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November, 2024

COSIA Fall Field Tour 2024
Reclamation Key Learnings and Opportunities

Final Report

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EXECUTIVE SUMMARY

On September 11-12, 2024, 41 individuals from across Alberta came together for the annual fall field tour hosted by the Land Environmental Priority Area (Land EPA) of Canada's Oil Sands Innovation Alliance (COSIA). The goal of the tour was to showcase progressive reclamation practices and discuss practical research findings at Imperial's Cold Lake Operations and CNRL's Wolf Lake Operations.

The field tour brought together participants from diverse professional backgrounds including individuals from research, industry, consulting, government and regulatory agencies. Over the two days, participants leveraged their unique perspectives and expertise to discuss key challenges, learnings, and opportunities for advancing progressive reclamation practices.

Key discussion points throughout the tour included:

- The evolution from past practices of planting grass and monocultures of trees to planting native species, use of woody material, rough and loose soils, etc.
- Emerging techniques for re-establishing forest cover on legacy sites with a high level of grass and clover.
- Opportunities for rapid re-establishment of forest ecosystems on sites with low disturbance and timely reclamation post-disturbance.
- Uncertainty associated with changing expectations of reclamation requirements within woodland caribou ranges, and potential adjustments considering sub-regional planning direction.
- Emerging beneficial practices for reclamation of wetland sites, including discussion of the appropriate levels of fill removal and ideal opportunities to re-establish wetland communities.
- Challenges and opportunities associated with watercourse crossing removals, and practical steps related to management of fill material, timing of crossing removals, and opportunities to re-establish fish passage in large portions of a watershed.
- Broader challenges associated with taking sites to closure:
    - The uniqueness of EPEA sites as it pertains to reclamation certification.
    - Navigating the evolving requirements for borrow pits and caribou sub-regional planning considerations.
    - Recognizing that many forms of vegetation control outside of weed spraying can be employed on reclaimed sites.
    - Managing conservation and reclamation data over the life span of an in-situ project footprint to minimize rework.
- Remote and field-based inquiries for reclamation certification.

The field tour participants also discussed a series of challenges to overcome. These included:

- Managing both recent and historical data for sites that have been in operation for long periods of time.
- Identifying opportunities for reclamation certification while also providing long-term company flexibility.
- Documenting current beneficial management practices and ensuring a new generation of reclamation practitioners and equipment operators are aware of, and actively applying, proven practices.

To compliment the field tour, a half-day workshop was hosted for participants to debrief what they learned on the field tour. The main workshop objective was to identify tangible next steps for advancing progressive reclamation practices and key lessons into practice. Workshop participants joined a prioritization exercise based on the leading question: “If you were to fully leverage your learnings from the tour, what would you bring back to your team, to implement or be aware of?”. Participants identified the top five opportunities, and then discussed: Why this practice? How could this practice be integrated? And what is the first step?

The five discussion topics included:

1. Longer-term considerations for where to put borrow material during reclamation.
2. The development of a guidebook to capture the variety of available wetland reclamation techniques and how surrounding environments impact the success of these techniques.
3. Importance of knowledge sharing, collaboration and developing best management practices among companies, researchers and operators.
4. Comparisons and contrasts between reclamation certificate requirements and caribou habitat restoration.
5. The role of natural regeneration instead of defaulting to legacy practices of planting grass on reclamation sites.

Breakout discussions led to a series of clear next steps for each of these five topics, including ideas to lead guidebook development for wetlands similar to past work through the Faster Forests program, a desire to develop a Wetland Task Force to improve knowledge sharing between diverse groups, and a recognition of the importance to avoid developments in caribou habitat and that landscape-level planning of site construction and reclamation could help to achieve this.

Feedback from participants on the tour was overwhelmingly positive. Of 24 respondents, 100% indicated they found the tour valuable and 92% of respondents said they would attend another field tour.

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ACKNOWLEDGEMENTS

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Planning and direction for the tour was provided by: Lori Neufeld (Imperial), Carolina Berdugo-Clavijo (Imperial), Kinzie Gray (Imperial), James Agate (CNRL), Paul Kip (CNRL), Jack O'Neill (Pathways Alliance), and Lindsay Clothier (Pathways Alliance).

Facilitation and logistical planning were provided by Matthew Pyper, Nakita Rubuliak, and Stephanie McKenzie of Fuse Consulting Ltd.

INTRODUCTION

The Land Environmental Priority Area (Land EPA) of Canada's Oil Sands Innovation Alliance (COSIA), has a history of hosting fall field tours to showcase emerging and progressive reclamation solutions. The fall 2024 field tour was held on September 11-12, 2024, and included participation from COSIA member companies, the Alberta Energy Regulator, Government of Alberta, Northern Alberta Institute of Technology, Université Laval, Pathways Alliance, Natural Resources Canada, and various consulting agencies.

The 2024 fall field tour was hosted out of Bonnyville, AB, and included site visits to Imperial's Cold Lake Operations (Day 1) and CNRL's Wolf Lake Operations (Day 2). A half day workshop was also hosted on the second day of the field tour, with the goal of synthesizing lessons learned on the field tour and identifying specific actions participants could take back into their organizations.

Site maps for each of the field tour days are included in Appendix 1 and 2 of this document.

DAY 1: IMPERIAL COLD LAKE OPERATIONS SITES

On the first day of the tour, participants visited seven sites at Imperial Cold Lake that covered key topics including:

- Improving seedling establishment and early growth in reclaimed legacy grassy sites,
- Weed control through rapid establishment of tree and shrub cover,
- Wetland reclamation techniques to reclaim peatland function, and
- Considerations for borrow pit reclamation.

The following summaries provide relevant background information on the sites visited during the tours and capture key discussion points raised during the field tour.

SITE 1: D62/D63 DRILLING SUMP (CFS RESEARCH)

SITE HISTORY

D63 is a drilling sump that was constructed in 1991/1992 and reclaimed shortly after. This site was reclaimed to the standard of the day and revegetation practices of that time involved seeding the following seed mix at 30 kg/ha: Canada Bluegrass (20%), Creeping red fescue (40%), Crested wheatgrass (20%), and Alsike Clover (20%). Historically, grassy seed mixes were used as a reclamation tool to quickly restore vegetation cover on sites. However, these seed mixes have proven to be challenging on boreal sites as the grasses compete with and hinder the establishment of desirable native species (i.e., trees and shrubs). In 2016, a research field study was started in collaboration with the Canadian Forestry Service to help evaluate treatments and techniques to promote the recovery of native species and trees on the site. A range of mechanical and chemical site preparation treatments were tested on the establishment and growth of tree and shrub seedlings. Learnings from this site were then incorporated into two new field studies established in 2019 (J10 and P3).

Historic Photo (2016)

Current Photo (June 2024)

TREATMENTS

Four treatments and a control were applied to the site in the spring of 2016:

1. Non-selective herbicide (glyphosate) 1 m x 2 m spot spray followed by planting the next year, installation of a 40 cm tall tree shelter supported by a wooden stake after planting, and an additional application of glyphosate around the tree shelter if required.
2. Excavator mounding of soil (mounds 30 cm wide x 25 cm long) followed by planting.
3. Excavator mounding of soil followed by the application of glyphosate only over the mound area in the year of treatment, followed by herbicide before planting if needed.
4. High-speed soil mixing (160 cm wide x 140 cm long patches) followed by the application of glyphosate only over the mixed area in the year of treatment, followed by herbicide before planting if needed.

White spruce seedlings, green alder seedlings, and balsam poplar cuttings were planted in 2017.

Given the persistent grass and clover at D63, pre-emergent herbicide (Torpedo—flumioxazone/phyroxasulfone) along with post-emergent herbicide Roundup were applied to the 2019 trial sites (J10 and P3) to address the seed bank.

FIELD TOUR DISCUSSIONS

Unique context and challenges

This site had heavily compacted soils with limited organic material and a seed bank dominated by grasses and clover, both of which had well-established root systems. The soil conditions and competition from both non-native plants created a unique challenge for the establishment of trees and shrubs at these sites.

Key takeaways

- Participants heard that site treatment improves the survival of tree or shrub species on legacy grassy sites — particularly for regeneration of deciduous species. White spruce is more tolerant of grass competition but still benefits from site treatments.
- Researchers suggested that mounding with herbicides is currently the best treatment for reducing clover competition and increasing seedling survival and growth.

Richard Krygier, lead researcher, provided a detailed explanation on the history of the trial, the treatments and key findings. This prompted an interesting discussion on the challenges of grassy sites and for integrating these findings of this trial into operational practices.

- Researchers found that pre-emergent weed control (i.e., Torpedo) is required alongside glyphosate to deal with seed banks created from the legacy use of grassy reclamation seed mixes. This treatment was initially not applied, however, following initial observations on the effectiveness of glyphosate, NAIT and NRCan agreed that Torpedo would be beneficial on these challenging sites. NAIT and NRCan have found the Torpedo treatment is effective for approximately one and a half years after its application.
- Typically, forbs will naturally ingress. However, planting could be beneficial to expedite their establishment.
- Participants also heard that fertilizer tablets were initially placed too close to the stem of seedlings and caused some damage and mortality (observed foliage burning, especially on the alder).

Following the introduction, participants had a chance to walk around the site, get a closer look at the treatment outcomes, and share their observations with one another.

Operational considerations

The researchers noted in the field that mounding is slow and costly, therefore, they recommended the following techniques and sequence of steps to help address legacy grassy sites:

1. **Mechanical site preparation:** One year before planting, use a powered disc trencher to treat the site and create elevated planting sites. This technique creates more microsites and at a lower cost than hoe mounding. Researchers also noted that disc trenchers can also drive in a sinuous pattern rather than straight rows. This was noted as an important consideration since too much linearity when the forest regrows does not always meet desired outcomes from key stakeholders and rights holders.
2. **Wait for vegetation to appear** in the spring.
3. **Herbicide application:** Before planting, apply a non-selective pre-emergent herbicide (e.g., Torpedo) in a tank mix using a side-by-side spray with nozzles. Spraying should target the trencher mounds. Researchers also noted the herbicide spray could be attached to the trencher during site preparation to increase efficiency.
4. **Plant seedlings:**
    - **Deciduous species:** plant on top of trencher mound only.
    - **White spruce:** plant some on the trench mound but plant the majority between mounds to break up the linear planting pattern.

Herbicide with shelter and fertilizer treatment in September 2024.

Mounding with herbicide treatment in September 2024.

Publications

COSIA. 2021. COSIA Land Environmental Priority Area: 2021 Annual Mine Research Report. Report. COSIA Research Report 2021_Land Environmental Priority Area_Mining_0.pdf

COSIA. 2022. COSIA Land Environmental Priority Area: 2021 Annual Mine and In-situ Research Report.

See Appendix 6 for the site handout prepared by Richard Krygier.

SITE 2: H57 RECLAMATION CERTIFIED DRILLING SUMP

SITE HISTORY

H57 is a reclamation-certified drilling sump located 675 m southwest of the Cold Lake Caribou Range. The site is 3.2 ha large and had a pre-disturbance assessment completed in 2004 (d2 ecosite dominated by trembling aspen). The site was constructed in 2007 and was reclaimed in 2011. A reclamation certificate was issued in 2022.

Historic photo (May 2011)

Current photo (September 2024)

TREATMENTS

- Planting of various tree and shrub species to a target density of 2500 stems/ha for trees and 450 stems/ha for shrubs.
- The species planted included white spruce (3240 stems), trembling aspen (1980 stems), balsam poplar (1896 stems), white birch (900 stems), green alder (360 stems), willow spp. (360 stems), red osier dogwood (360 stems), pin cherry (180 stems), and saskatoon (175 stems).
- Two handpicking attempts were made to control for Canada thistle and perennial sow thistle after they were observed during a 2019 site visit. Since both woody and herbaceous species were thriving at the site it was determined these weeds were not impeding desired vegetation growth and a justification request was made.

FIELD TOUR DISCUSSIONS

Unique context and challenges

The site was reclaimed in 2011 and a reclamation certificate was issued in 2022. The field tour participants discussed potential opportunities and risks at this site. For example, some participants raised the prospect that if a site was planted, but failed a Phase 1 assessment, that would mean potentially having to remove 12 years of forest growth to complete a Phase 2 assessment. This was not required on this site but the risk/reward was a key topic of discussion.

Lori Neufeld, lead expert from Imperial, provided a detailed explanation on the history of the site, the treatments, process for taking this site to closure and challenges and opportunities for similar sites.

Key takeaways

- Overall, field participants were impressed about the rapid rate of forest re-establishment on the reclamation site and saw the site as a great example of rapidly and successfully re-establishing a forest environment.
- Imperial was able to take this sump to closure sooner than other sumps because of its link to an (OSE) well, which facilitated earlier reclamation certification. It was certified under the upstream Oil & Gas reclamation certification process.
- No grass was seeded at this site. Instead, a diversity of trees and shrubs were planted coarse wood material was used and weeds were hand-picked to protect desirable species.
- It was noted that desirable vegetation (both woody and herbaceous species) is regenerating very well on this site (***see photo on right***). While weeds were initially found during the 2019 site visit, they did not appear to be interfering with tree and shrub growth after the handpicking efforts.
- Like many sites, there is considerable history and timelines associated with transitions from construction to reclamation, to certification. The participants discussed potential challenges in managing this data across time and across service providers.

Particpants were encouraged to explore the site and observe the dense vegetation growth.

Operational considerations

- Handpicking weeds was a successful form of weed control on this site (instead of herbicide application) and enabled the protection of desirable species that were establishing on the site. This can lead to a diverse and vibrant recovery of trees and shrubs.
- Opportunities exist for planting a diversity of trees and shrubs, rather than grass, on a site to support vegetation re-growth and forest regeneration.

SITE 3: H38 WETLAND RECLAMATION TRIAL (NAIT RESEARCH)

SITE HISTORY

H38 Pad was constructed in 2002 in a treed rich fen that had an average peat depth of 148 cm. 38,800 m3 of borrow was required to construct the pad. Due to reservoir issues encountered during drilling, CSS operations could not proceed so the site was selected as the candidate for a research proposal.

In 2004, Imperial received a new EPEA approval that required the submission of a proposal for a wetland reclamation trial. Phase 1 of the wetland reclamation trial began in March 2008, when 6700 m3 of clay and the geotextile liner were removed. Removed clay was laid out to dry and used as backfill for a nearby remediation project. Phase 2 (November 2009) used a modified approach where the pad was partially removed to just below the seasonal low water table (2400 m3).

In 2017, NAIT, University of Waterloo, and Laval University were engaged in research after the civil work was completed. The research study aimed to assess various restoration techniques for oil sand well-sites constructed on peatlands with two key goals:

- Restore the vegetation community structure to meet provincial reclamation criteria and,
- Restore ecosystem function to match regional reference peatland ecosystems.

This site is part of a network of research trials conducted across Alberta's peatland region, including the CNRL Pad 15-14-65-6W4 which was visited on Day 2 of this tour.

Historic Photo (June 2009, 9 months after full pad removal)

Current Photo (June 2024)

TREATMENTS

Sections of the well-pad underwent two treatments, a control (unrestored portion of the pad) and a reference (adjacent, undisturbed peatland):

- Complete removal (CR) in spring 2008 which included the complete excavation of the mineral soil fill and geotextile liner. Because of the high amount of peat compression during the initial well-site construction, up to four meters of fill was removed causing a deep depression that flooded.
- Partial removal (PR) in fall 2009 which involved scraping the surface mineral fill down to the level of the adjacent peatland to limit flooding. Two levels of partial removal were completed:
  - Levelling the surface to match the adjacent peatlands to connect its water table level (0 m), and
  - Levelling the surface with the even ground.

No planting or weed control was done at the site.

Aerial view of the site and its treatments.

FIELD TOUR DISCUSSIONS

Unique context and challenges

The H38 pad is surrounded by a moderately rich shrubby fen in the north and a wooded larch swamp/fen on the southwest side (***see photo on right***).

The fen was deep and required considerable amounts of fill material. Due to the amount of fill used to construct the well-pad, the layers of peat underneath were extremely compressed.

Bin Xu, lead researcher, described this effect using the analogy of the fill acting like adding a brick to brownie batter—the fill caused the peat to compress and squish out from underneath and the fill to sink.

The background of this photo shows a moderately rich shrubby fen to the north of the site, with partial removal in the foreground.

Key Takeaways

- Researchers from NAIT shared that partial removal of mineral fill can lead to the formation of a peat-accumulating community when the water table is maintained near the surface. This is like the process known as “paludification”, which is a common pathway for peatland formation on vegetated mineral substrates. For this study, this process took 7 to 9 years.

Complete pad removal which did not meet the Peatland Reclamation Criteria in 2018.

