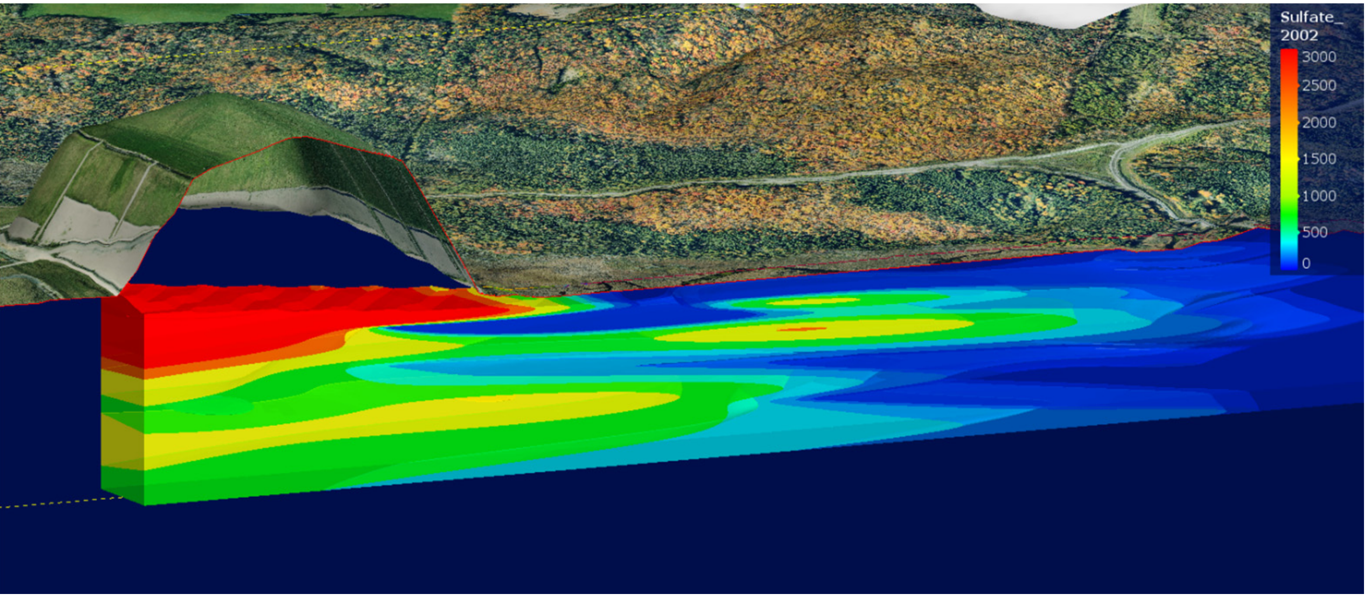
22nd BC MEND Metal Leaching and Acid Rock Drainage Workshop

December 2 - 3, 2015 | Vancouver, British Columbia, Canada

Closure of a Legacy WRP: Transitioning to Passive Treatment



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Public Works and Government Services Canada

O'Kane Consultants
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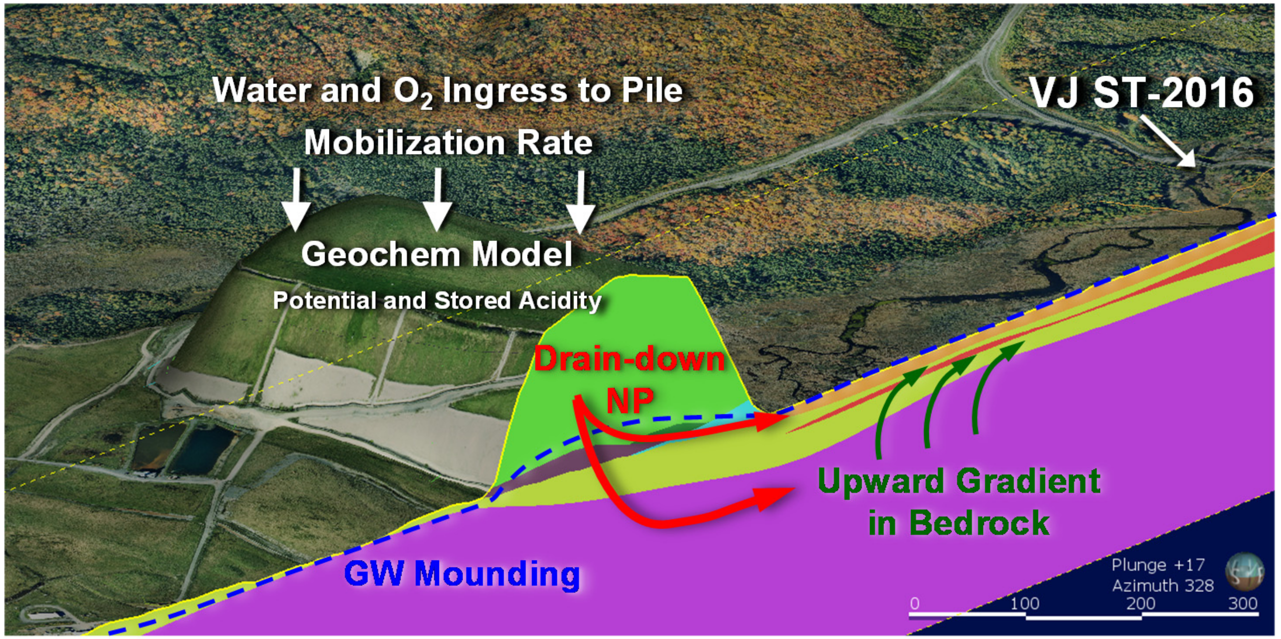
Specialists in Geochemistry and Unsaturated Zone Hydrology

Presentation Discussion Points

- Overarching Project Background
- Background for Focus of this Presentation
  - Reclaimed Victoria Junction Site
- Conceptual Model
  - Physical
  - Flow
  - Geochemical
- Summary Discussion Points



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Background – Site Location

Site: Near Sydney, NS
Cape Breton Island

Atlantic Canada

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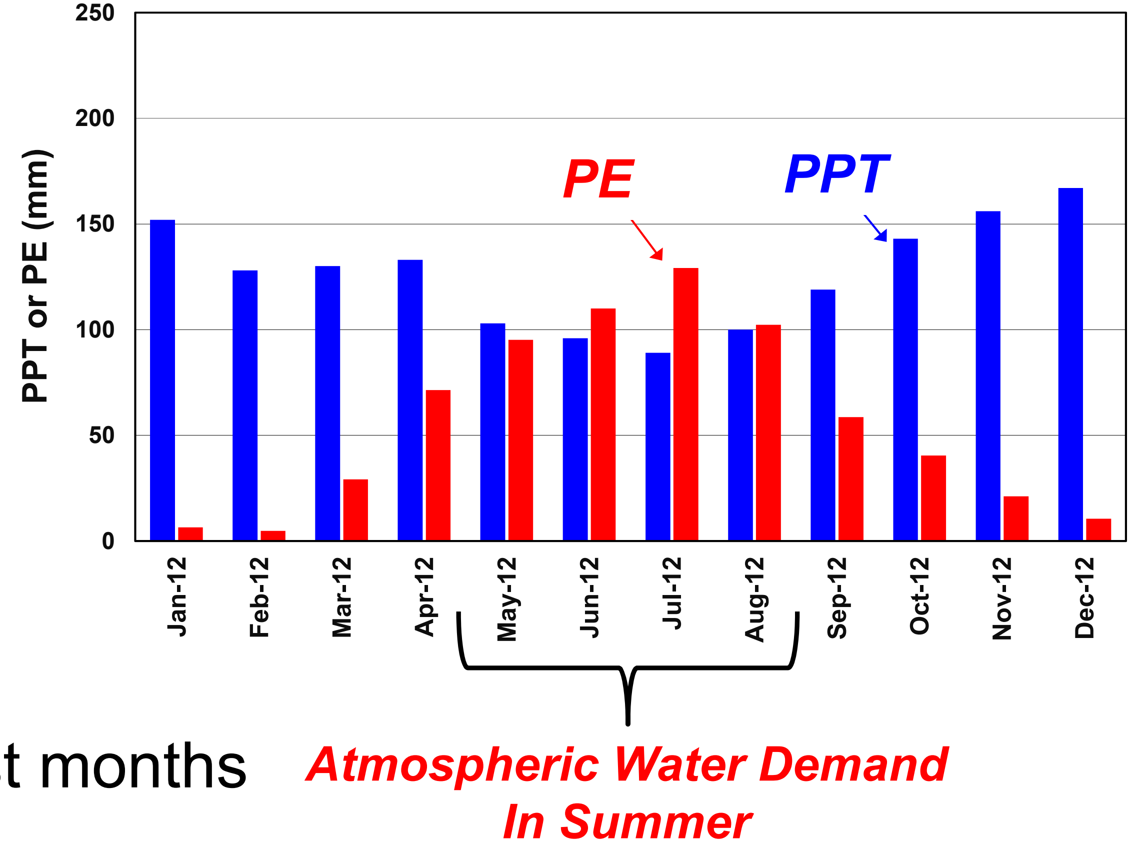
Background – Typical Climate

- Mean annual PPT is ***~ 1,500 mm***
- 60% occurs in Winter (October to March)
- ~50% of winter PPT is rainfall
- Mean annual ***PE ~700 mm***
- ***Energy deficit*** in most months



Meiers et al 2014

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Background

- ***ECBC is a Federal Crown Corporation responsible for environmental remediation associated with coal mining activities in Cape Breton***
  - ***Mining operations began in 1685 to the 1980s***
  - ***50 underground mines produced 500 million tonnes of coal***

Meiers et al 2014

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Historical Mine Sites: Sydney, N.S.

