Engineered Soil Covers For Management of Salt Impacted Sites

by

Douglas A. Sweeney, M.Sc., P.Eng. and
David Tratch, M.Sc., P.Eng.

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Outline/Purpose

- Present design concepts of soil covers used in the mining industry and it's potential applicability for salt impacted sites.
- Present a hypothetical analysis.
- Present a process for further research and development.

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Introduction

- Salt impact at operating oil and gas facilities is a significant environmental concern.
- Drainage improvement and chemical amendments have limited success at fine grained sites.
- Excavation and disposal is costly.

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Introduction

- Good majority of sites – fine grained and low sensitivity sites wrt. to groundwater
- major environmental challenge – vegetation sustainability and mitigation of long term impact.
- Research into new approaches is ongoing.
- Another option, Engineered soil covers.

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Soil Cover Systems Mining Application

- The use of Engineered Soil Cover Systems in mining – since late 1980's.
- Primarily used in ARD.
- Significant body of theoretical research, instrumented test covers and constructed covers.

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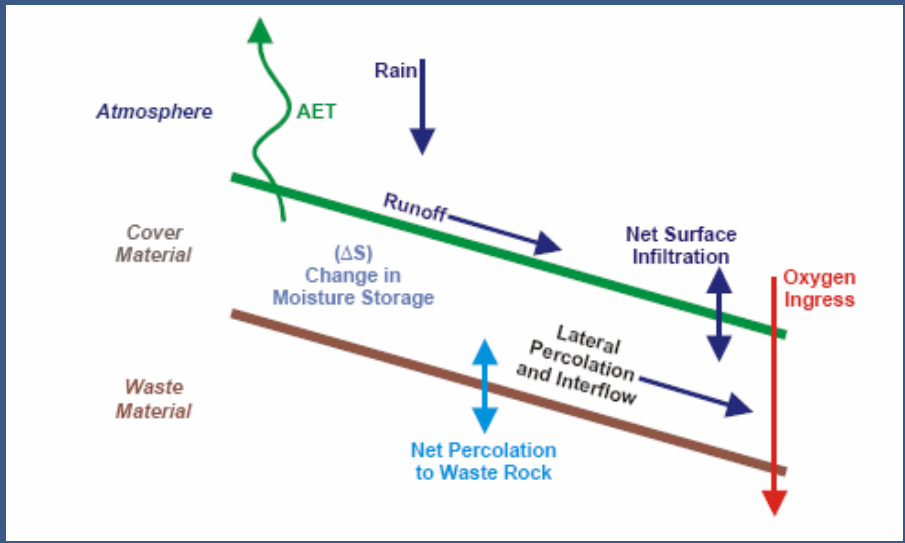
ARD Design Objectives

- Minimize flux of oxygen.
- Minimize flux of precipitation.
- Long term stability – physical and ecological.



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Types of Engineered Soil Covers

- Conventional low k covers.
- Store and release covers
- Covers incorporating a Capillary barrier.

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Low k Covers

- Compacted clay, 10^{-9} m/s.
- Effective where

  precip. = evap.
- Semi arid climate (precip < evap) likely desiccation.

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Store and Release Covers

- Effective when precip < evap.
- Acts as a sponge – infiltration of moisture then evapotranspiration before wetting front moves below base of rooting zone.
- Effective when precipitation events are not excessive and of long duration.