- Participants heard that the PR-E area (shown in yellow on the map) met the Peatland Reclamation Criteria in 2018. However, the complete pad removal (***CR grid 3 and photo to right***) resulted in the accumulation of water, creating a pond. Because of the open water, this area of the site did not meet the Peatland Reclamation Criteria in 2018.
- Participants learned that fen vegetation can tolerate the elevated nutrient and pH of the remnant fill, and that maintaining a relatively stable water table near the ground surface is crucial to support fen vegetation development. Excessively wet (CR) or dry (Control) conditions are not suitable for peat-forming system development.
- Researchers also shared that greenhouse gas dynamics and carbon balance were monitored at this site. The results show the reintroduction and growth of sedges, shrubs, and true mosses enhances carbon uptake in the restored sections, resulting in a seasonal carbon balance like the reference peatland. However, the complete removal of fill material resulted in a large release of carbon dioxide (CO_2) and methan (CH_4). The unrestored section had low CH_4 emissions but remained a source of CO_2. Sections with remaining mineral fill exhibited higher pore water electrical conductivity but had a comparable pH to the reference peatlands. Restored areas showed lower concentrations of dissolved organic carbon due to incomplete vegetation recovery and lower organic matter content in the underlying mineral fill. In the future, this site is expected to become a greater carbon sink over time.
- Field tour participants heard that findings from this study are encouraging, but they are limited by the scale and location of the specific well pad studied. Future trials should explore partial pad removal and revegetation (natural regeneration, planting, donor moss transfer) methods over more sites in different areas.

Operational Considerations

- The discussion about this study and site suggests that partial removal of fill material on peatland pads is desirable, compared to the complete removal of fill material, when the surrounding peatlands are a moderate to extreme rich fen with a high water table and abundant flow. This means that sites situated in drier peatlands (e.g. bogs) may require a different approach).
- Researchers suggested that when removing fill, use the surrounding undisturbed peatland’s water table as the lowest point for fill removal and setting the final elevation target. Although removing too much fill is not desirable and can result in the accumulation of water (i.e., creating a pond) that stagnates recovery, it is also not desirable to leave a site high and dry.
- Establishing good hydrological connectivity is critical for long-term success. Any barriers between reclaimed pads and surrounding peatlands should be removed to allow water flow, soil saturation, and ingress of propagules.
- If the correct moisture balance is achieved within the site, weed control may not be necessary as the native vegetation will regenerate. Planting of desirable species and moss transfers may accelerate this process.

Publications

Lemmer M, Xu B, Strack M, Rochefort L (2023) Reestablishment of peatland vegetation following surface leveling of decommissioned in situ oil mining infrastructures. Restoration Ecology 31

Lemmer M, Rochefort L, Strack M (2020) Greenhouse Gas Emissions Dynamics in Restored Fens After In-Situ Oil Sands Well Pad Disturbances of Canadian Boreal Peatlands. Frontiers in Earth Science 8

See Appendix 6 for the site handout prepared by Bin Xu.

SITE 4: BORROW Y EAST

SITE HISTORY

Borrow Y East is a borrow pit in the Cold Lake Caribou Range. It was constructed in 2013 to provide material for the N07 and N08 Pads and reclaimed in 2016. This end pit lake site has an average water depth of 2.7 m (fall 2023). Application for a reclamation certification is delayed due to trace levels of weeds, especially along the roadside and north end of the site.

Historic Photo (June 2016)

Current Photo (June 2024)

TREATMENTS

Coarse woody material was applied and spread throughout the site (***see bottom right photo***).

Trees and shrubs were planted based on target ecosites:

- Ecosite d2/e2 (2.8 ha): 11,900 trees (4000 stems/ha) and 3420 shrubs (1000 stems/ha) including white spruce, aspen, balsam poplar, green alder, Bebb's willow, pussy willow, red osier dogwood, pin cherry, prickly rose, and Canada buffaloberry.
- Ecosite j/k (0.5 ha): 720 trees (1200 stems/ha) and 560 shrubs (900 stems/ha).

Chemical weed management (***see bottom left photo)*** was conducted in 2023 (Clearview).

Spot application of herbicide is shown in blue.

Coarse woody material with a planted white spruce seedling in the background (September 2024).

FIELD TOUR DISCUSSION

Unique site context and challenges

Participants discussed that since this site is within the woodland caribou range, there are ever-evolving requirements for borrow pit sites that can be challenging. The vegetation on site is establishing well and the dominant species present are deciduous. Several conifers, like white spruce, are beginning to establish in the understory (***see photo to the right***). However, with evolving requirements through sub-regional planning participants discussed that this may mean future sites like this have different requirements than current reclamation targets.

Key Takeaways

- Participants discussed the importance of tracking a site's footprint over time to ensure that environmental consultants are aware of its entire planting and reclamation history. This helps to avoid duplication of work.
- Imperial noted the value in encouraging environmental practitioners to take alternative approaches to weed management versus applying herbicides on sites where desirable species are thriving. Staff shared that highly targeted herbicide use was implemented on this site, leaving other areas to regenerate quickly.
- Requirements for reclaiming borrow pits are ever-evolving, especially within caribou ranges. There are regulatory closure considerations for borrow pits reclaimed prior to the Guide to Water Authorizations Required for Dugouts, Borrow Pits and other types of pits/excavations, Guidelines for End Land Use Planning for Reclaiming Borrow Supporting Energy Activities on Public Lands (alberta.ca) and certification, and the Cold Lake Sub-Regional Plan coming into effect.
- It was also noted during the discussion that there has been evidence of beaver activity at this site, with a beaver lodge present within the end pit lake. This shows that in some cases, end pit lakes may add habitat diversity to a reclamation site, supporting various wetland species including beavers.

The edge of the beaver lodge can be seen on the left side of the photo.

Operational Considerations

- Consider alternative solutions to herbicide use for weed control, especially when desirable species are already present and establishing.
- While the deciduous growth is considerable on this site, participants discussed whether alternative planting prescriptions (i.e., prescriptions to support faster conifer establishment and growth) be used to achieve biodiversity and caribou goals and requirements under the sub-regional planning.

SITE 5: BORROW Y WEST

SITE HISTORY

Borrow Y West is a borrow pit located in the Cold Lake Caribou Range. It shares a Mineral Surface Lease with Borrow Y East. A pre-disturbance assessment (PDA) and Conservation and Reclamation Plan were completed in 2010 (dominant ecosites were c1 and k2), the site was constructed in 2013 and reclaimed in 2014. Reclamation monitoring was conducted in 2014 to assess soil and landscape condition and again in 2015 to assess vegetation. Trace levels of Canada thistle and perennial sow thistle were noted during the 2015 monitoring. A Detailed Site Assessment (Record of Observation Tool) was completed in 2022. A reclamation certificate application has been drafted and will be submitted by the end of the 2024 year.

Historic Photo (May 2014)

Current Photo (June 2024)

TREATMENTS

- Target reclamation ecosites include g1 (2.2 ha) and water (0.5 ha).
- Target planting of 4500 trees (1800 stems/ha) and 1080 shrubs (500 stems/ha) including black spruce, white birch, Jack pine, Bebb's willow, pussy willow, sandbar willow, and prickly rose.

FIELD TOUR DISCUSSIONS

Key Takeaways

- Participants discussed that stockpiles of topsoil and subsoil are currently present at this site and will need to be accessed at some point in the future. This raises the question of planning future access needs when a site is reclaimed.
- Participants noted that trees on this site were growing well. There was a much higher proportion of established conifer species at this site and lower presence of deciduous regeneration (see photo below), compared to Borrow Y east that was visited previously on the tour.

Photo from September 2024 showing the diversity of coniferous and deciduous species present on the site.

- The number of conifers at this site prompted a discussion about caribou biophysical habitat and how planting prescriptions could be adjusted at future sites to anticipate the needs of caribou range planning. Participants discussed that having a higher presence of conifer is more likely to achieve caribou biophysical habitat and is anticipated to better align to emerging guidance in caribou sub-regional plans. The group also discussed challenges if a site only has conifer species and the challenges with too much focus on management towards a single species.

Healthy black spruce seedling present at the site.

SITE 6: RECLAMATION CERTIFIED BORROW X

SITE HISTORY

Borrow X is a 3.74 ha site in the Cold Lake Caribou Range which provided material for the construction of the N07 access road and N08 pad. The pre-disturbance assessment was completed in 2009, and the site was constructed in 2013. After reclamation in 2014, monitoring was conducted in 2015 to assess the vegetation growth, soils, and landscape conditions. A Detailed Site Assessment (DSA) was completed in 2022, and the reclamation certificate was issued in June of 2024.

Historic Photo (May 2014)

Current Photo (September 2024)

TREATMENTS

- Target planting of 5940 trees (1700 stems/ha) and 1800 shrubs (500 stems/ha) including black spruce, Jack pine, green alder, Bebb's willow, and sandbar willow.
- Several large boulders were placed within the site to limit re-disturbance from recreational vehicles (***see photo on right***).

Site photo (June 2024)

FIELD DISCUSSIONS

Unique site context

Borrow X is the first EPEA reclamation certificate applied for by Imperial. The application involved pulling together the entire Conservation and Reclamation history for the site in accordance with the Checklist for Preparing a Complete Reclamation Certificate Application for EPEA Approved Activities (Alberta Energy Regulator [AER] 2019). Staff shared there were good records of this site which helped compile the site's history.

Participants also heard that this site had no weeds at the time of the DSA despite having no history of weed control.

Imperial staff also shared that an Indigenous perspectives section was included in the reclamation certificate application. This section gave recognition that the site is on Treaty 6 traditional lands and created space for the Cold Lake First Nations to incorporate their perspectives of the site.

Key Takeaways

- Incorporating Indigenous input into the reclamation certificate application added additional time and resulted in a more fulsome application.
- The site showed considerable growth of jack pine (***see photo below on left***) and already had a developing layer of lichens in the understory (***see photo below on right***). The group discussed how the site already has many characteristics that resemble caribou habitat, from a western science perspective, and that it is on a positive trajectory to creating a pine/lichen dominated forest.

Jackpine-dominant overstory, with other species including white spruce, tamarack, and buffalo berry.

Reindeer lichen surrounded by bearberry.

- The group discussed the rapid reclamation of this site – only one year following construction and identified these turnaround timelines likely contributed to the rapid re-growth and forest development on the site. The site also had lower levels of soil handling which may have contributed to the successful outcomes observed.
- Participants also visited the forest adjacent to the site and shared ideas and observations around what constitutes desirable habitat for caribou, and how reclaimed sites interact with adjacent forests. There was recognition among participants about the growing importance of reclamation teams considering caribou biophysical habitat as they reclaim sites within caribou ranges.

SITE 7: N09/10 BORROW

SITE HISTORY

The N09/N10 site is a 14.57 ha borrow pit in the Cold Lake Caribou Range. It was cleared in 2013, and soil was salvaged in 2016. Reclamation began in 2022 with the goal of creating a mixed landscape containing upland areas, riparian zones, and a water body.

This site is at its early stages of reclamation and will continue to be monitored and managed until it is ready for a reclamation application.

Site photo (June 2024)

Site photo (September 2024)

TREATMENTS

This site received reclamation treatments in two phases. In 2022, the first half of the site (5.4ha) received soil placement and tree/shrub planting based on target ecosites:

- Target ecosite d2/d3 (3.4 ha): Target planting of 10 350 trees (3000 stems/ha) and 2520 shrubs (700 stems/ha). Planted species included white spruce, balsam poplar, white birch, green alder, Bebb's willow, red-osier dogwood, chokecherry, and prickly rose.
- Target ecosite g, j/k (2.0 ha): Target planting of 3600 trees (1800 stems/ha) and 1440 shrubs (700 stems/ha). Planted species included black spruce, balsam poplar, larch, white birch, Bebb's willow, sandbar willow, and dwarf birch.

In 2024, the rest of the site had soils placed (3.2 ha), and trees/shrubs were planted based on target ecosites:

- Target ecosite d2/d3 (3.4 ha): Target planting of 6600 trees (3000 stems/ha) and 1620 shrubs (700 stems/ha). Planted species included white spruce, aspen poplar, balsam poplar, white birch, green alder, Bebb's willow, red-osier dogwood, rose, and buffaloberry.
- Target ecosite g, j/k (2.0 ha): Target planting of 3600 trees (1800 stems/ha) and 1440 shrubs (700 stems/ha). Planted species included black spruce, larch, jack pine, Bebb's willow, sandbar willow, and rose.

Degraded coarse woody material left over from the site's construction was distributed throughout the site.

FIELD TOUR DISCUSSIONS

Unique context and challenges

Prior to treatments, the site contained large amounts of degraded coarse woody material, which raised the question of how to best manage it in the short- and long-term (i.e., stockpiling the woody materials separately or within the topsoil stockpile). Participants also noted many weeds present on the site which will be addressed throughout the coming years.

Key Takeaways

- Overall, participants noted the planted trees are surviving well, and site diversity is currently being achieved in both higher and lower elevation (***see photos below***).

Planted aspen poplar seedling establishing in a higher elevation area of the site.

Cattails growing within the waterbody in a lower-elevation portion of the site that received treatments in the second phase.

- Imperial staff shared that when dealing with coarse woody material, it is important to consider its short- and long-term and associated implications. Participants discussed that stockpiling coarse woody material can be a fire hazard and integrating it within the topsoil stockpiles reduces the fire hazard risk. When the topsoil and coarse woody material is then distributed it can create microsites that support vegetation establishment (***see photo on right***).
- Participants discussed that natural regeneration can act as an effective form of weed control since it occupies available microsites and creates competition. Appropriately stockpiled soils and rapid reclamation can help enable natural regeneration to flourish.
- Planting contractors also shared that planting of the site proved challenging to identify the appropriate species. The borrow pit design had anticipated much higher volumes of water on the site than are currently observed. This resulted in an increase in the trees required and a change in species planting locations to match the current water levels on site. Participants discussed that these changes can create challenges and require a need for adaptability to changing conditions.

Planted black spruce seedling growing in a microsite created by the coarse woody material.

DAY 2: CNRL WOLF LAKE OPERATIONS SITES

On the second day of the tour, participants visited three sites at CNRL Wolf Lake Operations that covered key topics including considerations for:

- Watercourse crossing removal,
- Addressing untreated sites with natural regeneration, and
- Wetland reclamation techniques to reclaim peatland function including comparisons with site H38 visited on Day

Here we provide a summary of the sites that were visited and key themes from the field conversations.

SITE 8: Q1 PAD/CULVERT AND ROAD REMOVAL SITE

SITE HISTORY

Q1 pad was a Cyclic Steam Stimulation (CSS) thermal production well built in 1982-1984. The well produced from the Clearwater Formation from 1986 to 1998 and was later abandoned in 2010. The site was decommissioned in 2012, and facilities removal and remediation work began in 2014-2016. The site remained remediated until the watercourse crossing beside the pad was reviewed in 2022. Due to the high costs required to fix the crossing, the decision was made to complete reclamation of Q1 fully and remove both the culvert, pad and road. The site has not yet received reclamation certification.

Historic Photo (May 2019)

TREATMENTS

Road and culvert removal: In the spring of 2022, Woodlands North Inc. completed a fish survey and salvage on the stream before the remaining fill material (clay and gravel) and culverts were removed. To isolate stream flow and divert water around the crossing area, a combination of 6” pumps and aqua dams (gravity bypass system) were installed on each side of the crossing. The gravity bypass system consisted of directing water to one culvert with a silt barrier and then removing the other culvert.

The trench created from the first culvert removal was used to direct the water while the second culvert was removed.

In September 2022, willows were transplanted to help restore the vegetation, along the stream bank (***see rightside photo below***).

In the early summer of 2022, white spruce seedlings were planted throughout Q1 pad.

Excavator removing road fill material in spring 2022.

Transplanted willow two years after transplanting efforts.

FIELD TOUR DISCUSSIONS

Unique context and challenges

Participants heard that prior to the road and culvert removal, the site contained fish-bearing habitat that was negatively impacted by two damaged culverts. Water was pooling due to the undersized and damaged culverts. Bank slumping at the inlet and hanging culverts were causing erosion and posed a high risk of washing out. To optimize the restoration, a pad reclamation was completed at the same time as the crossing removal. This provided a key opportunity to use large amounts of fill to re-grade contours on the pad site.

Participants also heard that timing was tricky and planning the road and culvert removal presented several challenges. When the crossing removal was undertaken the spring melt had already begun, resulting in a high volume of water and significant fluctuations in water levels throughout the day. This required considerable flexibility and problem-solving at the time of removal.

