Regulatory Water Quality Sampling and Aquatic Effects Monitoring at the Diavik Diamond Mine, Northwest Territories, Canada

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Abstract
The Diavik diamond mine in the Northwest Territories, Canada mines kimberlite ore for diamond extraction. The mine site is located on a 20 km^2 island within a 560 km^2 oligotrophic lake. Effluent discharge and surveillance monitoring is regulated by a legally-recognized aboriginal management authority formed through a Federal and Territorial land claims and self-government agreement. Regulatory obligations for effluent and environmental water quality include routine surveillance monitoring at 76 stations (33 are currently active) on and around the mine site, and aquatic effects monitoring four times per year at 37 stations within the surrounding lake. Surveillance monitoring includes water quality from open pit and underground inflows, site collection ponds and discharge effluent. Aquatic effects monitoring includes sampling of sediment, water chemistry, benthic invertebrates, phytoplankton, zooplankton and fish health at near-field, mid-field and far-field stations within the surrounding lake. Although influences from the mine can be detected in various parameters at near-field and mid-field stations, effects measured remain below regulated criteria and predictions made during the Environmental Assessment.

Key Words: mining, regulatory sampling, water, sediment, biota

Introduction
Mining operations can introduced suspended and dissolved constituents to the receiving environment as a result of blasting, ore processing, waste rock and tailings storage, on-site construction activities, and other day-to-day mining activities.

Effluent quality criteria (EQC), surveillance monitoring, and aquatic effects monitoring at the Diavik diamond mine are regulated by a Type A Water License issued by the Wek'èezhìi Land and Water Board (WLWB). The WLWB is a legally-recognized aboriginal management authority formed through a Federal and Territorial land claims and self-government agreement. This paper describes the regulatory monitoring programs at the Diavik diamond mine and results from the monitoring programs.

Site description
The Diavik diamond mine is an operating open pit and underground diamond mine in the Northwest Territories, Canada (Figure 1). The mine site is in the zone of continuous permafrost in the treeless "barren lands" of the Canadian Arctic. The area receives little precipitation, with an annual average (1999-2006) of 280 mm, 60% of which occurs as snow (Environment Canada 2011). The mean annual air temperature (1998-2007) is -8.5 ºC, with maximum mean temperatures occurring in July (18ºC) and minimum mean temperatures occurring in January/February (-31ºC; Environment Canada 2011).

The mine site is located on a 20 km^2 island within Lac de Gras, a 560 km^2 oligotrophic lake. Lac de Gras flows from east to west and forms the headwaters of the Coppermine River. Lac de Gras water quality characterized during the 1996 baseline study is summarized in Table 1. The EQC parameters biological oxygen demand (BOD_5), oil and grease, and faecal coliforms were not reported in the baseline study and are omitted from the table. Dissolved metal concentrations were similar to total metal concentrations due to the low amount of particulate matter present in Lac de Gras (Table 1).

Figure 1: Location of Diavik Diamond Mine (Google maps). The white star identifies the location of the Diavik Diamond Mine and the yellow circle identifies Yellowknife, Northwest Territories.

Table 1: Water quality evaluated during 1996 baseline study. Parameters listed are the same as operational EQC parameters, with the exception of ammonia, which is reported as a dissolved concentration in the baseline study.

Parameter (units)	**Winter Median (range)**	**Summer Median (range)**	**Fall Median (range)**
Ammonia-N (dissolved) (mg/L)	0.04 (0.03– 0.05)	0.05 (0.01–0.06)	<0.1 (<0.1)
Total aluminium (mg/L)	0.16 (0.009–0.056)	0.044 (0.024–0.087)	0.008 (0.006–0.065)
Total arsenic (mg/L)	0.0003 (0.0003–0.0005)	<0.002 (<0.002)	N/A
Total copper (mg/L)	0.0012 (0.0007 – 0.0018)	0.0015 (0.0009–0.0172)	0.0007 (0.0002–0.0023)
Total cadmium (mg/L)	<0.0002 (<0.0002)	<0.0002 (<0.0002)	<0.0002 (<0.0002)
Total chromium (mg/L)	0.0002 (<0.0002–0.0004)	0.0068 (0.0035–0.0085)	0.0018 (0.0016–0.0031)
Total lead (mg/L	0.0010 (0.0003–0.0030)	<0.0003 (<0.0003–0.0010)	<0.0003 (<0.0003–0.0003)
Total Zinc (mg/L)	0.011 (0.006–0.028)	<0.0006 (<0.0006–0.0096)	0.004 (0.001–0.016)
Total nickel (mg/L)	0.002 (0.001–0.004)	0.0038 (0.0024–0.0075)	<0.0005 (<0.0005–0.0092)
Nitrite-N (mg/L)	0.003 (<0.003-0.004)	N/A	N/A
Total suspended solids (TSS) (mg/L)	2.0 (<2.0 – 3.0)	<0.4 (<0.4)	0.5 (0.4–0.7)
Turbidity (NTU)	N/A	0. 3 (0.1–0.70)	N/A
pH (lab)	6.16 (6.08–6.23)	6.06 (5.92–6.17)	6.09 (6.03–6.19)

The diamondiferous kimberlite ore bodies that are being mined are located underwater in Lac de Gras. Two water-retaining dikes have been constructed into the lake to permit open pit mining of the three ore bodies, referred to as A154N, A154S and A418. All mine infrastructure, including waste rock and tailings storage facilities, is located on the 20 km^2 island (Figure 2). Secondary containment for the waste rock and tailing storage facilities is provided by a series of collection ponds.

