

Soil Biodiversity and Chemistry Challenges to Reclamation in the Oil Sands

2018 NORTHERN LATITUDES MINING RECLAMATION WORKSHOP

September 11, 2018

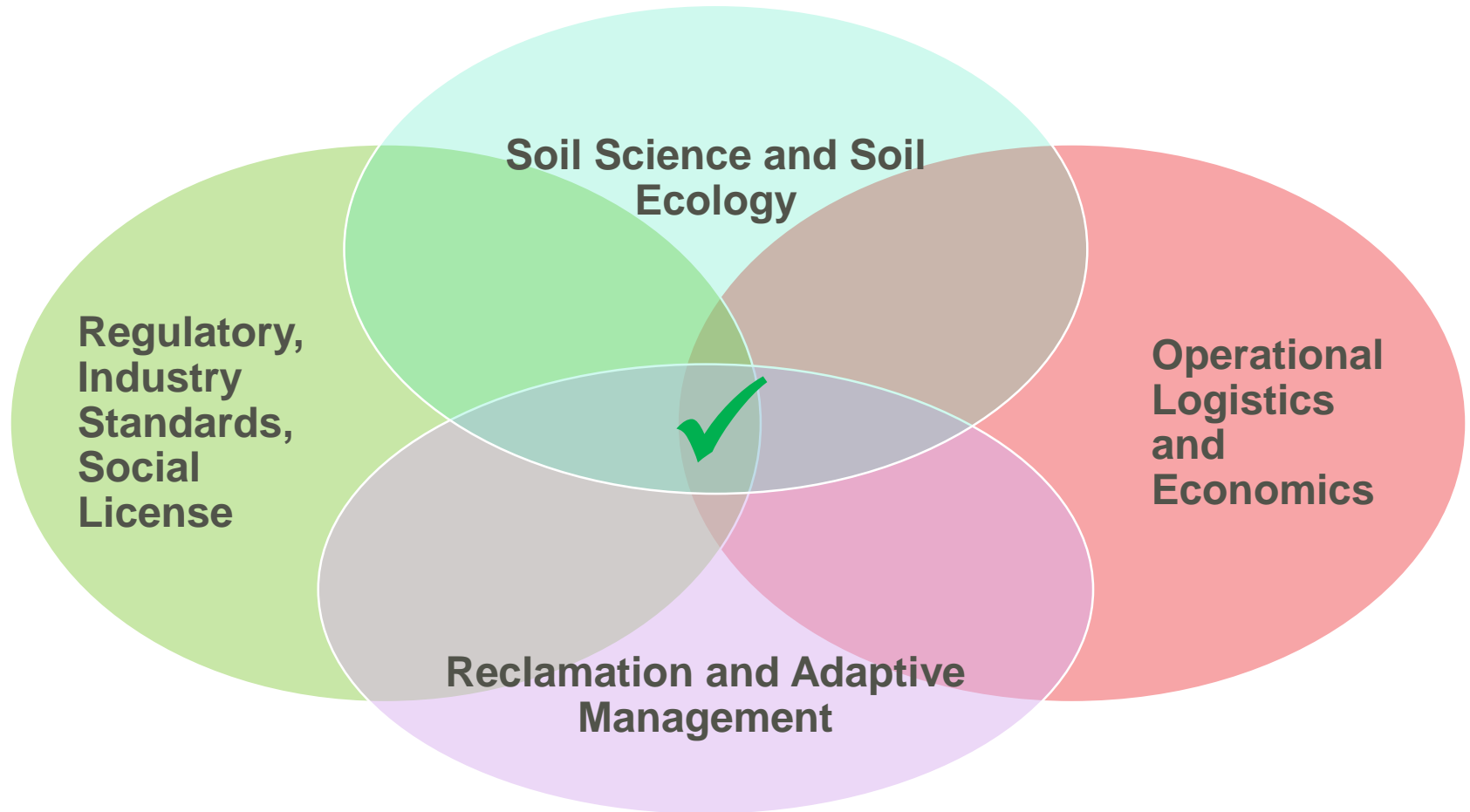


AGENDA

- **What are the Challenges?**
 - Soil biodiversity
 - pH
 - Salinity
- **Cautionary Statements and Context**
- **Implications**
- **Finding Solutions**



