

# Post Closure Water Management at the Reclaimed Sullivan Mine



November 29, 2018 – 25th MEND ARD/ML Workshop  
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# Outline of Presentation

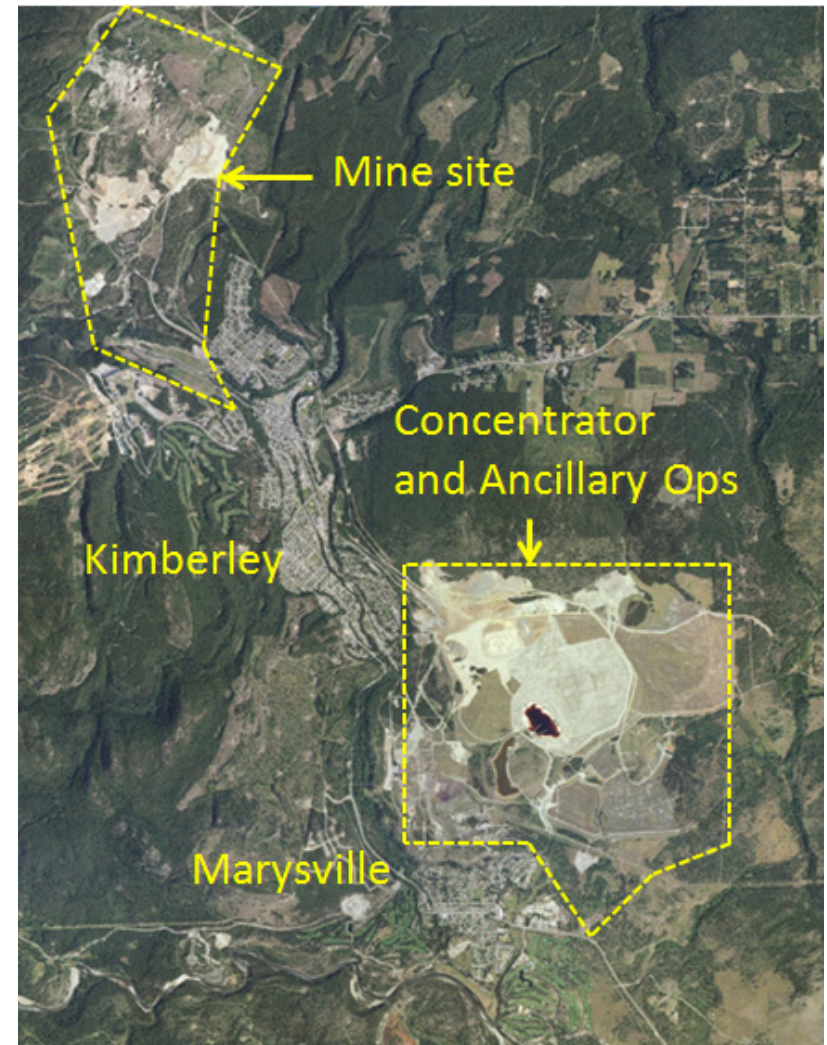
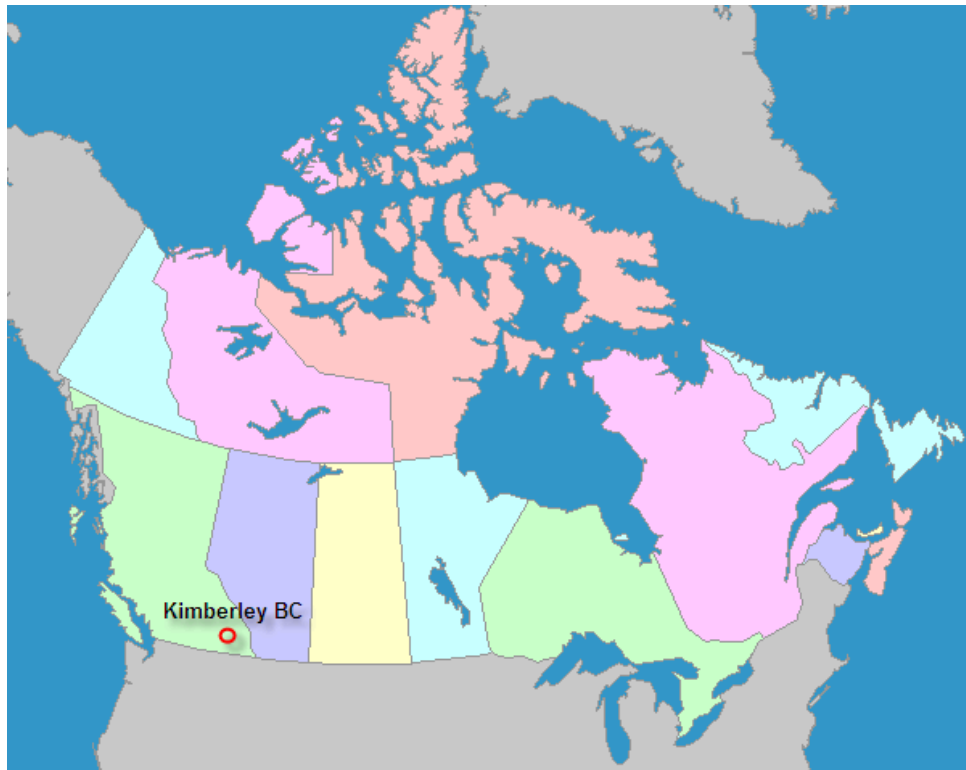
- › Location and history
- › Environmental concerns
- › Overview of water management
- › Monitoring and maintenance
- › Key challenges and improvements
- › Wrap-up



