Natural Resources Canada

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Silviculture knowledge for reclamation of oil and gas disturbances

Mounding

Mechanical site preparation

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Background

Silviculture is the practice of controlling the establishment, growth, composition, health and quality of forests at the stand level to meet diverse needs and values. Silvicultural practices can have a strong and beneficial impact on reclaiming areas associated with in situ extraction of oil and gas resources.

Site preparation, forest regeneration and vegetation management are all important aspects of silviculture and reclamation. Multiple techniques and practices can optimize the success of reclamation, which depends on many factors, including the physical, chemical and biological properties of the site.

Some of the great wealth of silviculture knowledge traditionally used by the forest industry will be explained in a series of publications on selected silviculture topics.

This guidebook explains mounding – a silviculture technique for preparing a site for reclamation. The Natural Resources Canada Canadian Forest Service (NRCan-CFS) developed this guidebook to help with the successful reclamation of disturbed in situ sites.

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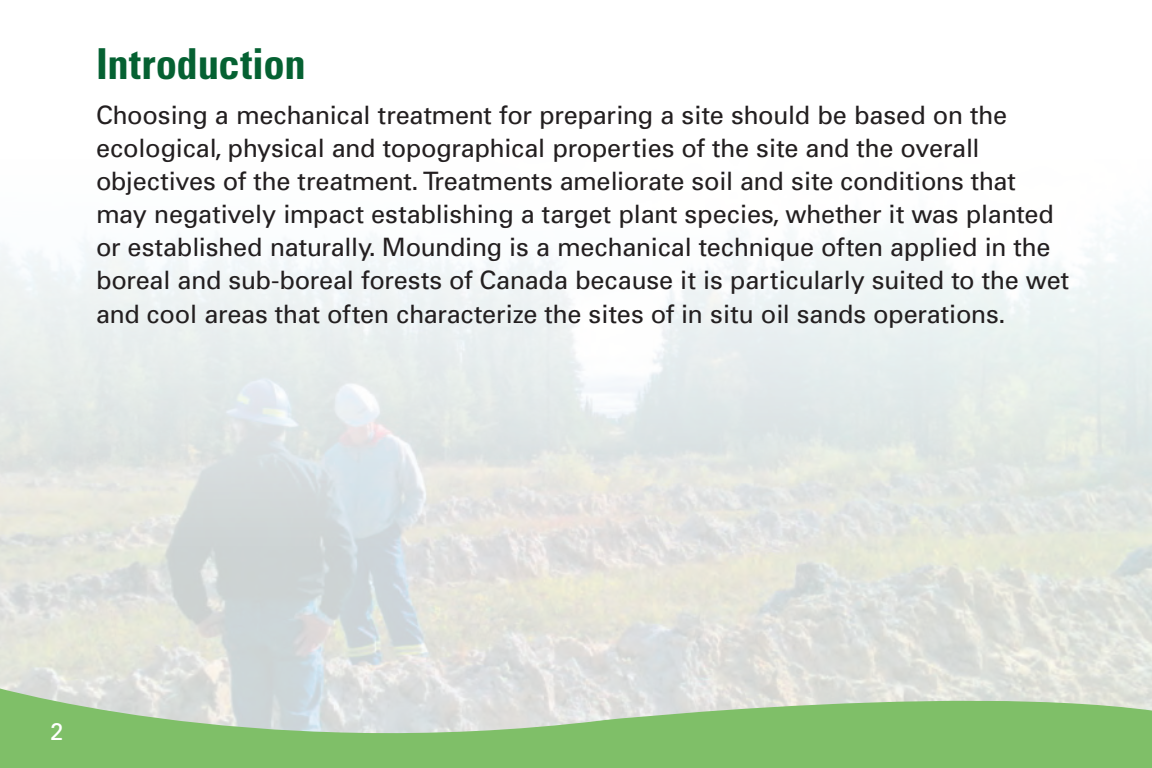
Introduction