The Challenges



Criteria and Indicators Framework (CEMA 2013)

Terrestrial Indicator	Acceptable	Other Monitoring	Not Suitable
Moisture		✓	
Depth	✓		
Macronutrients (N & P)		✓	
pH	✓		
Salinity	✓		
Locally Common Mycorrhizal Communities are Established			✓

Soil Biodiversity

pH

- Maximum diversity at pH ~6.5

Mechanical Disturbance

- Hyphae obliteration
- Microbial population dynamics

Soil Relocation

- Mycorrhizal compatibility
- Microbial population dynamics

Long Term Stockpiling

- Ecological resilience
- Recovery population dynamics
 - AM Fungi vs. EM Fungi, lag times
 - Aerobic bacteria, Actinomycetes vs. Anaerobes

pH and Salinity

Sensitive to elevated pH and salinity in peat-mineral mix:

- Reindeer lichen (a ecotype)
- Blueberry (b)
- Labrador tea (c and g)
- Jack Pine (a, c, g)
- Black Spruce (c, g)
- Others...

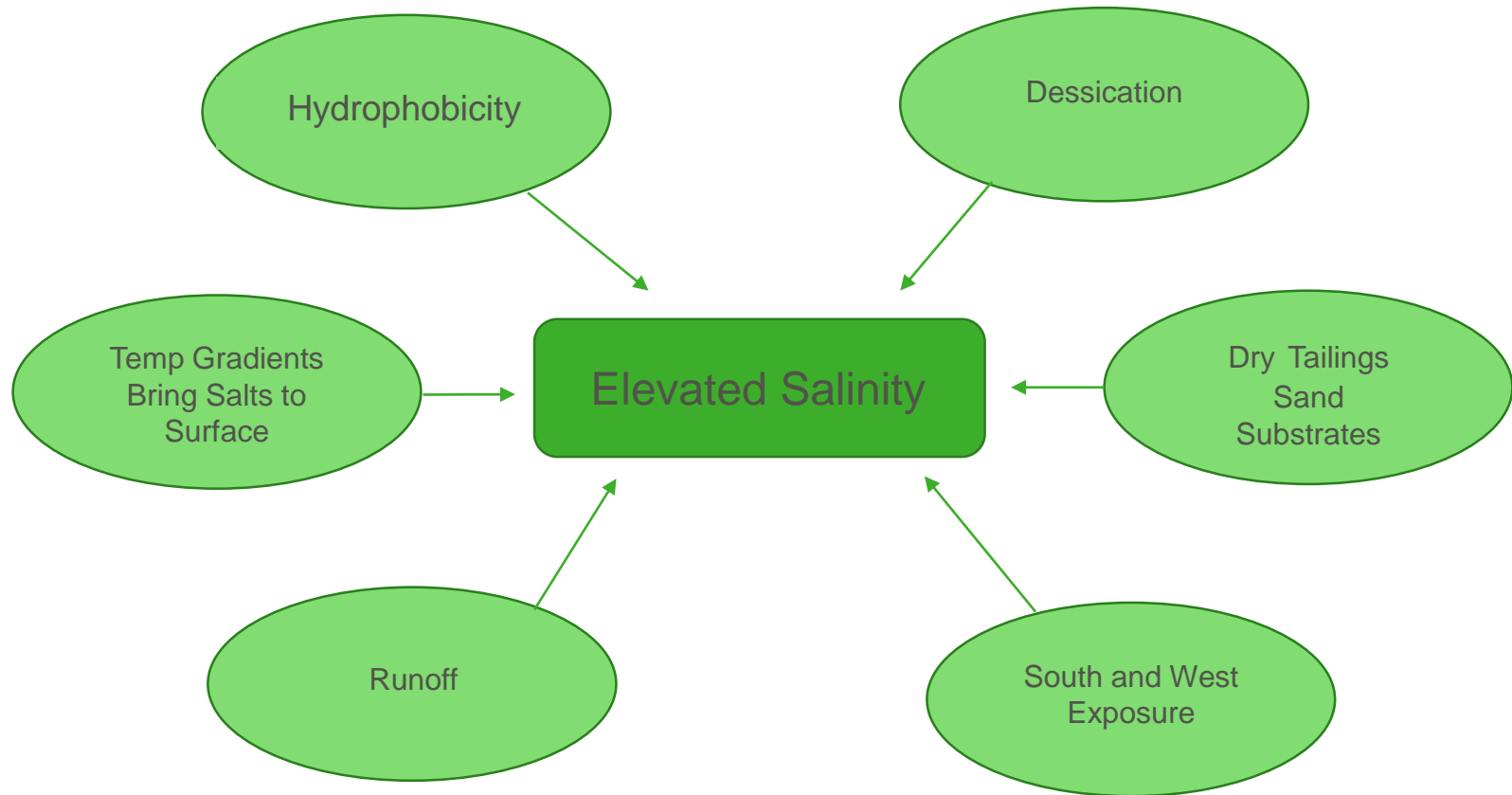


pH

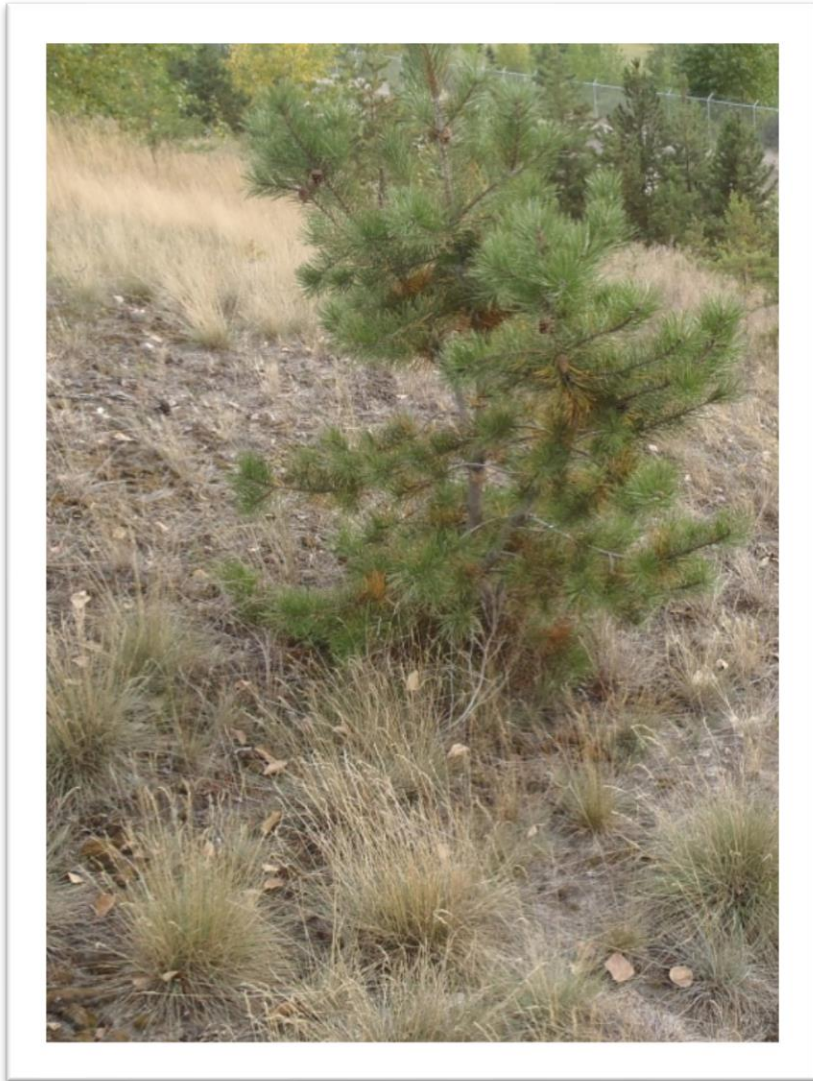
- pH of peat-mineral mix usually higher than source conditions
 - Dewatering of organic acid rich water
 - Unweathered parent material amendment
 - Carbonates
 - Medium/fine texture – naturally high in base cations
 - Marl?
 - Result in low P (in high Ca conditions), low B, low Fe
 - High buffering capacity of most peat species