*View from reclaimed No.1 Shaft waste rock dump*



# Site Location

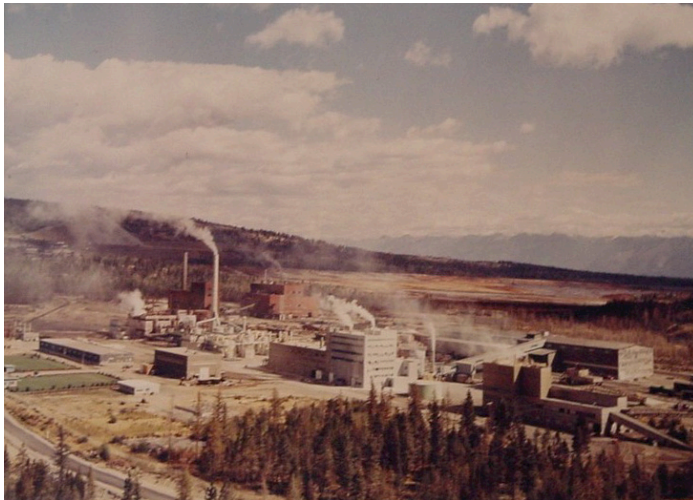


# Site History

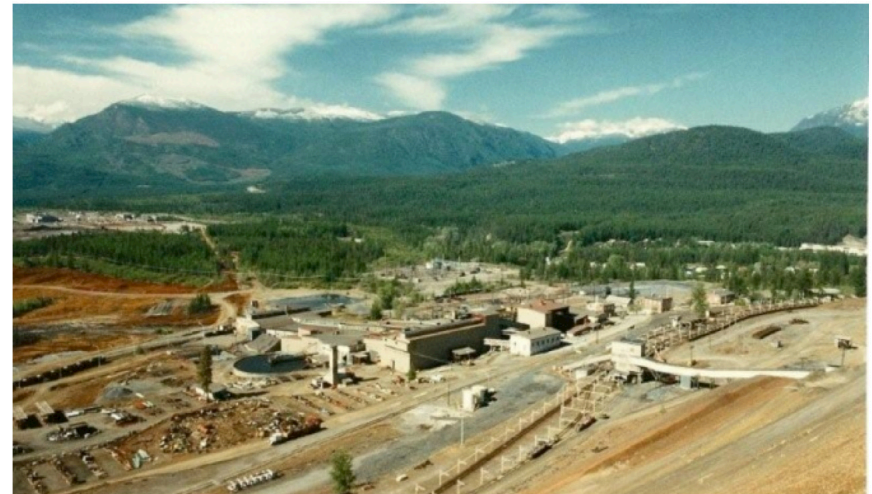
- › Ore body discovered in 1892
- › 6.0% Pb, 5.7% Zn, 71 g/t Ag, 25% Fe
- › Operated 1909 – 2001
- › Decommissioning and reclamation activities complete by 2006
- › EMPR and ENV Regulatory requirements