Key Takeaways

- Participants heard that overall, the road and culvert removal, and pad reclamation were successful, and the project helped restore 218.5 kilometres of viable upstream fish habitat. One of the highest-ranked priority crossings in the project area.
- CNRL contractors shared that the decision to remove the crossing rather than restore it was cost-effective because it allowed both the creek restoration and pad reclamation to be completed simultaneously using the same equipment. This also provided an opportunity to use the considerable volume of fill material from the road to recontour the reclaimed pad site.
- Participants also noted that clover growth was considerable on the site and planted seedlings at Q1 pad are experiencing high mortality (80-90% mortality). For future sites, CNRL contractors noted that finding strategies to manage a clover-dominated seed bank is critical to support the survival and establishment of planted seedlings.

Photo from June 2024 showing the restored watercourse and stream bank.

A planted white spruce seedling surrounded by competing clover cover.

Operational Considerations

- Participants discussed that removing and reclaiming roads that are no longer used can reduce liability and ecological risks. Unused roads can wash out, creating sediment build-up, and damaging watercourses and important fish habitats.
- Contractors advised that for watercourses with high daily and seasonal water fluctuations, consider planning removal/restoration efforts for the fall season when water levels are lower and more predictable (October/ November).
- Contractors also noted that identifying priority crossings that can significantly increase the availability of fish habitat and help merge reclamation efforts with other company priorities creates cost and logistical efficiencies. Developing these tools in advance of when they are specifically need can aid in strategic decision making and making the greatest gains for the dollars invested.
- CNRL staff also noted that road removals often involve considerable amounts of fill material that must be redistributed. Thinking about how to transport this material to other locations can reduce the need for additional borrow pits. In the case of this site, CNRL shared they use the road fill on numerous other reclamation and construction projects, reducing the need for more borrow pits.
- Last, participants heard that the Alberta Watercourse Crossing Collaborative (AWC3), has created a guidebook that can be used to leverage known best practices for both the installation and removal of watercourse crossings. A link to this resource is included in Appendix 3: List of Existing Guidebooks to Support Reclamation of this report.

Bruce Nielsen from Woodlands North Inc. discussed how this site is one example of many watercourse crossings in Alberta that should be addressed to reduce liability and improve habitat connectivity.

SITE 9: 9-12 SUMP

SITE HISTORY

This sump site has limited site history and appears to be from around 1981. Although it was excavated, it was likely unused.

TREATMENTS

No known treatments, natural regeneration only.

FIELD TOUR DISCUSSIONS

Unique context and challenges

This site provides a good example of a site that has been left to regenerate naturally. The access road has grown over and trees and forbs are both present despite a lack of topsoil. A mixture of coniferous and deciduous vegetation is growing well across most of the site, with most growing in the shallower pit on the west side.

View facing along the ridge separating the two pits with the shallower pit (west side) on the left with much denser natural regeneration.

View into the deeper pit (east side) with less dense natural regeneration.

No trees are growing on the ridge separating the two pits and a large soil pile was left on the east side of the site (***see photo on right)***.

A group of participants standing on top of the large soil pile.

Key Takeaways

- Participants discussed whether there are opportunities to leverage natural regeneration, and trade-offs associated with reclaiming sites that already have considerable regeneration.
- The group discussed whether a site like this, with significant natural regeneration and the redevelopment of a forest, should undergo reclamation (i.e., be re-disturbed to place topsoil and recontour the site), or how reclamation should be approached given the amount and age of natural regeneration.

SITE 10: 15-14-65-6W4 (FULL WELL PAD REMOVAL)

SITE HISTORY

The study site was a conventional drilling pad situated within a treed poor fen. The pad was built in 1997 using fill from a borrow pit approximately 100 m west of the study site. The pad consisted of approximately 1.5 m of clay-loam fill with moderate salinity deposited over corduroy constructed from on-site woody debris placed directly on the fen surface.

This CNRL Pad had the fill removed in November of 2010 and revegetation occurred in the spring of 2012.

Historic Photo (2010)

Current Photo (June 2024)

TREATMENTS

Most of the fill was removed (to the level of the water table) in November 2010 using a track hoe, leaving approximately 10 cm of fill across the site. The removed fill was returned to the borrow pit.

In the winter, once the remaining fill was frozen and could support equipment, two track hoes were used to “mound” the surface, bringing buried peat to the surface (an inversion in place) and incorporating the remaining fill underneath. This resulted in a very rough (up to 1 m relief) surface with patches of exposed peat and thin fill across the site.

Treatment blocks (40m x 40m) tested:

- Smooth and rough surface treatments
- Application of straw mulch
- Transplants of live peat material
- Transplants of black spruce, labrador tea, and sedge onto four different micro-topographic positions (top/middle/low on rough plots and high ground on smooth plots).

FIELD TOUR DISCUSSION

Unique context and challenges

The restoration design of this site informed a graduate thesis (2014) aimed at determining the success of different revegetation techniques. The results of this project can be compared to Imperial's H38 Wetland Trial site to obtain a broader understanding of pad recovery on a fen ecosite.

The site was reclamation certified in November of 2023 after the period of reclamation research.

Key takeaways

- Participants learned that water availability regulated species recovery at all locations in the study. After two years, all treatments remained highly dissimilar the adjacent undisturbed fens.
- Researchers shared that black spruce survival was greater overall on smooth treatments, but on the rough treatment (***see photo on right***) black spruce survival was best at the top and middle of the rough (mounded) treatments
- Researchers also shared that over time, moss cover, and depth have increased, and the moss transfers appeared to enhance moss establishment where applied.

Bin Xu, lead researcher pointing out one of the mounds with a black spruce planted at the top.

Particpants sharing observations on moss establishment at the site.

- Participants discussed that like Imperial's H38 Wetland Trial site, understanding the regional context (i.e., terrain, elevation, and water table level) and achieving the correct balance of water flow is key to supporting peatland vegetation recovery. If you get the hydrology right, weed control likely is not necessary.
- Participants also divided into two groups, one group looked at recovery within the site, another group observed the recovery from an adjacent road. Participants viewing the pad reclamation from a distance noted the considerable recovery on the reclaimed site and found it difficult to clearly delineate where the pad had previously been. Participants celebrated the pad as an example of strong reclamation within a difficult ecosite.
- Similar to H38, this site is surrounded by fens with a large amount of water flow. Therefore, the outcomes of these treatments would be different in other types of wetlands, like bogs. Research across a range of wetland types is needed to capture these differences.

Operational considerations

- Participants discussed that in the absence of direct or active drainage, roughening the mineral substrate surface should be considered. This can increase microsite variability and aid in the reclamation of peatland vegetation. If available, the excavated mineral surface should be capped with stockpiled peat or similar organic matter to provide an organic substrate for peatland plant (especially moss) establishment. Using such an approach was observed to help accelerate recovery of peatland characteristics on the reclamation site.
- Researchers noted the peat cap should be deep enough to provide some buffering capacity from the mineral soil chemistry, and to have a moderating effect on water table fluctuations. The surface can then be revegetated with the peat fragment transfer technique, planting of appropriate peatland vegetation, or both.

Terry Osko, lead researcher, explaining the site history, treatmnets and operational implications.

View of the site with particpants in the background taking a closer look at the treatments.

Publications

Shunina, A. 2014. Revegetation of Fen Peatlands Following Oil and Gas Extraction in Northern Alberta. MSc. Thesis. Department of Agricultural, Food and Nutritional Science. University of Alberta.

Shunina, A., Osko, T. J., Foote, L., and Bork, E. W. 2016. Comparison of site preparation and revegetation strategies within a sphagnum-dominated peatland following removal of an oil well pad.Ecol. Restor. 34(3): 225–235. University of Wisconsin Press. doi:10.3368/er.34.3.225.

See Appendix 6 for the site handout prepared by Terry Osko and Bin Xu.

DAY 2 AFTERNOON WORKSHOP: PRESENTATION AND FACILITATED DISCUSSION ON KEY LEARNINGS, CHALLENGES, AND OPPORTUNITIES

To help synthesize and identify key learnings from the field tour, participants met for a half-day workshop in Bonnyville, AB. The first portion of the workshop included a presentation from the Alberta Energy Regulator (AER) about the use of remote sensing in reclamation inquiries. The workshop facilitator then hosted an interactive activity to help participants identify the top five topics/learnings they wanted to discuss following the field tour. Breakout groups were then used to identify specific ways in which learnings from the field tour could be actioned within organizations. The following section summarizes both the presentation and the results of the breakout discussions.

PRESENTATION: USE OF REMOTE SENSING IN RECLAMATION INQUIRIES BY NADIA CRUIKSHANK (SR. RECLAMATION SPECIALIST WITH THE ALBERTA ENERGY REGULATOR)

Reclamation inquiries are a required step in the reclamation certification process for AEPA approved dispositions in Alberta. The inquiry process verifies the data and outcomes that applicants include in their reclamation applications. The Alberta Energy Regulator (AER) is currently trialing the use of remote sensing as part of the inquiry process. Determining which sites can be assessed using remote sensing considers several site factors:

- Remote location and/or difficult logistics
- Minimum disturbance, winter construction
- Site size (works best for smaller sites, ~1.5 ha)
- Site complexity.

Nadia Cruikshank (AER) taking questions following her presentation.

An Earth Engine App created by the Alberta Geological Survey for the AER is used to visualize the imagery captured by annual mid-summer Landsat composite imagery and produce time-series vegetation plots using:

- Normalized Difference Moisture Index (NDMI) or Normalized Burn Ratio (NBR) which indicates leaf moisture content and internal leaf structure.
- Normalized Difference Vegetation Index (NDVI) which indicates pigmentation and internal leaf structure.

This information can provide time-series data that shows the pre-disturbance site conditions and progress of the site post-reclamation providing an indication of vegetation cover, canopy density, (etc.) over time.

While remote sensing presents many opportunities for increasing the efficiency of inquiries, the technology used by the AER has several limitations:

- Cannot detect or provide information on soils.
- Cannot distinguish vegetation types at the species level (i.e., young trees may be identified as shrubs in the Land Cover Classification)
- Cannot identify noxious/prohibited weeds.
- Is limited by pixel size.

Therefore, ground truthing is still conducted as part of the inquiry to collect this information.

Since remote sensing is not limited by growing seasons, safety concerns, or ground-access resources and logistics, it can be an efficient and cost-effective tool that can support reclamation inquiries and decision-making. It can also assess reclamation trends over time resulting in more accurate interpretation of the site's trajectory. At this time, these tools (i.e., AER's Earth Engine App) are not available beyond the AER.

Following the presentation, it was noted that communication is key when discussing the use of remote sensing for reclamation inquiries. In particular, when discussing with Indigenous communities who may be less familiar with the tool, it is important to be clear about what is captured (i.e., vegetation) and what is not (i.e., soils, contaminant aspects) by the technology.

FACILITATED ACTIVITY AND DISCUSSION

Following the presentation, the event facilitator invited participants to engage in an activity to capture key learnings from the tour. The key question that was asked was:
"If you were to fully leverage your learnings from the tour, what would you bring back to your team, to implement or be aware of?"

Using a dynamic facilitation method called 25/10, each participant wrote their answer on a cue card and then had the opportunity to rank each other's answers. The top answers that emerged from this exercise were:

- The variety of potential wetland reclamation techniques that are available and how surrounding environments impact the success of these techniques. Develop a guidebook to capture this knowledge.
- Longer-term consideration for where to put borrow material at time of reclamation (i.e., CNRL road/ culvert removal). Importance of knowledge sharing and developing best management practices among industry/ government.

Matthew Pyper (Fuse Consulting Ltd.) leading the group through the first portion of the 25/10 exercise.

- Develop a peatland reclamation guidance book much like the previous ones done for Faster Forests.
- For peatland pad sites, achieving the right surface elevation is key to get the water table level just at the surface.
- Compare/contrast reclamation certificate requirements vs. caribou habitat restoration.
- Need to continue integrating and building connections between teams (i.e., field coordinators, corporate teams, academics, policy makers, regulators). Share learnings, successes, and failures.
- Planning needs to involve all stakeholders.
- Leaving a site to regenerate naturally is much better than quickly and cheaply making it green (grass). If it's not going to be done thoughtfully, don't do it at all.
- Industry and different companies share similar issues and there should be more collaboration among the companies to tackle these issues more efficiently and effectively.

Particpants wrote down their answers, then swapped cards with one another to rank each others answers from one to five (five being of highest priority to discuss).

Please see the Appendix 8 for a full list of all the key learnings written by participants from the 25/10 exercise.

Answers with overlapping themes were merged to create five topics for the breakout groups. Two of the answers ("in reclamation, planning is key" and "planning needs to involve all stakeholders") were not made into a breakout group but were decided to function as overarching themes for the breakout discussion. Participants selected a breakout group of their choice and were asked to discuss the following three questions: Why is this learning/practice important? How could it be integrated? What is a first step? The topics and key discussion points for the five break-out discussions were:

1. Placement of borrow material: Longer-term consideration for where to put borrow material at the time of reclamation (i.e., CNRL road/culvert removal)

The group emphasized the need to incorporate where to put borrow material during a site's reclamation into long-term reclamation planning. This can be more cost-efficient in the long-term and will help reclamation be more holistic. To integrate this, the group identified that borrow material is important and should be considered a reclamation material. The group identified several first steps needed to implement this:

- Amend Specified Enactment Directive 001 (SED 001) to require companies to track the volume of borrow used in road and pad construction.
- Incorporate borrow material balances into Project Level Closure and Reclamation Plan (PLCRCP)
- Understand borrow requirements for backfilling remedial excavations.
- Understand key watercourse crossings that need to be removed.

Group 1 capturing key thoughts around borrow material palcement during reclamtion.

2. Wetland reclamation techniques: Develop a guidebook that captures the variety of potential wetland reclamation techniques that are available and how surrounding environments impact the success of these techniques.

Given the current and ongoing research on wetland reclamation, the group expressed the need for better communication between researchers and end-users, like reclamation practitioners, to implement and scale-up these learnings. They identified that creating a guidebook focused on peatland reclamation, similar to the ones created for Faster Forests and the Alberta Watercourse Crossing Collaborative (see Appendix 3), to capture current knowledge and recommended techniques would help bridge this gap. Research on peatland reclamation is still in its early stages, therefore the guidebook should be a living document framed as a "State of Knowledge" (rather than "Best Management Practices"). The guidebook should use simple, but precise language supplemented with visuals and diagrams and could eventually be supported by a virtual tour. To implement this, the group identified the need for a champion to initiate this project as a first step, like COSIA or iFROG.

3. Knowledge sharing: Importance of knowledge sharing and developing best management practices among groups (i.e., field coordinators, corporate teams, academics, policymakers, and regulators). Industry/ different companies share similar issues and there should be more collaboration among the companies to tackle these issues more efficiently and effectively.

The group identified that improved knowledge sharing is needed to move work forward, reduce research redundancies, help resolve contradictions between regulations (i.e., caribou requirements), and inform policy/decision-making. They noted a lack of effective communication about existing research and information materials (i.e., best management practices, guidebooks, etc.). For example, while a lot of research is being conducted, it does not always reach the right

people and therefore gets duplicated. Furthermore, this work needs to be more effectively communicated to equipment operators who are implementing this work on the ground. The group noted that knowledge sharing can be integrated through more in-person events (e.g., workshops, field tours, symposiums), communication materials (e.g., guidebooks, infographics), and by leveraging communities of practice and websites like the Canadian Conservation and Land Management Portal (CCLM). As a first step, the group suggested the development of a 'Wetland Task Force', focused on Alberta's Green Zone that involves various collaborators (e.g., industry, communications experts, researchers, regulators, Ducks Unlimited, COSIA, BERA, ABMI).

4. Caribou and reclamation certifications: Compare/contrast reclamation certificate requirements vs. Caribou habitat restoration.

The group identified this as a key topic since there is a lack of clarity around reclamation within a caribou sub-regional planning context. Specifically, about what needs to be achieved from a reclamation certification perspective to fulfill caribou habitat requirements (e.g., defining what "biophysical" habitat means). It was noted there is a disconnect between how reclamation practitioners/operators and the government view the landscape—individual operators focus on individual sites and project areas whereas the government looks at the larger, regional or sub-regional level. Therefore, the group identified the need for practitioners to approach reclamation with more of a macro-scale lens to consider how an individual site fits within the broader sub-regional planning context. The group suggested seeking out community feedback on desired outcomes. Since each site is unique, the group also suggested that the definition of 'biophysical' habitat should be refined to reflect the mosaic of different sites (not one-size-fits-all). As a first step, the group identified avoidance (avoid developing in caribou habitat) as key and that ultimately there needs to be more landscape-level planning of site construction and reclamation into the future. They also discussed whether incentives or regulations can help accelerate alignment between reclamation and sub-regional planning requirements.

Group 4 capturing key thoughts around reclamation certificate requirements and caribou habitat restoration.