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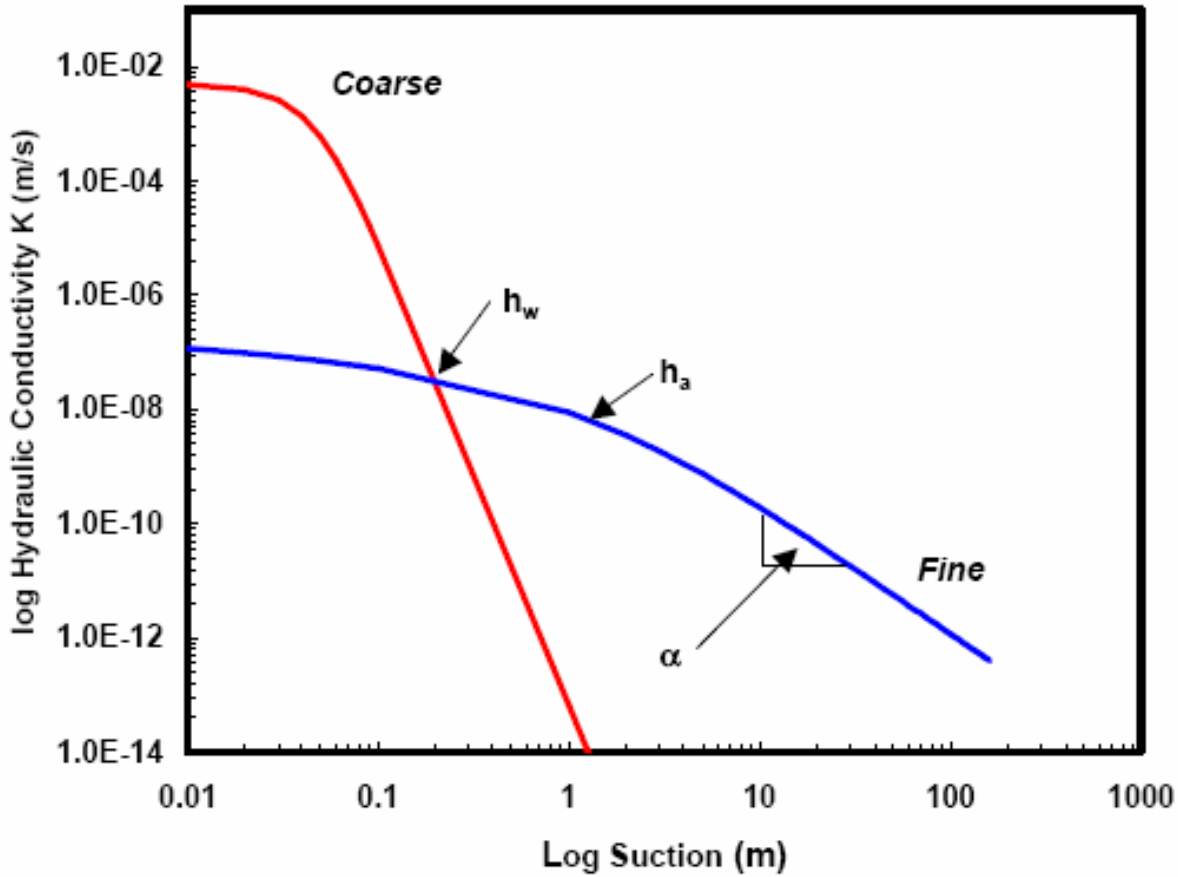

re 2.15 Hydraulic conductivity function for the coarse and fine textured materials used in the capillary barrier diversion length example.

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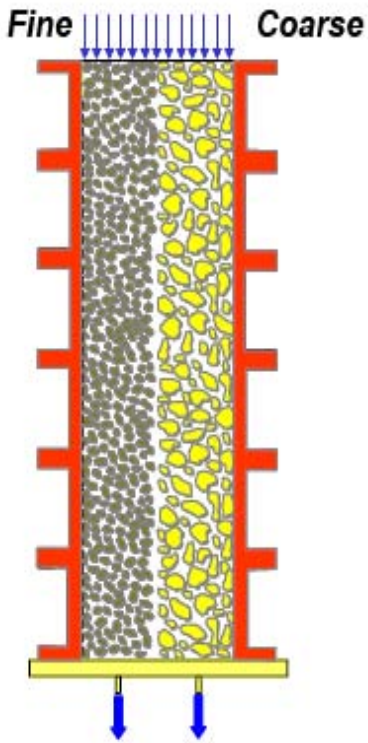
Unsaturated Groundwater Flow Case Study

- theoretical & laboratory scale study to characterize moisture movement through layered sand and clay
- high flux & low flux scenario



Schematic of a column with segregated coarse and fine textured materials (O'Kane *et al.*, 1999).

