EARTHMASTER
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IN-SITU HYDRAULIC CONDUCTIVITY TESTING OF SOILS WITH ELEVATED SAR'S – A CASE STUDY

Outline

- Background
- Permeameter Details
- Site Details
- Testing/Results
- Benefits/Limitations

Background

- What to do with salt impacted soils?
  - What do we currently do?
    - Landfill
  - Is it working?
    - Not Really
  - Should we look at a new approach?
    - Yes!
- Decided to explore alternative options for SAR impacted soils

Sodium Adsorption Ratio (SAR)

- Measure of sodicity in soil

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

- High SAR soils
  - Poor physical structure
    - Replacement of calcium and magnesium on clay particles by sodium causes soil dispersion (swelling)
  - Poor plant growth
  - Water infiltration issues

Background

- Research
  - What is the regulatory driver?
    - Restriction of subsurface water movement
    - Perched water table
    - Rooting zone exemption (1.0 to 1.5 m bgl)
  - Testing Methodology
    - Field vs. Lab
    - Equipment
    - Accuracy and cost
  - Guelph Permeameter

Guelph Permeameter

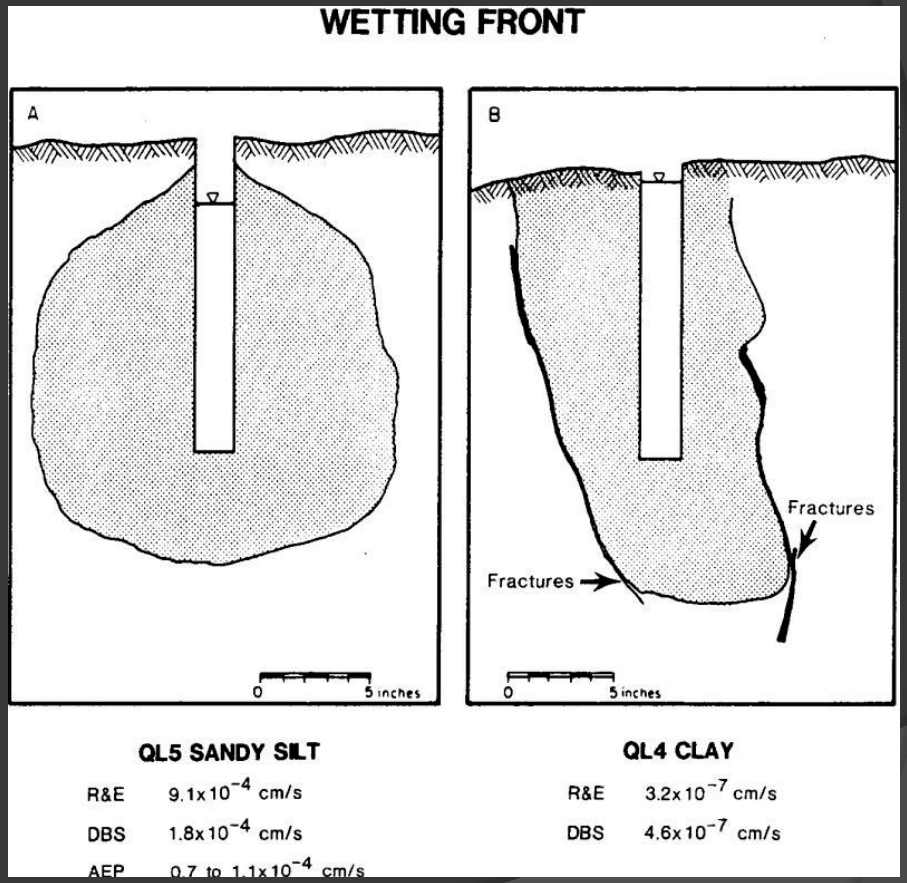
- In-hole constant head permeameter employing the Mariotte Principle
- Provides a quick and simple method for determining field saturated hydraulic conductivity

Guelph Permeameter

- Three dimensional flow vs. only vertical parameters
- Can measure to 10^{-9} cm/sec (takes a longer time in heavy clay soils)
- Theoretical testing depth of 6 m bgl
- Field Saturated Hydraulic Conductivity
  - Air bubbles caught in the wetting zone
  - May be more realistic of actual infiltration

Guelph Permeameter

- Establishes a bulb of saturated soil
- The bulb is very stable and its shape is dependent on the soil type
- Once the bulb is established the outflow of water reaches a steady state flow rate
- Graduated cylinder



Advances in Measurement of Soil Physical Properties: Bringing Theory into Practice. (1992) Applications of the Borehole Permeameter by Daniel B. Stevens. Soil Science Society of America. G. Clarke Topp, W. Daniel Reynolds and Richard E. Green (ed.)

