Research Collaboration Advances Best Practices and Ecological Outcomes for In Situ Oil Sands

Terry Osko

Circle T Consulting, Inc.

Key Objectives/Messages

- Demonstrate that Alberta's in situ oil sands operators are doing good things!
- Illustrate how collaboration enables doing those good things.
- Present a project as an example of a broader view in pursuing those good things
- One of those good things is accelerated development and adoption of better practices

Alberta Oil Sands

(Image courtesy COSIA)

- ~142,000 km^2
- 3rd largest proved oil reserve in the world
- ~20% is close enough to surface to be mined
- ~80% is too deep to mine and is extracted using in situ methods

About COSIA

- Alliance of oil sands producers focused on accelerating the pace of environmental
performance improvement in Canada's oil sands.
- A leader in collaboration, research and open source innovation.
- Brings together leading thinkers in Canada and from around the world.
- Conducts a large amount of environmental research.
- Develops technology that improves environmental performance.
- Strategic directive to be a trusted information source.

COSIA Vision: ***To enable responsible and sustainable growth of Canada's oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation.***

About iFROG

- **i**ndustrial **F**ootprint **R**eduction **O**ptions **G**roup
- A history of research collaboration studying primarily in situ related construction and reclamation practices since 2003.
- Focused on boreal wetlands since 2008
- Ten in situ oil sands partners (open to any who wish to join):
  - Canadian Natural Resources Limited, Cenovus Energy, ConocoPhillips Canada, Imperial, Athabasca Oil Sands, Harvest Energy, Husky Energy, Japan Canada Oil Sands, MEG Energy, CNOOC Petroleum North America**.**
- Purpose: “To develop, fund, and implement a balanced portfolio of wetlands research projects, based on the fundamental guiding principles of **Land Stewardship, Research Intelligently and Collaboration**.

History

- Originally started as “Removing the Wellsite Footprint”
- Spun off into two groups:
  - Faster Forests
  - iFROG
- Produced 3 MSc theses
  - 2 more presently in progress
- Produced 4 academic papers
  - 1 more presently in progress
- Produced or contributed to number of technical reports or guides

Motivation

- Regulatory compliance
  - Approval conditions
    - Wetland reclamation research
- Wetland Policy Hierarchy
  - Avoidance
  - Minimization
  - Replacement (reclamation/restoration)
- Stewardship
  - Doing good things

Land Stewardship

- Shared responsibility to do what is best for wetlands
- Smaller facilities, less intensive footprint and faster reclamation
- Balance bigger picture focus with regulatory compliance.
  - Sometimes compliance is the easiest thing to do, but can divert resources from bigger picture stewardship ideas and innovation, such as:
    - Developing advancements in avoidance strategies via new technologies in planning and exploration.
    - Minimizing impacts by improving construction practices and developing lower impact equipment.
  - iFROG's vision is to deliver compliance **AND** pursue the "bigger picture"