Salinity



Salinity

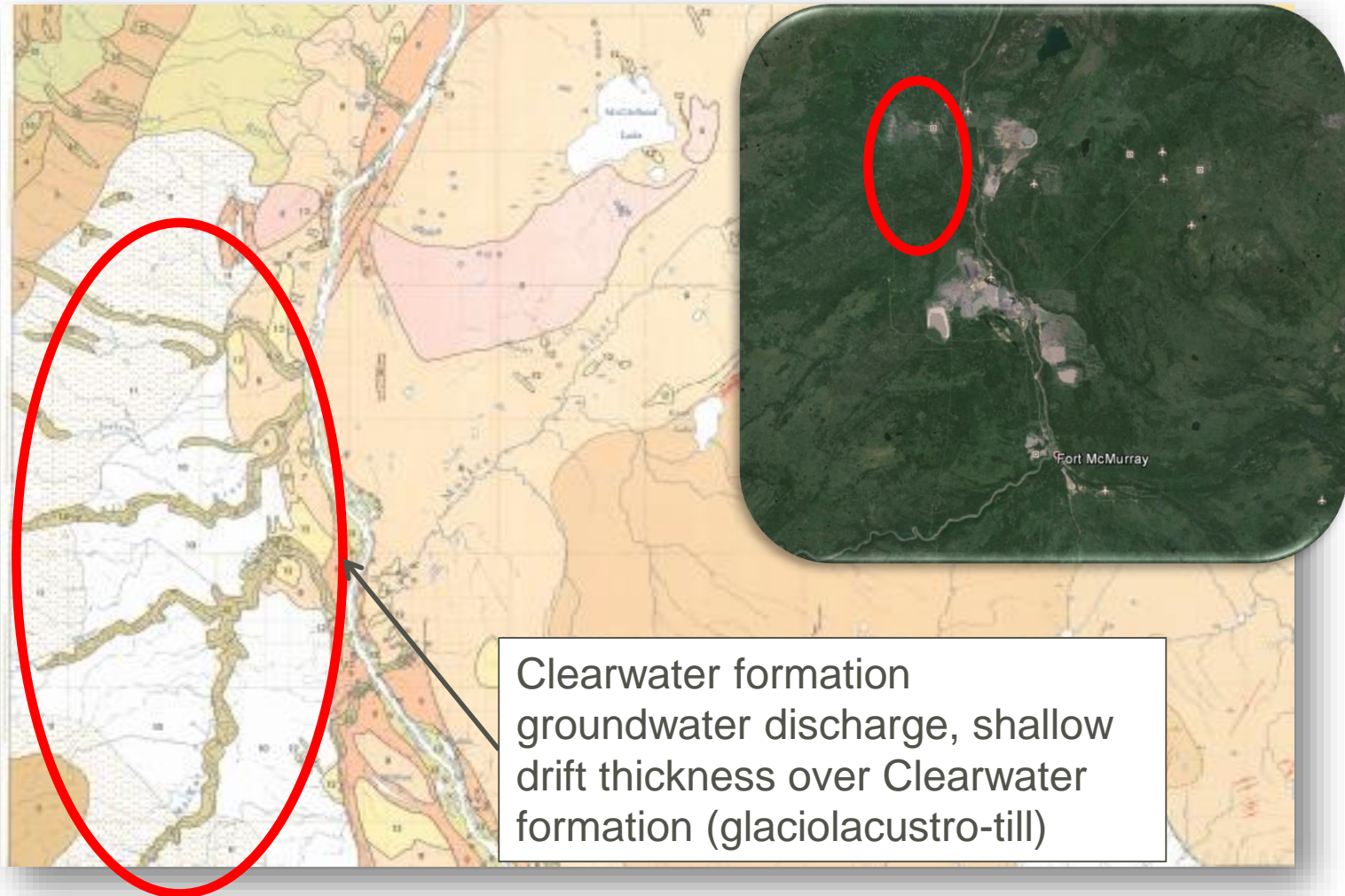


- Even “Fair” levels of salinity are enough to severely limit survival and growth
 - Saline parent material
 - marl