Figure 2: Diavik site map (2009) and SNP stations (red dots with labels)

Mine water, including pit and underground inflows and transfers from the site collection ponds, is stored in the North Inlet prior to treatment and discharge. The North Inlet is a natural inlet of Lac de Gras that was isolated from the main lake by two dams (Figure 2). All mine water in the North Inlet is treated at the North Inlet Water Treatment Plan (NIWTP) prior to discharge to Lac de Gras. The NIWTP is designed to remove fine solids in cold water conditions. The major system components include: coagulant and flocculant preparation equipment, four high capacity clarifiers, four deep bed sand filters, a pH-control system, and an effluent discharge diffuser. Clarifiers and filters can be operated in series or alone. The clarifiers alone have been sufficient to achieve EQC, thus the sand filters and pH-control system are not used.

Regulatory requirements

The Type A water license issued by the WLWB ("water license") is essentially the "license to operate" for the Diavik Diamond Mine. The water license outlines on-land and off-shore monitoring stations, sampling frequency, analytical parameters and reporting requirements. Operational EQC, applicable to all discharges from the mine site, are provided in Table 2.

Table 2: Operational Effluent Quality Criteria

Parameter (units)	**Maximum average concentration**	**Maximum concentration of any grab samples**
Total ammonia (mg/L)	6.0 mg/L	12.0
Total aluminium (mg/L)	1.5 mg/L	3.0
Total arsenic (mg/L)	0.05	0.1
Total copper (mg/L)	0.02	0.04
Total cadmium (mg/L)	0.0015	0.003
Total chromium (mg/L)	0.02	0.04
Total lead (mg/L)	0.01	0.02
Total Zinc (mg/L)	0.01	0.02
Total nickel (mg/L)	0.05	0.1
Nitrite (mg/L)	1.0	2.0
Total suspended solids (TSS) (mg/L)	15.0	25.0
Turbidity (NTU)	10	15
Biological oxygen demand (BOD_5) (mg/L)	15.0	25.0
Oil and grease (mg/L)	3.0	5.0
Faecal coliforms (CFU/100 ML)	10	20
	Minimum	**Maximum**
pH (pH units)	6.0	8.4
	Maximum monthly load	**Average annual load**
Phosphorus (kg)	300	1000

The Surveillance Network Program (SNP) required by the water license identifies 76 stations located on and around the mine site. Of these, 33 are active (Figure 2). Sampling locations are monitored at a frequency stipulated in the water license and water is sampled and analyzed when water is present at the SNP sample locations. Results are provided to the WLWB in monthly SNP reports.

Treated mine water that is discharged to Lac de Gras is the principal source of contaminants of potential concerns to Lac de Gras. Potential effects from the Diavik diamond mine on Lac de Gras are studied and reported through the Aquatic Effects Monitoring Program (AEMP), required by the water licence. The AEMP consists of 37 stations in Lac de Gras and is conducted three times per year during open water (typically July, August, September) and once per year under ice cover (typically in April). The ecosystem components evaluated through the AEMP include water chemistry, sediment quality, lake productivity, planktonic and benthic invertebrate communities and fish health. The AEMP also monitors dust deposition. The principal objective of the AEMP is to monitor the mine water discharge and other potential stressors from the mine, and assess potential ecological risks so that appropriate changes in mine operations can be implemented to mitigate possible adverse effects. The AEMP is subject to adaptive management and is updated, as necessary, when new information and results become available. For example, the AEMP, including sample locations, was expanded in 2007 to better capture spatial and temporal effects of the mine operations on the various ecosystem components within Lac de Gras.