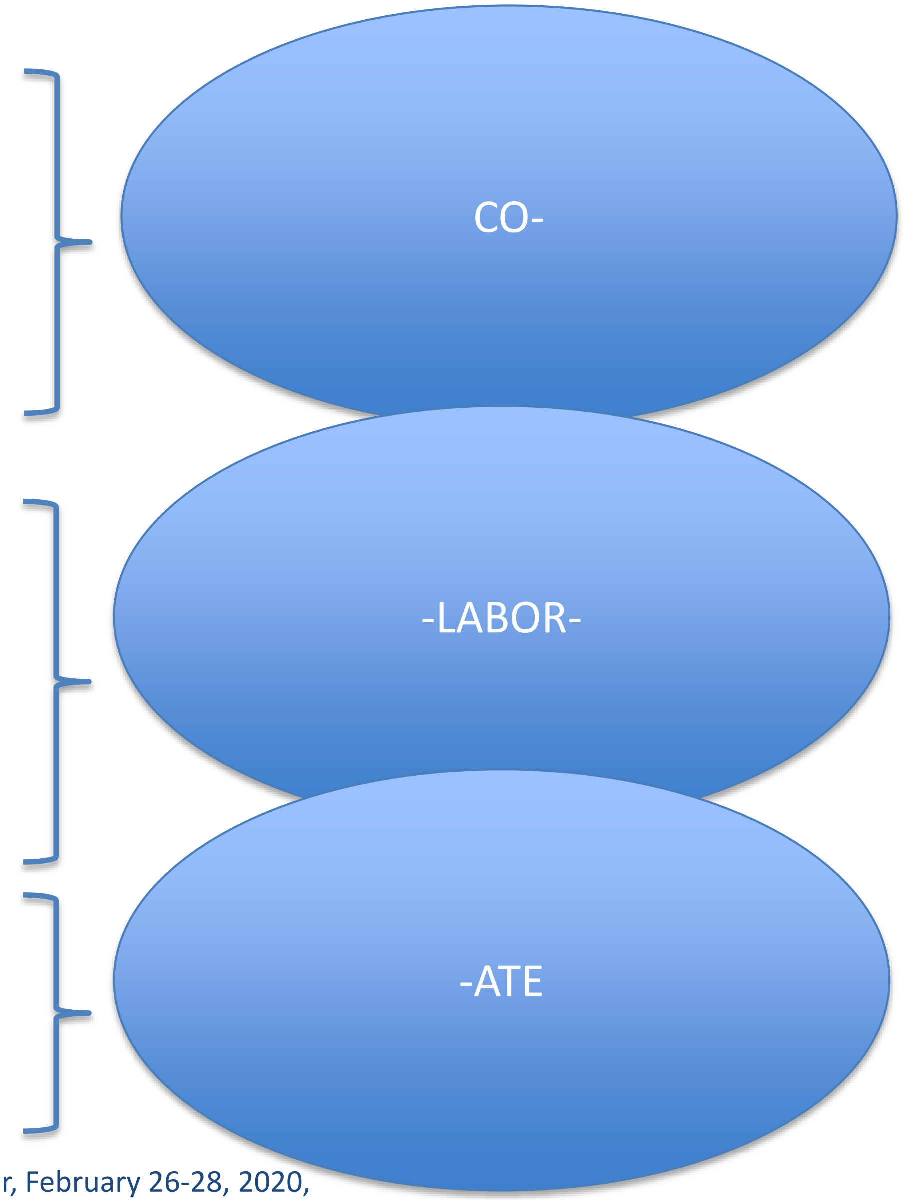
Research Intelligently

- Identify **knowledge gaps** and target those for research.
- Prioritize gaps based on the conservation impact versus effort and cost to close them.
- Choose projects with potential to increase conservation impact per research dollar spent.
- Reduce redundancy:
  - Know what others are doing.
  - Find synergies with other projects/agencies.
  - Strategically coordinate efforts and initiatives among agencies and organizations.
- Collect low hanging fruit:
  - Start right away on available sites that fit a priority, even if it is not the top priority.
  - Progress incrementally

Collaboration

- iFROG fosters relationships among:
  - Partner companies
  - Research agencies
  - Regulatory bodies (AER & AEP)
  - Consultants
  - NGOs
- Leverage brainpower available to examine specific problems
- Leverage time, effort, and financial resources
- Increase efficiency of efforts
- Improve quality of results

- A LOT of Timbits and coffee



Additional Considerations

In addition to our three guiding principles:

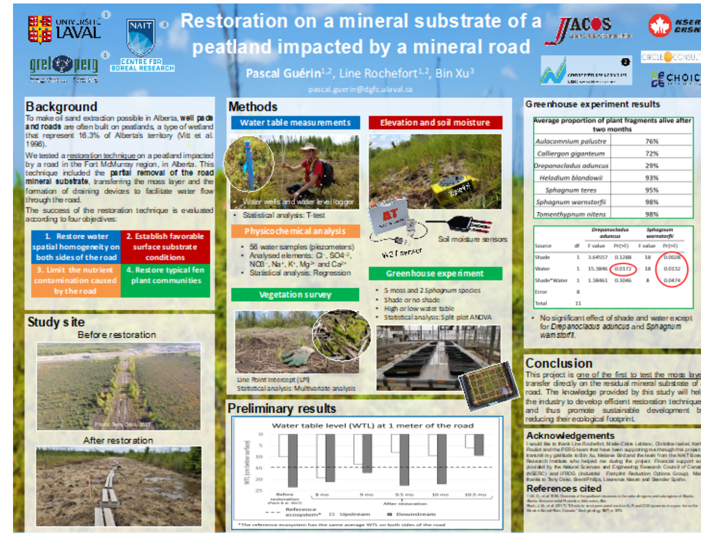
- Land Stewardship
- Research Intelligently
- Collaboration

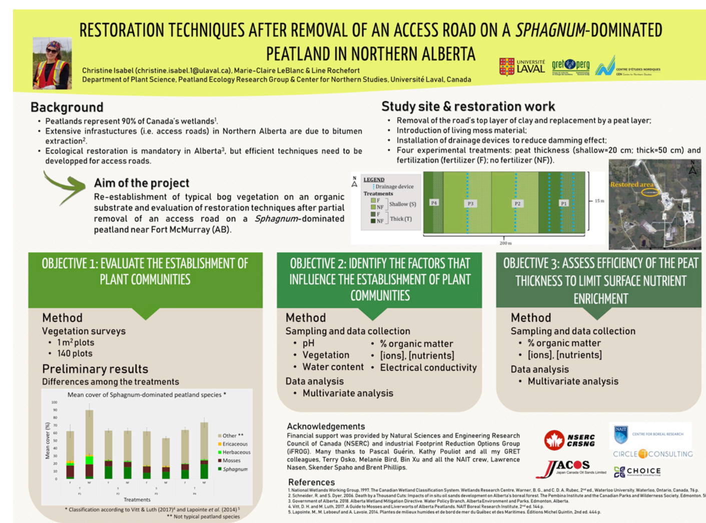
We also consider:

- Scale: Local (road/wellpad) <->Regional (landscape)
- Stage: Plan <-> Construct <-> Reclaim
- Multiyear and shorter term initiatives
- An element of **innovation**
- **Practical matters** (locations, partners, funding opportunities etc.)

