Facility

Another option for management of contaminated soil, if bioremediation proves ineffective, would be the direct placement of this material in a WRSF or on the TSF. Although the use of PHC contaminated soils in these storage areas is not optimal, the quantity generated on-site is small in comparison to the quantity of waste rock and cover on the TSF. While this method would not result in the treatment of soil, it is a viable contingency option because it would allow for the safe disposal of the contaminated material. Encapsulation and freeze-back would occur, eliminating any movement of contaminants. Over time, this material would undergo natural degradation. Consideration of this option would also include a suitable monitoring program for PHCs, which would be incorporated into the Closure and Reclamation Plan.

SECTION 5 • ASSESSMENT AND REPORTING

5.1 Feasibility

After three seasons of treatment in the Landfarm, degradation rates of PHC contaminants will be assessed to estimate the total remediation time required under these conditions. If remediation to GN guidelines is feasible within the life-of-mine timeframe, Landfarm operations will continue, with aeration and possible nutrient amendments, as described above. If rates of degradation are not sufficient through this method, alternative options will be further investigated (Section 4).

5.2 Reporting

Reporting of Landfarm activities will be submitted annually by Environment department, indicating the volume of material added to the facility, amount of material removed and disposal or re-use location, confirmatory analysis results, and, whether or not nutrient amendment was used.

5.3 Plan Review and Continual Improvement

The Landfarm Management Plan will be reviewed and updated on annual basis, as required, to reflect changes in operations and/or technology.

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- Agnico Eagle (Agnico Eagle Mines Limited). 2008. Landfarm Design and Management Plan In Accordance with Water License 2AM-MEA0815, Meadowbank Gold Project, 20 p. + Figures and Appendix. October 2008.
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AGNICO EAGLE

MELIADINE GOLD PROJECT

Landfill Design and Management Plan

**March 2018
Version 3**

EXECUTIVE SUMMARY

This Landfill Design and Management Plan outlines the conceptual design, operation and closure for an industrial waste landfill as part of Agnico-Eagle Mines Limited's (AEM) Meliadine Gold Project in Nunavut. This Plan was developed to operate a landfill as part of advanced exploration at the Meliadine Gold Project.

The landfill is required for the disposal of non-salvageable, non-hazardous, solid wastes generated during exploration activities. The proposed landfill will be located within the area where the future tailings/waste rock storage facility will be located. The camp is expected to accommodate a maximum of 150 to 300 persons during advanced exploration, dependent on the time of year.

The leachate from the landfill is anticipated to have very weak ionic strength (dilute) due to the controls on materials placed in the landfill. Also, abundant landfill cover material is to be found in the area, which will result in sufficient cover to isolate the waste in the landfill from the environment. At the end of its life, the landfill will be covered by a sufficient depth of material to isolate it from the environment, to permanently freeze it within the permafrost layer, and to chemically and physically stabilize it.

During operations, the slopes of the landfill will be protected from erosion by covering them with waste rock or coarse granular material. Additional surface water and erosion control measures will be incorporated into the landfill design, as appropriate.

To meet NWB guidelines, AEM conducted an environmental effects assessment to characterize environmental resources and determine the anticipated environmental effects of a landfill. The primary potential environmental effects from landfill activities included leachate generation, windblown debris, and habitat (vegetation) loss. Given the effective implementation of mitigation plans, no residual environmental effects to valued ecosystem components from construction, operation or closure of the landfill are anticipated.

This Plan will be implemented once approved, subject to any improvements proposed by the NWB.

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DOCUMENT CONTROL

Version	Date	Section	Page	Revision	Author
1	12/03/30			Version 1 of the Landfill Plan	
2	17/03/01			<p>Version 2 of the Landfill Plan</p> <ul style="list-style-type: none"> - Plan approved by: Jamie Quesnel; pg. Document Control - Landfill duration: November 2016-November 2018; pg. 1, 4 - Implementation Date: March 2017; pg. All (header) - Landfill Design - Overall Site Plan: Diagram; pg. 2 - Location of the Proposed Landfill on the Commercial Lease: Diagram; pg. 3 - Conceptual Cross Section: Diagram; pg. 14 - Removal of "Used Tires" from list of materials permitted in the landfill; pg. 7 - Removed Figure "Landfill Detailed Design", as it is covered in Figure 1-1 "Landfill Design - Overall Site Plan" - Added "empty prilled ammonia nitrate bags" to list of acceptable items to be landfilled 	
3	18/02/06			<ul style="list-style-type: none"> - Revision date updated to February 2018 on title page and page footers - "Based on the above criteria, a landfill is planned east of Lake B7 as shown on Figure 1-2" – This was updated from Figure 1-1; pg. 4, 11 - Figure 1-2 was updated to show location/direction of Lake B7 	

- Added “As of December 2017, the 2BB landfill is at capacity and is scheduled to have a final cover applied, as per the Conceptual Closure Plan identified in section 6 of this Management Plan”; pg.5

-Added “As of November 2017, operation of the exploration camp incinerator was suspended and replaced by the ECO 1.75 TN 1PVC100L Incinerator system located at the main camp, and which falls under the Type A license.”; pg. 10

-“This is followed by a final cover in excess of 1.5 metres of non-acid generating rock and/or granular material from the esker as shown on figure 1-2.” – This was updated from Figure 1-1 (Figure 1-2 also updated to show location of esker); section 4.1, pg 12

ACRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
BTEX	benzene, toluene, ethylbenzene, and xylene
CP1	Collection Pond 1
GN	Government of Nunavut
NWB	Nunavut Water Board
PHC	Petroleum hydrocarbons
Project	Meliadine Gold Project
RMMS	Responsible Mining Management System
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

SECTION 1 • INTRODUCTION

1.1 Project Overview

This Landfill Design and Management Plan outlines the conceptual design, operation and closure for a solid waste landfill as part of the advanced exploration program at Agnico-Eagle Mines Limited's (AEM) Meliadine Gold Project. Advanced exploration includes underground exploration comprising of bulk sample collection and ramp extension while surface activities have moved to pre-construction phase.

The Meliadine Gold Project is located on Inuit-owned land in the Kivalliq Region of Nunavut, approximately 25 km north of Rankin Inlet. Figure 1-1 provides an overview of the major infrastructure associated with the proposed landfill while Figure 1-2 shows its proposed location on the commercial lease AEM holds with the Kivalliq Inuit Association¹.

The Meliadine Gold Project operates under Water License 2BB-MEL1424 issued by the Nunavut Water Board on July 31, 2009. This Landfill Design and Management Plan is one of a series of environmental management plans that have been prepared for the Meliadine Gold Project, with all earlier plans required by terms and conditions of the water licence. The objectives of this Plan are summarized as follows:

1. To define the location, design and operating procedures to be used in the landfill disposal of non-hazardous solid waste generated at the Meliadine camp;
2. To define acceptable/non-acceptable types of solid waste to be placed in the Meliadine landfill; and
3. To define monitoring requirements for the landfill.

A landfill is required for the disposal of non-salvageable, non-hazardous industrial wastes from advanced exploration activities that cannot be incinerated. The Landfill Design and Management Plan was developed in accordance with the best management practices. Hazardous wastes will not be placed in the landfill. All waste materials considered unsuitable for landfill deposition will be packaged for shipment south to a certified waste management company for treatment, recycling and/or disposal.

Depending on the time of year, the camp is expected to accommodate from 150 to 300 persons during advanced exploration. A 2 year landfill life has been assumed, November 2016-November 2018.

¹ The Kivalliq Inuit Association has approved the construction, operation and closure of a landfill on the commercial lease. Their letter of approval is attached.

To meet NWB guidelines, AEM conducted an environmental effects assessment to characterize environmental resources and to determine the anticipated environmental effects of the proposed landfill.

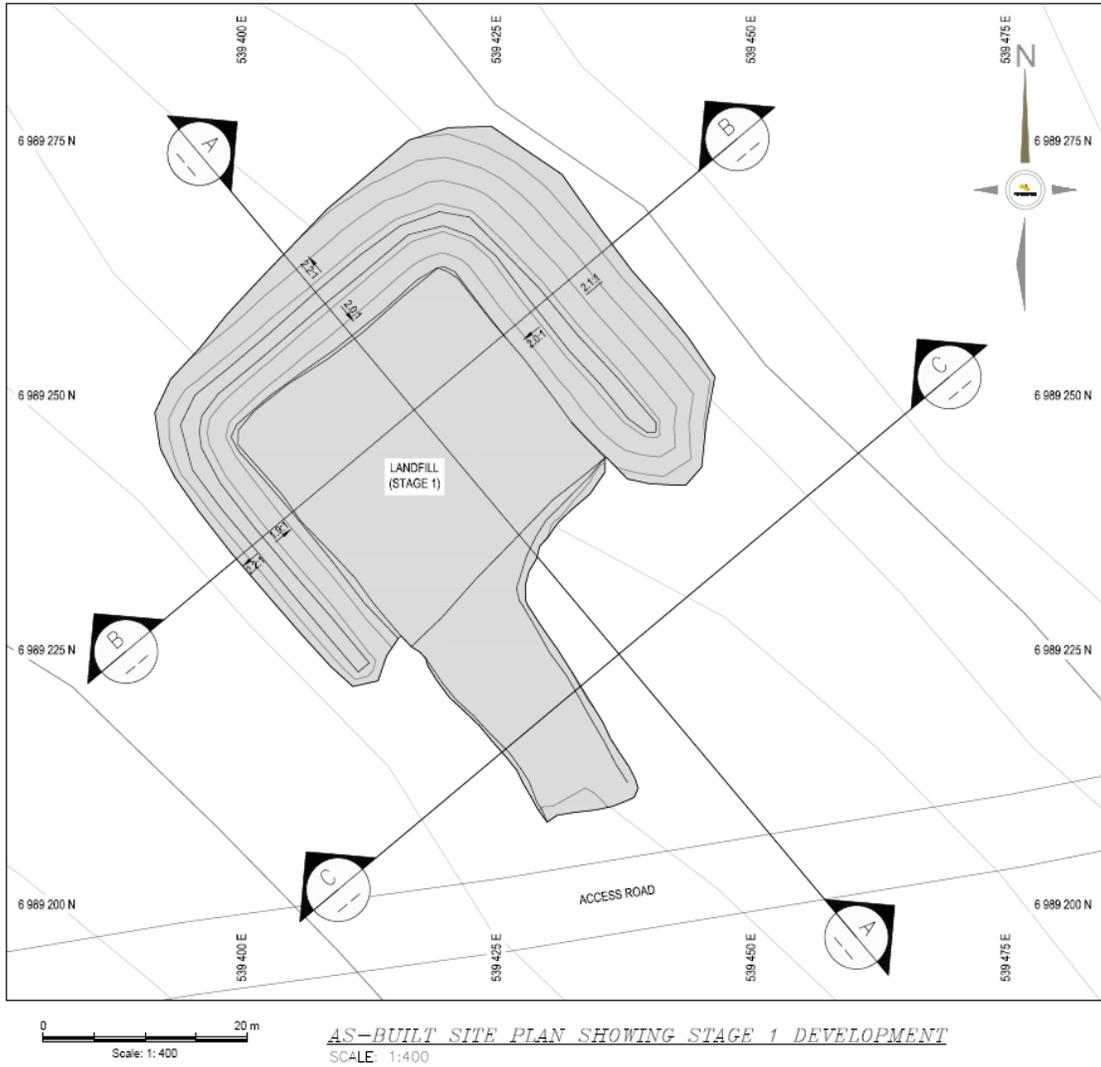
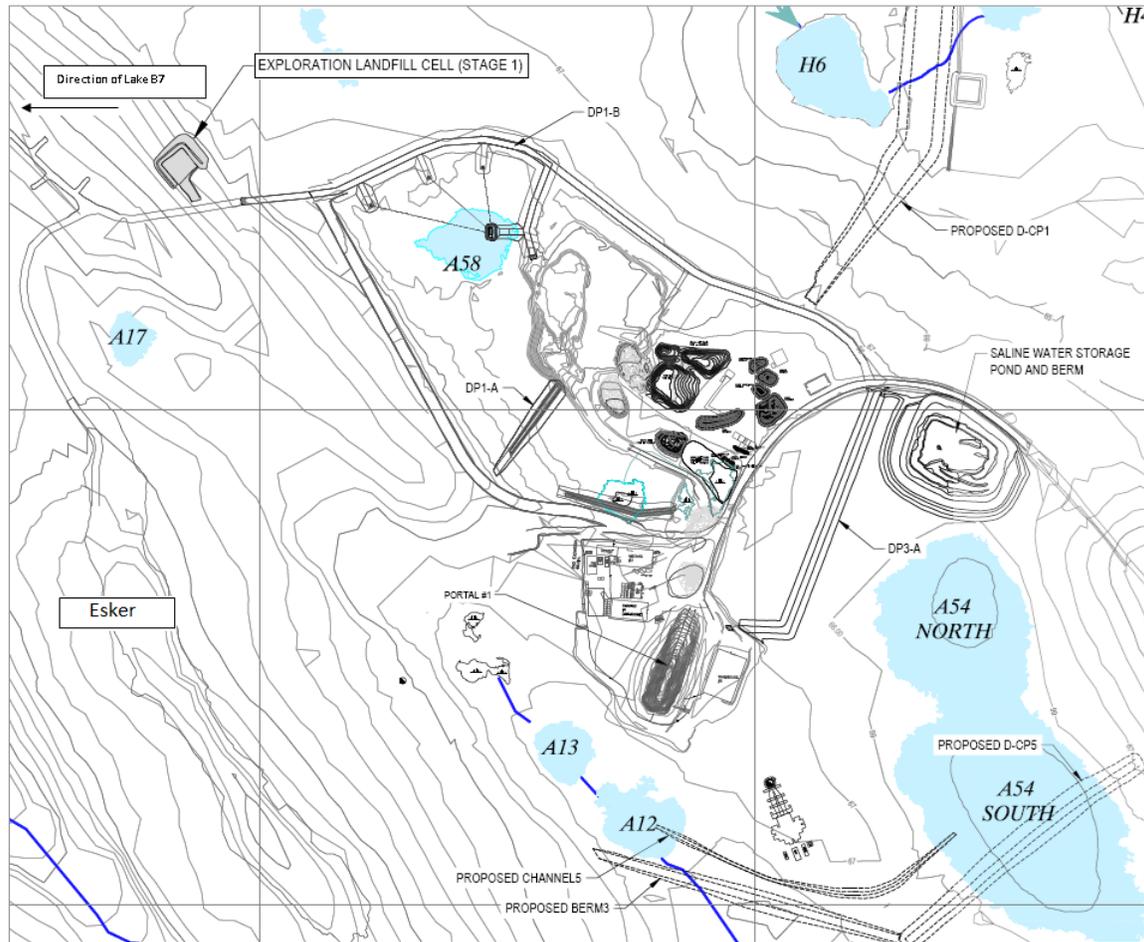


Figure 1: Landfill Design – Overall Site Plan



OVERALL LOCATION PLAN FOR EXPLORATION LANDFILL STAGE 1
SCALE: N.T.S.

Figure 2: Location of the Proposed Landfill on the Commercial Lease

1.2 Project Description

The Meliadine advanced exploration site includes the following structures and facilities:

- Camp, dormitories and kitchen;
- Core shack, storage and maintenance buildings;
- Portal and underground workings;
- Waste rock pads that hold ore stock piles, underground service buildings, and an underground bulk sample facility;
- Roads;
- Granular borrow pits;
- Water management facilities; and

- A proposed industrial waste landfill.

The Meliadine camp is designed to minimize the areas of surface disturbance, stabilize disturbed land surfaces against erosion, and return the land to a post-mining use that is chemically and physically stable, and consistent with past traditional pursuits and wildlife habitat (MGP, 2010a).

1.3 Location of the Landfill

The landfill will be located considering the following criteria:

- Drainage – sites that drain into areas where water will be collected and monitored as part of the overall site plan are preferred.
- Avoid Ice Rich Soil Excavation – sites where bedrock is at relatively shallow depths are preferred.
- Disturbed Areas – sites that will be within or near areas that will be disturbed as part of the future overall mine plan are preferred.
- Access – sites that are located close to existing access roads are preferred.

The first three criteria are recommendations from the Mine Site Reclamation Guidelines for the Northwest Territories (INAC, 2006).

Based on the above criteria, a landfill is located east of Lake B7 as shown on Figure 1-2. This is in the headwaters of the H drainage basin, which reaches Meliadine Lake approximately 1 kilometre to the east. Drainage patterns are poorly defined in the upper reaches of the H basin and are only active during spring freshet and during large rain events.

The Landfill was developed and served as the non-hazardous solid waste disposal site for >1 year of advanced exploration and pre-construction, November 2016 to December 2017.

As of December 2017, the 2BB landfill is at capacity and is scheduled to have a final cover applied, as per the Conceptual Closure Plan identified in section 6 of this Management Plan.

SECTION 2 • REGULATORY SETTING

Waste management in Nunavut is regulated under the *Nunavut Public Health Act*, the *Nunavut Environmental Protection Act* and the federal *Environmental Protection Act*. AEM is also bound by the terms and conditions of its commercial lease with the Kivalliq Inuit Association and its water licence from the Nunavut Water Board.

In addition to mandatory requirements, a number of waste management guidelines are commonly used in the NWT and Nunavut. The most recent of these was developed for municipal solid waste, and is titled "*Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT*"². While not all of the recommendations provided in this guideline are appropriate for the management of industrial waste such as those generated at the Meliadine advanced exploration camp, those principles considered applicable have been adopted in this Plan.

In addition, the *Mine Site Reclamation Guidelines for the Northwest Territories* (INAC 2006) were followed in this current document regarding specific landfill design and mitigation for impacts pertaining to waste. Where appropriate, recommendations from *Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure* (BGC 2003) were also incorporated into this document.

**Due to increased volume of material placement in 2017, transfer of material from the 2BB landfarm to the 2AM landfarm will likely be required to ensure appropriate decontamination.*

² Report was prepared by Ferguson Simek Clark, April 2003, on behalf of the Department of Municipal and Community Affairs, Government of Northwest Territories

SECTION 3 • PLAN FOR THE ON-SITE DISPOSAL OF SOLID WASTE APPROACH

The strategy for the disposal of solid waste is to first identify and segregate acceptable disposal items from non-acceptable items. Acceptable items that can be disposed of at the on-site facility are those that are non-hazardous, non-putrescible, with a low leachate and heat generation potential. All other materials will either be incinerated or hauled offsite for shipment to a licensed hazardous waste management company. This strategy for limiting the materials that can be placed in the landfill greatly reduces the concentration of constituents in the leachate.

All solid wastes that may contain food waste, food packaging waste or other organic waste that could attract wildlife will be incinerated onsite at the incinerator. This will include all garbage from the camp, camp kitchen, site lunchrooms and offices. The ash from the incinerator will be disposed of in the landfill. Incinerator ash samples will be collected and tested for metals according to the Government of Nunavut Environmental Guideline for Industrial Waste Discharges (Department of Sustainable Development, 2002). Ash that does not meet these guidelines will be packaged in drums and sent to a licensed hazardous waste management facility in the south.

The development of the landfill will minimize the area required for waste storage and the re-handling of waste. The landfill at the selected location will allow any leachate that may be generated to be collected, monitored and managed in the future waste rock area. The leachate from the landfill is anticipated to be weak in ionic strength due to the controls on materials placed in the landfill and thus site specific landfill leachate management is not considered to be required. Any point of discharge or runoff from the landfill will be sampled and analyzed for parameters as per NWB LIC# 2BB-MEL1424 Part D Item 14.

Based on the above strategy, a liner is not considered to be required for the landfill, nor is any special monitoring recommended. However, the landfill will conform to best management practices allowing for orderly landfill development, which reduces the potential for windblown debris.

3.1 Waste Acceptable for Placement in Landfill

The following materials will be acceptable for disposal at the landfill:

- Plastic (except expanded polystyrene);
- Steel, copper, aluminum, iron;
- White goods (heavy durables such as air conditioners, refrigerators, stoves);
- Wire;
- Wood;
- Fiberglass insulation;
- Fiberglass;
- Roofing materials;
- Asphalt;
- Concrete;
- Carpet;

- Bricks;
- Ceramics;
- Rubber
- Empty caulking tubes;
- Hardened caulk;
- Clothing;
- Glass including light bulbs, (fluorescent bulbs will require special handling, see below for more details);
- Waste Asbestos (see below for more details);
- Small appliances (with batteries removed);
- Gyproc;
- Ash, provided it has cooled to 60°C or less;
- Vehicles and machinery provided all liquids, grease, batteries, and electronics have been removed; and
- Empty prilled ammonia nitrate bags from Anfo Plant (explosives production facility)

3.1.1 – Waste Asbestos

Waste asbestos includes any type of material with greater than 1% asbestos by weight (Government of Nunavut, Environmental Protection Service, 2002a). Asbestos that has been immersed or fixed in a natural or artificial binder or included in a manufactured product is not considered waste asbestos; it is considered a hazardous waste (and will be disposed of accordingly). Waste asbestos can either be backhauled off-site for disposal in an approved facility or it can be landfilled. The following are guidelines for landfilling waste asbestos:

- Immediately buried and covered with 0.5 m of cover material;
- Buried where it will not be disturbed; and
- The location should be maintained on a map or diagram for future reference.

The complete *Environmental Guideline for Waste Asbestos* is included in Appendix A.

3.2 Waste Unacceptable for Placement in Landfill

Materials that are not listed above will be unacceptable for placement at the landfill, unless approved in writing by the Meliadine Environment department. These materials include:

- Organic matter including food, septic tank pumpings or sludge from waste water treatment, dead animals, paper, cardboard;
- Food containers and wrappings, unless cleaned;
- Hazardous waste including mercury, medical waste, batteries, solvents, glues, ethylene glycol antifreeze, adhesives (except empty caulking tubes);

- Electronics;
- Petroleum products, including materials contaminated with petroleum products; and
- Expanded polystyrene.

In particular, organic matter will not be accepted in the landfill, thus eliminating the attraction to carnivores and/or raptors. This will be accomplished by requiring all personnel to dispose of domestic waste in designated receptacles and by sending all collected domestic waste (e.g. from kitchens, offices and living quarters) to the site incinerator.

3.2.1 – Fluorescent Lamp Tubes

Fluorescent tubes contain mercury phosphorus powder and traces of lead and cadmium, which are considered environmental contaminants under the Nunavut *Environmental Protection Act*. The only disposal method for fluorescent tubes is through an approved hazardous waste recycling or disposal facility (Government of Nunavut, Environmental Protection Service, 2003). Ultraviolet (UV) lamp tubes used in the wastewater and potable water treatment systems shall be disposed of in the same way as fluorescent lamp tubes, as they also contain mercury (vapour).

At the Meliadine site and Rankin Inlet Itivia Laydown Area, hazardous waste materials will be stored in secure facilities until they can be backhauled for off-site recycling or disposal at an approved facility in another provincial or territorial jurisdiction. AEM has registered as a Hazardous Waste Storage Facility with the Government of Nunavut Department of Environment.³

3.2.2 – Ozone Depleting Substances

Ozone Depleting Substances (ODSs) include chlorofluorocarbons (CFCs) or halons. Common sources include refrigeration equipment, air conditioning equipment, motor vehicle air conditioners and fire extinguishing equipment (Government of Nunavut, Environmental Protection Service, 2002b). These materials are hazardous in nature; consequently, all disposal of ODS will take place at an approved facility in another provincial or territorial jurisdiction.

Any equipment containing ozone depleting substances should have the ODS removed by a certified technician prior to disposal in the landfill. The *Environmental Guideline for Ozone Depleting Substances* is included in Appendix A.

3.2.3 – Total Volume Of Waste

An estimate of waste volume is required to determine the appropriate size of the landfill. However, an exact volume of waste is not a critical parameter in the design because of the flexibility of design to accommodate extensions (larger to accept more waste) or contractions (smaller to accept less waste) of the landfill.