Surveillance Network Program

Sampling and analysis

Active sampling locations include the pond within the Processed Kimberlite Containment (tailings) facility (1645-16; sampled quarterly); the sump in the active open pit (1645-50; sampled bi-weekly); underground mine inflows sampled at the discharge to the North Inlet (1645-75; sampled bi-weekly); collection ponds that collect precipitation, runoff and seepage from the Processed Kimberlite Containment facility (1645-42, 1645-59, 1645-44; each sampled monthly when water is present); collection ponds that collect precipitation, and runoff from the plant site (1645-45, 1645-46, 1645-47, 1645-74; each sampled monthly when water is present); collection ponds that collect precipitation, runoff, and seepage from the North Country Rock Pile (waste rock stockpile; 1645-68, 1645-76, 1645-67; each sampled monthly when water is present); the on-site sewage treatment plant (treated sewage that is discharged to the Processed Kimberlite Containment facility;1645-11; sampled annually); seepage stations (1645-20, 1645-21, 1645-23, 1645-25, 1645-26; each sampled monthly when water is present); groundwater wells (1645-28, 1645-29, 1645-31, 1346-32, 1645-33; visited monthly but to date no water present for sampling); the North Inlet at the intake for the NIWTP (1645-13; sampled bi-weekly); treated effluent from the NIWTP (1645-18, 1645-18B; sampled every 6 days); and Lac de Gras 60 m from the NIWTP outflow diffuser (1645-19A, 1645-19B, 1645-19C; sampled monthly).

The five SNP stations that provide the most meaningful trend in terms of regulatory compliance are the intake for the NIWTP (1634-13), the outflow from the NIWTP (1645-18 and 1645-18B), and three stations located in Lac de Gras 60 m from the NIWTP ouflow diffuser (1645-19A, 1645-19B and 1645-19C).

The outflow from the NIWTP (1645-18 and 1645-18B) are the points of compliance and are sampled every six days. Samples are collected from a dedicated sampling spigot on the outflow pipeline. Samples from the NIWTP intake (1645-13) are collected bi-weekly from a dedicated sampling spigot on the intake pipeline. At each station, sampling spigot is opened and samples are collected for field parameters (pH , temperature and electrical conductivity), on-site lab