Jacos Road Reclamation

- Two primary objectives:
- Establish target peatland plant communities on both organic and mineral substrates:
  - Sphagnum-dominated communities on restored organic substrate:
    - Accelerated re-establishment using salvaged peat as proxy for peat accumulation under an undisturbed peatland.
  - Fen-like communities on mineral substrate:
    - Demonstrate peatlands can be initiated on mineral substrate if required.
    - Slower establishment because peat accumulation is starting from scratch.
- Re-establish hydrological conditions over the former road conducive to target peatland communities to be established:
  - Re-establishing water balance across the road (reduce damming effect of road).
  - Establishing substrate conditions necessary for moss regeneration (soil moisture, pH, nutrients…)





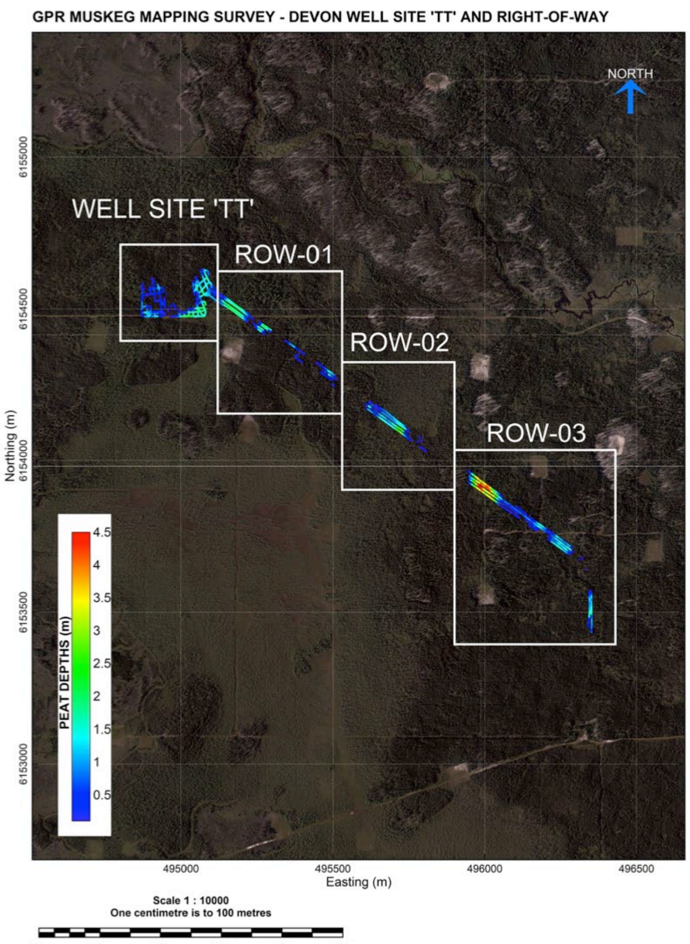
From Dirt to Peat

- Meta-study of 10 reclaimed boreal peatland sites (including the JACOS Road site).
- All reclamation involved some variation of partial fill removal.
- Sites vary in regional location, age, peatland type, fill removal methods and revegetation treatments.
- Objectives:
  – Quantify the degree to which sites are functioning as peatlands as determined by:
    - Peat accumulation.
    - Carbon storage (biomass production versus decomposition).
    - GHG exchange.
    - Species composition.
  – Relate degree of peatland function to commonalities or trends in sites as possible indicators of preferred reclamation practice.

Pad TT Road

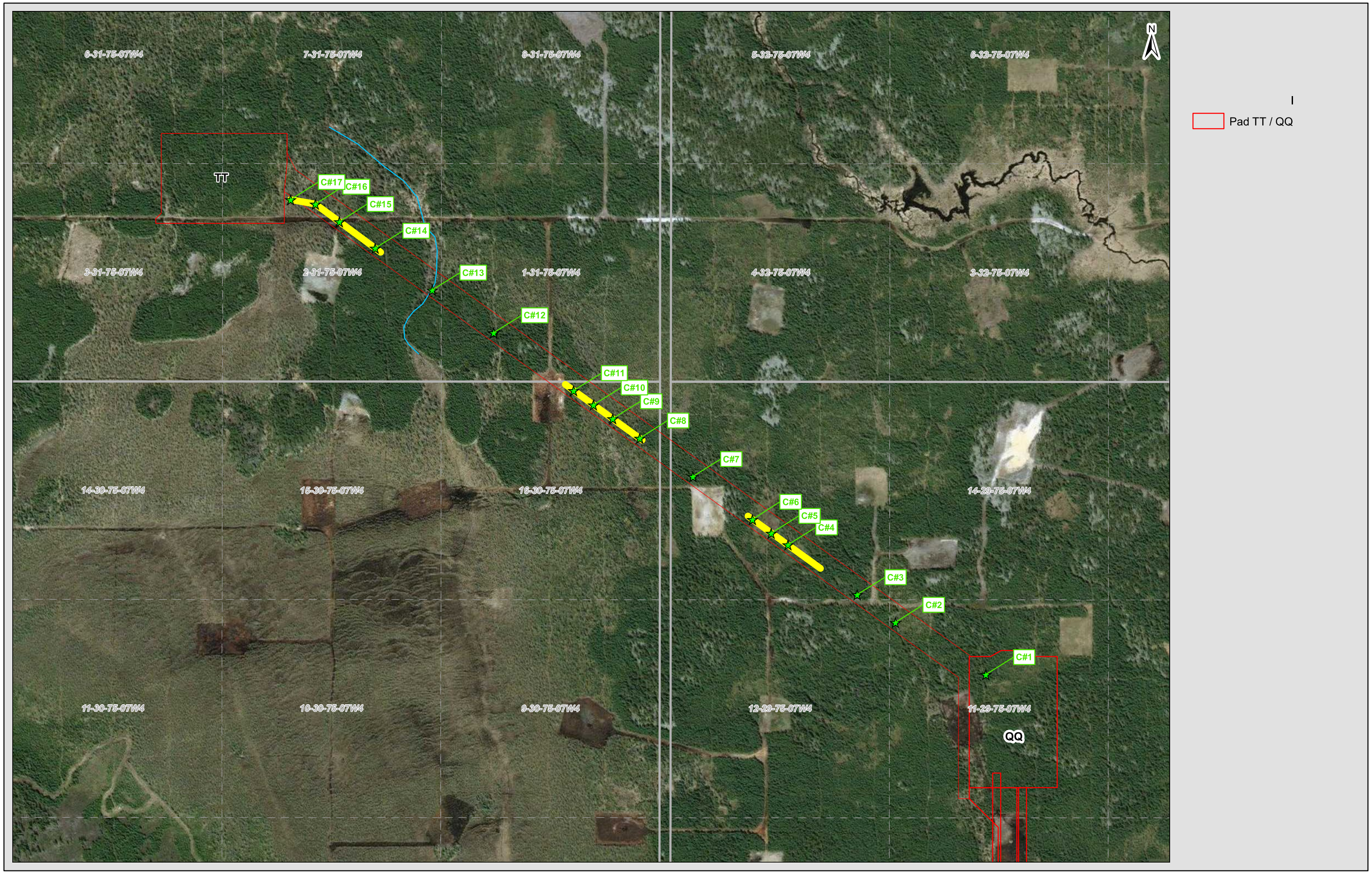
- Moving beyond reclamation to minimization and avoidance

