Post Closure Water Management at the Reclaimed Sullivan Mine

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Outline of Presentation

› Location and history
› Environmental concerns
› Overview of water management
› Monitoring and maintenance
› Key challenges and improvements
› Wrap-up

View from reclaimed No.1 Shaft waste rock dump
Site History

› Ore body discovered in 1892
› 6.0% Pb, 5.7% Zn, 71 g/t Ag, 25% Fe
› Operated 1909 – 2001
› Decommissioning and reclamation activities complete by 2006
› EMPR and ENV Regulatory requirements
Environmental Concerns

- Wastes produced
  - 9.75 M tonnes of waste rock
  - 4.3 M tonnes of float rock
  - 122 M tonnes of tailings
  - 7.0 M tonnes of phosphogypsum
  - 3.4 M tonnes of iron oxide
- Elevated metals in soil
- Water management required in perpetuity to address acid rock drainage (ARD)
Water Management – Mine Area

- No.1 Shaft Waste Dump
  - Till cover system
  - Toe drain
Water Management – Mine Area

› No.1 Shaft Waste Dump
  › Till cover system
  › Toe drain

› Open Pit and waste dump
  › Till cover system
  › Seepage collection in Sullivan Creek
Water Management – Mine Area

- No.1 Shaft Waste Dump
  - Till cover system
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- Open Pit and waste dump
  - Till cover system
  - Seepage collection in Sullivan Creek
- **Lower Mine Yard**
  - Flume and creek diversion
  - Portal seepage collection
  - Till cover systems
  - Toe drain (north dump)
  - Interception trench (south dump)
  - Deep pumping wells
Water Management - Underground

- Surface water and groundwater enter underground workings
- Voids between 2450’ and 3650’ levels act as reservoir
- Operating range from 3550’ and 3650’ - capacity of 625,000 m³
Water Management – Tailings area

› Waste impoundments are the primary sources:
  › Iron ponds
  › Siliceous ponds
  › Gypsum ponds
  › Calcine ponds
› Water impoundments for temporary storage
Water Management – Tailings area

› Cover systems
  › Tailings covered with float rock capillary break and till cover

› Clean water diversion
  › Intercepts surface water for conveyance around tailings

Weir at discharge point for Dobson’s Draw diversion

Cover system profile
Water Management – Tailings area

› Collection ditches
  › Within tailings and around perimeter to intercept near surface flows and seepage
  › Gravity drainage to collection ponds or designated pump stations

Gypsum Pond Collection Ditch
Dye Testing in Siliceous Pond Collection Ditch
Iron Pond Collection Ditch
Water Management – Tailings area

› Pump stations
  › Within storage ponds and conveyance features to collect surface flows and shallow groundwater

› Groundwater interception systems
  › Collect deeper groundwater in trenches for diversion to pumping location
Storage and Treatment

- Water stored in the ARD storage pond and underground mine
- Treated during two annual campaigns in a high-density sludge treatment plant
- Treated effluent discharged under permit to St. Mary River
- Sludge discharged to sludge impoundment
- Plant operating since 1979
Treatment Volumes

Drainage Water Treatment Plant Volumes 2000-2017

- Mine Closed 2001
- U/G Dewatering Started
Monitoring Programs

› Seepage Collection
  › Seepage and pumped flows
  › Seepage quality in source areas

› Groundwater
  › Approximately 80 wells sampled in routine program
  › Additional wells for specific investigations

› Receiving water
  › Approximately 15 locations sampled in routine program
  › Frequency varies between weekly and semi-annually
  › Additional locations for specific investigations
Operation and Maintenance Programs

- Completed by Teck staff and contractors
- Daily surveillance
- Inspections of engineered structures
- Preventative maintenance
  - Pump and pipe cleaning
  - Instruments, electrical systems
- Underground maintenance
  - Access, emergency systems
  - Pumping infrastructure
- Treatment plant operation and maintenance
Key Challenges and Continual Improvement

› Collection system efficiency
   › Aging infrastructure
   › Limited performance criteria
   › New and evolving performance objectives
   › Bypass events

› Improvements through:
   › Replacement and upgrades
   › Performance verification plans
   › Instrumentation upgrades
   › New and expanded systems

Figure A: Dissolved zinc at KC-S6 (2004-2016) compared to BCWQG AW for total zinc Values plotted on log scale

Precipitate staining from ARD bypass identified in 2012
New Groundwater Interception System

Interception trench excavation and collection system installation

Low permeability liner installed on downgradient side of trench

Collection piping installed in trench box, depths up to 8 m

Collection vault, temporary pumping configuration
Treatment Plant Diffuser Replacement

- Damaged diffuser pipe
- Construction of primary containment with gravel totes
- Overview of primary and secondary containment
- Installation of trench box with structural sheet pile
Treatment Plant Diffuser Replacement

- Diffuser pipe and riser installation
- Sheet pile removal and bed restoration
- Site restoration above rip rap bank protection
- Site restoration in lay down area, planting mounds and woody debris
Treatment Plant Diffuser Replacement

Aerial view of site following restoration
Key Challenges and Continual Improvement

› **Conveyance and storage**
  › Pipe capacity
  › Pipe fouling
  › Water balance
  › Storage capacity limited

› **Improvements through:**
  › Upgrading piping
  › Routine preventative maintenance
  › Instrumentation upgrades
  › Increasing clean water diversion
  › Exploring alternative treatment options
Alternative Treatment Options – Passive treatment bench and field scale research

- Bench scale column testing
  - Biological system (SRB)
  - Silage, pulp mill biosolids, peat, brewing grains
  - 100-day duration
  - >98% Zn and Cd removed

- Field column testing
  - Groundwater used as feed
  - 80-day duration
  - >99% Zn and Cd removed
  - Secondary parameters (Fe, Mn, BOD) in effluent
In-situ field trial

- Funnel and gate PRB concept
- Gravity fed system
- >99% Zn and Cd removal during first year of operation
- Metals removal rates decreasing over time (still ~90%)
- Biological activity limited
- Trial ongoing > 2 years
Key Challenges and Continual Improvement

› **Operation and Maintenance**
  › Resources/staff required
  › Numerous systems
  › Aging systems, fouling
  › Confined space entry
  › Power interruptions

› **Improvements through:**
  › Realistic budgeting/forecasts
  › Use of experienced contractors
  › Preventative maintenance, upgrades
  › Design to reduce confined space entry
  › Back-up power systems
Wrap-up

- ARD from waste rock/mine areas and tailings facilities (90 year mine operation)
- Water management and treatment required in perpetuity
- Comprehensive water monitoring programs
- Routine maintenance program and dedicated contractors key
- More staff onsite than visioned during closure planning
- Continual improvement to water management systems required for long-term risk management
Thank you

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