ATLANTIC
CLRA | ACRSD

October 29 - 30, 2014 | Wolfville, Nova Scotia

Measuring Net Percolation Rates for Waste Storage Facility Cover Systems

Authors: Cody Bradley - B.Sc. Civil Engineering
Greg Meiers - P.Geo.

O'Kane Consultants Inc.

Presentation Outline

Net percolation from the base of a cover system is a key measure of performance

Methods of estimating net percolation:

- Direct measurements
  - Lysimeter Design
- Water Balance
- Numerical Simulations
- Conservative Tracer

Use a multiple phase approach to instill confidence in cover system performance

Direct Measurement - Lysimeters

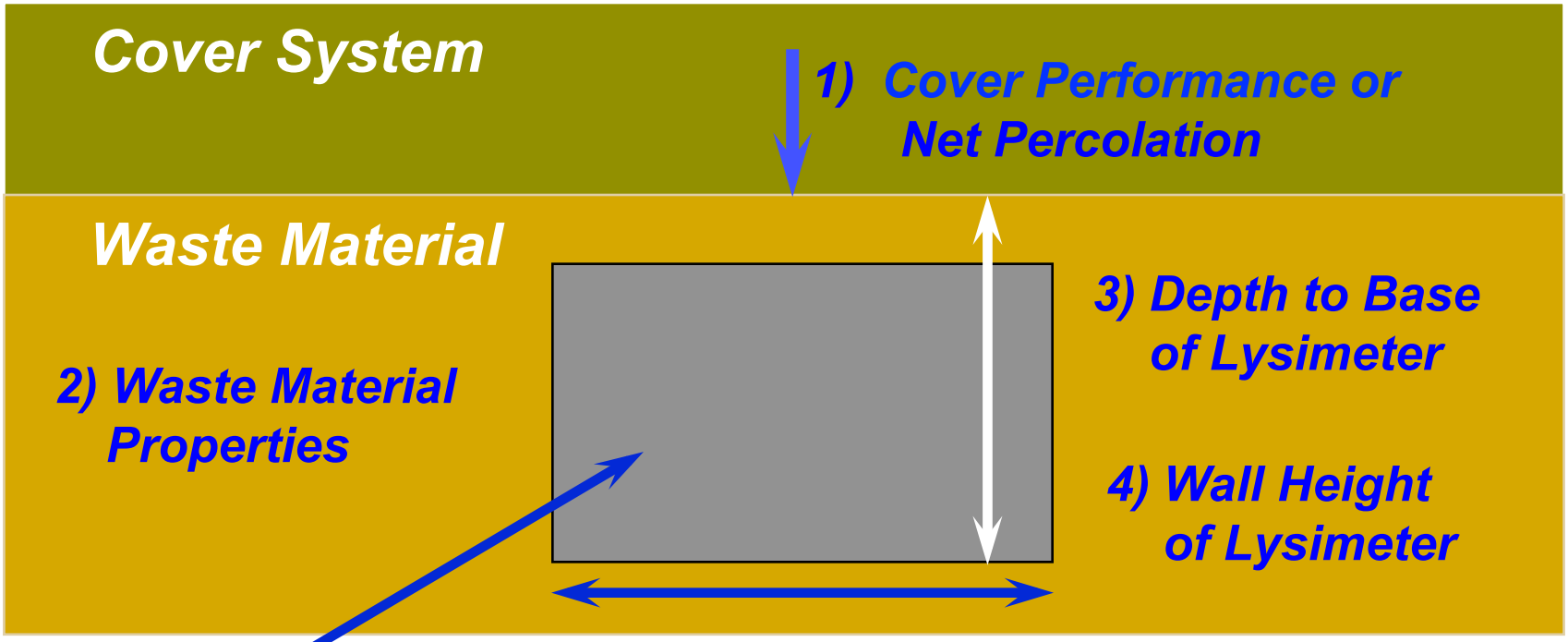
Advantage:

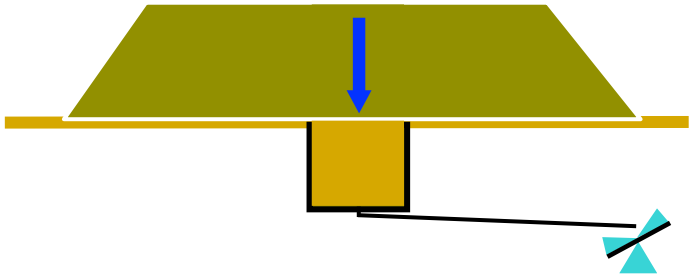
- Immediate measurement of net percolation volume
- Conceptually simple to understand

Disadvantage:

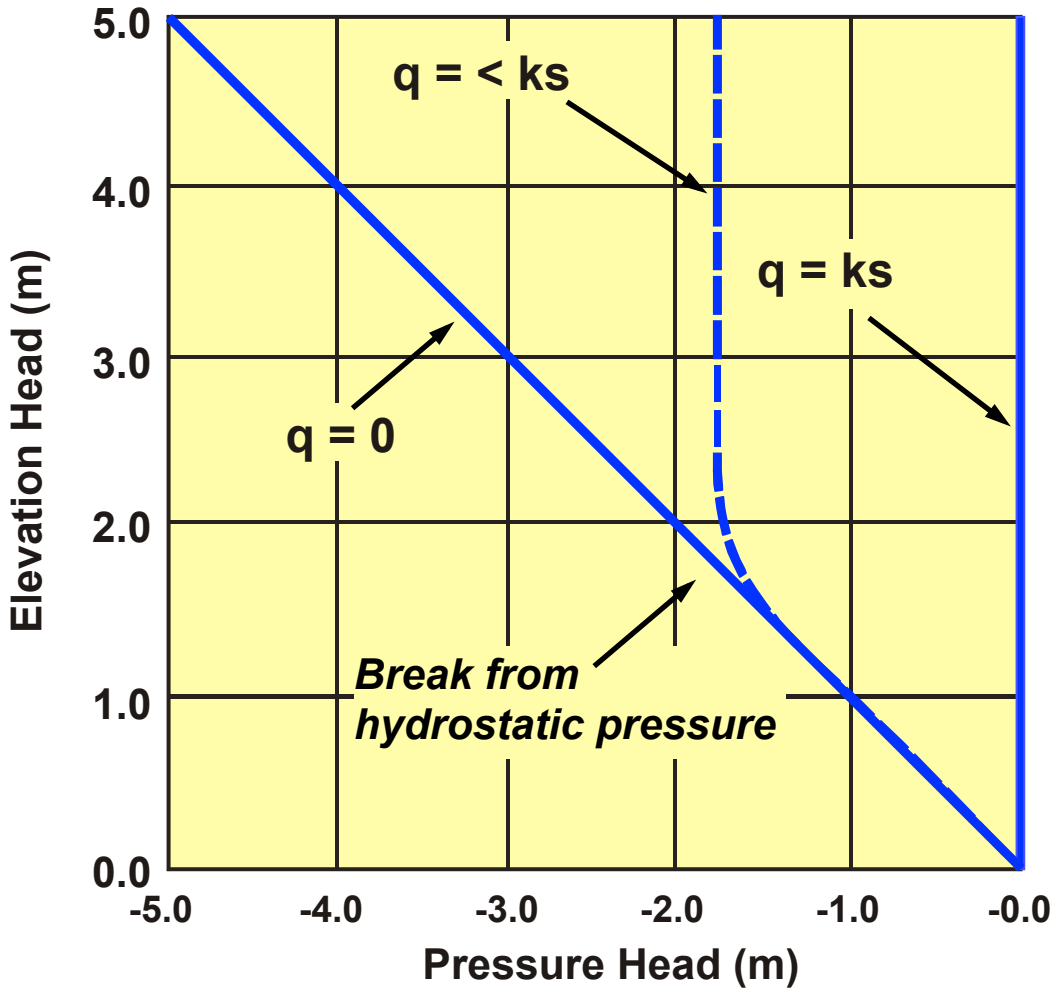
- Lysimeter design NOT intuitive!! - Unsaturated system
- Require understanding and proper design
- Performance Monitoring of Lysimeter is Required
- Safety issues during installation