Pre-Construction Peat Depth Assessment Using GPR



- Road is 1.5 km long.
- Intersects several areas of deep peat (2 – 4 m).
- Deep peat locations are a concern for road construction and operability.
- Risk of road impeding natural water flow through the deep peat sections.
- How to minimize risks?
  - Firm the foundation.
  - Increase drainage capacity.
    - Plan for subsurface flow.

Construction Plan Overview



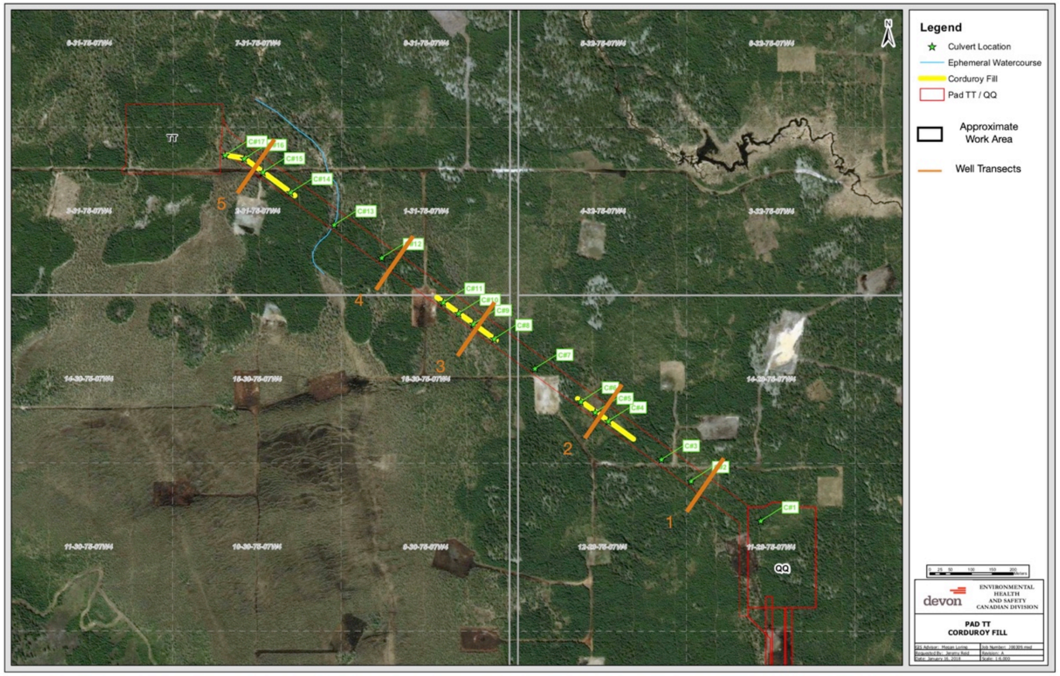
Integrating Old With New

- Corduroy foundation over deep peat.
- Multiple drainage conduits placed at short spacing.
  - Four to six, where only one or two might have been used conventionally.
- Multiple conduit types: culverts, log bundles, pipe bundles.
- Corduroy also promotes flow beneath road.