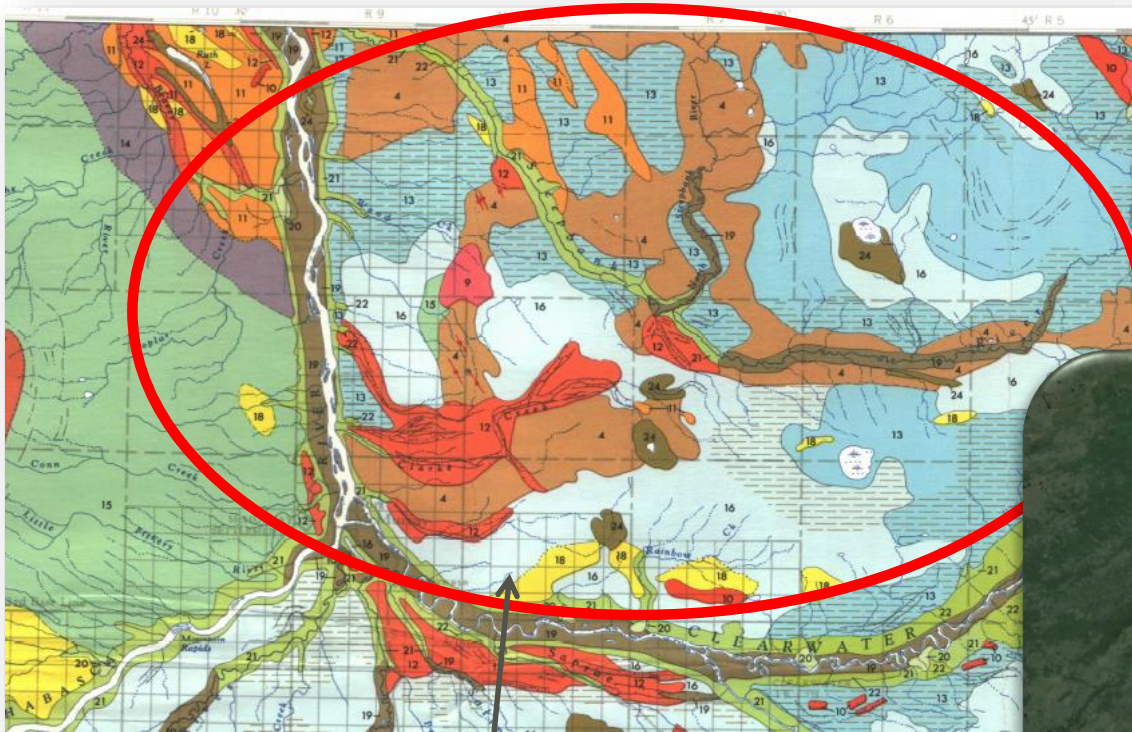
Salinity

WEST SIDE OF ATHABASCA RIVER



Salinity

NORTH OF CLEARWATER RIVER



Recent lacustrine deposits: peat with marl substrates occur at margins and shallow regions.

Cautionary Statements

BEST MANAGEMENT PRACTICES FOR CONSERVATION OF RECLAMATION MATERIALS IN THE MINEABLE OIL SANDS REGION OF ALBERTA

...peat-mineral mixes and peat-alone are believed to need fertilization...

Early application of fertilizers may condition shrub and tree seedling so that they require repeated fertilization...

...not a sustainable practice.

Cautionary Statements

Acceptable Salinity, Sodicity, and pH Values for Boreal Forest Reclamation (Alberta Environment 2000)

A tolerance range does not imply a plants species' growth is sustainable within that range...

...only that research results from at least one particular study indicated plant survival, and possibly growth, given specific conditions

Results from Long Term Soil and Vegetation Plots Established in the Oil Sands Region (CEMA 2005)

... some subtle differences in soil properties, particularly higher pH and EC in the reclaimed soils may result in different forest ecosystems than targeted.