*Lower Mine Yard*



*Fertilizer, iron, steel plants*



*Sullivan concentrator*



# 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)



*Lower Mine Yard and North Waste Rock Dump*



*Sullivan concentrator and iron tailings pond*

# 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

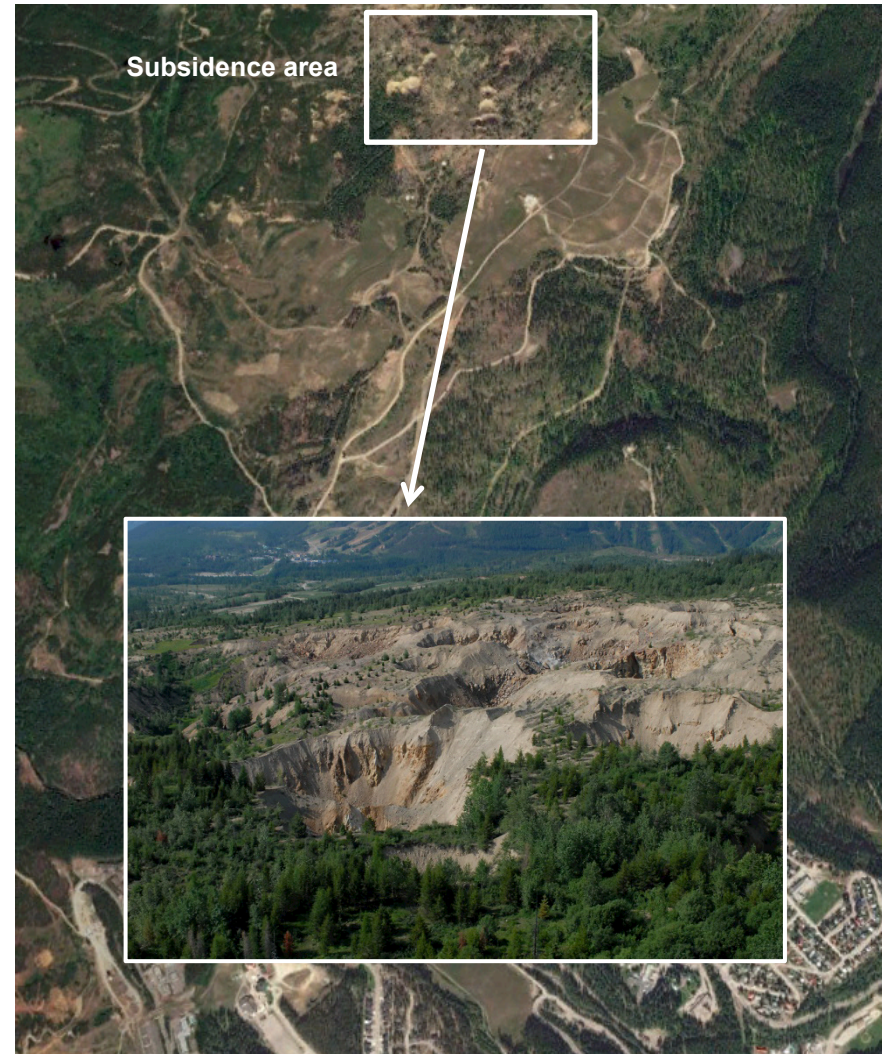
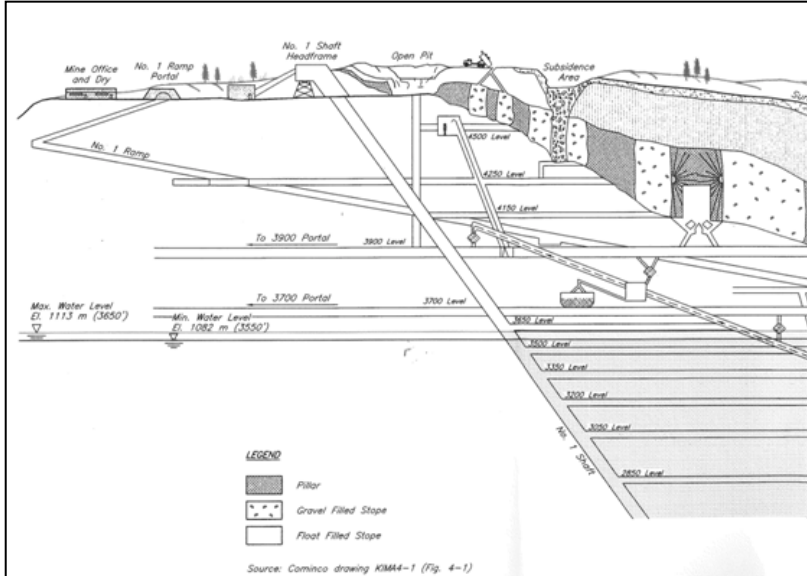
- › No.1 Shaft Waste Dump
  - › Till cover system
  - › Toe drain
- › Open Pit and waste dump
  - › Till cover system
  - › Seepage collection in Sullivan Creek
- › **Lower Mine Yard**
  - › Flume and creek diversion
  - › Portal seepage collection
  - › Till cover systems
  - › Toe drain (north dump)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