parameters (pH, turbidity, TSS, dissolved oxygen and total ammonia), and parameters for analysis at an external laboratory (nutrients, major ions, organic carbon and metals, including the EQC parameters). Samples are collected in clean, dedicated sample bottles that are triple-rinsed with sample water. Field parameters are measured using a calibrated Oakton PCD-650 multimeter. Samples sent to the external laboratory are collected in sample bottles provided by the laboratory.

Samples form 1645-19A, 1645-19B and 1645-19B are sampled monthly from either a boat (during open water) or through holes drilled in the ice (during ice cover). Field measurements of temperature, dissolved oxygen (DO), conductivity, turbidity and pH are obtained at 2 m intervals from surface to the lake bottom by lowering a HydroLab DS5 water quality meter through the water column at each sample station. Samples are collected a 2 m, 5 m, 10 m, 15m, and 20 m depths using a vertical (beta) Van Dorn sampler.

Samples and quality control/quality assurance samples are transferred from the sampler to appropriate sample bottles that are either cleaned at the Diavik Environment Lab (for field measurements), or provided by the analytical laboratory. Samples for dissolved parameters are not filtered in the field, but rather are filtered by the analytical laboratory. Water samples are sent to either ALS laboratories (before 2010) or Maxxam laboratories (after 2010) for analysis of dissolved and total parameters, including the EQC parameters total Al, total As, total Cu, total Cd, total Cr, total Pb, total Zn, total Ni, nitrite, ammonia, TSS and turbidity.

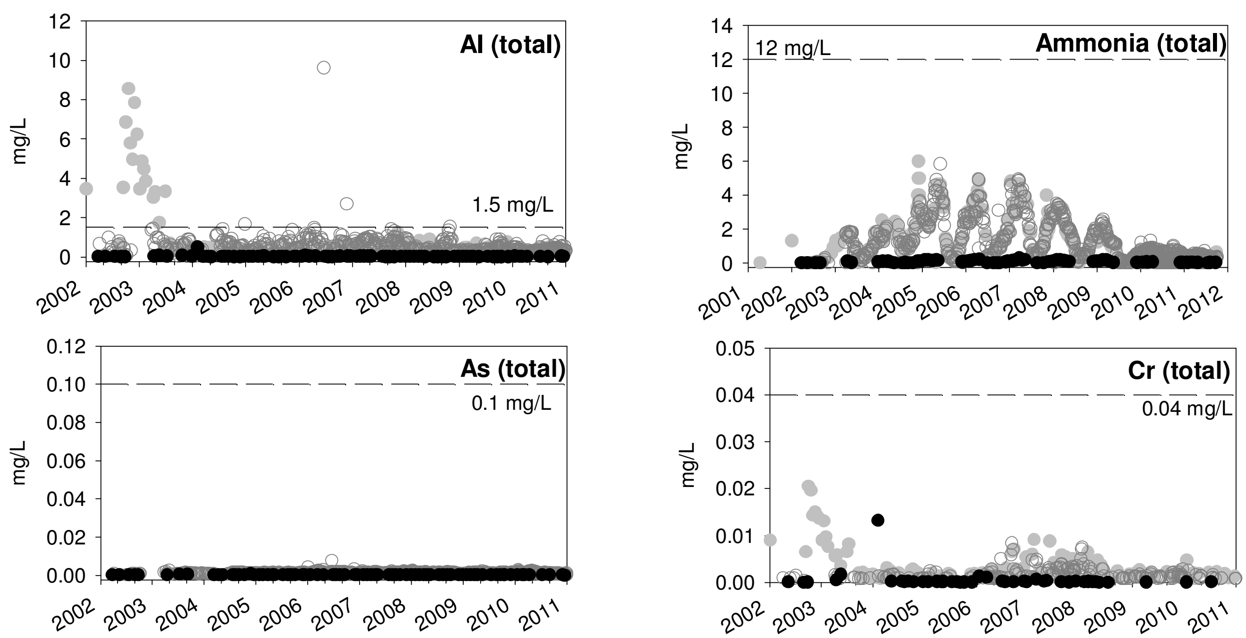
In addition to water quality sampling, toxicity testing is conducted using water collected from the outflow sampling point (1645-18). Toxicity testing requirements include: chronic toxicity to the early stages of salmonid fish, the crustacean *Ceriodaphnia dubia*, and the alga *Raphidocelis subcapitata*; acute toxicity testing with the same species and Hyalella azteca with quarterly tests unless a >50% mortality in 100% effluent is obtained when the frequency would increases to monthly. Toxicity testing is conducted by Hydroqual laboratories of Calgary, AB according to standard protocols.