Soil Quality Criteria

Rating/Property	Good (G)	Fair (F)*
Soil Type	Topsoil	Topsoil
Reaction (pH)	5.0 to 6.5	4.0 to 5.0 6.5 to 7.5
Salinity (Ec) (dS/m)	<2	2 to 4
CaCO ₃ Equivalent (%)	<2	2 to 20

* Most peat-mineral mix is “Fair”

For Context: Glacier Bay Primary Succession (c. 1955 – Crocker and Major)

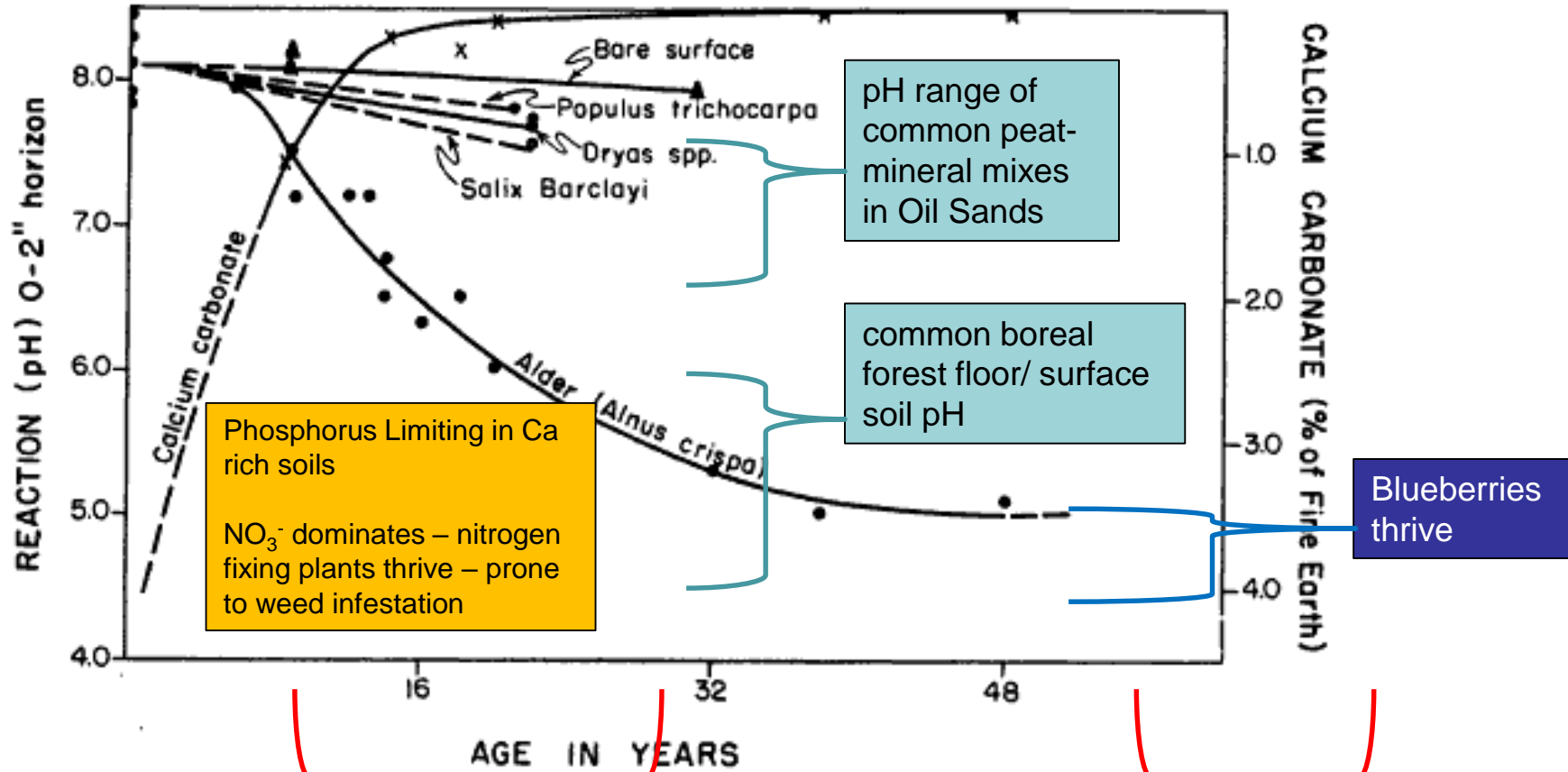
