Aboriginal Affairs and Northern Development Canada | Affaires autochtones et Développement du Nord Canada

The Link Between Tailings Pond Gas Generation and Variable Ice Conditions

Colomac Mine Remediation Project, Northwest Territories

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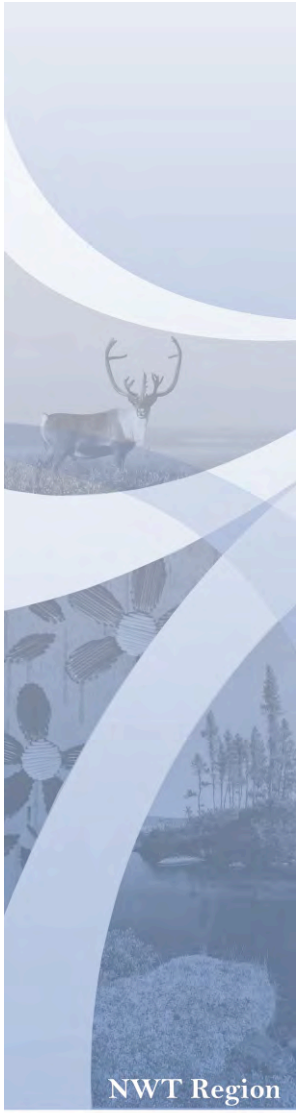

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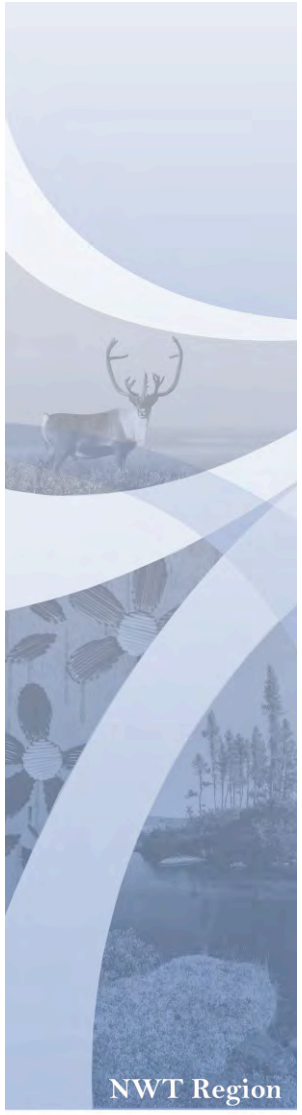
Acknowledgements

- Golder Associates Ltd
- AANDC-CARD Senior Management
- Colomac Care and Maintenance Contractor (Tli Cho Logistics Ltd.)
- Colomac Final Remediation Contractor (AEL-TEES)



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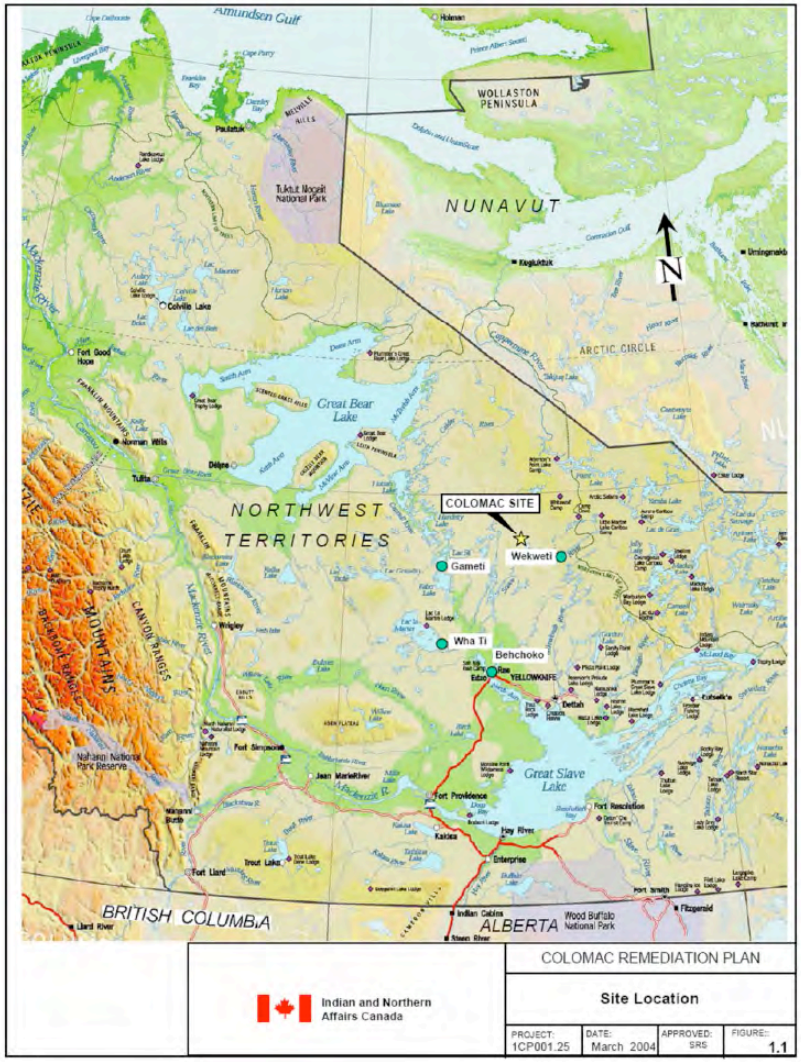
Project Location