Lysimeter Design - Background

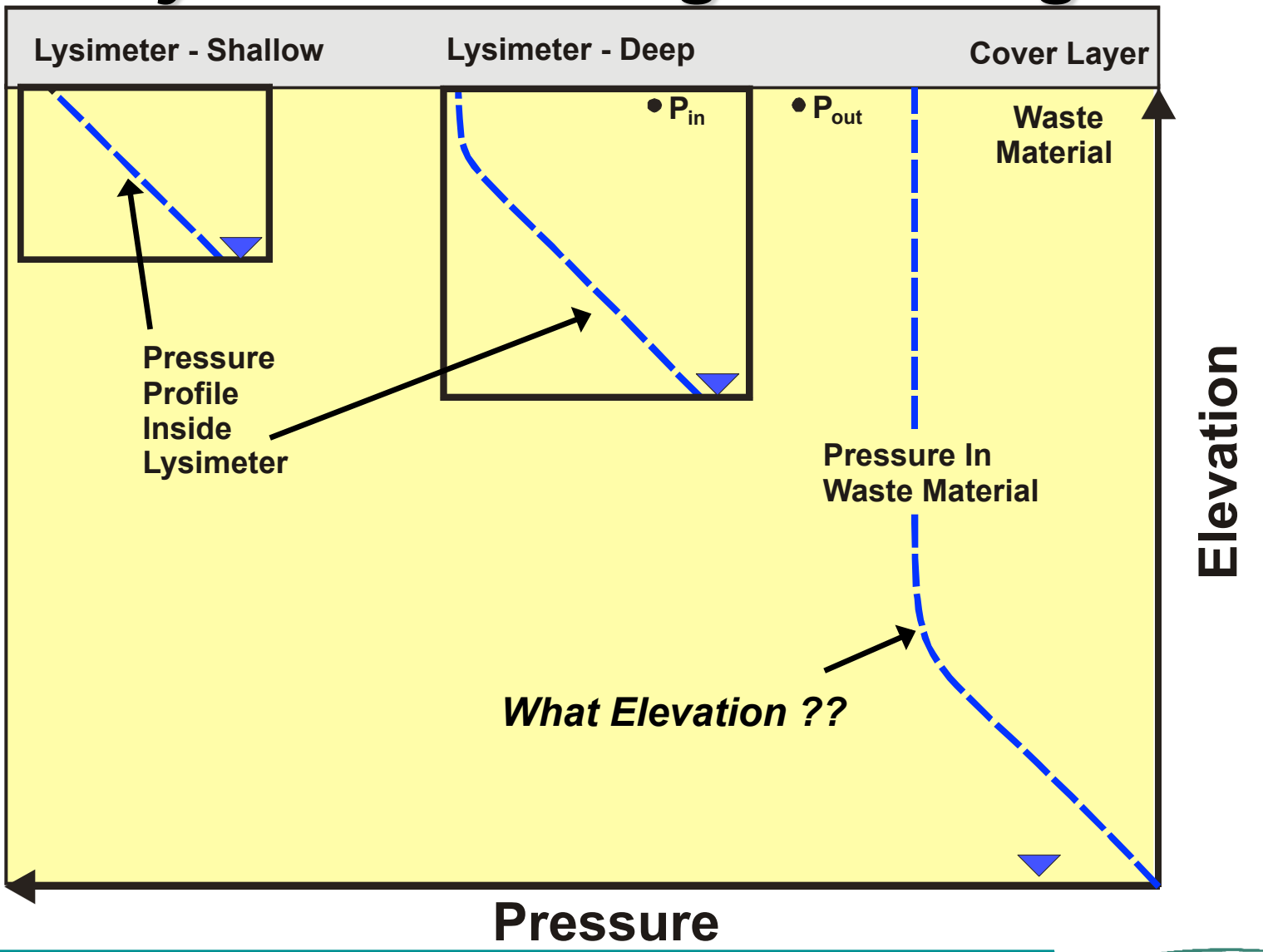




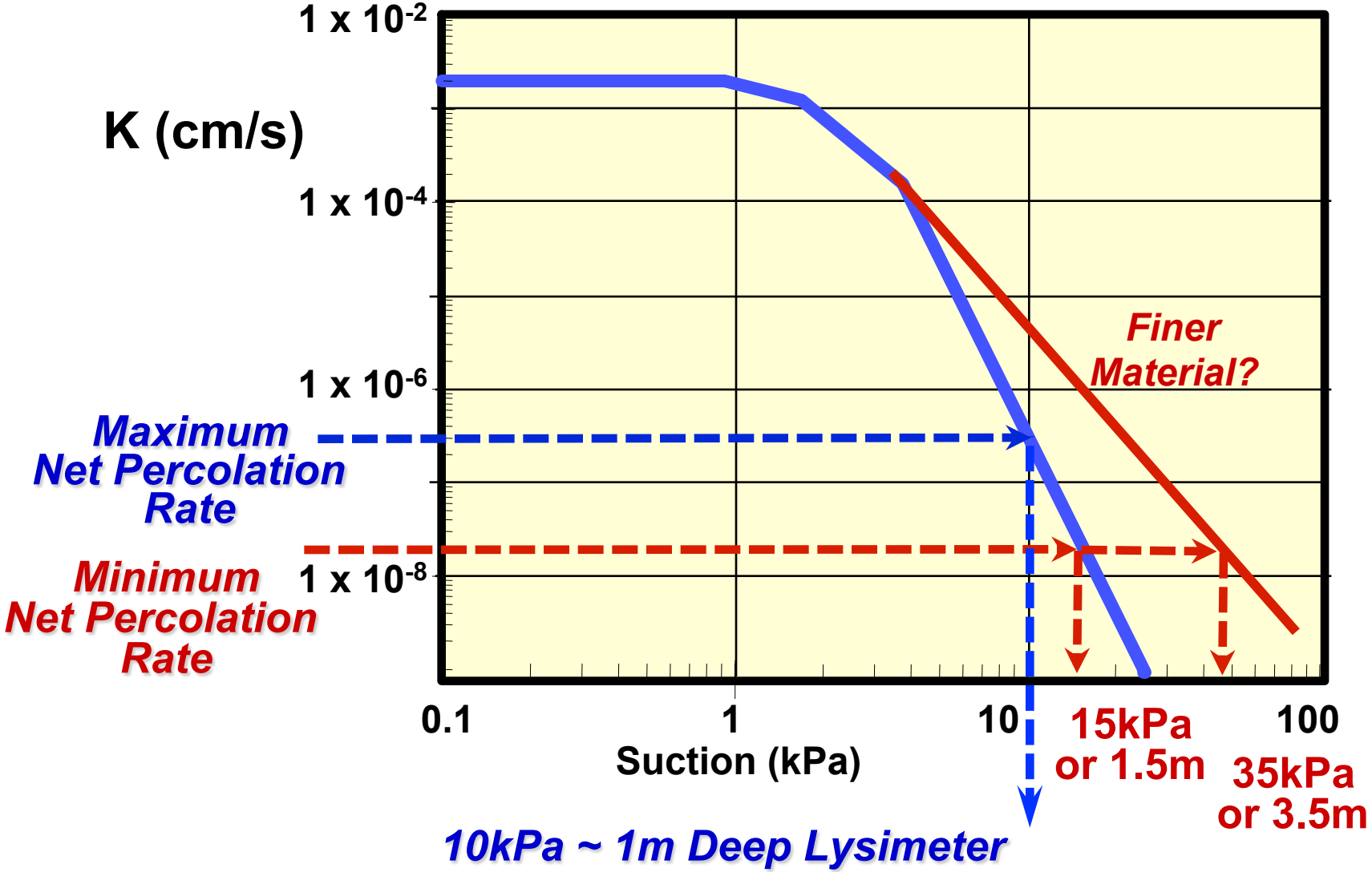
Lysimeter Design - Background



