

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

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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

- ~142,000 km²
- 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



(Image courtesy COSIA)

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

- industrial **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”

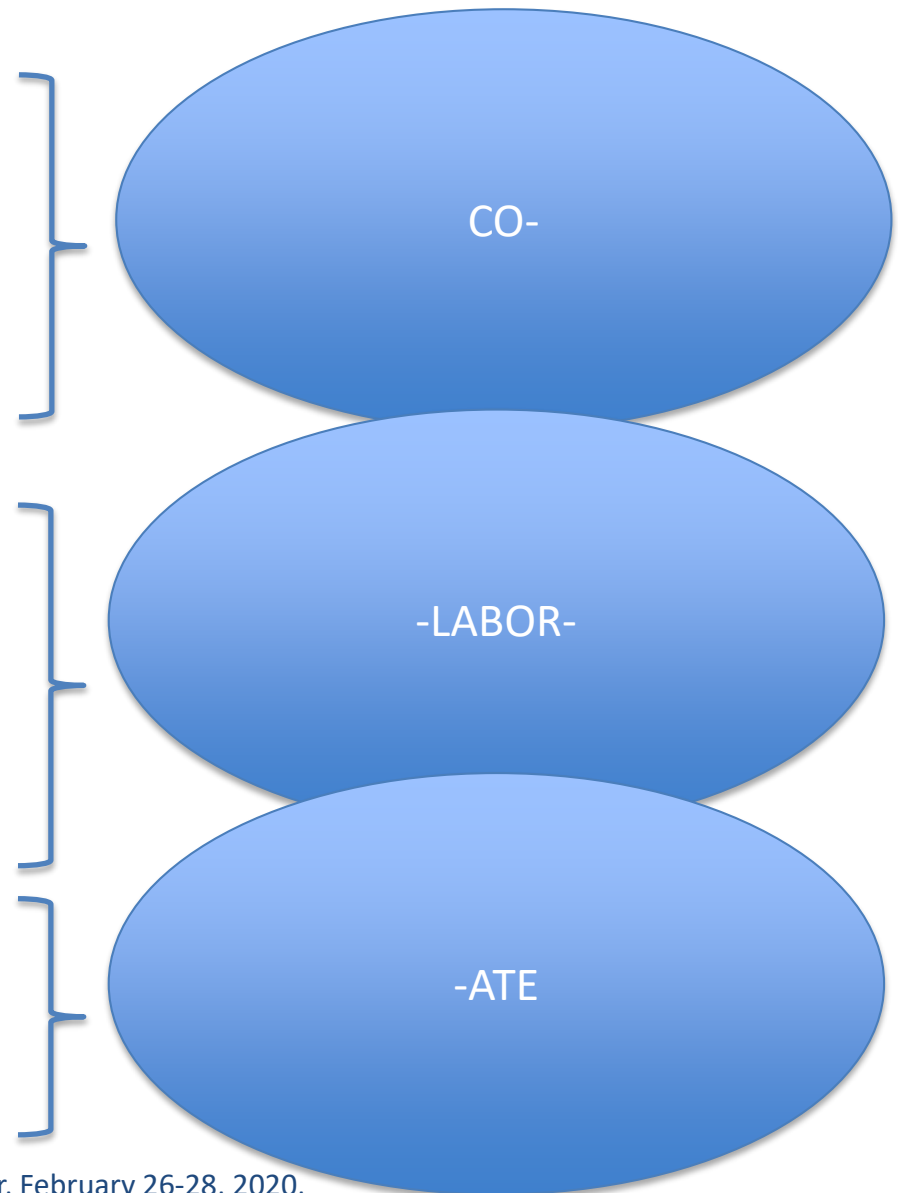


Research Intelligently

- 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...)

Restoration on a mineral substrate of a peatland impacted by a mineral road
 Pascal Guérin^{1,2}, Line Rochefort^{1,2}, Bin Xu³
 pascal.guerin@pql.ulaval.ca

Background
 To restore land restoration possible in Alberta, well peat and roads are often built on peatlands, a type of wetland that represents 18.2% of Alberta territory (Vid et al. 1996). We tested a restoration technique on a peatland impacted by a road in the Fort McMurray region, in Alberta. This technique involved the partial removal of the road mineral substrate, transferring the moss layer and the formation of draining ditches to facilitate water flow through the road.