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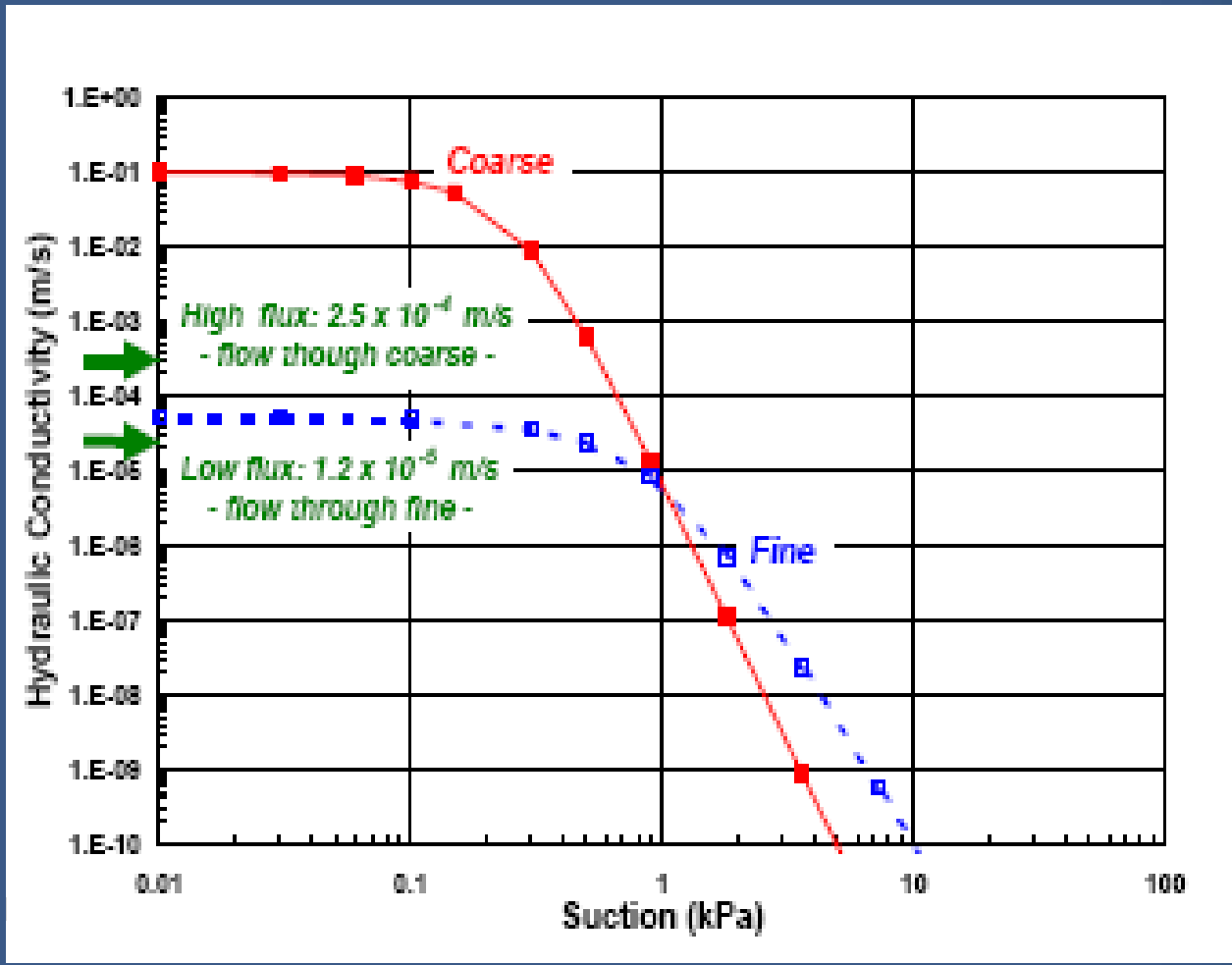
Flow Through Sand or Clay?



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Application to Salt Impacted Sites

- Fine grained sites - Low sensitivity wrt Groundwater

Design Objectives

- Properly reclaimed soil for vegetation growth.
- Minimize (zero) infiltration.
- Minimize exfiltration flux.
- Long term sustainability