5. Good reclamation does not need grass: Leaving a site to regenerate naturally is better than quickly and cheaply making it 'green' (planting grass). If it's not going to be done thoughtfully, don't do it at all.

The group identified that planting grass tends to hinder reclamation and tree growth, which is often a challenge on legacy sites that were reclaimed using past practices which included seeding with grass. While agronomic grass species do not count towards the herbaceous species components of the 2010 Reclamation Criteria, participants noted that grass seed mixes are still used on some sites. One suggestion was to ban or discourage the use of grass within forest reclamation sites. While grass is cheap and efficient to "green-up" a forest site, it takes significant time and resources to get trees to grow on these sites after the grass establishes, and ultimately extends the time needed to certify a site. To integrate this learning the group noted that operators need to be informed and educated, on when and when not to use grass. Limiting fertilizer and herbicide use can also be helpful since these treatments can lead to a grass explosion. In some cases, it may be best to leave a site to naturally regenerate, but this can be unpredictable and risky. Therefore, tree/shrub planting can help ensure that desirable species establish on the site. From this discussion, the group had several questions:

- What site conditions or reclamation practices are associated with good natural regeneration?
- When should we plant trees/shrubs vs. leave the site to naturally regenerate?

Closing Observations

Following the breakout discussions, the group came together to reflect on the tour and share any remaining questions or observations. Key questions and takeaways that emerged included:

- As a regulator, what should be done with grassy sites or those with lots of natural regeneration (i.e., CNRL's 9-12 Sump)? How do we determine when a site like this is on the right trajectory for closure?
- How can the learnings and practices from in-situ sites apply to mineable oil sands sites?
- How do we replicate the natural understory observed at Borrow X (jack pine dominant site) at sites with longer-term stockpiles?
- Can we accelerate collaboration between industry and government to create a unified vision for how to do things and what we know for sites that are within caribou habitat.
- Are there learnings that we can capture about the construction phase, before reclamation occurs?
- There is a need for more guidebooks and awareness about links to resources that currently exist about best management practices and current states of knowledge.
- For some sites, less is more regarding reclamation treatments.

Group 3 capturing and reflecting on opportunties for knoweldge sharing.

PARTICIPANT FEEDBACK

Following the tours, participants filled out a survey to capture their overall impression of the tour and to provide a chance for them to comment about what went well and what they would suggest for next time. Below is a summary of the key information captured from the survey.

What participants liked about this year's field tour:

Participants shared many positive comments about the organization of the tour, including the variety of sites, transportation, pacing, catering, and networking opportunities. One participant also noted they liked having a diverse group of participants which led to great conversations. Specifically, participants appreciated the number and variety of sites that were visited and noted the value of visiting sites in person to learn about key challenges and opportunities. Many commented that the wetland sites were a highlight of the tour, and feedback was positive about bringing in the subject matter experts to talk about site-specific research and learnings.

Feedback also suggests the workshop improved the experience of the tour, with one attendee sharing that the workshop breakout session helped solidify the learnings from the tour. Feedback on the tour logistics was also positive, with notes about snacks, lunches, bus operators, and scheduling receiving specific positive feedback.

The post-event feedback survey had 24 respondents out of the 41 participants, and in general, the feedback on the tour was positive. The majority of respondents indicated they were 'very satisfied' with the tour and no responses were recorded that indicated a lack of satisfaction in the event. 100% of respondents indicated they found the tour valuable, with 92% of respondents confirming that they would attend another field tour.

What participants suggested for next time:

While the feedback on the tour was overwhelmingly positive, some participants shared qualitative suggestions for improvement on subsequent tours. Two respondents provided that the subjects discussed at sites were quite technical and could be difficult to follow along without a reclamation background.

Feedback was also given for logistics adjustments, including more frequent bio breaks, better clarity on dietary restrictions, and more use of the bus time, especially when raining. One participant also shared that socializing at the Land EPA dinner was restricted by the sit-down dinner format, and that more of a mingling social hour would allow for better networking.

CONCLUSION

Overall, this 2024 COSIA Fall Field Tour generated thoughtful and dynamic conversations among the participants who came from a diverse range of professional backgrounds and expertise.

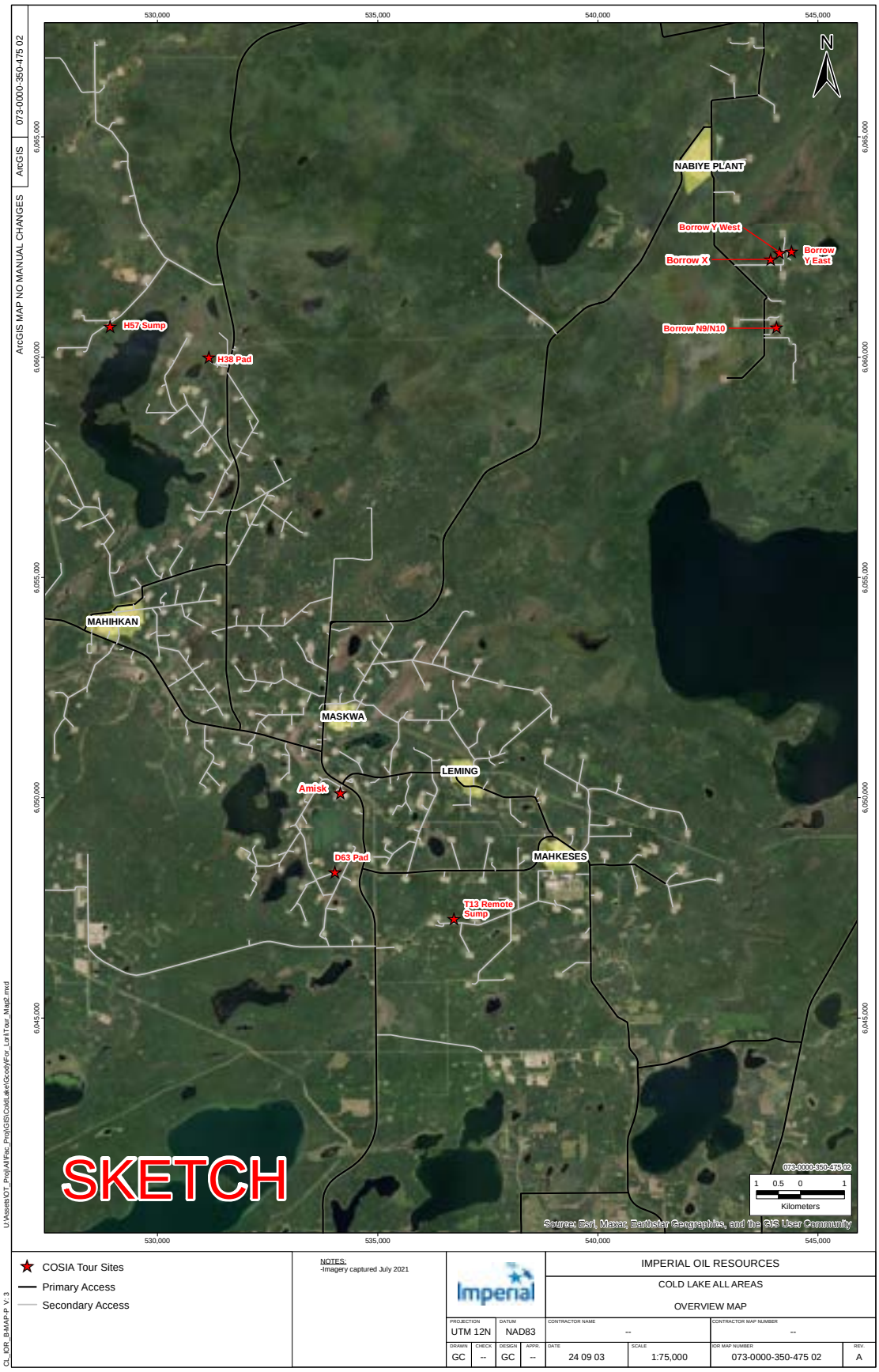
The tour provided an interesting opportunity to visit both older and newer reclamation sites. A key theme was that when good practices are used, they lead to the successful and often rapid recolonization of a site by trees and shrubs. Most sites visited had also been planted resulting in faster and more predictable forest regeneration on sites.

The tour also helped showcase that new findings related to wetland reclamation are emerging. Although practices may not be fully tested in a wide range of environments, current findings related to the amount of fill material that should be removed and opportunities to encourage the recolonization of wetland vegetation and reformation of peat were all key learnings that emerged over both days.

There was also widespread interest in existing guidebooks to support reclamation efforts and in the development of new guidebooks to aid in planning, operations, and ultimately successful reclamation practices.

We thank all the participants for joining this year's tour. Your participation and engagement are an important part of knowledge sharing and advancing progress within the field of in-situ reclamation.

APPENDIX 1: SITE MAP FOR IMPERIAL COLD LAKE OPERATIONS



APPENDIX 2: SITE MAP FOR CNRL WOLF LAKE OPERATIONS

APPENDIX 3: LIST OF EXISTING GUIDEBOOKS TO SUPPORT RECLAMATION

Alberta Watercourse Crossing Guidebook by the Alberta Watercourse Crossing Collaborative. Link to access an electronic or hardcopy version: https://www.awccc.ca/

A Visual Guide to Handling Woody Materials: https://era.library.ualberta.ca/items/1c729c9c-ce37-4197-8ee7-43089331cc30/view/1a20f746-3a7a-4a62-82a9-198d06603e58/TR-31-20--20Woody-20Materials-20Guide.pdf

Managing Woody Materials on Industrial Sites: https://era.library.ualberta.ca/items/4cf58549-d130-4540-85b7-6484b2694573/view/ed436469-4617-4057-8e6b-3d25a6204a62/WoodyDebrisFinal-Issuu.pdf

Faster Forests: A Visual Guide to Planting: Contact Terry Osko (terryosko@circletconsulting.ca) or Matthew Pyper (matthew@fuseconsulting.ca) for access.

Faster Forests: A Visual Guide to Improved Construction and Reclamation Practices on Oil Sands Exploration Sites: Contact Terry Osko (terryosko@circletconsulting.ca) or Matthew Pyper (matthew@fuseconsulting.ca) for access.

A Guide to Planting in Reclamation: https://www.cclmportal.ca/resource/guide-planting

A Guide to Mechanical Vegetation Control: https://www.cclmportal.ca/resource/guide-mechanical-vegetation-control

A Guide to Chemical and Biological Vegetation Control: https://www.cclmportal.ca/resource/guide-chemical-and-biological-vegetation-control

A Guide to Site Preparation: https://www.cclmportal.ca/resource/guide-site-preparation

Technical Notes on Upland and Peatland Reclamation and Restoration: https://www.nait.ca/applied-research/technical-resources

APPENDIX 4: FIELD TOUR ITINERARY

DAY 1 Wednesday, September 11

7:15 AM	Board Bus and Travel from Bonnyville to Imperial's Cold Lake Operations
8:15 AM	Arrive at Imperial's Cold Lake Operations — Check-In and PPE Verification, Bio Break
9:00 AM	**Site 1: D62/D63 Drilling Sump** *(Lead by: Richard Krygier and Lori Neufeld)* *Overview treatments to improve seedling establishment and early growth in reclaimed legacy grassy sites*
9:45 AM	Board bus and travel to H57 Sump
10:15 AM	**Site 2: H57 Reclamation Certified Drilling Sump** *(Lead by: Lori Neufeld)* *General discussion on opportunities for early permanent reclamation and certification of in-situ oil sands footprint; challenges with taking some sumps to closure; and contrasting revegetation practices employed in the mid-2010s with those employed in the 1990s to early 2000s*
10:45 AM	Board bus and travel to H38
11:00 AM	**Site 3: H38 Wetland Reclamation Trial** *(Lead by: Bin Xu and Lori Neufeld)* *Learnings from partial and full pad removal trials to reclaim a peatland community*
11: 45 AM	Lunch on the bus and stop at Nabiye Plant for bio break
12:30 PM	Board bus and travel to Borrow Y East
12:45 PM	**Site 4: Borrow Y East** *(Lead by: Lori Neufeld)* *Discussion on evolving requirements for end pit lakes, sub-regional planning considerations, and challenges associated with weeds.*
1:30 PM	**Site 5: Borrow Y West** *(Lead by: Lori Neufeld)* *Permanently reclaimed borrow pit in caribou range. Draft reclamation certificate application prepared*
2:00 PM	Board Bus and Travel to Borrow X
2:15 PM	**Site 6: Reclamation Certified Borrow X** *(Lead by: Lori Neufeld)* *Imperial's first reclamation certificate applied for via EPEA approval and inclusion of Indigenous perspectives in a reclamation certificate application*
2:45 PM	Board Bus and Travel to N09/10 Borrow
3:30 PM	**Site 7: N09/10 Borrow** *(Lead by: Kinzie Gray)* Caribou subregional planning considerations and the role of natural regeneration as a form of weed control
4:00 PM	Board Bus and stop at Amisk Office for Bio Break
4:30 PM	Travel back to Bonnyville
6:30 PM	Dinner at Mr. Mike's Restaurant *(Appetizers provided by COSIA but not meals)*

DAY 2 ON NEXT PAGE...

DAY 2 Thursday, September 12

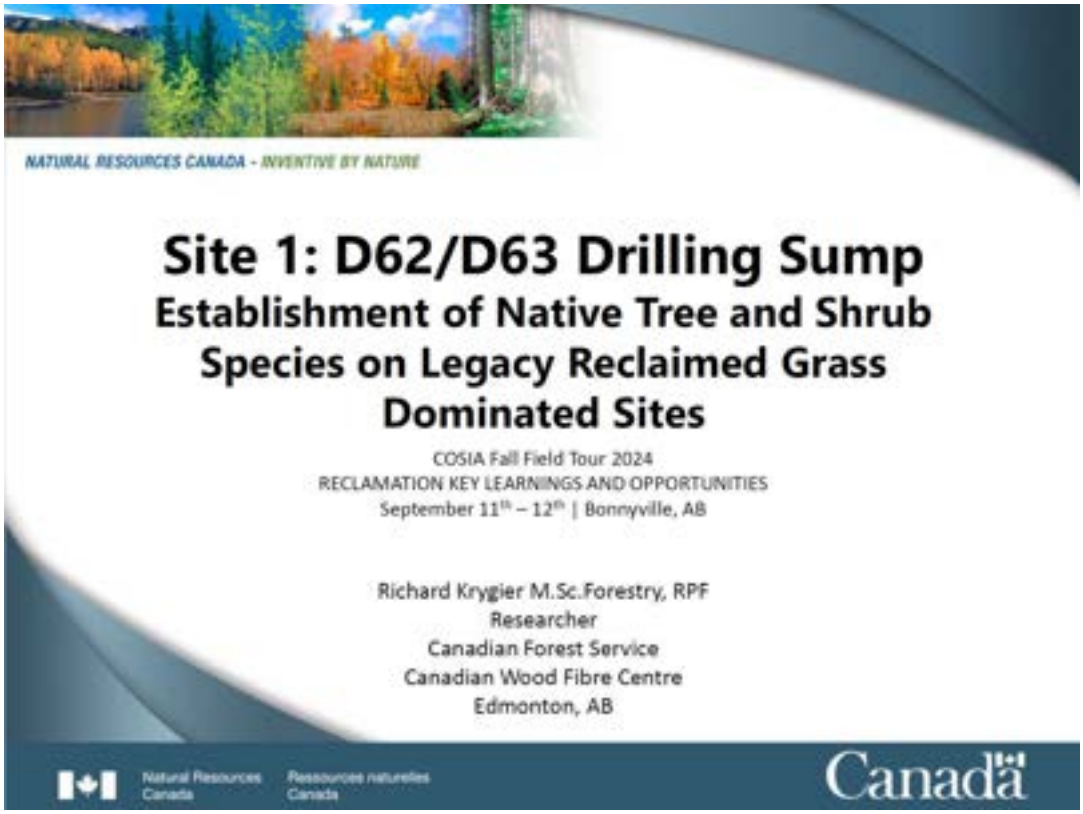
7:15 AM	Board Bus and travel from Bonnyville to CNRL's Wolf Lake sites
8:15 AM	Arrival at CNRL Wolf Lake – Check-In, PPE Verification, Bio Break
9:00 AM	**Site 8: Q1 Pad/Culvert and Road Removal Site** *(Lead by: Bruce Nielsen and Dave Parke)* *Improving watercourse connectivity and flow, the outcome of a positive planning process, uncertain reclamation criteria for thermal sites, and setting a precedent for future sites*
9:45 AM	Board Bus and Travel to 9-12 Sump
10:15 AM	**Site 9: 9-12 Sump** *(Lead by: Paul Kip)* *Navigating natural regeneration and a lack of site history information*
10:45 AM	Board Bus and Travel to Main office for Bio Break
11:00 AM	**Site 10: 15-14-65-6W4 Full Well Pad Removal** *(Lead by: Terry Osko and Dave Parke)* *Effectiveness of mounding, achieving equivalent land capability, and how do the learnings from this site compare to Imperial's H38 pad removal wetland site*
12:00 PM	Lunch on Bus with Travel to Bonnyville for Afternoon Workshop
1:30 PM	Opening Remarks and Welcome to Afternoon Workshop at Neighborhood Inn – Alberta Room
1:45 PM	**Presentation: Use of Remote Sensing in Reclamation Inquiries** *(Lead by: Nadia Cruickshank, Sr. Specialist, Reclamation P.Ag., Alberta Energy Regulator)*
2:15 PM	**Facilitated Activity:** *Drawing out the Key Conclusions from Our Two Days*
3:30 PM	Closing Remarks

