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# DDMI 2012 AEMP Annual Report Review

**Presented to**

Environmental Monitoring Advisory Board
(for the Diavik Mine)

**Presented by**

North/South Consultants Inc.

*Yellowknife, 24 June 2013*

# Background

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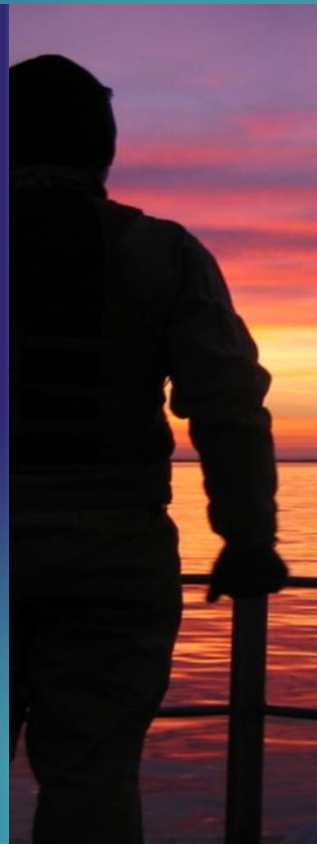
- The current AEMP Study Design (Version 3.0) for the Diavik mine site was conditionally approved by the WLWB in May, 2012
- 20 recommendations were outlined in the WLWB Staff Report as part of the Decision Package for the new Design
- Diavik is required to revise the Design to include these recommendations and resubmit as Version 3.1



# Background

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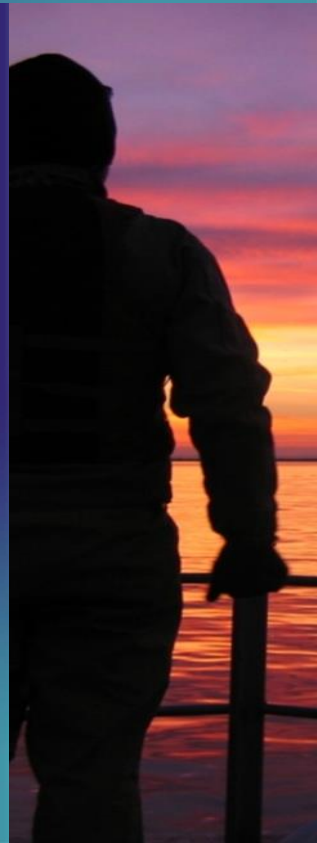
- An important recommendation included further work by Diavik on Effects (Action) Levels, initiated and coordinated by WLWB staff
- Diavik has recently submitted a revised Section 5.3 (Action Levels) and Section 5.4 (Benchmarks) as part of Version 3.1 for WLWB review and approval
- There will be an opportunity to learn more about these revisions and ask questions tomorrow afternoon



# Background

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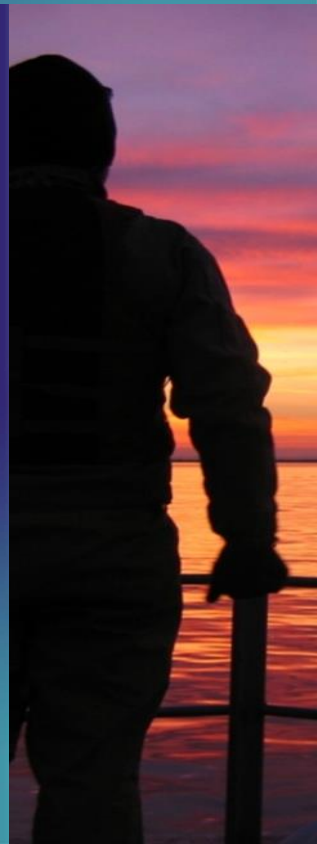
**The 2012 program included the following components:**

1. Dust Deposition (dust gauges and snow cores)
2. Effluent and Water Chemistry (effluent from the North Inlet Water Treatment Plant and lake water)
3. Plankton (algae and zooplankton)
4. Eutrophication Indicators (nutrients, chlorophyll *a*, zooplankton biomass)
5. Large Bodied Fish – Palatability and Tissue Chemistry (mercury in Lake Whitefish and Trout)