Methods
Water table measurements
 • Water table level (WTL) measurements
 • Statistical analysis: T-test
Vegetation survey
 • 5 moss and 2 Sphagnum species
 • Shade and soil moisture
 • High or low water table
 • Statistical analysis: Split plot ANOVA
Greenhouse experiment
 • 5 moss and 2 Sphagnum species
 • Shade and soil moisture
 • High or low water table
 • Statistical analysis: Split plot ANOVA

Greenhouse experiment results
 Average proportion of plant fragments alive after two months

Species	Survival (%)
Autumnella pulchella	75%
Calliergia glutinosa	72%
Drepanocladus adpressus	29%
Restioidium blandfordii	93%
Sphagnum teres	95%
Sphagnum auriculatum	98%
Sphagnum angustatum	98%

Study site
 Before restoration
 After restoration

Preliminary results
 Water table level (WTL) at 1 meter of the road

Distance from road	WTL (cm)
Reference	~10
0 m	~10
3 m	~10
6 m	~10
9 m	~10
12 m	~10
15 m	~10
18 m	~10
21 m	~10

RESTORATION TECHNIQUES AFTER REMOVAL OF AN ACCESS ROAD ON A SPHAGNUM-DOMINATED PEATLAND IN NORTHERN ALBERTA
 Christine Isabel, Marie-Claire LeBlanc & Line Rochefort
 Department of Plant Science, Peatland Ecology Research Group & Center for Northern Studies, Université Laval, Canada

Background
 • Peatlands represent 90% of Canada's wetlands.
 • Extensive infrastructures (i.e. access roads) in Northern Alberta are due to bitumen extraction.
 • Ecological restoration is mandatory in Alberta, but efficient techniques need to be developed for access roads.

Study site & restoration work
 • Removal of the road's top layer of clay and replacement by a peat layer.
 • Introduction of living moss material.
 • Installation of drainage devices to reduce damming effect.
 • Four experimental treatments: peat thickness (shallow=20 cm; thick=50 cm) and fertilization (fertilizer (F); no fertilizer (NF)).

Objectives
OBJECTIVE 1: EVALUATE THE ESTABLISHMENT OF PLANT COMMUNITIES
Method
 Vegetation surveys
 • 1 m² plots
 • 140 plots
Preliminary results
 Differences among the treatments

Species	Mean cover (%)
Other**	~10
Cladonia	~10
Hylocomium	~10
Hylocomium splendens	~10
Sphagnum	~10

OBJECTIVE 2: IDENTIFY THE FACTORS THAT INFLUENCE THE ESTABLISHMENT OF PLANT COMMUNITIES
Method
 Sampling and data collection
 • pH
 • % organic matter
 • [ions], [nutrients]
 • Water content
 • Electrical conductivity
Data analysis
 • Multivariate analysis

OBJECTIVE 3: ASSESS EFFICIENCY OF THE PEAT THICKNESS TO LIMIT SURFACE NUTRIENT ENRICHMENT
Method
 Sampling and data collection
 • % organic matter
 • [ions], [nutrients]
Data analysis
 • Multivariate analysis

References
 1. Guérin, P., Rochefort, L., & Xu, B. (2019). The Carbon Sequestration Capacity of Peatlands in Northern Alberta, Canada. In: Proceedings of the 10th International Conference on Peatlands (ICP 2019).
 2. Guérin, P., Rochefort, L., & Xu, B. (2019). The Carbon Sequestration Capacity of Peatlands in Northern Alberta, Canada. In: Proceedings of the 10th International Conference on Peatlands (ICP 2019).
 3. Guérin, P., Rochefort, L., & Xu, B. (2019). The Carbon Sequestration Capacity of Peatlands in Northern Alberta, Canada. In: Proceedings of the 10th International Conference on Peatlands (ICP 2019).
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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.



