CENTRE FOR
BOREAL RESEARCH

TECHNICAL NOTE #24
PEATLAND RESTORATION
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Wellsite Clay Pad Removal and Peat Inversion



INTRODUCTION

Reclaiming in-situ well pads built in peatland presents many challenges. With the release of the "Reclamation Criteria for Wellsites and Associated Facilities for Peatlands", new emphasis is placed on the re-establishment of peat-forming communities that are on a trajectory towards functional peatlands.

Our project offers an innovative approach that removes the clay pad and geotextile, fluffs and re-profiles the buried peat, followed by the transfer of a moss layer to introduce propagules for peatland vegetation development. This technical note describes the **civil earth work procedures** to remove the clay pad and to create a flat, hydrologically connected peat surface suitable for peatland vegetation development.

The **re-vegetation** following the civil earth work is addressed in a separate technical note series "**Using Moss Layer Transfer Technique (MLTT) for Peatland Revegetation on In-situ Facilities**."

THE SITE – INVERSION PAD (IPAD)

The 1.4-hectare study site is located within a treed bog/poor fen complex in the Peace River oil sands region (Figure 1). The surrounding area is dominated by:

- **Black spruce** *(Picea mariana)*
- **Labrador tea** *(Rhododendron groenlandicum)*
- **Lingonberry** *(Vaccinium vitis-idaea)*
- **Sphagnum mosses** *(Sphagnum spp.)*

The pad was constructed in December 2006 using borrowed clay from a nearby upland site. The woody vegetation was laid down and covered with geotextile followed by a 1.4 m-thick clay pad. The well was drilled but never actually operated.

Figure 1. View of clay pad before reclamation. The area is sparsely vegetated with upland weed species.

MAIN CHALLENGES

The thick clay pad is dry and hydrologically disconnected from the surrounding peatland. The mineral substrate is different, both physically and chemically, from peat.

In order for peatland vegetation to develop, we need to create a saturated peat substrate by removing the clay pad and geotextile. The challenges are:

1. How to remove the clay pad and what to do with the removed clay
2. How to target the elevation to prevent the creation of a pond after pad removal

RECLAMATION PROCEDURES

- **Winter civil earth work** was done to take advantage of frozen conditions
- **The clay pad** overburden was **returned** to the original **borrow pit** and the geotextile was disposed of
- **The buried peat was fluffed and re-profiled**
- **A flat, saturated peat surface was created with the elevation restored** to 10 cm below that of the hollows (low depressions) of the surrounding natural peatland
- **Three approaches were used:**

  1. PEAT INVERSION for areas where deep peat was present

  2. CLAY INVERSION and 3. MIXED INVERSION were used where only shallow peat was available
- **No barriers** were created between the natural peatland and the reclaimed site
- **Edges** of the site were **contoured into the surrounding** peatland

Note: Because this was a research project with multiple experimental trials, the operator worked in long strips 4 m wide from north to south. The exact operational procedure may vary depending on each site/project.

APPROACH 1 – PEAT INVERSION

COMPLETE PAD REMOVAL AND PEAT FLUFFING (DEEP PEAT)

The clay material and geotextile were removed using a backhoe with a digging bucket and transported to the borrow pit. This exposed the peat buried beneath the pad, which had been compressed by the weight of the clay overburden (Figure 2). The peat depth beneath the pad varied across the site, therefore fluffing helped to achieve the target elevation only where the compressed peat depth was greater than 60 cm (deep peat).

The peat needed to be fluffed (or pseudo de-compacted) in order to raise the surface elevation to a similar height as the surrounding natural peatland and to restore the lateral and vertical water flow (Figure 3). We aimed for **10 cm lower** than the hollows (i.e. low depressions) in the natural peatland, presuming there would be a rebound effect as water started to flow into the reclaimed site.

