

# PRACTICES TO EFFECTIVELY TILL INDUSTRIAL FOREST SOILS

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Minimizing the footprint of industrial operations on forest lands is an important goal for maintaining the integrity and sustainability of forest species and communities. Industrial operations and facilities that include vehicle trafficking and moving soils can have a lasting impact on the ability of these areas to be returned to forests and produce the values, goods and services that the land supplied before disturbance.

The development of industrial facilities of all types generally causes some level of soil impacts unless practices are used to insure that the soil freezes into a solid mass prior to trafficking. The direct soil impacts and ecological consequences of soil trafficking are a complex interaction of soil, machines, and environment (Froehlich and McNabb 1984). Soil impacts include the following: compaction, reduced soil porosity, destruction of soil structure, and formation of massive soils depending on the severity of trafficking and soil moisture content (McNabb 1995). The common consequence of trafficking is impaired hydrologic function of the soil. Effective soil tillage to decompact and restructure soil by increasing soil porosity is required to restore hydrologic function and increase plant root access to the soil profile. Increasing soil porosity will also allow other soil development processes to eventually produce a more natural, fully functioning soil profile.

A wide range of teeth, shank spacing, and tooth modifications are used to till forest soil, but are less effective than tillage implements designed for deep tillage (Andrus and Froehlich 1983). Increasing clay content and soil wetness limit the effectiveness of these implements to a critical depth below which soil only flows around the shank and tooth (Raper 2005). Even subsoilers specifically designed for deep tillage are ineffective for deep tillage under these conditions (McNabb 1994). In the early 1990s, nontradi-



FIGURE 1: RIPPLAWS® ARE USED IN PAIRS.

tional tillage practices produced some effective soil treatments for forest logging roads (McNabb 1997). While these practices were highly effective, they were impractical for use on many industrial lands. To overcome these limitations, RipPlaws® were developed for deep plowing through topsoil without inverting the profile. The large voids created by plowing allow the freeze/thaw process to restructure the entire tillage zone in as little as one freeze/thaw cycle. Deep soil tillage with RipPlaws® improves hydrologic function of the soil profile, minimizes the loss of topsoil, is effective across a wide range of soil moisture conditions, and avoids