- 220 km North of Yellowknife, NT
- 50 km Northwest of Wek'weeti
- At the headwaters of the Indin R. and Snare R. watersheds

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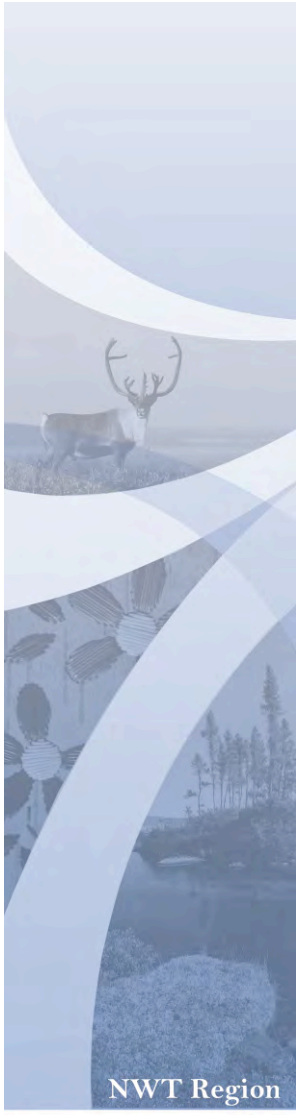
Background

- Former gold mine (1990-1997)
- During operation, cyanide bearing tailings were deposited in Tailings Lake and Spruce Lake
- AANDC (formerly INAC) assumed responsibility for site in April 1999
- Project in care and maintenance until the Remediation Plan was developed and approved in 2005
- Main remediation activities were completed between 2005 – 2011
- Project is currently entering the closure and monitoring stages of the remediation process