APPENDIX 5: LIST OF PARTICIPANTS

- Amanda Schoonmaker (NAIT)
- Anu Saini (Imperial)
- Bin Xu (NAIT)
- Bruce Nielsen (Woodlands North)
- Carolina Berdugo-Clavijo (Imperial)
- Caroline Hann (MEG Energy)
- Chantale Campbell (ConocoPhillips Canada)
- Cindy Connolly (Cenovus)
- Dan McCurdy (Boreal Horticultural Services)
- Dave Parke
- Derek Hodder (Suncor)
- Diana Boxma (Government of Alberta, Environment and Protected Areas)
- Emily Cribb (Alberta Energy Regulator)
- Harpreet (Sandhu Cenovus)
- Helene de Beer (Pathways Alliance)
- Jack O'Neill (Pathways Alliance)
- Jason Desilets (Cenovus)
- John Potter (Imperial)
- Jon Gareau (CNRL)
- Katie Howes (CNRL)
- Kennedy Bailey (Pathways Alliance)
- Kinzie Gray (Imperial)
- Kitty Chow (Imperial)
- Kyle Jones (Government of Alberta, Environment and Protected Areas)
- Laura Van Der Veen (Alberta Energy Regulator)
- Lindsay Clothier (Pathways Alliance)
- Lori Neufeld (Imperial)
- Lynette Sinclair (Alberta Energy Regulator)
- Marty Yarmuch (Syncrude (Operated by Suncor))
- Matthew Pyper (Fuse Consulting Ltd.)
- Matthew Serfas (Cenovus)
- Mélina Guêné-Nanchen (Université Laval)
- Mitchell Alberts (Imperial)
- Nadia Cruickshank (Alberta Energy Regulator)
- Nakita Rubuliak (Fuse Consulting Ltd.)
- Natasha Rowden (MEG Energy)
- Paul Kip (CNRL)
- Richard Krygier (Natural Resources Canada, Canadian Forest Service)
- Stephanie McKenzie (Fuse Consulting Ltd.)
- Steve Kullman (CNRL)
- Terry Osko (Circle T Consulting, Inc.)
- Wayne Bamber (Cenovus)

APPENDIX 6: SITE HANDOUTS PROVIDED BY LEAD EXPERTS

Imperial Site D63: Richard Krygier



Objectives

To evaluate a suite of seedling centred site treatments (mechanical and chemical) for their ability to improve seedling establishment success and early growth

Legacy Sites

- Issues- site dependent
  - Older reclaimed areas
  - High above and below ground competition
  - Species- high non-native grass and herbaceous (clover) from use of forestry reclamation seed mix
  - Seedbank
  - Lack of organic matter in soil
  - Soil Compaction
  - Moisture- too much or too little

D63- 30+ yrs. old

Legacy Sites

- Two rounds
  1. D63 (established 2016)
  2. J10 and P3 (established 2019 incorporating learnings from D63)

P3- 30+ yrs. old

J10- 30+ yrs. old

UNCLASSIFIED - NON CLASSIFIÉ

Legacy Sites

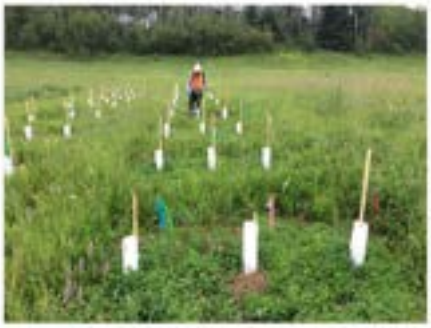
- Treatments-
  1. Mounding (with and without herbicides)

Legacy Sites

- Treatments
  1. Mounding
  2. Roto-tilling with herbicides

Legacy Sites

- Treatments: based on last COSIA In-situ tour
  1. Mounding (with and without herbicides)
  2. Roto-Spike with herbicides
  3. Shelter with herbicides



2nd herbicide application spring of second growing season after treatment

Legacy Sites

- Treatments-
  1. Mounding (with and without herbicides)
  2. Rototilling with herbicides
  3. Shelter with herbicides
  4. No treatment

Legacy Sites

- Planted 3 species
  - White spruce (container seedlings)
  - Green alder (container seedlings)
  - Balsam poplar (cuttings)
- Used only systemic herbicide (Roundup) in first round (D63)
- Used fertilizer slow-release tablets to augment poor soil nutrient conditions
- Incorporated pre-emergent herbicide (Torpedo-flumioxazine/phyroxasulfone) along with Roundup herbicide in second round of trials to address seedbank

Legacy Sites

- Findings
  - D63 demonstrated the need for more aggressive vegetation control due to seedbank dominated by clover

D63- Mixing dominated by clover in the spring of second growing season after treatment

UNCLASSIFIED - NON CLASSIFIÉ

Legacy Sites

- Findings
  - D63 demonstrated the need for more aggressive vegetation control due to seedbank dominated by clover
  - Incorporated pre-emergent herbicide

J10 Mixing with herbicide treatment (Roundup and pre-emergent) at the end of the first growing season

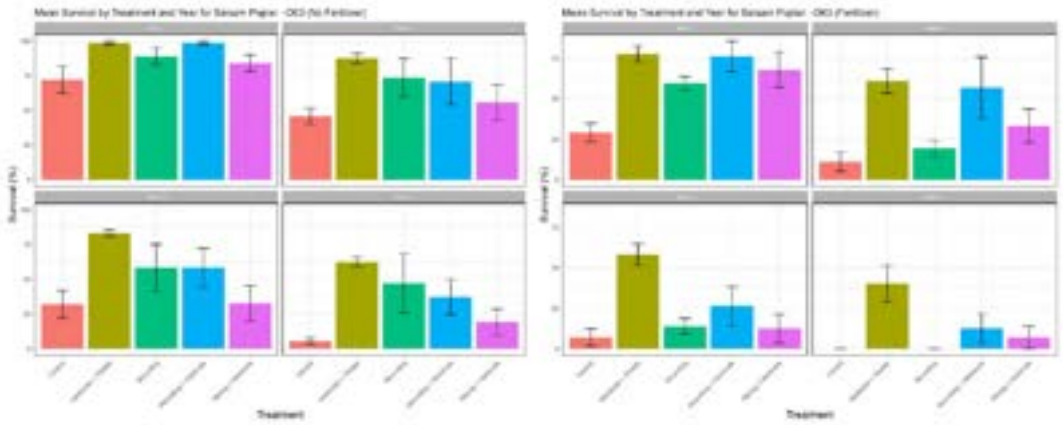
J10 Mounding herbicide treatment (Roundup and pre-emergent) (left) and mounding with no herbicide (right) at the end of the first growing season

Legacy Sites- D63 Survival

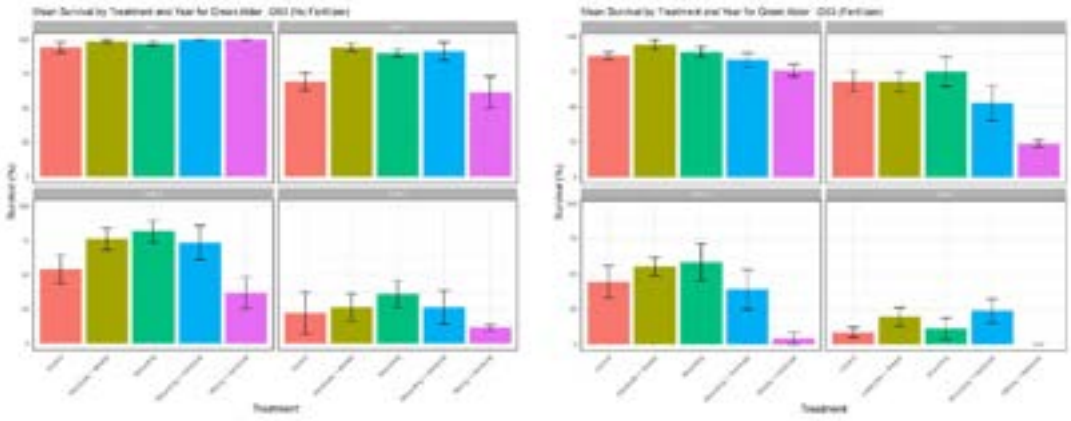
- Seven growing seasons after planting- (first round)
  - For alder and poplar- SD between fertilizer treatments- higher survival with no fertilizer
    - fertilizer tablets placed too close to stem caused damage/mortality
  - Best treatment compared to control-
    - Poplar:
      - No-Fert: herbicide with shelter and mounding with/without herbicide
      - Fert: herbicide with shelter
    - Alder:
      - No-Fert: no significant difference between treatments
      - Fert: no significant difference between treatments

      (High mortality between year 5 and 7 due to rodent damage)
    - Spruce:
      - No-Fert & Fert: no significant difference between treatments and control within each

Balsam Poplar Survival- D63



Green Alder Survival- D63



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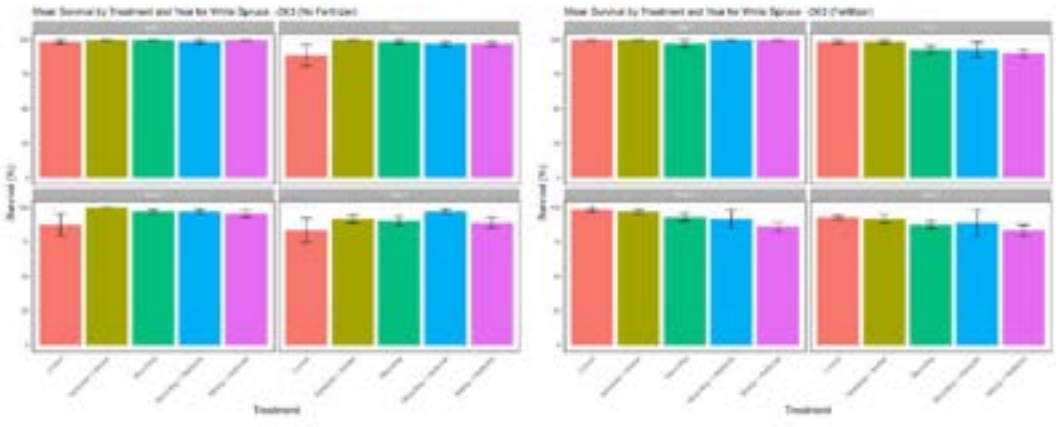
White Spruce Survival- D63



Natural Resources Canada | Ressources naturelles Canada

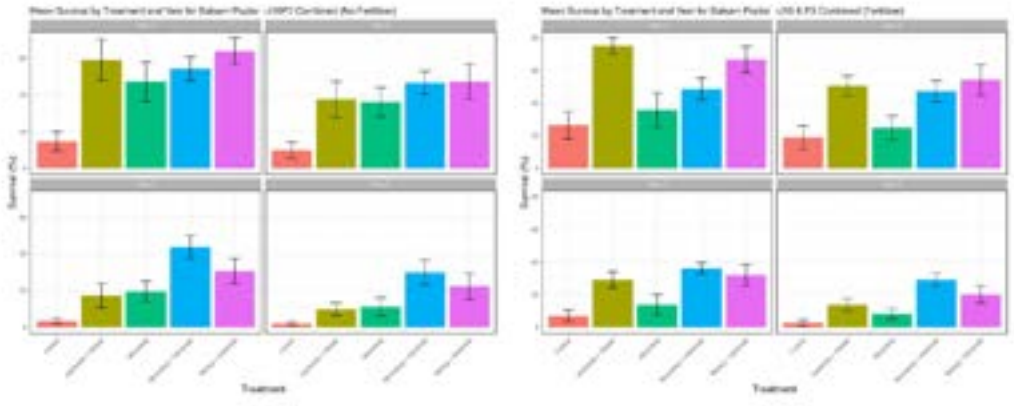
Canada

Legacy Sites- Survival J10 & P3 Combined

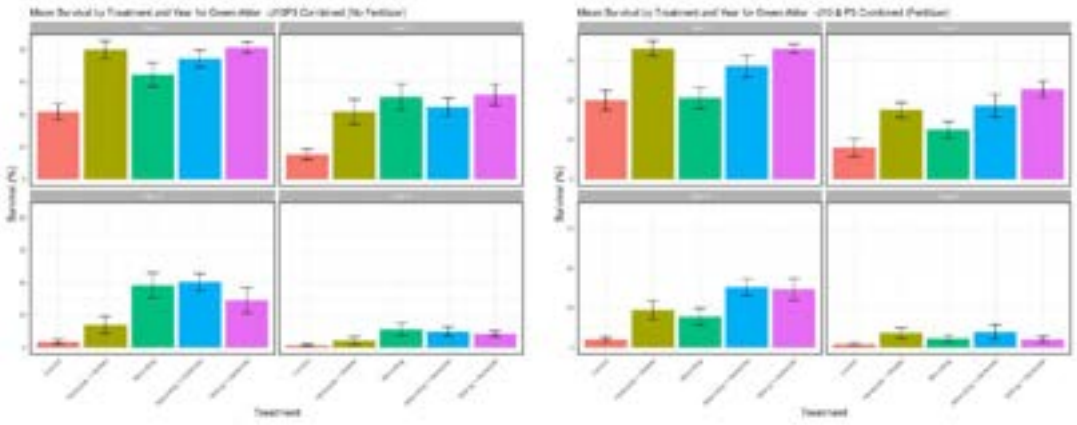
- Five growing seasons after planting- (Second round)
  - No significant difference between fertilizer treatments for all species
  - Best treatment compared to control-
    - Poplar:
      - No-Fert: mounding with herbicide and mixing with herbicide
      - Fert: herbicide with shelter, mounding with herbicide and mixing with herbicide
    - Alder:
      - No-Fert: no significant difference between treatments
      - Fert: no significant difference between treatments

      (High mortality between year 3 and 5 due to rodent damage. In year 3, treatments including herbicide were significantly better than control)
    - Spruce:
      - No-Fert: no significant difference between treatments
      - Fert: mounding and mounding with herbicide
  - Pre-emergent herbicide treatment effective for approximately one and half years after application
    - Dependent on applicator quality control

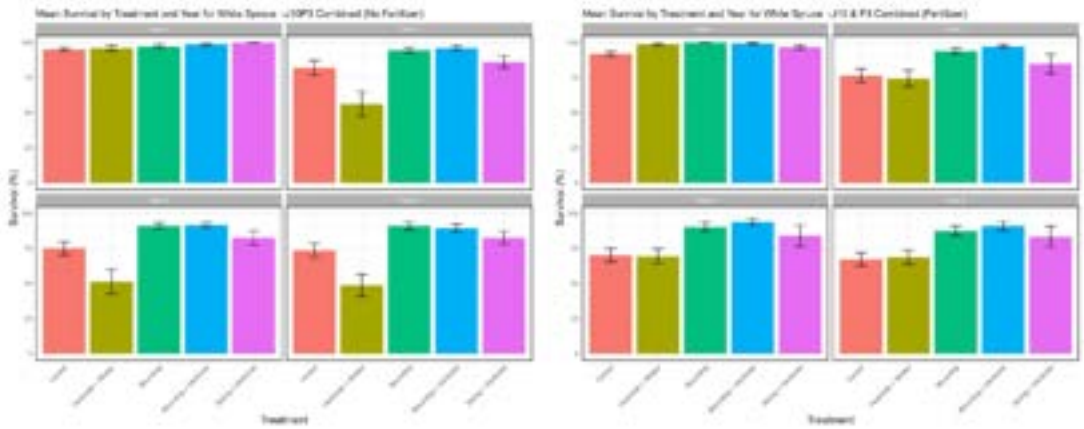
Balsam Poplar Survival- J10 & P3 Combined



Green Alder Survival- J10 & P3 Combined



White Spruce Survival- J10 & P3 Combined



Legacy Sites

- Conclusions
  - Any site treatment is better than just planting in the grass for green alder and balsam poplar survival
  - White spruce does benefit from site treatment but planting through the grass still results in high survival
  - Pre-emergent weed control required to deal with alsike clover seed bank
  - Green alder subject to rodent damage
  - Treatment recommendation- mounding with herbicides (Roundup + Torpedo)
    - reduced competitive cover, and increased seedling survival

Operational Treatment Recommendation

- Treat the site the year before planting with a powered disc trencher to produce an elevated planting site similar in profile to hoe mounding
  - More planting spots
  - Can produce a sinuous pattern across site
  - Lower cost
- Wait for vegetation to sprout in spring
- Prior to planting, apply non-selective/pre-emergent herbicide (e.g. Roundup/Torpedo) in a tank mix
  - Side-by-side sprayer with nozzles focused on trencher mound
  - Water volume critical
- Plant deciduous species on trencher mound only
- Plant some white spruce on trencher mound but majority between mounds to break up linear planting pattern

Thank You

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H38 Wetland Trials – 2017-2019 Study Summary

In 2017, NAIT, University of Waterloo, and Université Laval collaborated with Imperial Oil to obtain funding via a joint NSERC ARD-CRD application. The objective was to assess various restoration techniques for oil sand well-sites constructed on peatlands with two primary aims: 1) restoring vegetation community structure to meet provincial reclamation criteria (ARD) and 2) restoring ecosystem function to match regional reference peatland ecosystems (CRD).