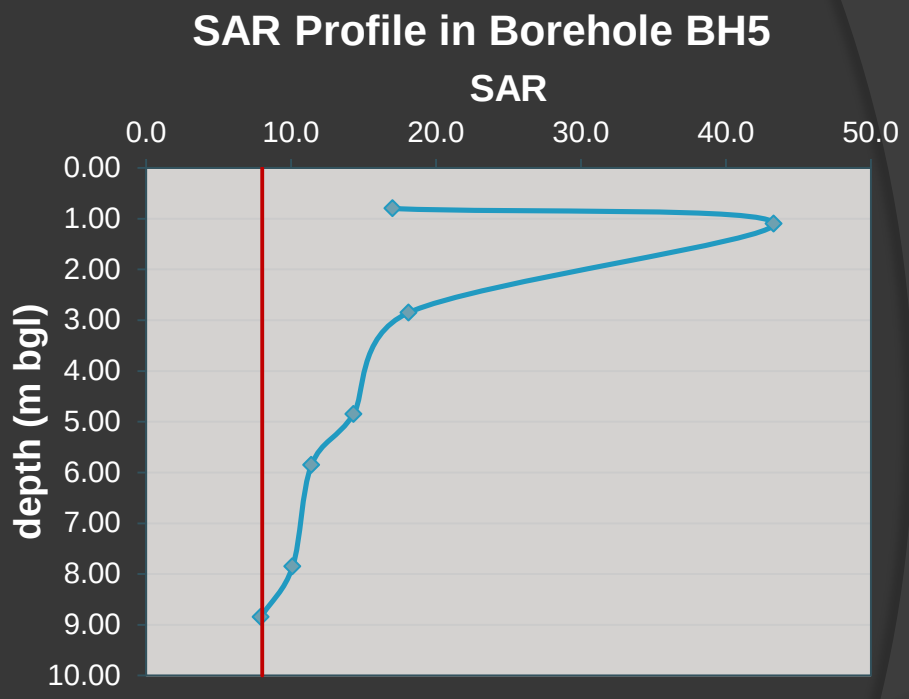
Site Details

- Abandoned oil and gas lease in SE AB

Evaporation Pit

Site Details

- Phase II ESA
  - SAR levels from 8 to 45
  - Chloride levels up 1260 mg/kg
  - From surface to 8.00 m bgl
  - Loam – Clay Loam with Clay at depth
  - Shallow EC and boron issues



Testing

- Excavated 150 m^3 surficial salt and boron impacted soil
- Collected 8 hydraulic conductivity measurements in the base of the excavation (15 x 20 m)
- 12 background measurements
  - Collected at same depth and soil type as the base of the excavation
- At every point the tested soil was collected - detailed salinity and particle size analysis

Testing

Results

- **Background** SAR levels ranged from 1.13 to 6.98 (avg. 5.4)
  - Ranged from 1.19×10^{-6} to 9.64×10^{-8} cm/s with a mean conductivity of **3.52×10^{-7} cm/s**
- **Excavation base** sample SAR levels ranged from 25.6 to 43.5 (avg. 31.2)
  - Ranged from 2.67×10^{-7} to 6.93×10^{-8} cm/s with a mean conductivity of **1.82×10^{-7} cm/s**

Results

- Soils with SAR values up to 43.5 had comparable hydraulic conductivity to soil with a SAR of 8 or less
- Statistical analyses of the data showed a difference between the two data sets – absolute difference was 1.7×10^{-7} cm/s
- Weighing environmental affect…
- 700 m^3 of sodium rich soil was left in-situ

Results

- Regulatory Framework
  - Tier II Assessment
    - Equivalent land capability
    - Site-specific endpoint

Limitations/Benefits

- Limitations
  - SAR's at depth
    - Borehole to 6 m bgl/test pit
    - Winter conditions
    - Does not include rooting zone (1.0 – 1.5 m bgl)
- Benefits
  - In-situ
  - Reduces landfill disposal
  - Sustainable
  - Cost effective (~$15k vs ~$85k)

Acknowledgements

- Enerplus Corporation
- Alberta Environment and Sustainable Resource Development

Thank You!!

Questions???