Results

Results are provided to the WLWB in monthly SNP reports and an annual SNP report. Results for EQC for the intake for the NIWTP, outflow from the NIWTP, and the three stations located 60 m from the NIWTP outflow diffuser in Lac de Gras are provided here. The outflow points from the NIWTP are the points of compliance.

Since the establishment of the SNP program, there have been only isolated occurrences of parameters exceeded the EQC at the point of compliance (Figure 3). It was determined that the Zn excursions were due to analytical error and were not true increases in effluent Zn concentrations.

To date, no concerns have been identified from toxicity testing at the NIWTP outflow station 1645-18 and 1645-18B.



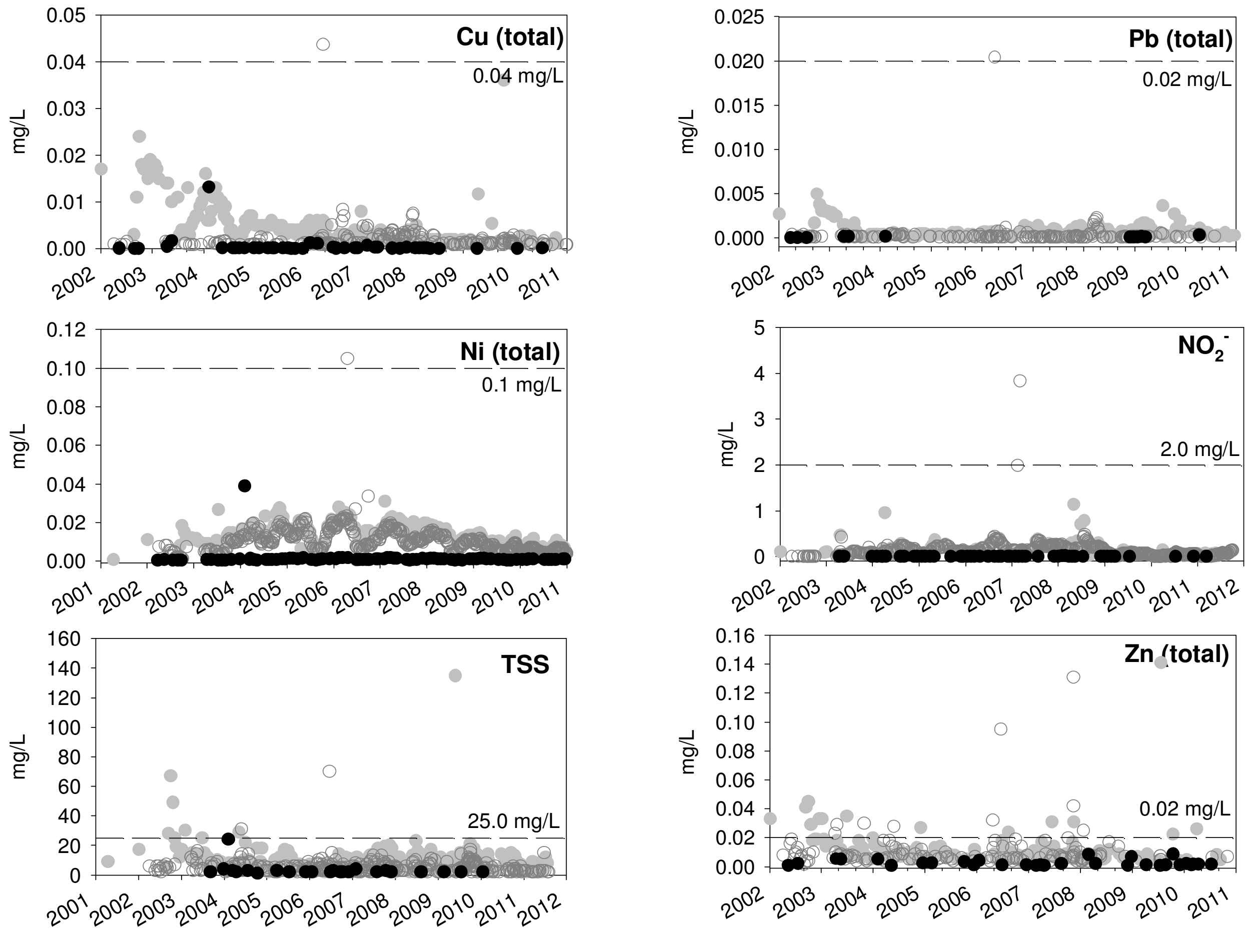


Figure 3: Concentrations of effluent quality criteria at 1645-13 (North Inlet, prior to treatment, solid grey circles), 1645-18 (North Inlet Water Treatment outflow; point of compliance, open grey circles) and 1645-19A (Lac de Gras, 60 m from outflow diffuser at 10 m depth, black circles). EQC (maximum grab concentration) is represented by dashed line. Cadmium is not presented because all samples from 1645-13 and 1645-18 were <0.0007 mg/L (below EQC), and most samples were below detection limit (either 0.0005 or 0.0002 mg/L). All samples from 1645-19A (10 m) were below detection limit (either 0.0005 or 0.0002 mg/L). Points measured below detection limit do not appear in plots. Turbidity, BOD_5, oil and grease and faecal coliforms are not illustrated.

Aquatic Effects Monitoring Program

Sampling and analysis

Water samples for the AEMP are collected at five near-field (NF) stations, three mid-field (MF) areas with four stations in each area, and four far-field (FF) areas with five stations in each area (Figure 4).Samples are collected during four sampling periods: one sampling period during ice cover (April), and three open water periods, approximately monthly, from July to September.

Field measurements of temperature, dissolved oxygen (DO), conductivity, turbidity and pH are obtained by lowering a HydroLab DS5 water quality meter through the water column at each sample station. Water samples for chemical analysis are collected at designated depths using a vertical (beta) Van Dorn sampler. Samples and quality control/quality assurance samples are transferred to appropriate sample bottles provided by the analytical laboratory. Samples for dissolved parameters are not filtered in the field, but rather are filtered by the analytical laboratory. Water samples are sent to either ALS laboratories (before 2010) or Maxxam laboratories (after 2010) for analysis of dissolved and total parameters, including the

EQC parameters total Al, total As, total Cu, total Cd, total Cr, total Pb, total Zn, total Ni, nitrite, ammonia, TSS and turbidity.