The H38 pad is surrounded by a moderately-rich shrubby fen in the north (**SRF**) and a wooded larch swamp/fen on the southwest side (**TRF**). In spring 2008, the first section of the pad underwent restoration by completely excavating the mineral soil fill and geotextile liner (Complete Removal **CR**). Due to peat compression during well-site construction and use, up to 4 m of fill was removed, resulting in deep inundation even after the rebound of the underlying peat. Based on these findings, the subsequent section was reclaimed by scraping the surface mineral fill down to the level of the adjacent peatland in fall 2009 with the aim of limiting flooding. It resulted in two specific sections of partial removal (PR) and levelling with the adjacent peatland to connect to its water table level (0 cm) with wet and dry microforms (**PR-0-D/W**), and with even ground (**PR-0-E**). One section of the pad was left unrestored with all mineral soil fill intact, serving as a negative control (**UNR**; **Error! Reference source not found.**).

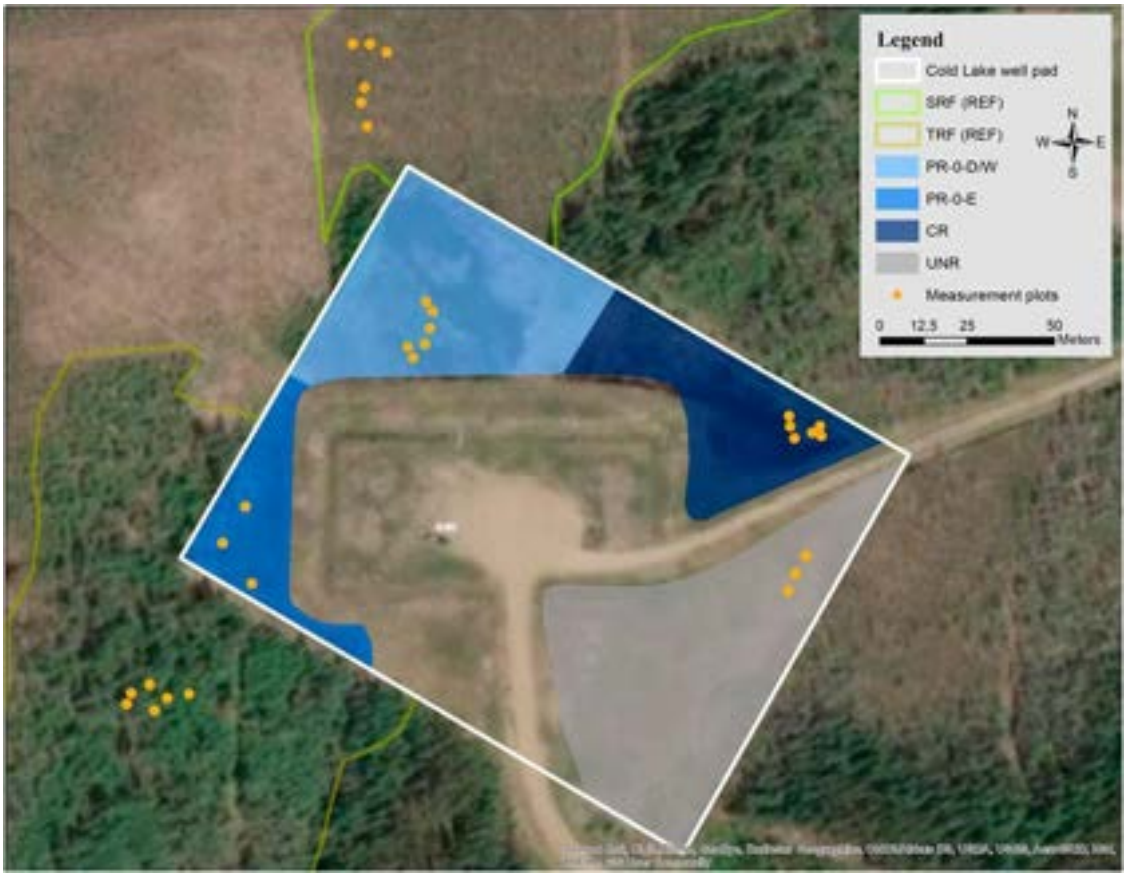
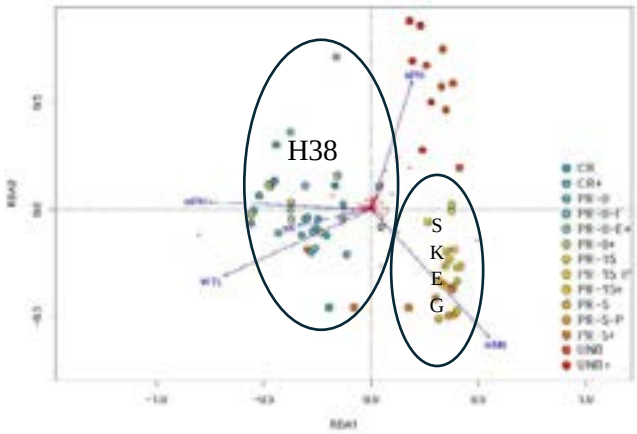
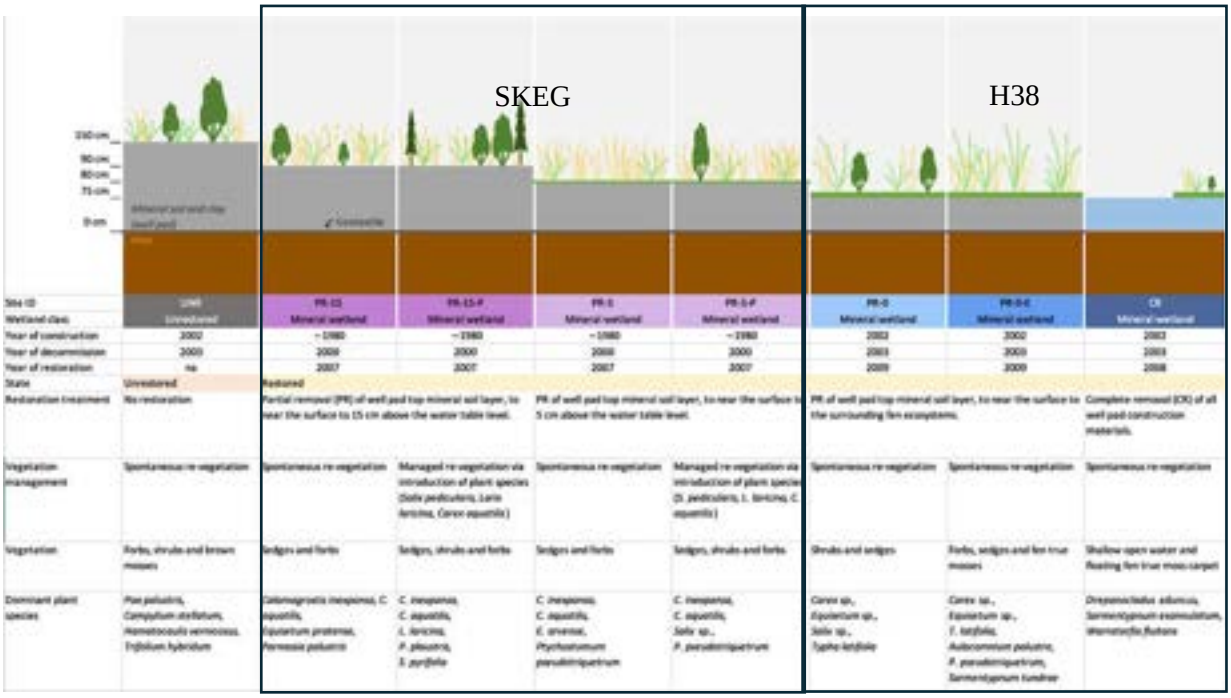


*Figure SEQ Figure * ARABIC 1. Map of H38 pad with its three restored areas and the unrestored control area (UNR). Restoration approaches tested complete removal (CR) of the in situ well pad's mineral fill and underlying geotextile, and the partial removal (PR) and levelling with the adjacent peatland to connect to its water table level (0 cm) with wet and dry microforms (PR-0-D/W), and with even ground (PR-0-E). Natural wetlands surround the pad, with a moderately-rich shrubby fen in the north (SRF) and a wooded larch swamp/fen on the southwest side (TRF).*

Overall Community Development: *Lemmer M, Xu B, Strack M, Rochefort L (2023) Reestablishment of peatland vegetation following surface leveling of decommissioned in situ oil mining infrastructures. Restoration Ecology 31*

Our results obtained 7 to 9 years after restoration demonstrated that partial removal of mineral fill can lead to the formation of a peat-accumulating community when the water table is maintained near the surface (Figure 2). This is similar to the process known as "paludification", which is a common pathway for peatland formation on vegetated mineral substrates. Both excessively wet conditions (complete removal) and excessively dry conditions (unrestored control) are not favorable for the development of peatland vegetation (Figure 3). In the absence of active planting or moss donor introduction, connectivity to the adjacent fen played a vital role in maintaining water table and the natural regeneration of bryophytes, sedges, and shrubs.





Greenhouse Gas Dynamics and Carbon Balance: *Lemmer M, Rochefort L, Strack M (2020) Greenhouse Gas Emissions Dynamics in Restored Fens After In-Situ Oil Sands Well Pad Disturbances of Canadian Boreal Peatlands. Frontiers in Earth Science 8*



The reintroduction and growth of sedges, shrubs and true mosses significantly enhanced carbon uptake in the restored sections, resulting in a seasonal carbon balance similar to reference peatlands (Figure 5, Figure 6, Table 1). On the other hand, the complete removal of fill material that resulted in inundation resulted in a large release of both CO_2 and CH_4. The unrestored section had low CH_4 emissions but remained a source of CO_2. Sections with remaining mineral fill exhibited higher pore water electrical conductivity but had a comparable pH to the reference peatlands. Restored areas showed lower concentrations of dissolved organic carbon due to incomplete vegetation recovery and lower organic matter content in the underlying mineral fill.

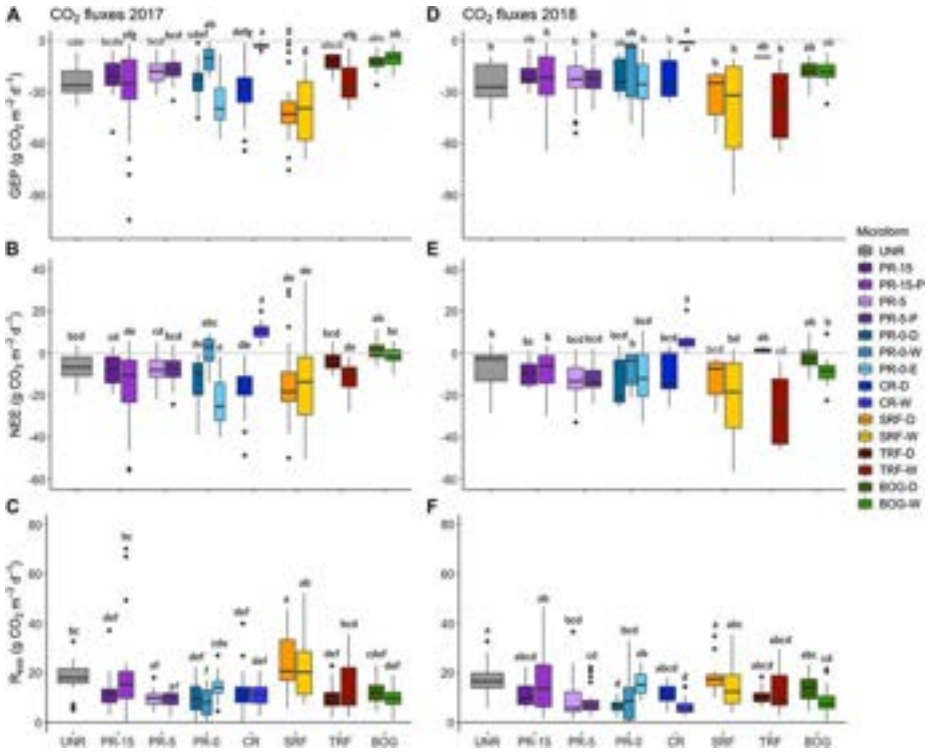


*Figure SEQ Figure * ARABIC 5. Measurements in all monitoring sectors* during the monitoring season of 2017 (A–C) and the season of 2018 (D–F) show the mean gross ecosystem production (GEP), ecosystem respiration (Reco) and net ecosystem exchange of CO2 in g CO2 m−2 d−1.*

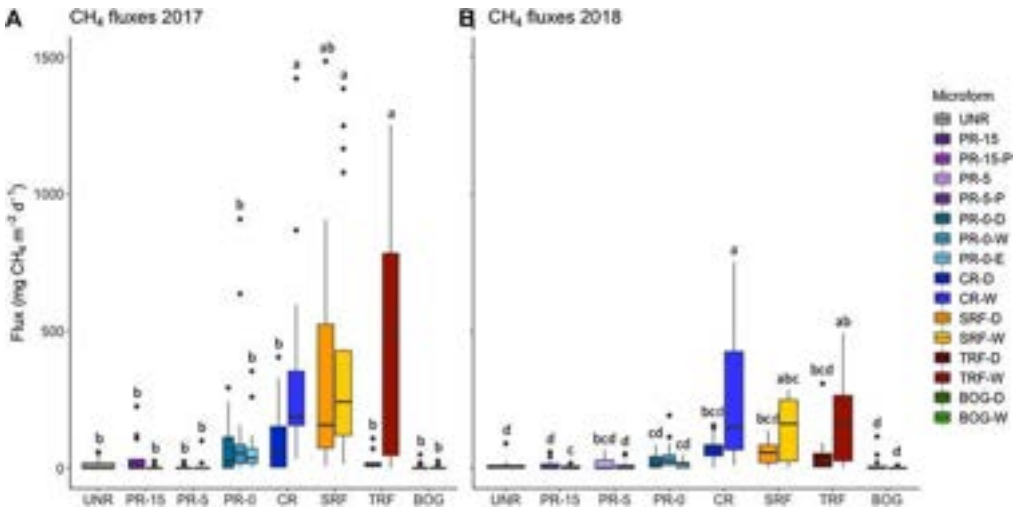


*Table SEQ Table * ARABIC 1. Cumulative two-year total C balance and global warming potential (GWP) for two 107-days-research seasons in two consecutive years (17.5.2017–31.8.2017 and 22.5.2018–5.9.2018). Calculations of the total C balance include C fluxes of methane (CH_4), and net ecosystem exchange (NEE) as a sum of gross ecosystem production (GEP) and ecosystem respiration (R_{eco}). IPAD in Peace River, and H38 in Cold Lake.*

Status	Sector[a]		Total C balance (g C m^{-2})	GWP (g CO_2-e)
Well pad	UNR	SKEG	400	788
Restored 2009	PR-15		137	326
	PR-15-P		43	92
Restored 2009	PR-5		−238	−94
	PR-5-P		−329	−556
Restored 2008	PR-0-D	H38	−625	−942
	PR-0-W		831	1875
	PR-0-E		−67	34
Restored 2007	CR-D		−423	−315
	CR-W		1,039	3,807
REF	SRF-D		700	2013
	SRF-W		−13	1,408
REF	TRF-D		535	1,210
	TRF-W		−614	571
REF	BOG-D		500	964
	BOG-W		−22	−37

[a]UNR: Unrestored; CR: Complete removal of mineral soil (MS); PR-15: Partial removal MS to 15 cm above seasonal water table; PR-5: Partial removal of MS to 4–6 cm above seasonal water table; PR-0-D/W: Partial removal of MS to surface elevation of surrounding fen reference ecosystem (uneven ground relief); PR-0-E: Partial removal of MS to near the surrounding fen reference ecosystem (even ground relief); REF-BOG: a wooded bog; REF-TRF: a treed rich fen; REF-SRF: a shrubby extreme-rich fen

The partial removal section with even ground (PR-0-E) (Figure 7), characterized by a stable, near-surface water table, met the Peatland Reclamation Criteria in 2018. It displayed the highest coverage of bryophytes and peatland vegetation, a higher thickness of newly accumulated peat, and minimal open water presence (Table 2, Figure 9, Figure 8). The partial removal section with dry and wet microforms (PR-0-D/W) and the complete removal section (CR) failed to meet criteria for landscape composition, desirable species cover, and woody stem counts, primarily due to the presence of large open water areas. The CR section also failed due to high coverage of undesirable species (e.g., cattail). Although these areas could potentially develop into mineral wetlands, efforts should be made to avoid the formation of deep pools (> 2 m) if peatlands are the targeted communities for reclamation.