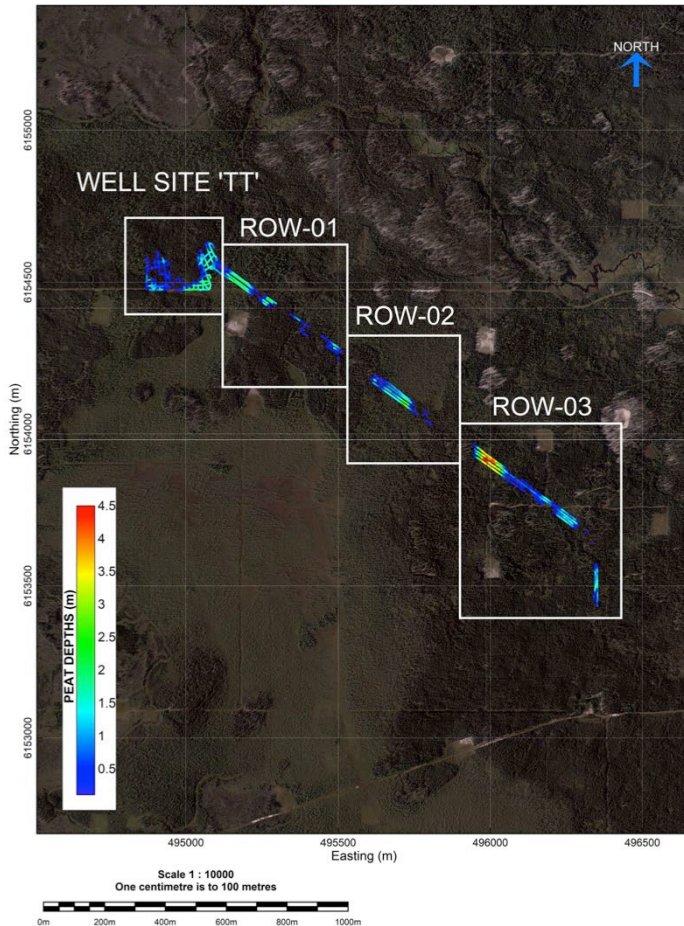
Pad TT Road



- Moving beyond reclamation to minimization and avoidance

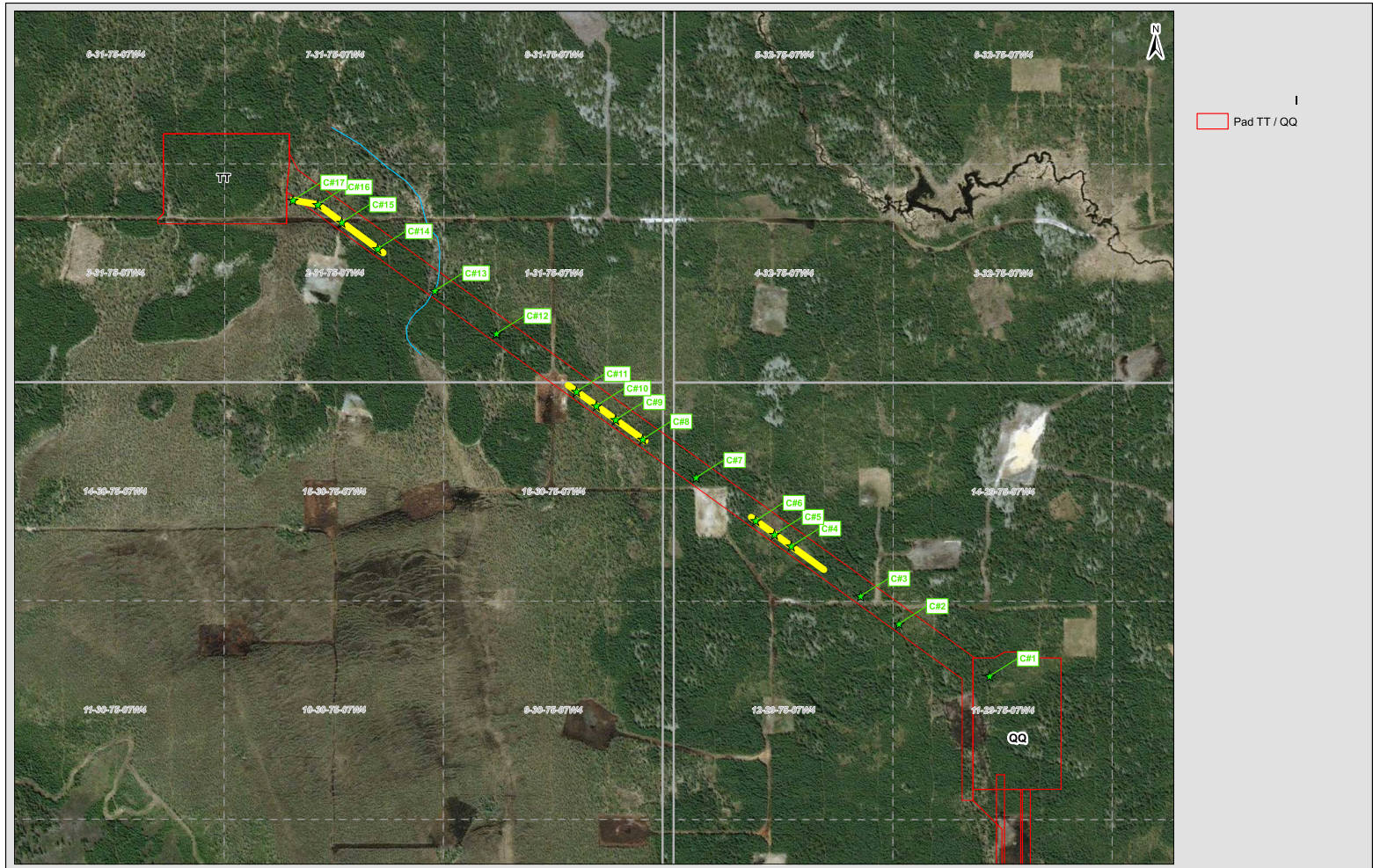
Pre-Construction Peat Depth Assessment Using GPR