Lysimeter Design - Background

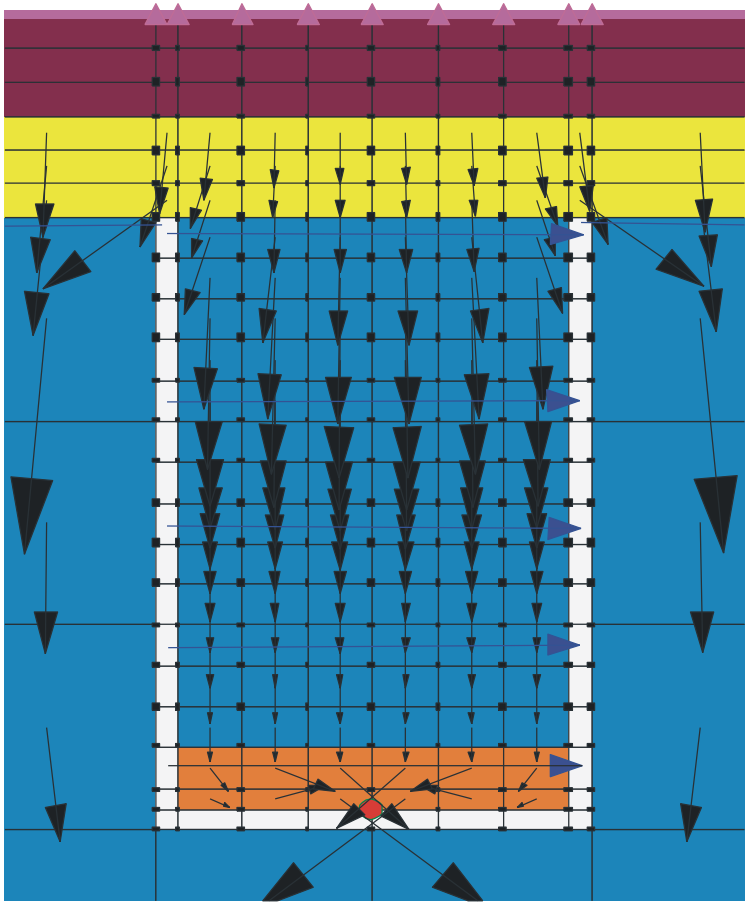


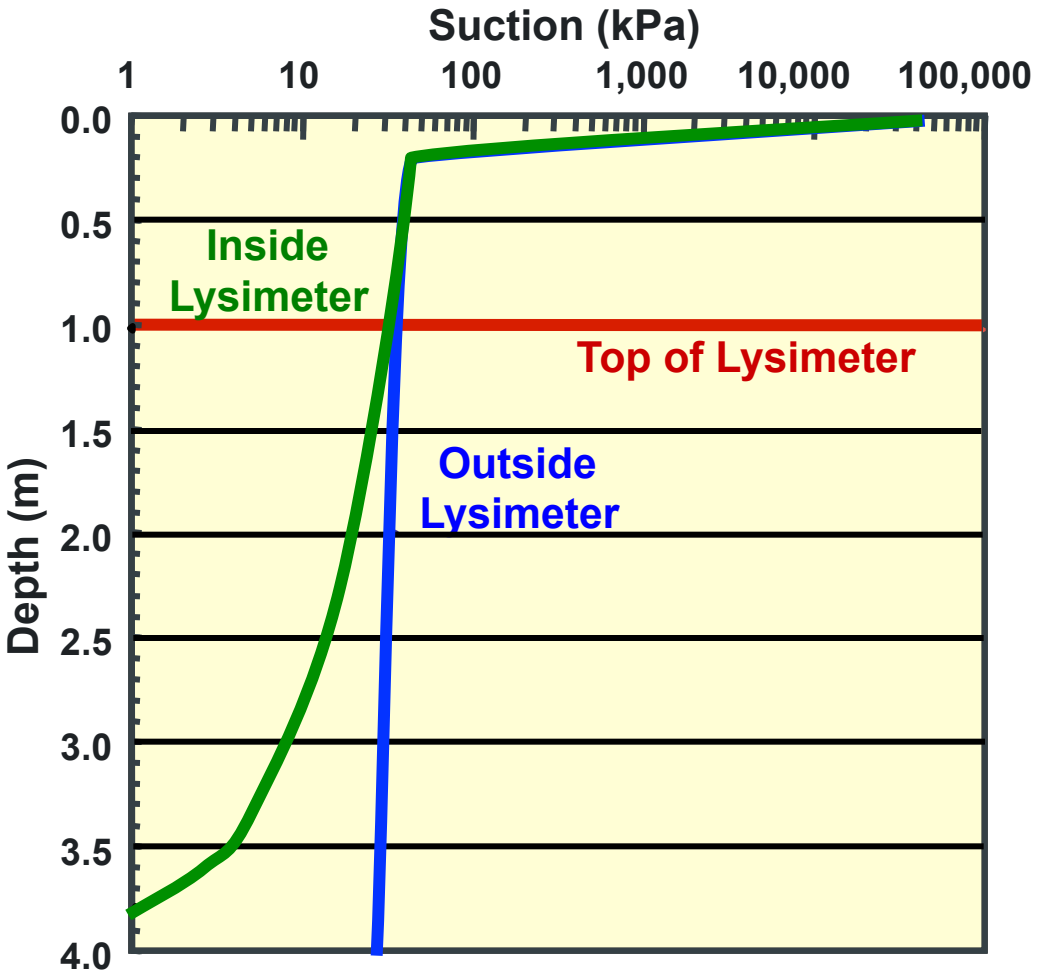
Lysimeter Design "back of envelope"