For the proposed conservative population of 150 to 300 persons⁴, it has been assumed that each person will produce 1 tonne of refuse per year, and that 50% of the refuse by weight can be incinerated (i.e. not landfilled,

³ Waste Generator Number - NUG100063

⁴ For conceptual planning of landfill capacity, it was estimated that 300 persons (size of on-site camp facility) will be employed at any one time on-site. Environment Canada's 'State of the Environment InfoBase', Environmental Indicator Series 2003 (<http://www.ec.gc.ca>), indicates that the per capita non-hazardous solid waste generation in 2000 for Canada was almost 1 tonne per person per year. Thus, for landfill conceptual planning purposes, 300 tonnes of waste has been assumed to be generated each year.

except for the ash). Thus, 100 to 200 tonnes of solid waste would need to be landfilled each year. If it is further assumed that the density of this solid waste is 0.5 tonnes / m³, then 200 to 400 m³ of waste would need to be landfilled each year over the four year life of the landfill.

The quantity of ash from the incinerator is estimated to be between 22.5 to 45 tonnes/yr., assuming incineration results in a 70% reduction in mass. Incinerator ash will be packaged in drums or sacks and the whole container landfilled, thereby eliminating any windblown effects.

3.3 Incinerator Ash Testing Protocol

Upon commissioning the new incinerator at Meliadine Exploration Camp* (a Camp Waste Incinerator - model: Westland Environmental Services, Model: CY-2050-FA-D, an ash testing protocol will be implemented to ensure that the incinerator ash is suitable for disposal in the landfill.

Ash samples will be collected and tested annually, or upon a significant change in the source or type of material sent to the incinerator. The samples will be compared to the Government of Nunavut guidelines for solid waste/process residual concentrations suitable for landfill, as described in the Environmental Guideline for Industrial Waste Discharges and presented in Table 3.1 (Department of Sustainable Development, 2002).

If monitoring indicates the ash is above the guidelines and not suitable for landfilling, an investigation will be undertaken to identify the cause and eliminate the source for this exceedance. Ash with elevated metals concentrations will be packaged in drums and sent to a licensed hazardous waste disposal facility in the south.

As of November 2017, operation of the exploration camp incinerator was suspended and replaced by the **ECO 1.75 TN 1PVC100L Incinerator system located at the main camp, which falls under the Type A license.*

Table 1: Guidelines for Solid Waste/Process Residuals Suitable for Landfill

Parameter	Concentration maximum (mg/L)
Arsenic	2.5
Barium	100
Cadmium	0.5
Chromium	0.5
Lead	5
Mercury	0.1
Selenium	1
Silver	5
Zinc	500

NOTE: Standards based on leachate test results

3.4 Leachate Testing Protocol

Despite the location being placed in area of poor drainage, should leachate occur, it will be sampled as Station MEL-8 as per Water License 2BB-MEL1424. The specific sampling location will be 15V E539440 N6989240, and the sampling frequency will be whenever leachate is observed and prior to discharge to land. Sampling duration will be once prior to discharge as discharge is of short duration.

The following sampling parameter list will be analyzed for:

- Total Metals: Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, Zinc;
- Total Suspended Solids;
- Oil and Grease; and
- pH.

SECTION 4 • LANDFILL LOCATION AND CONSTRUCTION

The proposed location of landfill is shown on Figure 1-2 to the east of Lake B7. This is an area of level topography having a nearby source of coarse granular esker material for covering the waste in the landfill. It is anticipated that this landfill will serve as the solid waste disposal facility for 2 years of advanced exploration and during pre-construction. The design of the landfill will require no exacting survey data or measurement. This is due to the restriction on materials that can be landfilled and the location of the landfill being within the proposed future waste rock and/or tailing storage facilities. These factors reduce the need for leachate collection or control or mitigation measures against vectors such as carnivores and/or raptors. Thus, the main environmental mitigation measure required is a wind screen to reduce windblown debris.

The area to receive waste will be bounded on sides by a granular material or rockfill berm as shown in Figure 4-1. The purpose of the berm is to confine the waste and to act as a wind shield to reduce windblown debris. The landfill will be a rectangular shape with the length perpendicular to the prevailing wind direction so that much of the waste will be protected from wind by the berm. The landfill will be oriented so that the main wind direction has a minimal impact on the contents of the landfill.

Provided the materials that go into the incinerator are controlled to exclude all hazardous materials (*i.e.*, even small quantities of hazardous waste such as batteries are not disposed in the landfill), then the incinerator ash should be non-hazardous. An ash testing protocol will be implemented to ensure that the incinerator ash is suitable for disposal in the landfill.

4.1 Landfill Protocol For Placement of Material

Annual landfill operation will involve clearing of snow prior to spring melt, placement of waste rock or granular material over the waste during the summer period, and placement of a graded cover prior to the winter period of snow accumulation.

An area method of deposition will be used such that materials will be deposited in rows and covered as required. Wastes will be disposed directly on the ground and compacted with heavy equipment against the berm or an existing row of compacted debris. This is followed by a final cover in excess of 1.5 metres of non-acid generating rock and/or granular material from the esker as shown on figure 1-2.

4.2 Leachate Management

Should there be any leachate from the landfill, it is anticipated to be of very low ionic strength (dilute) due to controls on materials to be placed in the landfill, and as a result site-specific landfill leachate management is not considered to be required.

Owing to their placement within the future waste rock/tailing storage facility, the landfill will also become encapsulated within waste rock/tailings. AEM plans to use NPAG waste rock or granular material to surround and cover the landfill wherever practical. A minimum 2 m thick layer of cover material would also be placed over the landfill cover as part of planned closure activities for the landfill.

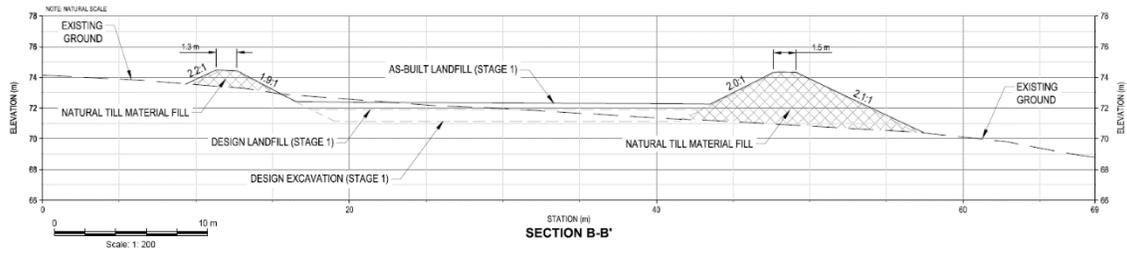


Figure 3: Conceptual Cross Section

SECTION 5 • LANDFILL CONEPTUAL OPERATIONS PLAN

5.1 Materials Acceptable for Disposal

See section 3.1

5.2 Materials Not Acceptable for Disposal

See section 3.2

5.3 Plan Review and Continual Improvement

The proposed landfill capacity assumes an average of 200 to 400 m³ of waste will be landfilled per year.

5.4 Site Development and Landfilling Method

The site for the landfill was prepared by first excavating soil down to bedrock or to 2.1 metres depth, whichever is less. The excavation was then filled with granular material. This will provide a suitable working surface for the landfill for all seasons.

The landfill was filled progressively in an orderly manner. Specifically, waste will be placed at one end of the landfill at full height and then the active waste area would progressively advance. Areas where the waste has been placed to full height and levelled would be progressively covered by placement of a minimum 0.3 m thickness of rock fill or granular material on top of the waste.

5.5 Staffing and Equipment

The landfill will not require a full-time attendant. Trucks will haul waste to the landfill and a dozer would be used to spread and level the waste.

5.6 Leachate Management

The leachate from the landfill is anticipated to be of very weak (dilute) ionic strength due to the controls on materials placed in the landfill. Therefore, specific leachate management is not considered to be required.

5.7 Surface Water and Erosion Control

The slopes of the landfill will be covered with rockfill or coarse granular material, thereby protecting them from erosion. Additional surface water and erosion control will be incorporated into the landfill design, as appropriate.

5.8 Operational Inspections

The Meliadine Environment Department plan to undertake periodic inspections of the landfill operations to verify compliance with the water licence, and operations and closure plan, including the

condition of landfill works, evidence of erosion, excessive ponding or unusual landfill settlement, and adequacy of safety measures.

SECTION 6 • CONEPTUAL CLOSURE PLAN

The following is a conceptual plan for closing the landfill:

6.1 Estimate of Total Waste Volumes, Tonnage and Life of Landfill

Upon closure, it is estimated that the landfill will have a maximum volume of 2,000 m³ of waste.

6.2 Final Cover Design

The waste in the landfill will be covered granular material or waste rock, and should thereafter be stable.

6.3 Water Management

Contact water from the landfill in closure will continue to be managed using best management practices.

SECTION 7 • CONCEPTUAL CLOSURE PLAN

The landfill is designed and built as part of the future waste rock/tailing storage facilities. The access road to the Tiriganiaq esker borrow pit is used to access the landfill. Landfill activities that were identified to have potential effects on valued ecosystem components (VECs) include site preparation and construction, operations and closure.

Potential effects from the landfill on VECs were assessed as follows:

- Degradation of permafrost;
- Change in surface water and groundwater drainage patterns due to the landfill footprint (altered landscape);
- Change in groundwater and surface water quality from leachate percolation, leading to degradation of aquatic habitat;
- Change in air quality from dust and windblown debris;
- Loss of vegetation cover and terrestrial mammal habitat due to landfill footprint;
- Attraction of predatory, small mammals to waste and raptors; and
- Loss of sites of heritage significance or traditional ways of life.

A summary of the environmental effects assessment, including mitigation measures and potential for residual effects is provided in Table 7.1.

Table 7-1: Environmental Overview Effects Assessment Summary

Valued Ecosystem Component	Description of Potential Project Effect	Mitigation of Effect	Residual Effect
Permafrost	<p><u>Permafrost Degradation</u></p> <p>The construction, operations and closure of the landfill may disturb permafrost.</p>	<p>The landfill will be designed and built within the footprint of the proposed future waste rock/tailing facilities to minimize ground disturbance and permafrost degradation, as per the Pre-mining Planning Option objectives outlined in the Mine Site Reclamation Guidelines for the Northwest Territories (INAC, 2006).</p>	None
Surface Water and Groundwater Quantity and Distribution	<p><u>Change in Drainage Pattern</u></p> <p>The construction, operations and closure of the landfill may alter surface water and groundwater drainage patterns.</p>	<p>The landfill will be designed and built within the footprint of the proposed future waste rock/tailing storage facilities. Construction control measures are available for existing facilities to limit impacts to groundwater.</p>	None
Water Quality	<p><u>Change in Water Quality</u></p> <p>Leachate generation from landfill waste during operations may have an effect on water quality in the nearby water bodies.</p>	<p>Waste that can result in high toxicity leachate will be incinerated or hauled offsite, and will not be landfilled. Incinerator ash will be tested periodically to confirm that it is not hazardous waste.</p> <p>The leachate from the landfill is anticipated to be very low ionic strength (dilute) due to controls on materials to be placed in the landfill.</p> <p>At the end of its life, the landfill will be capped with waste rock and or coarse granular material (> 2m).</p>	None
Air Quality	<p><u>Change in Air Quality (Emissions and Dust)</u></p> <p>Emissions, dust and windblown debris from landfill operations may affect air quality.</p>	<p>Emissions and dust deposition are anticipated to be low due to the small quantity of waste and the covering by waste rock or coarse granular material.</p> <p>A rockfill or granular material berm will be constructed to act as a wind shield to reduce amount of windblown debris.</p>	None

Valued Ecosystem Component	Description of Potential Project Effect	Mitigation of Effect	Residual Effect
Vegetation Cover	<p><u>Vegetation Loss</u> Landfill construction and operation will reduce vegetation.</p>	<p>The landfill will be designed and built within the footprint of the proposed future waste rock/tailing facilities; therefore there will be no additional effects to vegetation cover. Where appropriate, these mitigation measures will be incorporated into landfill closure.</p>	None
Predatory Mammals	<p><u>Attraction to Landfill</u> Food and camp wastes attract scavengers during landfill operations including grizzly bear, Arctic fox and wolverine. Mortality of animals may occur if they are a threat to human safety.</p>	<p>Putrescible waste will be incinerated and will not be landfilled and thus there should be no food attraction for animals.</p>	None
Small Mammals	<p><u>Attraction to Landfill and Habitat Loss</u> Landfill construction and operation will reduce vegetation cover and habitat for small mammals. Food and camp wastes attract scavengers during landfill operations.</p>	<p>Putrescible waste will be incinerated and will not be landfilled and thus there should be no food attraction for animals.</p>	None
Raptors	<p><u>Nesting and Foraging Habitat Loss</u> Construction and operation of the landfill will reduce vegetation cover and habitat for raptor prey (small mammals and birds).</p>	<p>The landfill will be designed and built within the footprint of the proposed future waste rock/ tailing facility; therefore there will be no additional effects to vegetation cover.</p>	None

Valued Ecosystem Component	Description of Potential Project Effect	Mitigation of Effect	Residual Effect
Breeding Birds	<p><u>Roosting, Foraging and Nesting Habitat Loss</u> Construction and operation of the landfill will reduce vegetation cover resulting in loss of nesting sites.</p>	<p>The landfill will be designed and built within the footprint of the future waste rock/ tailing facilities; therefore there will be no additional effects to vegetation cover (breeding bird habitat). Progressive reclamation of the landfill will restore small breeding bird habitat.</p>	None
Ungulates (caribou and muskoxen)	<p><u>Habitat Loss (foraging)</u></p>	<p>The landfill will be designed and built within the footprint of the proposed future waste rock/ tailing facilities; therefore there will be no additional effects to vegetation loss (ungulate foraging habitat). Progressive reclamation of the landfill will restore foraging habitat for ungulates after mine closure.</p>	None
Fish Habitat and Fish Populations	<p><u>Aquatic Habitat Degradation</u> Leachate generation from landfill waste during operations and closure may have an effect on water quality in the nearby water bodies.</p>	<p>Waste that can result in high toxicity leachate will be incinerated and hauled offsite. It will not be landfilled. Incinerator ash will be tested periodically to confirm that it is not a hazardous waste. The leachate from the landfill is anticipated to be very low ionic strength (dilute) due to controls on materials to be placed in the landfill. At the end of mine life, the landfill would be capped with at least 2 metres of either waste rock or coarse granular material.</p>	None

Valued Ecosystem Component	Description of Potential Project Effect	Mitigation of Effect	Residual Effect
Sites of Heritage Significance	<u>Loss to Heritage Sites</u>	Project design was adjusted to the extent practicable to ensure that identified/known heritage resources sites are away from planned infrastructure. Sites on the nearby esker were mitigated.	N/A
Traditional Way of Life	<u>Loss to Traditional Way of Life</u>	According to traditional knowledge, there has been little to no human activity in the Meliadine area where the proposed landfill is to be located.	N/A

SECTION 8 • EFFECTS SUMMARY

The primary potential environmental effects from landfill activities include leachate generation, windblown debris and habitat (vegetation) loss. Given the effective implementation of mitigation plans, no residual environmental effects to VECs from construction, operation or closure of the landfill are anticipated. See summary below:

- The leachate that will be generated by the landfill is anticipated to be of very low ionic strength (dilute) due to restrictions on the materials that would be placed in the landfill. A rockfill or granular material berm will be constructed to act as a wind shield to reduce amount of windblown debris.
- Habitat loss will be minimized because the landfill will be designed and built within the footprint of proposed future waste rock/tailing storage area. With the implementation of terrestrial habitat reclamation strategies, the final surfaces of the landfill will be graded to blend into the existing topography and enhance conditions for wildlife.
- The landfill will be within the footprint of the proposed future tailings/waste rock storage facility for the mine, and at the end of its life be covered with waste rock or coarse granular materials to a minimum of 2 metres.

SECTION 9 • PLAN REVIEW AND CONTINUAL IMPROVEMENT

The Landfill Design and Management Plan will be reviewed annually by the Meliadine Environment Department. If necessary, it will be updated every two years as required. Improvements suggested through these reviews will be implemented in consultation with the Nunavut Water Board.

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MGP (Meliadine Gold Project) 2010b MGP Waste Management Plan, August 2010

Appendix A

Government of Nunavut Environmental Guidelines

Environmental Guideline for Waste Asbestos

Environmental Guideline for Ozone Depleting Substances

Environmental Guideline for Waste Asbestos



Department of Environment
Government of Nunavut

GUIDELINE: WASTE ASBESTOS

Original: January 2002

Revised: January 2011

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act*.

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with waste asbestos. This Guideline does not replace the need for the owner or person in charge, management or control of the waste to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of waste asbestos.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut

P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0

Electronic version of the Guideline is available at <http://env.gov.nu.ca/programareas/environmentprotection>

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Introduction

Asbestos is the commercial term given to a group of silicate minerals that occur naturally in the environment. These minerals have separable long fibers that are heat resistant, strong and flexible enough to be woven or spun. Because of these characteristics, asbestos has been used in a wide range of manufactured products, mostly in building materials (i.e. roofing shingles, ceiling and floor tiles, wallboard, clapboard and asbestos cement products), friction products (i.e. automobile clutch, brake and transmission parts) and heat resistant insulation, fabrics, packaging, gaskets and coatings. Loose-fill vermiculite insulation may also contain small amounts of asbestos.

During the 1980s the health and safety risks associated with asbestos started to become known. As a result, the use of asbestos was banned or phased out throughout North America. Asbestos products may still be found when buildings are being renovated or demolished, or when carrying out repairs on older vehicles and electrical appliances.

Although asbestos is typically considered to be a human health hazard, the route of exposure is through breathing air and drinking water that contain the very small asbestos fibres. The *Environmental Guideline for Waste Asbestos* (the Guideline) provides information on the characteristics and potential environmental and human health effects of waste asbestos and guidance on its proper storage, handling and removal, transportation and disposal. It is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of waste asbestos is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the management of waste asbestos.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

1.1 Definitions

<i>Asbestos</i>	A commercial term given to naturally occurring fibrous silicate minerals including crocidolite, amosite, chrysotile, fibrous anthophyllite, tremolite, actinolite and mysorite.
<i>Commissioner's Land</i>	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.
<i>Contaminant</i>	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.

<i>Dangerous Good</i>	Any product, substance or organism included by its nature or by the <i>Transportation of Dangerous Goods Regulations</i> in any of the classes listed in the schedule provided in the <i>Transportation of Dangerous Goods Act</i> .
<i>Environment</i>	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
<i>Friable Waste Asbestos</i>	Waste asbestos which can be crumbled by hand pressure when it is dry.
<i>Minister</i>	The Minister of Environment of the Government of Nunavut.
<i>Qualified Person</i>	A person who has an appropriate level of knowledge and experience in all relevant aspects of waste management.
<i>Responsible Party</i>	The owner or person in charge, management or control of the waste.
<i>Transport Authority</i>	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - <i>Transportation of Dangerous Goods Act (Canada) and Regulations; Interprovincial Movement of Hazardous Waste Regulations and Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations</i> . (b) Air – <i>International Air Transport Association (IATA) Dangerous Goods Regulations and International Civil Aviation Organization (ICAO) Technical Instructions</i> ; and (c) Marine – <i>International Maritime Dangerous Goods Code (IMDG)</i> .
<i>Waste Asbestos</i>	A substance containing asbestos in a concentration greater than 1% by weight that is no longer wanted or is unusable for its intended purpose and is intended for storage or disposal. Waste asbestos does not include asbestos that is immersed or fixed in a natural or artificial binder.

1.2 Roles and Responsibilities

1.2.1 Department of Environment

The Environmental Protection Division is the key environmental agency responsible for ensuring parties properly manage waste asbestos and will provide advice and guidance on its management. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be

obtained by contacting the Department of Environment or by visiting the web site at <http://env.gov.nu.ca/programareas/environmentprotection>.

1.2.2 Generators of Waste Asbestos

The owner or person in charge, management or control of waste asbestos is known as the responsible party. In general, the responsible party must ensure asbestos is properly and safely managed from the time it is produced to its final disposal. This is referred to as managing the waste from cradle-to-grave. Information on the general management of hazardous waste in Nunavut, including generator, carrier and receiver responsibilities, can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste*.

Contractors may manage unwanted or waste asbestos on behalf of the responsible party. However, the responsible party remains liable for ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the waste, the responsible party may also be charged.

1.2.3 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of waste asbestos as there may be other environmental or public and worker health and safety issues to consider.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers. The *Asbestos Safety Regulations* provide specific requirements for the safe handling of asbestos in the workplace and for medical surveillance of workers.

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities.

Department of Health and Social Services

Activities related to the handling and management of waste asbestos may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act*.

Department of Economic Development and Transportation

The Motor Vehicles Division of the Department of Economic Development and Transportation is responsible for the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and road safety matters.

Environment Canada

Environment Canada is responsible for administering the *Canadian Environmental Protection Act (CEPA)*¹ and for regulating the interprovincial and international movement of hazardous waste, including waste asbestos, under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*. Environment Canada is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Indian and Northern Affairs Canada

Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters, including the impact waste asbestos may have on the quality of these lands and waters.

Local Municipal Governments

The role of municipal governments is important in the proper local management of waste asbestos. Under the Nunavut Land Claims Agreement, municipalities are entitled to control their own municipal disposal sites. Unwanted waste may be deposited into municipal landfill sites and sewage lagoons only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue involving asbestos is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and disposal of waste asbestos may be controlled through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board and other co-management boards and agencies.

¹ Asbestos is listed in Schedule 1 of the *Canadian Environmental Protection Act* as being a "Toxic Substance"

Characteristics and Potential Effects of Asbestos

2.1 Characteristics

Asbestos is a naturally occurring silicate mineral with several unusual properties. Its long flexible silky fibres are strong enough to be spun or woven into a variety of blanket-like products. It is resistant to high temperatures, chemical corrosion and wear. A poor conductor of electricity, asbestos also insulates well against heat and electricity. This combination of properties gives asbestos performance characteristics that are difficult to match and, as a result, it has been used in a wide range of manufactured products over the years including building materials (i.e. roofing shingles, ceiling and floor tiles, wallboard, clapboard and asbestos cement products), various automotive friction products (i.e. clutch, brake and transmission parts) as well as heat resistant insulation, fabrics, packaging, gaskets and coatings. Although asbestos use was either banned or largely phased out in North America starting in the mid 1980s, it can still be found in many older buildings, vehicles and appliances. Appendix 3 provides a listing of products that have been manufactured in the past using asbestos.



Figure 1 - Anthophyllite Asbestos Fibres
Source: Public Domain

2.2 Potential Effects on Environment and Human Health

Asbestos fibres are stable and do not break down into other compounds in soil, evaporate into air or dissolve in water. In other words, the basic silicate structure of the fibre remains largely intact in the environment. Small diameter fibres may remain suspended in air and water and be carried long distances while larger fibres tend to be deposited more quickly. Asbestos fibres are not able to move through soil.

Human exposure to asbestos occurs when the asbestos-containing material is disturbed in some way so as to release fibres into the air and water. Small amounts can also be released to the environment through the breakdown of natural deposits. Health risks occur when fibres are present in drinking water and in the air that people breathe. When inhaled, asbestos fibres can cause asbestosis (a scarring of the lungs which makes breathing difficult), lung cancer and mesothelioma (a rare cancer of the lining of the chest or abdominal cavity). The risk of contracting an asbestos related disease is greatest when fibre concentrations in the air are high and the exposure period is long, such as in the workplace. Smoking combined with asbestos inhalation also greatly increases the risk of lung cancer.

Waste Management

Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.²

3.1 Pollution Prevention

Pollution prevention is a term used to describe methods and practices that minimize or eliminate the generation of waste. If asbestos is known to be present, removal of the asbestos material should only be undertaken by a qualified person and only when the material is beyond repair or, if it is in a building, when the building is undergoing renovation or demolition. Asbestos that is not disturbed or deteriorated does not, in general, pose a risk to human health and can be left alone.

Other pollution prevention opportunities for waste asbestos include:

- Reduce*
- Replace asbestos-containing materials with less hazardous materials. A number of materials have been developed as replacements for asbestos in manufactured products including fiberglass, carbon and graphite fibres and PTFE (polytetra fluoroethylene).
- Reuse*
- Encapsulate existing asbestos material by sealing with paint or an epoxy product or cover the material with paneling or other non-asbestos product. The Workers' Safety and Compensation Commission, Chief Medical Officer of Health and your Regional Environmental Health Officer must be consulted prior to encapsulating or sealing existing asbestos material.
 - Friable asbestos materials should never be reused for any purpose once it has been removed. Non-friable asbestos materials (i.e. asbestos cementous board) can only be re-used if it remains intact and unbroken. This will extend the life of the product and reduce replacement costs.