Finally, while these findings are encouraging, they are limited by the scale and location of the specific well pad studied. Future trials should explore both civil earthwork (partial removal) and revegetation (natural regeneration, planting, donor moss transfer) methods on a larger number of sites in different peatland settings to further validate these results.

Methods and Results:

1. Each section was treated as a survey grid.
2. Each grid has distinct communities of wetland plants (Figure 9, Figure 8).
3. Only Grid 1 (PR-E) passed the peatland criteria (Table 2). Both grids 2 and 3 failed for landscape, desirable species cover, and woody stem counts, due to presence of large open water areas. Grid 3 also failed for high undesirable species cover (Table 2).

4. Grid 1 had the highest bryophyte cover (62%) and an average of 13.5 cm of newly formed peat carpet. Grid 2 had the lowest peatland vegetation cover, higher open water area and only 3.8 cm of newly formed peat.

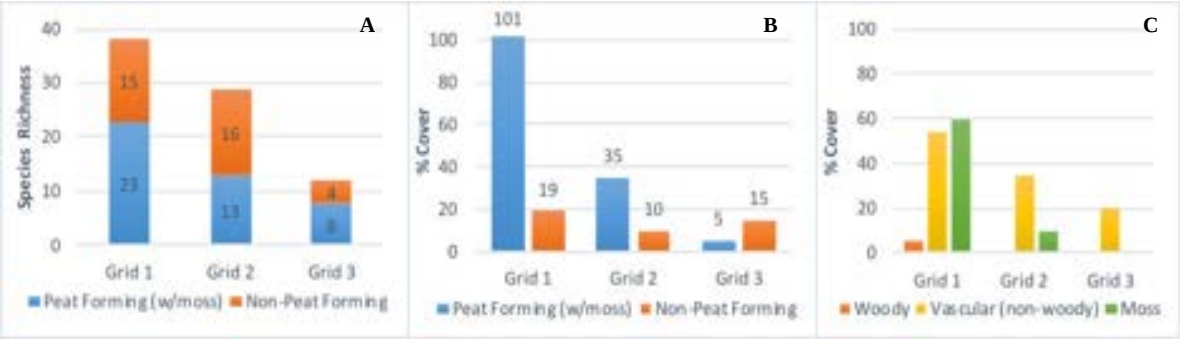


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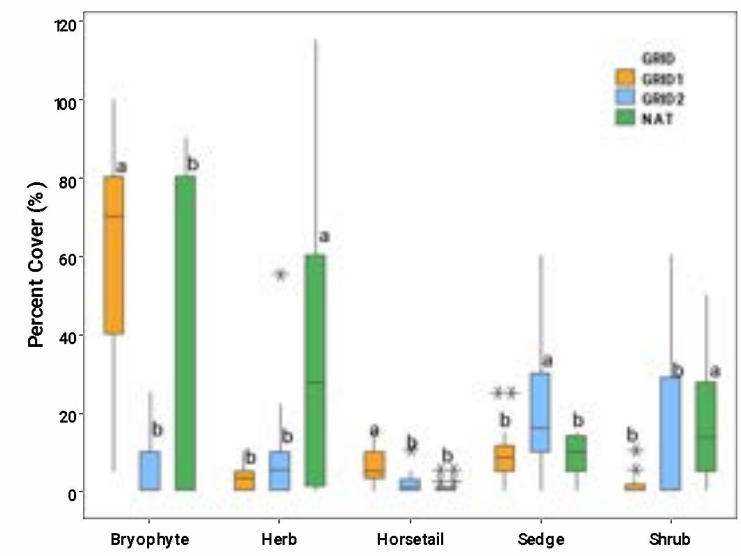
*Table SEQ Table * ARABIC 2. Summary of 2018 peatland reclamation criteria assessment.*

	Grid 1	Grid 2	Grid 3
Landscape Parameter	Pass	Fail	Fail
Species Richness	Pass	Pass	Pass
Desirable Species % Cover	Pass	Fail	Fail
Undesirable % Cover	Pass	Pass	Fail
Woody stems	Pass	Fail	Fail
Site Performance Using Peatland Criteria	**Pass**	**Fail**	**Fail**
Reclamation Technique	Partial Removal	Partial Removal	Complete Removal
Wetland Classification	Fen	Emergent Marsh	Shallow Open Water Wetland
Criteria Should Assess With	Peatland	Other Wetland	Other Wetland



CNRL Pad 15-14-65-6W4

Site History

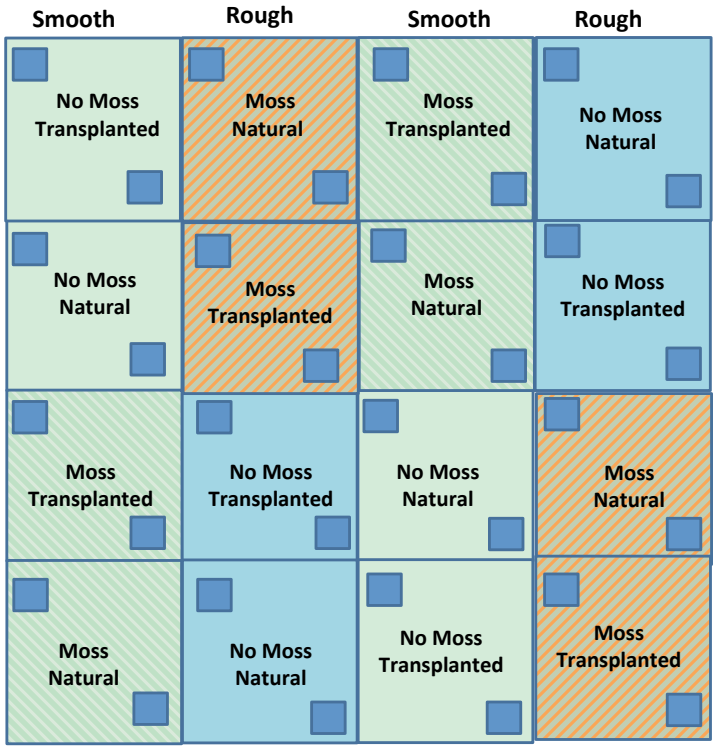
The study site was a conventional drilling pad situated within a treed poor fen. The pad was built in 1997 using fill from a borrow pit approximately 100 m west of the study site. The pad consisted of approximately 1.5 m of clay-loam fill with moderate salinity deposited over corduroy constructed from on-site woody debris placed directly on the fen surface. Most of the fill was removed in November 2010 across the study site with a track-hoe and returned to the borrow pit, leaving a layer of fill approximately 10 cm thick across the site. Once this layer was frozen enough to support equipment, two track-hoes were used to “mound” the surface, bringing buried peat to the surface and incorporating the remaining fill underneath. The result was a very rough (up to 1 m relief) surface consisting of variation in patches of exposed peat and thin fill veneer across the study site.

Initial Fill Removal

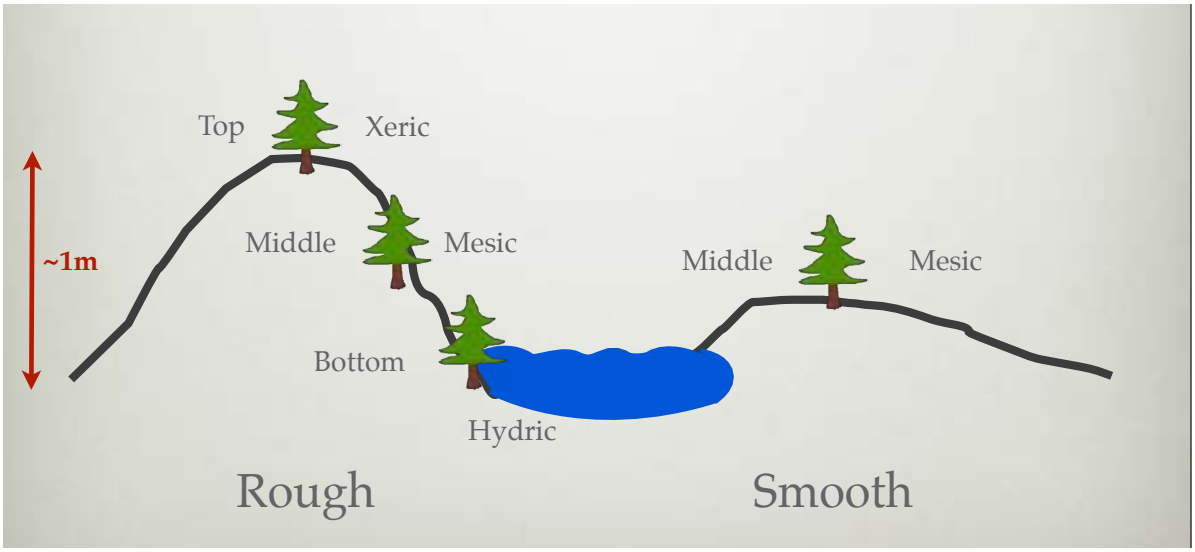
Mounding of remaining fill, producing mixed surface substrate.

Final product

Original Experimental Design and Treatments



Four 40 by 40 m treatment blocks established, divided into four main treatment plots (smooth and rough). Each main plot divided into 2 subplots (moss transfer and no moss transfer). Each subplot divided into 2 sub-subplots (transplants and natural regen).



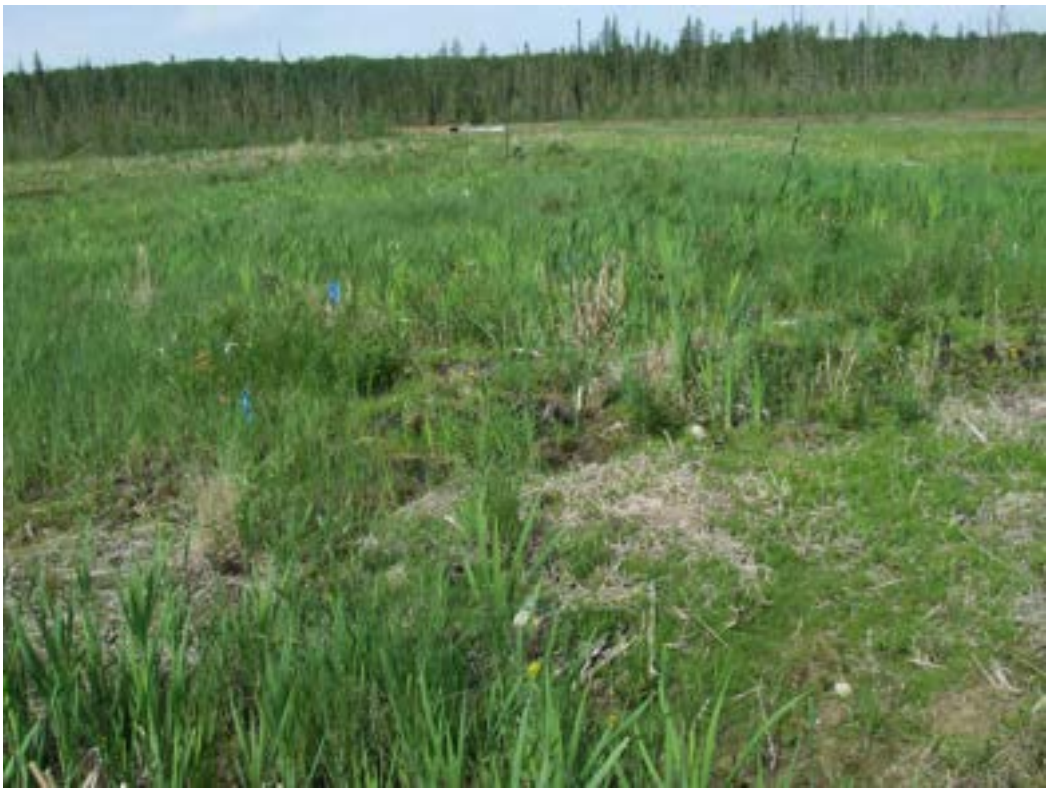
Planting positions on rough and smoothed plots. Three individuals of each species (black spruce, labrador tea, sedge) were planted at each microtopographic position.

Initial Planting and Moss Transfer Results

- Black spruce and lab tea survival was greater overall on the smooth treatment
- Black spruce and Labrador tea had best survival on top and middle positions of the rough treatment
- Sedge transplants had high survival in all transplant locations
- Moss transfer seemed to improve initial sedge survival
- Moss transfer areas had greater plant diversity and richness

Site Progress Over Time

- Cattails were an initial concern, but disappeared over time
- Transplants became less and less relevant because the site was colonized very well naturally
- Moss cover and depth increased
- Moss transfer appeared to enhance moss establishment (greater cover where applied)



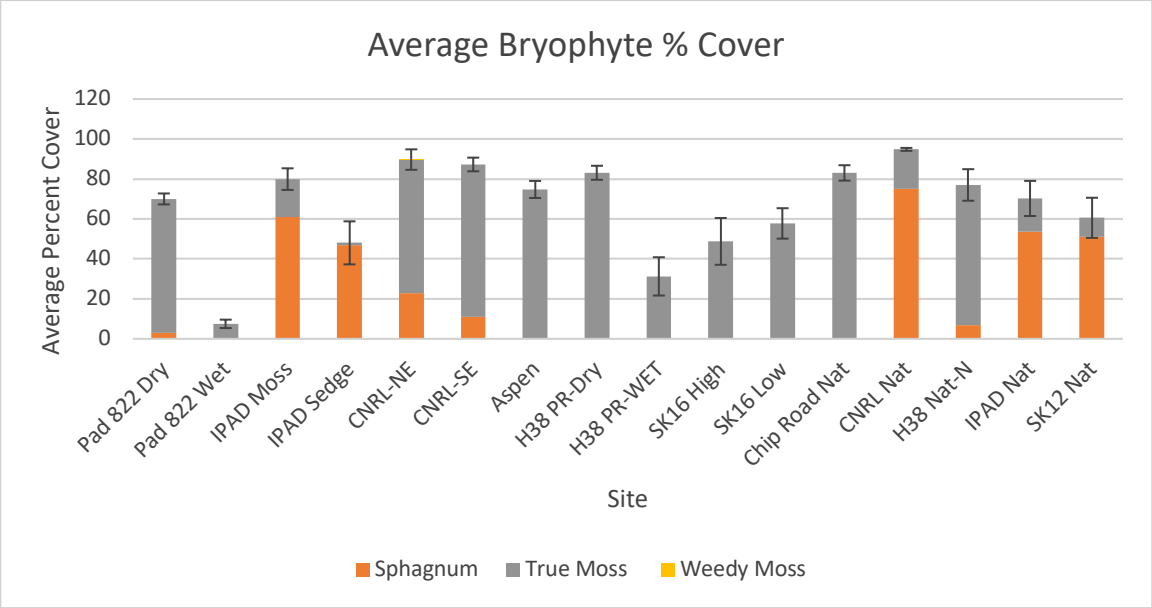
June of 2013.

August of 2017.