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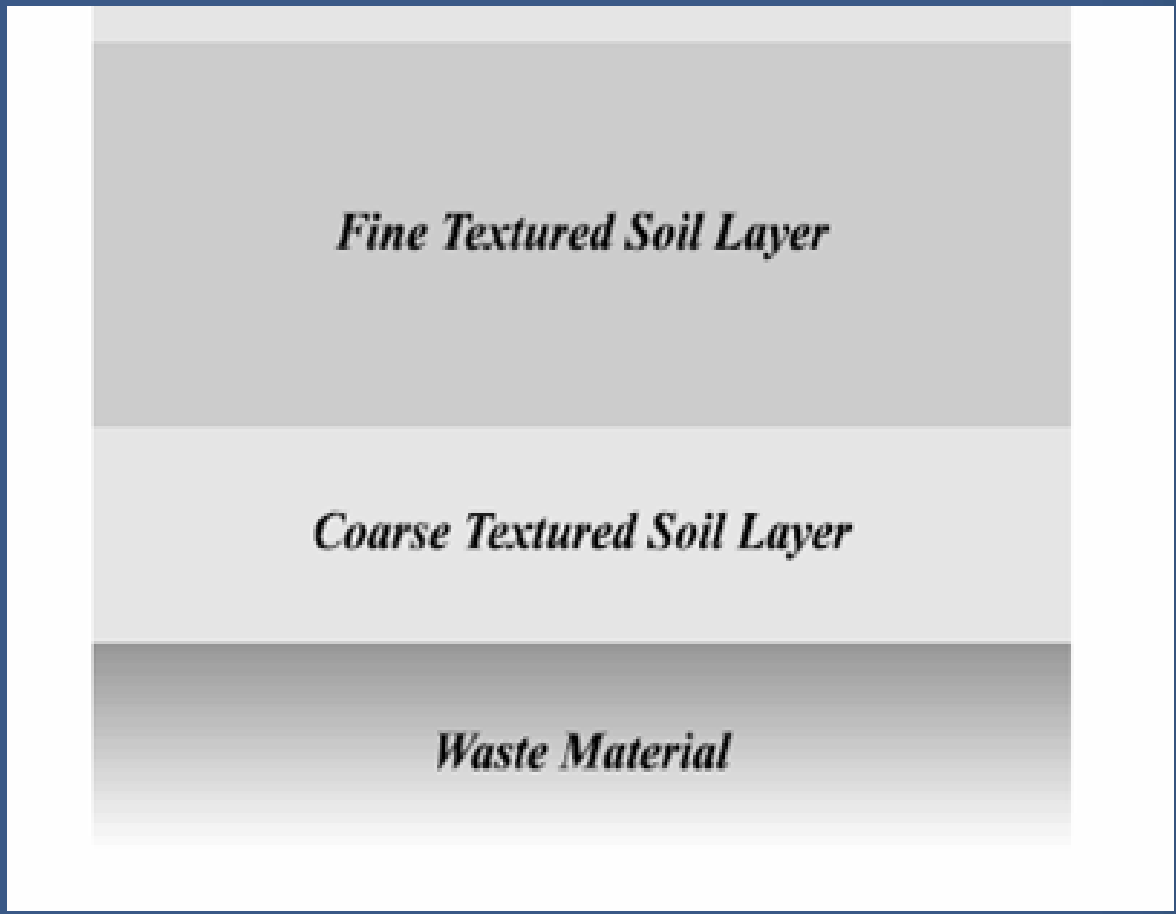
Proposed Soil Cover System



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Regulatory Framework

- **Risk Management an option.**

Criteria to meet

- **Equivalent land capability restored – reclamation and store and release cover.**
- **No long term impact to environment and human health demonstrated – moisture movement limited.**

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Hypothetical Analysis

- **Hypothetical Site Characteristics**
  - agricultural land base
  - located near Edmonton (climate data)
  - clay till profile
  - 3 m depth to groundwater table
  - low sensitivity wrt groundwater utilization
  - shallow profile impacted by salinity

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Hypothetical Analysis

- **Analysis Objectives**
  - numerical modelling to predict vadose zone groundwater movement through various soil profiles
  - attempt to design cover system to control vertical gw movement
  - SoilCover Model used
    - climatic data – Edmonton climatic Normal season
    - soil properties – typical sand and clay properties, no site specific data available

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SoilCover Analysis

- **BASE CASE:**
  - no cover.
- **COVER SYSTEM 1:**
  - 1 m of uncompacted till (store and release cover).
- **COVER SYSTEM 2:**
  - 0.5 m capillary break layer and 1 m of uncompacted till (store and release).