GPR MUSKEG MAPPING SURVEY - DEVON WELL SITE 'TT' AND RIGHT-OF-WAY



- 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.

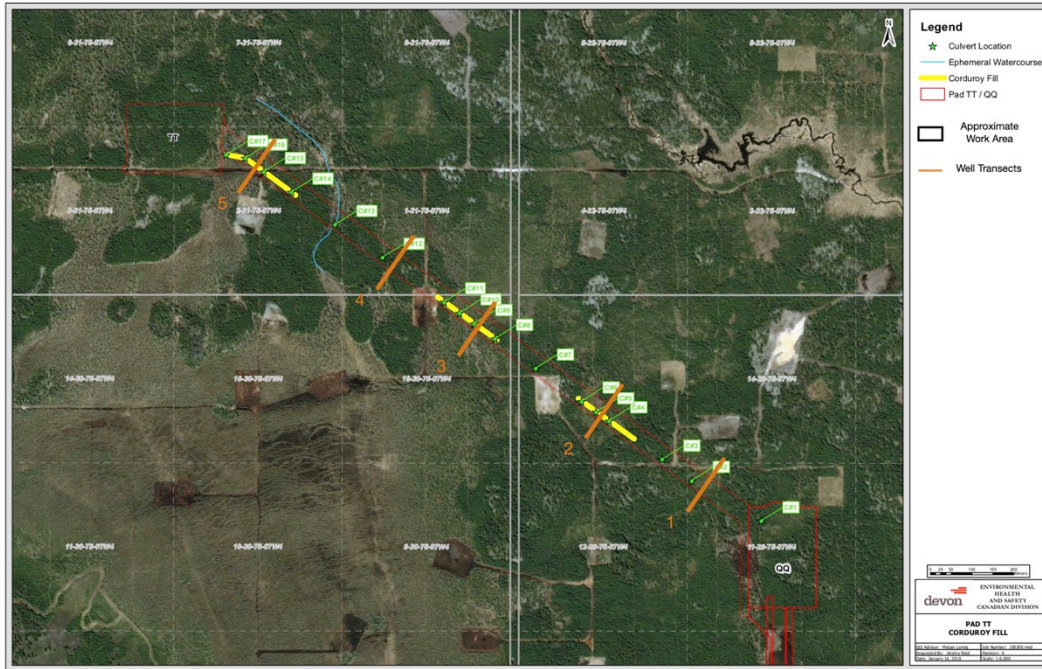


Road Performance Observations



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

Hydrologic Study

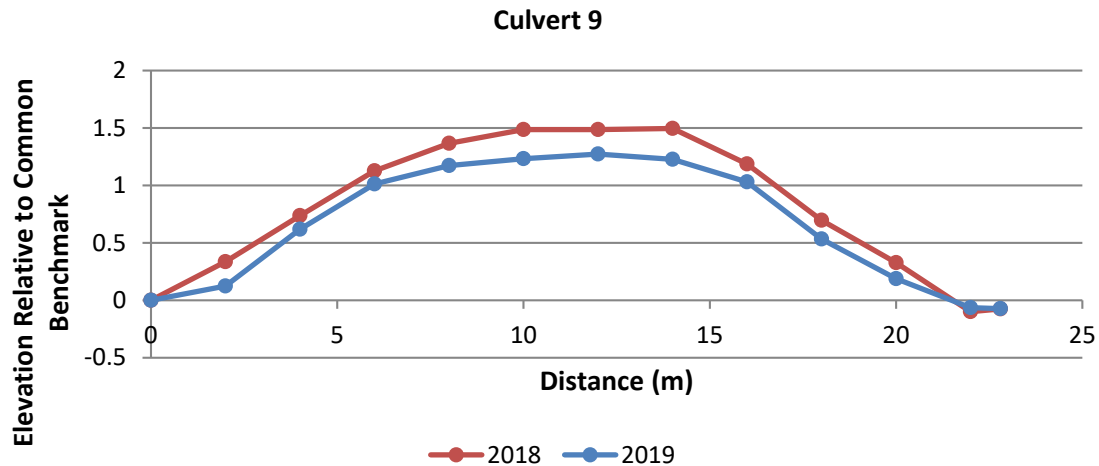