Public and commercial building and home owners should keep an inventory of asbestos material so as to inform users, contractors and regulatory and municipal authorities in the event of renovation or demolition activities or an emergency (i.e. fire).

3.2 Handling and Removal

The safe handling and removal of asbestos requires a thorough understanding of the potential risks and knowledge of abatement measures. As long as the asbestos fibres remain enclosed or tightly bound in the material, the fibres will not be released to the air and there is no significant health risk. However, asbestos materials that are disturbed, broken or removed can result in the release of fibres if adequate safety measures are not in place. Unfortunately, simply looking at the material may not confirm whether asbestos is present. If in doubt, have the material analyzed by a qualified person.

Homeowners should contact the Chief Medical Health Officer or Regional Environmental Health Officer before handling material that contains asbestos. Check the material regularly for any sign of damage or wear and have renovations or asbestos removal carried out by a trained and qualified person.

² Source – Canadian Council of Ministers of the Environment.

The *Asbestos Safety Regulations* provide employers with specific requirements for the safe handling of asbestos in the workplace. The *Regulations* require that employers:

- Provide workers with protective respiratory equipment, clothing and eye protection.
- Enclose the work area and ventilate the air using filtering equipment.
- Post warning signs and notices.
- Soak the asbestos material through its entire thickness with water during its removal to minimize release of asbestos fibres.
- Thoroughly clean the work area each day.
- Place all asbestos material and debris in clearly labeled, sealed and airtight containers.
- Provide training to workers in the use of protective equipment, the safe handling and disposal of asbestos waste and health information on the potential effects of asbestos exposure.
- Pay and arrange for a medical examination upon the written request of a worker involved in handling and disposing of asbestos materials and waste.

Employers should consult the *Asbestos Safety Regulations* in order to obtain a complete description of the regulatory requirements. A consolidated copy of the current *Regulations* is provided in Appendix 2. The authoritative text can be obtained by contacting the Workers' Safety and Compensation Commission or by downloading a copy from the Department of Justice web site at <http://www.justice.gov.nu.ca/apps/search/docSearch.aspx>.

The handling and removal of asbestos should only be undertaken by trained and qualified persons. The names of qualified asbestos abatement companies can be obtained by contacting the Workers' Safety and Compensation Commission or the waste management exchanges and associations listed in Appendix 10 of the *Environmental Guideline for the General Management of Hazardous Waste*.

3.3 Storage

Storage refers to the maintenance of waste asbestos while awaiting its transport and disposal. Storage is not acceptable for the long-term management of waste asbestos except under extraordinary circumstances and should be considered as a temporary measure only.

Waste asbestos should be stored in the following manner:

- Store wet waste asbestos in airtight, non-leaking plastic or 16 gauge steel drums. Dry asbestos can be stored in 6 mil plastic bags sealed within non-reusable drums or a second 6 mil plastic bag. Containers should be tightly sealed when not in use to prevent release of asbestos fibres.
- Each container must be clearly labeled "ASBESTOS" in accordance with the *Asbestos Safety Regulations*. If waste asbestos is being stored in an institutional, commercial or industrial location or if the asbestos is being stored for transport, the containers must also be labeled in accordance with the *Workplace Hazardous Materials Information System* (WHMIS) and relevant Transport Authority.
- Place all labeled containers in a secure and clearly marked area.
- Containers should be located so as to be protected from the sun, weather and physical damage.
- Workers must be trained in the safe handling and shipping for waste asbestos, have access to material safety data sheets and be provided with personal protective equipment. Only trained personnel should have access to the designated storage area.

If a commercial facility is used to store hazardous waste for periods of 180 days or more or the quantity of asbestos and other waste on-site at any one time exceeds the criteria set out in the *Environmental Guideline for the General Management of Hazardous Waste*³, the facility must be registered with the Department of Environment as a hazardous waste management facility. Copies of registration forms are available at <http://env.gov.nu.ca/programareas/environmentprotection/forms-applications> or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

3.4 Transportation

Friable waste asbestos should never be transported in bulk, but in storage containers as described in section 3.3 of the Guideline. The waste should be properly secured and transported within an enclosed vehicle or covered with a tarpaulin or net if transported in a vehicle that is not enclosed. A compaction type waste haulage vehicle must never be used to transport friable asbestos waste. Asbestos waste that is non-friable (i.e. asbestos that is immersed or fixed in a natural or artificial binder) does not need to be specially packaged for transport and disposal.

Under the federal *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*, no person may transport hazardous waste in Canada for the purpose of disposal or recycling in a quantity greater than five litres or five kilograms unless it is accompanied by a completed manifest. Manifest forms are available from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further information on manifesting can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste* or Environment Canada's *User's Guide for the Hazardous Waste Manifest*.

Friable waste asbestos is classified as a Class 9 Miscellaneous Waste by the *Transportation of Dangerous Goods Act*. The classification, packaging, labeling and placarding of this waste must conform to the federal and territorial *Transportation of Dangerous Goods Act* and *Regulations*. Schedule I of the *Regulations* classifies waste asbestos as follows:

Shipping Name:	WASTE Asbestos Blue (crocidolite)
	Classification: 9
	Product Identification Number: UN2212
	Packing Group: II
Shipping Name:	WASTE Asbestos Brown (amosite, mysorite)
	Classification: 9
	Product Identification Number: UN2212
	Packing Group: II
Shipping Name:	WASTE Asbestos White (chrysotile, actinolite, anthophyllite, tremolite)
	Classification: 9
	Product Identification Number: UN2590
	Packing Group: III

³ The criterion for Class 9 Miscellaneous Waste is 1000 kilograms or litres and the total aggregate quantity is 5000 kilograms or litres.

Non-friable asbestos is not a hazardous waste and does not need to be accompanied by a manifest.

The transport of waste asbestos by air must conform to the *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization (ICAO) Technical Instructions*, while transport by marine must conform to the *International Marine Dangerous Goods Code*. Further information on transporting these materials can be obtained by contacting Transport Canada or by referring to the appropriate Transport Authority.

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. A unique registration number is assigned to each registrant through the registration process, which enables completion of the manifest document. Copies of registration forms are available at <http://env.gov.nu.ca/programareas/environmentprotection/forms-applications> or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

A listing of hazardous waste carriers, receivers and management facilities registered to operate in Nunavut is available by contacting Nunavut's Department of Environment.

3.5 Disposal

Friable waste asbestos may be disposed of at a municipal landfill site in Nunavut provided that authorization and approval has first been obtained from the local municipal government. The local municipal government must be registered with Nunavut's Department of Environment as a hazardous waste receiver before accepting the waste.

Upon arrival at the landfill site, the waste asbestos should immediately be buried and covered with at least 30 centimetres (one foot) of soil to ensure further direct contact with people and heavy equipment is avoided. Care should be taken to ensure the asbestos containment (i.e. plastics bags) is not broken or ruptured while being covered. A final cover of at least 60 centimetres (two feet) of soil should be placed over the waste asbestos within 24 hours. The excavation site should be separate from other disposal or burning activities and a sign erected so the asbestos is never disturbed. A detailed map or drawing of the excavation site location should also be maintained by the local municipal government for future reference.

Where friable asbestos is being unloaded for the purpose of disposal, the unloading must be carried out so that no loose asbestos waste or punctured, broken or leaking containers are landfilled. Any friable asbestos that is in a punctured, broken or leaking container must be repackaged in drums or two 6 mil plastic bags prior to its disposal.

Where local disposal of friable waste asbestos is not available, the asbestos should be transported for disposal by a registered hazardous waste carrier to a receiver or management facility that is registered to operate in Nunavut. A listing of hazardous waste carriers, receivers and management facilities is available by contacting Nunavut's Department of Environment. A listing of receivers and management facilities authorized to accept waste asbestos in other territories and provinces can be obtained by contacting the environment department in that jurisdiction or the Canadian waste exchanges and associations found in Schedule 10 of the *Environmental Guideline for the General Management of Hazardous Waste*.

Conclusion

Asbestos is a commercial term given to a group of fibrous silicate minerals that occur naturally in the environment. Because of its unique and unusual properties, asbestos has been used over the years in the manufacture of a wide range of products. These products include building materials, friction products, heat resistant insulation, fabrics, packaging, gaskets and various coatings. During the 1980s the human health and safety risks associated with asbestos started to become known. As a result, the use of asbestos was banned or phased out throughout North America. However, a variety of asbestos products may still be found when older buildings are being renovated or demolished, or when repairs are being carried out on older vehicles and electrical appliances. The *Environmental Guideline for Waste Asbestos* is an introduction to the management of asbestos. It provides information on the characteristics of asbestos, its possible effects on the environment and human health and guidance on its proper storage, handling and removal, transportation and disposal.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of waste asbestos to comply with all applicable federal and territorial legislation and municipal by-laws. The management of waste asbestos may also be controlled through permits and licenses issued by Nunavut's co-management boards, Indian and Northern Affairs Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of waste asbestos, or to obtain a listing of available guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729

Fax: (867) 975-7739

Email: EnvironmentalProtection@gov.nu.ca

Website: <http://env.gov.nu.ca/programareas/environmentprotection>

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Krytiuk Specialty Contracting Inc. What is Asbestos Webpage.

<http://ksccanada.com/21.html>

APPENDICES

APPENDIX 1 - ENVIRONMENTAL PROTECTION ACT

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
 - (a) endangers the health, safety or welfare of persons,
 - (b) interferes or is likely to interfere with normal enjoyment of life or property,
 - (c) endangers the health of animal life, or
 - (d) causes or is likely to cause damage to plant life or to property;

"Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

"Environment" means the components of the Earth and includes

- (a) air, land and water,
- (b) all layers of the atmosphere,
- (c) all organic and inorganic matter and living organisms, and
- (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

"Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

- 2.2 The Minister may
 - (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
 - (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
 - (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
 - (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:
3.
 - (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.
 - (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.
5.
 - (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.
 - (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
 - (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
 - (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
 - (c) the contaminant was discharged from the exhaust system of a vehicle;

- (d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
- (e) the discharge of the contaminant resulted from burning for land clearing or land grading;
- (f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
- (g) the contaminant was discharged for the purposes of combating a forest fire;
- (h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
- (i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

- 5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
- (a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
 - (b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
 - (c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.
6. (1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.
7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.
- (2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – SAFETY ACT: ASBESTOS SAFETY REGULATIONS

This consolidation is not an official statement of the *Asbestos Safety Regulations*. It is a current consolidation prepared for convenience of reference only. The authoritative text of the *Regulations* should be obtained from the Northwest Territories and Nunavut Workers' Safety and Compensation Commission.

1. In these regulations,

"Asbestos" means crocidolite, amosite, chrysotile, fibrous anthophyllite, tremolite, actinolite or any mixture containing any of these minerals;

"Asbestos dust" means dust consisting of or containing asbestos fibres;

"Asbestos process" means the handling of materials containing asbestos and includes:

- (a) sawing, cutting, sanding or spraying materials,
- (b) repair or maintenance of materials,
- (c) cleaning or disposal of materials,
- (d) mixing or applying asbestos shorts, cements, grouts, putties or similar compounds,
- (e) storage or conveyance of materials.

2. These regulations apply to every establishment.

3. No person shall use crocidolite in any asbestos process.

4. No person shall apply, by spraying, insulation materials containing asbestos.

5. (1) An employer conducting an asbestos process shall:

- (a) provide each worker who may be exposed to asbestos with respiratory equipment designed for use in asbestos processes and that has been approved by the Canadian Standards Association;
- (b) provide each worker who may be exposed to asbestos with dustproof coveralls, gauntlets, eye protection and headgear;
- (c) ensure that, at all times during the asbestos process, ventilation and air filtering equipment is in operation and removing asbestos dust from the air;
- (d) enclose the work area to prevent the escape of asbestos dust;
- (e) post warning notices in prominent places indicating that an asbestos process is in progress;
- (f) ensure that, prior to disturbing any asbestos surface, the asbestos is soaked with water through its entire thickness;
- (g) where a safety officer is of the opinion that it is not practicable to comply with the requirements in paragraph (d), ensure that any asbestos surface is kept wet as it is being disturbed;
- (h) clean the work area surrounding an asbestos process thoroughly each day by vacuum equipment or a wet cleaning method approved by a safety officer; and
- (i) ensure that all asbestos materials, debris and dust are placed in sealed, airtight containers and clearly labeled "ASBESTOS".

(2) A safety officer may, in writing, exempt an employer from the requirements of paragraph 1(a) where the safety officer is of the opinion that the nature of the asbestos process is such that the employer cannot, practically, comply with the requirements.

(3) An employer providing equipment under subsection (1) shall dispose of the equipment after use or shall remove all traces of asbestos dust and shall store the equipment in an airtight container.

6. An employer conducting an asbestos process shall provide the following training to any worker who is likely to come in contact with asbestos:
 - (a) demonstration and instruction in the use of all protective equipment;
 - (b) the safe handling and proper disposal of waste asbestos;
 - (c) health education including information relating to pneumoconiosis, lung cancer, mesothelioma and the effects of smoking; and
 - (d) any other information a safety officer considers necessary.
7.
 - (1) Where an employer uses ventilation and air filtering equipment, the employer shall inspect and clean the equipment weekly.
 - (2) A safety officer may designate a person in the workplace to inspect any ventilation and air filtering equipment yearly to report to the employer on the condition of the equipment and the need for repair.
 - (3) An employer receiving a report recommending repair under subsection (2) shall complete the recommended repairs within 30 days of receipt of the report.
8. No person shall employ a minor where an asbestos process is being conducted unless
 - (a) the process is conducted under constant supervision; and
 - (b) the process has been inspected and approved by a safety officer.
9.
 - (1) Within 30 days of receipt of a written request for a medical examination by a worker involved in an asbestos process, an employer shall arrange and pay the full cost of an examination by a physician.
 - (2) The employer shall make arrangements for a medical examination that includes:
 - (a) a complete physical examination with special attention to the respiratory system;
 - (b) lung function tests including forced vital capacity and forced expiratory volume at one second; and
 - (c) any medical procedures considered necessary by the examining physician for the diagnosis of asbestos related illness.
 - (3) Upon written request by the Minister, a physician who has conducted an examination under subsection (2) shall provide the Minister with a report containing all information resulting from the examination.
 - (4) Every report provided under subsection (3) is a privileged communication of the person making it.

APPENDIX 3 – ASBESTOS CONTAINING MATERIALS

The following products have in the past been manufactured using asbestos. If in doubt, confirm with the product's manufacturer as to whether it is asbestos-free.

- Acoustical Plaster
- Base Flashing
- Breaching Insulation
- Cement Pipes
- Chalkboards
- Ductwork
- Electrical Panel Partitions
- Fire Blankets
- Fireproofing Materials
- Heating and Electrical Ducts
- Joint Compounds
- Packing Materials
- Roofing Shingles
- Taping Compounds (thermal)
- Wallboard
- Vinyl Floor Tile
- Adhesives
- Blown-in Insulation
- Caulking and Putties
- Cement Siding
- Construction Mastics and Adhesives
- Electrical Wiring Insulation
- Elevator Brake Shoes
- Fire Curtains
- Flexible Fabric Connections
- High Temperature Gaskets
- Laboratory Gloves
- Pipe Insulation
- Spackling Compounds
- Textured Paints and Coatings
- Vinyl Sheet Flooring
- Cooling Towers
- Asphalt Floor Tile
- Boiler Insulation
- Ceiling Tiles
- Cement Wallboard
- Decorative Plaster
- Electrical Cloth
- Elevator Equipment Panels
- Fire Doors
- Flooring Backing
- HVAC Duct Insulation
- Laboratory Hoods and Table Tops
- Roofing Felt
- Spray-Applied Insulation
- Thermal Paper Products
- Vinyl Wall Coverings

Source - Krytiuk Specialty Contracting Inc.

APPENDIX 4 – GOVERNMENT AND INDUSTRY CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Motor Vehicles Division
Department of Economic Development and
Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free)
Fax: 1-866-979-8501

Department of Community and Government
Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine
Fax: (204) 983-1734 Air

Industry

National Demolition Association
16 N. Franklin Street, Suite 203
Doylestown, Pennsylvania USA 18901-3536
Telephone: (215) 348-4949 Fax (215) 348-8422
Website: <http://www.demolitionassociation.com>

Environmental Guideline for Ozone Depleting Substances



Department of Environment
Government of Nunavut

GUIDELINE: OZONE DEPLETING SUBSTANCES

Original: January 2002

Revised: April 2011

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act*.

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with ozone depleting substances. This Guideline does not replace the need for the owner or person in charge, management or control of ozone depleting substances to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of these substances.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut

P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0

Electronic version of the Guideline is available at <http://env.gov.nu.ca/programareas/environmentprotection>

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Introduction

A layer of colourless gas known as “ozone” surrounding the earth helps to filter the sun’s harmful ultraviolet radiation from reaching the planet’s surface. This layer is located in the stratosphere eight to ten kilometres above the earth. Scientific evidence shows that this ozone is being destroyed, and therefore this protective layer is becoming thinner, because of manufactured chlorofluorocarbons, halons and other similar substances being released into the air. These substances are commonly referred to as ‘ozone depleting substances’.

As one of the early signatories to the *Montreal Protocol on Substances that Deplete the Ozone Layer*, Canada is committed to protecting the earth’s ozone layer from further deterioration. The Protocol, developed in 1989 under the auspices of the United Nations Environmental Programme, provides a coordinated international response to the global problem of ozone depletion.

Canada’s *National Action Plan for the Environmental Control of Ozone Depleting Substances and their Halocarbon Alternatives* was initially endorsed in 1998 through the Canadian Council of Ministers of the Environment (CCME) in response to Canada’s commitments under the Montreal Protocol. The Action Plan is a national framework under which federal, provincial and territorial governments commit to implementing an ozone layer protection program focused on chlorofluorocarbons. The Action Plan was updated in 2001 to include all ozone depleting substances.

The original *Environmental Guideline for Ozone Depleting Substances*, which was approved by the Government of the Northwest Territories in 1999 and subsequently adopted by the Government of Nunavut in 2002, represented the Government’s initial response to the National Action Plan. This version of the *Environmental Guideline for Ozone Depleting Substances* (the Guideline) provides updated information on the most common ozone depleting substances and their replacements, the impacts of ozone depletion and best practices respecting the phase-out, recovery, reuse and disposal of these substances. It focuses on the refrigeration, air conditioning and fire protection sectors, although ozone depleting substances have been used by many other sectors in Canada. The Guideline does not address the production, import or export of new or recovered ozone depleting substances as these activities are controlled under regulations administered by Environment Canada. It is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of an ozone depleting substance is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the management of these substances.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister with authority to develop, coordinate, and administer the Guideline.

1.1 Definitions

<i>Air Conditioning and Refrigeration Equipment</i>	Equipment used to remove heat from one medium or another using an inert gas (i.e. ozone depleting substance). The Equipment may be stationary (i.e. building air conditioner, commercial or household refrigerator) or mobile (i.e. vehicle air conditioner).
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<i>Certified Service Technician</i>	A person who is qualified to service air conditioning, refrigeration or fire extinguishing equipment through the successful completion of an environmental awareness course for ozone depleting substances approved by Environment Canada.
<i>Commissioner's Land</i>	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.
<i>Contaminant</i>	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.
<i>Dangerous Good</i>	Any product, substance or organism included by its nature or by the <i>Transportation of Dangerous Goods Regulations</i> in any of the classes listed in the schedule provided in the <i>Transportation of Dangerous Goods Act</i> .
<i>Environment</i>	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
<i>Fire Extinguishing Equipment</i>	A handheld, wheeled or fixed unit or system that is designed to control or extinguish a fire.
<i>Minister</i>	The Minister of Environment of the Government of Nunavut.
<i>Motor Vehicle Air Conditioner</i>	A mechanical vapour compression refrigerant system on a motor vehicle that is designed to provide cooling for the passenger compartment.
<i>Ozone</i>	A colourless gas containing three atoms of oxygen (O ³). In the upper atmosphere, ozone absorbs ultraviolet radiation thereby preventing the radiation from reaching the surface of the earth. In the lower atmosphere (i.e. near the surface of the earth), ozone is one of the detrimental component of urban smog.
<i>Ozone Depleting Substance</i>	A chlorofluorocarbon, hydrochlorofluorocarbon, halon or other substance that is sufficiently stable to reach the stratosphere and has the potential of reacting with and destroying ozone.
<i>Qualified Person</i>	A person who has an appropriate level of knowledge and experience in all relevant aspects of waste management.

<i>Reclamation</i>	The cleaning of recovered ozone depleting substances by filtering, drying, distillation or chemical treatment to meet or exceed industry-accepted reuse standards.
<i>Recovery</i>	The transfer of an ozone depleting substance into a container that is not part of the system from which the substance is transferred.
<i>Recycle</i>	The reuse of recovered ozone depletion substances by transferring the substance back into similar equipment after servicing.
<i>Refillable Container</i>	A container that meets the requirements of Transport Canada and is approved for multiple use.
<i>Responsible Party</i>	The owner, vendor or service technician in charge, management or control of the ozone depleting substance.
<i>Servicing</i>	Repairing, maintaining or adjusting a component of air conditioning, refrigeration or fire extinguishing equipment.
<i>Transport Authority</i>	The statute and regulations controlling the management of hazardous waste under that mode of transport. These include (a) Road and Rail - <i>Transportation of Dangerous Goods Act (Canada) and Regulations; Interprovincial Movement of Hazardous Waste Regulations and Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations.</i> (b) Air – <i>International Air Transport Association (IATA) Dangerous Goods Regulations and International Civil Aviation Organization (ICAO) Technical Instructions; and</i> (c) Marine – <i>International Maritime Dangerous Goods Code (IMDG).</i>

1.2 Roles and Responsibilities

1.2.1 Department of Environment

The Environmental Protection Division is the key territorial government agency responsible for ensuring parties properly manage ozone depleting substances. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Department of Environment or by visiting the web site at:

<http://env.gov.nu.ca/programareas/environmentprotection>.

1.2.2 Owners, Wholesalers, Retailers and Service Technicians

Owners, wholesalers, retailers and service technicians in charge, management or control of an ozone depleting substance are considered to be the responsible party. The responsible party must ensure the substance is properly and safely managed from the time it is purchased to its final destruction so as to prevent its release to the environment.

Building, equipment and vehicle owners need to be aware of the presence of ozone depleting substances in their air conditioning, refrigeration and fire extinguishing equipment. Equipment that may be leaking or discharging these substances into the air must immediately be taken out of service, the leak stopped and the discharge reported to the Nunavut/NWT 24-Hour Spill Report Line at (867) 920-8130 (refer to table 3 on page 11 of the Guideline). Owners may also be affected by the phase-out of ozone depleting substances in Canada and should develop a plan for replacing the ozone depleting substance with an acceptable alternative.

Wholesalers and retailers of ozone depleting substances, other than where the substance is an integral part of the equipment, should sell replacement substances only to companies that employ certified service technicians.

A service technician may become certified by successfully completing an environmental awareness course for ozone depleting substances that is approved by Environment Canada. Only certified service technicians should maintain and repair air conditioning, refrigeration and fire extinguishing equipment that contain ozone depleting substances. Technicians should immediately advise the owner when they become aware of leaking equipment and the equipment must not be refilled or put back into service until the necessary repairs are completed.

Contractors may manage ozone depleting substances on behalf of the responsible party. However, the responsible party remains liable for ensuring the method of management complies with all applicable statutes, regulations, standards, guidelines and local by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing the ozone depleting substance, the responsible party may also be charged.

1.2.3 Other Regulatory Agencies

Other regulatory agencies may have to be consulted regarding the management of ozone depleting substances as there may be other environmental or public and worker health and safety issues to consider.

Environment Canada

Environment Canada is responsible for controlling the import, manufacture, use in some cases, sale and export of ozone depleting substances through the federal *Ozone-depleting Substances Regulations* and *Federal Halocarbon Regulations* which have been adopted under the *Canadian Environmental Protection Act*. Environment Canada is also responsible for regulating the international and interprovincial movement of hazardous waste under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*.

Department of Community and Government Services

The Office of the Fire Marshal in the Department of Community and Government Services is responsible under the *Fire Prevention Act*, National Fire Code and National Building Code for ensuring adequate fire prevention and response measures are in place. The Department, in cooperation with communities, is also responsible for the planning and funding of municipal solid waste and sewage disposal facilities in most Nunavut communities.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers.