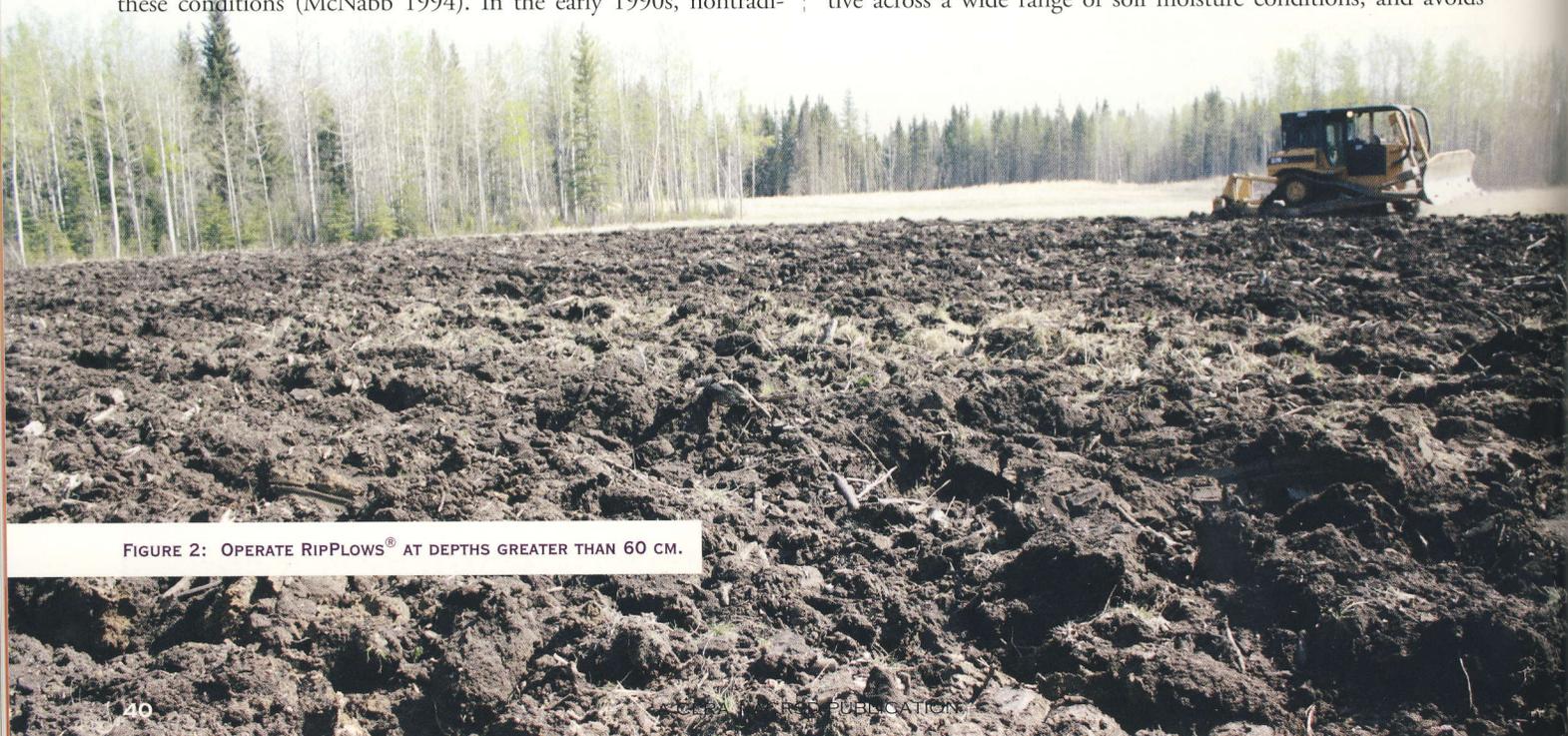


FIGURE 2: OPERATE RIPPLAWS® AT DEPTHS GREATER THAN 60 CM.

trafficking of previously plowed soil; hence, soil tillage is done after all soil handling has been completed.

The purpose of this article is to present the effective application of RipPlows® as a soil restoration implement on disturbed, industrial sites. The gain in soil elevation (difference between the elevation of soil along transects before and after tillage) is used as the principle indicator of the effectiveness of soil tillage (McNabb 2011).

### RECOMMENDED PRACTICES

The RipPlows® are designed to be used in pairs in the outside pockets of a multi-shank toolbar (Figure 1). In this position, dozers will not be trafficking plowed soil, which will maximize the effectiveness of the freeze/thaw process, and the rougher surface will provide a wider range of microsites on which vegetation may become established. More than half the elevation gain from plowing can be lost in driving a machine across plowed soil. Control of the dozer is always maximized when both RipPlows® are operating in similar soil conditions. RipPlows® should not be in the ground when turning.

The RipPlows® should be operated at depths greater than 60 cm (Figure 2). It has been observed that plowing at depths less than 60 cm increases the mixing of soil layers. Hence, more subsoil comes to the surface and is mixed with the topsoil. Furthermore, deep plowing improves the hydrologic function of the soil profile, increases the volume of soil available to sustain maturing perennial vegetation, and serves as a buffer to climatic stresses. Deep plowing will generally lower any temporary water table where a high water table is likely to affect forest establishment.

The soil should be plowed in straight lines, and should be implemented in parallel and over-lapping passes. This allows the RipPlows® to always operate in unplowed soil. The first pass of a pair of RipPlows® will cover about 30-35 percent of the area being tilled. Lapping the first pass will result in 1 m wide furrows and cover a minimum of 65 percent of the area. The second pass generally fractures all of the soil between the first pass furrows (Figure 3). Hence, the effectiveness of the second pass plowing is improved if the furrows are straight and evenly spaced. At the end of the furrow it is advised to minimize shallow plowing by simply lifting the plows out of the ground.