# Review Approach

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**To provide a technical review of the 2012 studies while considering whether:**

- Sampling and analyses as detailed in the Study Design Version 3.0 were performed
- Quality Assurance Project Plan Version 2.0 was followed;
- Results and conclusions were appropriately and accurately reported
- Recommendations for the 2012 AEMP provided by the WLWB in Decision Packages were considered from
  - 2011 AEMP
  - Study Design Version 3.0

# General Comments

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- 2012 AEMP results reflect those observed in previous years – nutrients (N and P) released from the treated mine water discharge are causing low to moderate enrichment-effect in Lac de Gras
- The non-technical summary is generally consistent with the more detailed information provided in the technical appendices
- Recommendations provided in the technical appendices are sound; however, DDMI inconsistently brings the recommendations forward to the non-technical summary

# Dust Deposition: AEMP Conclusions

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- Dust deposition rates measured since 2001 (including 2012) have exceeded those predicted from model results
- As in previous years, daily deposition rates were highest immediately adjacent to the highest activity areas (e.g., airport, south and west of the open pits)
- Concentrations of regulated parameters in snow water (metals, nutrients) were highly variable among zones, but all were below the maximum allowed concentration outlined in the water license

# Dust Deposition: Key Points

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- WLWB Decision Package for 2011 AEMP recommended that potential impacts to LdG surface water quality from dust deposition be assessed as part of 2012 AEMP
  - Does not appear to have been included in 2012 Annual Report
- QA/QC samples (duplicates, equipment blanks) were collected; however, they were not evaluated to aid in determining whether or not the sampling program is providing reliable data (e.g., potential contamination of samples)

# Effluent and Water Chemistry: AEMP Design

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- AEMP Study Design Version 3.0 follows a 3-year cycle: annual monitoring of exposure areas; monitoring of reference areas every third year
- Objective of the Annual Report is to provide updates on trends in the data
- Detailed spatial analysis and determination of effects levels will follow comprehensive sampling in 2013
- 2012 sampling periods
  - April 20 – May 6 (ice-cover)
  - August 16 – 23 (open-water)

# Effluent and Water Chemistry: AEMP Conclusions

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- All effluent samples passed acute or chronic toxicity tests
- Regulated effluent parameters were below water licence discharge criteria (Nov 2011 – Oct 2012)
- Total ammonia loads generally lower in 2012 open-water season compared to previous years
- Total phosphorus loads highest in 2012 since 2002 (did not exceed monthly or annual maximum discharge criteria)
- Total arsenic loads have generally increased since 2009 (highest in 2012)

# Effluent and Water Chemistry: AEMP Conclusions

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- No water quality variables with benchmarks (guidelines for aquatic life, drinking water) were exceeded (TP evaluated in Eutrophication Indicators)
- TDS, total alkalinity, chloride, sulphate, total molybdenum, and total strontium concentrations continue to increase at exposure areas
- Barium concentrations continued to decline, reflecting reductions in total annual loads to LdG since 2006
- Arsenic concentrations are increasing at exposure stations beyond the NF

# Effluent and Water Chemistry: Key Points

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- A lower DL for total boron is required to allow continued analysis of this variable
- Ongoing QC issues for total ammonia, total aluminum, and total zinc cause some uncertainty in the results for these substances of interest
- Follow-up on implementation of WLWB recommendations (e.g., review phosphorus loadings)
- Clarification of changes with Study Design Version 3.0 (e.g., relocation of MF stations; data used to estimate normal range of substances of interest)

# Plankton: AEMP Design

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- AEMP Study Design Version 3.0 includes plankton component (Special Effects Study in Version 2.0)
- Goal is to monitor plankton communities during the open-water and assess effects of mining
- Objective of the Annual Report is to provide updates on trends in the data
- Detailed spatial analysis and determination of effects levels will follow sampling in 2013
- 2012 sampling periods
  - August 16 – 23 (open-water)