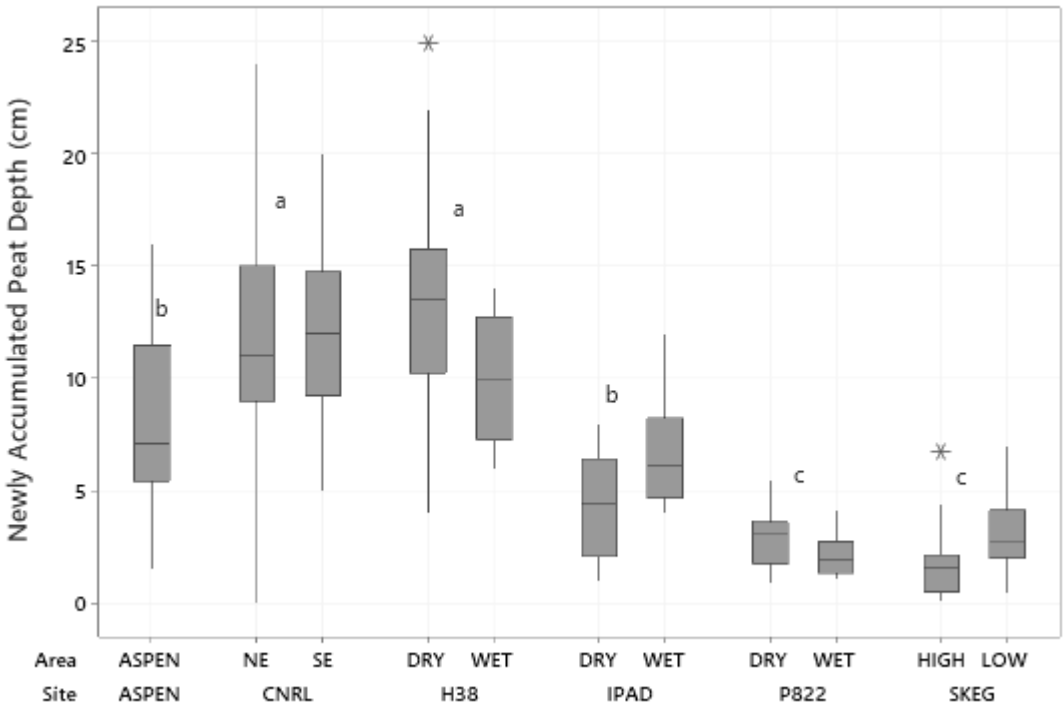
September 2021

Natural colonization: balsam poplar, willow, bog birch, larch, cattail and sedges.

Peat Accumulation



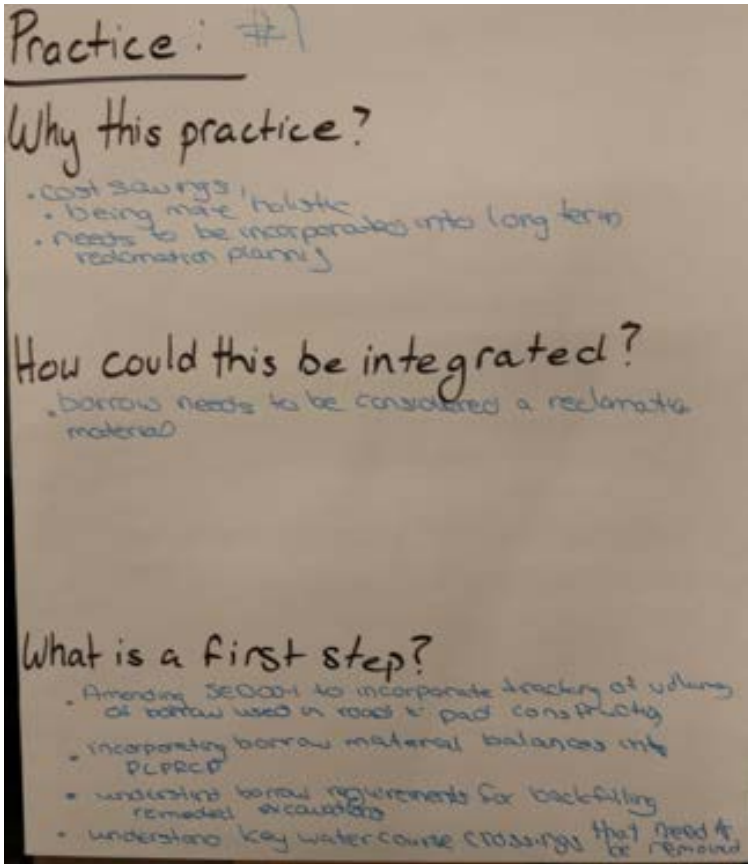
Mean percent cover of bryophyte by study areas.



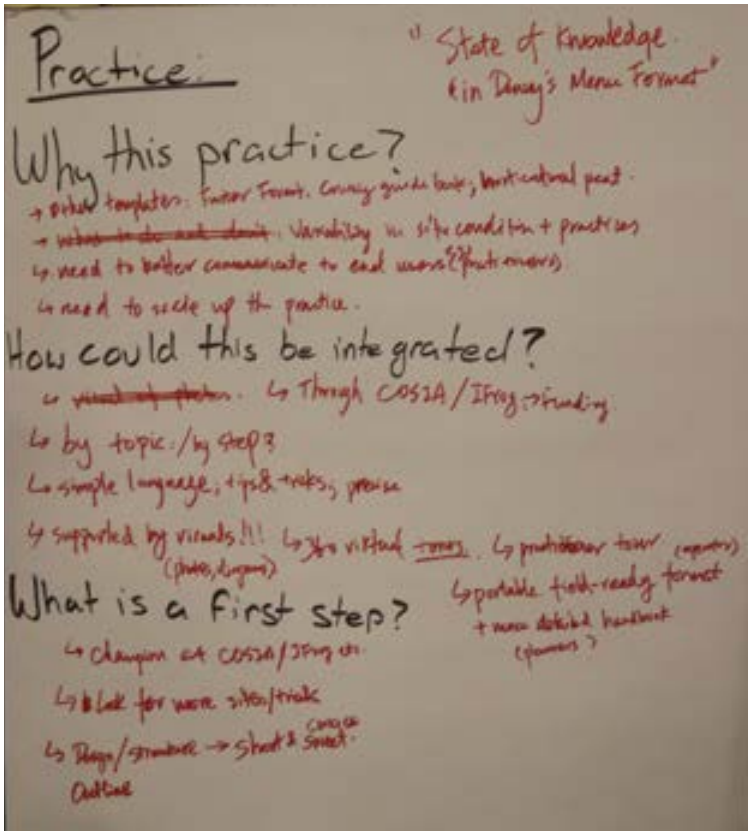
Mean depth of newly formed peat by site.

APPENDIX 7: WORKSHOP BREAKOUT GROUP DISCUSSIONS

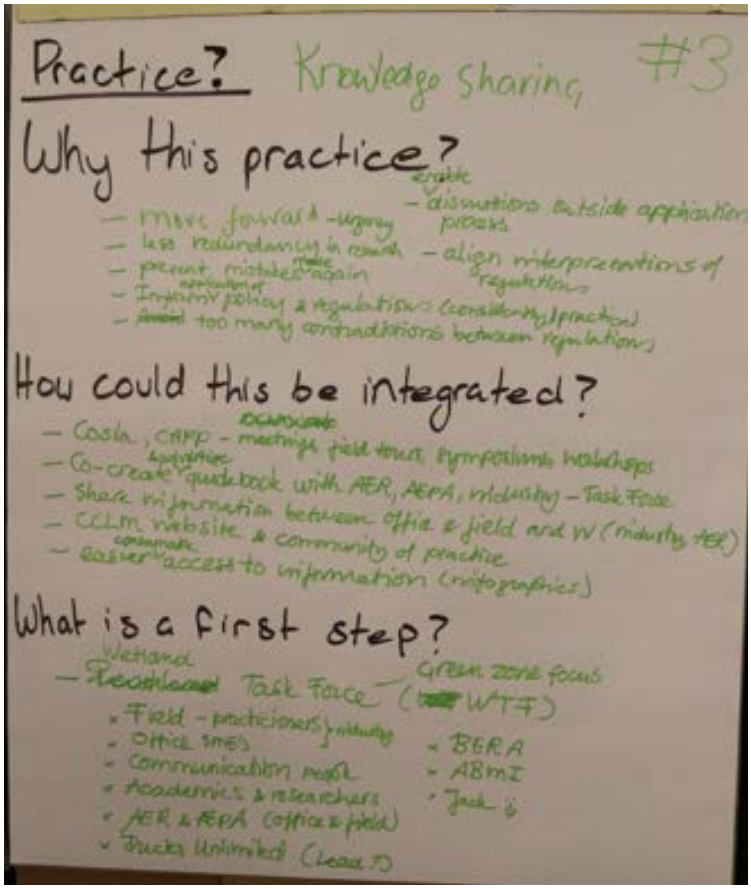
Group 1: Planning for Borrow Material: Longer-term consideration for where to put borrow material at the time of reclamation (i.e., CNRL road/culvert removal)



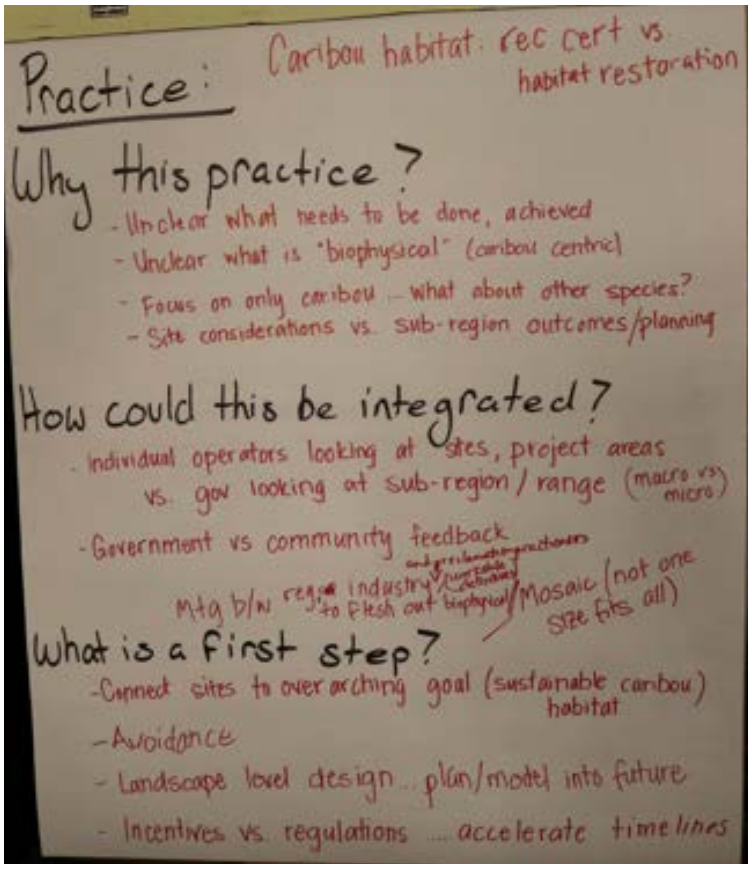
Group 2: Wetland reclamation techniques: The variety of potential wetland reclamation techniques that are available and how surrounding environments impact the success of these techniques. Develop a guidebook to capture this knowledge.



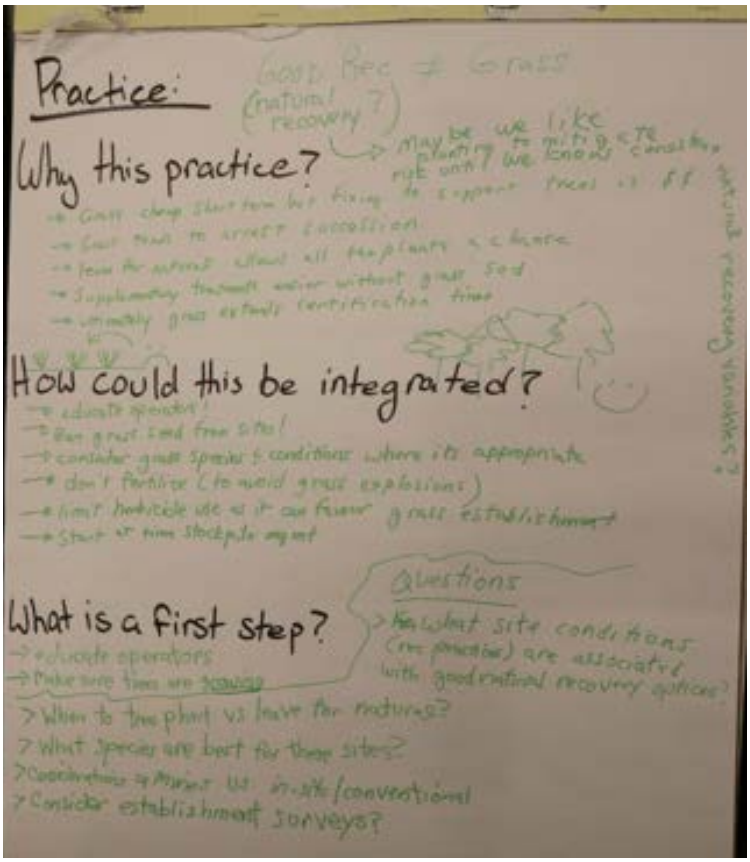
Group 3: Knowledge Sharing: Importance of knowledge sharing and developing best management practices among groups (i.e., field coordinators, corporate teams, academics, policymakers, and regulators). Industry/different companies share similar issues and there should be more collaboration among the companies to tackle these issues more efficiently and effectively.



Group 4: Caribou and reclamation certifications: Compare/contrast reclamation certificate requirements vs. Caribou habitat restoration.



Group 5: Good reclamation does not need grass: Leaving a site to regenerate naturally is better than quickly and cheaply making it 'green' (planting grass). If it's not going to be done thoughtfully, don't do it at all.



APPENDIX 8: 25/10 ACTIVITY
KEY LEARNINGS SCORING

Scoring	Learning
24	The variety if potential wetland reclamation techniques that are available and how surrounding environments impact the success of these techniques. Develop a guidebook to capture this knowledge.
24	Longer-term consideration for where to put borrow material at time of reclamation (i.e., CNRL road/culvert example).
22	In reclamation, planning is key.
22	Importance of knowledge sharing and developing/sharing best management practices among industry/ government.
20	Development of a peatland reclamation guidance book much like the previous ones done for Faster Forests.
20	For peatland pad sites, achieving the right surface elevation is key, to get the water table level just at the surface.
20	Compare/contrast reclamation certificate requirements vs. Caribou habitat restoration.
20	Need to continue integrating and building connections between teams (i.e., field coordinators, corporate teams, academics, policymakers, and regulators). Share learnings, successes, and failures.
19	Planning needs to involve all stakeholders
19	Leaving a site to regenerate naturally is a much better option than quickly and cheaply making it green (grass). If it's not going to be done thoughtfully, don't do it at all.
19	I learned that industry/different companies share similar issues and there should be more collaboration among the companies to tackle these issues more efficiently and effectively.
19	Exploring incentives for taking action to influence converting old sites dominated by grasses to boreal forest species.
18	Transplanting moss to start regenerating a site.
18	Need to understand at all levels what it takes to certify a site.
18	Eliminate grass/agronomic planting at every stage—too difficult to remove from the seed bank once it progresses.
17.5	Well-planned natural revegetation can be useful with patience and proper weed control.
17	There is no 'one size fits all' in reclamation and flexibility is important.
17	Do not plant grass or clover.
17	Understanding of stable water table over soil for peat development.
16	Importance of planning in general, but 2 specific examples are: 1) material management (i.e., where to put fill material), and 2) wetland restoration (context of the landscape, hydrology, etc.).
16	Less prescriptive more outcome-based reclamation regulation criteria,
16	When it is known that a clay pad must be removed/reclaimed within a fen, start water table measurements several years in advance to get the most accurate water table level. This will indicate how much fill should be removed and support a successful trajectory for mosses, sedges, etc.
16	Timely regulatory closure (i.e., reclamation certification application).
16	Doing less is more (sometimes). Natural regeneration capabilities are more than we sometimes expect.

16	There needs to be clarity on how best to move forward on areas that have been left and have naturally established. Does the site need to be re-disturbed to meet current/modern/best practices?
15	Look at our water crossings and understand their impacts.
15	When selecting plant species to use in a reclamation project, you need to be flexible with the species that will actually work and be able to adapt when roadblocks come up.
14	For reclamation of upland sites, rely on treed shrub planting with coarse wood debris and natural ingress. Don't broadly plant grass.
13	Site prep is key to achieve the target ecosystem: reduce weeds and support vegetation establishment. 1. Patience: wait 5 years because clover may take care of itself 2. Work two or more sites together because of cut/fill requirements 3. No grass seed 4. Peatland restoration requires moss (but not sphagnum moss)
13	Remove mineral fill near the surface to find the top level of the water table to support fen creation.
12	It is feasible to establish peat-forming community well pads, but it's highly site-specific.
8	Doing forest reclamation well initially is much easier than trying to "fix" a grassy clover site later. The best fix is to grow a forest.
NA	'Doing' less is more (sometimes).

COSIA Fall Field Tour 2024

RECLAMATION KEY LEARNINGS AND OPPORTUNITIES

Final Report

cosia with Pathways Alliance