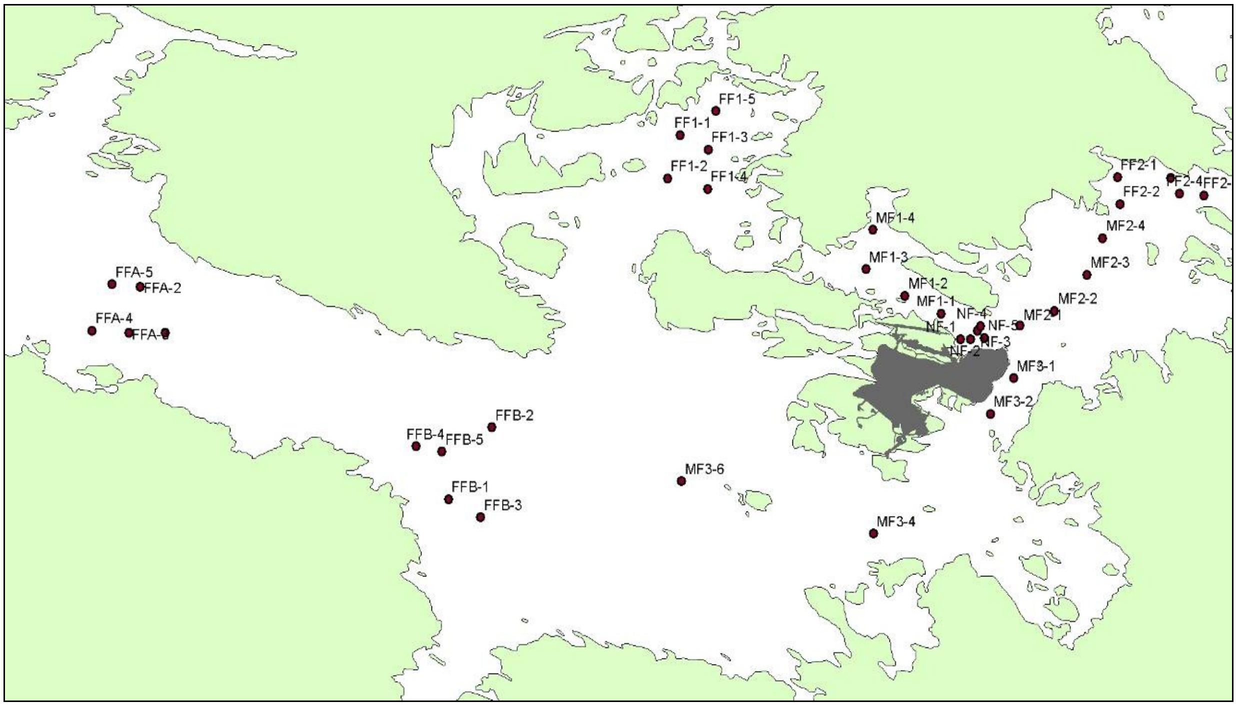


Figure 4: AEMP sample locations (dark circles with labels) in Lac de Gras. Grey shaded area represents the Diavik Mine site.

Sediment samples for the AEMP are collected during the second open water period (August) at the same time as water chemistry sampling and benthic invertebrate sampling. A plexiglass sediment piston-corer is used to collect samples of the top 1 cm of sediment. Multiple 1 cm cores are collected at each sampling location and combined into a single sample for analysis. Sediment core samples are analysed for sediment chemistry at ALS laboratories in Edmonton, Alberta. An Ekman grab is used to collect the top 5 cm of sediment for analysis of particle size distribution, total organic carbon (TOC), total nitrogen (TN) and total phosphorus (TP). Ekman grab samples are analysed by ALS Laboratories in Edmonton Alberta.

Benthic invertebrate samples for the AEMP are collected at each of the sample locations during the second open water sampling period (around August). An Eckman grab is used to collect samples at each sample location. Six individual samples are collected per sample location. Each sample is sieved and the material retained on the 250 µm mesh is transferred to a 1 L plastic bottle for transport to an independent consultant. The samples are analysed for taxonomy and enumeration: total invertebrate density and biomass, richness, Simpson's Diversity Index, evenness index, dominance, Bray-Curtis distance from median reference area community, percentage of Chironomidae, densities of dominant taxa, Pisidiidae, *Procladius sp*., *Heterotrissocladius sp*., *Microspectra sp*., and *Abiskomyia sp.*

Small-bodied fish (slimy sculpin, *Cottus cognatus*) are sampled as the fish health indicator because they remain in a local area throughout their life-cycle, thus providing spatially discrete fish health information. Slimy sculpin are collected in NF and FF stations during the first open water period (June-July). At each station, 100 fish are collected by stunning using a Smith-Root Model type VII backpack shocker with an 18-inch anode ring. The shocker has been modified to provide sufficient current for electro-fishing in the very low conductivity waters of Lac de Gras. Of the 100 fish samples per station, 40 are used for non-lethal measurements which include external examinations of length, weight and any observation of wounds or parasites. The remaining 60 samples are used for lethal measurements including age (from otoliths), length, weight, observation of wounds or parasites, sex, maturity, organ condition, stomach contents, and fish tissue chemistry. Fish tissue chemistry was analyzed by ALS Laboratories in Vancouver, BC.

Dust deposition is monitored by snow core surveys in April and dust collection gauges. Snow cores are collected using a custom snow core. The snow core is allowed to melt and the melt water is analyzed for total suspended solids (TSS) in the internal lab. The TSS is assumed to originate from dust. Dust collection gauges are installed to capture dust particles at 12 stations. The dust collection gauges are 52 cm long and approximately 12.7 cm in diameter. The dust gauges are sampled four times per year in March, May, August and December and the dry weight of the collected dust is measured from each gauge. The snow core and dust gauge locations are illustrated in Figures 5a and 5b, respectively.