Lysimeter Performance

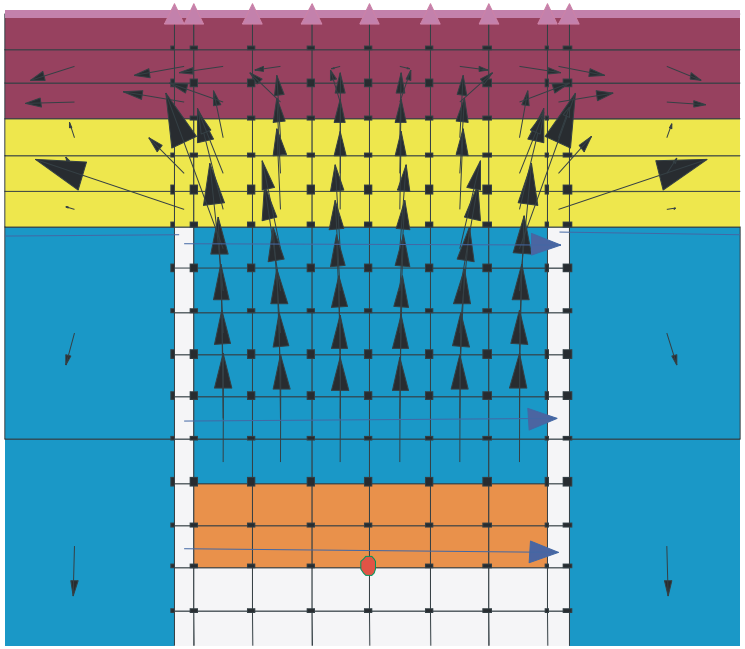
Example of a Properly Functioning Lysimeter

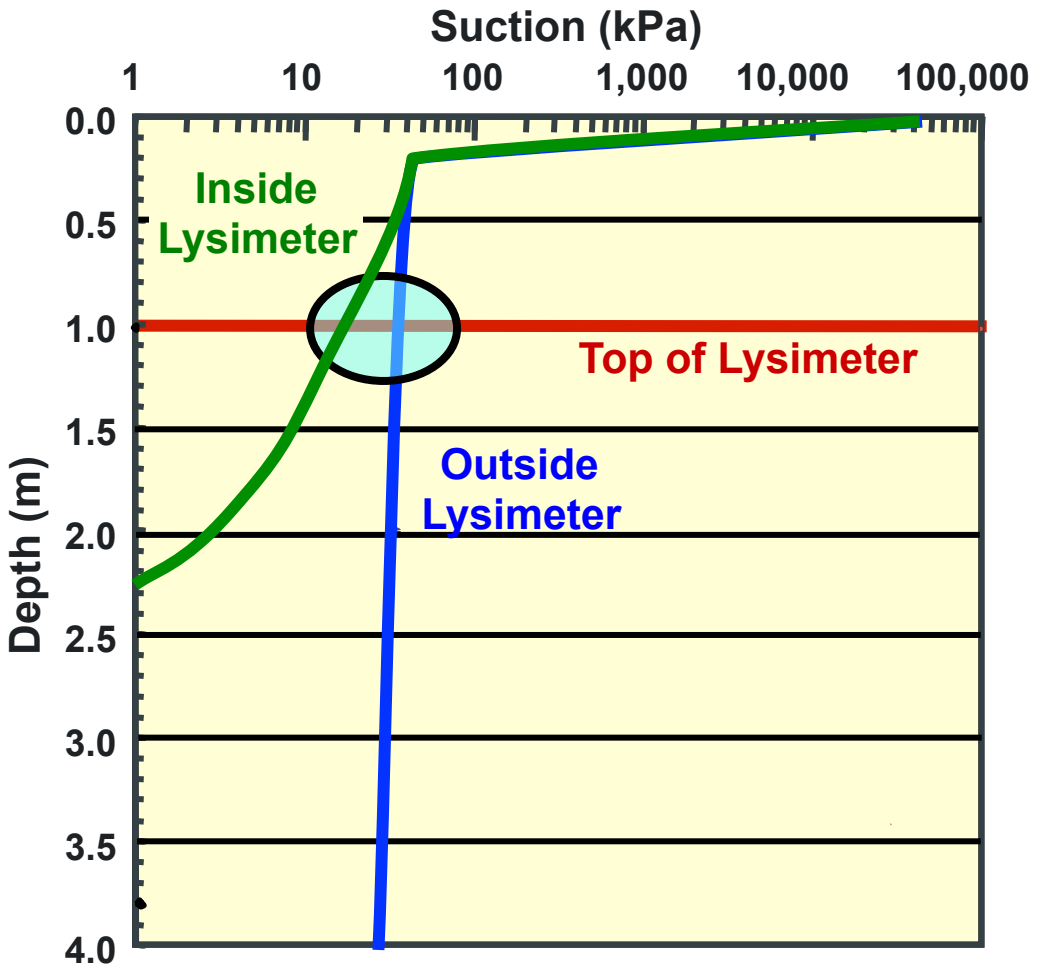




Lysimeter Performance

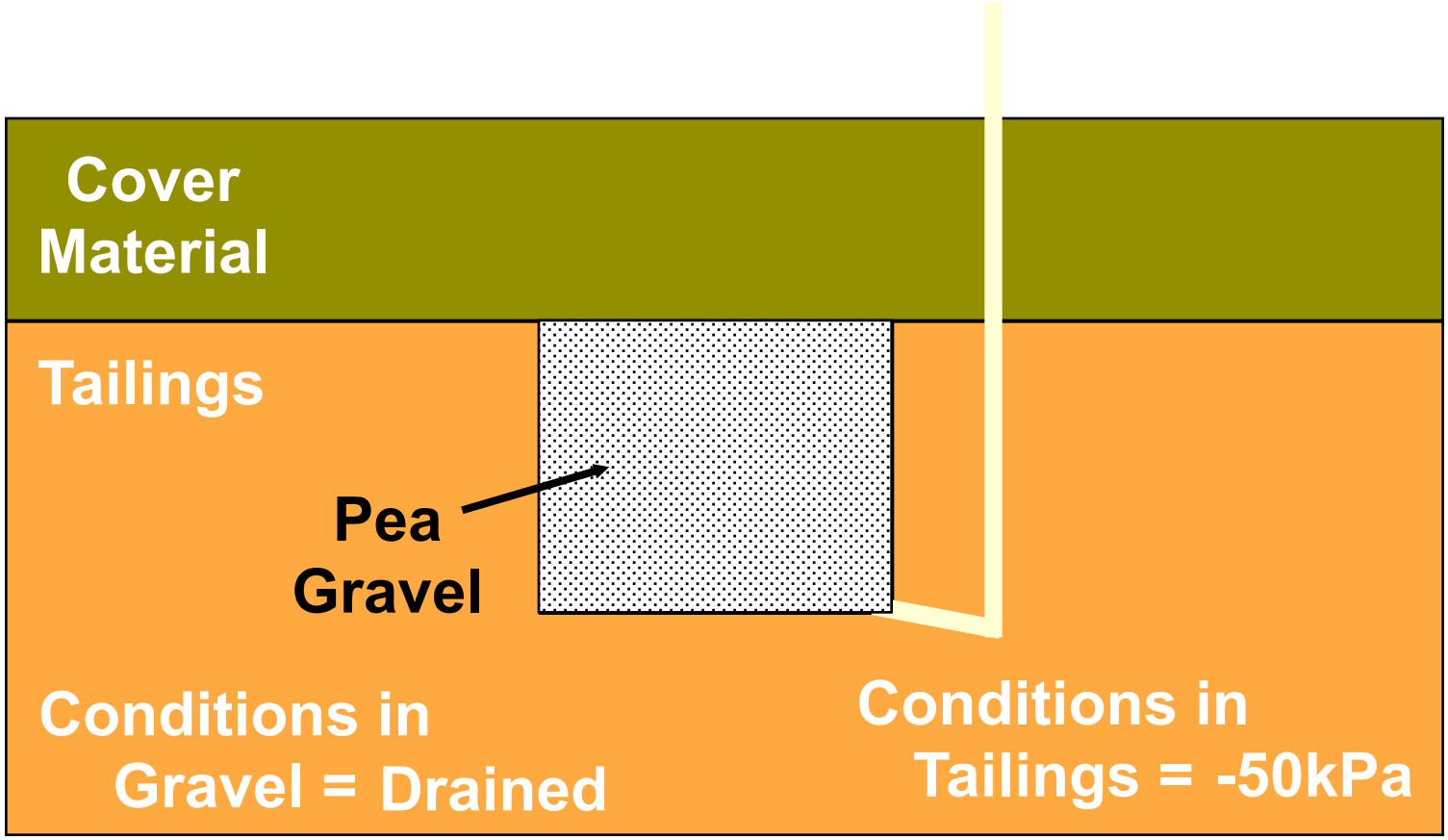
Example of a Poorly Functioning Lysimeter