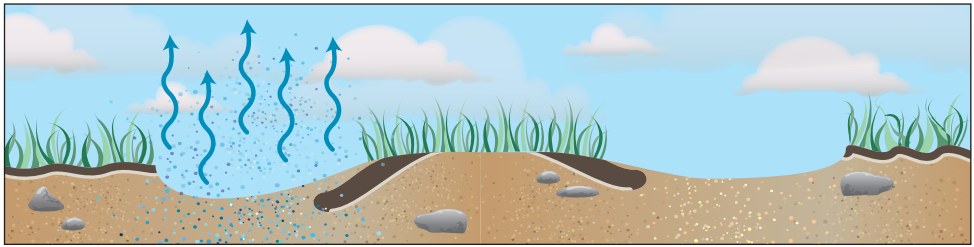
Choosing a mechanical treatment for preparing a site should be based on the ecological, physical and topographical properties of the site and the overall objectives of the treatment. Treatments ameliorate soil and site conditions that may negatively impact establishing a target plant species, whether it was planted or established naturally. Mounding is a mechanical technique often applied in the boreal and sub-boreal forests of Canada because it is particularly suited to the wet and cool areas that often characterize the sites of in situ oil sands operations.



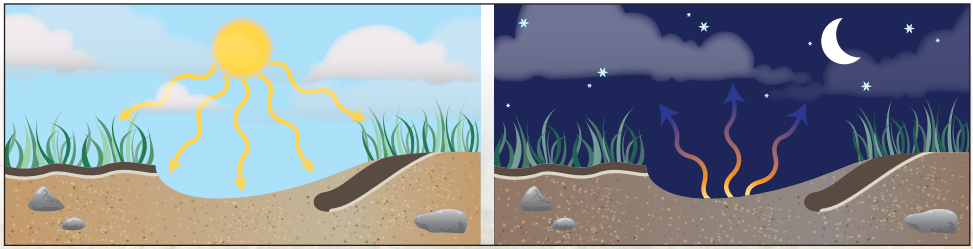
Raised planting spots

Raised planting spots (mounds) can greatly improve establishing seedlings by:

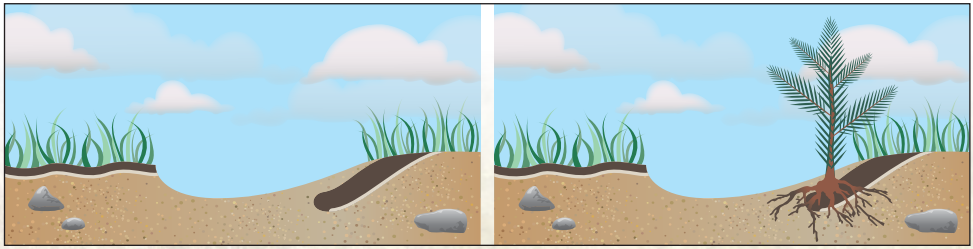
- **Improving microsite drainage and aeration on wet sites**, which is particularly important on clay soils, on sites with high water tables (e.g. treed bog or fen) and on soils compacted by machine traffic (e.g. in-situ sites).



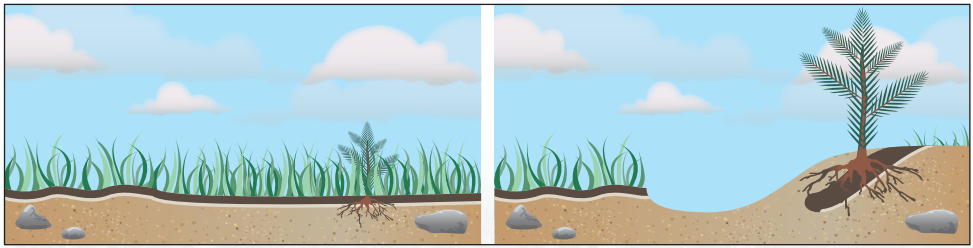
- **Increasing the soil and air temperature**, which causes the growing season to start earlier, improves germination and seedling root growth, and reduces the risk of frost damage. The elevated microsite warms quickly during the day, and the mound and divot retain heat into the night.



- **Improving nutrient availability and the rooting conditions of the seedling**. Redistributing the topsoil and the higher soil temperatures make the organic matter decompose more quickly. Thus plant roots can access nutrients and moisture more easily in the organic layer that is composting beneath the mound.



- **Reducing the negative effects of competing vegetation**. The elevated planting spot, the divot and the soil-covered mound allow the seedling to growth without severe competition for one to three growing seasons.