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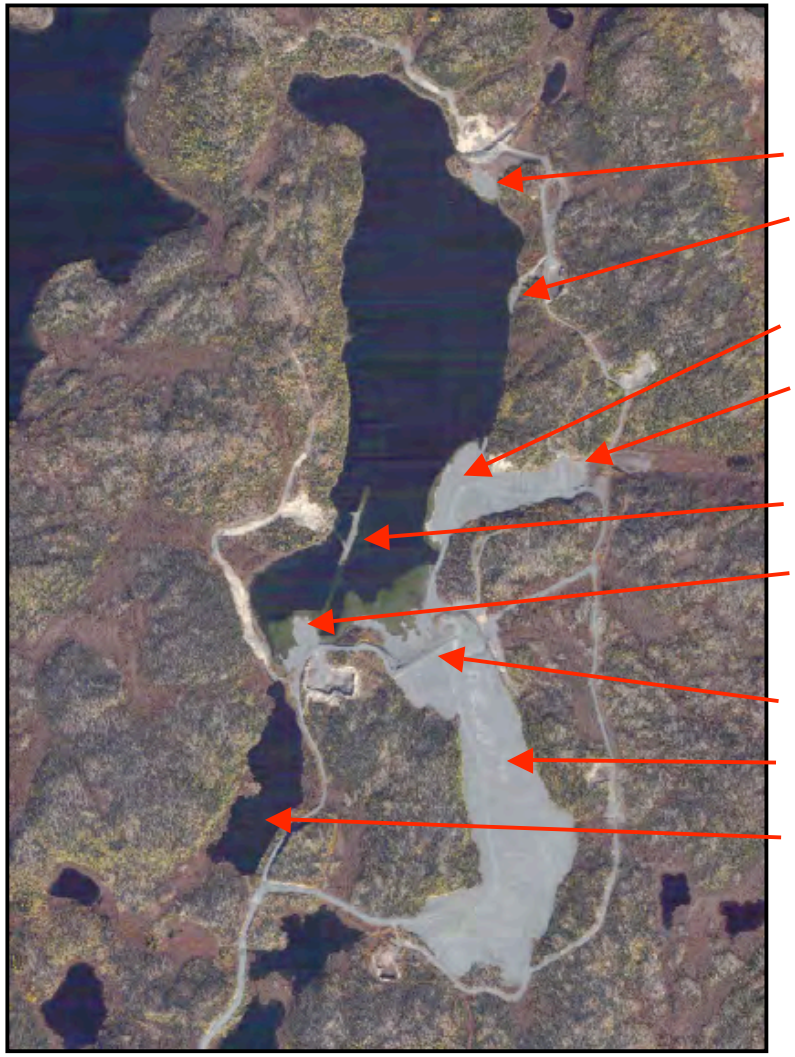
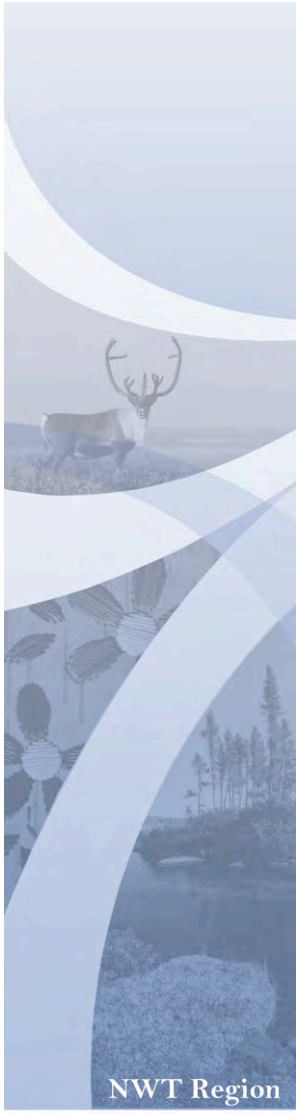
Tailings Containment Area



- Dam 2 Tailings Beach (capped)
- Mid-Lake Tailings Beach (capped)
- Dam 1 Tailings Beach (capped)
- Dam 1/1b
- Causeway
- Causeway West Tailings Beach (capped)
- Dyke 7
- Spruce Lake (capped)
- Fuscum Lake (un-impacted)

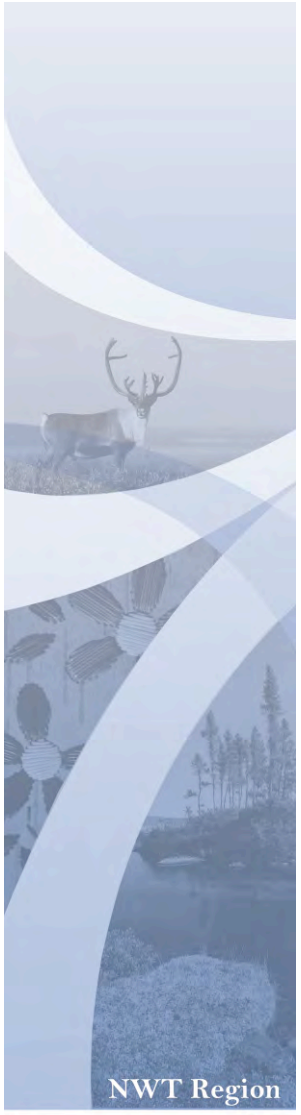
Tailings Lake Remediation

- In 2002-2003 high cyanide concentrations treated using an Enhanced Natural Remediation (ENR)
- Tailings beaches capped with waste rock in 2006 to prevent wildlife exposure to tailings
- New Dam 1b constructed downstream of existing Dam 1 in 2006-07
- Discharge Channel Constructed at Dam 2 in 2006
- Discharge from Dam 2 Area to receiving environment commenced Fall 2008



Tailings Lake Gas Generation

- Gas generation has been observed in Tailings Lake over the project life
- Bubbling occurs in distinct vents and is characterized as either consistent or intermittent
- Open vents have been observed in aerial and ground level photos taken during winter months
- Variable ice formation and quality have been observed over short distances



