Risk-based approach to revegetation of challenging post mine landforms

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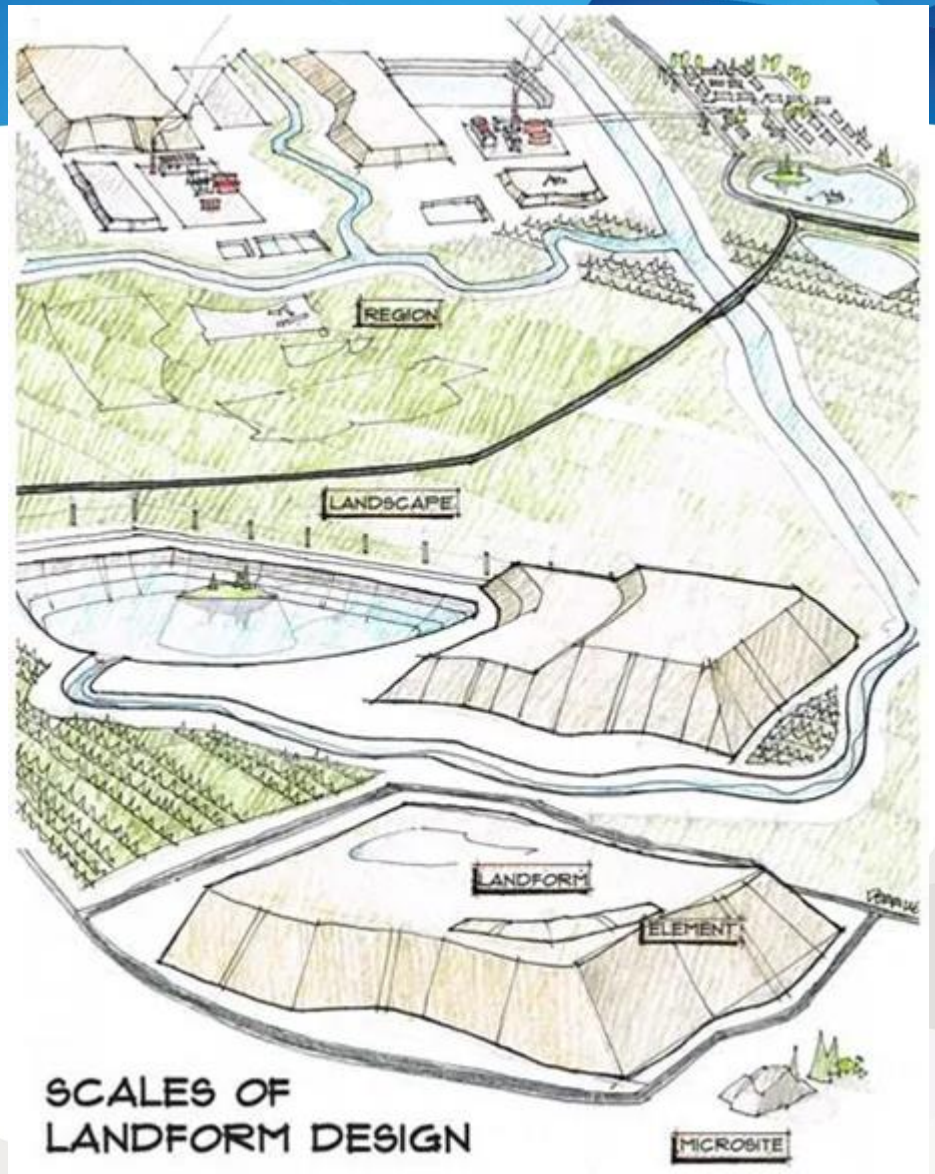
Introduction

