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Tilling Frozen Soils with RipPlows and Environmental Risk Assessment

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This technical note is the continuation of the *Tilling Compacted Soils with RipPlows: A Disturbed Soil Restoration Technique* technical note.

Frozen soils are the most difficult soils to till and many cannot be plowed with RipPlows or require some specific practices to increase the probability of success. As a point of reference, the wide bottom of RipPlows cannot penetrate frozen soil nearly as easily as ripper shanks. The depth of frozen soil that limits plowing depends on the depth that the soil is frozen, soil texture, and amount of water in the soil when it freezes; interaction of how these variables affect plowing is complex. Deeper frozen layers of coarse- and medium-textured soils that are not wet can be plowed easier than can finer-textured and wetter soils. Therefore, knowing the depth and hardness of the frozen soil and limiting the trafficking of soil in winter in advance of plowing are important to improving reliability of scheduling winter plowing operations. Most of the early testing of RipPlows was done in winter; unfortunately, the conditions that limit their use are difficult to assess beforehand and can vary across a site. Some observations suggest that if a 1.2 cm diameter piece of reinforcing rod cannot be driven into the soil with a 2 kg hand sledge, the frozen soil mostly like cannot be plowed. In general, soils in the Boreal Ecoregions are more likely to limit the use of RipPlows on a D7 size dozer later in the winter than in the Foothills Ecoregion, where deep snow and less cold can insulate the soil unless it has been disturbed.

- Winter sites should not be trafficked until just prior to plowing because the soil can freeze quickly once the snow cover is removed.

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- Snow that has changed to a more granular ice crystal may have to be cleared from a site to be plowed so that the dozer will have traction.
- Plow winter sites as early in the winter as possible.
- If RipPlows are to work in partly frozen soil, most of the wide bottom of the RipPlows needs to remain below the frozen layer.
- Entering the soil where snow is deeper may allow the plows to get through the frozen layer easier.
- If the depth of plowing cannot be maintained in frozen soil, it is better to back up and to the point where the RipPlows were deeper in the soil rather than continue to try and push them down.
- Going over a frozen soil in more than two cycles to get deeper is not recommended because of the excessive soil mixing and the plows and dozer.
- The most successful three pass tillage of a drier frozen soil was to plow the first pass furrows a second time. The tracks of the dozer remained in the furrow, which improved control and traction, and the RipPlows were able to go deeper. The third pass was a parallel lapping pass between the original furrows and effectively broke the soil to the full depth. Although severe soil mixing occurred in the original furrows, the mixing was avoided on about half the area.
- Plowing soil before it has frozen during the contouring of a reclamation project in winter is a viable option. Once the soil has frozen, it can be handled and trafficked by dozers and other equipment without compromising the outcome of the tillage. Once a plowed soil has frozen, it should not be plowed because it will bring the largest clods to the top and the smallest clods and topsoil will most likely be buried.

Plowing wellsite with frozen surface soil breaks the soil into larger clods which remain on the surface when plowed in two passes.

When plowing frozen soil starting at the edge of an area where soil is not frozen as deep can help get the bottom of the plows under the frozen layer

Environmental Risk

This section refers to environmental risk assessment for plowing frozen and non-frozen soil.

1. On steeper slopes where downslope flow of water is an issue, plowing across the slope is recommended.

- The high porosity of plowed soil will seldom erode from the surface but the water can flow downslope in the bottom of the furrow and exit the soil at the lowest point.
- Surface erosion will be more likely after the soil has had a season to freeze/thaw and settle.
- Slopes should be plowed in ways that water from multiple furrows do not accumulate at one location, and plowing perpendicular to the contour treat the ends of a site should be avoided.
- Periodically starting the plowing on the contour from openings in the edge of adjacent forests will help divert water into the forest that may accumulate in furrows.

2. When plowing narrow, linear disturbances on steeper slopes, Extra effort is required to minimize the flow of water in furrows.

- Water bars and other methods of diverting on these slopes should be installed as required prior to plowing. These structures should insure that water is diverted off the site.
- Plowing cannot reduce the integrity of the water diversion structures.
- Logs that are sometimes placed a cross roads to divert water are not effective on plowed soil because the soil will settle in the furrows and the water can flow under them unimpeded.
- Periodically starting a downslope end of a furrow off the edge of a linear disturbance may help divert water as well.
- A RipPlow on an excavator is probably a better machine for treating linear disturbances on steeper slopes than is a dozer.

3. Protocols for buried pipe and other services must be followed.

4. Workers on foot should be warned not to walk in furrows but to always step across them.

- The largest voids are often in the bottom of the furrow, which can sometimes be covered with unstable clods. Stepping on or near these clods could result in their collapse and falling with a leg caught in the furrow.
- Soil around furrows will remain unstable until a freeze/thaw cycle and effectively fractured the large clods and filled the voids.