Types of mounds

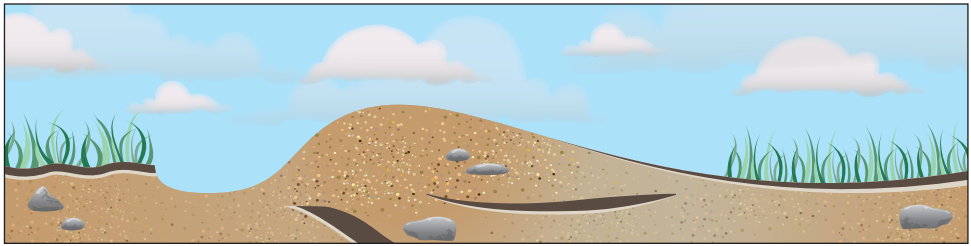
The characteristics of the mound depend on factors such as soil texture and the equipment used. The most important features are the depth of the mineral soil or organic matter capping and the amount and distribution of the organic matter.

The mounds should always have flat-to-concave capping and gently sloping sides. This arrangement helps collect rainwater and prevents the mound from drying out, which can greatly affect the growth and survival of the seedlings, especially on drier sites. Also, avoid building mounds over slash or other woody debris because the mound will tend to dry out.

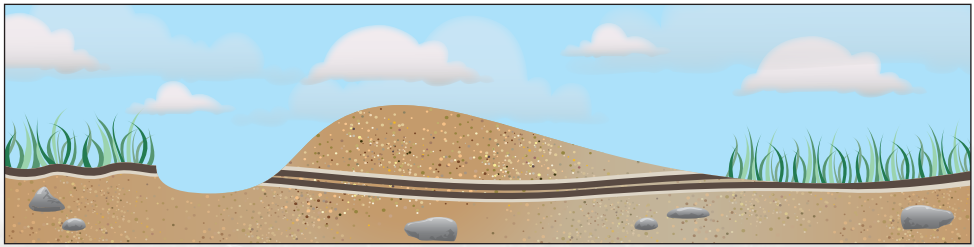
The mound and the soil beneath must form a continuous soil profile, and it is important that the up-turned material is adjacent to the excavated divot. This arrangement improves weed control and ensures a good seal of the mound edges.

Note that creating mounds on reclamation sites can produce mounds made mainly of mineral soil because a distinct organic layer is often absent. The following is a list of the most common types of mounds typical of forestry activities where the organic layer has not been removed:

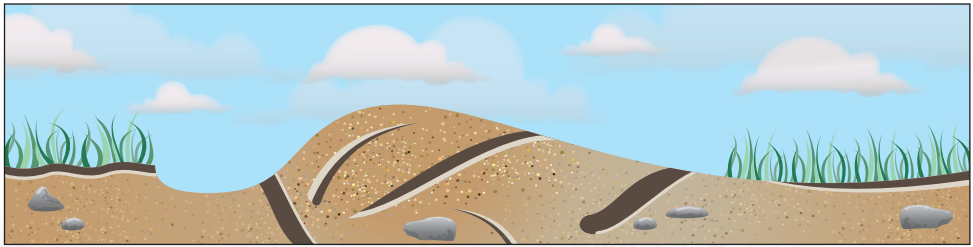
- **Mineral mounds** are created by removing the top soil that is rich in organic matter (i.e. humus) and creating a raised planting spot composed of mineral soil. This method is well-suited for cold and drought-prone sites where nutrients are abundant in the subsoil.



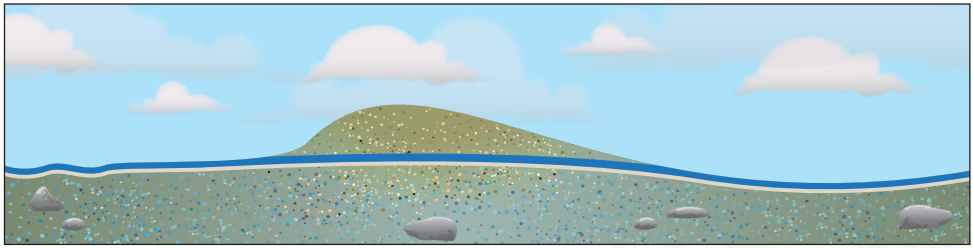
- **Inverted humus mounds** are created by placing a scoop of top soil and the underlying mineral soil upside down. This is the most common and easily employed method. It is well-suited for fine textured soils but it is not recommended for drought-prone sites.