Department of Health and Social Services

Activities related to the management of ozone depleting substances may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act*.

Department of Economic Development and Transportation

The Motor Vehicles Division is responsible for ensuring the safe transport of hazardous waste and other dangerous goods by road through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and road safety matters.

Local Municipal Governments

The role of municipal governments is important in the proper local management of unwanted ozone depleting substances and equipment and vehicles that contain these substances. Under the Nunavut Land Claims Agreement, municipalities are entitled to control their own municipal disposal sites. Unwanted waste may be deposited into municipal landfill sites only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and disposal of ozone depleting substances may be controlled through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board and other co-management boards and agencies.

Characteristics and Impacts of Ozone Depleting Substances

2.1 Characteristics

Ozone depleting substances generally contain a combination of chlorine, fluorine, bromine, carbon and hydrogen and are often referred to by the general term 'halocarbons'. Although each has its own unique chemical characteristics, ozone depleting substances are described as having low toxicity, low boiling points and low flammability. These characteristics have resulted in their wide use as refrigerants, fire extinguishing agents, blowing agents in manufacturing foam, propellants in aerosols and medical applications, and degreasing solvents.

Many halocarbons are highly effective in breaking down ozone. Unlike many other substances that are released into the atmosphere, ozone depleting substances are not 'washed' back to Earth by precipitation or destroyed by other chemicals but can remain in the atmosphere for several decades or more. This enables the substances to drift upward into the stratosphere where ultraviolet radiation from the sun releases the chlorine or bromine atoms which, in turn, destroy stratospheric ozone. Many ozone depleting substances are also powerful greenhouse gases with a much higher potential to enhance the greenhouse effect than carbon dioxide and methane.

Table 1 describes the characteristics of many common ozone depleting substances.

Ozone depleting substances are broadly grouped into the following categories, depending upon their molecular structures.

<i>Chlorofluorocarbons</i>	Chlorofluorocarbons, or CFCs, contain chlorine, fluorine and carbon atoms. First developed in the 1920s, they began to replace ammonia as a refrigerant gas in the 1930s and as an aerosol propellant in the 1940s. By the 1980s they were widely used as coolants in refrigerators and air conditioners, solvents in degreasers and cleaners, and as blowing agents in the production of foam.
<i>Halons</i>	Halons contain bromine, chlorine, fluorine and carbon atoms. The characteristics of halons make them very effective for extinguishing fires and are suitable for all types of fire extinguishing equipment ranging from industrial total flooding equipment to hand-held fire extinguishers popular for home or office use.
<i>Hydrochlorofluorocarbons</i>	Hydrochlorofluorocarbons, or HCFCs, contain chlorine, fluorine, hydrogen and carbon atoms. HCFCs have been developed for use as transitional or temporary replacements for CFCs because the hydrogen atom makes them less stable and therefore less damaging to the ozone layer. HCFCs are used mainly for foam blowing, refrigeration and air conditioning, solvent cleaning and, to a lesser extent, aerosols and fire protection.

Table 1.

		Classification under Transportation of Dangerous Goods Regulations	ODP^a	GWP^b	Life Time^c
Chlorofluorocarbons (CFC's)					
CFC-11	Trichlorofluoromethane	Not restricted under TDG	1.0	4600	45
CFC -12	Dichlorofluoromethane	UN 1029 Class 2.2 Non-flammable Gas	1.0	10600	100
CFC-113	Trichlorofluoroethane	Not restricted under TDG	0.8	6000	85
CFC-114	Dichlorotetrafluoroethane	Not restricted under TDG	1.0	9800	300
CFC-115	Chloropentafluoroethane	UN 1020 Class 2.2 Non-flammable Gas	0.6	7200	1700
All other chlorofluorocarbons		Consult TDGA for classification			
Halons (Bromofluorocarbons)					
Halon 1011	Bromochloromethane	Un 1887 Class 6.1 Toxic Substance	0.12	-	-
Halon 1211	Bromochlorodifluoromethane	Not restricted under TDG	3.0	1300	11
Halon 1301	Bromotrifluoromethane	Un 1009 Class 2.2 Non-flammable Gas	10.0	6900	65
Halon 2402	Dibromotetrafluoroethane	Not restricted under TDG	6.0	-	-
All other halons		Consult TDGA for classification			
Hydrochlorofluorocarbons (HCFC's)					
HCFC-22	Chlorodifluoromethane	Un 1018 Class 2.2 Non-flammable Gas	0.055	1700	11
HCFC-123	Dichlorotrifluoroethane	Not restricted under TDG	0.02	-	1
HCFC-124	Chlorotetrafluoroethane	UN 3297 Class 2.2 Non-flammable Gas	0.022	620	6
HCFC-141b	Dichlorofluoroethane	Not restricted under TDG	0.11	700	9
HCFC-142b	Chlorodifluoroethane	Not restricted under TDG	0.065	2400	18
HCFC-225ca	Dichloropentafluoropropane	Not restricted under TDG	0.025	-	2
HCFC-225cb	Dichloropentafluoropropane	Not restricted under TDG	0.033	-	6
All other hydrochlorofluorocarbons		Consult TDGA for classification			

- a. 'Ozone Depleting Potential' is a measure of the capability of a chemical to destroy ozone. It is measured against CFC-11 which has an ozone depleting potential of one (1.0). As an example, one molecule of Halon 1301 has the potential to destroy ten times more ozone than one molecule of CFC-11.
- b. 'Global Warming Potential' is a measure of the warming effect that the emission of a gas has on the atmosphere. It is measured as a factor relative to carbon dioxide (CO₂) which has a global warming potential of one (1.0). As an example, one molecule of CFC-11 has the potential to warm the atmosphere 4600 times more than one molecule of carbon dioxide.
- c. 'Life time' is the number of years it takes for the substance to break down in the lower atmosphere.

2.2 Impacts

Ozone is very effective in absorbing ultraviolet radiation in the stratosphere. Its depletion, or thinning, allows more of this high-energy radiation to reach the Earth's surface. Releases of halocarbons, particularly chlorofluorocarbons and halons, enable photochemical reactions¹ to take place in the stratosphere that destroy the ultraviolet radiation-shielding layer of ozone.

Increased exposure to ultraviolet radiation by humans can lead to an increase in sunburn, skin cancer, eye cataracts, weakening of the immune system and aging of the skin (i.e. the skin becomes drier and

¹ The most important reaction is the photo-induced breaking of the carbon-chlorine or carbon-bromine bond. Once released, the radical chlorine and bromine atoms catalyze the conversion of ozone (O₃) into oxygen (O₂).

looses elasticity). Ecosystem impacts can also occur. This begins at the bottom of the food chain where plankton populations in the ocean have been reduced by increased ultraviolet radiation. Damage and impacts to vegetation, food crops, wildlife and domestic animals can also occur.

The atmospheric impact of ozone depleting substances is not limited solely to the reduction of ozone. Many of these substances are also powerful greenhouse gases with much higher 'global warming potentials' than carbon dioxide and methane.

The Management of Ozone Depleting Substances

Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.²

In the past, the refrigeration, air conditioning and fire protection sectors have incorporated ozone depleting substances as critical components in their equipment and processes. Although a large portion of Canada's ozone depleting substances consumption has been eliminated in recent years, a significant quantity remains in use or storage. Many of the same ozone depleting substances used by the commercial, industrial and institutional sectors were also used in domestic applications (i.e. household refrigerators, freezers, vehicle air conditioners). An inventory completed for the Government of the Northwest Territories in 1992 confirmed that approximately three-quarters of the ozone depleting substances in use in the Northwest Territories and Nunavut at that time were accounted for by the commercial, industrial and institutional sectors. As a result, this section focuses on the use of ozone depleting substances by the commercial, industrial and institutional refrigeration, air conditioning and fire extinguishing sectors in Nunavut. References are made to domestic sector use where appropriate.

3.1 Phase-out Objectives and Approaches

The overall strategy in Canada has been to eliminate the manufacture, import and export of ozone depleting substances and to phase-out their sale and use as suitable replacements become available. Several substances have been identified as being suitable replacements for chlorofluorocarbons in refrigeration and air conditioning equipment including hydrochlorofluorocarbons and hydrofluorocarbons. Unfortunately, these replacements are not totally benign (i.e. some are very powerful greenhouse gases) and an active approach to controlling their sale and use continues to be necessary.

Under the federal *Ozone-depleting Substances Regulations*, no person may use, sell or offer for sale halons in Canada. The Nunavut Office of the Fire Marshal should be consulted on suitable replacements for halon systems when the servicing, recharging or replacement of existing equipment is being considered³.

Table 2 describes the phase-out objectives and approaches that apply to these ozone depleting substances in refrigeration, air conditioning and fire extinguishing equipment in Nunavut along with their primary replacement, hydrochlorofluorocarbons. The phase-out objectives and approaches described in the table are consistent with those outlined in *Canada's Strategy to Accelerate the Phase-Out of CFC and Halon Uses and to Dispose of Surplus Stocks 2001* and the federal *Ozone-depleting Substances Regulations*.

² Source – Canadian Council of Ministers of the Environment.

³ The United States Environmental Protection Agency periodically updates a list of acceptable alternatives to halons and other ozone depleting substances. The listing can be downloaded at <http://www.epa.gov/ozone/snap/lists/index.html#halons>.

Table 2. Phase-out Objectives

Objective	Phase-Out Date
Refilling or replacement of chlorofluorocarbon-containing small (< 5 horsepower), medium, (5-30 horsepower) and large (>30 horsepower) commercial, industrial or institutional refrigeration and air conditioning equipment with a suitable alternative.	September 2011 or next service
Refilling or replacement of chlorofluorocarbon-containing mobile air conditioning equipment with a suitable alternative.	September 2011 or next service
Refilling or replacement of chlorofluorocarbon-containing mobile commercial and industrial refrigeration and chiller equipment with a suitable alternative.	September 2011 or next service
Refilling or replacement of halon-containing handheld or wheeled fire extinguishing equipment with a suitable alternative, except for critical uses ^a .	September 2011 or next service
Refilling or replacement of halon-containing fixed fire extinguishing equipment with a suitable alternative, except for critical uses ^a .	September 2011 or next service
Use and sale of hydrochlorofluorocarbons, except dichlorotrifluoroethane (HCFC-123).	January 2020
Use and sale of dichlorotrifluoroethane (HCFC-123).	January 2030

a. 'Critical use' for halons only include fire extinguishing equipment in military equipment.

3.2 Releases to the Environment

Ozone depleting substances must not be released to the environment. Equipment owners, managers and service technicians should be made aware of the environmental and human health impacts of ozone depleting substance emissions and the use of alternatives. To prevent releases from occurring, compressors, condensers, evaporators, piping and all associated equipment fitted to them need to be thoroughly inspected according to manufacturers' specifications, or at least twice each year if no specifications exist. These inspections should be incorporated into the facilities' regular maintenance plan.

Leaking equipment must not be 'recharged' with an ozone depleting substance until all necessary repairs have been completed by a certified service technician.

Spills or releases of ozone depleting substances must be immediately reported to the Nunavut/NWT 24-Hour Spill Report Line by phoning (867) 920-8130 in accordance with Schedule B of the *Spill Contingency Planning and Reporting Regulations*. Table 3 describes the minimum reportable quantities for ozone depleting substances as described in Schedule B.

Table 3. Minimum Reportable Quantities Following a Release

Ozone Depleting Substance	Minimum Reportable Quantity
CFC-12, CFC-15, HCFC-22, HCFC-124, Halon 1301 ^a	Any release from a container with a capacity greater than one hundred (100) litres
Halon 1011 ^b	5 litres or 5 kilograms
All other ozone depleting substances	100 litres or 100 kilograms

a. Transportation of Dangerous Goods Class 2.2 Non-flammable Gas

b. Transportation of Dangerous Goods Class 6.1 Toxic Substance

3.3 Recovery, Reclamation and Disposal

Table 2 describes the phase-out objectives of ozone depleting substances currently in use in Nunavut. Owners of fire extinguishing equipment and commercial, industrial or institutional mobile and stationary refrigeration and air conditioning equipment should either replace existing chlorofluorocarbons and halons with acceptable alternatives by September 2011 or during the next scheduled equipment service, or provide the Department of Environment with a suitable phase-out plan for the substance.

3.3.1 Stationary Refrigeration and Air Conditioning Systems

All compressor rooms housing stationary refrigeration and air conditioning systems should have refrigerant detectors and alarms installed in accordance with the Canadian Standards Association publication *B-52 – Mechanical Refrigeration Code* to detect refrigerant leaks and emissions. A refrigerant level greater than 10 parts per million in the compressor room is an indication that one or more of the systems is leaking. While refrigerant alarms are important, they are not substitutes for the physical leak testing of the system itself, which should take place a minimum of one time each year. Leak testing should also immediately be undertaken upon finding that a refrigeration or air conditioning system appears to be short of refrigerant. Any leak must be repaired prior to the system being recharged with refrigerant or put back into service. Chlorofluorocarbons must not be used to ‘top up’ a system. Recommendations on acceptable alternative refrigerants should be sought from the equipment’s manufacturer.

Refrigerant must be recovered during the servicing of equipment to avoid its venting or release to the atmosphere. All recovery equipment should meet the Air-Conditioning, Heating and Refrigeration Institute (AHRI) *Standard 740 – Refrigerant Recovery/Recycling Equipment* or the Underwriters’ of Canada (ULC) *Standard C1058.5-2004 - Halon and Halocarbon Clean Agent Recovery and Reconditioning Equipment*.

Only refillable containers may be used to store recovered refrigerants. These containers are less likely to leak and their use eliminates emissions caused by the disposal of throwaway or recyclable containers. All containers must meet the specifications listed in the *Transportation of Dangerous Goods Act* and be labeled in accordance with the *Workplace Hazardous Materials Information System* (WHMIS).

The venting or release of refrigerants to the atmosphere for the purposes of disposal is unacceptable. Chlorofluorocarbons that are recovered from equipment must be returned to the original supplier, an independent reclaimer or licensed disposal facility for destruction. Contact Refrigerant Management Canada⁴ (RMC) by telephone at 1-866-622-0209 or by email at rmc@hrai.ca for information on the nearest reclaimer or licensed disposal facility. Only hydrochlorofluorocarbons and hydrofluorocarbons may be reclaimed to their original properties and used to 'top up' or recharge refrigeration and air conditioning equipment.

Unwanted refrigeration and air conditioning equipment must be completely emptied of refrigerant by a certified service technician prior to its disposal. A weatherproof notice should be permanently attached to the equipment stating the date of servicing, name of the certified technician and servicing company, and a statement confirming the equipment no longer contains refrigerant. Household refrigeration and air conditioning equipment is exempt from this requirement as long as it is disposed of in a separate area of the landfill specifically set aside for the disposal of 'white goods'. Local municipal governments are encouraged to use certified service technicians to recover the refrigerant from stored 'white goods' when quantities warrant.

Additional design and service practices are described in Environment Canada's *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*.

3.3.2 Mobile Air Conditioning Systems and Chillers

The basic principles outlined in section 3.3.1 also apply to mobile air conditioners and chillers containing chlorofluorocarbons – recovery of the refrigerant during the installation, operation and servicing of equipment; avoiding the venting of refrigerants to the atmosphere; use of refillable containers to store recovered refrigerants; and servicing by certified service technicians.

Newer-model vehicle air conditioners and chillers already contain alternative non-chlorofluorocarbon refrigerants while older vehicles are likely to still contain CFC-12. The servicing of a motor vehicle air conditioner should be undertaken by a certified service technician in accordance with the Society of Automotive Engineers publication *SAE J1661 – Procedures for Retrofitting CFC-12 (R-12) Mobile Air-Conditioning Systems to HFC-134a (R-134a)* and *SAE J1989 - Recommended Service Procedure for the Containment of CFC-12 (R-12)*. Owners and service technicians should refer to the manufacturers' specifications when choosing a replacement refrigerant.

All motor vehicle air conditioning systems and chiller refrigerant must be recovered before the vehicle is wrecked or scrapped. A certified service technician who is trained in the safe handling of refrigerants should remove the refrigerant, transfer it to a suitable refillable and labeled container, and arrange to have it transported to the original supplier, an independent reclaimer or licensed disposal facility for destruction. A personal motor vehicle delivered to a landfill by its owner is exempt from this requirement as long as the vehicle is disposed of in a separate area of the landfill specifically set aside for this purpose. Local municipal governments are encouraged to use certified service technicians to recover refrigerants from discarded vehicles when quantities warrant.

⁴ RMC is a not-for-profit corporation established by the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) to ensure the responsible disposal of surplus ozone depleting substances from refrigeration and air conditioning equipment. The program is an EcoLogo™ certified program.

Additional design and service practices for mobile air conditioners and chillers are described in Environment Canada's *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*.

3.3.3 Fire Extinguishing Equipment

The basic principles outlined in section 3.3.1 also apply to halon fire extinguishing equipment - recovery of the extinguishant during servicing and decommissioning; avoiding release of halons during training and equipment testing; use of refillable containers to store recovered halons; and servicing by certified service technicians.

Owners of fire extinguishing equipment that contain halons should develop a management plan in accordance with the phase-out objectives described in Table 2. Fire extinguishing equipment may not be recharged with halons in Canada except for use in military applications. Owners should contact the Underwriters' Laboratories of Canada (ULC) for information on the nearest reclaimer or licensed disposal facility. The Office of the Fire Marshal should also be consulted on suitable replacement fire extinguishing equipment when decommissioning halon systems.

Existing halon equipment must be properly maintained for as long it remains in service in order to avoid releases to the environment and to ensure the facility or asset is not without adequate fire protection. The training of personnel and testing of equipment must not result in any release of halons. Alternative procedures, such as video demonstrations and the use of halon stimulants, should be used to achieve the same testing and training objectives.

The servicing and decommissioning of halon fire extinguishing equipment must only be undertaken by a certified service technician. All equipment and servicing procedures must comply with Underwriters' Laboratories of Canada *Standard ULC/ORD-C1058.5-2004: Halon and Halocarbon Clean Agent Recovery and Reconditioning Equipment* and the *Standard ULC/ORD-C1058.18-2004: The Servicing of Halon and Clean Agent Extinguishing Systems*.

The venting or release of halons to the atmosphere for the purposes of disposal is unacceptable and must be avoided. Should a release occur, it must immediately be reported to the Nunavut/NWT 24-Hour Spill Report Line at (867) 920-8130.

Additional design and service practices for fire extinguishing equipment containing halons are described in Environment Canada's *Environmental Code of Practice on Halons*.

3.4 Transportation

Under the federal *Ozone-depleting Substances Regulations*, any person wishing to import or export a controlled ozone depleting substance must first obtain a permit from Environment Canada. In addition, several ozone depleting substances are classified as either Class 2.2 or 6.1 dangerous goods under the *Transportation of Dangerous Goods Act* and must be transported in accordance to this Section.

Under the federal *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*, no person may transport waste dangerous goods in Canada for the purpose of disposal or recycling in a quantity greater than five kilograms or five litres unless it is accompanied by a completed manifest. Manifest forms are available

from Nunavut's Department of Environment and completion instructions are included on the reverse side of each manifest. Further information on manifesting can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste* or Environment Canada's *User's Guide for the Hazardous Waste Manifest*.

The classification, packaging, labeling and placarding of several ozone depleting substances must conform to the federal and territorial *Transportation of Dangerous Goods Act* and *Regulations* while the substances are being transported. Schedule I of the *Regulations* classify these substances as follows:

Shipping Name:	WASTE Bromotrifluoromethane; or Refrigerant Gas R-13b1 Classification: 2.2 Product Identification Number: UN1009
Shipping Name:	WASTE Chlorodifluoromethane; or Refrigerant Gas R-22 Classification: 2.2 Product Identification Number: UN1018
Shipping Name:	WASTE Chloropentafluoroethane; or Refrigerant Gas R-115 Classification: 2.2 Product Identification Number: UN1020
Shipping Name:	WASTE Dichlorofluoromethane; or Refrigerant Gas R-21 Classification: 2.2 Product Identification Number: UN1029
Shipping Name:	WASTE Bromochloromethane Classification: 6.1 Product Identification Number: UN1887 Packing Group: III
Shipping Name:	WASTE Ethylene Oxide and Chlorotetrafluoroethane Mixture Classification: 2.2 Product Identification Number: UN3297

The transport of ozone depleting substances by air must conform to the *International Air Transport Association (IATA) Dangerous Goods Regulations* and *International Civil Aviation Organization (ICAO) Technical Instructions*, while transport by marine must conform to the *International Marine Dangerous Goods Code*. Further information on transporting these substances can be obtained by contacting Transport Canada or referring to the appropriate Transport Authority.

Hazardous waste generators, carriers and receivers operating in Nunavut must be registered with the Nunavut Department of Environment. A unique registration number is assigned to each registrant through the registration process, which enables completion of the manifest document. Copies of registration forms are available at <http://env.gov.nu.ca/programareas/environmentprotection/forms-applications> or by contacting Nunavut's Department of Environment. Refer to the *Environmental Guideline for the General Management of Hazardous Waste* for additional information on the registration process.

A listing of hazardous waste carriers, receivers and management facilities registered to operate in Nunavut is available by contacting Nunavut's Department of Environment.

3.5 Certification and Awareness Training

Only certified service technicians may service refrigeration, air conditioning and fire extinguishing equipment containing an ozone depleting substance. To achieve certification, a technician must successfully complete an environmental awareness training course approved by Environment Canada. A card indicating completion of training should be carried by the certified service technician at all times. Completion of training only enables the person to handle ozone depleting substances as provided in the Guideline and is not evidence of qualifications to otherwise service refrigeration, air conditioning or fire extinguishing equipment.

Only certified service technicians may purchase or possess an ozone depleting substance for the purpose of servicing equipment that already contains an ozone depleting substance. Companies employing certified service technicians must maintain records indicating the name, training date and qualifications of employees who are certified to service ozone depleting substance-containing equipment.

3.6 Labeling and Record Keeping

Each piece of refrigeration, air conditioning and fire extinguishing equipment containing an ozone depleting substance must be permanently labeled with the quantity and type of ozone depleting substance contained within that equipment. The label must be amended if the equipment has been 'evacuated' of ozone depleting substances or if the equipment is recharged with a different refrigerant or extinguishant.

An up-to-date service record should be maintained in close proximity to equipment containing ozone depleting substances, or with the owner of the facility. The record should include servicing dates, name of servicing company and certified technician, details on leak testing and detection, quantities of substances recovered or re-charged, and any other information pertinent to the servicing, operation and maintenance of the equipment. The record must be retained for the operating life of the equipment and be made available for inspection upon the request of an Inspector appointed under the *Environmental Protection Act*.

3.7 Sales Records

Any person who sells an ozone depleting substance, except where the substance is a component of another product, should maintain a sales record indicating the type of ozone depleting substance sold, the date of sale, the name of the person who purchased the substance and the name of that person's business. Only persons who are certified service technicians should purchase ozone depleting substances, except where the substance is a component of another product.

Conclusion

The *National Action Plan for the Environmental Control of Ozone Depleting Substances and their Halocarbon Alternatives* commits federal, provincial and territorial governments to implement an ozone layer protection program focused on all ozone depleting substances. The *Environmental Guideline for Ozone Depleting Substances* represents the Government of Nunavut's updated response to the National Action Plan. The Guideline focuses on the industrial, commercial and institutional refrigeration, air conditioning and fire protection sectors, although it is recognized that ozone depleting substances can still be found in older-model household refrigerators and freezers and older-model vehicle air conditioners and chillers. The Guideline provides information on the most common ozone depleting substances and their replacement, the impacts of ozone depletion and best practices respecting the phase-out, recovery, reuse and disposal of these substances.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of ozone depleting substances to comply with all applicable federal and territorial legislation and municipal by-laws. The management of these substances may also be controlled through permits and licenses issued by Nunavut's co-management boards, Indian and Northern Affairs Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of ozone depleting substances, or to obtain a complete listing of guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729

Fax: (867) 975-7739

Email: EnvironmentalProtection@gov.nu.ca

Website: <http://env.gov.nu.ca/programareas/environmentprotection>

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Society of Automotive Engineers (SAE). J1989: Recommended Service Procedure for the Containment of CFC-12 (R-12). 1998. Available for purchase online.
http://standards.sae.org/j1989_199811

Underwriters' Laboratories of Canada. ULC/ORD-C1058.18-2004: The Servicing of Halon and Clean Agent Extinguishing Systems. Available for purchase online.