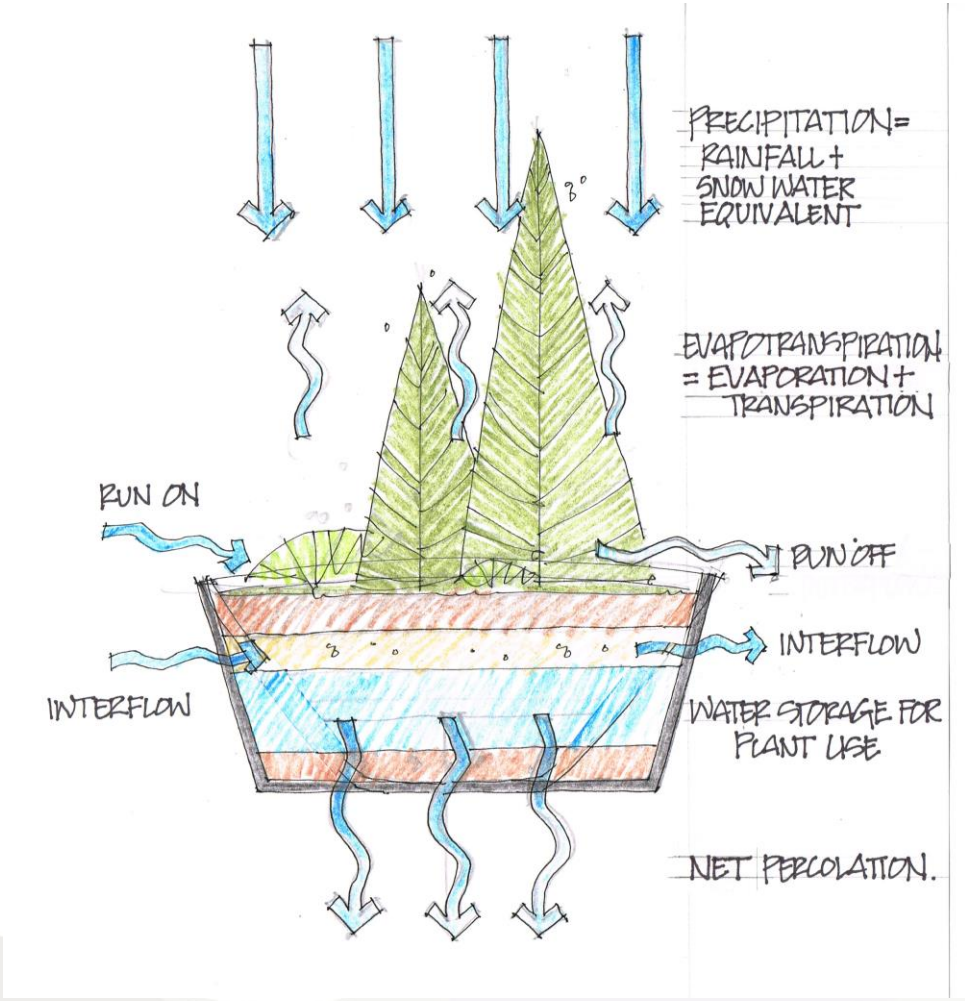
- Mine closure is a process.
- Challenging landforms like waste rock stockpiles and tailing storage facilities.
- Role of engineered cover systems.
- A risk-based approach to design and revegetation.



Landform Design Institute, 2021

Cover Systems 101

- Cover system performance objectives:
  - Limit net percolation.
  - Limit oxygen ingress.
- Cover system secondary objectives
  - Surface stability.
  - Support vegetation establishment, supporting target post mine land use.
- Site-specific design is crucial.



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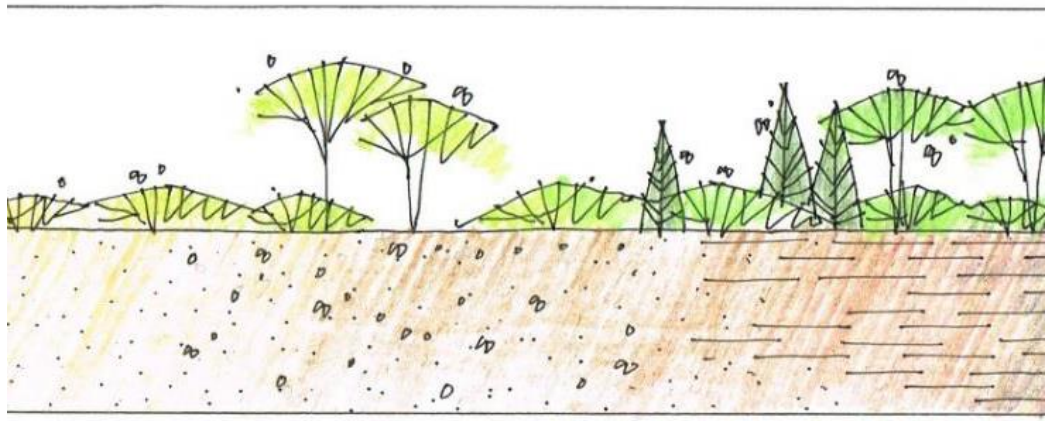
Revegetation Challenges on Mine Cover Systems

Engineering Stability.



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Ecological Function.

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A holistic design is key.

Cover System Objectives

The Engineering Perspective

- Physical Barrier: Separate waste from the environment.
- Limit Net Percolation: Control water seepage into waste.
- Limit Oxygen Ingress: Reduce potential for acid-forming reactions.
- Limit Upward Movement: Prevent contaminants from leaching.
- Vegetation: A functional part of the system, not just for show.