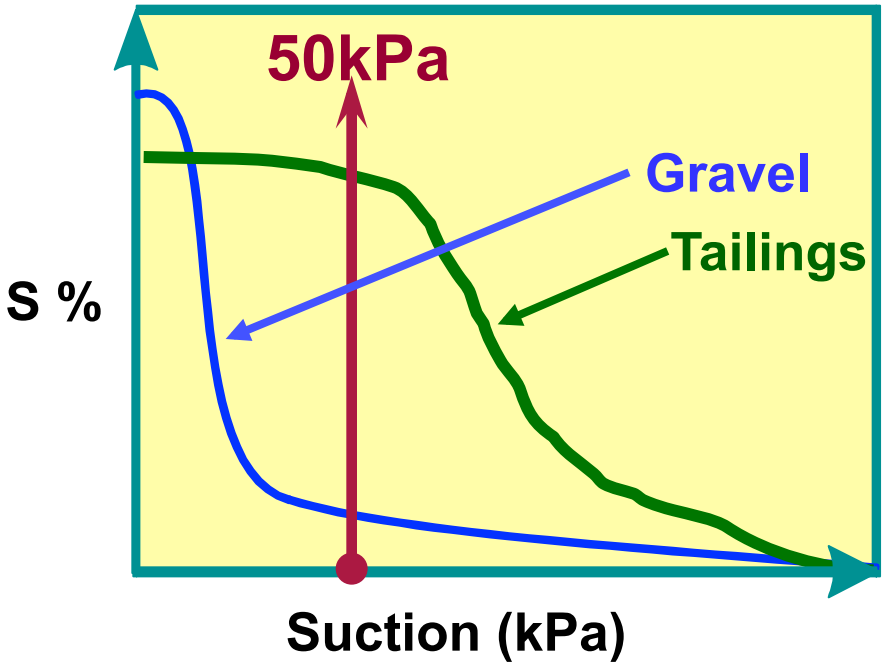
Lysimeter Design

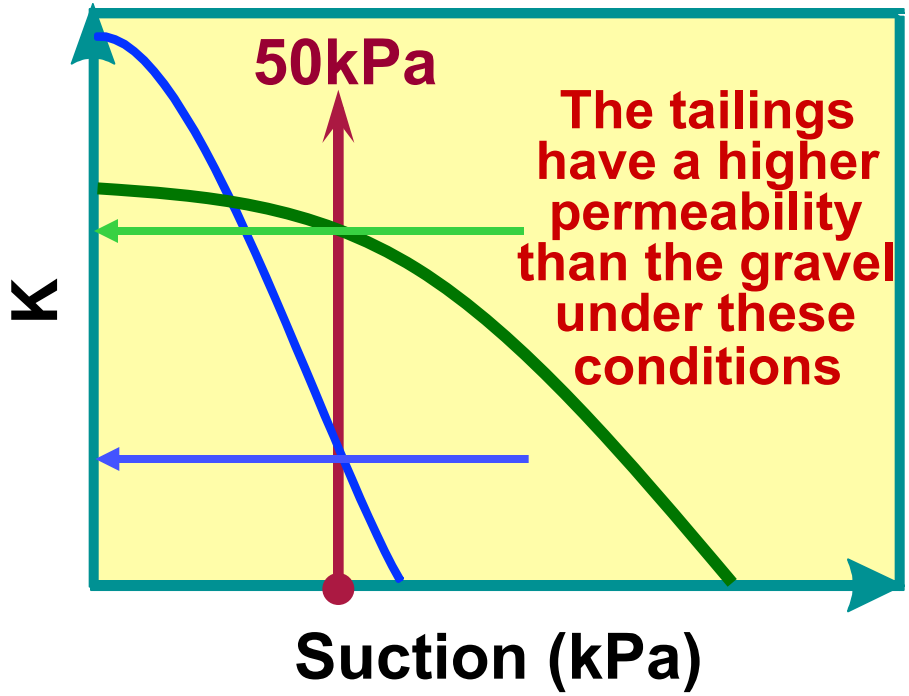
Lysimeter Design Problems Backfill



Lysimeter Design

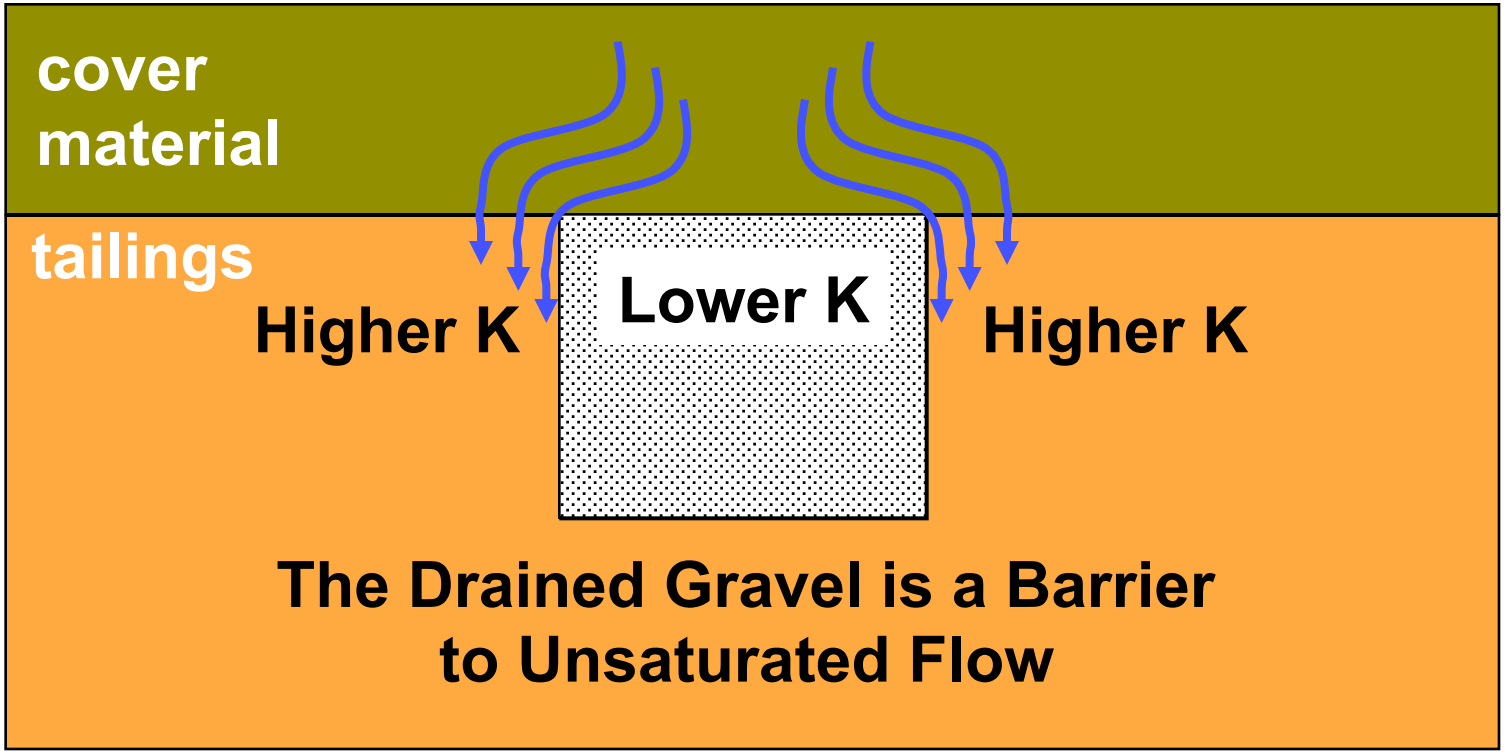
Lysimeter Design Problems Backfill



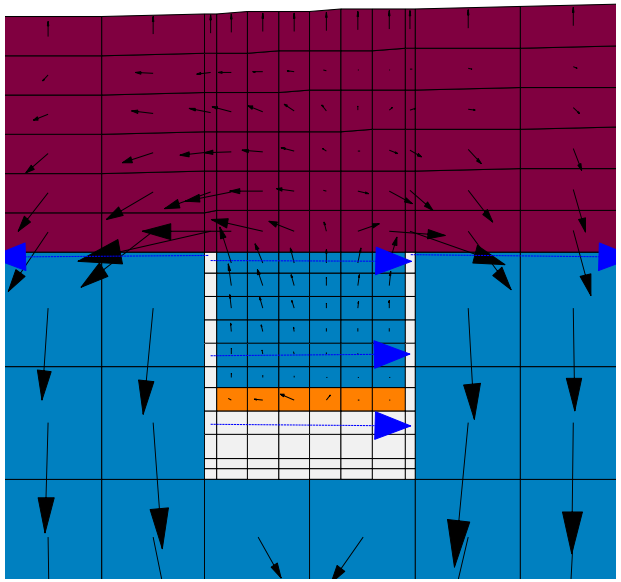


Lysimeter Design

Lysimeter Design Problems Backfill



Lysimeter Performance