The optimal soil moisture for plowing is operationally wide-ranging, but moist soils are preferred. Dry and wet soils require



FIGURE 3: PLOW SITES IN STRAIGHT LINES AND MAKE A SECOND PASS PARALLEL AND BETWEEN THE FIRST PASS FURROWS TO MAXIMIZE COVERAGE AND MINIMIZE LOSS OF TOPSOIL.

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FIGURE 4: SOIL PILED UP IN FRONT OF THE TOOLBAR CAN OFTEN BE CLEARED BY TEMPORARILY RAISING THE TOOLBAR A SHORT DISTANCE.

more power to pull RipPlows®, which can limit the depth at which RipPlows® can operate. Wet soils also require more strain to fracture the soil; hence, the front tooth will need to be tilted down and/or the soils plowed less deep (which is not ideal). Whenever possible, plowing should be scheduled so that soils will be moist at the time of soil freezing.

#### OPERATIONAL CONSIDERATIONS

When plowing gentle slopes, it is recommended to make the first pass downslope. The first pass always requires the most power; the plowing will be deeper and more efficient if the first pass is downslope. The lapping second pass will be easier (and deeper) going uphill

after the first pass has been completed.

Small cyclic changes in the depth (3-5 cm) of plowing can reduce the power required for plowing and increase speed. When plowing requires more power, the requirement can be reduced by temporarily raising the RipPlows® higher. An added benefit is that it may help clear soil piling up in front of the toolbar (Figure 4).

Dozers should not attempt to turn while RipPlows® are in the ground. Some steering in wide curves is possible with RipPlows® in the ground, but the radius of the curve is generally greater than 100 m. If a dozer is unable to track a curve easily, the radius is too short to plow with RipPlows® in the ground. The alternative

is to plow short curves in short straight segments.

Except for short distances, turning the dozer around will generally provide better control than backing between the furrows of the first pass to make the second pass. Backing between furrows requires the dozer to remain on the inter-furrow soil. Otherwise, the dozer will drift into the plowed furrow and reduce the tillage benefit of the first pass.

#### CONCLUSIONS

RipPlows® are an effective implementation for the deep tillage of severely impacted soils in a single operation. This tool can restore the hydrologic function of the soil and its accessibility by the roots of perennial forest vegetation. The primary advantage of RipPlows® is that the large voids created between clods by plowing enhance the ability of the freeze/thaw process to fracture the soil. The roughness of the plowed soil also creates a wide range of microsites on which native forest vegetation can be established. ■

#### REFERENCES

- Andrus, C.W., and H.A. Froehlich. 1983. An evaluation of four implements used to till compacted forest soils in the Pacific Northwest. Res. Bull. 45. For. Res. Lab., Oregon State Univ., Corvallis. 12p.
- Froehlich, H.A., and D.H. McNabb. 1984. Minimizing soil compaction in Pacific Northwest forests, p. 159-192. In E.L. Stone (ed.), Proc. Sixth N. Amer. For. Soils Conf., June 1983, Univ. Tennessee, Knoxville.
- McNabb, D.H. 1994. Tillage of compacted haul roads and landings in the boreal forests of Alberta, Canada. Forest Ecol. Manage. 66: 179-194.
- McNabb, D.H. 1995. Effects of soil modifications on soil physical processes, soil quality, and ecosystem health. 32nd Annual Alberta Soil Science Workshop, March 13-15, 1995. Grande Prairie, Alberta.
- McNabb, D.H. 1997. Rehabilitation of forest haul roads, p. 177-189. In: Compiled, B. Stokes et al., Forest Operations and Environmental Protection, Proc. Symp. IUFRO Proj. Group P3.11.00. XX IUFRO World Congress, 6-12 Aug. 1995. Tampere, Finland.
- McNabb, D.H. 2011. Assessing the Effectiveness of Forest Soil Tillage Practices. 34th Council on Forest Engineering Ann. Mtg., June 12-15, 2011, Quebec City, Canada.
- Raper, R.L. 2005. Subsoiler shapes for site-specific tillage. Appl. Eng. Agric. 21(1): 25-30.

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