Road Performance Observations

- Road settling
- Conduit distortions
  - Bowing, deflection
- Operability issues

Hydrologic Study

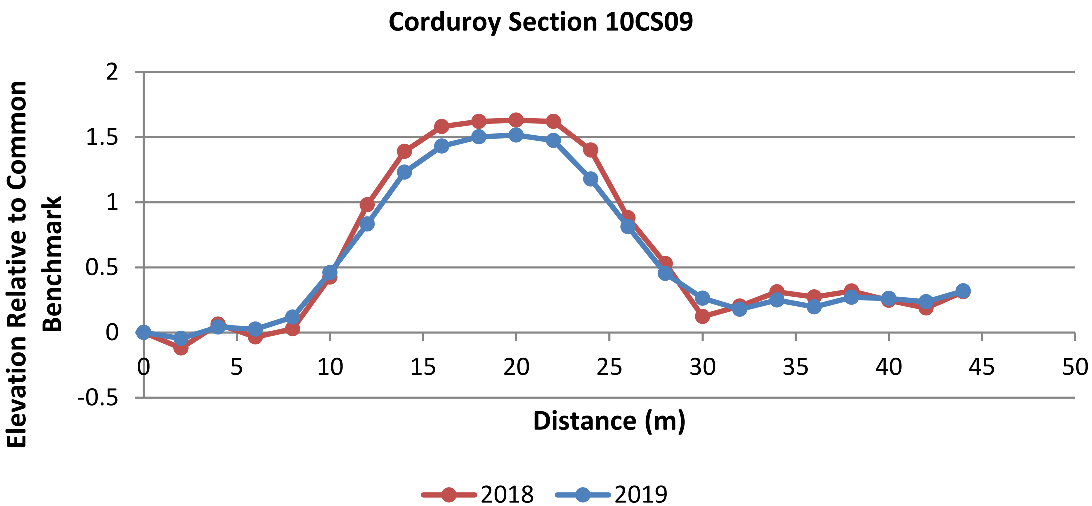


- Water table elevations and depth to water table
  - 5 transects at deep peat locations
  - 3 wells on each side of road at 15 m, 30 m, 45 m
  - Slotted entire below surface depth (depth of peat or 2 m)
  - Ground surface and well elevations surveyed
- Conduit flow

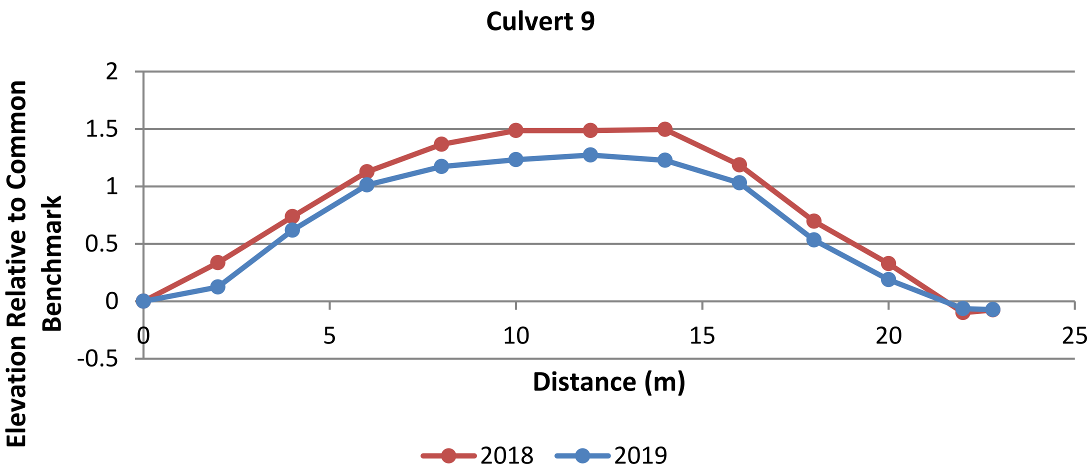
Road Performance Results

- Settling expected in initial years
- 2019 road elevations within peat sections generally lower than 2018
  - Over all conduit types
  - Between conduits
  - Differential settling: conduits vs areas in between
- Much vertical movement of culverts and conduits
- Culvert embedment inconsistent
- Most culverts bowed with upward end deflection
- All culverts remain flowing (optimum?)
- Corduroy promoting water flow
- Road remains in very good operational condition