Underwriters' Laboratories of Canada. ULC/ORD-C1058.5-2004: Halon and Halocarbon Clean Agent Recovery and Reconditioning Equipment. Available for purchase online.

APPENDICES

APPENDIX 1 - ENVIRONMENTAL PROTECTION ACT

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
 - (a) endangers the health, safety or welfare of persons,
 - (b) interferes or is likely to interfere with normal enjoyment of life or property,
 - (c) endangers the health of animal life, or
 - (d) causes or is likely to cause damage to plant life or to property;

"Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

"Environment" means the components of the Earth and includes

- (a) air, land and water,
- (b) all layers of the atmosphere,
- (c) all organic and inorganic matter and living organisms, and
- (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

"Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

- 2.2 The Minister may
 - (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
 - (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
 - (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
 - (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:
3.
 - (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.
 - (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.
5.
 - (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.
 - (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
 - (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
 - (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
 - (c) the contaminant was discharged from the exhaust system of a vehicle;

- (d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
- (e) the discharge of the contaminant resulted from burning for land clearing or land grading;
- (f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
- (g) the contaminant was discharged for the purposes of combating a forest fire;
- (h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
- (i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

- 5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
- (a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
 - (b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
 - (c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.
6. (1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.
7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.
- (2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – GOVERNMENT AND INDUSTRY CONTACTS

Government of Nunavut

Environmental Protection Division
Department of Environment
Inuksugait Plaza
P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-7729 Fax: (867) 975-7739

Workers' Safety and Compensation Commission
P.O. Box 669
Baron Building/1091
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free)
Fax: 1-866-979-8501

Office of Chief Medical Health Officer of Health
Department of Health and Social Services
P.O. Box 1000, Station 1000
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5774 Fax: (867) 975-5755

Government of Canada

Indian and Northern Affairs – Nunavut Region
P.O. Box 2200
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-4500 Fax: (867) 975-4560

Environment Canada (NWT and Nunavut)
5019 52nd Street
Yellowknife, Northwest Territories X1A 1T5
Telephone: (867) 669-4730 Fax: (867) 873-8185

Industry

The Heating, Refrigeration and Air Conditioning
Institute of Canada (HRAI)
2800 Skymark Avenue, Building 1, Suite 201
Mississauga, Ontario L4W 5A6
Telephone: 1-800-267-2231 (toll free)
<http://www.hrai.ca>

Motor Vehicles Division
Department of Economic Development and
Transportation
P.O. Box 10
Gjoa Haven, Nunavut X0B 1J0
Telephone: (867) 360-4615 Fax: (867) 360-4619

Department of Community and Government
Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
Iqaluit, Nunavut X0A 0H0
Telephone: (867) 975-5400 Fax: (867) 975-5305

Department of Transport – Road, Rail, Marine, Air
P.O. Box 8550
344 Edmonton Street
Winnipeg, Manitoba R3C 1P6
Telephone: 1-888-463-0521 (toll free)
Fax: (204) 983-8992 Road, Rail and Marine
Fax: (204) 983-1734 Air

Refrigerant Management Canada (RMC)
<http://www.refrigerantmanagement.ca>

Underwriters' Laboratories of Canada
7 Underwriters Road
Toronto, Ontario M1R 3A9
Telephone: (866) 937-3852 Fax: (416) 757-8727
Email: customerservice@ulc.ca



AGNICO EAGLE

MELIADINE GOLD PROJECT

Wastewater Management Plan

MARCH 2018

Version 3

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DOCUMENT CONTROL

Version	Date	Section	Page	Revision	Author
	May 2013			Complete document revision	Environment Department
	March 2018	All	All	Changed name to "Wastewater Management Plan" from "Used Water Management Plan"	Environment Department
		All	All	Addition of BIONESTs to the treatment system descriptions.	
		All	All	General revision	

ACRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
BTEX	benzene, toluene, ethylbenzene, and xylene
CP1	Collection Pond 1
GN	Government of Nunavut
NWB	Nunavut Water Board
PHC	Petroleum hydrocarbons
Project	Meliadine Gold Project
RMMS	Responsible Mining Management System
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

SECTION 1 • INTRODUCTION

This Wastewater Management Plan is designed to reduce adverse impacts on the environment at the Agnico-Eagle Mines Limited (AEM), Meliadine Gold Project's exploration camp located at Meliadine Lake, Nunavut. It is designed to comply with the terms and conditions for water use and waste management outlined in Nunavut Water Board License 2BB-MEL1424.

A site plan showing the general layout of the Meliadine Gold Project's exploration camp and associated infrastructure is given in Figure 1.

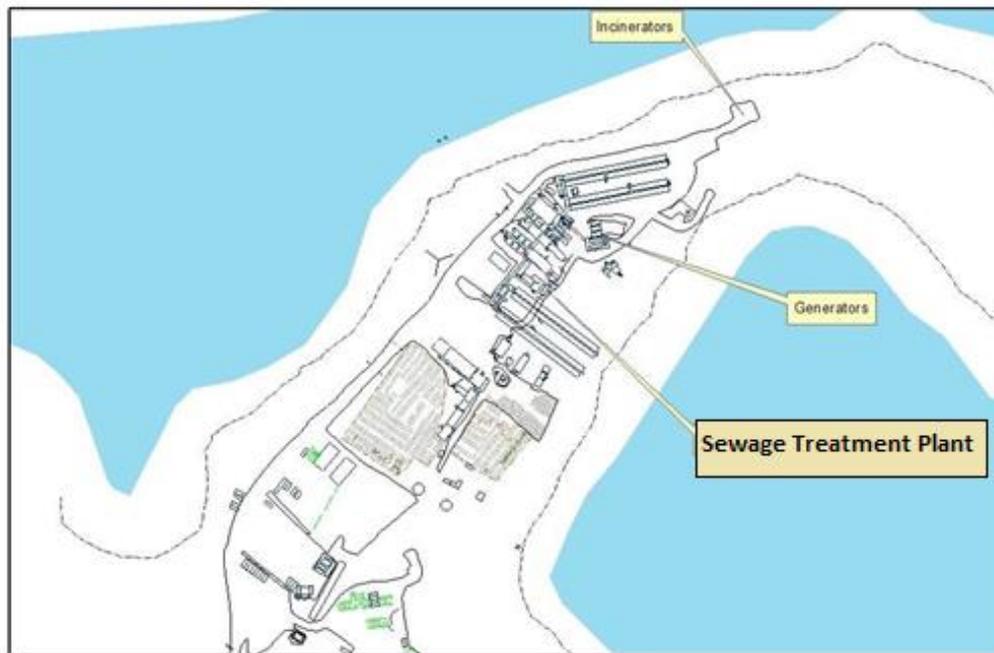


Figure 1: Camp and Related Infrastructure

SECTION 2 • BIODISK AND BIONEST TREATMENT

2.1 Introduction

AEM is presently using two BIODISK and 2 BIONEST wastewater treatment systems working in parallel and designed to treat both black and grey water to produce final effluent that meets the discharge criteria outlined in the NWB water license 2BB-MEL1424. Sewage wastes at the Meliadine Gold Project advanced exploration camp were at first incinerated but this practice ended with the BIODISKS coming on line in 2010, and the addition of the BIONESTs in 2016. The grey water from the laundry and kitchen facilities passed through a sump and wetland system before reaching Meliadine Lake. This grey water is now being redirected to the BIODISK and BIONEST systems, together referred to as the sewage treatment plant (Figure 1). All wastewater generated by the exploration camp is directed to 2 equalization tanks (EQ Tanks) in which wastewater is homogenized through the use of aeration diffusers and pumped to the BIODISK and BIONEST units for initial biological treatment.

2.2 Location

The 2 BIODISKS have been positioned on the southeast side of the camp in a position amenable to the plumbing of the EQ tanks. The 2 BIONESTs (portable treatment units built into seacans) are located exterior of the camp sewage treatment plant in a position amenable to the plumbing of the EQ Tanks.

Lift stations located throughout the camp (Kitchen grease trap, Dry/Locker room, Dormitory wings) collect wastewater generated in each respective area to the EQ tanks through the associated plumbing. A grinder pump within each lift station delivers a wastewater slurry to the EQ tanks by a system of float controls.

2.3 BIODISK Unit Information

2.3.1 General Description of Operation (BIODISK Operations Manual)

The following information is from the manual provided by BIODISK Corporation.

The waste water treatment facility at the Meliadine Lake exploration camp is a tertiary treatment aerobic sewage treatment plant. The unit is designed to remove phosphorus, and destroy nitrogenous products and organic material. It is comprised of a primary clarifier, rotating bacterial contactor (RBC) and final clarifier.

Raw sewage and grey water is pumped from the EQ tank into the primary clarifier. A grease trap installed between the kitchen wastewater discharge point and the EQ tank will remove most fats, oils and greases (**FOG**) before any wastewater reaches the EQ tank. The primary clarifier concentrates the majority of the bio-solids pumped from the EQ tank prior to the wastewater entering the "bio-zone" of the RBC. The clarified water enters the RBC section through the inlet located at the end of the BIODISK that is opposite of the RBC motor/gearbox. The RBC is composed of three baffled aeration segments in which biological treatment occurs. This process utilizes a fixed growth bacteria system, whereby bacteria are grown on a series of disk shaped media that are mounted on a shaft that is rotating within the wastewater. The treated wastewater flows through three zones, each with a progressively higher standard of treatment. The first section is where most of the biological oxygen demand (BOD) reduction occurs. The third section has recycle buckets allowing the return of a portion of clarified water back to the primary clarifier.

Under normal conditions, the addition of chemical or biological amendments to the system is unnecessary. The biomass is naturally occurring and fixes itself to the disks, which are 40% submerged in the wastewater at any given time and have 60% exposure to air. As the disks rotate, the biomass is exposed to oxygen in the air, and consumes pollutants when submerged. Two basic classes of organisms are represented; the early stages of the process are dominated by *carbonaceous consuming bacteria* that eat organic material, while later stages are dominated by *nitrification bacteria* that convert ammonia to nitrate. The early stage *carbonaceous consuming bacteria* are typically dark brown and coat the disks to a thickness of about 1/16th of an inch. *Nitrification bacteria* are lighter in color and creates a thinner coating on the disks. Experienced operators can monitor the condition of the system by monitoring the color and odor of the biomass.

Partially treated water from the BIODISK now enters the final clarifier. Spent biomass settles in this chamber, while clarified water exits the system into a subsequent disinfection loop through an outlet point.

2.3.2 General Process Inspection Guideline

The process efficiency of the BIODISK system can be checked by monitoring common elements of the process. The amount of bio-solids on the surface of the primary clarifier is proportional to the sludge on the bottom. Fats, oils and greases (**FOG**) need to be removed from the wastewater before it enters the BIODISKS. As previously stated, a grease trap is installed between the kitchen and EQ tank supplying wastewater to the BIODISKS.

The **thickness and distribution of the biomass** is an indicator of plant capacity. When the flow is close to design maximum, the biomass will be approximately 32 mm in the first stage and progressively less in the following stages. When the treatment is at capacity, biomass will be evident on the last stage. As flow is reduced, the amount of biomass on the disks will be proportional to the loading. At 50% of design, the organic removal biomass will occupy 50% of the length of the shaft. Light brown nitrification bacteria in the last stages is a good sign. This does not occur until the BOD is less than 30 mg/L. If the last stage is without biomass, this is a good indication that complete nitrification has been accomplished.

Biomass color is a good process indicator. In the lead stages, the biomass color should be medium brown. In the latter stages, the disks will be lighter brown when the system is lightly loaded. The appearance of black or grey patches of biomass is not good. **Black and grey biomass** is an indicator of organic overload and/or excessive FOG. This will appear first on the lead stage and may indicate the need to pump the system out.

Odor is evident when the dissolved oxygen (DO) levels are low in the BIODISK. Low DO in the first stage is an indicator of organic overload. If the problem causes black, grey and gelatinous biomass and if not addressed, it will lead to more odor and process break down. The problem will appear first in the first stage and will progress down the shaft as it gets worse. Generally, the BIODISK produces a rich loamy odor that is not offensive when operating correctly. If it is producing abnormal odor it is an indication of poor effluent, organic overload or excessive FOG.

Small amounts of scum on the surface of the final clarifier is an indication that nitrogen gas is being released. Nitrogen gas is released in an anoxic environment when a carbon source and nitrates are present. This indicates that de-nitrification is taking place. When the final clarifier is more than 50% covered with scum, the BIODISK may need to have the bio-solids and scum removed.

2.3.3 Electrical Controls

A control panel connects all electrical circuits within the control room of the BIODISK units. Pumps and heaters are normally left in the auto position and the BIODISKS run 24 hours a day, 365 days a year. The effluent pumps installed inside the EQ tank are controlled by switches with manual and automatic settings and have multi-level floats alarms. The timing for the pump activation are controlled by a Zen control panel from which the pumping intervals are set. In the event of the activation of a high level float alarm inside the EQ tank, 1 of the pump pairs will activate regardless of the programmed interval in order to prevent overtopping of the EQ tank.

There is a red strobe light outside of the control room that will activate in the event of a problem. The strobe light is activated by one of the following conditions:

- Drive motor amps too high or too low
- High water
- Effluent pump malfunction

The exact problem will be indicated by control panel lights within the control room

2.3.4 Electrical Controls

Bio-solids/sludge must be periodically removed from the system in order to prevent a reduction in treatment efficiency. Generally, the first step is to remove the scum blanket and then remove the sludge. Sludge accumulates throughout the primary and final clarifiers over time as well as within the RBC bio-zone. The primary clarifier has a sludge storage capacity of about 15 cubic meters and the final clarifier has a capacity of about 0.6 cubic meters. The sludge is pumped into 205 L drums and stored in seacans for HAZMAT shipment and disposal.

Sludge removal frequency is determined by the wastewater treatment operator though regular assessment of bio-solid accumulation.

2.3.5 Electrical Controls

Good kitchen techniques can help keep the BIODISKS units operating correctly. A grease trap has been installed after the drain in the kitchen at the Meliadine Camp and Rhino filters under some kitchen sinks. There is also a bigger grease trap in the building. **The largest source of problem fats, oils and greases (FOG) is the kitchen sink.** Poor kitchen techniques can double the BOD loading. All plates and pots should have food scraps removed before rinsing.

Antibacterial soaps are designed to kill bacteria and should be avoided. The use of harsh cleaners and strong detergents will be limited and controlled in order to protect the growth of bacteria within the sewage treatment plant. When possible, biodegradable cleaners and detergents will be used.

Specific components of the unit require some routine maintenance. **The bearings of the BIODISKS shaft should be lubricated every 3 months.** Look for lubricant leaks around the gear box and motor.

2.4 BIODISK Operation and Maintenance

2.4.1 General Description of Operation

At the beginning of 2016, two BIONEST units were added to the overall sewage treatment system and were installed to work in tandem with the BIODISKS. An additional EQ tank was also installed so that the BIODISKS and BIONESTs were each supplied with wastewater from dedicated EQ tanks. The BIODISKS are supplied by EQ tank 1, and the BIONESTs by EQ tank 2.

Each BIONEST is designed to operate and discharge final effluent that would meet discharge parameters outlined in the 2BB license, however, the water that is discharged from each unit is piped into the main sewage treatment plant building where it is mixed with the wastewater discharged from the BIODISKS and subsequently disinfected in the disinfection loop.

The contents of EQ tank 2 are pumped into the first chamber of each BIONEST, which is referred to as a septic tank compartment. Once filled, the wastewater passes through an effluent filter and into the second chamber referred to as the bioreactor. It is in the bioreactor where the biological treatment occurs (nitrification, just as in the RBC bio-zone of the BIODISKS). Instead of disk media, the BIONEST bioreactor contains ribbon shaped polymer media onto which bacterial cultures adhere. The third chamber acts as a final clarifier to remove residual solids before the water exits the system. Each BIONEST is equipped with a UV disinfection system at the final outlet, which are redundant in this configuration due to the discharge being later disinfected in the disinfection loop.

Sludge removal for the BIONESTs occurs when the sludge blanket in the septic tank portion of the unit reaches a thickness of approximately 18 inches, which according to the manufacturer occurs approximately every two years.

2.4.2 Disinfection Loop

The disinfection loop portion of the sewage treatment system (Figure 2) consists of a series of particle filters (2x 3 micron and 2x 25 micron) and a 2 stage UV disinfection system (1st UPSTREAM NC15-50 and 2nd Trojan UV3000 PTP – Figure 3)



Figure 2: Disinfection loop showing filters and UV systems

2.4.3 Factors Affecting UV Disinfection

The UV dose delivered by a disinfection system is a product of UV intensity (milliwatts per square centimeter) and retention (exposure) time in seconds: **UV Dose = Intensity X Time**

The units of dose are milliwatt seconds per square centimeter (mW.s/cm²) or millijoules per square centimeter (mJ/cm²). "UV intensity" is affected by:

- Wastewater quality,
- Microbial inactivation kinetics,
- Equipment/lamp configuration, and
- Lamp age and sleeve fouling



Figure 3: Two UV Water Disinfection Systems

2.4.4 Tertiary Disinfection by Ozone

One tertiary disinfection system is in place following the disinfection loop depicted in figure 2, which consists of an ozone generation system (Ozomax). The effluent passes through the Ozomax prior to being released from the MEL-7 discharge point (Figure 4). The system is designed as a “polisher” to remove any residual fecal coliforms, oil and grease, TSS, and NH3- NH4 that may pass through the disinfection loop. The system is able to produce 10 grams of ozone per hour.

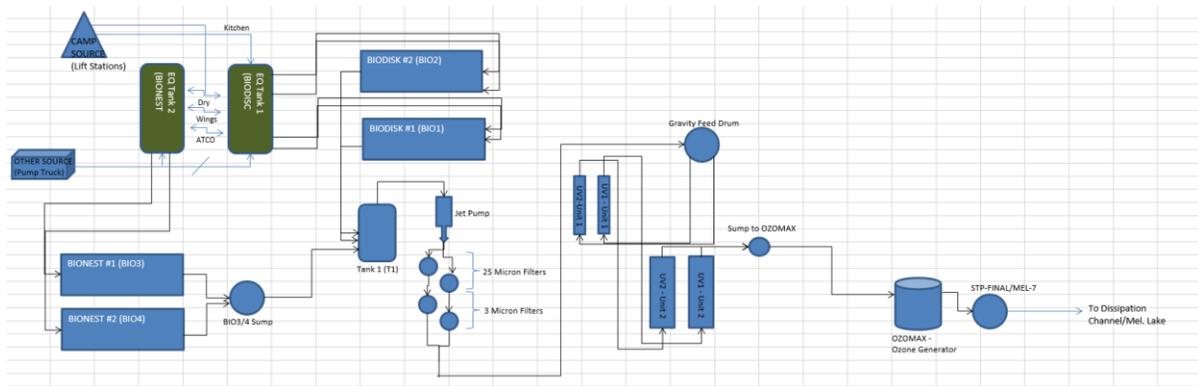


Figure 4: Meliadine Exploration Camp STP Schematic

2.4.5 Retention Basins and Effluent Dissipation Channel

By January 2013, the Kivalliq Inuit Association required Agnico-Eagle Mines (AEM), to install a system to store the Sewage Treatment Plan (STP) effluent if the sampling results did not meet the license 2BB-MEL1424 requirements (Part D, 11) for two consecutive weeks. A series of four retention tanks, each with a 30,000L capacity, were installed on the exterior of the STP. In the event of consecutive exceedances, the effluent discharge from MEL-7 can be bypassed and diverted to the retention tanks.

A dissipation channel has been created between the final MEL-7 discharge outlet and Meliadine Lake (Figure 4). The channel is composed of a dug channel, lined with geotextile and covered with non-PAG riprap. The channel boundary is outside the designated 31m buffer zone of Meliadine Lake.

2.5 Performance and Monitoring

By January 2013, the Kivalliq Inuit Association required Agnico-Eagle Mines (AEM), to install a system to store the Sewage Treatment Plan (STP) effluent if the sampling results did not meet the license 2BB-MEL0914 requirements (Part D, 13) for two consecutive weeks. A series of four retention tanks, each with a 30,000L capacity, were installed on the exterior of the STP. In the event of consecutive exceedances, the effluent discharge from MEL-7 can be bypassed and diverted to the retention tanks.

A dissipation channel has been created between the final MEL-7 discharge outlet and Meliadine Lake (Figure 4). The channel is composed of a dug channel, lined with geotextile and covered with non-PAG riprap. The channel boundary is outside the designated 31m buffer zone of Meliadine Lake.

The final point of control is the end of the pipe from the BIODISKS and is noted in the water license as MEL-7. This station was established to monitor the performance of the BIODISKS treatment plant. The parameters monitored include BOD₅, fecal coliforms, TSS, pH, and oil and grease (Table 1). Weekly samples will be collected at the end of the pipe to document the performance of the plant against the effluent requirements set in the water license, with the results submitted to the Water Board in the monthly reports.

Table 1: License 2BB-MEL1424

Parameter	Maximum Concentration of any Grab Sample
pH	6.0 to 9.5
BOD ₅	80 mg/L
TSS	100 mg/L
Faecal Coliforms	1000 CFU/100mL
Oil and Grease	5 mg/L & No visible sheen

2.6 Updates to Effluent Discharge

In November 2015, multiple exceedances in fecal coliform for MEL-7 occurred. To minimize risk to the environment, it was decided to send treated effluent to the retention tanks for temporary storage. The treated effluent would then be transferred from the retention tanks to CP1 for disposal. This is a temporary measure for the foreseeable future but is subject to change with approval by regulatory bodies.



AGNICO EAGLE

Meliadine Gold Project

Waste Management Plan

March 2018

Version 5

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	2010/08/25			Changes made to reflect comments from INAC, ENV – Nunavut, and Environment Canada
2	2012/04/02	3	14	Reference is made to changes in waste management as a landfill is to be established on site.
3	2012/09/19			Complete document revision and update
4	2013/11/14			Revision
5	2018/02/06	2.1	4	Added "As of November 2017, the exploration camp incinerator is no longer in operation. All putrescible waste is now being incinerated in the main camp incinerator (2A license)"
		All	All	General revision

Revised by:

Meliadine
Environment
Department

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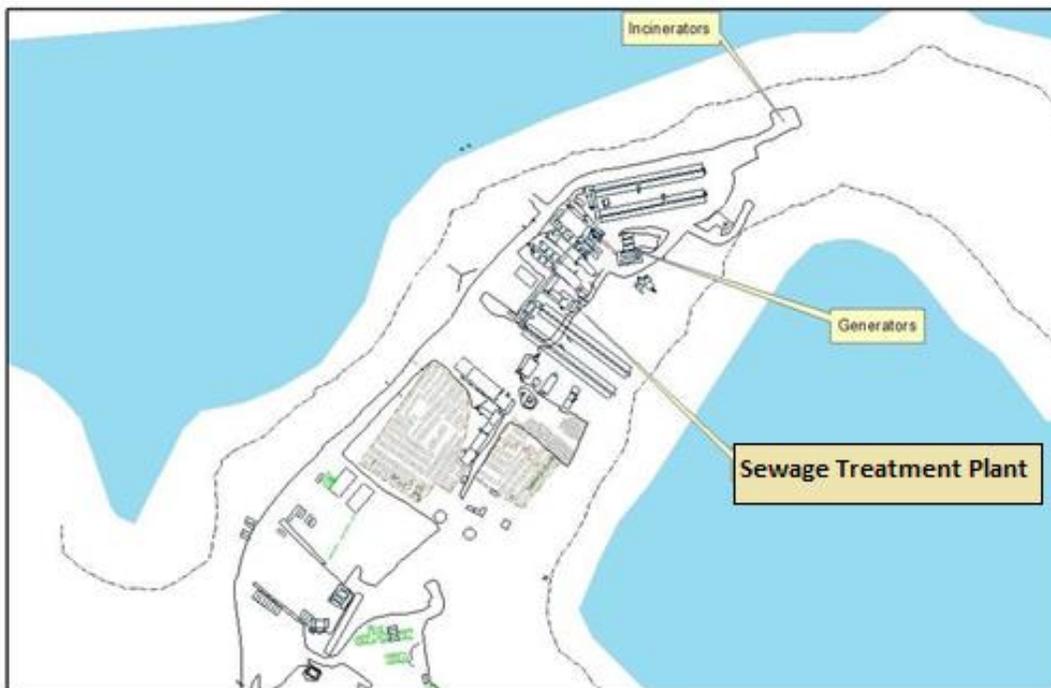
1. INTRODUCTION

This Waste Management Plan is designed to reduce adverse impacts on the environment at the Agnico Eagle Mines Limited (AEM), Meliadine Gold Project's exploration camp on Meliadine Lake, Nunavut. It is designed to comply with the terms and conditions for water use and waste management outlined in Nunavut Water Board License 2BB-MEL0914.