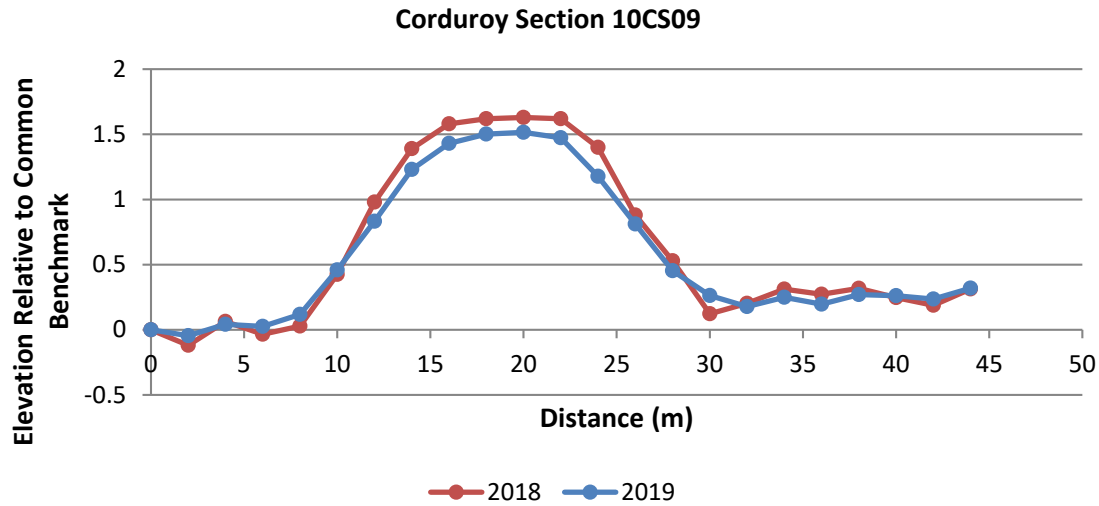


- Water table elevations and depth to water table
 - 5 transects at deep peat locations
 - 3 wells on each side of road at 15 m, 30 m, 45 m
 - Slotted entire below surface depth (depth of peat or 2 m)
 - Ground surface and well elevations surveyed
- Conduit flow