Gas Vent Formation

Aerial view, Spring

Ground Level view, Fall

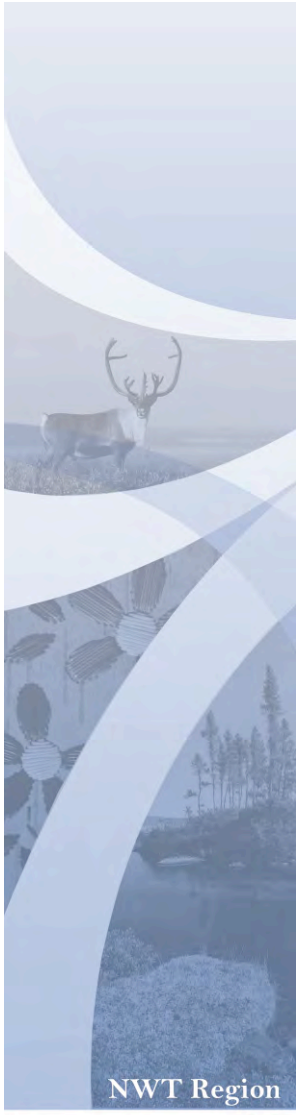
Variations in Ice Composition

Poor ice quality showing high concentration of air bubbles

Good Ice Quality – Blue Ice

Tailings Lake Study (2009-2010)

- Tailings Lake Investigation:
  - Phase I completed in Fall 2009
  - Phase II completed in Fall 2010
- Included:
  - Gas vent distribution mapping
  - Collection of gas, water quality, sediment and benthic samples
  - Bathymetry data
  - Isotopic analysis of gas samples



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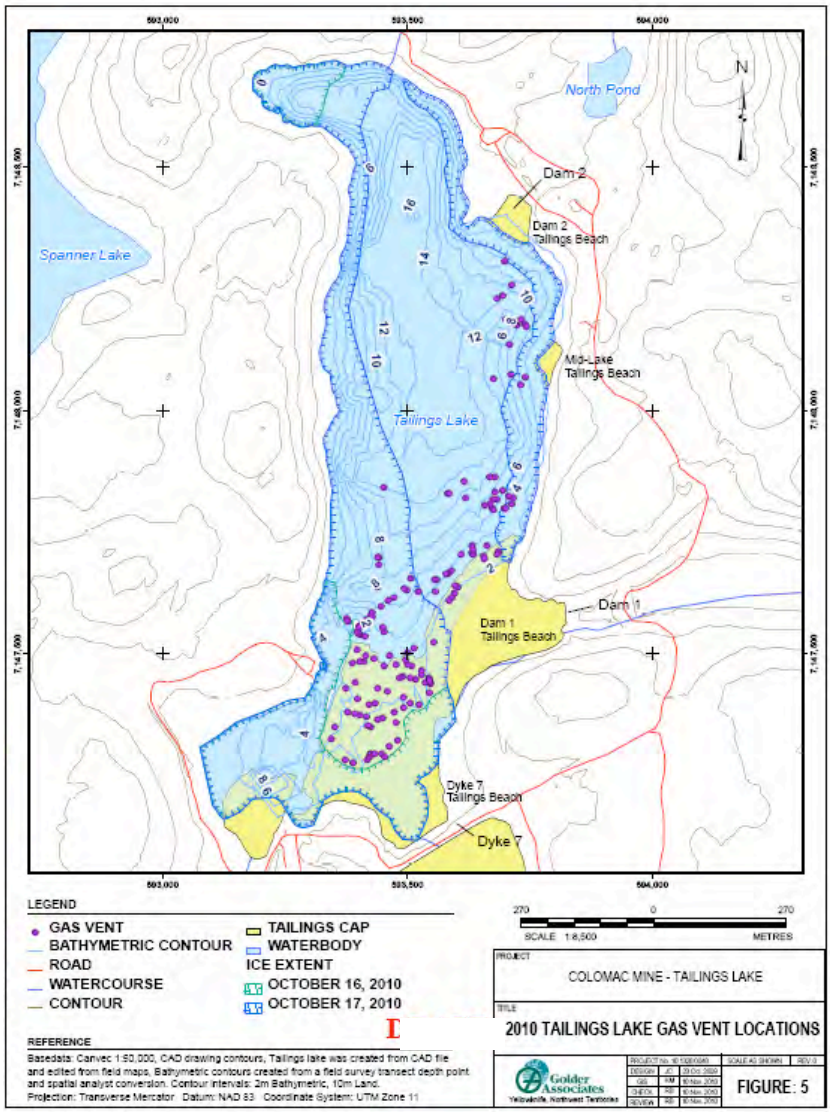
Gas Vent Distribution