Chapter 2 discusses other aspects of waste management at the camp including the operation of the on-site incinerator and the segregation of wastes designated for disposal off-site.

A site plan showing the general layout of the Meliadine Gold Project's exploration camp and associated infrastructure is given in Figure 1 (page 3)

Figure 1: CAMP AND RELATED INFRASTRUCTURE



2. MANAGEMENT OF WASTE

2.0 General Waste

The incinerator¹ will dispose of putrescible solid waste from the accommodation camp, kitchen, shops, and offices that cannot be recycled at the Meliadine Gold Project Site. The incineration of waste will divert waste from the on-site landfill, which could create odors and potentially attract wildlife. The materials to be incinerated will be limited to putrescible waste such as paper, food packaging and food waste. The waste management policy stipulates that materials are segregated at the source to minimize the potential for inadvertent loading of the incinerator with problematic materials. Appendix A shows the waste segregation operated at the camp site.

The main aspects of the policy are:

- The minimization of the creation of dioxin and furan compounds that are a by-product the incineration of some wastes. This is principally accomplished through the segregation from the incinerated wastes;
- The elimination of potential mercury sources from the incinerated wastes;
- The segregation and elimination of waste oils and oil stained materials from the incinerated waste; and
- The segregation and elimination of industrial and household hazardous wastes from the incinerated waste.

Wastes that are deemed non-combustible will be treated in the following manner:

- Scrap Metal and used tires will be stocked in containers and will be transported to southern facilities to be recycled.
- Non-hazardous, solid “inert” waste (wood, plastics, glass) will be disposed of in approved landfill.
- All hazardous wastes and waste items that cannot be incinerated or landfilled are securely packaged and sent to a licensed hazardous waste treatment facility.
 - Prior to disposal, the hazardous waste will be properly packaged, labeled, and stored and manifested in a Transportation of Dangerous Goods (TDG) approved shipping container;
 - The container will have the appropriate hazardous waste labels; and

¹ As of November 2017, the exploration camp incinerator is no longer in operation. All putrescible waste is now being incinerated in the main camp incinerator (Type A water license)

- All Federal, Provincial and Territorial regulations will be adhered to.

2.1 USED CONTAINER DISPOSAL

It is important to ensure the proper disposal of used containers that have contained, collected or contained a hazardous or regulated substance (e.g. paint cans, oil cans, acid containers, aerosol cans). Generally, residual liquids will be collected in 205 L metal drums or 1000 L plastic totes, manifested as hazardous waste and shipped to a licensed hazardous waste treatment facility. The original containers could be cleaned and reused or packaged as a hazardous waste and treated to a facility.

2.2 HAZARDOUS WASTE GENERATION AND DISPOSAL

The hazardous waste generator number used by the Agnico Eagle Meliadine is NUG 100063. Waste containers and their labeling will be inspected by accredited TDG personnel (third party contractor) and appropriate paperwork will be kept on file by AEM. Details of the waste types, waste volumes, waste manifests and shipping destination of the associated hazardous wastes will be documented in the annual report delivered to the NWB.

2.3 USED DRUM DISPOSAL

The majority of used fuel drums for Jet-B fuel and diesel (205 L/45 gal drums) will be stored on site for future use. Generally, AEM uses bulk fuels and only keeps a limited number of used drums on-site. However, during operations drums may be used for storage of other “used” petroleum products. Drums that are deemed unusable will be crushed and send to a southern facility for recuperation/recycling.

2.4 USED TIRE RECYCLE AND DISPOSAL

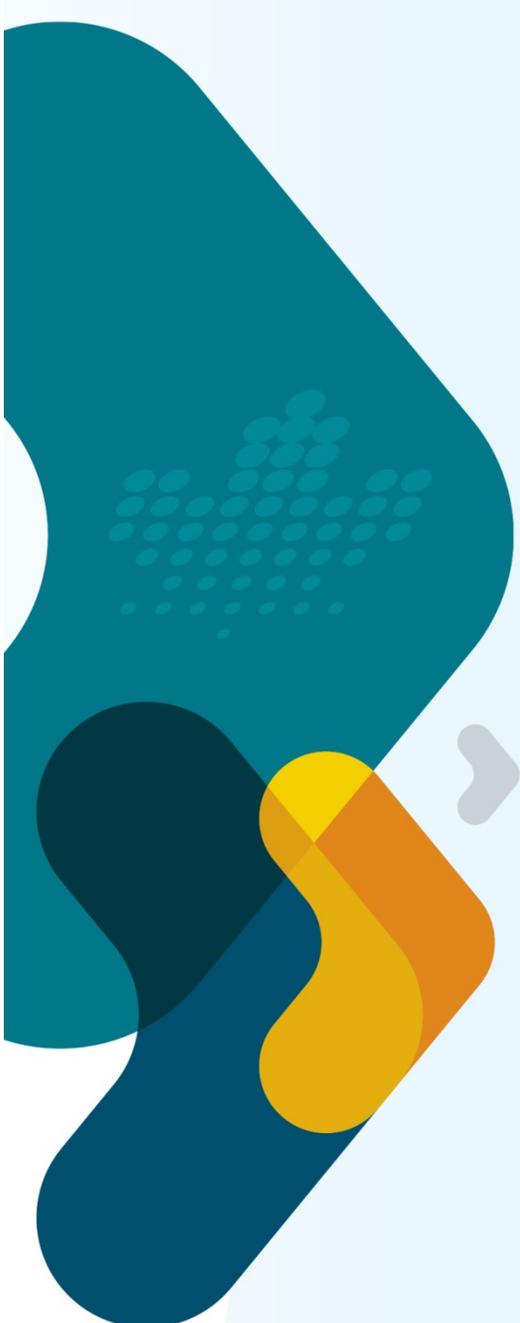
Used tires must be recycled or disposed of on-site if recycling is not possible. In general, all tires smaller than 24.5 inches (wheel rim size) must be recycled by an approved tire recycler.

No commercial recycling options exist for tires larger than 24.5 inches in diameter, so these tires may be disposed of in the approved landfill. Generally, larger tires are in demand at mine sites for the construction of safety barriers along roads and thus these spent tires will be kept for such purposes.

APPENDIX A: MELIADINE WASTE MANAGEMENT

 <h2 style="text-align: center;">Meliadine Waste Management</h2>			
<p>Domestic Waste</p> <p>Includes:</p> <ul style="list-style-type: none"> • Food and containers that contain or have contained food • Organic waste (deceased animals) • Paper products (cardboard) <p>These items are collected and sent to the on-site incinerator</p> 	<p>Hazardous Waste (HAZMAT)</p> <p>Includes:</p> <ul style="list-style-type: none"> • Petroleum/ hydrocarbon products and their containers • Aerosol cans • Absorbent matting and booms • Batteries <p>These are collected in Quatrex bags and drums and sent for disposal</p> 	<p>Recycled Waste</p> <p>Includes:</p> <ul style="list-style-type: none"> • Beverage cans • Scrap tires • Scrap metal <p>These are collected in bins and seacans and sent for recycling</p> 	<p>Construction Waste</p> <p>Includes:</p> <ul style="list-style-type: none"> • Plastic • Wood • Inert materials (non-hazardous, non-putrescible) <p>These are collected in roll-off bins and sent to the on-site landfill</p> 

Appendix G
NRC Report on Feasibility of PHC Biodegradation



NRC-CMRC

Meliadine Mine - PHC Biodegradation Feasibility Study

Date: December 22, 2017

Author: David Juck, PhD.

Energy, Mining and Environment



National Research
Council Canada

Conseil national de
recherches Canada

Canada

Executive Summary

NRC performed a site visit and lab based bioremediation feasibility study on petroleum hydrocarbon (PHC) contaminated soils from the Meliadine mine site. Based on the chemical and microbiological analyses, the following results were observed:

- There was moderate PHC contamination in the soils.
- The numbers of total heterotrophic and diesel degrading bacteria present in the impacted soils were at typical levels.
- The indigenous microbial population was able to effectively mineralize both hexadecane and naphthalene (representative of alkane and aromatic contamination, respectively).
- Addition of the nutrient amendment 20-8-20 or diammonium phosphate, and to a lesser extent monoammonium phosphate, positively stimulated the mineralization of both hexadecane and naphthalene.
- A biopile based bioremediation approach was proposed to address the PHC contaminated soil.

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Introduction

The Meliadine Mine, owned by Agnico Eagle Mines Limited (AEM), is located approximately 25 km north of Rankin Inlet, in the Kivalliq region of Nunavut. The high-grade gold mine is currently under development, with the construction of above and below ground infrastructure underway and a planned operational start in mid-2019.

On April 8, 2017, an estimated 30,000 L of diesel fuel was released from a storage tank at the Meliadine mine site fuel storage facility. Spill response activities were started on April 8, which consisted of the excavation of impacted soils and their transfer into a contained landfarm area, and was completed April 21. The total volume of diesel impacted soils was estimated at 577 m³. The spill event and response activities are detailed in the Agnico Eagle Mines Limited report titled “Final Spill Report Tank Release April 8, 2017”.

At the request of AEM, the National Research Council Canada (NRC) performed a feasibility study to determine the potential for biodegradation of the diesel contamination by indigenous microorganisms present in the soil.

Objective

The goal of this proposed work was twofold: 1) characterize the PHC contamination in the soil, e.g. PHC Fractions F1-F4, PAHs, etc., and compare the concentrations of the detected PHCs to the Canadian Council of Ministers of the Environment (CCME) guidelines and 2) perform a feasibility study to determine the number of total heterotrophic and diesel degrading bacteria present in the soils and examine the potential of the indigenous microbial population to biodegrade the PHC(s) exceeding CCME guidelines. The feasibility study examined several nutrient amendments to identify the most promising approach to augment indigenous PHC biodegradation activities compared to the current PHC biodegradation rates.

Activities and Methodologies

Site Visit and Soil Sampling

One NRC staff was on site from September 18, 2017, to September 21, 2017. Landfarm site visit and localization of sampling points was performed on September 19, 2017. Sampling of the soils was performed on the morning of September 21, 2017, prior to departure from Rankin Inlet. Conditions during sampling were as follows: overcast with a mix of fog and drizzle, temperature of 3°C and winds 30-50 kmh from the northeast.

A total of 6 samples were collected (Zone 1A, 1B, 2A, 2B, 3A and 3B) for chemical analysis and microbiological/mineralization assays. Figure 1 presents a photo of the landfarm area with the 3

general sampling zones indicated (i.e. 1, 2 and 3) while Figure 2 presents the approximate location of the sub-samples for each zone.



Figure 1. View from the entrance of the landfarm area, towards the northwest, with sampling zones 1, 2 and 3 indicated.

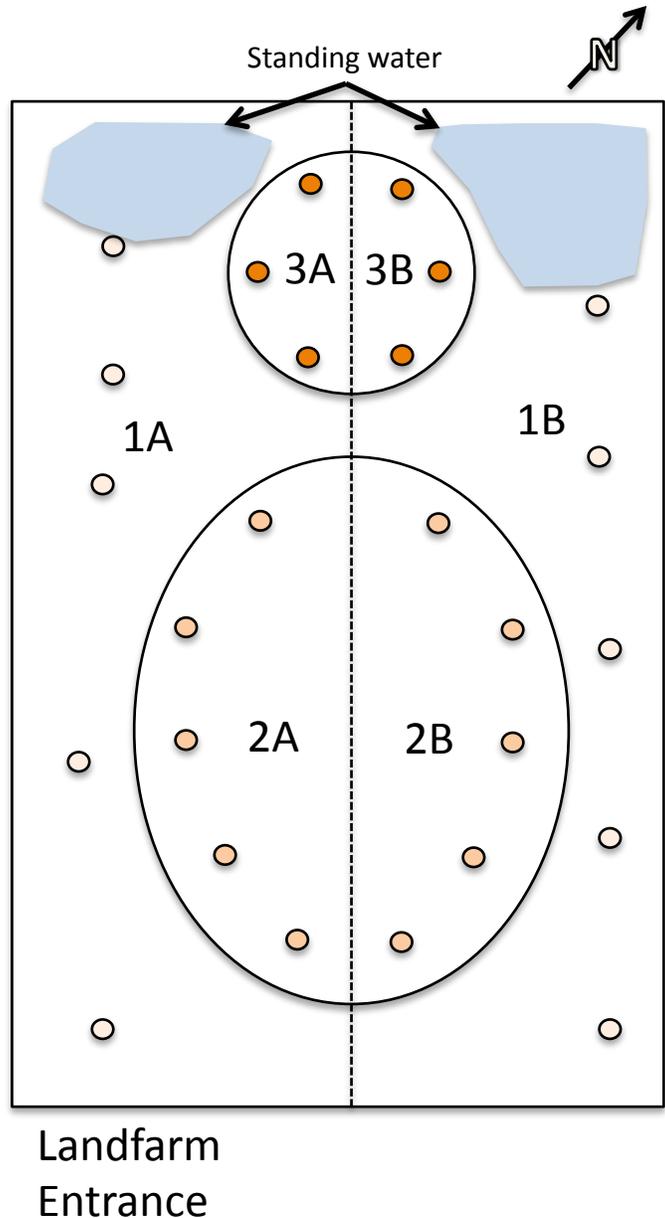


Figure 2. Sampling plan for landfarm soil zones, with approximate locations of the sub-samples indicated by the small colored circles.

For sampling zones 1 and 2, a total of 5 sub-samples were collected in each zone, while for zone 3, a total of 3 sub-samples were collected due to its smaller area. Samples for zones 2 and 3 were collected at a height of approximately 1-2 m above ground, while samples for zone 1 were collected at ground level. Sub-samples were collected by digging approximately 20-30 cm into the material, removing any large rocks and loose material, and then collecting approximately 400 g of freshly exposed soil which was then placed into a new sealable bag. Once all sub-samples were collected for the zone being sampled (e.g. 1A), the soil was well

mixed and then placed into the appropriate sample containers in the following order: BTEX+F1 (120 mL glass jar), PHC F2-F4 and granulometry (250 mL glass jar), microbiology/mineralization assays (700 mL sterile Whirlpak bag). All samples were then immediately placed on ice and kept cold until delivery to the NRC lab in Montreal or the analytical lab (AGAT Laboratories) in Ville St. Laurent. Fresh gloves were used for each sample zone.

Laboratory Analysis

Soil Samples

Once soils arrived at the NRC labs, the 2 samples from each zone (A and B samples) were combined to create a composite for further microbial analysis (1, 2 and 3). At this point, any remaining rocks were removed and the samples were homogenized. The samples were then divided to start the bacterial count and mineralization assays. The percent humidity for each of the 3 samples was also determined at this point.

Bacterial Counts

Bacterial counts were performed on the initial soils samples using 96 well plates and the Most Probable Number (MPN) statistical analysis. Total heterotrophic bacterial counts (i.e. those which use organic matter as a source of carbon and energy) were performed using the medium YTS₂₅₀ (yeast extract, tryptone and soluble starch, each at 250 mg/L of water) while counting of bacteria able to use diesel as a source of carbon and energy was performed using the medium Minimal Salts Medium (MSM) adjusted to pH 7.0 and supplemented with diesel. A ten-fold dilution series of the soils, using 0.1% sodium pyrophosphate adjusted to pH 7.0, was created for each soil and each dilution was placed into 8 wells of the 96 well plate. Incubation of the plates was performed aerobically (i.e. in the presence of oxygen) at 10°C, for 14 and 21 days for the total heterotrophs and diesel degraders, respectively.

Mineralization Assays

The capacity of the indigenous microbial population to mineralize compounds representative of the diesel contamination, hexadecane for the alkane component and naphthalene for the aromatic component, was tested in microcosms. The microcosms were prepared in 120 mL serum bottles containing 20 grams of soil. Soils received a mixture of non-radioactive and radiolabeled chemical to a final concentration of 100 ppm for ¹⁴C-hexadecane and 10 ppm for ¹⁴C-naphthalene. The nutrient amendment conditions tested are outlined in Table 1, and each was prepared in triplicate. The nutrient amendments used were monoammonium phosphate (MAP), diammonium phosphate (DAP) and 20-8-20 (ratio of nitrogen-phosphate-potassium), all commercially available fertilizers.

The sterile control was created using soil 2, which was placed into the microcosms and autoclaved 2 x for 20 minutes, with a period of 24 hours between autoclavings.

The microcosms were incubated at 10°C, and sampled regularly. Mineralization (i.e. the complete breakdown of the compound into CO₂ and H₂O) was measured by liquid scintillation spectrometry (Tri-Carb model 2800, Canberra Packard) and was expressed as the cumulative percentage of evolved ¹⁴CO₂ relative to the initial radioactivity injected into each microcosm.

Table 1. Nutrient amendment conditions examined.

Soil	No Amendment	MAP (150 mg/microcosm)	DAP (150 mg/microcosm)	20-8-20 (150 mg/microcosm)
1	X			
		X		
			X	
				X
2	X			
		X		
			X	
				X
3	X			
		X		
			X	
				X
Sterile Control	X			

Analytical Chemistry

The six samples prepared in the field (1A, 1B, 2A, 2B, 3A and 3B) were sent directly to AGAT Laboratories for the following analyses: Petroleum Hydrocarbon (PHC) Fraction 1 to Fraction 4 (F1-F4), benzene, toluene, ethylbenzene and total xylenes (BTEX), polycyclic aromatic hydrocarbons (PAH), total Kjeldahl nitrogen (TKN) and total organic carbon (TOC). The guidelines against which concentrations of PHC F1-F4 and BTEX in the soil were compared are based on the Department of Environment Government of Nunavut (2014 revision) and the Canadian Council of Ministers of the Environment (CCME) (2008a) and CCME PAH (2010) guidelines.

Sample 2A was also subjected to particle size distribution analysis to determine whether the soil is considered 'fine' or 'coarse' in the context of the CCME guidelines for PHC F1-F4 and BTEX contaminated soils (CCME, 2008a). Based on the on-site activities and the site access restrictions, the site is considered industrial (CCME, 2008b).

Results

Chemical Analyses

The results of the PHC F1-F4, BTEX, PAH, TKN and TOC analyses are presented in Table 2 and the certificates of analysis are in Appendix A. The result of the particle size distribution

analysis (lab results in Appendix A) revealed that the fraction of the representative sample 2A less than 0.075 mm was 6.6% of the total, which classifies this soil as 'coarse' for the comparison of guideline values (presented in Table 2, 'Guidelines').

Table 2. Results of analytical chemistry analysis for PHCs, BTEX, PAHs, TKN and TOC.

Contaminant	Guidelines (mg/kg)	Sample name/Sampling date (dd/mm/yyyy)							RDL
		(mg/kg)							
	CCME ⁽¹⁾	MB1A 21/09/2017	MB1B 21/09/2017	MB2A 21/09/2017	MB2B 21/09/2017	MB3A 21/09/2017	MB3B 21/09/2017		
F1 Petroleum Hydrocarbons (C6 - C10) ^(a)	320	121	120	152	70.4	<10.0	<10.0	10	
F2 Petroleum Hydrocarbons (C10 - C16) ^(a)	260	1200	2100	3670	1980	278	394	10	
F3 Petroleum Hydrocarbons (C16 - C34) ^(a)	2,500	99.8	440	283	204	50.7	203	10	
F4 Petroleum Hydrocarbons (C34 - C50) ^(a)	6,600	14.5	81	19.1	16.8	<10.0	33.5	10	

NOTES:
 1) CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil, Table 1, Revised January 2008
 <XX Less than the method detection limit
 XX Concentration is over the CCME guideline (2008)

Contaminant	Guidelines (mg/kg)	Sample name/Sampling date (dd/mm/yyyy)							RDL
		(mg/kg)							
	CCME ⁽¹⁾	MB1A 21/09/2017	MB1B 21/09/2017	MB2A 21/09/2017	MB2B 21/09/2017	MB3A 21/09/2017	MB3B 21/09/2017		
Benzene	0.0068	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	
Toluene	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	
Ethylbenzene	0.018	<0.05	0.06	0.16	<0.05	<0.05	<0.05	0.05	
Total Xylenes	2.4	0.85	0.53	0.2	<0.05	<0.05	<0.05	0.05	

NOTES:
 1) CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil, Table 1, Revised January 2008
 <XX Less than the method detection limit
 XX Concentration is over the CCME guideline (2007)

Contaminant	Guidelines (mg/kg)	Sample name/Sampling date (dd/mm/yyyy)							RDL
		(mg/kg)							
	CCME ⁽¹⁾	MB1A 21/09/2017	MB1B 21/09/2017	MB2A 21/09/2017	MB2B 21/09/2017	MB3A 21/09/2017	MB3B 21/09/2017		
Anthracene	32	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Benzo (a) anthracene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Benzo (a) pyrene	72	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Benzo (b,j,k) fluoranthene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Benzo (b) fluoranthene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Benzo (k) fluoranthene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Dibenzo (a,h) anthracene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Fluoranthene	180	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Indeno (1,2,3-cd) pyrene	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Naphthalene	22 ⁽²⁾	0.2	0.3	0.6	0.2	<0.1	<0.1	0.1	
Phenanthrene	50 ⁽³⁾	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	
Pyrene	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	

NOTES:
 1) CCME Canadian Soils Quality Guidelines for the Protection of Environmental and Human Health Polycyclic Aromatic Hydrocarbons, 2008, revised 2010.
 2) Due to the contamination of the system and no direct impact on surface waters, the guideline value used is the 'Provisional SQGE (CCME 1997)'
 3) Due to the contamination of the system and no direct impact on surface waters, the guideline value used is the 'Interim Soil Quality Criteria (CCME 1991)'
 <XX Less than the method detection limit
 XX Concentration is over the CCME guideline (2007)

Parameter	Units	Sample name/Sampling date (dd/mm/yyyy)							RDL
		(mg/kg)							
	CCME ⁽¹⁾	MB1A 21/09/2017	MB1B 21/09/2017	MB2A 21/09/2017	MB2B 21/09/2017	MB3A 21/09/2017	MB3B 21/09/2017		
Total Kjeldahl Nitrogen	mg/kg - N	98	291	334	381	394	390	90	
Total Organic Carbon	%	0.9	1.5	1.7	1.2	1.3	1.7	0.3	

The analytical chemistry results demonstrate, on average, a moderate level of PHC F2 contamination above CCME guidelines, which is consistent with a diesel fuel spill event and is the most important contaminant in this system. Concentrations of PHC F2 in zones 1 and 2 were similar, with an average of 2,238 mg/kg, while the PHC concentration average for zone 3 was 336 mg/kg, which is 6.7 times lower than the average for zones 1 and 2. The average PHC F2 concentration for the system as a whole was 1,600 mg/kg.

Concentrations of F1, F3 and F4, below CCME guidelines were detected in 4, 6 and 5 samples, respectively. For the BTEX analysis, only 2 samples (MB1B and MB2A) had concentrations of ethylbenzene above CCME guidelines. The PAHs presented in Table 2 are those for which CCME guideline values have been developed. Additional PAHs were analysed for (see Appendix A) but will not be discussed in the context of this project. No PAHs were detected above CCME guidelines in any of the soils samples.

The TKN results revealed that five of the six areas had roughly the same TKN concentration (approximately 350 mg/kg); MB1A was approximately 3.5 fold lower at 98 mg/kg. The average TKN concentration for the system as a whole was 315 mg/kg, which is approximately 20% of the PHC concentrations of the soils.

TOC analysis revealed an average concentration of organic carbon at 1.4%, which could be considered moderate. It should be noted that during sampling of the soils, clumps of peat/vegetation were avoided as they represented only a small fraction of the total excavated material, based on visual observations.

Bacterial Counts

Bacterial counts for the total heterotrophic population and the diesel degrading population are presented in Table 3. The number of cells /g soil dry weight for both of the populations examined are consistent with those observed at other similar sites and represent a typical dynamic bacterial population.