Fluffing is done using a backhoe and bucket or rake attachment to "work-up" or "flip" the surface of peat (about 1 m deep) in order to increase volume. The peat was fluffed, then lightly tapped down and smoothed to remove any large trapped air pockets. **This step created a flat surface to provide maximum contact between the peat surface and the donor material to be applied post-civil earth work**. For details on how to re-vegetate the recreated peat surface, see our technical note series titled "**Using Moss Layer Transfer Technique (MLTT) for Peatland Revegetation on In-situ Facilities.**"

Figure 2. Clay pad material on the right waiting for removal. In the foreground, exposed peat as the geo-textile is being peeled back by the hoe. Note the elevation differences between the surface of the clay (right), the exposed peat (middle) and the natural vegetation (left).

STEP BY STEP

1. **Remove clay and geotextile** with backhoe and digging bucket and **dispose off-site**.
2. **Fluff** the peat with the hoe bucket **(up to 1 m in depth)**
3. **Tap down** and **smooth** the surface to the **desired elevation (10 cm below elevation of the hollows in the nearby peatland).**

Figure 3. *Left:* The peat surface after clay removal waiting for fluffing. *Right:* The peat surface following fluffing.

APPROACH 2 – CLAY INVERSION

MULTI-STEP BURIAL OF CLAY BENEATH INVERTED PEAT (SHALLOW PEAT)

In areas with shallow underlying peat, fluffing alone was insufficient to raise the exposed peat to the elevation of the adjacent natural peatland. The 'CLAY INVERSION' involved inserting a layer of the clay pad material under the newly exposed peat surface. This process resulted in 40 cm of exposed peat on top of a layer of buried clay material (Figure 4).

The end goals to achieve are:

- **No clay chunks left on the peat surface**, with special care to contour the reclaimed area into the surrounding area
- **A peat** surface that is a **minimum 40 cm thick** on top of the inverted clay material
- **A peat surface that must be 10 cm lower than the hollows of the natural area.** The appropriate volume of clay needed to achieve the correct surface elevation varied based on the amount of available peat

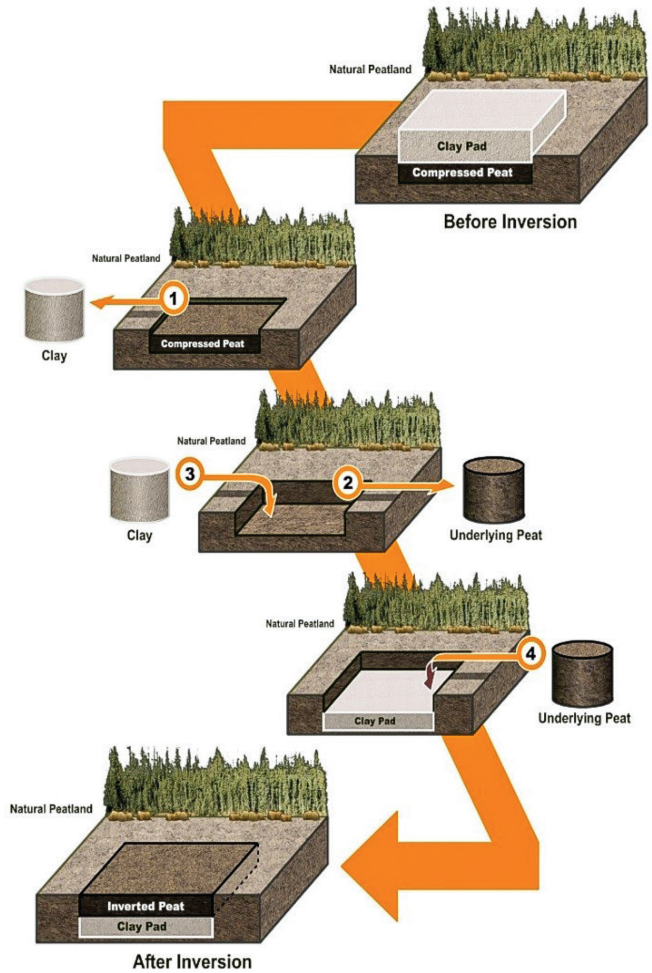


Figure 4. Conceptual diagram of the CLAY INVERSION process.