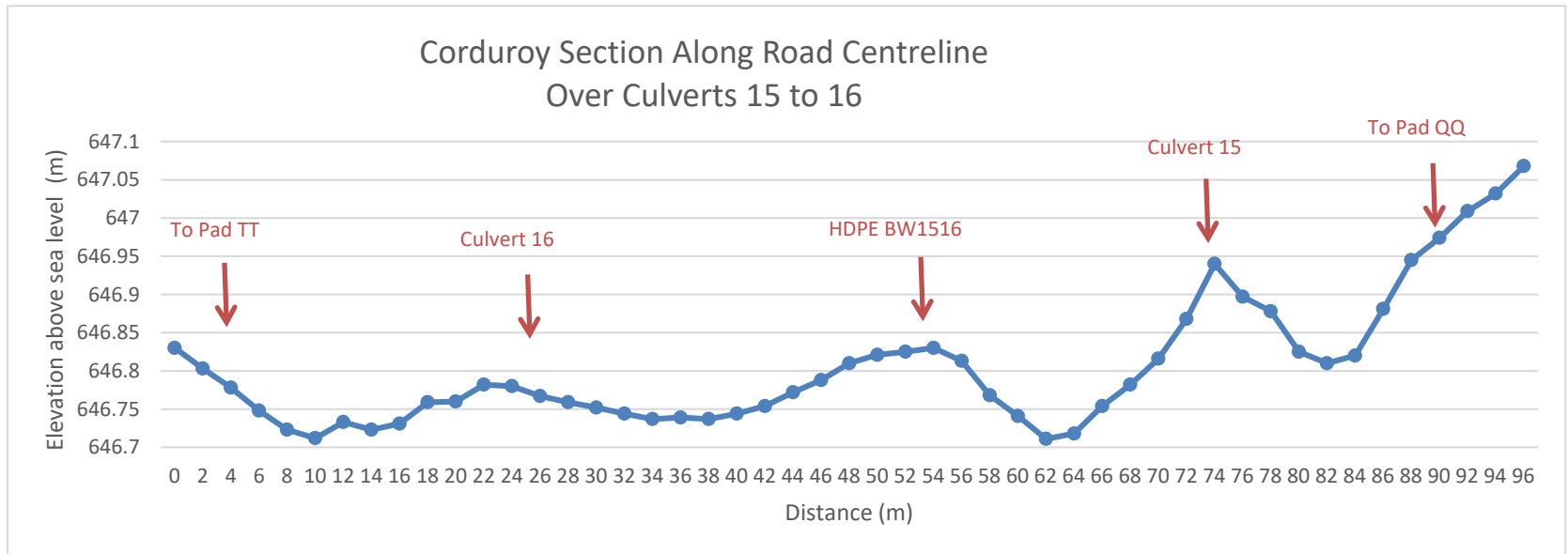
Road Performance Results

- 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

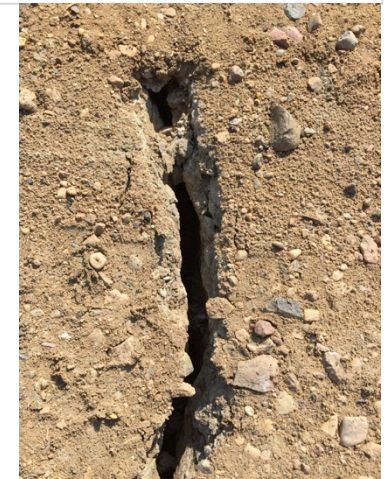
Settling



