Case Study – Canadian Malartic

Map Data: Canadian Malartic

~4.1 km

Facility Type

- Conventional
- High-Density Thickened / Paste
- Filtered

Klohn Crippen Berger

MEND / NEDEM
**Location:** Val-d’Or, QC

**Mine Type:** Open Pit – Gold

**Production Rate:** 55,000 tpd

**Tailings Facility Type:** Conventional (with High Density Thickened Tailings) (64-65% solids)

**Climate:** 910 mm average annual precipitation; 650 mm annual evaporation; with net positive balance.

**Status:** Operating since 2011
• The supernatant and runoff water reports to the reclaim water pond located south-east of the facility.
• The internal overflow spillways are situated near the centre of the South Perimeter and the Central Perimeter dykes.
• The supernatant and runoff water is 100% recycled to the process plant.
According to the 2014 NI 43-101 Technical Report:

- According to the classification scheme in Directive 019, a significant proportion of the ore, waste rock and tailings classify as potentially acid-generating or leachable.
- Cyanide is used in the process.
• Dam safety and limiting water storage on the site.
• Thickening tailings also reduces the need for containment structures, reduces the footprint of the tailings facility and improves water recovery.

Image reference: Canadian Malartic
Why Does it Work?

- Continuous improvement and flexibility in the tailings facility type.
- External water management.

Challenges:

- Tailings processing not achieving design targets.
Case Study – Musselwhite

Image reference: Goldcorp 2017
Location: 475 km north of Thunder Bay, ON
Mine Type: Underground - Gold
Production Rate: 4,500 tpd
Tailings Facility Type: Thickened Tailings – Conventional
Climate: 730 mm precipitation annually; 410 mm evaporation annually, net positive water balance
Status: In operation since 1997
Musselwhite - Tailings Properties

Physical Classification

- Slurry dewatered from 50% solids content by weight to about 68%.
- Deposited tailings has a concave beach slope profile
  - slopes as high as 3 to 4% close to the spigots discharge points
  - decreasing to 2% towards the center of the facility
Geochemical Classification

• Low to moderate sulphide content (0.2% to 2%).
• Classified between PAG, Uncertain, and NPAG.
• Lag times to acid generation > 5 years.
• Water treatment is used on site.
• Adopted to increase the capacity of the existing facility by stacking thickened tailings layers over their existing facility (Jewell and Fourie 2015).
• Changed closure concept from wet cover to dry cover for final closure.
• More desirable from a community perspective, as this strategy allowed the mine to maintain the same footprint, minimize long-term seepage impacts and align with future progressive reclamation plans.
• Benefits of reduced operational expenditure (OPEX), capital expenditure (CAPEX) and operational risk compared to a comprehensive analysis of other tailings disposal methodologies.
Why it Worked:

• Changed to thickened tailings in 2010
• Known material properties and materials available for testing

Challenges:

• Dust management
• Change in closure design approach
Case Study – Greens Creek

Alaska, USA

Image reference: Louisberger 2015
Location: 30 km southwest of Juneau, AK
Mine Type: Underground – Polymetallic Silver
Production Rate: 2,200 tpd
Tailings Facility Type: Filtered Pile
Climate: High rainfall (1450 mm precipitation annually, half as snow; 400 mm evaporation), coastal
Status: In operation since 1989
Greens Creek - Tailings Properties

Physical Classification

Geochemical Classification

- Potential for metal leaching (primarily lead)

Image reference: Condon 2006
Greens Creek - Tour of the Facility

- Geomembrane Liner
- Water Management Ponds
- Water Treatment Plant
- Erosion Protection on Inactive Pile Slopes
- Temporary Rockfill Haul Roads

Klohn Crippen Berger
Filtered tailings was adopted to minimize overall footprint and for site-specific environmental and geotechnical considerations.

Because there is no pond on the tailings surface, there is little potential for tailings to be mobilized and transported significant distances if the pile were to fail during a seismic event.
Greens Creek - So What?

**Why it Works:**
- Material properties
- Site conditions conducive to the cost balance for filtered
- Low production rate
- Back-up storage options

**Challenges:**
- Trafficability
- Water and erosion management
- Requirement for water treatment
Case Study – Raglan Mine

Map Data: Google, Landsat / Copernicus

1.1 km

Map Data: Google, Landsat / Copernicus
Location: Nunavik Region, QC

Mine Type: Underground (Open Pit) – Nickel-Copper

Production Rate: 4,000 tpd

Tailings Facility Type: Filtered

Climate: 520 mm precipitation annually (50% as snow) and ~ 100 mm evaporation annually, continuous permafrost

Status: In operation since 1997
Geochemical Classification

- The tailings contain up to 8% sulphides, mostly as pyrrhotite (Garneau 2012).
- Generates acidic runoff enriched in metals when exposed to air and moisture above freezing temperature.
- Water is treated prior to discharge.

Physical Classification

- Filter pressed tailings to 18-20% m.c.
• Economic and waste water management-related.
• Borrow material for constructing starter facilities for a conventional impoundment were scarce.
• Cost trade-off between process requirements and waste water management and water treatment costs.
• Raglan is located in an area that has a limited water source (especially during the winter), which prompted the company to initiate the zero process water discharge (a system that recycles water from mill process) in 2002.
Why it Worked:
• Challenging climate and water management area to work in helped overcome the cost decisions.
• Low production rate and suitable tailings properties.

Challenges:
• Closure planning that accounts for climate change (permafrost encapsulation or geomembrane).
1. Introduction
   • Study Objectives
   • Methodology
   • Spoiler Alert: Key Conclusion

2. Tailings Management Strategy Considerations
   • Tailings Properties
   • Site Conditions
   • Dewatering Technologies and Facility Types

3. Case Histories
   • Canadian Projects using Dewatering Technologies
   • Select Case Studies

4. Conclusions
• Tailings physical properties need to be suitable for technology selection. Testing should be comprehensive (physical and chemical) at the planning and trade-off stages.

• Achieving design targets (e.g. solids content, slopes) can be challenging during start-up and operations, and continuous effort and investment is required.

• Need allowance for operational upsets (e.g. back-up storage).

• Water management cannot be avoided.
Case Study Lessons Learned For Dewatered Tailings Projects

• More work is required to evaluate the relationship between geochemical properties and dewatered facility’s closure.

• We need to share more information as an industry to progress as an industry.

• Dewatered tailings are not widely applied in Canada. The dewatered projects reviewed as part of this study have been implemented with variable success, ranging from not successfully to marginally successful to providing real benefit.
We still want to be here

But sometimes we are still here
Need to consider **SITE** and **ORE DEPOSIT SPECIFIC CONDITIONS** and **RISK PROFILE** of potential alternatives
MEND Tailings Study Report link:

Kate Patterson, M.Eng., P.Eng., Associate, Water Resources and Tailings Engineer (kpatterson@klohn.com)
Lindsay Robertson, M.Sc., P. Geo, Associate, Senior Geochemist (lrobertson@klohn.com)
REFERENCES


REFERENCES


Levac, C. 2016. “Raglan as a case study in MEND Tailings Study Report”. E-mail message to K. Patterson, October 10, 2016.


