Golden Sunlight Soil Covers on Waste Rock and Tailings

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Objective

• Use of numerical modelling to evaluate the performance of cover systems installed on the waste rock dump and tailings area under different weather and vegetation conditions.
Mining Engineering
Modeling input data

- Laboratory testing program
  - Grain size distribution
  - Saturated hydraulic conductivity
  - Estimated SWCC

- Weather data from local weather station

- Suction and temperatures profile from TC sensors.
Laboratory testing program
Grain size – Waste rock – Main Station

The graph illustrates the percentage passing through different grain size ranges for various rock categories. The categories include:
- Cover (0-40 cm)
- Waste rock (80-90 cm)
- Waste rock (90-120 cm)
- Waste rock (120-160 cm)
- Waste rock (160-180 cm)

The graph shows the cumulative percentage of material passing through each grain size range.
Grain size – waste rock – Satellite st.

![Graph showing grain size distribution for different particle sizes and depths.](image-url)
Grain size – Tailings area

% Finer than

Particle size (mm)

cover (0 - 15 cm)       cover (15 - 45 cm)       cover (45 - 80 cm)
cover (80 - 110 cm)     cover (110 - 180)     Tailings
K Sat. – Waste rock
K sat - Tailings

Graph showing the relationship between K (m/s) and a scale ranging from 1.00E-07 to 1.00E-04. The graph includes markers labeled 'cover' at various points along the scale.
Estimated SWCC – Waste Rock Main station

Grav. water content

Soil suction (kPa)

- Main - WRM#1
- Main - wrm#4
- Main - WRM#2
- Main - WRM3
- Main - VWM#5
- Main - WRM#6
Estimated SWCC – Waste Rock Satellite station
SWCC – Tailings area

Graph showing soil suction (kPa) vs. grav. water content for different tailings samples.

- Tailings - TPBS#1
- Tailings - TPBS#2
- Tailings - TPBS#3
- Tailings - TPBS#4
- Tailings - TPBS#5
- Tailings - TPBS#6
Numerical Modeling
Numerical Modeling

- One-dimensional Model Soil Cover
- Influence of rain
  - Typical year case – 348 mm of rain / snow
  - Wet year case – 425 mm of rain / snow
  - Very wet year case – 539 mm of rain / snow
- Influence of vegetation
  - No vegetation, poor, good and excellent condition
- Initial suction profile

Mining Engineering

http://www.mining.ubc.ca
Precipitation history
Simulated profiles

- Waste rock - Main station
- Waste rock - Satellite station
- Tailings area

Depth (cm)

- Cover soil
- Waste Rock
- Oxidized rock
- Tailings
- Results -

Initial suction profiles calculated by the model
Waste rock cover
Waste rock – Infiltration in typical year

![Graph showing infiltration (% of total precipitation) vs vegetation condition.](http://www.mining.ubc.ca)
Waste rock infiltration in wet year

![Graph showing infiltration rates under different vegetation conditions.](image)
Waste rock infiltration in very wet year

![Graph showing infiltration (%) vs vegetation condition for Very Wet year. The graph indicates a decrease in infiltration with better vegetation conditions.](http://www.mining.ubc.ca)
Summary

The diagram shows the infiltration (%) for different levels of vegetation and wetness.

- **No vegetation**:
  - Typical: 12.8
  - Wet: 15.4
  - Very Wet: 15.6
- **Poor**:
  - Typical: 4.2
  - Wet: 4.2
  - Very Wet: 4.3
- **Good**:
  - Typical: 0.6
  - Wet: 0.6
  - Very Wet: 1
- **Excellent**:
  - Typical: -0.15

The diagram uses different colors to represent typical, wet, and very wet conditions.
Tailings cover
Tailings – Infiltration in typical year

- No vegetation: 1.6
- Poor: -7.4

Vegetation condition
Tailings – Infiltration in wet year

![Graph showing infiltration rate vs. vegetation condition]

- No vegetation: 5.5%
- Poor vegetation: 3.1%
- Good vegetation: -5.4%

Vegetation Condition

Infiltration (%)
Tailings – Infiltration in very wet year

![Image of graph showing infiltration percentage vs vegetation condition]

- No vegetation: 6.6%
- Poor: 0.6%
- Good: -4.4%
- Excellent: -5.8%

Vegetation condition
Tailings infiltration summary

- No vegetation
  - Typical: 1.6
  - Wet: 5.5
  - Very Wet: 6.6

- Poor
  - Typical: -7.4
  - Wet: -3.1
  - Very Wet: -0.6

- Good
  - Typical: -5.4
  - Wet: -4.4
  - Very Wet: -4.4

- Excellent
  - Typical: -5.8
  - Wet: -5.8
  - Very Wet: -5.8
- Results -
Suction profiles from TC sensors – Waste rock
Infiltration summary

![Graph showing infiltration summary with categories: Poor, Good, Excellent, Typical, Wet, Very Wet.](image)
Infiltration evolution in typical year

- Cumulative flux at the bottom of the cover system (0.8 m in depth)
- Cumulative flux at the bottom of the simulated profile (1.8 m in depth)

Days (starting on April 1st, 1996)
Infiltration evolution in very wet year

Days (starting on April 1st, 1993)

Cumulative infiltration at the bottom of the cover system (0.8 m in depth).

Cum. infiltration at the bottom of the simulated profile (1.8 m in depth)
Hydraulic Head

The graph shows the hydraulic head changes over time from 23-March to 19-October. Four different levels are marked:
- 20 CM
- 75 CM
- 106 CM
- 129 CM

The head values range from 0 to 12 meters, with significant variations observed in the data.
Conclusions

• On the waste rock dump, the performance of the cover system is strongly influenced by the vegetation condition.
• If the vegetation is preserved in good conditions, low infiltration is expected.
• On the tailings area, the finer material and the higher thickness cause the cover to be less dependant on the vegetation condition.
• Low infiltration expected
Conclusions

• The simulation showed the existence of different patterns of infiltration with upward flux from the waste rock dump in spite of infiltration through the bottom of the cover system.

• TC sensors suction profile supports the modeling results.

• Despite the modeling results, field monitoring of the infiltrations is recommended.