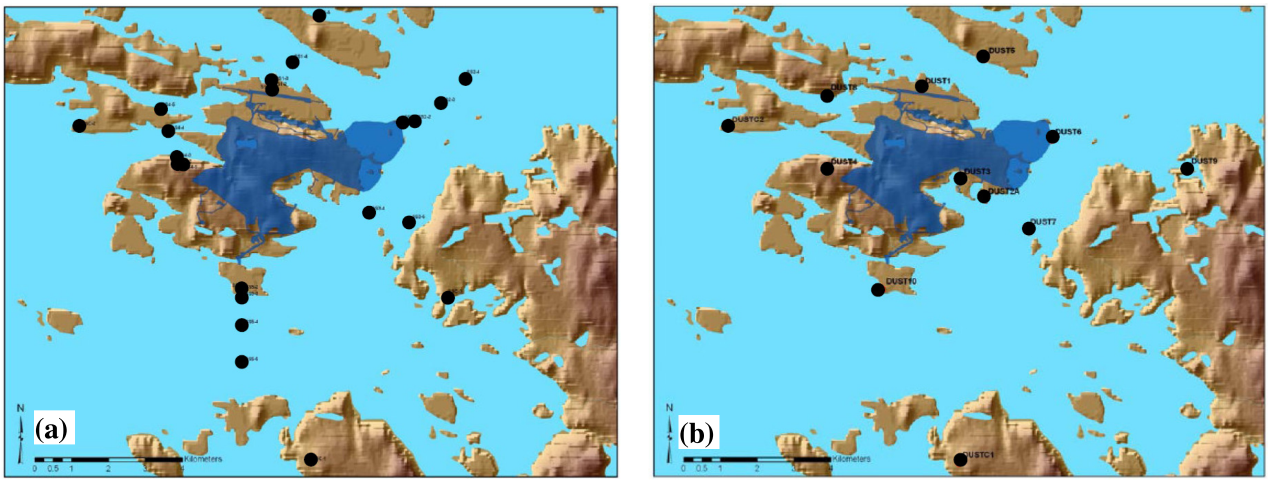


Figure 5: (a) Snow core survey locations (black dots) and (b) dust gauge locations (black dots). The extent of the Diavik Diamond Mine is shaded dark blue.

Results

Results are provided to the WLWB in an annual AEMP reports, available to the public on the WLWB on-line public registry. A summary is provided here.

Water chemistry

Water quality parameters have been consistently below operational EQC for all stations in the AEMP, including at the NIWTP discharge station. Substances of Interest (SOI) were identified for more rigorous evaluation of spatial effects of mine water discharge on Lac de Gras. Statistical differences in SOI concentrations between NF and FF stations, effluent actute toxicity failures, or SOI exceedence of bench marks are used to determine effect levels on Lac de Gras.

The SOIs for 2010 included total dissolved solids (TDS), total ammonia, sulphate, chloride, total aluminum, total arsenic, total boron, total copper, total iron, total manganese, totally molybdenum, total uranium, total alkalinity, calcium, magnesium, potassium and strontium. Total copper did not trigger any effect. The remaining SOI showed an early warning or low effect. No higher-level effects have been identified in 2010 or in previous years.

Of the SOIs, TDS, total alkalinity, Cl, SO_4, Mo, and Sr increased gradually over time in each NF, MF and FF areas, however concentrations remain low. MF and FF stations farther from the NF areas showed less pronounced, or no, trends. Increases of total alkalinity, Mo and Sr were statistically significant in both ice-covered and open water seasons whereas increases in concentrations of Cl and SO_4 were only statistically significant in open water seasons. No trend over time was identified for total ammonia, Al, As, B, Fe and Mg.

Table 3 provides the EQC predictions for mine water discharge and Lac de Gras at the end of mine life. Turbidity and Oil and Grease, operational EQC in the water license, were not evaluated as part of the Environmental Assessment and are omitted from the table.

Table 3: Mine water discharge screening predictions for the year 2023 from the Environmental Assessment (DDMI 1998).

Parameter (units)	**Mine water discharge**	**Average in Lac de Gras**	**In Lac de Gras within 0.01 km2 of outflow**
Ammonia nitrogen as N (mg/L)	1.783	0.052	0.086
Aluminium (mg/L)	0.059	0.023	0.024
Arsenic (mg/L)	0.0044	0.0003	0.0003
Copper (mg/L)	0.0072	0.0012	0.0013
Cadmium (mg/L)	0.00098	0.00006	0.00008
Chromium (mg/L)	0.0038	0.0001	0.0002
Lead (mg/L	0.0010	0.0004	0.0004
Zinc (mg/L)	0.006	0.005	0.005
Nickel (mg/L)	0.017	0.002	0.003
Nitrite nitrogen as N (mg/L)	0.248	0.010	0.014
Total suspended solids (TSS) (mg/L)	25	1.5	1.9
Biological oxygen demand (BOD_5) (mg/L)	<10	-	Change in DO <0.1 mg/L
Faecal coliforms (CFU/100 ML)	<5	0	<<1
pH (pH units)	8.22	6.5	NA

In addition to chemical parameters, total phosphorus, total nitrogen, chlorophyll a and zooplankton biomass are used as indicators for eutrophication in Lac de Gras. Chlorophyll a concentrations and zooplankton biomass at NF stations were higher and statistically different than FF stations, with enrichment in up to 20% of Lac de Gras. Concentrations of total phosphorus and chlorophyll a increased at both NF and FF stations from baseline conditions, but the geographical extent has not been observed to be expanding over time. Total phosphorus concentrations remain within the normal range (calculated from baseline concentrations plus/minus two standard deviations), however phosphorus enrichment has been identified in up to 16% of Lac de Gras, but with no progression of aerial extent over time. Total nitrogen concentrations have been above the normal range in open water conditions, however there is no increasing temporal trend, and may actually be decreasing. The area of Lac de Gras affected by total nitrogen is about 20%. Zooplankton biomass in NF areas indicate increasing seasonal trends, though within or only slight exceedences of the normal range. FF stations have inconsistent trends with some years showing an increase in biomass and other years showing a decrease. Less than 14% of Lac de Gras has been affected by zooplankton changes.