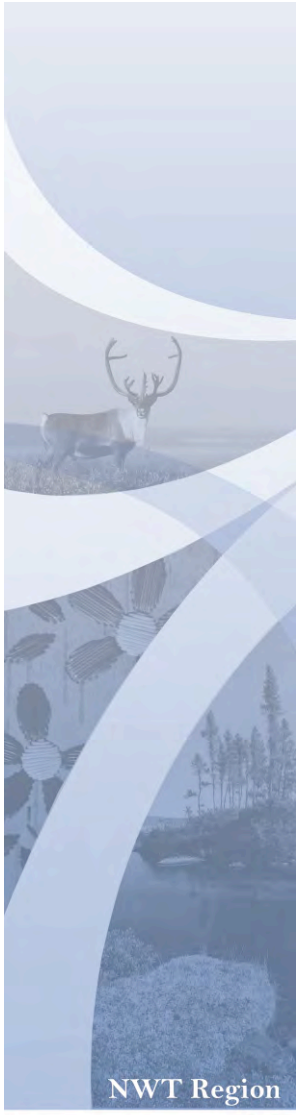


- Gas generation primarily associated with and/or down gradient of capped tailings
- Gas venting occurs to lesser extent in the capped mid-lake tailings beach (East shore)

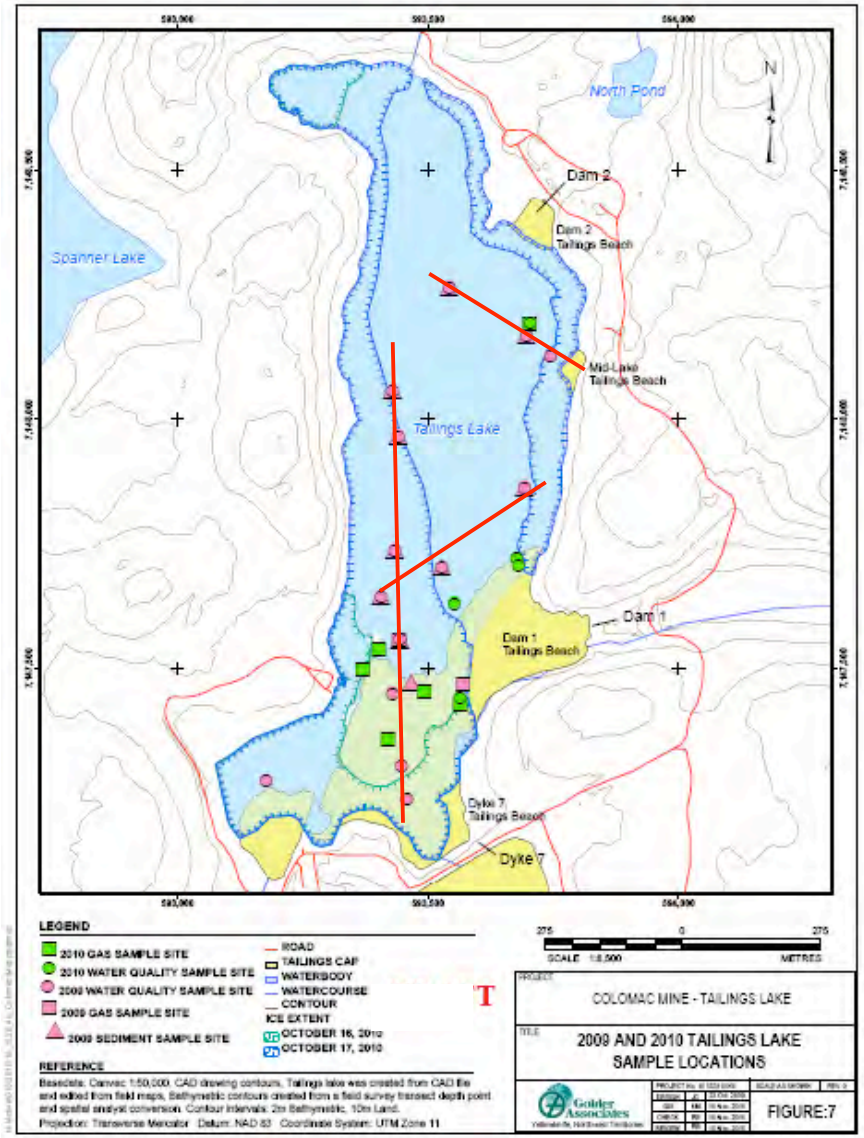
Golder, 2011

Sample Collection

- Gas Samples:
  - Collected using an innovative PVC frame + tarp device, and Silonite canisters under vacuum
  - Included collection of ambient air samples
- Sediment Samples:
  - Collected using an Eckmann Dredge
  - Coring devices were shown to be ineffective
- Water Quality Samples:
  - Collected using a Kemmerer sampler
  - Collected along three transects