- **Mixed humus and mineral soil mounds** are composed of organic matter and mineral soil. This composition is well-suited for sites that are relatively dry and have few nutrients. It is not recommended for sites that have abundant competing vegetation that can quickly develop from the mound capping.



- **Peat mounds** are commonly used in soils that are often waterlogged for the entire growing season (e.g. in a high water table). Planting the seedling in a mound allows it to develop its roots in a much drier and warmer microsite. This method is well-suited for deep peat soils.



Equipment options for creating mounds

Before you select the most suitable type of equipment, it is important to assess the main characteristics of the site, including the water regime, soil texture, slope and slash conditions. The equipment used to create mounds can be divided in two main groups:

- **Excavator mounding attachments** are versatile and can create any type and size of mound, even on sites that have a thick humus layer and heavy woody debris. Mounding attachments such as a mounding rake (Figure 1) work well on wet sites because excavators tend to have low ground pressure. Also, the attachments can push woody debris aside with the teeth on the back of the rake. A conventional bucket works well on deep peat soils. It is the most efficient and cost-effective attachment, especially on small and isolated sites (e.g. in-situ sites).

Figure 1. Mounding rake

Source: M. A. von der Gönna, section 1.7

- **Skidder or pulled-mounted mounders** are most suitable on gentle slopes that are easily accessed, but they are not recommended on extremely wet sites and on sites that have a thick humus layer or heavy woody debris (Figure 2). Skidder mounders are more efficient and cost-effective for extensive areas (e.g. large clear-cuts).

Figure 2. Bracke mounder

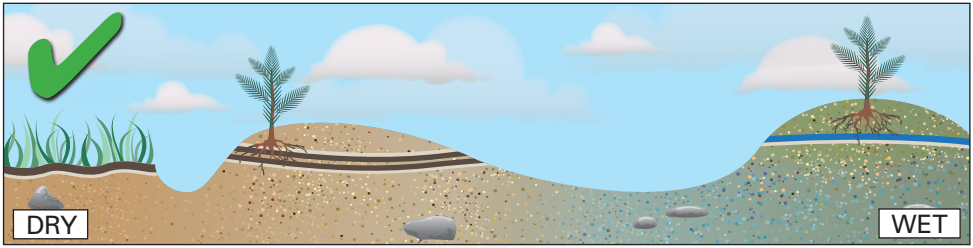
Source: brackeforest.com

Planting spots characteristics

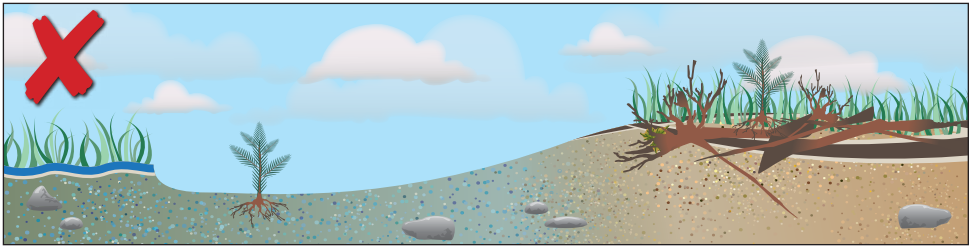
It is recommended to let the mounds settle over the winter to reduce the number of air pockets in the soil. However, the mounds could be promptly occupied by undesired vegetation (e.g. calamagrostis) if they are not planted during the following growing season. Mineral mounds should not be built higher than 40 centimetres (cm) nor be higher than 20 to 30 cm after settling. Peat mounds can be higher on deep organic soil and where the water table is high (e.g. up to 80 cm).

Mounds can be planted with either container stock or bare root seedlings. The root collar of the seedling should be buried up to 5 cm into the mineral soil or the humus layer. Deep planting protects the seedlings from drought stress and frost damage and also protects the root system from potential exposure (e.g. post-planting erosion).

On sites prone to flooding, the seedlings should be planted at the top of the mound, whereas on drier sites, the preferable spot is the slope of the mound on the side facing the divot because it is less affected by weed competition.



The divot and sites that have thick woody debris or an organic layer are not suitable for planting.