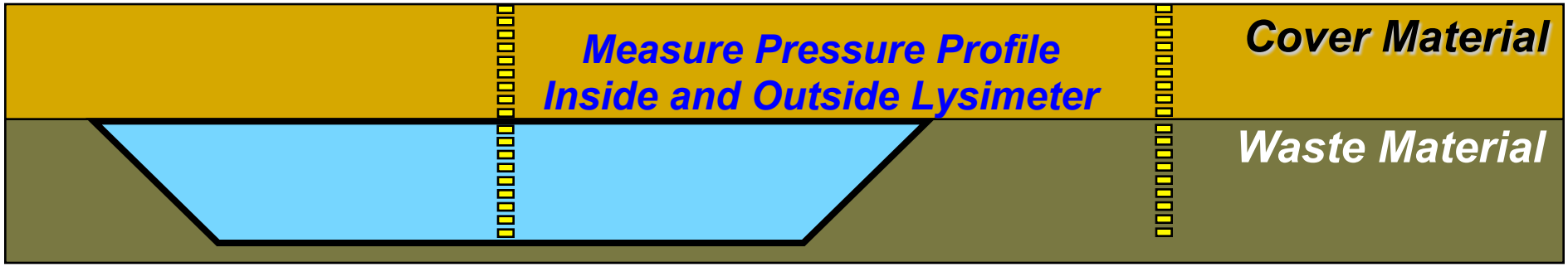


Monitor Pressure Conditions Inside and Outside Lysimeter to:

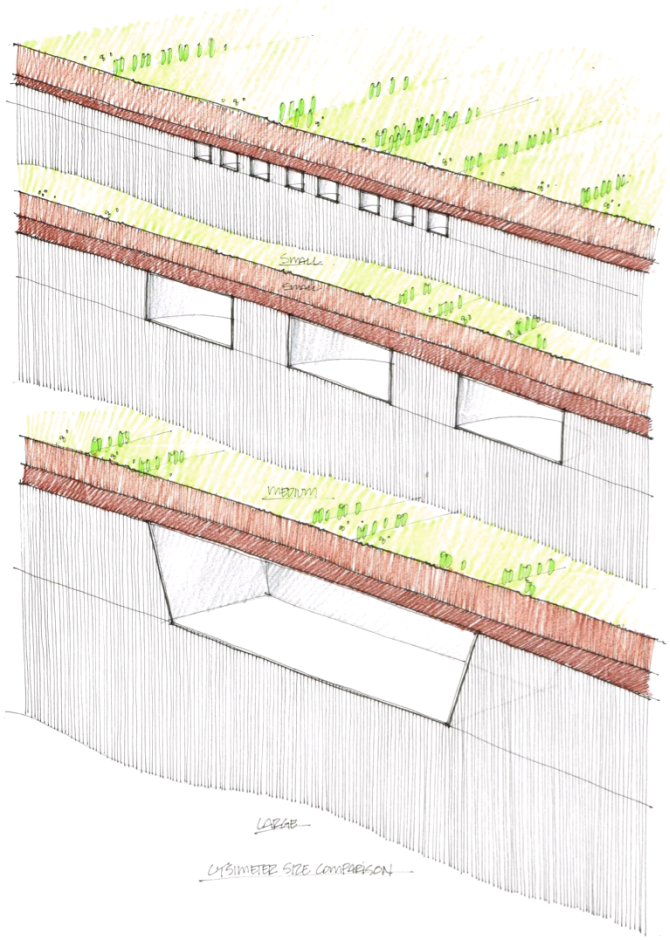
- *Verify measured net percolation is accurate*

Or, if not

- *"Back Simulate" Net Percolation*
  - *calibrate a model to lysimeter results*
  - *"re-run" model with proper in situ suction at base*