Sample Locations



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Sample Collection

Golder, 2011

Gas sampling apparatus

Golder, 2011

Silonite canister

Gas Analysis

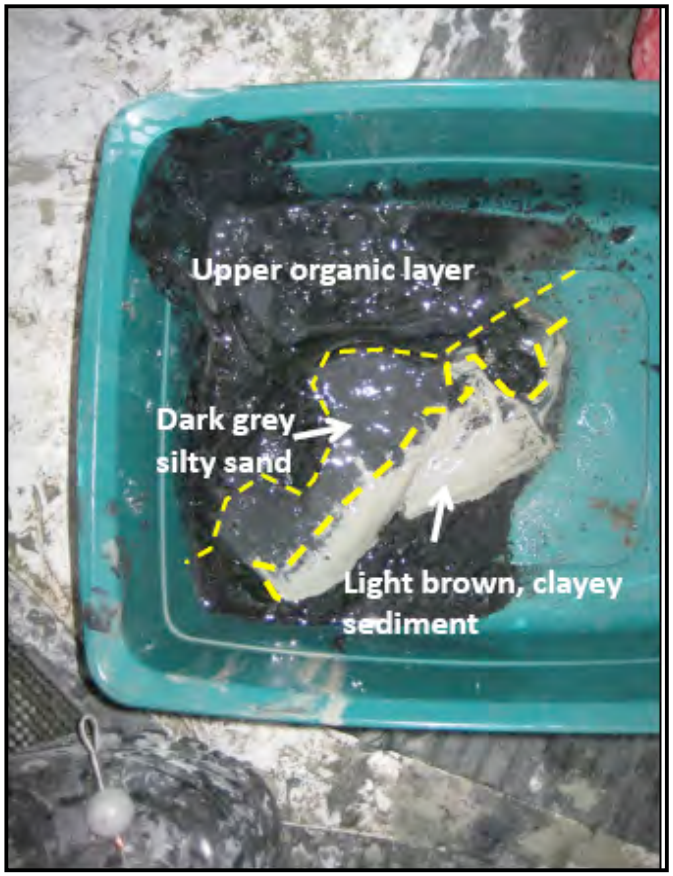
	N_2 (%)	O_2 (%)	HC (%)	CO_2 (%)	H_2S (%)
Low	4.7	2.1	0.01	0.0952	<dl
High	57.5	16.3	0.92	0.1470	<dl
Ambient	78.5	21.2	<dl	0.0462	<dl

Golder, 2011

N = 7

- Subsamples for two samples were analyzed at a second lab due to low calculated mass balances (10-74%)
  - H_2 :
    - Lab 1: 0.13 -0.2%
    - Lab 2: 81% - 90%