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

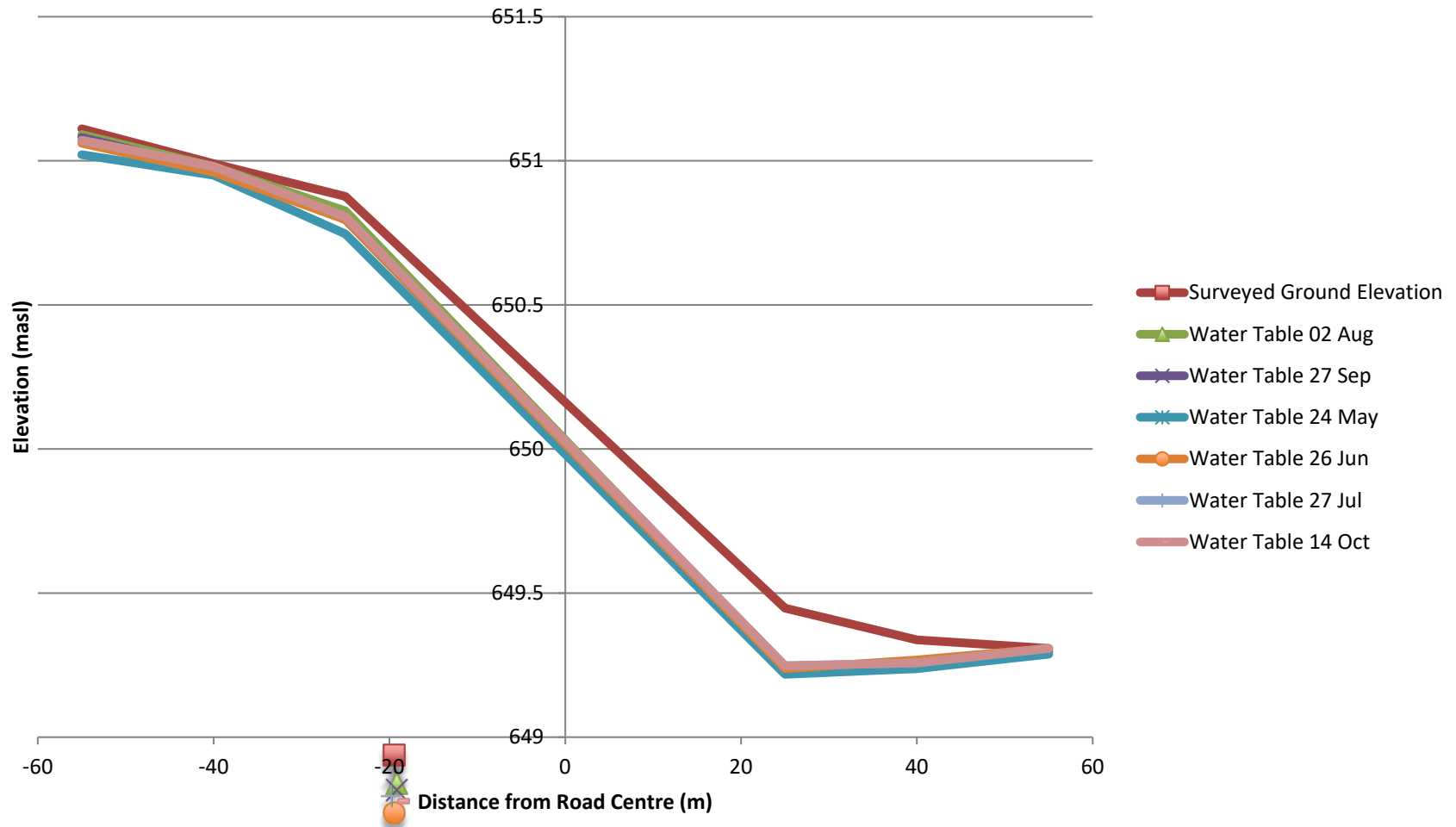
Bundle and Corduroy Flow



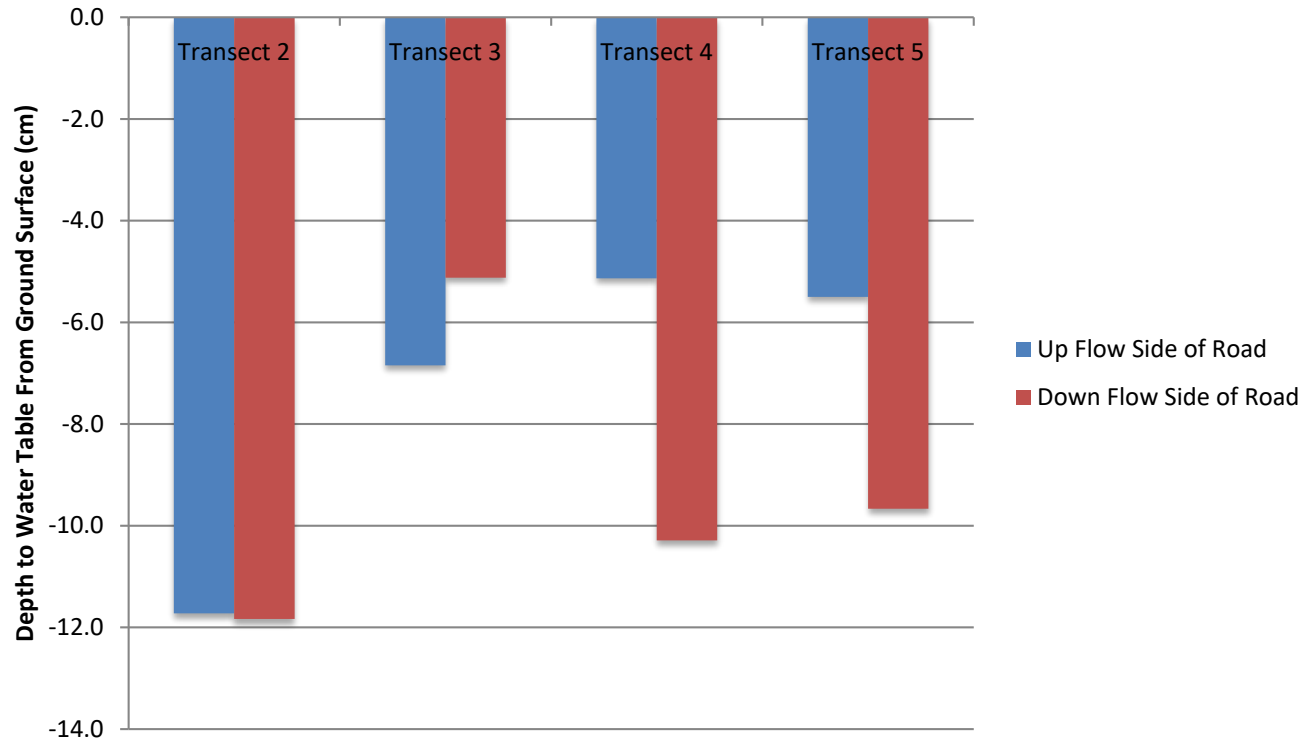
- All conduits, including corduroy appear to be drawing flow