Remediation: Enterprise Cape Breton Corporation

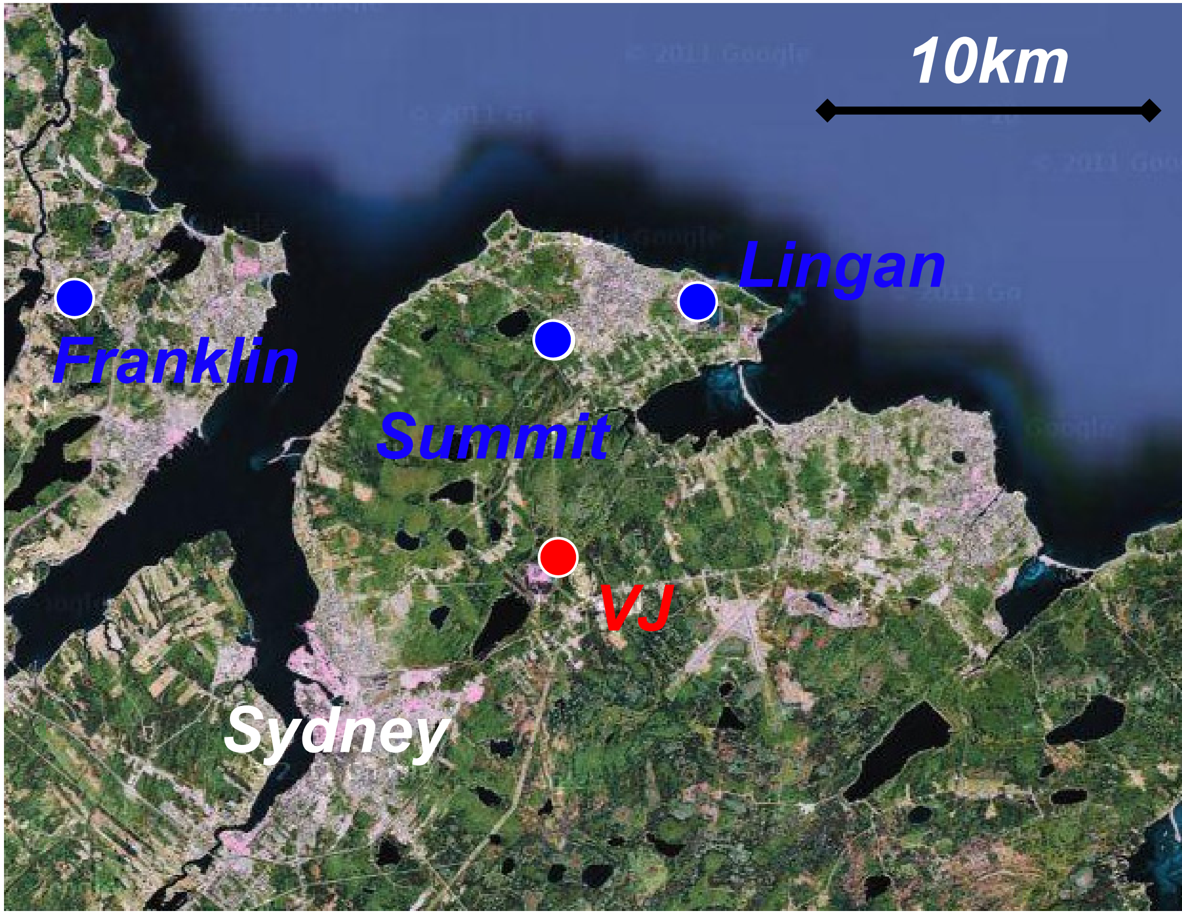
Current Management: Public Works and Government Services Canada

ecbc | secb
Inspire. Build. Succeed. | Inspirer. Bâtir. Réussir.
Canada

- Victoria Junction (VJ)

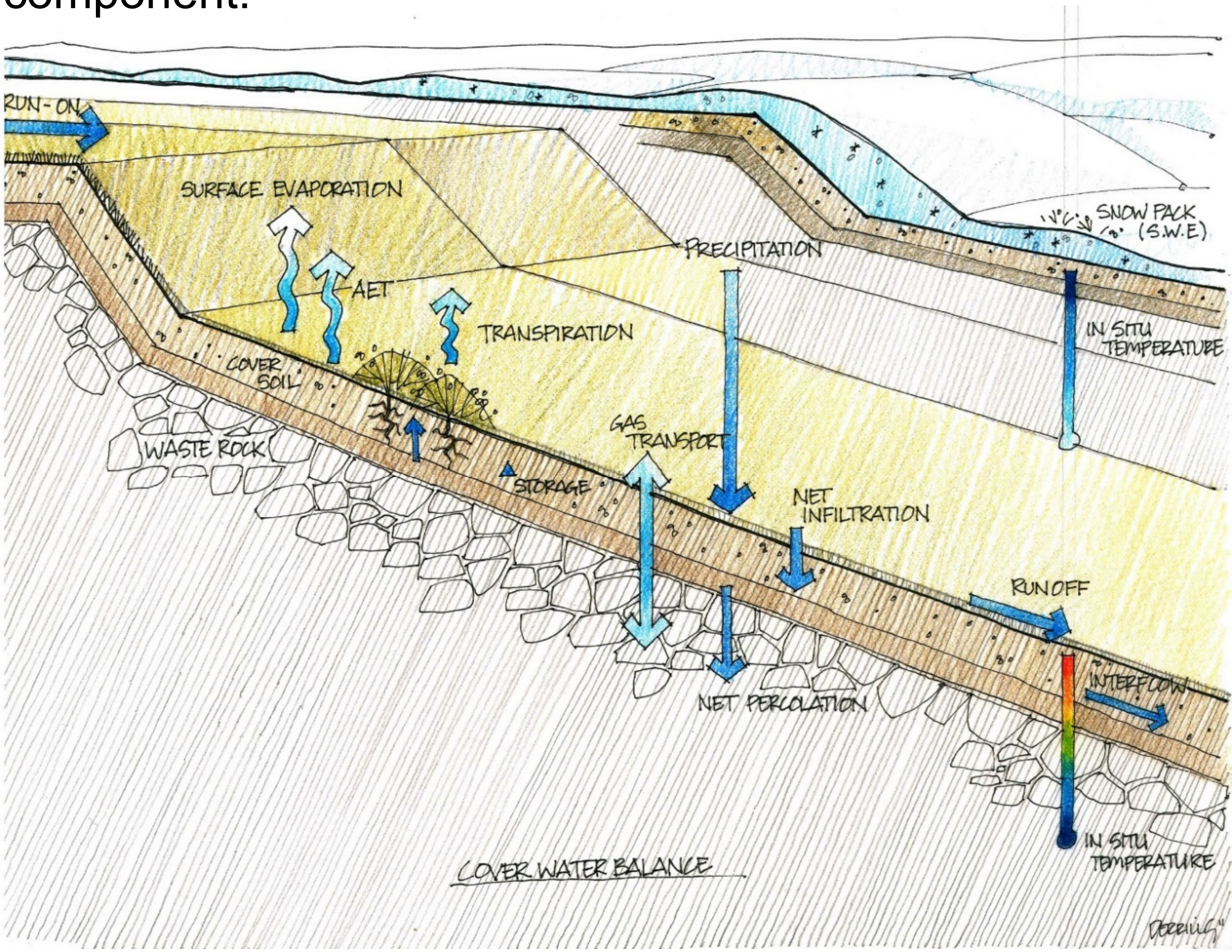
Other Reclaimed WRPs

- Scotchtown Summit (Summit)
- Franklin
- Lingan
- Dominion No.4
- Gowrie
- Princess



WRP Monitoring System

- Monitored water balance component:
  - AET
  - PPT
  - Runoff
  - Interflow
  - Water Storage
  - Net Percolation (NP)
- NP Estimated through:
  - Water Balance
  - Analytical Estimates
  - Conservative Tracer
- Internal WRP Monitoring System:
  - Temperature
  - Pressure
  - GW Elevations
  - Pore-Gas Concentrations
  - Pore-Water Quality



Meiers et al 2014

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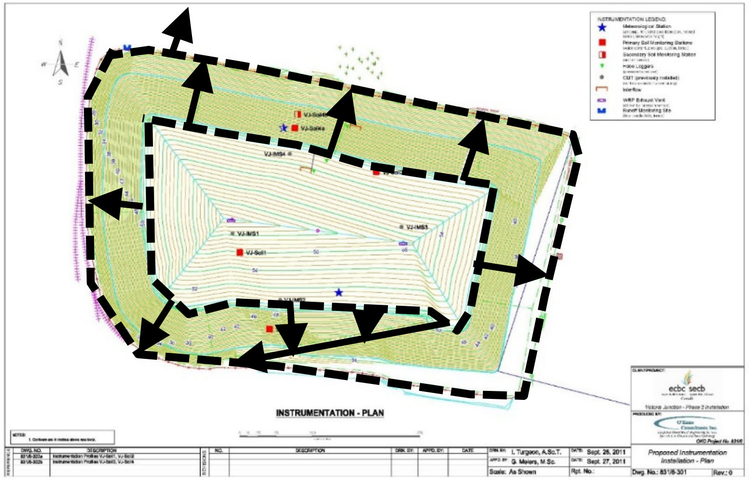
VJ – Site Background

Landform:

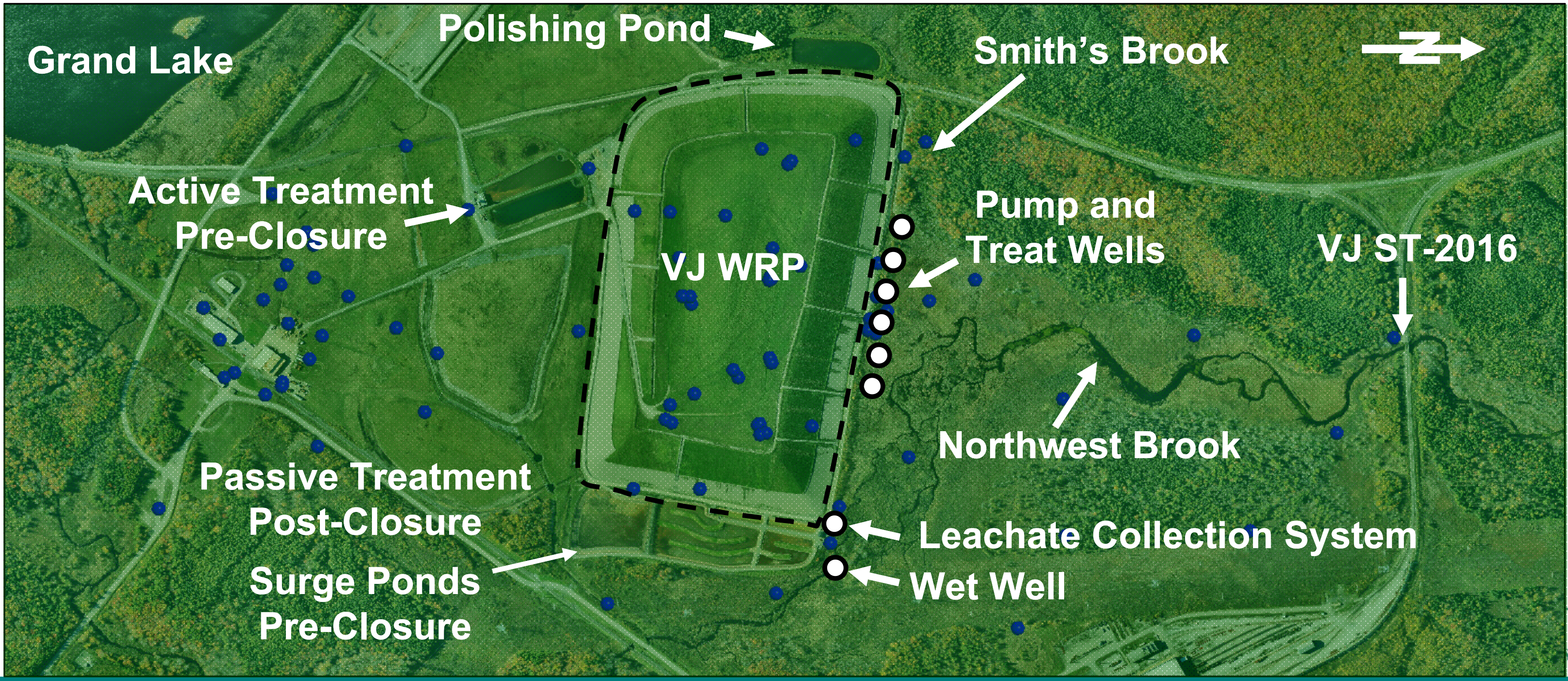
- Covers an area of 26 ha
- Height of 40m
- Plateau ~7%
- Side Slope 3:1
- Runoff ditch constructed around plateau which channels runoff to drop structures on side slope



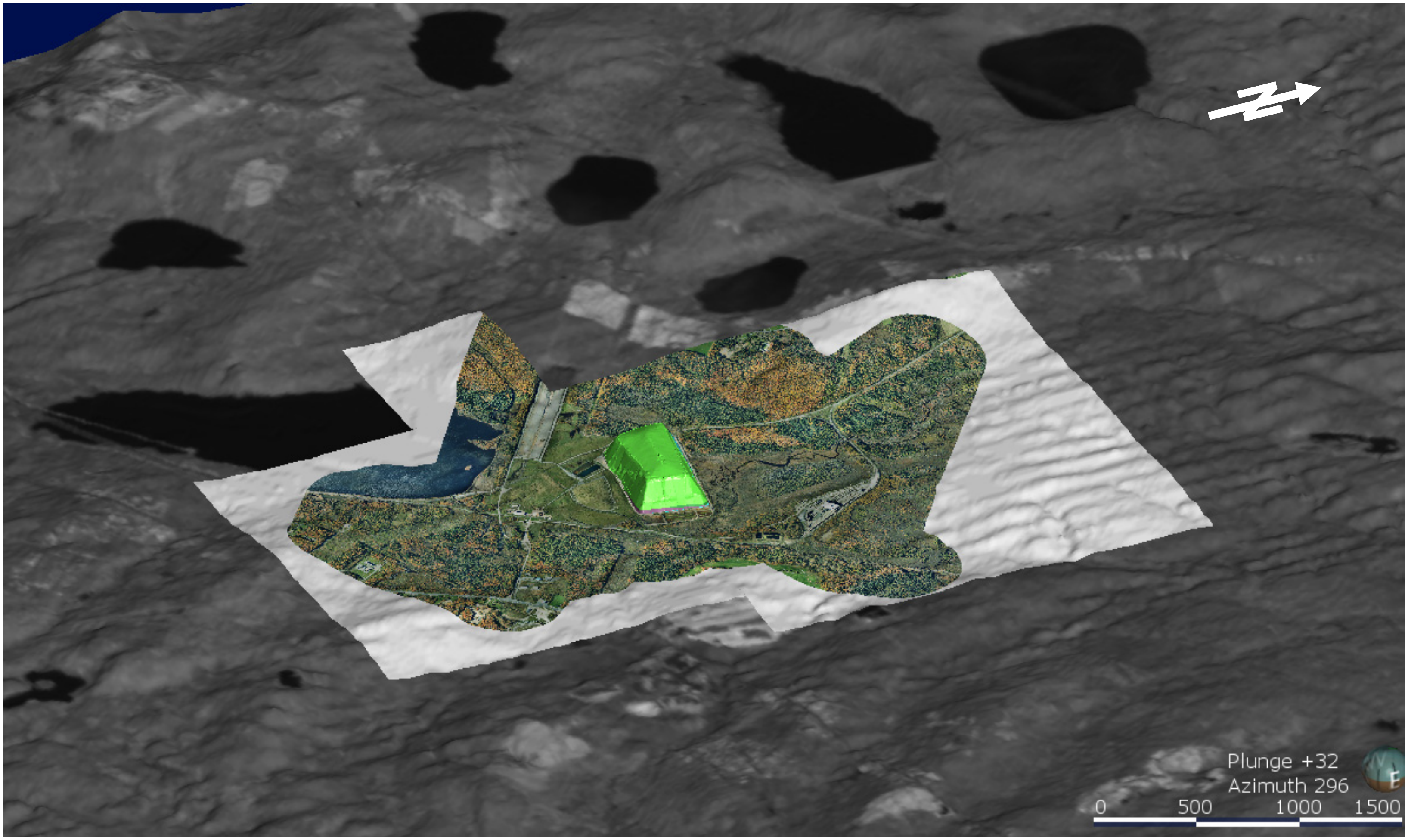
VJ – Developing Conceptual Model

- Surface Hydrology
- Treatment and collection
- ***Indicator / Receptor*** to identify changes to loading to wetland and groundwater

Allow for Testing of Geochemical Model



VJ – Physical Model



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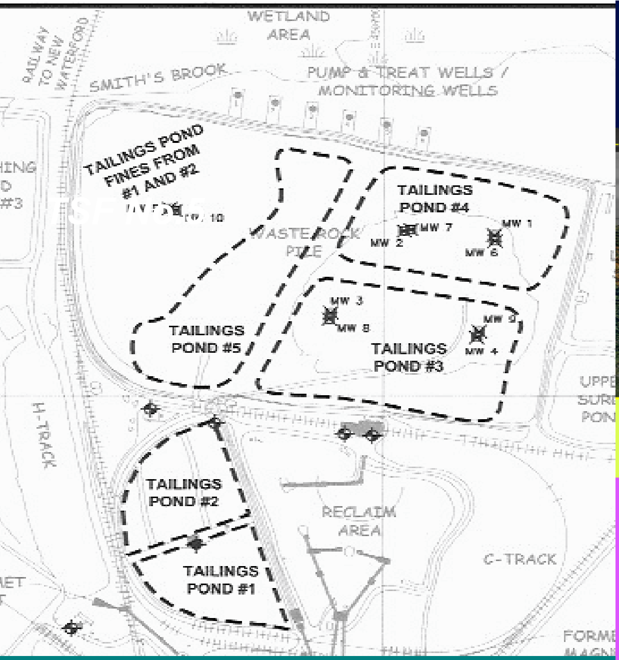
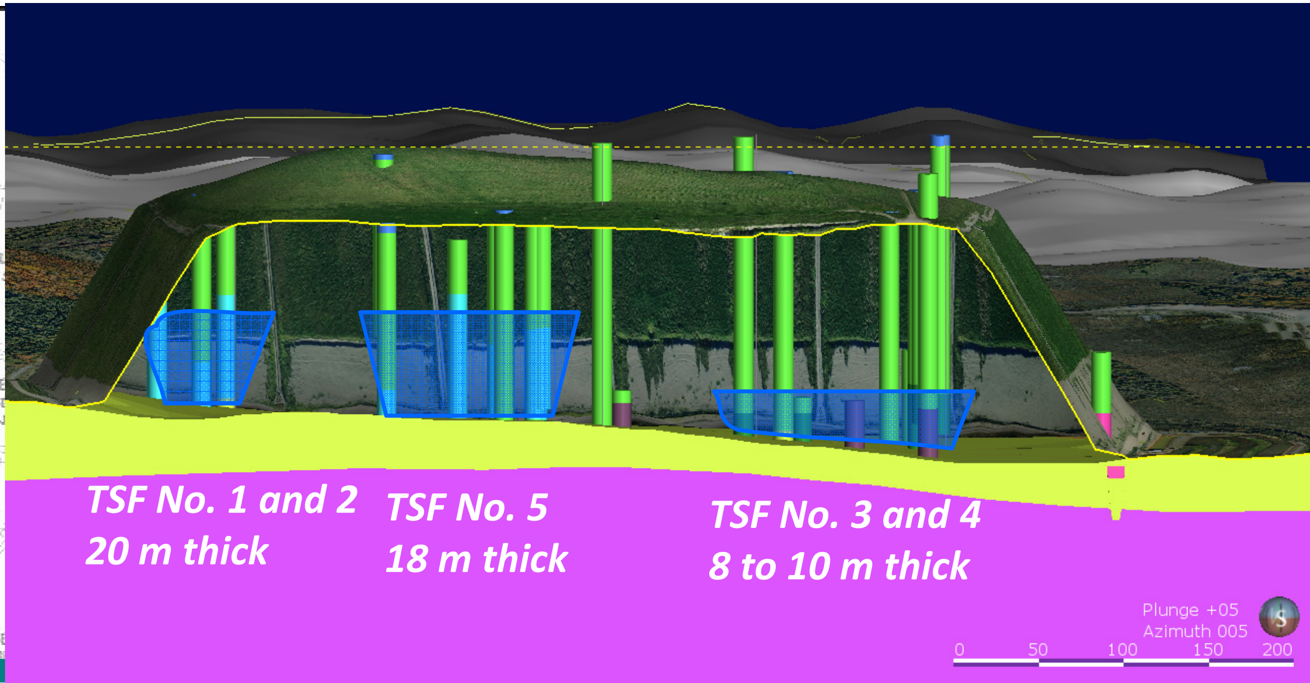
VJ – Physical Model