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SoilCover Results

- **Base Case – no cover**
  - **exfiltration causing upward migration of salts.**
  - **No short term improvement**
  - **No long term improvement due to long term salts migration.**

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SoilCover Results

- Cover System 1: 1 m store and release cover.
  - Upward exfiltration flux.
  - Less than Base Case, but upward migration of salts.
  - Short term improvement due to importing clean fill.
  - Long term decrease in productivity due to long term salts migration.

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SoilCover Results

- **Cover System 2: 1 m store and release cover and capillary break.**
  - **Net infiltration flux ~ 1% of precip or 4 mm/yr – could be engineered to zero.**
  - **Short term improvement due to importing clean fill.**
  - **Long term vegetation sustainability by controlling salt migration.**

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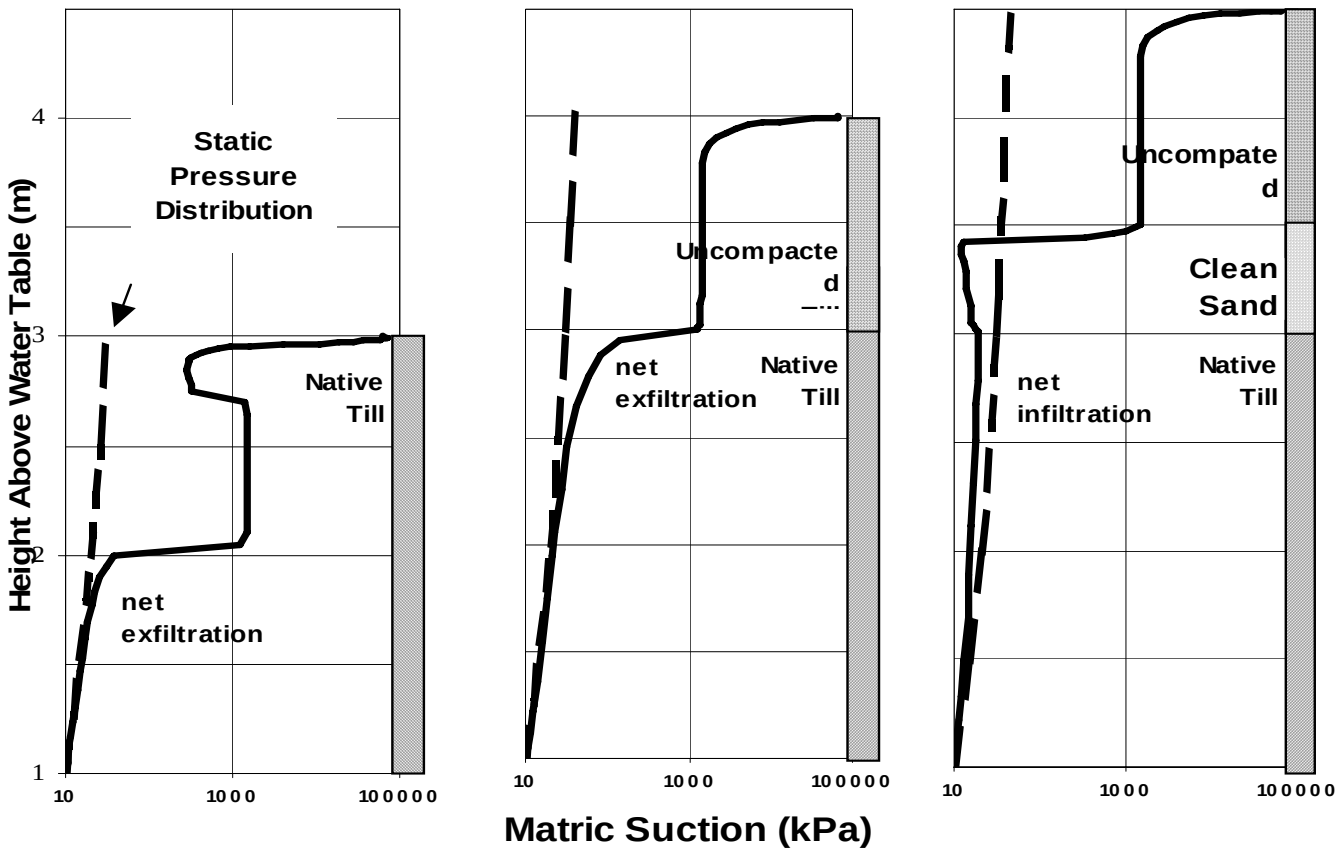
SoilCover Results