# Plankton: AEMP Conclusions

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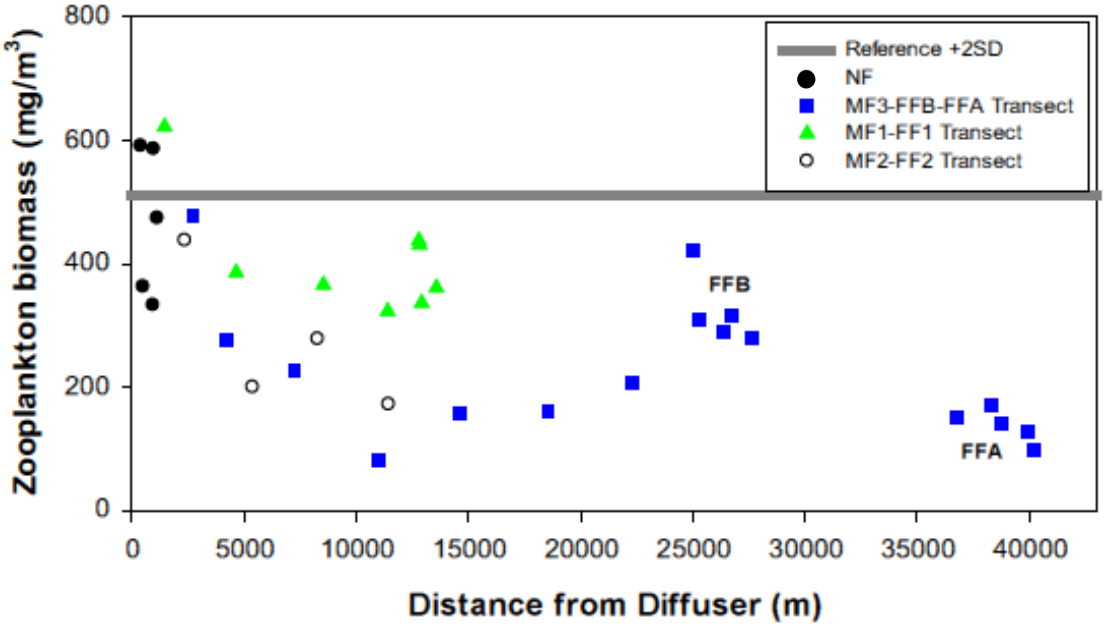
**Figure 3-10 Zooplankton Biomass in Lac de Gras According to Distance from the Diffuser during the Open Water Period, 2012 AEMP**




Note: mg/m$^3$ = milligrams per cubic metre; m = metre; NF = near-field; MF = mid-field; FF = far-field; SD = standard deviation.

# Plankton: Key Points

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- Clarification of  changes with Study Design Version 3.0 (e.g., data used to estimate normal range for 2012 zooplankton biomass)
- Follow-up on implementation of WLWB recommendations (e.g., include edible vs. non-edible phytoplankton species & associated effects through the food chain)
- Decline in phytoplankton richness and biomass over time in most areas of LdG may be related to other factors (e.g., weather) rather than a reduced response to nutrient enrichment

# Eutrophication Indicators: AEMP Design

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- Objective is to determine if effluent is having an effect on concentrations of nutrients & chlorophyll *a* (phytoplankton biomass estimate), & zooplankton biomass
- Level of effects (early/warning, moderate, high) based on categories in AEMP Study Design Version 2.0 (new effects levels currently under review)
- 2012 sampling periods
  - April 20 – May 5 (ice-cover)
  - August 16 – 23 (open-water)