VJ – Physical Model

WRP: Waste Rock / Tailings

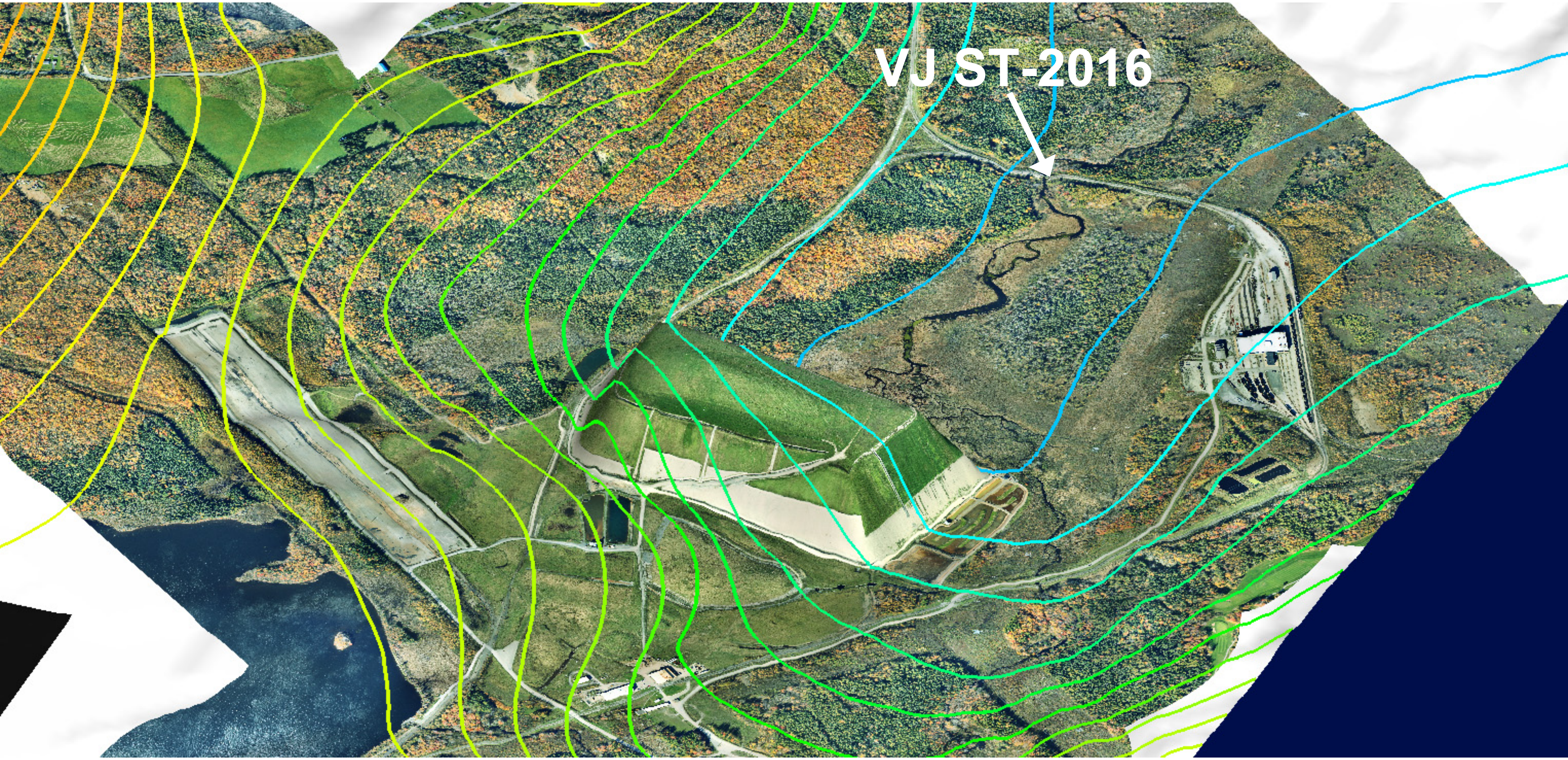
- ***TSF No.1 and No.2 relocated to WRP***
- ***TSF No.3 and No.4 covered in 1987***
- ***TSF No.5 active until 1988***
- ***Effect of tailings facilities on WRP drain-down***





Surface and GW Flow Model

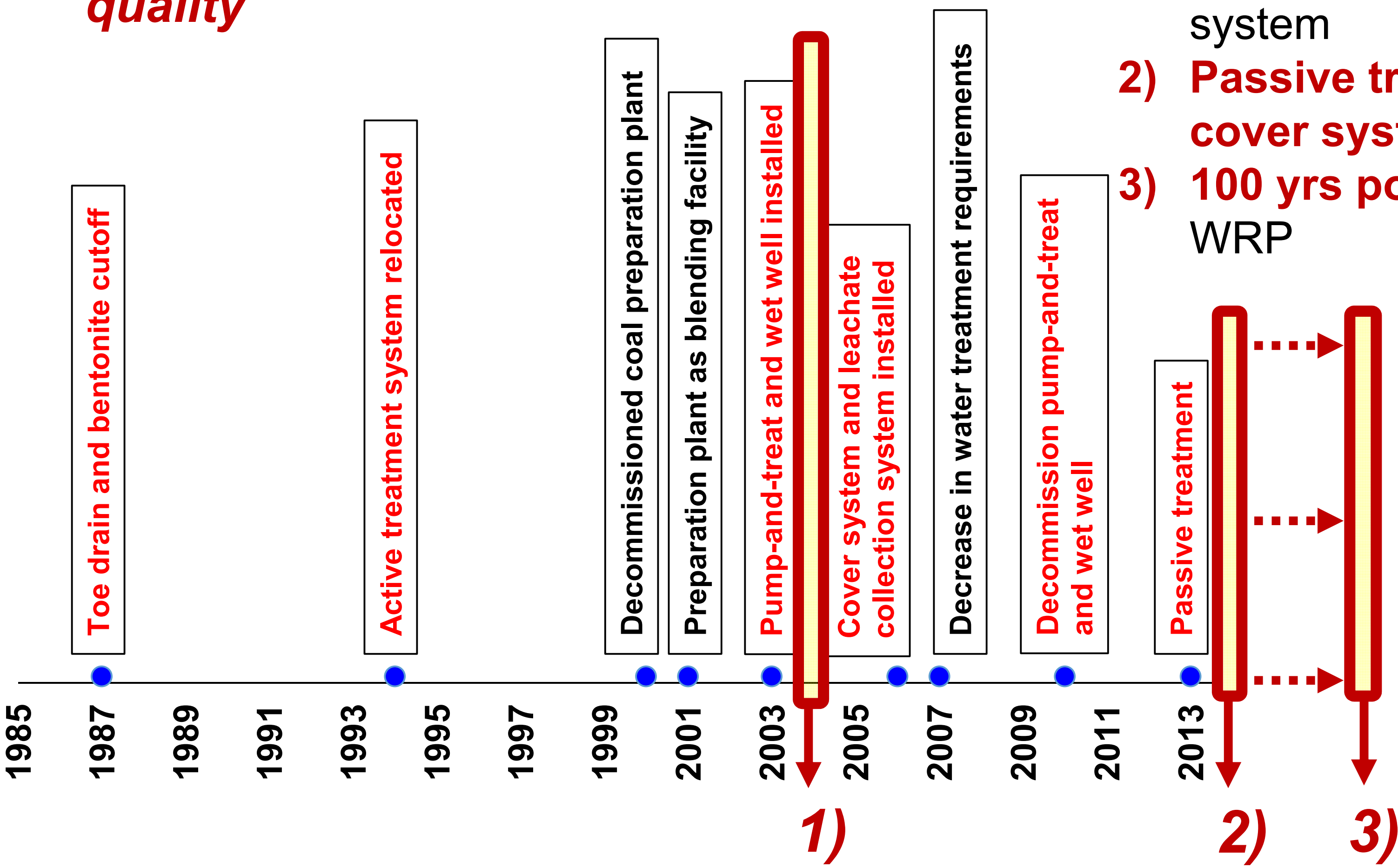
- Upward gradient in bedrock drives contaminant plume to surface
- Surface and groundwater contaminant load focused to Monitoring Point VJ ST-2016



Loading, Collection, and Treatment

Progressive changes to site operations:

- Lead to ***changes in loading and water quality***



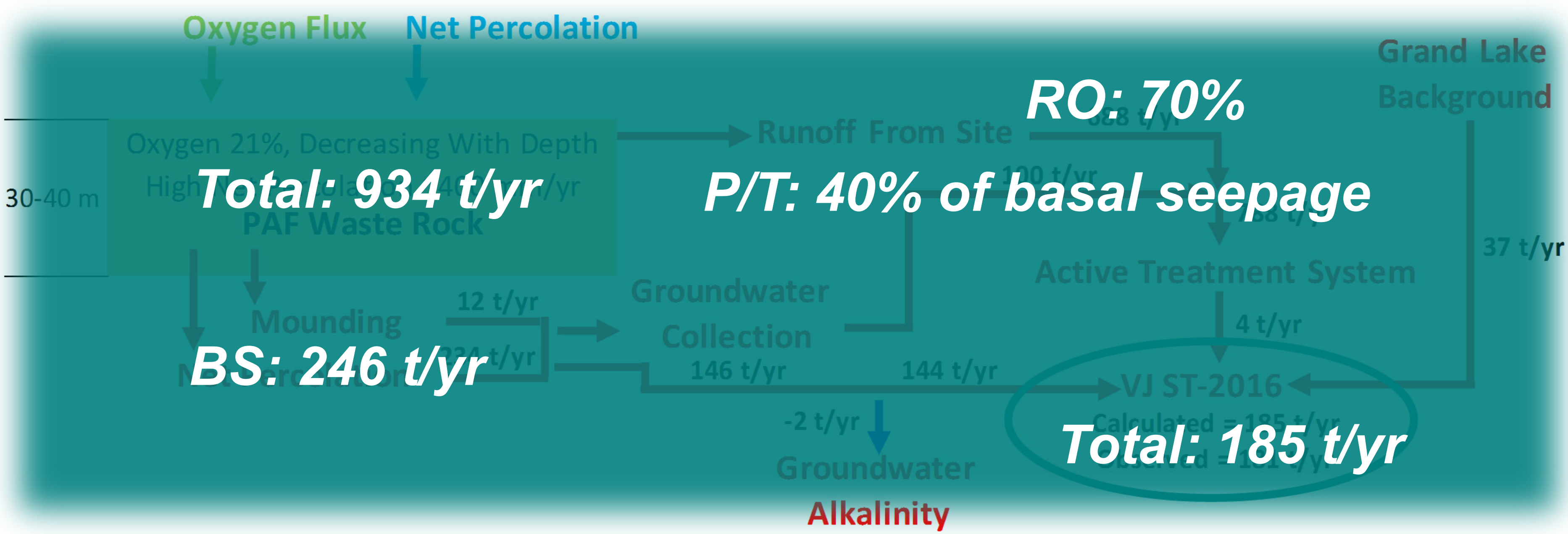
Acid Load Mass Balance to Test Three Conceptual Models:

1) **Active treatment** no cover system
2) **Passive treatment** with **cover system**
3) **100 yrs post** reclaimed WRP

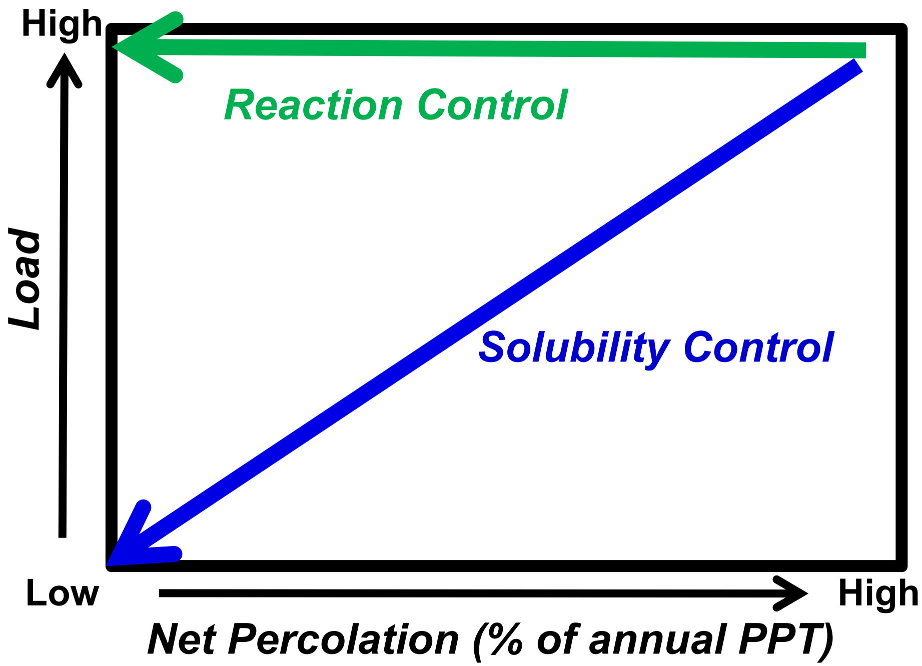
Acid Load Phase 1

Active Treatment Pre-Cover System

- Flow × Concentration = ***Load***
- NP ~400 mm/yr
- ***NP and mounding*** provides the basal seepage
- Water treatment ***removes ~788 t/yr***



Managing Load & Cover Systems



Two "Models", or Approaches, used to Typically Evaluate Benefits of Managing Net Percolation and Oxygen to Sulphidic Waste

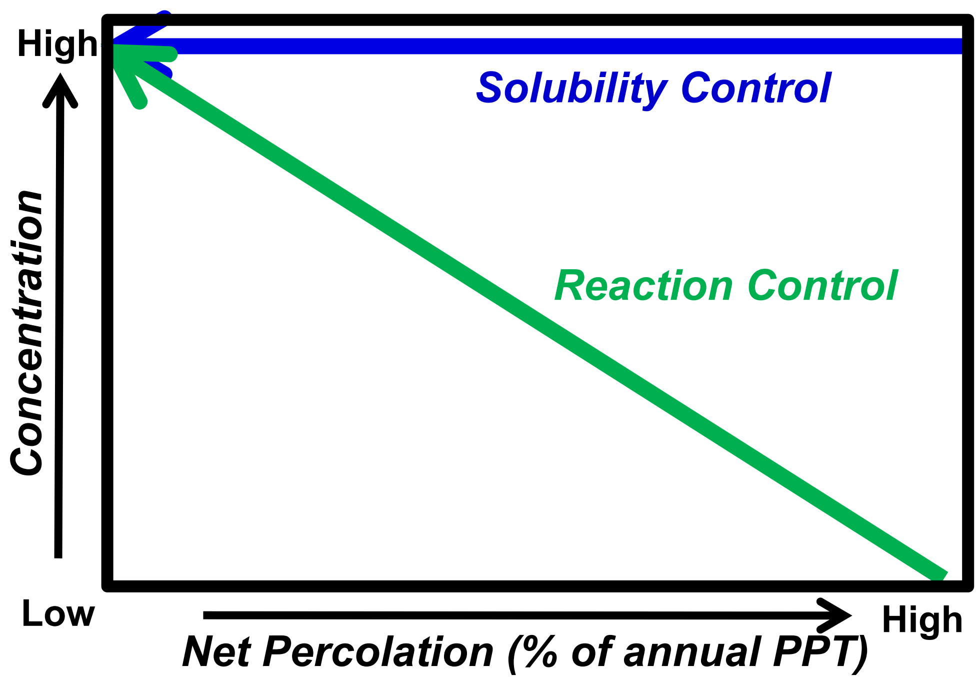
Acid Load vs. Acidity

Acid Load:

Concentration x Flow Rate

Acidity:

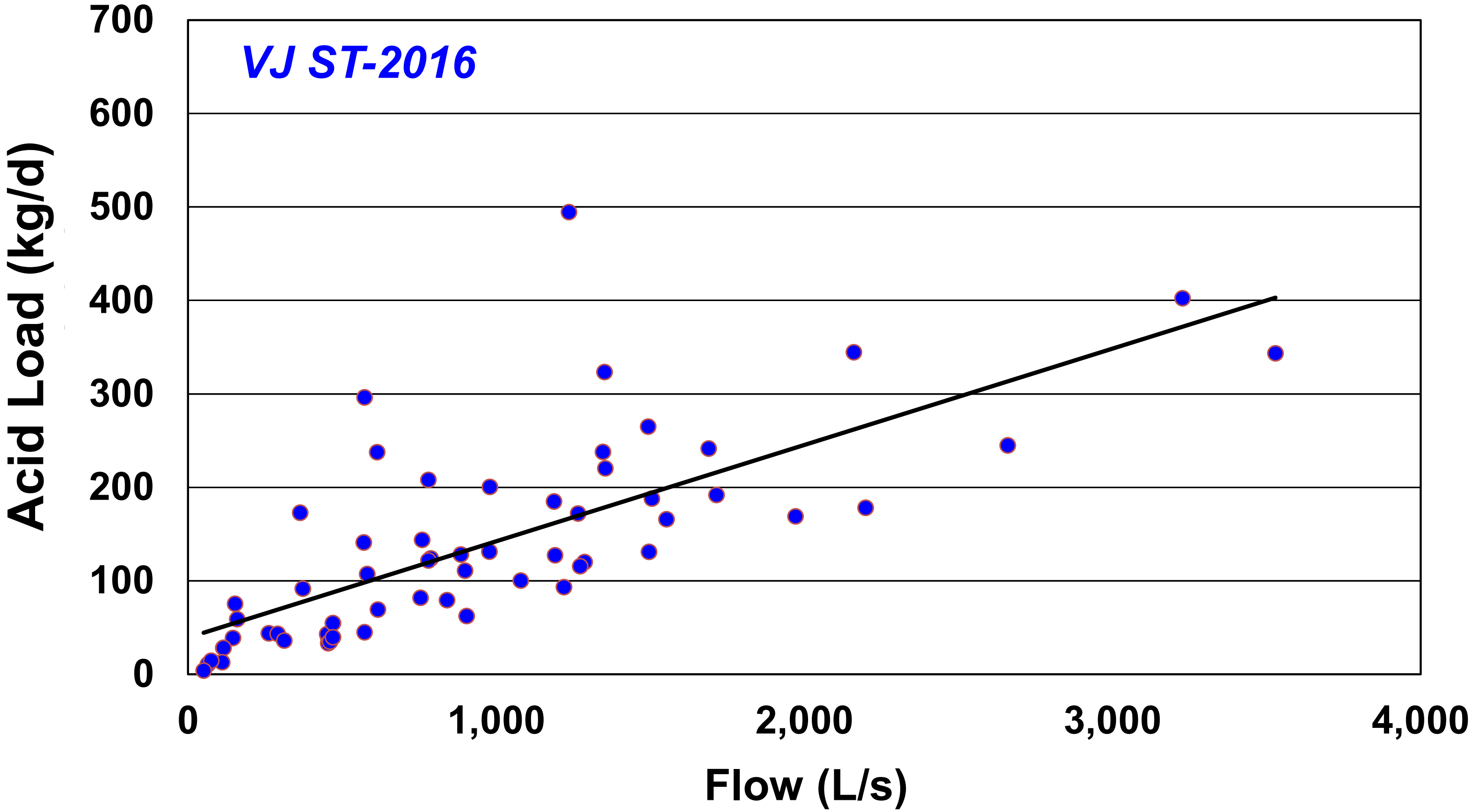
Concentration



VJ – Managing Load

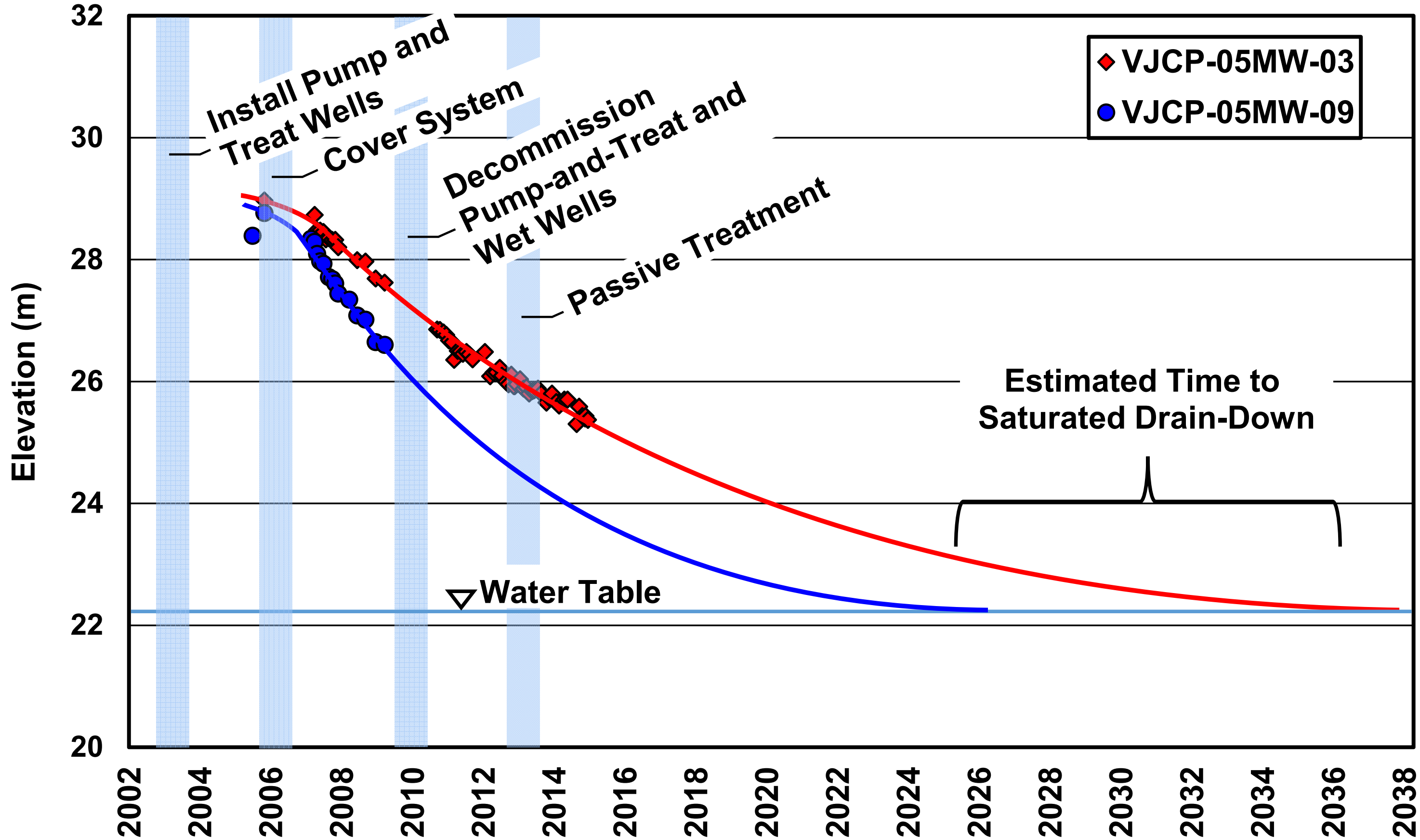
Seasonal Changes in Acid load at VJ ST-2016 would support:

- ***Solubility Controlled – Constant Concentration***



WRP Drain-Down

- ***Saturated drain-down*** estimated at 75 mm/yr and will terminate in approximately ***20 years***
  - Numerical modelling completed to verify rates and inform on ***unsaturated drain-down*** which ***terminate in ~100 years***



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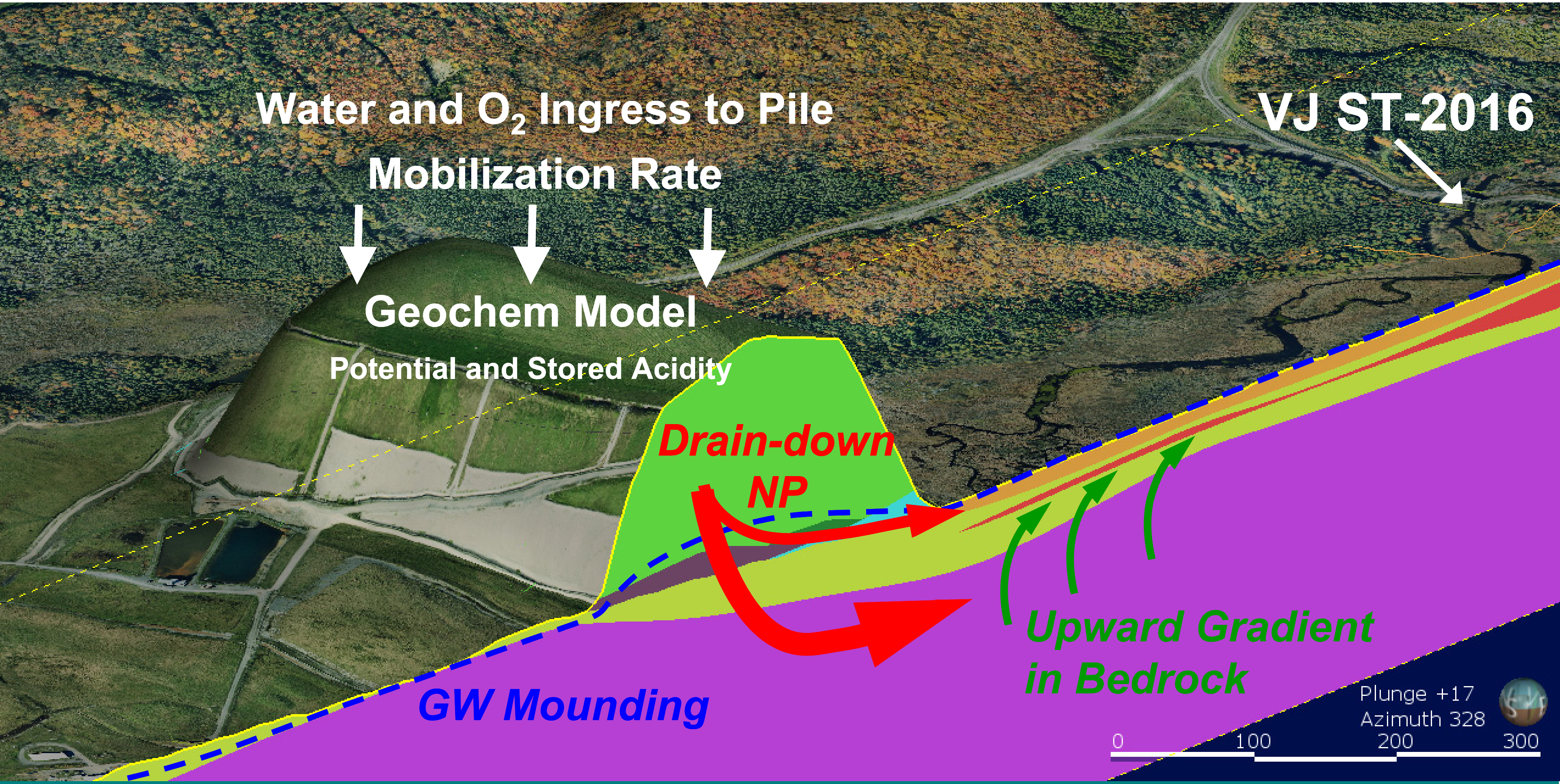
Post-Cover System Conceptual Model

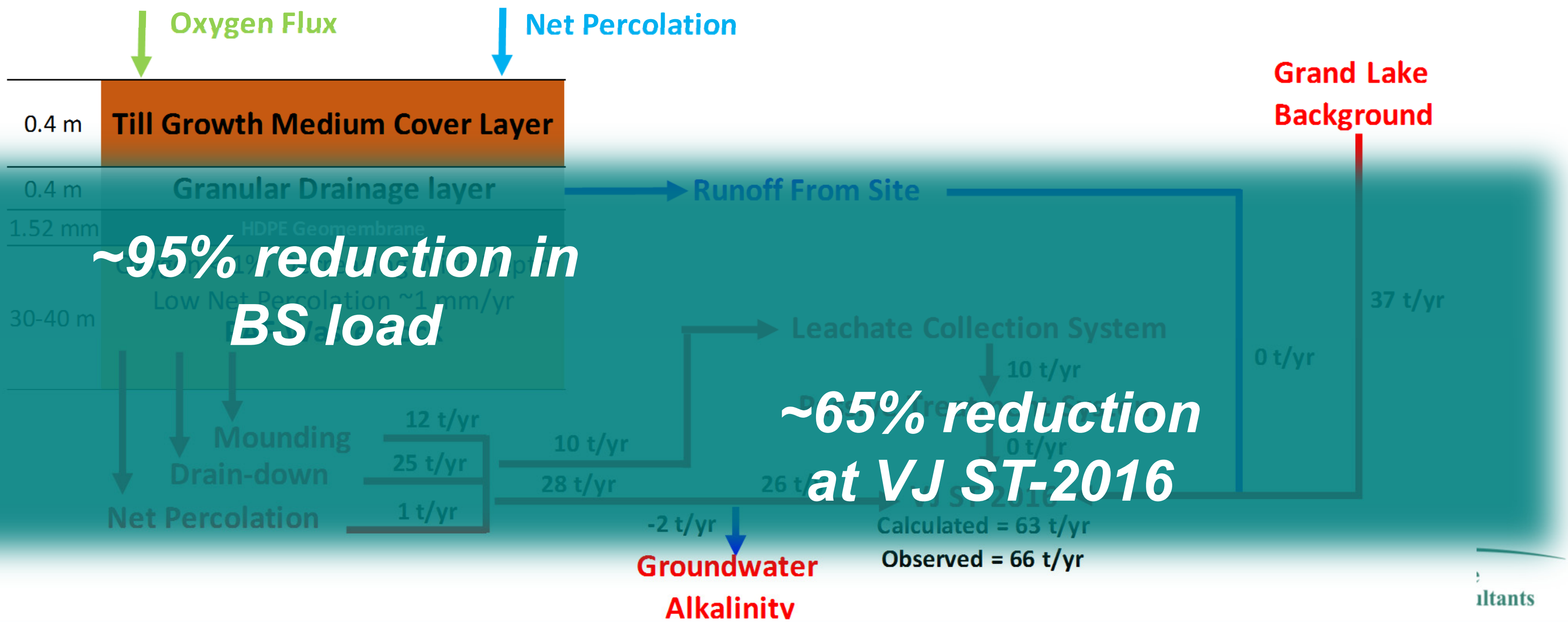
- Reduction in deep groundwater loading
- Upward gradient in bedrock