Table 3. MPN bacterial counts for zones 1, 2 and 3.

Sample	MPN (# of cells/g soil dry weight)	
	Total Heterotrophs	Diesel Degradars
MB1	7.47E+06	2.42E+04
MB2	4.72E+07	6.42E+05
MB3	2.17E+07	1.31E+05

Mineralization

The goal of the mineralization assays was two-fold: to determine what the mineralization potential was of the indigenous microbial population without any nutrient amendments and to determine which nutrient amendment had the most positive impact on the mineralization (i.e.

complete biodegradation of the contaminant into CO₂ and H₂O) of a representative alkane (hexadecane) and an aromatic (naphthalene).

The nutrient amendments under examination were monoammonium phosphate (MAP), diammonium phosphate (DAP) and 20-8-20 (ration of N-P-K). These commercially available fertilizers provide an additional source of nitrogen and phosphorus to the indigenous microbial community as nitrogen, and to a lesser degree phosphorus, are typically very quickly consumed by PHC degrading bacteria and become one of the major limiting parameters in the complete biodegradation of the PHC contamination.

The results of the mineralization assays for hexadecane and naphthalene are presented in Figure 3. For hexadecane, the total level of mineralization in the un-amended microcosms for the three zones was from 1-2%. With amendment, the range of mineralization was from 3.5 to 21.5% after 41 days of incubation at 10°C. While this level of mineralization is slightly lower than might be expected, it indicates that nitrogen (and possibly phosphorus) was limiting the biodegradation of hexadecane. For the three zones, 20-8-20 appeared to have the most positive impact on overall level of mineralization (from 7.5 to 21.5%), although DAP was close behind (from 12 to 14.5%). MAP had the least positive impact on overall hexadecane mineralization (from 3.5 to 11.5%).

For the mineralization of naphthalene, there was less of a difference between the un-amended and amended microcosm; the range of mineralization for the un-amended microcosms was 35-42% while the amended microcosms ranged from 41.5 to 49.5% mineralization. These results are in line with what could be expected in this type of a soil and the concentration of TKN present. Despite this similarity between the un-amended and amended microcosms, for all zones, all three nutrient amendments had a positive impact on the overall level of mineralization observed as compared to the un-amended soils. In contrast to the hexadecane assays, there was no clear preferred amendment for the naphthalene biodegrading microbial populations.

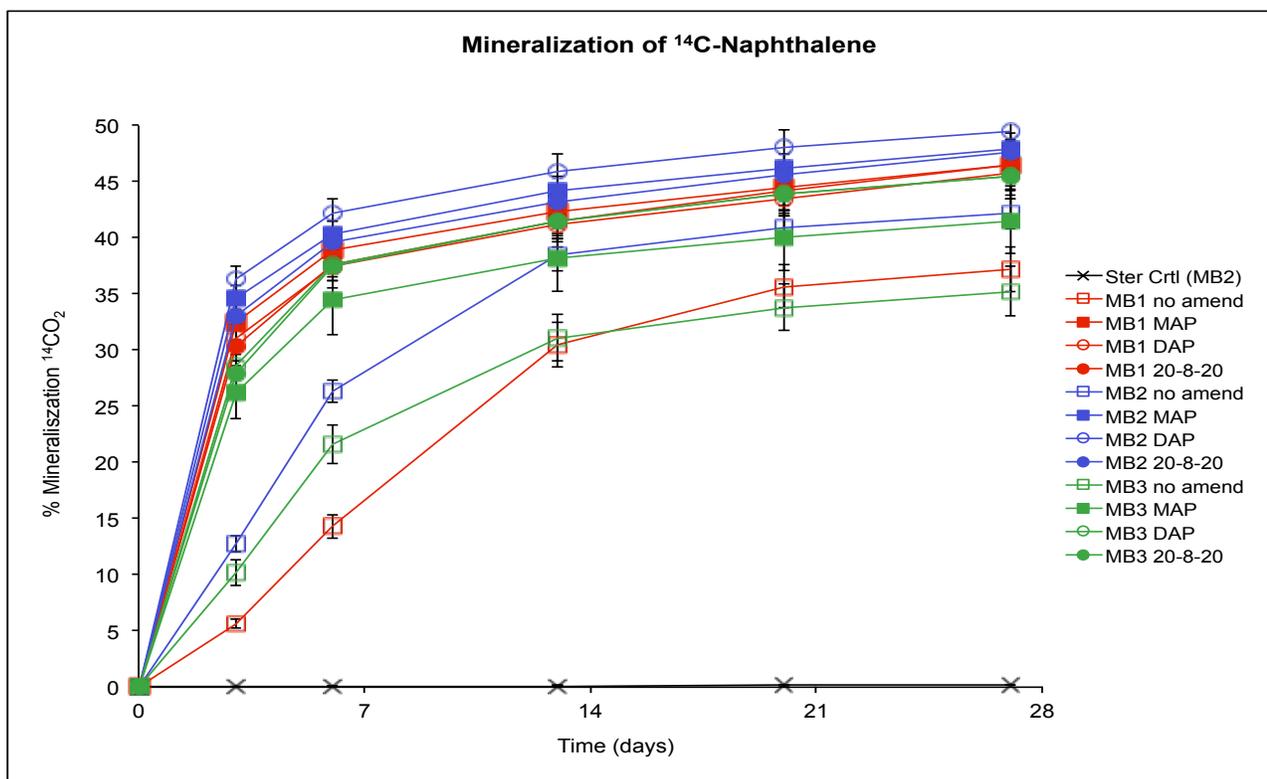
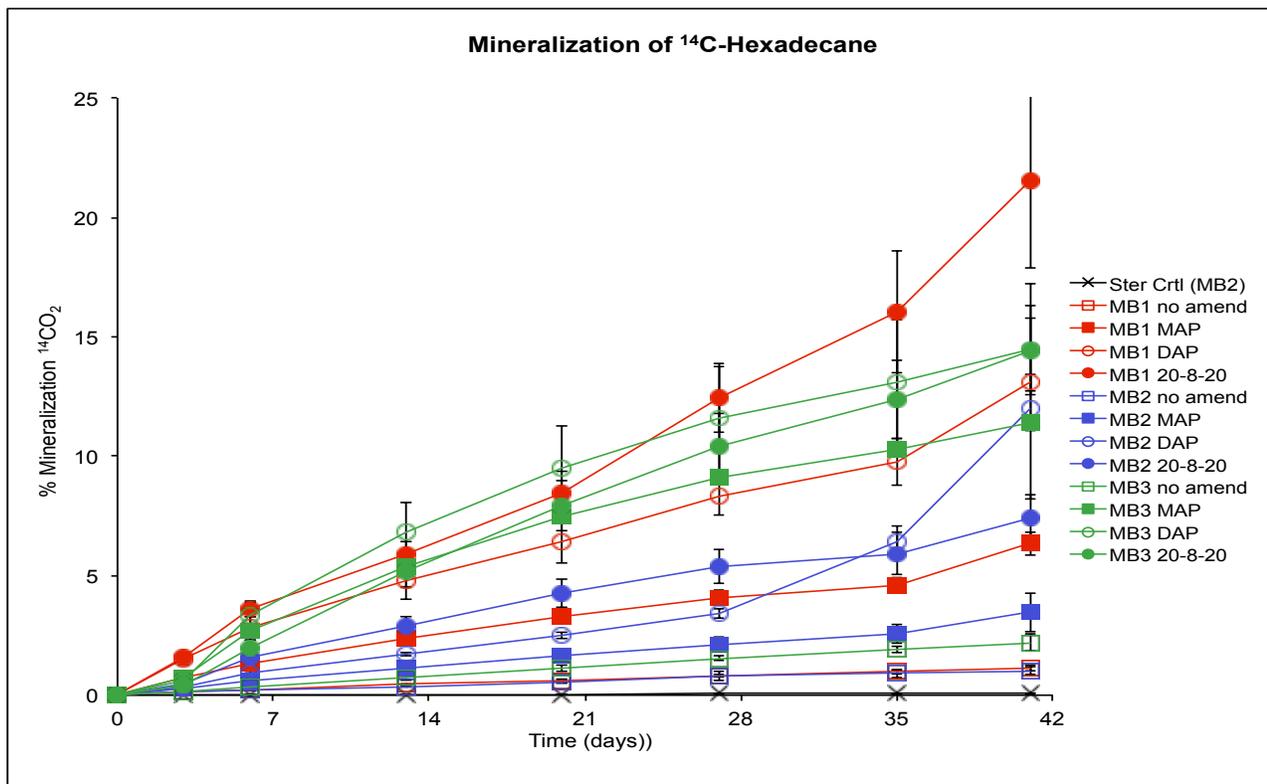


Figure 3. Mineralization results for hexadecane (upper panel) and naphthalene (lower panel).

Conclusions

The soil chemistry results indicated a moderate level of PHC contamination, primarily F2, with some ethylbenzene in 2 of the 6 samples. Soil nitrogen and TOC contents were moderate, and the bacterial numbers, both total heterotrophs and diesel degraders, were typical for a soil of this type.

Mineralization results indicated that there was a good indigenous biodegradation activity for both hexadecane and naphthalene, and both of these communities benefited from the addition of a nutrient amendment, with 20-8-20 being the most promising, followed closely by DAP.

Recommendations

Based on the mineralization results, a biopile bioremediation approach to address the PHC contaminated soils is recommended. The bioremediation of these soils should be carried out as follows:

- A nutrient amendment (slow release granular 20-8-20 or DAP) should be added to the soil each spring at an annual rate of approximately 0.1 g/kg soil. This equals 100 kg per year for the current estimated volume of 577 m³.
- The soil should be arranged in windrows no more than 1.5 m in height and no more than 1.5 m wide.
- Immediately after even broadcasting of the nutrient amendment, the windrows should be turned to incorporate the nutrient amendment and aerate the soils.
- If the soils are moved to the large engineered landfarm area, which was designed with a slope to capture any snow melt and leachates coming from the contaminated soils, the windrows should be positioned so that they are not at the very bottom of the slope where they will be under water saturated conditions. This will reduce the amount of aeration of these portions of the biopiles and reduce the rate of biodegradation of the PHCs.
- Any meltwater/leachates that do accumulate within the landfarm/biopile area can be used to wet the biopiles later in the summer/early autumn, to ensure that adequate moisture levels are maintained.
- Annual sampling of the biopiles (e.g. 6 sampling zones composed of sub-sample composites from each zone) should be performed at the end of each autumn, with analytical chemistry analysis for PHCs, BTEX and TKN performed to follow the progress of the bioremediation system and ensure that nitrogen levels do not significantly increase.

The approach proposed by NRC in no way guarantees the complete remediation of PHC contamination of these soils. This remains the sole responsibility of AEM and/or the firms contracted to perform this work.

References

Agnico Eagle Mines Limited. Final Spill Report Tank Release April 8, 2017. [http://www.nwb-oen.ca/public/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-MEL1631%20Agnico/3%20TECH/8%20EMERGENCY%20RESPONSE%20AND%20CONTINGENCY%20PLAN%20\(H\)/170408%20AM-MEL1631%2030000L%20Fuel%20Spill_FINAL%20Follow%20Up%20Report-ILAE.pdf](http://www.nwb-oen.ca/public/registry/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-MEL1631%20Agnico/3%20TECH/8%20EMERGENCY%20RESPONSE%20AND%20CONTINGENCY%20PLAN%20(H)/170408%20AM-MEL1631%2030000L%20Fuel%20Spill_FINAL%20Follow%20Up%20Report-ILAE.pdf)

Department of Environment Government of Nunavut 2014. Environmental Guideline for the Management of Contaminated Sites. 2014 revision.

CCME 2008a. Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil. Table 1 Revised January 2008.

CCME 2008b. Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil. Technical Supplement. January 2008.

CCME 2010. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Polycyclic Aromatic Hydrocarbons. 2008, revised 2010.

Appendix A

ANALYTICAL CHEMISTRY CERTIFICATES OF ANALYSIS

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6100 ROYALMOUNT
MONTREAL, QC H4P2R2
(514) 496-7250**

ATTENTION TO: David Juck

PROJECT: Meliadine

AGAT WORK ORDER: 17M264711

SOIL ANALYSIS REVIEWED BY: Jalel Rouissi, Chimiste

TRACE ORGANICS REVIEWED BY: Robert Roch, Chimiste

DATE REPORTED: 2017-10-04

VERSION*: 1

PAGES (INCLUDING COVER): 14

Should you require any information regarding this analysis please contact your client services representative at (514) 337-1000

***NOTES**

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



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PROJECT: Meliadine

9770 ROUTE TRANSCANADIENNE
ST. LAURENT, QUEBEC
CANADA H4S 1V9
TEL (514)337-1000
FAX (514)333-3046
http://www.agatlabs.com

CLIENT NAME: NATIONAL RESEARCH COUNCIL
SAMPLED BY:

ATTENTION TO: David Juck
SAMPLING SITE:

Granulometry/Sedimentometry				
DATE RECEIVED: 2017-09-26			DATE REPORTED: 2017-10-04	
SAMPLE DESCRIPTION:		MB2A		
SAMPLE TYPE:		Soil		
DATE SAMPLED:		2017-09-21		
Parameter	Unit	G / S	RDL	
Granulometry	NA	NA	8759989	Annexe

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

Certified By:



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9770 ROUTE TRANSCANADIENNE
ST. LAURENT, QUEBEC
CANADA H4S 1V9
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FAX (514)333-3046
http://www.agatlabs.com

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ATTENTION TO: David Juck
SAMPLING SITE:

Inorganic Analysis (Soil)											
DATE RECEIVED: 2017-09-26					DATE REPORTED: 2017-10-04						
					SAMPLE DESCRIPTION:		MB1A	MB1B	MB2A	MB2B	MB3A
					SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
					DATE SAMPLED:		2017-09-21	2017-09-21	2017-09-21	2017-09-21	2017-09-21
					RDL		8759826	8759983	8759989	8759997	8760006
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL					
Total Kjeldahl Nitrogen	mg/kg - N					90	98	291	334	381	394
Total Organic Carbon	%					0.3	0.9	1.5	1.7	1.2	1.3
					SAMPLE DESCRIPTION:		MB3B				
					SAMPLE TYPE:		Soil				
					DATE SAMPLED:		2017-09-21				
					RDL		8760009				
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL					
Total Kjeldahl Nitrogen	mg/kg - N					90	390				
Total Organic Carbon	%					0.3	1.7				

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; A Refers to QC PTC 2016 A, B Refers to QC PTC 2016 B, C Refers to QC PTC 2016 C, D Refers to QC RESC (Annex 1)
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

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ST. LAURENT, QUEBEC
CANADA H4S 1V9
TEL (514)337-1000
FAX (514)333-3046
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PAHs in Soil											
DATE RECEIVED: 2017-09-26						DATE REPORTED: 2017-10-04					
Parameter	Unit	SAMPLE DESCRIPTION:				RDL	MB1A	MB1B	MB2A	MB2B	MB3A
		G / S: A	G / S: B	G / S: C	G / S: D		Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2017-09-21	2017-09-21	2017-09-21	2017-09-21	2017-09-21
							8759826	8759983	8759989	8759997	8760006
Acenaphthene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	0.2[A-B]	<0.1[<A]	<0.1[<A]
Acenaphthylene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	0.1[A]	<0.1[<A]	<0.1[<A]
Anthracene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (a) anthracene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (a) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (b,j,k) fluoranthène	mg/kg	0.1	1	10	136	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (b) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (j) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (k) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (c) phenanthrene	mg/kg	0.1	1	10	56	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Benzo (g,h,i) perylene	mg/kg	0.1	1	10	18	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Chrysene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Dibenzo (a,h) anthracene	mg/kg	0.1	1	10	82	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Dibenzo (a,i) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Dibenzo (a,h) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Dibenzo (a,l) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Dimethyl-7,12 benzo (a) anthracene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Fluoranthene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Fluorene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	0.2[A-B]	<0.1[<A]	<0.1[<A]
Indeno (1,2,3-cd) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Methyl-3 cholanthrene	mg/kg	0.1	1	10	150	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Naphtalene	mg/kg	0.1	5	50	56	0.1	0.2[A-B]	0.3[A-B]	0.6[A-B]	0.2[A-B]	<0.1[<A]
Phenanthrene	mg/kg	0.1	5	50	56	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Pyrene	mg/kg	0.1	10	100	100	0.1	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]	<0.1[<A]
Methyl-1 naphthalene	mg/kg	0.1	1	10	56	0.1	0.2[A-B]	0.4[A-B]	0.4[A-B]	0.2[A-B]	<0.1[<A]
Methyl-2 naphthalene	mg/kg	0.1	1	10	56	0.1	0.3[A-B]	0.7[A-B]	0.6[A-B]	0.2[A-B]	<0.1[<A]
Dimethyl-1,3 naphthalene	mg/kg	0.1	1	10	56	0.1	0.4[A-B]	1.3[B-C]	2.1[B-C]	1.1[B-C]	<0.1[<A]
Trimethyl-2,3,5 naphthalene	mg/kg	0.1	1	10	56	0.1	<0.1[<A]	0.2[A-B]	0.5[A-B]	0.3[A-B]	<0.1[<A]

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 ST. LAURENT, QUEBEC
 CANADA H4S 1V9
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 FAX (514)333-3046
 http://www.agatlabs.com

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PAHs in Soil											
DATE RECEIVED: 2017-09-26					DATE REPORTED: 2017-10-04						
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	SAMPLE DESCRIPTION:	MB1A	MB1B	MB2A	MB2B	MB3A
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
Surrogate	Unit	Acceptable Limits				RDL	8759826	8759983	8759989	8759997	8760006
Moisture	%					0.1	9.9	14.1	8.8	14.4	8.6
Acenaphthene-D10	%			40-140			106	139	140	137	110
Fluoranthene-D10	%			40-140			87	92	94	91	88
Perylene-D12	%			40-140			82	83	83	84	81

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PROJECT: Meliadine

9770 ROUTE TRANSCANADIENNE
ST. LAURENT, QUEBEC
CANADA H4S 1V9
TEL (514)337-1000
FAX (514)333-3046
http://www.agatlabs.com

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SAMPLING SITE:

PAHs in Soil								
DATE RECEIVED: 2017-09-26					DATE REPORTED: 2017-10-04			
SAMPLE DESCRIPTION: MB3B							Soil	
SAMPLE TYPE:							2017-09-21	
DATE SAMPLED:							8760009	
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL		
Acenaphthene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Acenaphthylene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Anthracene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Benzo (a) anthracene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Benzo (a) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Benzo (b,j,k) fluoranthène	mg/kg	0.1	1	10	136	0.1	<0.1[-A]	
Benzo (b) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[-A]	
Benzo (j) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[-A]	
Benzo (k) fluoranthene	mg/kg	0.1	1	10	136	0.1	<0.1[-A]	
Benzo (c) phenanthrene	mg/kg	0.1	1	10	56	0.1	<0.1[-A]	
Benzo (g,h,i) perylene	mg/kg	0.1	1	10	18	0.1	<0.1[-A]	
Chrysene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Dibenzo (a,h) anthracene	mg/kg	0.1	1	10	82	0.1	<0.1[-A]	
Dibenzo (a,i) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Dibenzo (a,h) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Dibenzo (a,l) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Dimethyl-7,12 benzo (a) anthracene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Fluoranthene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Fluorene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Indeno (1,2,3-cd) pyrene	mg/kg	0.1	1	10	34	0.1	<0.1[-A]	
Methyl-3 cholanthrene	mg/kg	0.1	1	10	150	0.1	<0.1[-A]	
Naphtalene	mg/kg	0.1	5	50	56	0.1	<0.1[-A]	
Phenanthrene	mg/kg	0.1	5	50	56	0.1	<0.1[-A]	
Pyrene	mg/kg	0.1	10	100	100	0.1	<0.1[-A]	
Methyl-1 naphtalene	mg/kg	0.1	1	10	56	0.1	<0.1[-A]	
Methyl-2 naphtalene	mg/kg	0.1	1	10	56	0.1	<0.1[-A]	
Dimethyl-1,3 naphtalene	mg/kg	0.1	1	10	56	0.1	<0.1[-A]	
Trimethyl-2,3,5 naphtalene	mg/kg	0.1	1	10	56	0.1	<0.1[-A]	

Certified By:



Robert Roch

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AGAT CERTIFICATE OF ANALYSIS (V1)

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Certificate of Analysis

AGAT WORK ORDER: 17M264711
PROJECT: Meliadine

9770 ROUTE TRANSCANADIENNE
ST. LAURENT, QUEBEC
CANADA H4S 1V9
TEL (514)337-1000
FAX (514)333-3046
http://www.agatlabs.com

CLIENT NAME: NATIONAL RESEARCH COUNCIL
SAMPLED BY:

ATTENTION TO: David Juck
SAMPLING SITE:

PAHs in Soil							
DATE RECEIVED: 2017-09-26				DATE REPORTED: 2017-10-04			
SAMPLE DESCRIPTION: MB3B						Soil	
SAMPLE TYPE: Soil						DATE SAMPLED: 2017-09-21	
DATE SAMPLED: 2017-09-21						RDL 8760009	
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL	
Moisture	%					0.1	11.7
Surrogate		Acceptable Limits					
Acenaphthene-D10	%			40-140			109
Fluoranthene-D10	%			40-140			91
Perylene-D12	%			40-140			83

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: A Refers to QC PTC 2016 A, B Refers to QC PTC 2016 B, C Refers to QC PTC 2016 C, D Refers to QC RESC (Annex 1)
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.
8759826-8760009 Due to sample matrix interferences. The sample was diluted 10 times and the detection limit was increased accordingly.

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AGAT CERTIFICATE OF ANALYSIS (V1)

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Certificate of Analysis

AGAT WORK ORDER: 17M264711
PROJECT: Meliadine

9770 ROUTE TRANSCANADIENNE
ST. LAURENT, QUEBEC
CANADA H4S 1V9
TEL (514)337-1000
FAX (514)333-3046
http://www.agatlabs.com

CLIENT NAME: NATIONAL RESEARCH COUNCIL
SAMPLED BY:

ATTENTION TO: David Juck
SAMPLING SITE:

Petroleum hydrocarbons TPH F1-F4 (- BTEX)									
DATE RECEIVED: 2017-09-26				DATE REPORTED: 2017-10-04					
Parameter	Unit	SAMPLE DESCRIPTION:		MB1A	MB1B	MB2A	MB2B	MB3A	MB3B
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2017-09-21	2017-09-21	2017-09-21	2017-09-21	2017-09-21	2017-09-21
		G / S	RDL	8759826	8759983	8759989	8759997	8760006	8760009
Benzene	mg/kg	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	mg/kg	0.05	<0.05	0.06	0.16	<0.05	<0.05	<0.05	<0.05
Xylenes	mg/kg	0.05	0.85	0.53	0.20	<0.05	<0.05	<0.05	<0.05
C6-C10 (F1)	mg/kg	10.0	121	120	152	70.4	<10.0	<10.0	<10.0
C6-C10 (F1-BTEX)	mg/kg	10.0	120	119	152	70.4	<10.0	<10.0	<10.0
C>10-C16 (F2)	mg/kg	10.0	1200	2100	3670	1980	278	394	394
C>16-C34 (F3)	mg/kg	10.0	99.8	440	283	204	50.7	203	203
C>34-C50 (F4)	mg/kg	10.0	14.5	81.0	19.1	16.8	<10.0	33.5	33.5
Heavy Hydrocarbons by gravimetry (F4G-sg)	mg/kg	300	NA	NA	NA	NA	NA	NA	NA
% Moisture	%	0.2	12.3	11.0	9.6	11.7	8.3	11.8	11.8
Surrogate	Unit	Acceptable Limits							
Rec. Fluorobenzène (BTEX F-1)	%	40-140	91	92	94	94	94	94	96
Rec. Nonane (F2-F4)	%	40-140	105	104	101	101	94	96	96

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

8759826-8760009 Results are expressed on a dry basis.

Fraction F1-BTEX presents results after subtraction of BTEX.

Fraction F1 is quantified in function of the response factor of toluene. Response factors of alkanes nC6 and nC10 don't exceed 30% between Toluene.

Fractions F2, F3 et F4 are quantified in function of the response factor medium of alkanes nC10, nC16 et nC34. The response factor of alkane nC50 don't exceed 30% from the response factor average of the alkanes nC10, nC16 et nC34. Responses factor of the alkanes nC10, nC16 et nC34 don't vary more than 10 % between each other.