# Eutrophication Indicators: AEMP Conclusions

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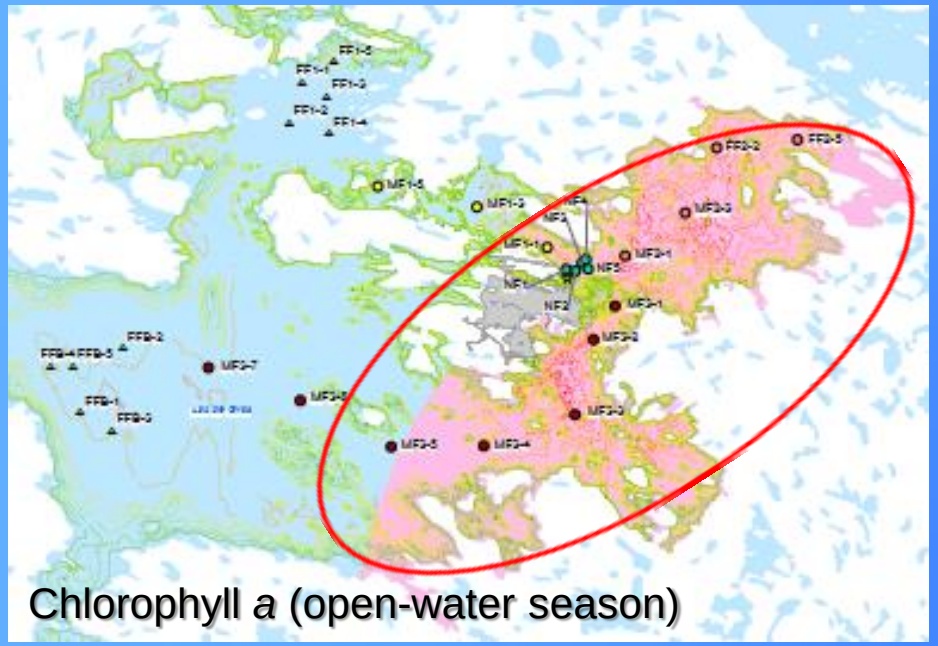

Chlorophyll *a* (open-water season)

Total Phosphorus (ice-cover season)

# Eutrophication Indicators: AEMP Conclusions

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**Table 4-1 Extent of Effects on Chlorophyll *a*, Total Nitrogen, Total Phosphorus Concentrations and Zooplankton Biomass from 2007 to 2012**

| Year | Chlorophyll a | | Total Nitrogen | | Total Phosphorus | | Zooplankton Biomass | |
|---|---|---|---|---|---|---|---|---|
| | Area ($km^2$) | Proportion of lake (%) | Area ($km^2$) | Proportion of lake (%) | Area ($km^2$) | Proportion of lake (%) | Area ($km^2$) | Proportion of lake (%) |
| 2007 | 93.4 | 16.3 | 49.8 | 8.7 | 77.7 | 13.6 | - | - |
| 2008 | 120 | 21.0 | 121 | 21.1 | 91.6 | 16.0 | 57.7 | 5.7 |
| 2009 | 177 | 31.0 | 143 | 24.9 | 63.7 | 11.1 | 77.7 | 13.7 |
| 2010 | 180 | 31.4 | 138 | 24.0 | 85.8 | 15.50 | 32.6 | 10.1 |
| 2011 | 88.8 | 15.5 | 204 | 35.6 | 197 | 34.4 | 195 | 34.0 |
| 2012 | 140 | 27.3 | 211 | 36.9 | 1.78 | 0.31 | 0.92 | 0.16 |

Notes: "-" = no sample; $km^2$ = square kilometres; the proportion of the lake affected calculation is based on the area affected divided by the total surface area of the lake (573 $km^2$) .

# Eutrophication Indicators: AEMP Conclusions

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**Table 5-1 Effect Levels for the Eutrophication Indicators Analysis Based on the Study Design Version 2.0 (DDMI 2007a)**

| Analysis | Measurement Endpoint | Effect Classification[(a)] |
|---|---|---|
| Reference Areas vs. Exposure Areas | Chlorophyll *a* (estimate of phytoplankton biomass) and total phosphorus | ++ |
| | Zooplankton Biomass | + |

(a) – "+" = early warning/ low level effect; "++" = moderate level effect, and "+++" = high level effect (the "+" indicates an increase in measurement endpoints).