Lysimeter Areal Extent

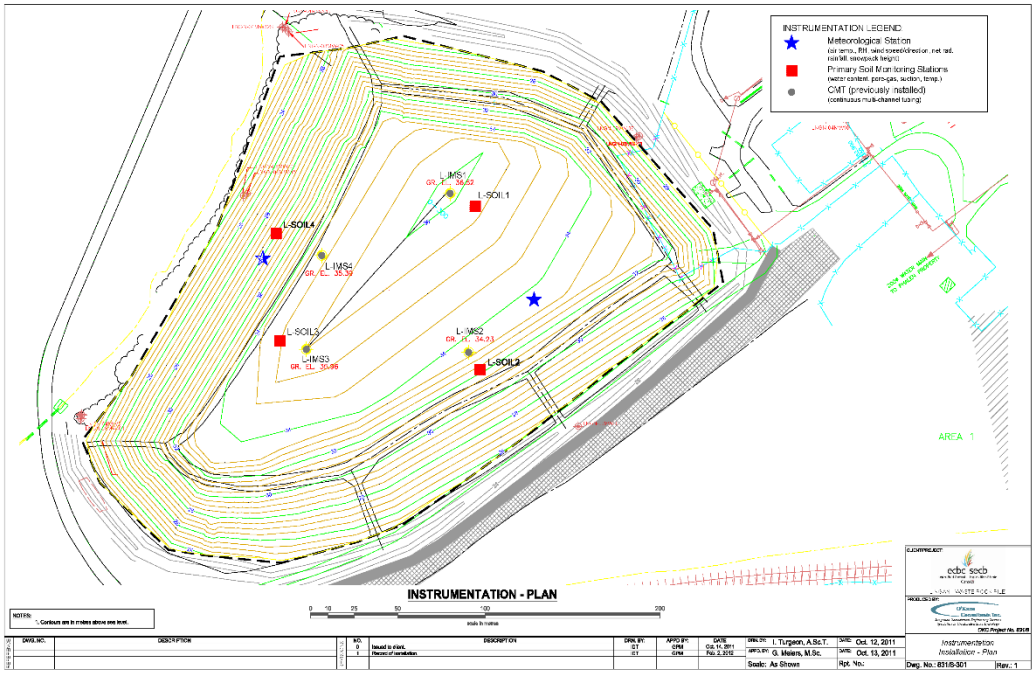


- **Small** areal extent:
  - Expect **high variability**

- **Large** areal extent:
  - **Capture spatial variability**
    - Obtain 'bulk' net percolation rate

Enterprise Cape Breton Corporation (ECBC)

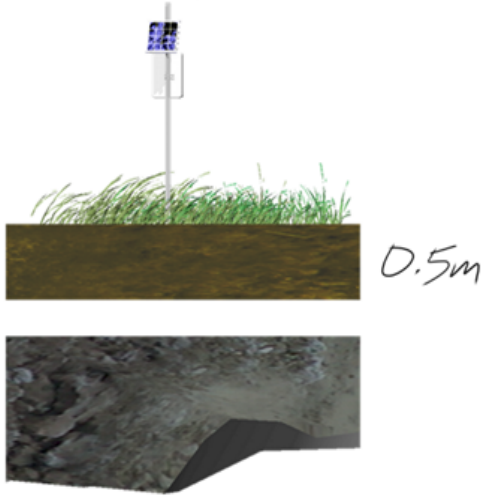
Lingan Waste Rock Pile – Cape Breton, NS