Sediment Analysis

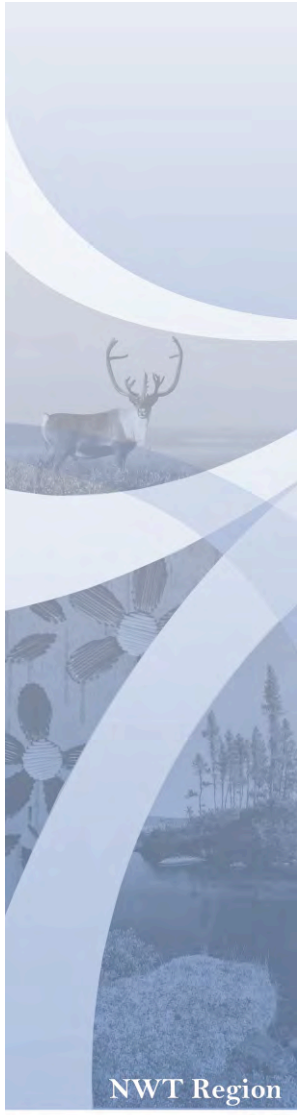


Golder, 2010

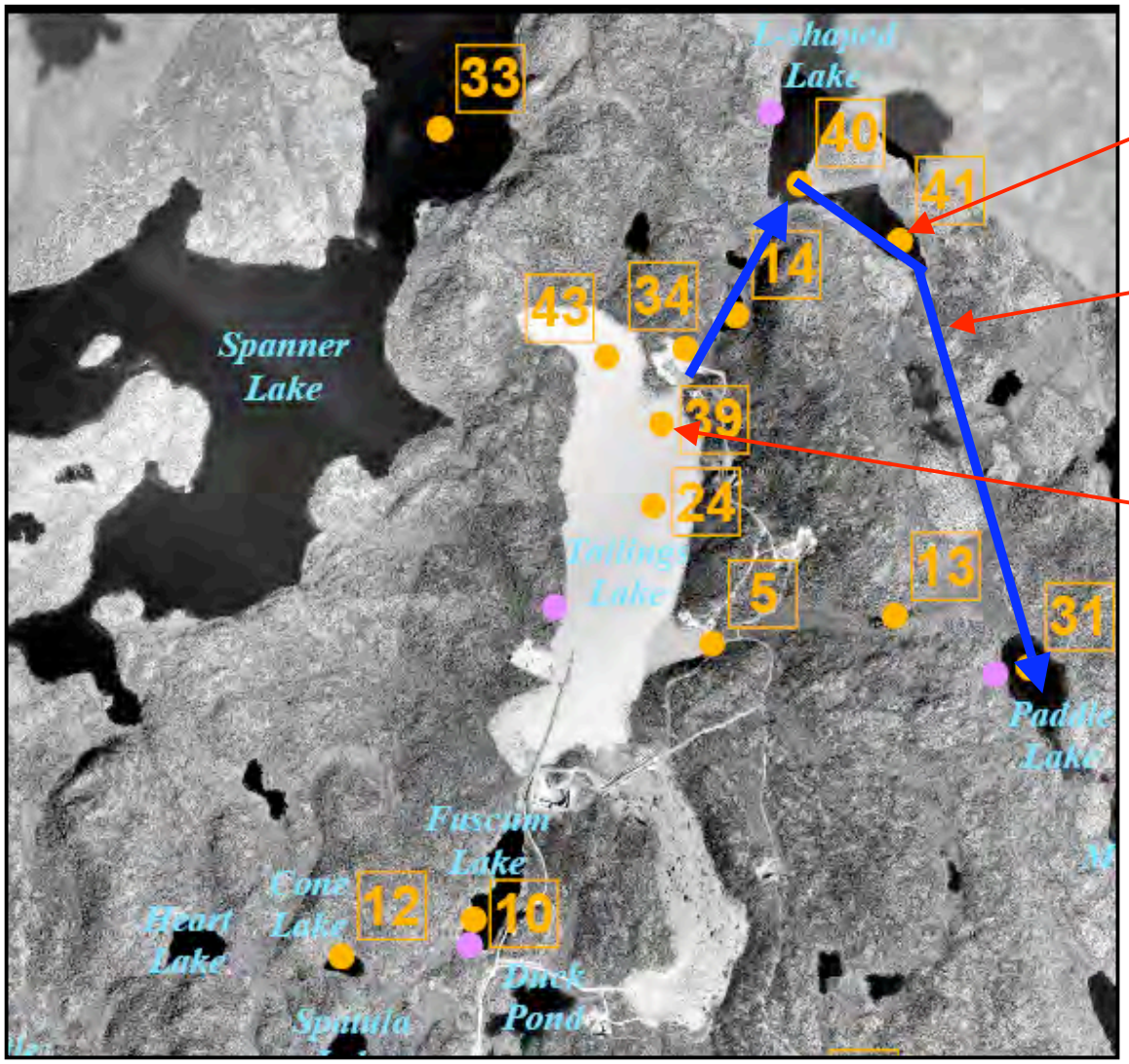
- Upper Organic Layer – deposited during ENR
- Mid layer – fine grained tailings deposited during mine operations
- Basal layer – native lake bottom sediments
- Iron bacteria, slime – forming bacteria, sulphur reducing bacteria identified in all three layers

Water Quality Results

- Relatively clear, very hard, and alkaline
- Nutrients (NH_3, P) were enriched at depth; P was below detection limit at surface
- Total metals concentrations were generally within CCME Guidelines
- Cu concentrations were above the CCME Guideline (naturally elevated due to geology)
- Consistent with SNP Data which show that water quality has remained within Water License Discharge Criteria (W2009L8-0003)