Sediment quality
Sediment quality from AEMP sample stations in Lac de Gras is evaluated to determine nutrient enrichment and/or contaminant exposure. Sediment TOC concentrations at NF and FF areas were not statistically different. Twelve SOIs were identified by NF concentrations higher than FF concentrations. Sediment SOIs include bismuth, boron, calcium, chromium, lead, magnesium, potassium, sodium, tin, titanium, uranium and vanadium. Concentrations of B, Cr, Ti and V were statistically higher in NF areas than FF areas, but within normal ranges, however concentrations of Bi, Ca, Pb, Mg, K, Na, Sn and U were both statistically higher in NF areas than FF areas, and above the normal range. Concentrations of a number of trace metals and nutrients in Lac de Gras sediments naturally exceed guidelines from the Canadian Council of Ministers of the Environment (CCME, 2002) and the Ontario Ministry of the Environment and Energy (OMOEE, 1993).

Benthic invertebrates
Benthic community analysis evaluates potential effects on populations from nutrient enrichment and from toxicological impairment. Total density, richness and densities of common invertebrates are higher in the NF areas compared to the FF areas. Trends in benthic invertebrate populations are consistent with water quality and sediment quality results. Benthic communities in NF areas were dominated by the Chironomidae with *Pisidiidae sp.* and midges accounting for over 90% of the total invertebrates. Other common, but less abundant groups included Oligochaeta and Hdracarina. Dominance and Simpson's diversity index remain mostly within normal ranges, though varied over time without trend, in each area. Evenness was low in NF and MF areas and remain within normal range. Densities of *Pisidiidae* sp. vary without trend, with densities above the normal range in some years; densities have generally increased in MF areas. Densities of *Procladius* sp, *Heterotrissocladius* sp. and *Micropsectra* sp. tend to fluctuate within the normal range without trend. In general, the magnitude of nutrient enrichment effect has increased over time.

Fish health and fish tissue
Results from the fish population assessments on slimy sculpin indicated populations were within normal range but there was a statistical difference between NF and FF stations. Statistical differences were observed in condition factor, relative liver size, population size, size-at-age, and incidence of pathology. The differences included increased size, size-at-age and condition factor in adult fish at NF stations, as a result of increased food availability from nutrient enrichment.

A Lake Trout survey conducted in 2008 indicated no increase in tissue metals concentrations relative to baseline concentrations. Tissue from slimy sculpin indicated higher body burdens of metals in populations in NF areas compared to FF areas. However, there is no evidence of negative effects on fish health.

Dust
Dust deposition rates are highest adjacent to the mine and rapid decrease with distance from the mine. The highest deposition rates are to the east, south and west of the mine, as per the prevailing northeast wind direction, and are influenced by localized activity such as infrastructure (dam) construction, pit blasting, rock crushing, haul truck traffic and airport activities. Chemical analysis of snowmelt indicate that concentration of all parameters are below EQC, with the exception of a single sample that had elevated Zn concentrations, and multiple samples along one transect with elevated phosphorus concentrations.

Conclusions
The Diavik Diamond Mine conducts comprehensive environmental monitoring around the mine site as well as in the surrounding oligotrophic lake. The monitoring programs are the Surveillance Network Program (mine site sample locations) and the Aquatic Effects Monitoring Program (lake sample locations). These programs are regulatory requirements of the water license issued by the legally-

recognized aboriginal management authority, the Wek'èezhìi Land and Water Board. The water license stipulates maximum acceptable discharge limits (effluent quality criteria) for total ammonia, total aluminum, total arsenic, total copper, total cadmium, total chromium, total lead, total zinc, total nickel, nitrite, total suspended solids, turbidity, BOD_5, oil and grease and faecal coliforms.

The Surveillance Network Program consists of 33 active sample locations around the mine site for water quality sampling, including the point of compliance for the effluent quality criteria. The point of compliance is the outflow from the on-site water treatment plant, which treats mine water for suspended solids. To date, mine water discharge has complied with the effluent quality criteria except for isolated excursions, which may be related to analytical error.

Water, sediment and benthic invertebrates, phytoplankton, zooplankton and fish health are sampled at 76 stations within the lake as part of the Aquatic Effects Monitoring Program. Although influences from the mine can be detected in various parameters at near-field and mid-field stations, effects measured remain below regulated criteria and predictions made during the Environmental Assessment.

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Acronyms

AEMP – Aquatic Effects Monitoring Program
EQC – Effluent Quality Criteria
FF – far-field
MF – mid-field
NF – near-field
NIWTP – North Inlet Water Treatment Plant
SNP – Surveillance Network Program
SOI – substance of interest
TDS – total dissolved solids
TN – total nitrogen
TOC – total organic carbon
TP – total phosphorus
TSS – total suspended solids
WLWB – Wek'èezhìi Land and Water Board

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