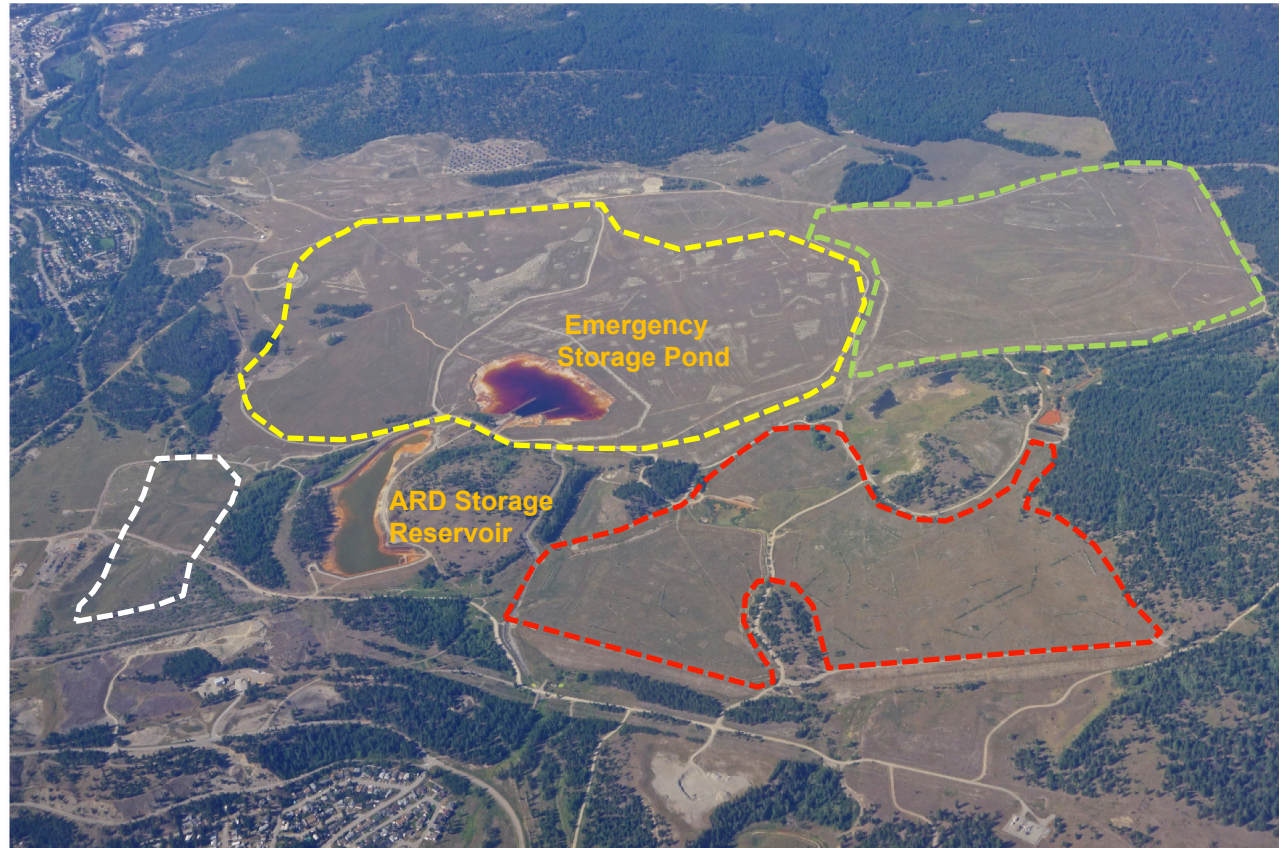
# Water Management - Underground

- › 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 m<sup>3</sup>



# 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



*Pump station 938 and instrumentation panel*



*Backfilled groundwater interception trench system for PS937*

# 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



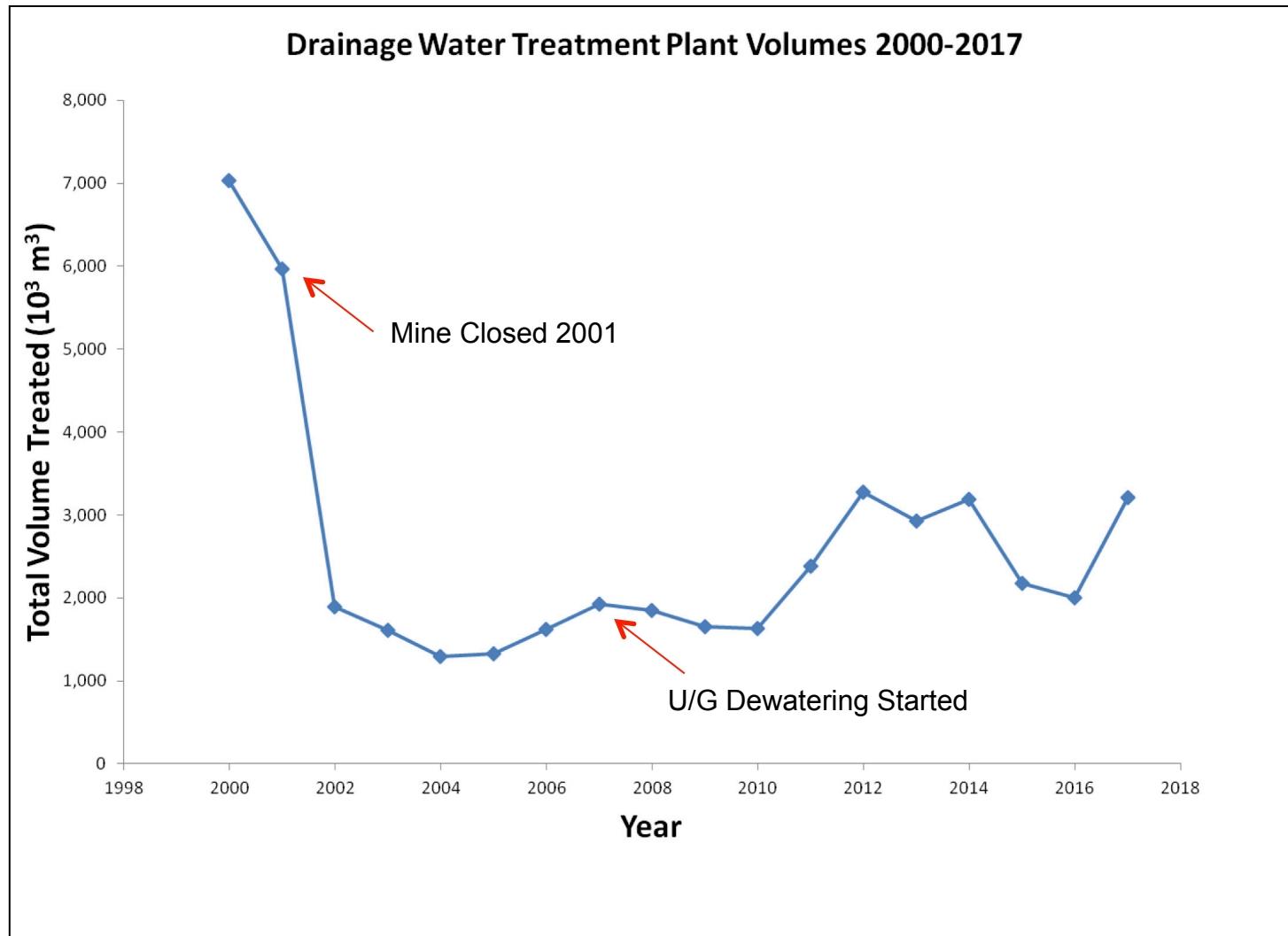
*ARD Storage Pond*



*Drainage Water Treatment Plant on St. Mary River*



# Treatment Volumes



# 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



*Monitoring well upgradient from Open Pit Waste Rock Dump*



*Mark Creek through Lower Mine Yard area*



# 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



*Pump removed from deep aquifer pump station for 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