Settling

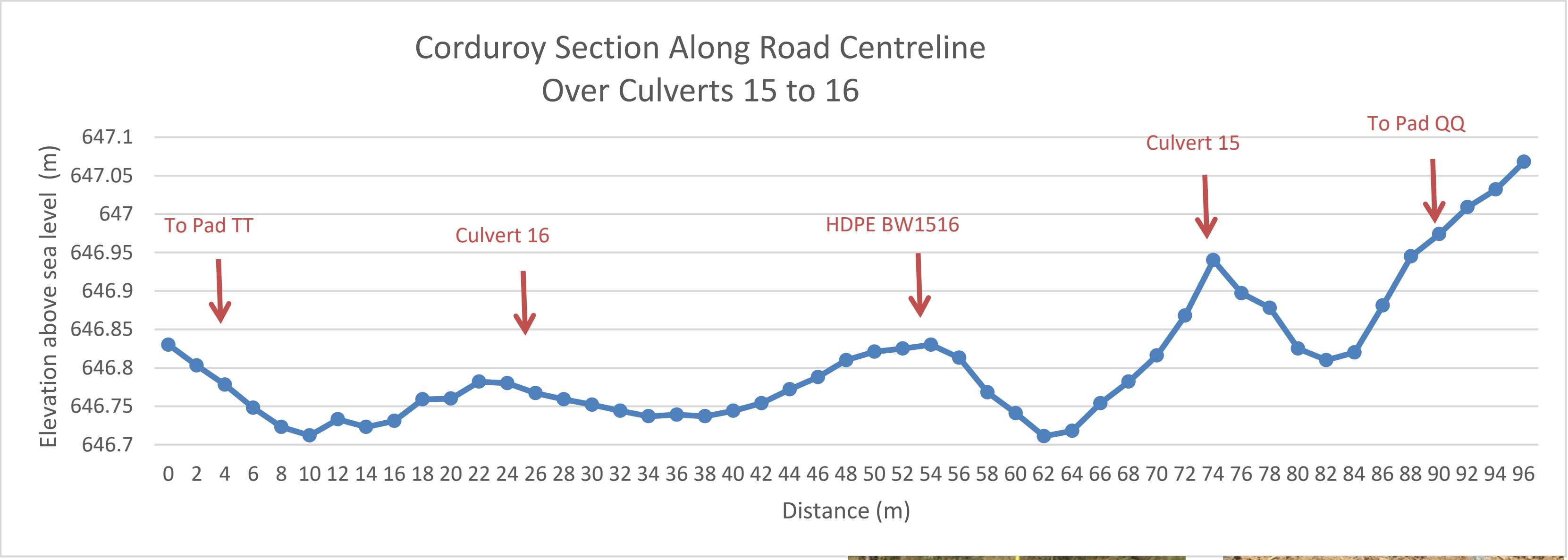


Corduroy Section 10CS09
Elevation Relative to Common Benchmark
2
1.5
1
0.5
0
-0.5
0 5 10 15 20 25 30 35 40 45 50
Distance (m)
2018
2019

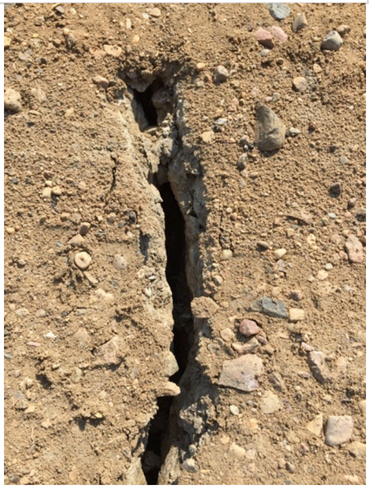


Culvert 9
Elevation Relative to Common Benchmark
2
1.5
1
0.5
0
-0.5
0 5 10 15 20 25
Distance (m)
2018
2019

Differential Settling



- Road fill in areas between conduits settled more than directly above conduits
- Tension cracks evident in some locations