Surveillance Network Program



Compliance Point

Direction of Water flow

Tailings Lake Discharge Station

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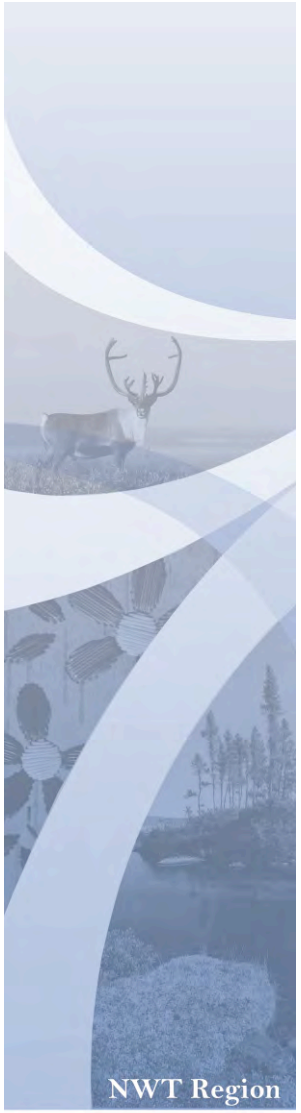
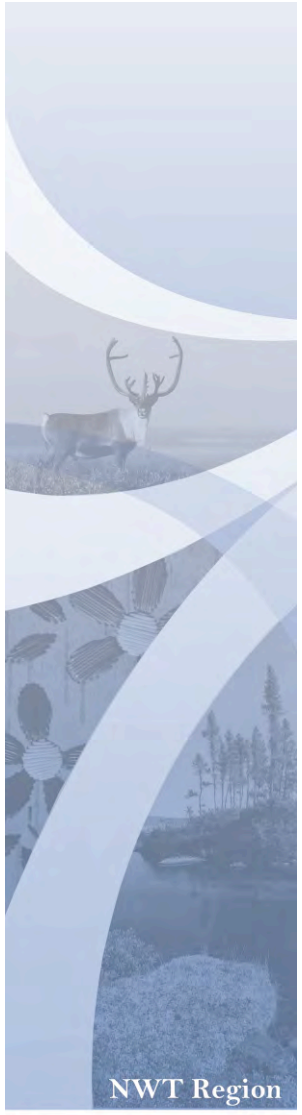
Summary of Investigation

- Several mechanisms were hypothesized to contribute to gas generation
  - Organic matter biogeochemical degradation
  - Biochemical degradation of cyanide residuals in tailings below cap
  - Re-consolidation/re-saturation of tailings below cap (physical)
- Additional research is required to improve understanding of processes within sediments



Public Safety at Site Closure

- Installation of warning signs at access points and high water mark
- Placement of waste rock barriers to warn approaching snowmobilers
- Public Safety Announcements



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Public Safety at Site Closure

Safety barrier construction at Dyke 7 (L) and completed barrier at Dam 1 (R)

Aerial view of Dam 1 Berm

Weak Ice Warning Sign

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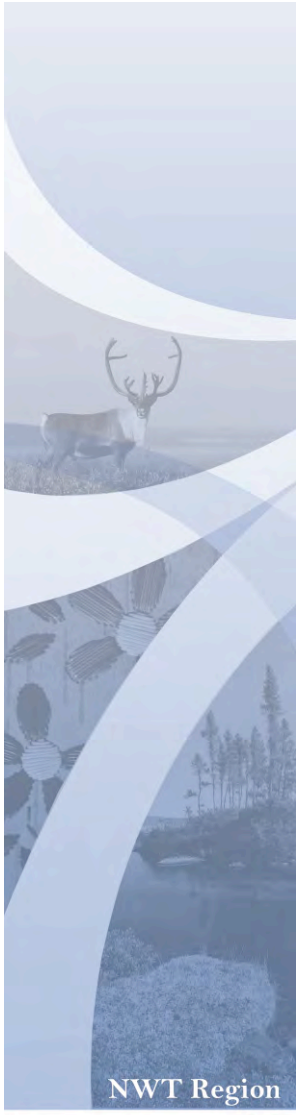
Key Messages

- Information Sharing/ Risk Communication
  - Authorities Having Jurisdiction
  - Federal and Territorial Government Departments/Organizations
  - Industry/Professional organizations
- Site Closure planning
  - Consideration of residual health and safety concerns during project planning and implementation
  - Implementation of public safety measures at site prior to/during site closure



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Conclusions

- Similar processes may be active in other tailings ponds on other mine sites
- Mine and exploration project operators, environmental assessors, and mine remediation personnel need to be aware of potential for variable ice conditions
- Further research is required to better understand site-specific, gas generating processes in tailings ponds