Acid Load Phase 2 - Cover & Passive

Post-Cover System with Passive Treatment

- ***Total acid*** load generated ***reduced from ~934 t/yr to ~38 t/yr***
- Approximately 26% of load collected in leachate collection system
- ***Decommissioned pump-and-treat wells***, reduction in treated load from 100 t/yr to 10 t/yr… ***Why***



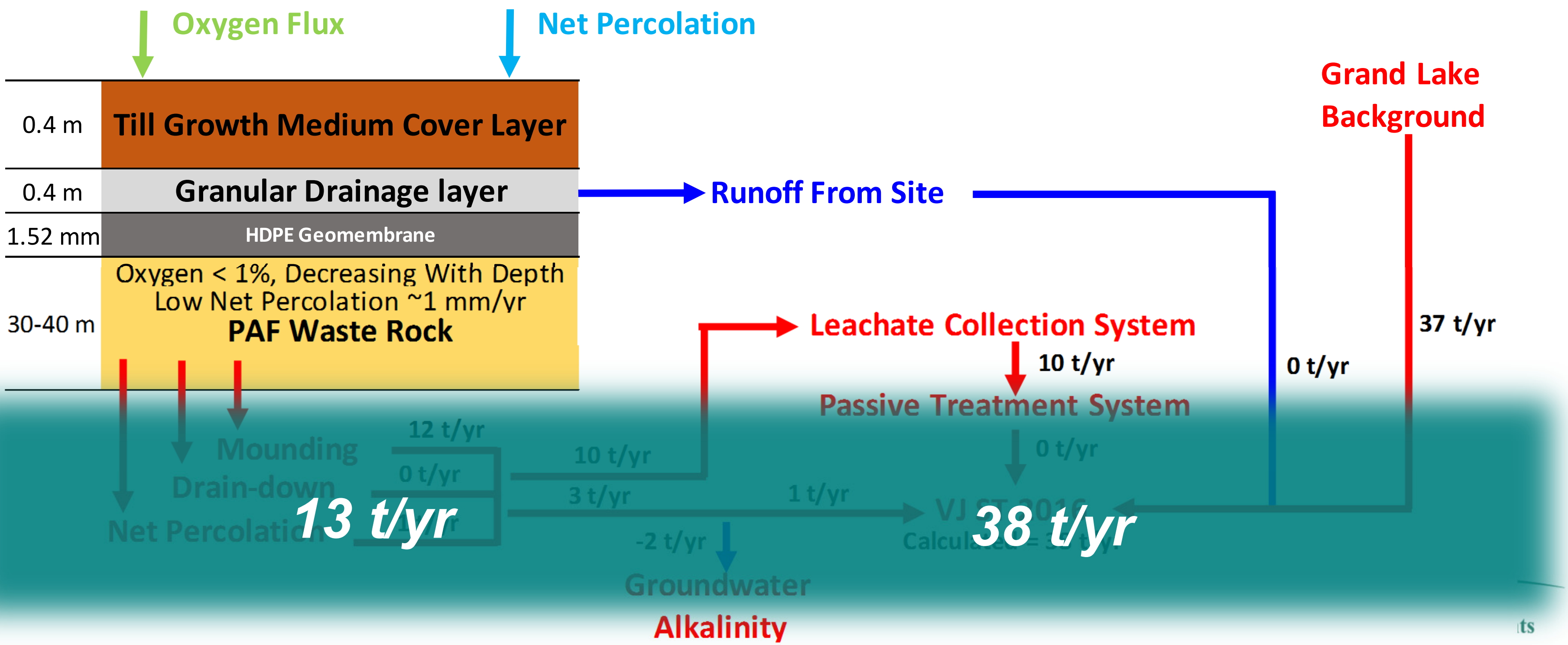
~95% reduction in BS load

~65% reduction at VJ ST-2016

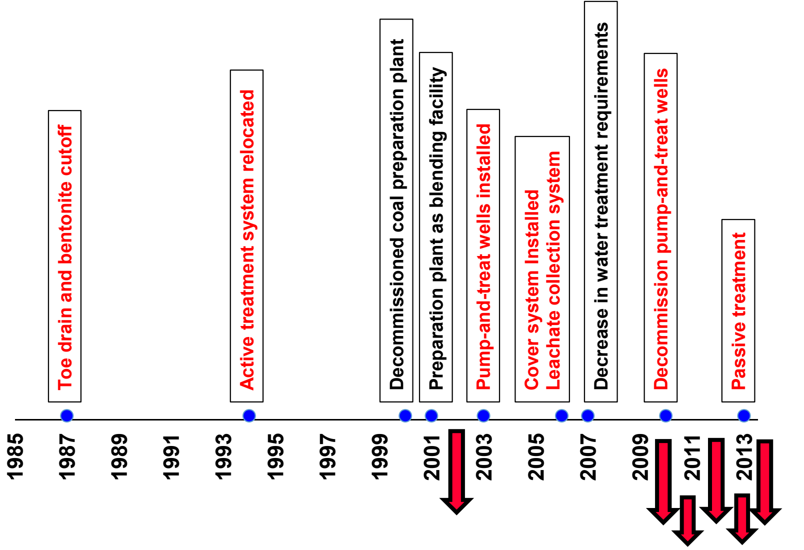
Acid Load Phase 3 – Prediction

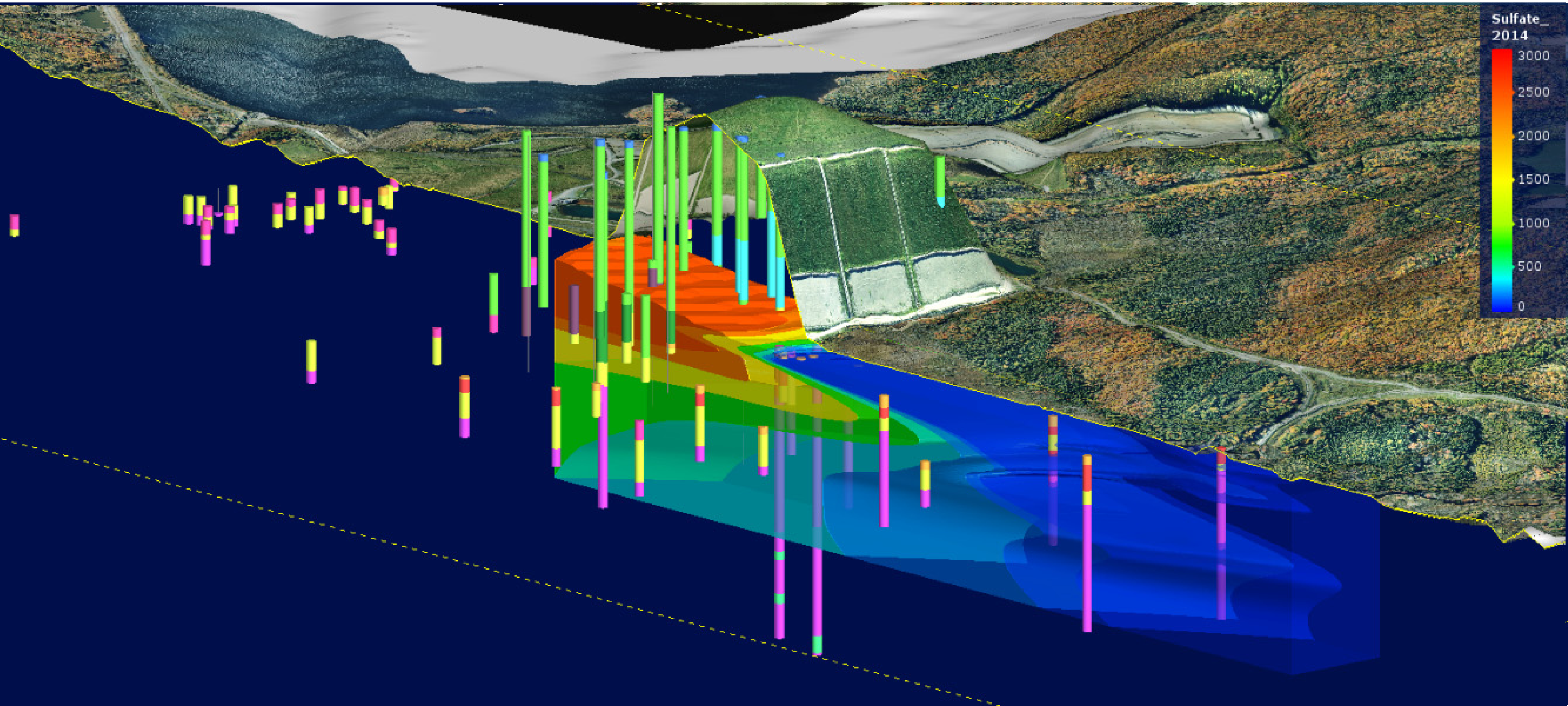
100 Years Post-Cover System w/ Passive Treatment

- ***Mounding*** contributes largest load
- Total acid load reduced to ~38 t/yr
- ***Understanding for long-term loading and outcomes without numerical simulations***

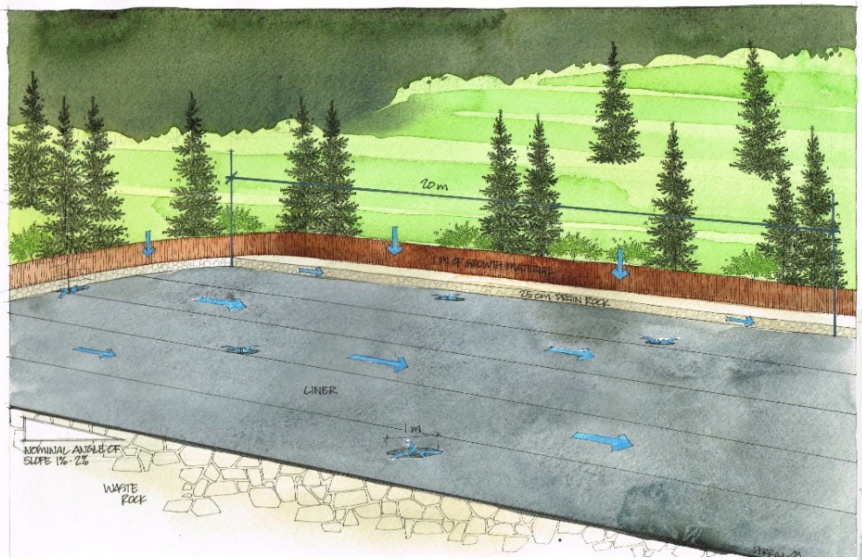


Solute Transport (Sulphate)