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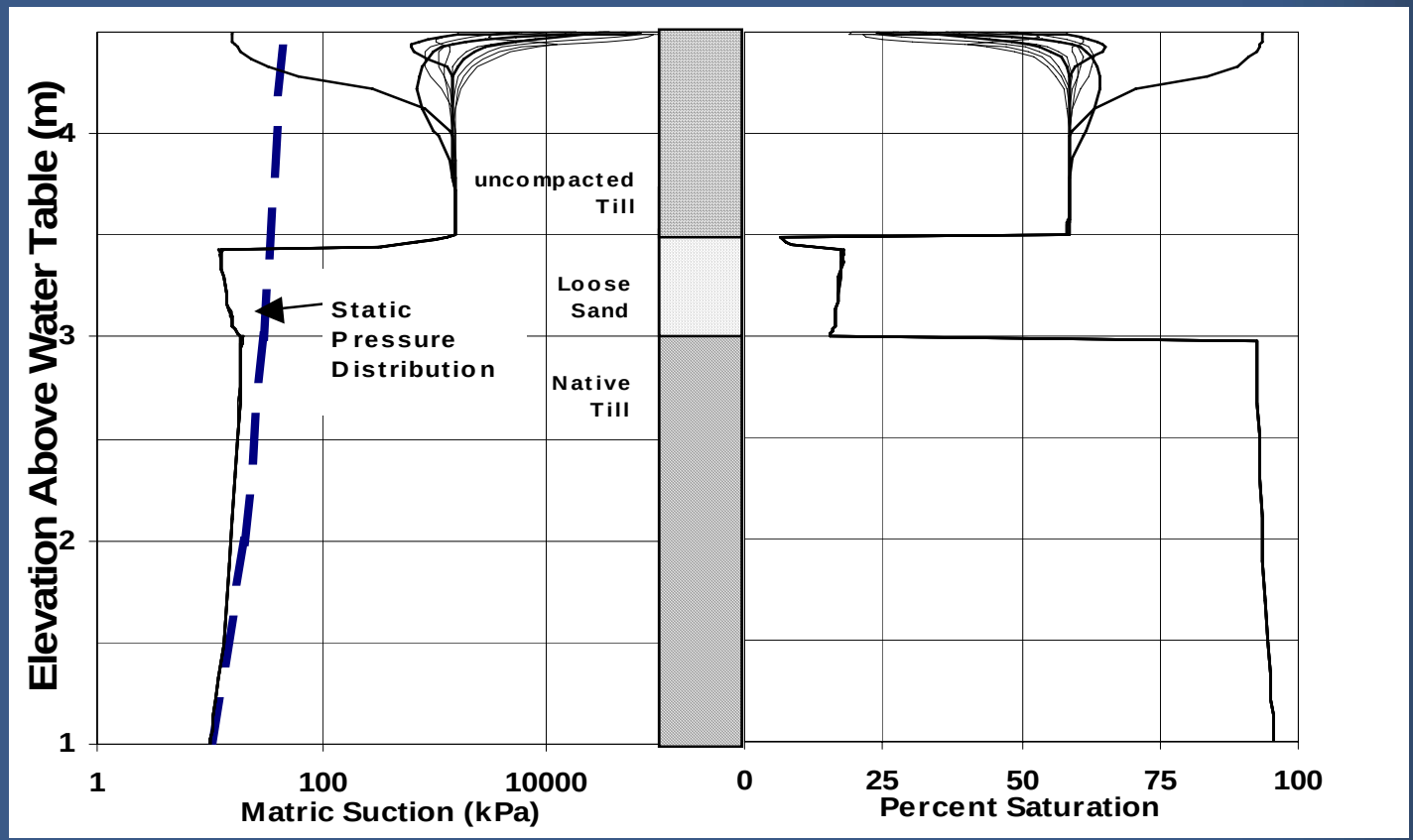
SoilCover Results



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Where to From Here?

- Stakeholder Input
- Research Study Program
  - Pre-Feasibility Study
  - Site Selection
  - Feasibility Study
  - Field Trial
  - Long Term Performance Trends
- Full Scale Investigation

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Summary

- Application of Soil Cover Systems to salt impacted sites possible.
- Research and development approach required similar to mining approach.
- Multi stakeholder involvement required.

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