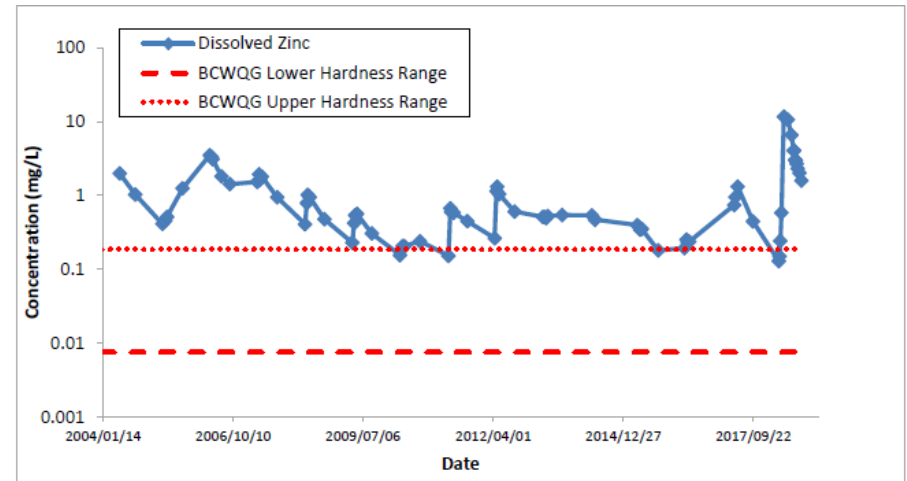


Figure A: Dissolved zinc at KC-S6 (2004-2018) compared to BCWQG AW for total zinc  
Values plotted on log scale



*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*



SNC • LAVALIN



# 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



*Build up in Lower Mine Yard pump discharge piping*



*Water pooling in borrow pit*

# 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



*Bench-scale column set-up, upflow configuration*

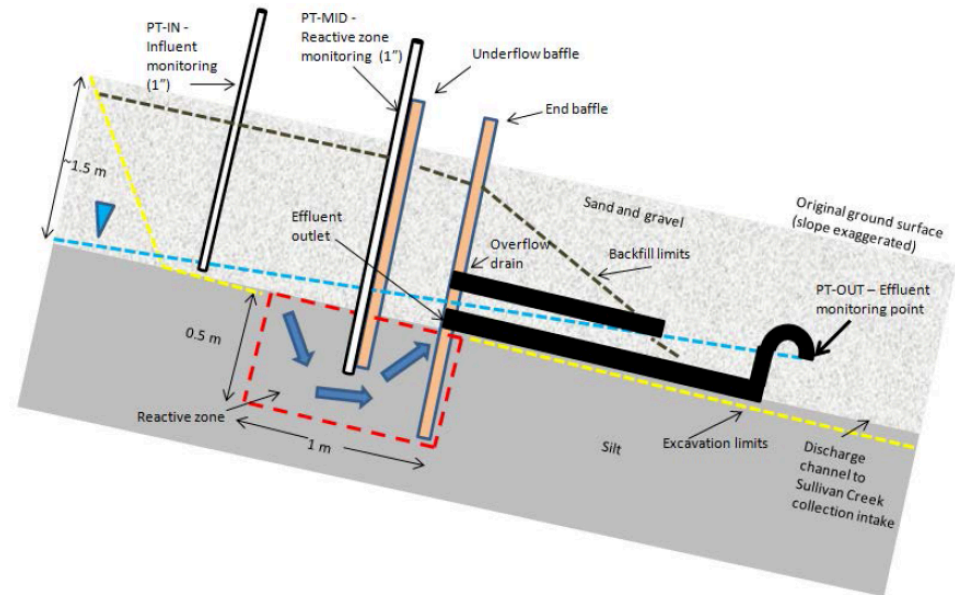


*Field column testing set-up*



## 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



*In-situ trial conceptual profile*



*In-situ trial structure after backfilling*

# Key Challenges and Continual Improvement

## › Operation and Maintenance

- › Resources/staff required
- › Numerous systems
- › Aging systems, fouling
- › Confined space entry
- › Power interruptions



*Precipitate build up on deep aquifer pump*

## › Improvements through:

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



*Back-up power generator housing*



## 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



*St. Mary River with diffuser construction in background*



*Looking west across reclaimed NISWRD*



# Thank you



*Elk Crossing St. Mary River - Shona Rubens Photo*

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