Linearity domain respect a maximum difference of 15%.

The chromatogram line come back to base line before the retention time of the alkane nC50. If not, the analysis of the fraction F4G is done. Fraction F4G-sg represent the heavy hydrocarbons analysis by gravimetry after a silicium gel treatment. Results of F4G cannot be add to hydrocarbons C6 to C50. Quality control results are available in the section Quality control of the certificate of analysis.

Sampling for BTEX and F1 Fraction analysis was carried out in a glass container, which was not preserved with methanol. The holding time of 48h has not been respected; the integrity of the sample may be altered. The holding time for the extraction and the analysis was respected for Fractions F2, F3 and F4.

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AGAT CERTIFICATE OF ANALYSIS (V1)

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Quality Assurance

CLIENT NAME: NATIONAL RESEARCH COUNCIL

AGAT WORK ORDER: 17M264711

PROJECT: Meliadine

ATTENTION TO: David Juck

SAMPLED BY:

SAMPLING SITE:

Soil Analysis															
RPT Date: 2017-10-04			DUPLICATE			REFERENCE MATERIAL			METHOD BLANK			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Analysis (Soil)															
Total Kjeldahl Nitrogen	1	NA	NA	NA	0.0%	< 90	NA	80%	120%	99%	80%	120%	105%	80%	120%
Total Organic Carbon	8760006	8760006	1.3	1.3	NA	< 0.3	NA	80%	120%	NA	80%	120%	NA	80%	120%

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AGAT QUALITY ASSURANCE REPORT (V1)

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Quality Assurance

CLIENT NAME: NATIONAL RESEARCH COUNCIL

AGAT WORK ORDER: 17M264711

PROJECT: Meliadine

ATTENTION TO: David Juck

SAMPLED BY:

SAMPLING SITE:

Trace Organics Analysis															
RPT Date: 2017-10-04			DUPLICATE			REFERENCE MATERIAL				METHOD BLANK			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measure d Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
PAHs in Soil															
Acenaphtene		NA	NA	NA	0.0%	<0.1	119%	70%	130%	NA	70%	130%	NA	70%	130%
Acenaphtylene		NA	NA	NA	0.0%	<0.1	106%	70%	130%	NA	70%	130%	NA	70%	130%
Anthracene		NA	NA	NA	0.0%	<0.1	113%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (a) anthracene		NA	NA	NA	0.0%	<0.1	117%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (a) pyrene		NA	NA	NA	0.0%	<0.1	91%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (b,j,k) fluoranthène		NA	NA	NA	0.0%	<0.1	87%	70%	130%	NA	130%	130%	NA	70%	130%
Benzo (b) fluoranthene		NA	NA	NA	0.0%	<0.1	99%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (j) fluoranthene		NA	NA	NA	0.0%	<0.1	90%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (k) fluoranthene		NA	NA	NA	0.0%	<0.1	94%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (c) phenanthrene		NA	NA	NA	0.0%	<0.1	116%	70%	130%	NA	70%	130%	NA	70%	130%
Benzo (g,h,i) perylene		NA	NA	NA	0.0%	<0.1	96%	70%	130%	NA	70%	130%	NA	70%	130%
Chrysene		NA	NA	NA	0.0%	<0.1	104%	70%	130%	NA	70%	130%	NA	70%	130%
Dibenzo (a,h) anthracene		NA	NA	NA	0.0%	<0.1	92%	70%	130%	NA	70%	130%	NA	70%	130%
Dibenzo (a,i) pyrene		NA	NA	NA	0.0%	<0.1	108%	70%	130%	NA	70%	130%	NA	70%	130%
Dibenzo (a,h) pyrene		NA	NA	NA	0.0%	<0.1	111%	70%	130%	NA	70%	130%	NA	70%	130%
Dibenzo (a,l) pyrene		NA	NA	NA	0.0%	<0.1	104%	70%	130%	NA	70%	130%	NA	70%	130%
Dimethyl-7,12 benzo (a) anthracene		NA	NA	NA	0.0%	<0.1	121%	70%	130%	NA	70%	130%	NA	70%	130%
Fluoranthene		NA	NA	NA	0.0%	<0.1	118%	70%	130%	NA	70%	130%	NA	70%	130%
Fluorene		NA	NA	NA	0.0%	<0.1	112%	70%	130%	NA	70%	130%	NA	70%	130%
Indeno (1,2,3-cd) pyrene		NA	NA	NA	0.0%	<0.1	85%	70%	130%	NA	70%	130%	NA	70%	130%
Methyl-3 cholanthrene		NA	NA	NA	0.0%	<0.1	83%	70%	130%	NA	70%	130%	NA	70%	130%
Naphtalene		NA	NA	NA	0.0%	<0.1	89%	70%	130%	NA	70%	130%	NA	70%	130%
Phenanthrene		NA	NA	NA	0.0%	<0.1	113%	70%	130%	NA	70%	130%	NA	70%	130%
Pyrene		NA	NA	NA	0.0%	<0.1	109%	70%	130%	NA	70%	130%	NA	70%	130%
Methyl-1 naphtalene		NA	NA	NA	0.0%	<0.1	102%	70%	130%	NA	70%	130%	NA	70%	130%
Methyl-2 naphtalene		NA	NA	NA	0.0%	<0.1	96%	70%	130%	NA	70%	130%	NA	70%	130%
Dimethyl-1,3 naphtalene		NA	NA	NA	0.0%	<0.1	108%	70%	130%	NA	70%	130%	NA	70%	130%
Trimethyl-2,3,5 naphtalene		NA	NA	NA	0.0%	<0.1	85%	70%	130%	NA	70%	130%	NA	70%	130%
Petroleum hydrocarbons TPH F1-F4 (- BTEX)															
Benzene	1	8759989	< 0.03	< 0.03	0.0%	< 0.03	100%	80%	120%	NA	100%	100%	98%	70%	130%
Toluene	1	8759989	< 0.05	< 0.05	0.0%	< 0.05	103%	80%	120%	NA	100%	100%	100%	70%	130%
Ethylbenzene	1	8759989	0.16	0.16	NA	< 0.05	107%	80%	120%	NA	100%	100%	101%	70%	130%
Xylenes	1	8759989	0.20	0.19	NA	0.06	108%	80%	120%	NA	100%	100%	104%	70%	130%
Rec. Fluorobenzène (BTEX F-1)	1	8759989	94	91	3.2%	92	91%	40%	140%	NA	100%	100%	97%	40%	140%
C6-C10 (F1)	1	8759989	152	150	1.3%	< 10.0	88%	70%	130%	NA	100%	100%	76%	60%	140%
C>10-C16 (F2)	1	8760009	394	344	13.6%	< 10.0	110%	70%	130%	NA	100%	100%	114%	60%	140%
C>16-C34 (F3)	1	8760009	203	189	7.1%	< 10.0	112%	70%	130%	NA	100%	100%	120%	60%	140%
C>34-C50 (F4)	1	8760009	33.5	31.6	NA	< 10.0	123%	70%	130%	NA	100%	100%	129%	60%	140%
Rec. Nonane (F2-F4)	1	8760009	96	94	2.1%	92	86%	40%	140%	NA	100%	100%	99%	40%	140%
% Moisture	8759997	8759997	11.7	11.9	1.4%	< 0.2	96%	80%	120%	NA	100%	100%	NA	100%	100%



Quality Assurance

CLIENT NAME: NATIONAL RESEARCH COUNCIL

AGAT WORK ORDER: 17M264711

PROJECT: Meliadine

ATTENTION TO: David Juck

SAMPLED BY:

SAMPLING SITE:

Trace Organics Analysis (Continued)

RPT Date: 2017-10-04			DUPLICATE			REFERENCE MATERIAL			METHOD BLANK			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Comments: TPH CCME F1-F4 analysis is not controlled under MDELCC regulation.

Certified By: _____



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Method Summary

CLIENT NAME: NATIONAL RESEARCH COUNCIL

AGAT WORK ORDER: 17M264711

PROJECT: Meliadine

ATTENTION TO: David Juck

SAMPLED BY:

SAMPLING SITE:

PARAMETER	DATE PREPARED	DATE ANALYZED	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis					
Granulometry	2017-10-04	2017-10-04	INOR-161-6031F, unaccredited by MDDELCC	MA. 100 - Gran. 2.0	SIEVING
Total Kjeldahl Nitrogen	2017-10-02	2017-10-03	INOR-101-6048F	MA.300-NTPT 2.0	COLORIMETRY
Total Organic Carbon	2017-10-04	2017-10-04	INOR-101-6057F	MA. 405-C 1.1	TITRATION

Method Summary

CLIENT NAME: NATIONAL RESEARCH COUNCIL

AGAT WORK ORDER: 17M264711

PROJECT: Meliadine

ATTENTION TO: David Juck

SAMPLED BY:

SAMPLING SITE:

PARAMETER	DATE PREPARED	DATE ANALYZED	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis					
Acenaphtene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Acenaphthylene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Anthracene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Benzo (a) anthracene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Benzo (a) pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Benzo (b,j,k) fluoranthène	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Benzo (b) fluoranthene	2017-09-28	2017-09-29	ORG-100-5102	EPA SW-846 8270	GC/MS
Benzo (j) fluoranthene	2017-09-28	2017-09-29	ORG-100-5102	EPA SW-846 8270	GC/MS
Benzo (k) fluoranthene	2017-09-28	2017-09-29	ORG-100-5102F	EPA SW-846 8270	GC/MS
Benzo (c) phenanthrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Benzo (g,h,i) perylene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Chrysene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dibenzo (a,h) anthracene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dibenzo (a,i) pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dibenzo (a,h) pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dibenzo (a,l) pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dimethyl-7,12 benzo (a) anthracene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Fluoranthene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Fluorene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Indeno (1,2,3-cd) pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Methyl-3 cholanthrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Naphtalene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Phenanthrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Pyrene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Methyl-1 naphtalene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Methyl-2 naphtalene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Dimethyl-1,3 naphtalene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Trimethyl-2,3,5 naphtalene	2017-09-28	2017-09-29	ORG-100-5102F	MA.400-HAP 1.1	GC/MS
Acenaphtene-D10	2017-09-28	2017-09-29	ORG-100-5102	EPA SW-846 3510C & 8270	GC/MS
Fluoranthene-D10	2017-09-28	2017-09-29	ORG-100-5102	EPA SW-846 3510C & 8270	GC/MS
Perylene-D12	2017-09-28	2017-09-29	ORG-100-5102	EPA SW-846 3510C & 8270	GC/MS
Moisture			LAB-111-4040F	MA.100-ST 1.1	SCALE
Benzene	2017-09-29	2017-09-29	VOL-160-5002F	MA. 400 - COV. 2.0	(P&T)GC/MS
Toluene	2017-09-29	2017-09-29	VOL-160-5002F	MA. 400 - COV. 2.0	(P&T)GC/MS
Ethylbenzene	2017-09-29	2017-09-29	VOL-160-5002F	MA. 400 - COV. 2.0	(P&T)GC/MS
Xylenes	2017-09-29	2017-09-29	VOL-160-5002F	MA. 400 - COV. 2.0	(P&T)GC/MS
Rec. Fluorobenzène (BTEX F-1)	2017-09-29	2017-09-29	VOL-160-5002F	MA. 400 - COV. 2.0	GC/MS
C6-C10 (F1)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
C6-C10 (F1-BTEX)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
C>10-C16 (F2)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
C>16-C34 (F3)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
C>34-C50 (F4)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
Heavy Hydrocarbons by gravimetry (F4G-sg)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GRAVIMETRY
Rec. Nonane (F2-F4)	2017-09-29	2017-09-29	ORG-160-5110F	CCME Method 1st section	GC-FID
% Moisture	2017-09-29	2017-09-29	INOR-161-6006F	MA. 100 - S.T. 1.0	SCALE



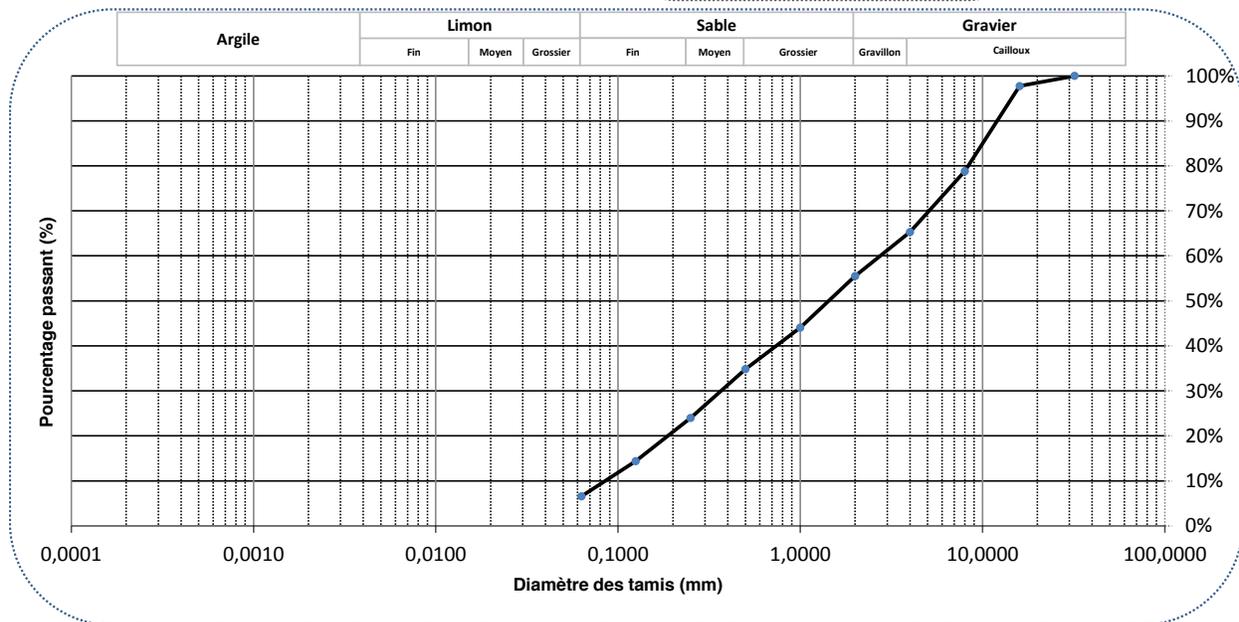
GRANULOMÉTRIE - SÉDIMENTOMÉTRIE

Classification Wentworth

No bon de travail : 17M264711 Client : National Research Council
 No échantillon : 8759989 Votre référence : MB2A
 Version du certificat :

Granulométrie Tamis (mm)	Pourcentage Passant (%)
32	100,0%
16	97,7%
8	78,8%
4	65,3%
2	55,5%
1	44,1%
0,500	34,8%
0,250	24,0%
0,125	14,4%
0,063	6,6%

Sédimentométrie Diamètre équivalent (μ m)	Pourcentage Passant (%)



Commentaires : Gravier (2-32mm) : 44,49% Limon, Argile (<63 μ m) 6,57%
 Sable (0.063-<2mm) : 48,94%

Date : 2017-10-04

Appendix H
Summary of Public Consultations / Participation

Public Consultation 2017 Meliadine

Date	Title	Location	Type	Subject categories
2017-12-11	Meeting with Peter Tapatai		In person	
2017-12-09	One-on-one assistance with M&T		Meeting	IIBA - Contractor Training
2017-11-24	By Pass road site visit with Elder/HTO representative	Rankin Inlet, NU	In person	Community - Community Development / Infrastructure / Investment Community - Hunting / Harvesting / Fishing Community - Hunters and Trappers' Organization (HTO) Community - Impacts Environment - Visual Impacts
2017-11-24	Training discussion with Albert Netser (Arctic College director for Trades program)		In person	Training / Education
2017-11-17	Rankin Inlet Community Information Session	Rankin Inlet, NU	Open House	Community - Business opportunities / Business development Community - Community Development / Infrastructure / Investment Community - Community Visits Community - Scholarships Community - Consultation Community Community Agreements - Community Investment Fund (CIF) Community Agreements Human Resources - Recruitment Human Resources - Labour Pool Process
2017-11-09	Hamlet Agnico Gala		Meeting	Community - Assistance, Donation or Sponsorship
2017-10-23	FW: Partnership Agreement- Whale Cove		Meeting	Community Agreements - Community Coordinator Agreement Community Agreements - Community Partnership Agreement
2017-10-20	Rankin HTO Meeting - October 20-2017.docx		Meeting	Community - Hunters and Trappers' Organization (HTO)
2017-10-12	Community Liaison Committee Meeting-Oct 11		Meeting	Community - Business opportunities / Business development Community - Community Development / Infrastructure / Investment Community - Hunting / Harvesting / Fishing Community - Hunters and Trappers' Organization (HTO) Community - TASK Week Community - Community Liaison Committee (CLC) Community - Wellness Planning Environment - Hazardous Waste / Waste Environment - Dust Environment - Wildlife Community Agreements - Family Days Human Resources - Recruitment Human Resources - Labour Pool Process
2017-10-03	FW: Information Meeting - TODAY 5:30		Meeting	Community - Community Development / Infrastructure / Investment Community
2017-09-22	Aluki Kotierk, NTI President		In person	Community - Impacts Community - Gender Equity Community - Employment/Jobs IIBA - Implementation IIBA Socio-Economic Training / Education
2017-09-22	Presented to Exucutive Development Leadership Program in Iqaluit	Iqaluit, NU	In person	Community Socio-Economic Training / Education Human Resources
2017-09-20	Kivalliq Mayors meeting	Rankin Inlet, NU	Meeting	Community IIBA Socio-Economic

Public Consultations 2017 Meliadine

Date	Title	Location	Type	Subject categories
2017-08-02	13 December 2016 Hamlet Council Meeting - Itivia	Rankin Inlet, NU	Meeting	Community - Community Development / Infrastructure / Investment Government - Permitting Project - Construction Activities
2017-07-27	Rankin Inlet Public Meeting - Itivia	Rankin Inlet, NU	Public Meeting	Community - Community Development / Infrastructure / Investment Environment - Vibration Environment - Dust Environment - Caribou Project - Construction Activities Issues or Concerns - Complaint
2017-07-26	Rankin HTO Meeting	Rankin Inlet, NU	Meeting	Community - Hunters and Trappers' Organization (HTO)
2017-07-18	Rankin Inlet - Community Open House		Meeting	Community Environment - Dust Project - Construction Activities
2017-07-18	Rankin Inlet - Open House Itivia	Rankin Inlet, NU	Open House	Environment - Dust Project - Construction Activities Issues or Concerns - Complaint
2017-07-17	Rankin SAO: Dust control	Rankin Inlet, NU	Meeting	Community - Impacts Environment - Dust Environment - Water
2017-07-12	MEL OSWG #2017-01	Rankin Inlet, NU	Meeting	IIBA - Meliadine Working Group
2017-07-11	Phone call with Nunavut Airports - Itivia project		Meeting	
2017-07-10	Meeting with Chesterfield Hamlet Council	Chesterfield Inlet, NU	In person	
2017-07-05	Meeting with Coral Harbour HTO	Chesterfield Inlet, NU	In person	Project - Whale Tail
2017-06-19	High school awards	Rankin Inlet, NU	In person	Community
2017-06-19	Phone call with Nunavut Airports - Itivia Permitting project		Meeting	Government - Permitting
2017-06-08	Meeting with Panniuq		Meeting	IIBA - KIA Information Transmission IIBA - Meadowbank Working Group
2017-06-05	Q2 Employment session Rankin Inlet	Rankin Inlet, NU	Open House	IIBA Human Resources - Labour Pool Process
2017-05-23	Implementation Committee Meeting #2017-01	Rankin Inlet, NU	Meeting	IIBA - Implementation Committee (IC)
2017-05-18	CPA Financial Statements Training Review	Rankin Inlet, NU	Meeting	Community - Business opportunities / Business development Training / Education
2017-05-17	Rankin Shooting Range		Meeting	Community - Community Development / Infrastructure / Investment Health & Safety
2017-05-17	Meliadine On-Site IIBA Awareness	Rankin Inlet, NU	Meeting	IIBA - Implementation
2017-05-17	Meliadine On-Site IIBA Awareness	Rankin Inlet, NU	Meeting	IIBA - Implementation
2017-05-16	High School Awards	Rankin Inlet, NU	Meeting	Training / Education
2017-05-16	IIBA awareness and BOC visit presentation notes	Rankin Inlet, NU	Meeting	IIBA - Business Opportunities Committee (BOC)
2017-05-16	Phone call with Nunavut Airports - Itivia Permitting project		Meeting	Government - Permitting
2017-05-15	Rankin Hamlet Agnico Working group	Rankin Inlet, NU	Meeting	Community - Hamlet Working Committee Community - Impacts Community Community Agreements - Community Investment Fund (CIF) Community Agreements - Green Community Agreement Health & Safety
2017-05-12	2017 Business Opportunities Information Session - Rankin Inlet		Open House	Procurement - Pre-qualification Process Procurement - Tendering Process
2017-05-10	Meliadine On-Site IIBA Awareness	Rankin Inlet, NU	Meeting	IIBA - Implementation

Public Consultations 2017 Meliadine

Date	Title	Location	Type	Subject categories
2017-05-04	Site Tour		Site Tour	Community - Impacts Environment - Visual Impacts
2017-04-28	Phone call with Hamlet - Itivia Permitting project		Meeting	Government - Permitting
2017-04-24	Hamlet Council meeting - Itivia Permitting project	Rankin Inlet, NU	Meeting	Government - Permitting
2017-04-20	Introduced and set up future meeting re: Itivia Emergency Services		Meeting	Community - Impacts Community
2017-04-20	2017 Q1: Open Door Baker Lake	Baker Lake, NU	Public Meeting	IIBA - Business Opportunities Committee (BOC) IIBA - Employment and Culture Committee (ECC) Project - Whale Tail Procurement - Pre-qualification Process Human Resources - Labour Pool Process
2017-04-19	2017 Q1: Rankin Inlet - Itivia Open House and Q1 Employment Information Session April 2017	Rankin Inlet, NU	Open House	IIBA - Employment Information Session (EIS) Project - Construction Activities Human Resources - Labour Pool Process
2017-04-13	Meeting with Nunavut Airports - Itivia Permitting project		Meeting	Government - Permitting
2017-04-03	Phone call with Hamlet - Itivia Permitting project		Meeting	Government - Permitting
2017-03-31	Baker Lake Interim Mayor		Meeting	Community - Community Development / Infrastructure / Investment Community - Assistance, Donation or Sponsorship Community Government Socio-Economic Community Agreements Training / Education
2017-03-31	Rankin Inlet - Itivia Open House March 2017		Open House	Project - Construction Activities Human Resources - Labour Pool Process
2017-03-30	Robert Janes Hudson Bay Roundtable		Meeting	Community Government
2017-03-30	Mayor Bob Leonard		Meeting	Community Government
2017-03-30	Naujaat Mayor		Meeting	Community Government
2017-03-24	Phone call with Nunavut Airports - Itivia Permitting project		Meeting	Government - Permitting
2017-03-16	Hamlet meeting re: boat launch and Itivia Project		In person	
2017-03-16	informal meeting with councillor	Rankin Inlet, NU	In person	Community - Hamlet Working Committee Project
2017-03-15	Meeting with National Defense - Itivia Permitting project		Meeting	Government - Permitting
2017-03-13	Hamlet Council meeting - Itivia Permitting project	Rankin Inlet, NU	Meeting	Government - Permitting
2017-02-27	Meeting with Nunavut Airports - Itivia Permitting project	Rankin Inlet, NU	Meeting	Government - Permitting
2017-02-27	Hamlet Council Meeting - Itivia Permitting project	Rankin Inlet, NU	Meeting	Government - Permitting
2017-02-17	Hamlet AEM Working group meeting	Rankin Inlet, NU	Meeting	Community
2017-02-10	Itivia and NU Airports		In person	Community
2017-01-25	Meeting with Nunavut Airports - Itivia Permitting project	Rankin Inlet, NU	Meeting	Government - Permitting
2017-01-24	Meeting with National Defense - Itivia Permitting project		Meeting	Government - Permitting
2017-01-19	Boat laung idea meeting with Hamlet		Meeting	Community
2017-01-17	Boat launch idea		Meeting	Community