STEP BY STEP

Figure 4 shows the multi-step procedure to remove and bury clay under inverted peat.

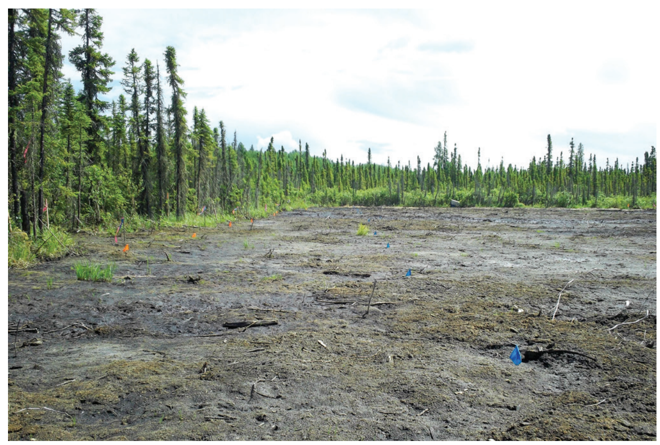
1. **Use a backhoe** with a digging bucket to **remove** the **clay** material for a small area and **pile** on the adjacent remaining clay pad.
2. Remove the remaining clay and **discard the geotextile**; this can be returned to the borrow pit with leftover clay material.
3. **Excavate** the underlying **peat** material and deposit it in a **separate pile.**
4. Establish temporary markers for the desired clay and peat depth to assist the operator.
5. **Half-fill the excavated area with the piled clay** (Figure 5-B). The amount required will depend on the amount of available peat (which is going to sit on top).
6. **Scrape the peat into the hole on top of the clay.** Using the bucket, lightly **tap down** and **smooth** the surface (Figure 5-C).

Figure 5. CLAY INVERSION procedures.

A. Clay to be removed (left side) and the completed clay peat inversion using the multi-step technique (right side).

B. Clay has been replaced in the hole where peat had been excavated and placed on top.

C. Inverted peat over buried clay being tapped and smoothed for a uniform surface. Note the smooth transition between the surrounding peatland and the recalimed surface.



D. CLAY INVERSION areas thawed in the spring, ready for re-vegetation.

APPROACH 3 – MIXED INVERSION

SINGLE STEP CLAY-GEOTEXTILE-PEAT INVERSION (SHALLOW PEAT)

The **single-step inversion** technique was an attempt to shorten the inversion process, thereby reducing operational costs.

This method sees the partial removal of the majority of the clay pad off-site, leaving 20 to 30 cm of clay, followed by a one-scoop inversion (flip) of the remaining clay, geotextile and buried peat. During the flipping, geotextile was broken to allow vertical water fluctuation and mixing of peat and clay was inevitable. The buried clay and geotextile underneath was not uniform (compared to approach 2), creating a variable peat surface even after careful tapping and smoothing of the inverted peat.

As such, this approach led to the least-desirable peatland vegetation response. Therefore this is not a recommended practice compared to the other two approaches.

LESSONS TO DATE – 2017

1. **Creating a flat, saturated, hydrologically connected peat surface is most critical** to successful peatland vegetation development. The exact techniques to achieve such end goals can vary depending on site conditions.
2. **PEAT INVERSION** (approach 1) was the **fastest** and **easiest** method to creating the desired peat surface. However, it was **only effective** in areas **with deep peat** (>1 m) below the pad.
3. Areas with **shallow peat** (<0.5 m) beneath the pad **required some clay material to be buried** under the peat surface in order to reach the desired elevation. The **multi-step CLAY INVERSION** (approach 2) achieved the desirable peat surface. It was **effective** in areas with shallow peat below the pad, **but was time-consuming** and therefore expensive compared to **PEAT INVERSION**.
4. The **peat surface did not rebound as much as expected**. Some areas of the pad have become too wet for moss establishment, and are instead dominated by sedges and cattails which tolerate wetter conditions. Introduction of peatland sedges (*Carex* spp.) can effectively control invasion by cattails in such areas and should be considered during initial site monitoring.

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