- *Lysimeters Unfeasible*
- *8.5 ha*
- *Height: 15 m*
- *Volume: 380,000 m3*

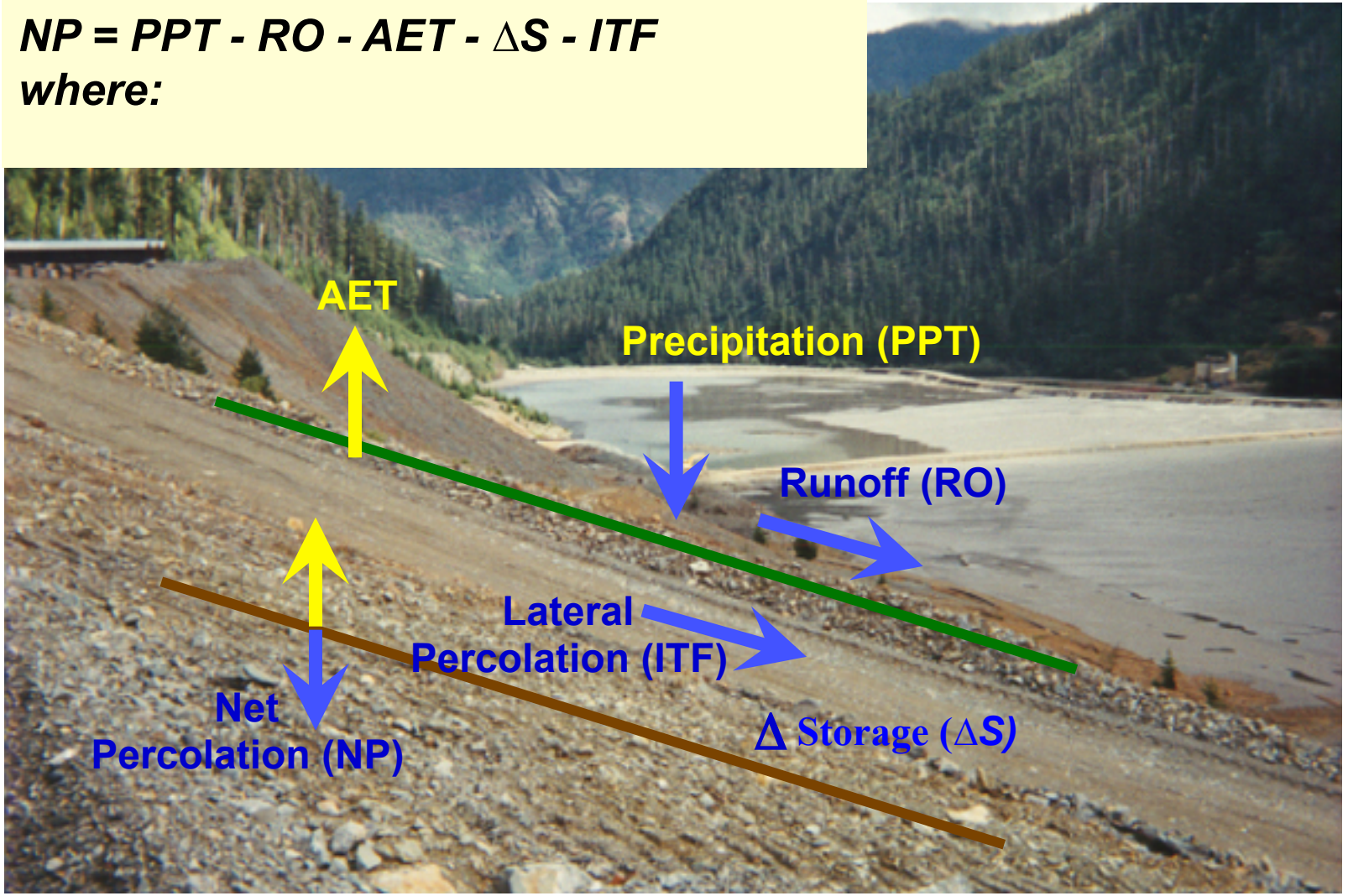
Store and Release Cover System

- *PPT: 1518 mm*
- *PE: 600 mm*
- *AET: 390 mm*

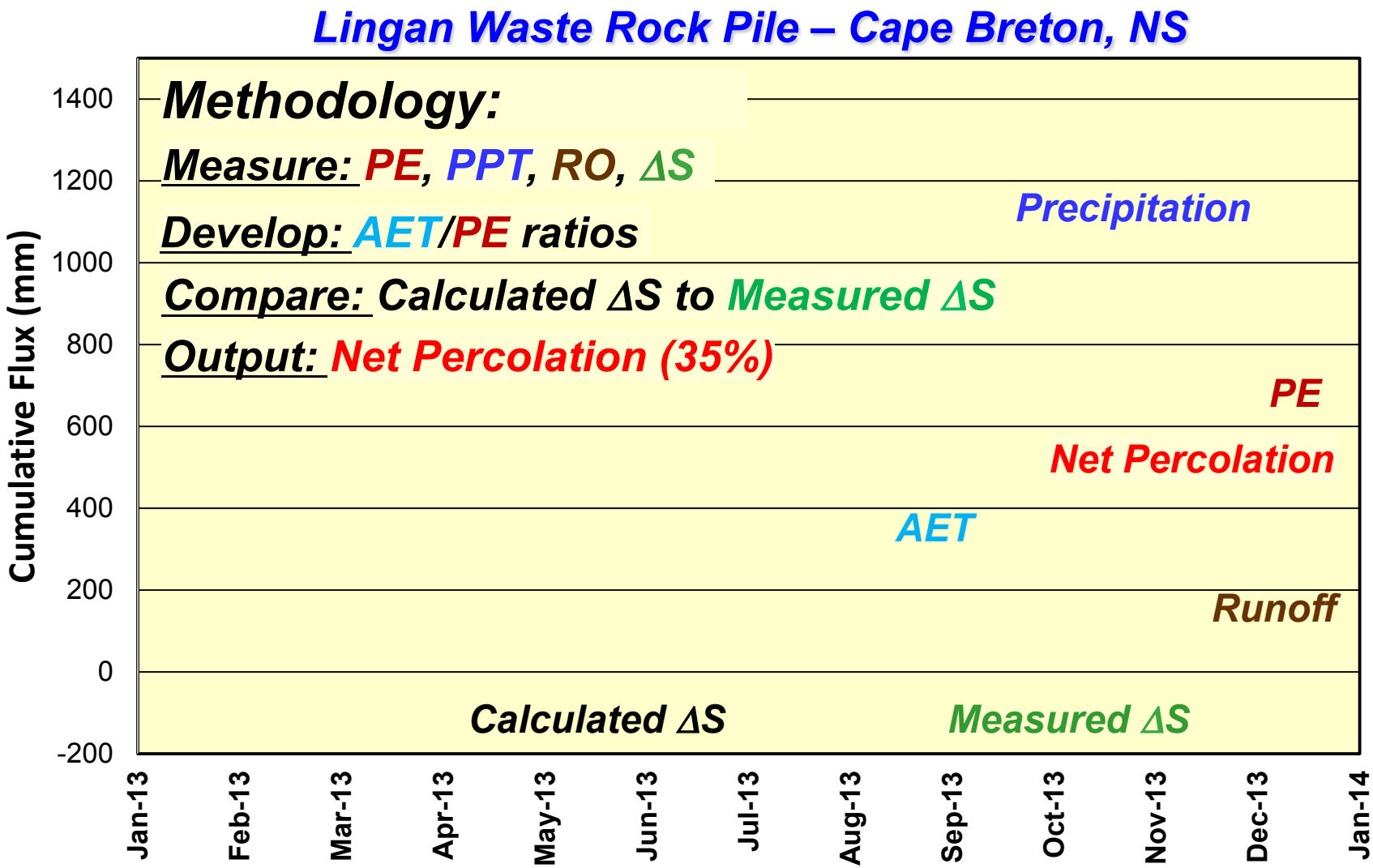


Simple Water Balance

NP = PPT - RO - AET - ΔS - ITF
where:



Simple Water Balance - example



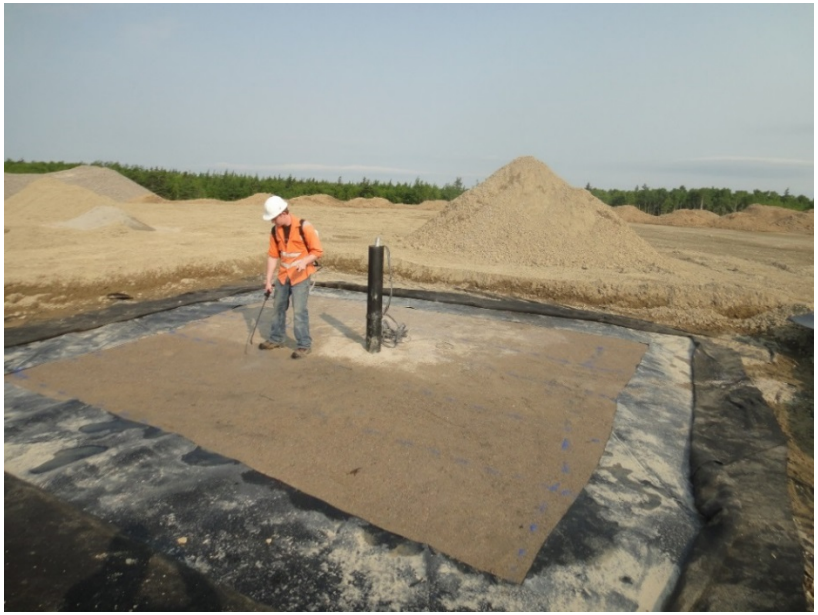
Conservative Tracer Analysis

Deuterium (^2H)

- Natural H Isotope
- Tracer migrates through the cover with infiltrating water
- $H_2O_{(liquid)}$ - $H_2O_{(vapor)}$ equilibration

Application

- Water Spiked with ^2H
- 5 x 5 m Area
- ~2-3 mm of Water over the area



Conservative Tracer Analysis

Cover System Type

Geomembrane | Growth Medium | Exposed Material

Range of Net Percolation Rates

Very Low | Low | Moderate | High

Conservative Tracer Analysis

Deuterium

- Higher NP rates
  - Point source (Plateau)
  - Preferential flow

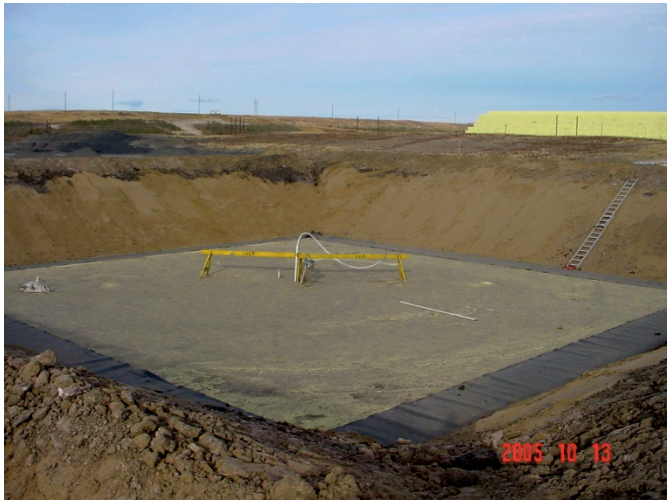
Water Balance

- Lower NP rates
  - Entire landform

Key Points

Net Percolation is a Key Measure of Cover System Performance

- Lysimeter Design is Not Intuitive
  - Wall Height of Lysimeter is Critical
- Monitor Lysimeter Performance
  - Verify Measured Net Percolation
  - "Back Simulate" Net Percolation
- A Simple Water Balance Can Be Completed
  - Measure Remaining Components
- Conservative Tracer
  - Novel Method
  - Multiple Lines of Evidence



Thank You!

O'Kane Consultants Inc.

Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology

Habitat for Humanity®

O'Kane Consultants Inc.
Habitat for Humanity Initiative – El Salvador

Rainbow of HOPE for Children