You must determine the number of planting spots before you start the site preparation treatment and base the choices on the local regulations for stocking standards and on the target density identified for the site. For example, to achieve a planting density of 1,200 seedlings per hectare (sph), the mounds should be created at 3.1-metre (m) intervals. A planting density of 1,800 sph can be achieved with mounds at 2.5-m intervals.

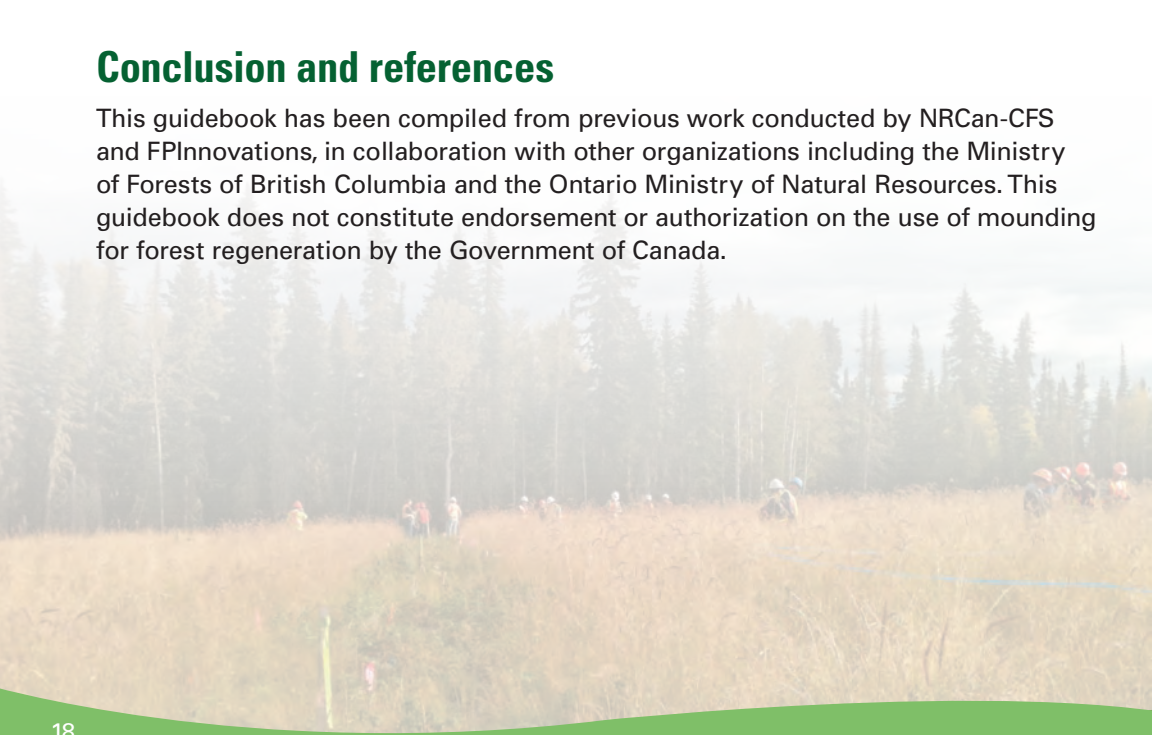
Finally, it is important to monitor and assess the survival and growth of the planted seedlings for three to five growing seasons. If seedling survival is poor, you may need to use fill planting, fertilization and treatments to control the competing vegetation to successfully regenerate the site.

Context information – In-situ sites

Not all challenges to re-establishing the desired vegetation on sites of in-situ disturbances are explained in this guidebook. The industrial activities related to these sites tend to have strong and lasting effects on soil properties, including increased soil bulk density (i.e. soil compaction) and poor soil fertility (e.g. removing the forest floor and topsoil, high salt levels). These soil-related issues should be addressed before a site preparation treatment such as mounding can be successfully applied to reforest the disturbed areas.

Conclusion and references

This guidebook has been compiled from previous work conducted by NRCan-CFS and FPInnovations, in collaboration with other organizations including the Ministry of Forests of British Columbia and the Ontario Ministry of Natural Resources. This guidebook does not constitute endorsement or authorization on the use of mounding for forest regeneration by the Government of Canada.



For more information, see the following publications:

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