# Eutrophication Indicators: Key Points

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- Lack of reliable 2012 open-water season total phosphorus (TP) data is problematic
  - Spatial comparisons for 2012 not possible
  - Data not available to assess temporal trends
- Golder noted that measured and calculated TP yield different results, with calculated TP concentrations being greater and more variable than measured
  - Given the difficulties with the P analysis in 2012, they recommend that both calculated and measured TP concentrations be determined in 2013

# Large Fish – Tissue Chemistry: AEMP Design

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- As per the AEMP Study Design Version 3.0, the fish palatability & tissue chemistry surveys have been incorporated into the Traditional Knowledge (TK) program
- AEMP TK Camp held July 31 – August 4, 2012, at the community-based monitoring camp site on the south shore of LdG
- Tissue from 14 fish (13 Lake Trout, 1 Lake Whitefish) was sampled for metal concentrations (including Hg)
- Surveys will be conducted every three years (2015)

# Large Fish – Tissue Chemistry: AEMP Conclusions

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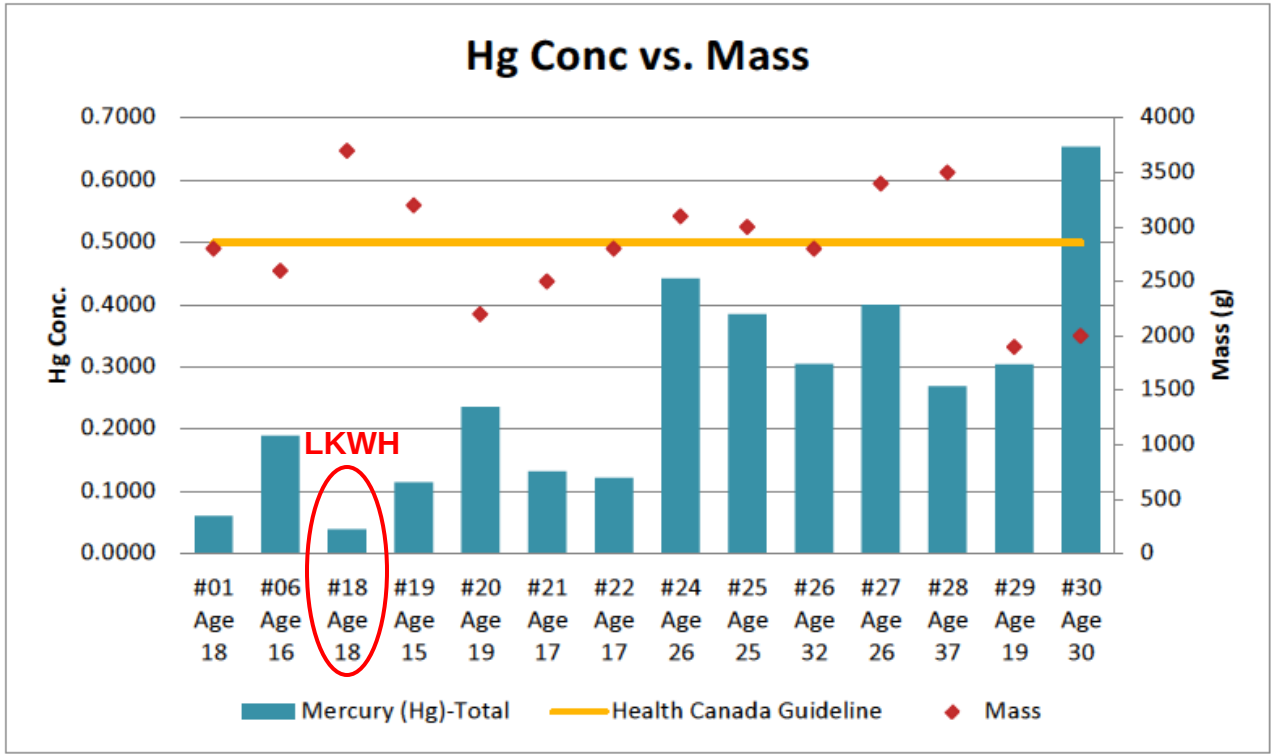
**Figure 3.2-1** Mercury (Hg) Levels for Fish Based on Weight and Age




# Large Fish – Tissue Chemistry: Key Points

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- It would be helpful to indicate in tables and on figures the location of fishing sites (UTMs are provided)
  - NF, MF, FF, etc.
- *"Additionally, we can see that the two fish identified as being skinny and unsuitable for eating (Fish 29 & 30) by community participants had quite high mercury concentrations with lower than average body weights and ages of 19 and 30, respectively."*
  - Need to consider all factors that may contribute to reduced condition factor of a fish (e.g., Fish 30 had intestinal worms)

# Questions & Discussion

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