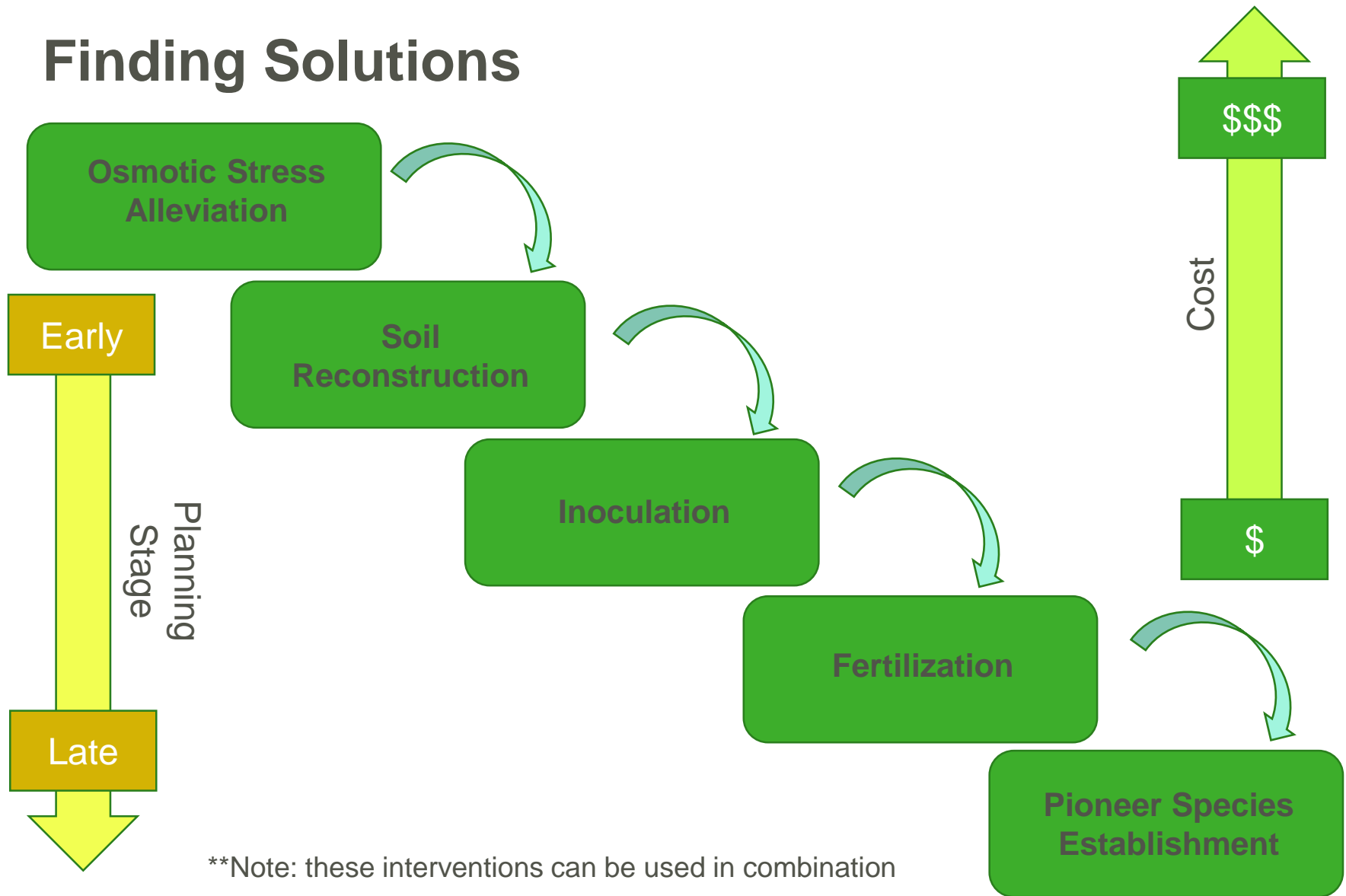


Fig. 4. Rate of change of reaction 0-2 in. horizon relative to type of vegetative cover; rate of change in calcium carbonate content under *Alnus*.

Reclamation Certificate

Indigenous and Public Stakeholder Expectations for Post-Closure End Land Use Objectives

Finding Solutions





GOLDER