GUNNAR MINE TAILINGS REMEDIATION DESIGN – A WATER SHEDDING COVER SYSTEM AND LANDFORM

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Gunnar Mine - Site Background

- 25 km southwest of Uranium City, SK
- Sub-arctic climate; precipitation ~375 mm
- Bedrock outcrops infilled with glacial deposits
- Thickly forested with shrub and mossy ground cover
Gunnar Site History

Uranium mines and mills operated in 1953-1964
- Total ~8.5 million tons of rock mined and processed
- Open pit developed over 100 m deep, and over 3 million m$^3$ volume
- Vertical shaft and mine work over 600 m deep
- Uranium mill, acid plant, other utility, structures, and buildings
- Over 5 million tons of unconfined tailings

Mining ceased in 1964
- The pit and subsurface workings were flooded, shaft plugged with concrete, and mine site abandoned
- All the buildings, structures, tailings, and waste rock piles were left on site “as is”
- The open pit and mine work were flooded by blasting a channel between the pit and Lake Athabasca
Project Timeline

- **2006 Memorandum of Agreement**
  - SRC Project Manager of CLEANS Project

- **2009 Comprehensive EA completed in 2013**
  - Engagement and Consultation
  - Objectives and Criteria
Stakeholder Engagement and Consultation

- Rigorous program carried out by SRC prior to development of any plans.

- Benefits:
  - Gather ideas for future endpoints
  - Communicate options, pros and cons
  - Make decisions
  - Integrate traditional knowledge
From the EA Process:

Key Outcomes

1. Overarching Land Use Objective:

“to manage the use of the land and renewable resources of the Athabasca in an integrated and environmentally sound manner to ensure ecological, economic, social, cultural, and spiritual benefits for present and future generations” (SRC, 2013)

2. Design Criteria - Site Specific Remedial Objectives

• Site-specific criteria for all identified constituents of potential concern
Gunnar Tailings Areas

- Total of 4.4 million tonnes of tailings were discharged from the mill.
- Located in three main tailings deposits on the Gunnar site.
- Gamma Radiation levels: ~4-10 μSv/h
  - Reduce to 1.14
  - Eliminate dust

(SRC, 2015)
# Tailings Plan Remediation Objectives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>Gamma</td>
<td>Reduce gamma to 1.14 $\mu$Sv/h</td>
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<tr>
<td>COPC Loadings</td>
<td>Meet site-specific remedial objectives (SSROs)</td>
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<tr>
<td></td>
<td>Reduce COPC loadings to Langley Bay</td>
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<tr>
<td>Air Quality</td>
<td>Eliminate tailings dust emissions</td>
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<tr>
<td>Land Use</td>
<td>Ensure traditional land uses can occur adjacent to the site</td>
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<tr>
<td>Landform</td>
<td>Design landform to be water-shedding and increase distance between plant roots and water table</td>
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<tr>
<td>Surface Water Management</td>
<td>Design surface water channelsstreams to handle flows from 1:200 year event</td>
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<tr>
<td>Vegetation</td>
<td>Establish a community of plant species native to region</td>
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Tailing Remediation Plan Scope

How? Cover System

1. How thick does the cover need to be? Material type?
2. What materials are available? Is there enough?
3. Where will the material come from? How much disturbance?
4. What should the final landform look like?
5. How do we create a new landform?
   1. Fill needed? If so, what do we use?
   2. Design/construct waterways?
Options Assessment

Feasible alternatives were identified from earlier studies.

Come up with all possible landform and cover configurations.

Alternatives with fatal flaw removed.

e.g. potential for catastrophic failure.

Options ranked based on issues of constructability, cost, and environmental impacts.

Interaction between site aspects was included in this analysis.

Identify Alternatives

Pre-Screening Assessment

Multiple Accounts Analysis

Preferred Option
Cover Design Objectives

Improving the quality of surface water discharging from the tailings

— Contamination via contact with surface tailings
  • 0.5 m of soil cover reduces contact (EIS, 2013)
Cover Design Objectives

Creation of a landform for grasses and shrubs that blends into the surrounding landscape

— To support vegetation, a landform requires:
  • Soil layer to support vegetation
  • Drainage to ensure soil layer not contaminated by capillary rise

● Water shedding landform

Currently quite flat
Cover Design Objectives

- Place a 0.5 m thick cover on this landform:

  *Shallow water table will lead to capillary rise of contaminants from the tailings.*

  ![Diagram of capillary rise](image)

  *Capillary rise of contaminants can lead to:*
  - *Contamination in soil and surface water, and*
  - *Vegetation uptake of contaminants.*
Cover Design Objectives

- Water-shedding landform

Positive drainage will:
- prevent ponding, lowering the water table below the depth where capillary rise can occur.
- reduce net percolation through the tailings by increasing both runoff and evapotranspiration.
Cover Design Objectives

- Water-shedding landform
  - Requires **FILL** in many areas

**Fill Options:**
- **Till borrow material**
- **Waste rock**
FMEA identified material volume a potential area of high risk.

- Establish confidence in:
- Previously estimated volumes
- Previously estimated properties
Cover Design Objectives

Till Borrow vs Waste Rock for Fill

- Waste Rock Borrow Material:
  - **PRO**: Provides
    - good working platform on wet tailings,
    - capillary barrier beneath the cover,
    - minimizes land disturbance, and
    - removal of portion of contaminant source adjacent to Zeemal Bay.
  - **CON**: Similar concentrations of some COPCs but still below criteria
Final Designs:

- Results of FMEA guided additional studies for final design:
  - Loadings Assessment – Ecometrix Inc.
  - Soil-plant atmosphere modelling
  - Freeze-thaw of covers
  - Consolidation
  - Solute Update and Transport Modelling
  - Surface Water Management System
- Nominal 0.6 m till cover system
- Waste rock used to create water shedding landforms
- Exception is near Langley Bay
Gunnar Main Existing Landform
Gunnar Main Proposed Landform

SPRING LAKE

PROPOSED TAILINGS MANAGEMENT FACILITY

BEAVER POND
Central Existing Landform
(looking SE)
Central Proposed Landform
(looking SE)
Langley Bay Existing Landform
Preferred Designs – Langley Bay

- Cover tailings in place with soil cover

Diagram:
- Fill
- 0.3%
- 0.5 m
- Till Cover

Tailings
Langley Bay Proposed Landform
Final Approved Plan

- Aligns with local community preferences,
- Meets regulatory requirements,
- Prioritized by risks associated,
- Addresses the impacts and risks of the site, and
- Projected to meet the provincial relinquishment targets.

Achieved by:

- Collaborative approach to setting remediation objectives and targets.
- Using site-specific conditions and materials to guide the design to meet long-term stability.
Rainbow of Hope for Children and, Habitat for Humanity Initiative

Ask us for more information on

UNIVERSITY OF SASKATCHEWAN
Mine Overlay Site Testing Facility
GLOBAL INSTITUTE FOR WATER SECURITY
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