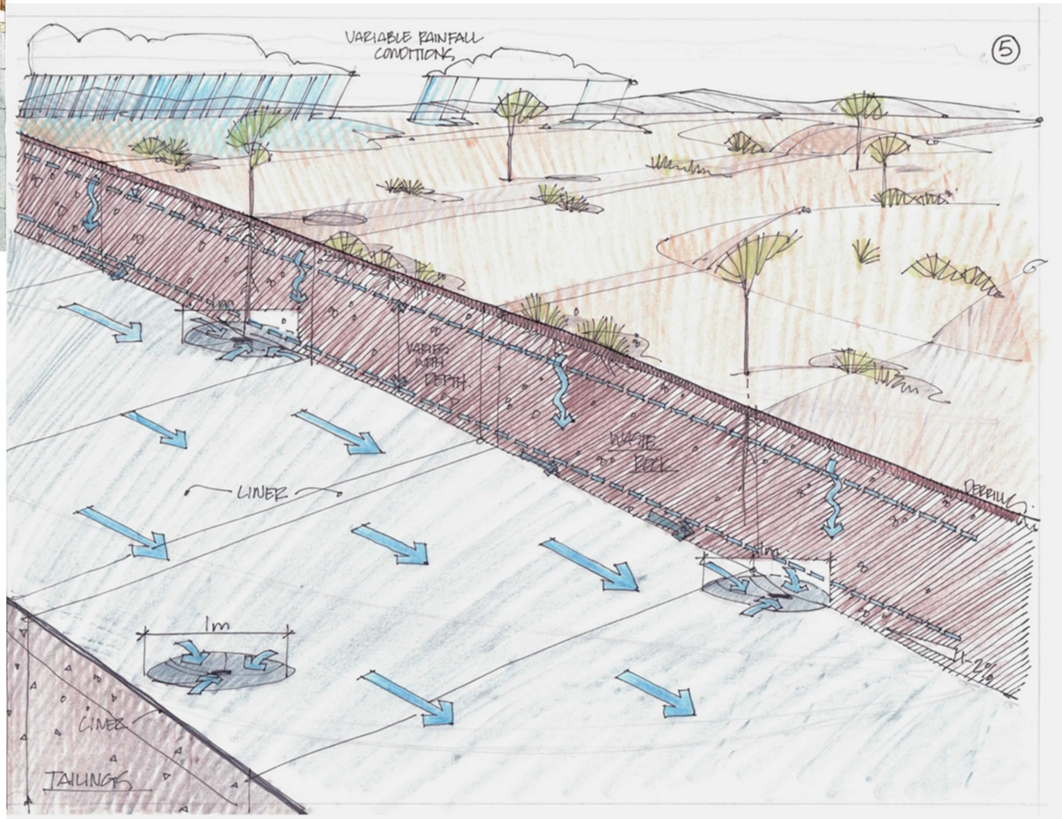




Risk – Influence of Holes



- *Does a product in design carry the risk of failure, or a system*



- ***Very Good Lateral Drainage Capacity:***
  - ***… extend timeline***
- ***Service Life of Geomembranes?***
  - ***e.g. Benson et al 2011: 55-125 yrs***

O'Kane and Meiers 2014

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Costs, Loading, and Risk

Discount Rate (%)	Collection and Treatment NPV	Cover System NPV
1.0	$ 29.5M	$ 16.1M
2.5	$ 17.0M	$ 14.6M
4.0	$ 11.2M	$ 13.8M

Groundwater Collection System Only Captured 40% of Basal Load

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Summary Discussion Points

- Going Back in Time: “Correct” Decision?
  - Depends on what ***Discount Rate*** you would use...
  - Value in receiving environment…
- More Importantly
  - Stop and think about the number of ***Technical Assumptions*** within the NPV calculation
    - For example:
      Flow Reduction = Load Reduction (i.e. constant)
- Is the Level of Information available for this Site Typical?

Getting Back to the Question…

- Can we Achieve Passive Treatment to Manage Residual Seepage in the Short Term?
  - Strong evidence for it at this site

- What About Other Sites?
  - Scale / Size of WRP

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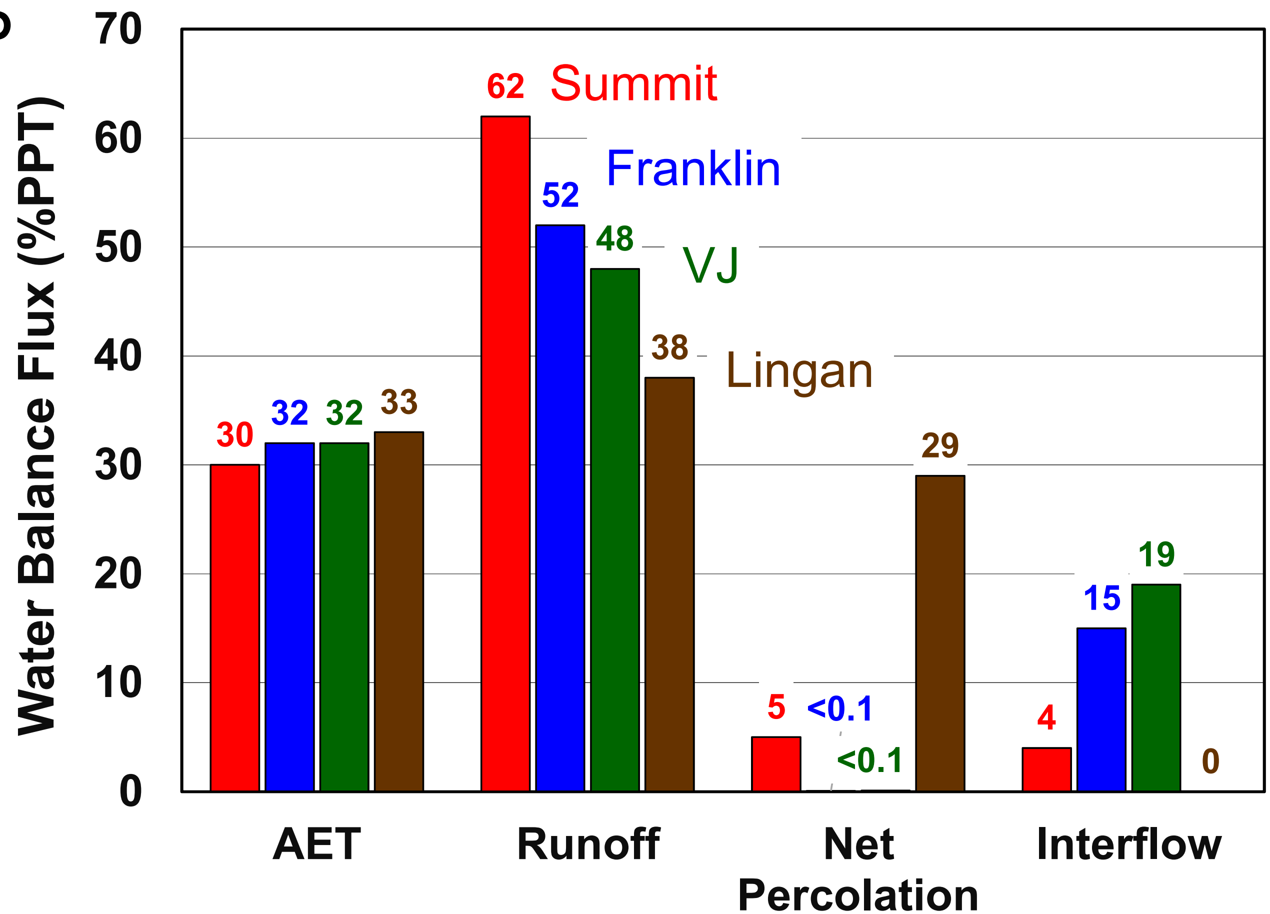
Rainbow of Hope for Children and,

Habitat for Humanity Initiative

Water Balance

- Cover system layering influences surface runoff
- Surface runoff and interflow ~65% for the geomembrane cover systems
- Interflow and NP offsets proportional runoff volume
- NP at Lingan ~30%
- High leakage at Summit



Geomembrane Defects

- Construction (wrinkles, tears, welds, punctures,…)
- Post Construction
  - Service Stress (differential settlement, Δ temp)
  - Anthropogenic (e.g. artisanal mining)
  - Bioturbation
  - Vegetation (roots, blow down, etc.)

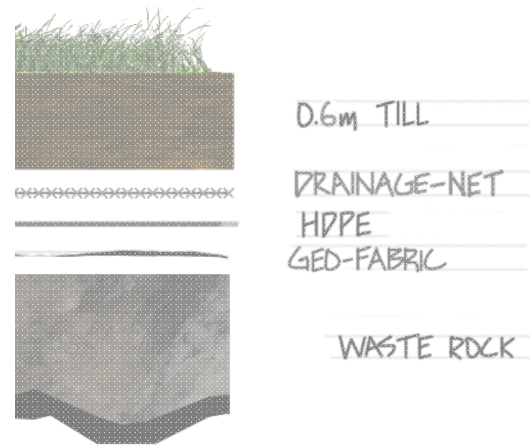
http://heapsolutions.com/applications/heap-liner-leak-detection/

O'Kane and Meiers 2014

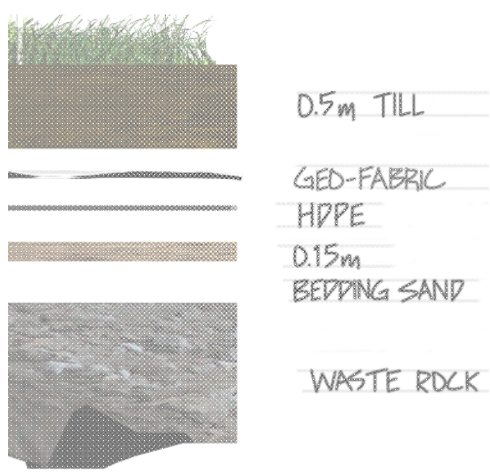
Background – Cover System Profiles

Victoria Junction

Franklin



Scotchtown Summit



Lingan

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