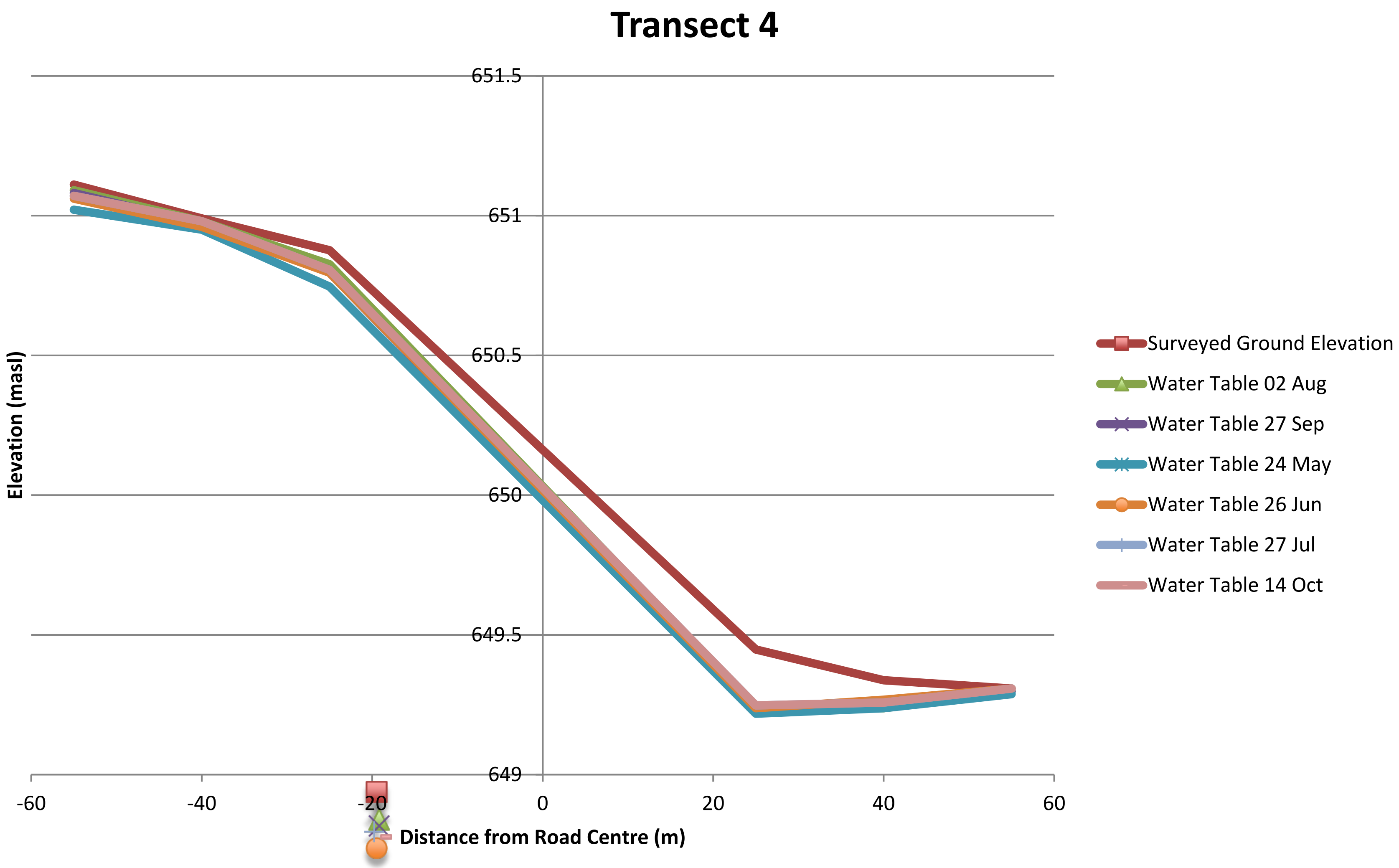
Culvert Performance and Flow

- Culverts range in depth of embedment
  - Inconsistent performance of supporting piles
- All culverts flowing over most of the season