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Ecological Objectives

The Ecological Perspective

- Establish a self-sustaining ecosystem.
- Meet post-mine land use and closure objectives.
- Improve closure landform stability.
- Accommodate root depth, water, and nutrients.

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Factors Limiting Revegetation Success

- Plant available water.
- Permanent wilting point.
- Vegetation root characteristics.

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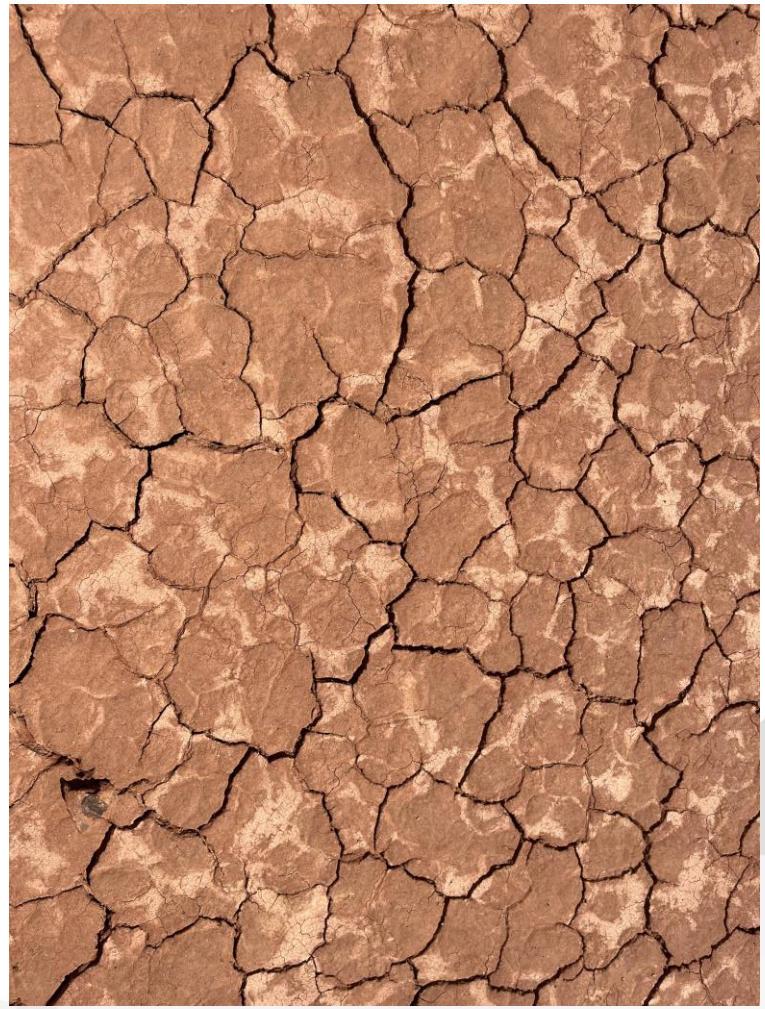
Plant Available Water and Permanent Wilting Point

- **Plant Available Water**: The amount of water in the soil that a plant can access.
- **Permanent Wilting Point**: The point at which a plant cannot recover from a lack of water.
- **The Challenge**: A cover system's design can lead to moisture stress, pushing plants to the wilting point.
  - Drought-tolerant species may become dormant.
  - Less-tolerant species are at risk of mortality.



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Vegetation Root Characteristics

Primary Functions:

- Anchor the plant and improve landform stability.
- Provide access to water and nutrients.
- Improve soil health.

The Challenge:

- Cover material must be deep enough for healthy roots.
- Deep-rooted species can compromise cover system integrity and risk exposure to toxic mine rock.

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Applying the Risk-Based Approach

A flexible and proactive strategy for managing uncertainty in mine closure.

- **Probability:** The likelihood of a revegetation failure (e.g., drought causing plant death) or unacceptable impact to cover performance.
- **Consequence:** The impact of that failure.
  - Environmental: Erosion. Exposure of hazardous material. Oxygen and water ingress can lead to Acid and Metalliferous Drainage.
  - Financial: increased costs for maintenance and monitoring.
  - Reputational: Damage to public image, stakeholder pushback.
- **Methodology:**
  - Observational Method: Continually monitor performance.
  - Staged Approach: progressing from small scale trials to large field trials, and executable methods.
  - Adaptive Management: Use pre-planned contingencies to fix issues as they arise.

Proposed Solutions and Path Forward

- Integrated design – move away from siloed thinking, support interdisciplinary collaboration from project conception.
- Site-specific trials – detailed analyses of local ecology and root systems to inform cover system design choices.
- Long-term monitoring – continuously monitor revegetation success and cover system performance to ensure the site is trending towards a self-sustaining state.

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