Water Table Elevations

Transect 4

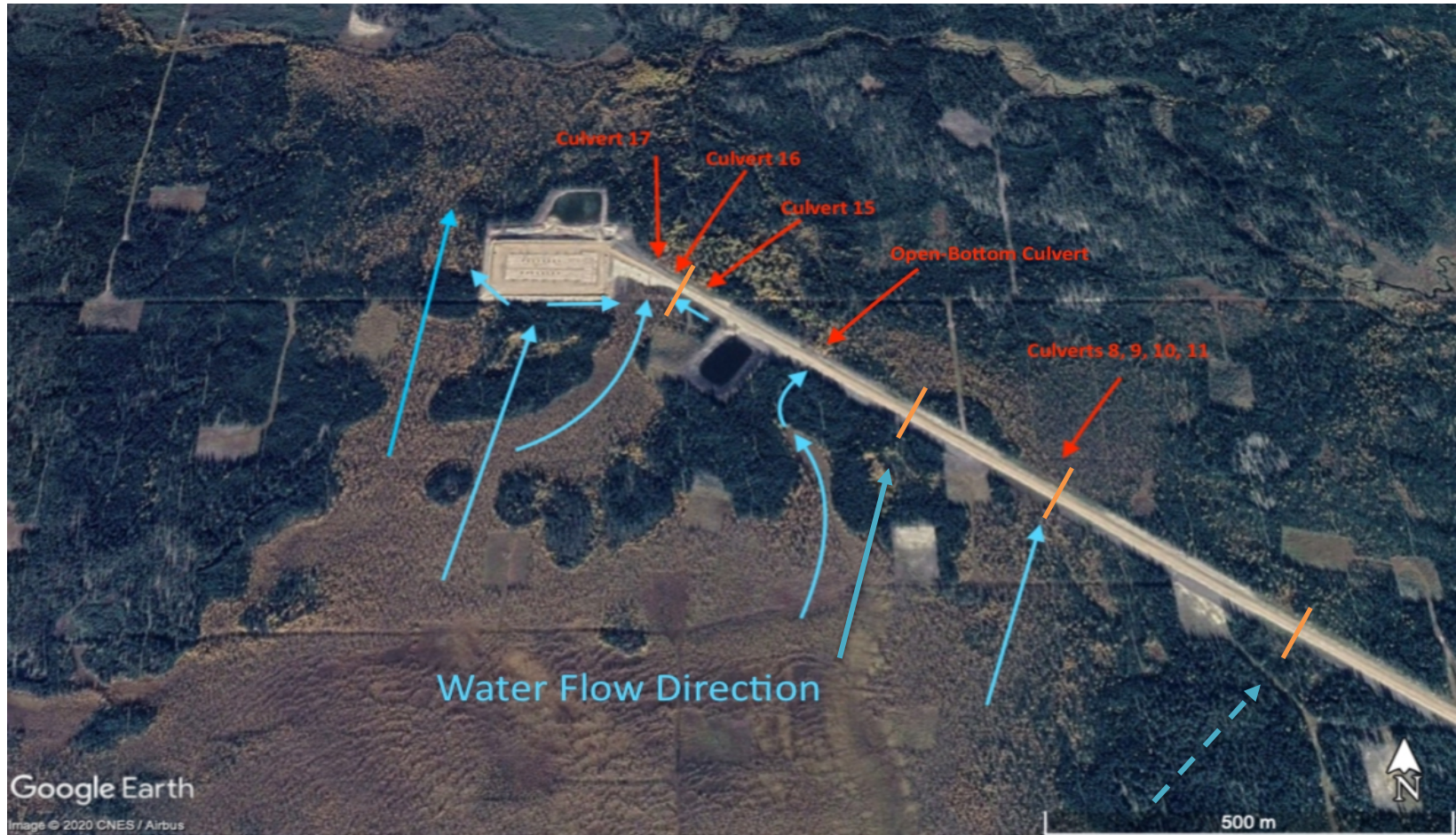


Depth to Water Table



- 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!

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