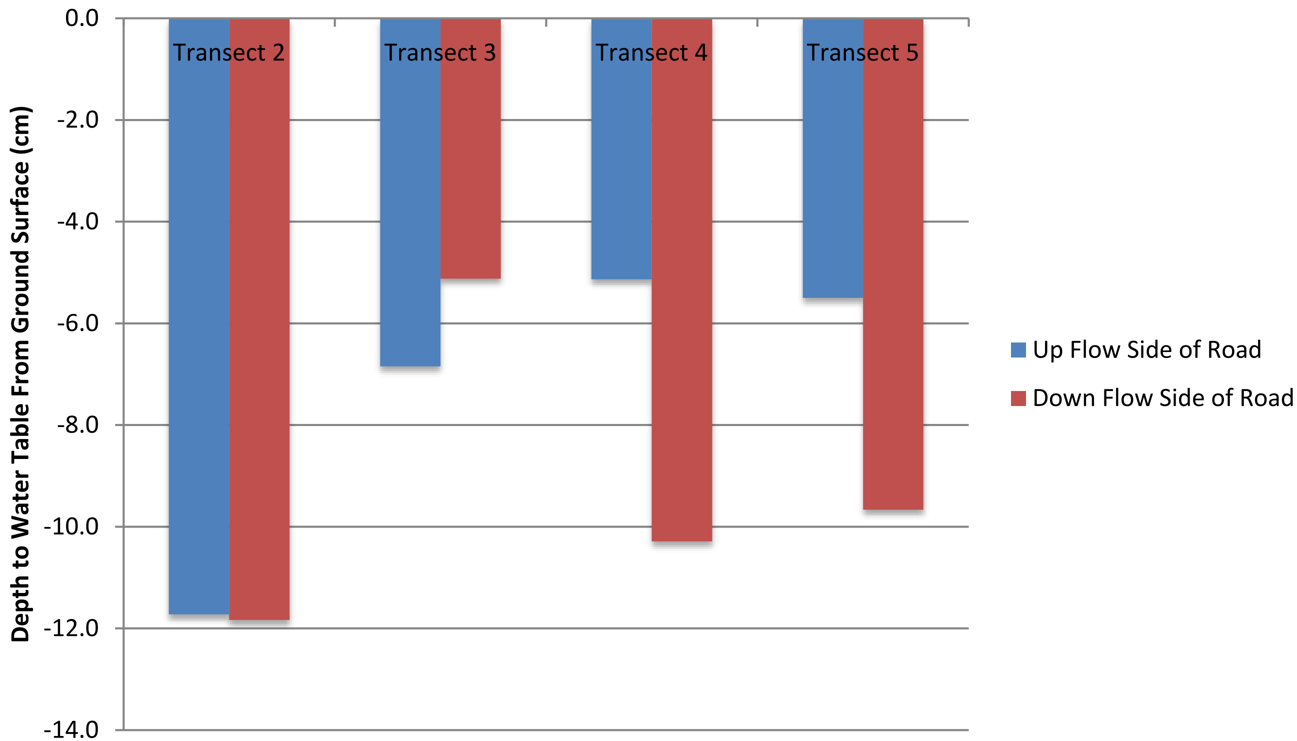
Bundle and Corduroy Flow

- All conduits, including corduroy appear to be drawing flow

Water Table Elevations

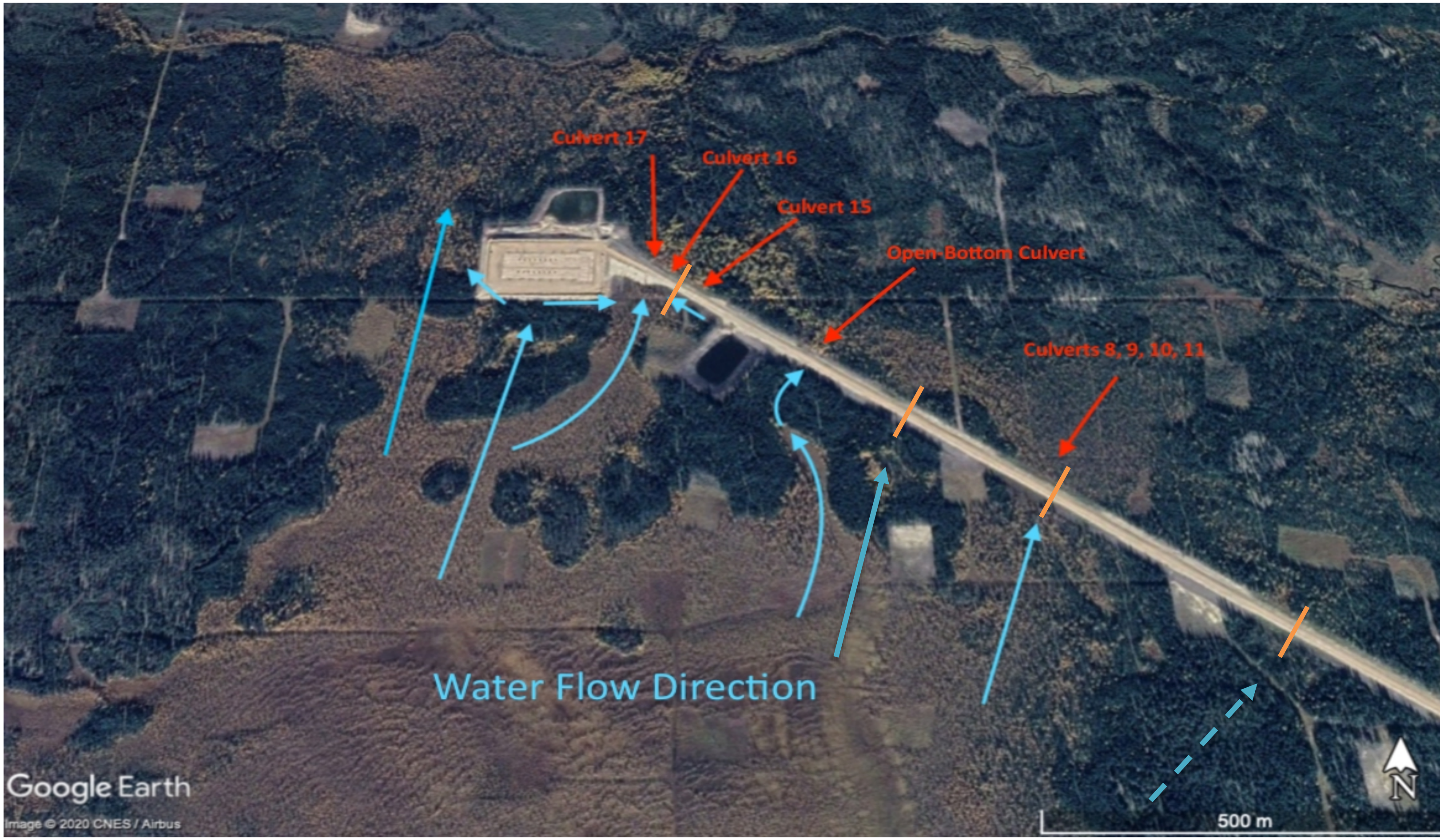


Depth to Water Table



- Depth to water table did not differ overall between sides of the road
- Water table depth differed between sides for individual transects
  - Indication of flow impediment

Water Flow Concentration



- Highest natural flows near pad location
- Flow concentrated by road and pad near pad location
- Culverts least embedded near pad location (well transects 4 and 5)

Next Steps for Pad TT Road Study

- Quantify flow rates on either side of the road
- Characterize vertical water movement within the peat column
  - i.e. upwelling caused by road?
- Quantify proportional flow among the various conduit types and embedment depths
  - nests of piezometers at key locations slotted at 3 depths
  - chemical tracers
- Inform future construction prescriptions – promote practice adoption

Key Messages Revisited

- More studies like the Pad TT road project required
- Stewardship includes focus on avoidance and minimization ahead of the need to reclaim
- Collaboration allows flexibility to focus on the bigger picture in addition to regulatory compliance
  - Leveraged funding (can do more than going it alone)
  - Research can focus on improving ecological outcomes before the reclamation phase
  - Shared “regulatory” credit for research efforts
  - Shared voice with regulatory agencies
- Improved ecological outcomes
  - Broader suite of research addressing a broader suite of questions (reduced redundancy)
  - Moving up the Wetland Policy hierarchy
  - Hastened communication and adoption of practices
- Alberta’s in situ operators are doing good things!

Join Us!

Terry Osko
terryosko@circletconsulting.ca

Robert Albricht
robert.c.albricht@conocophillipos.com