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INSTALLATION OF A LOG BUNDLE FOR WATER MANAGEMENT DURING WINTER ROAD DEACTIVATION

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Introduction

Water management for winter roads needs to be carefully considered and planned in order to achieve a high level of environmental performance. Where water from a road surface or ditch needs to be managed, planning ahead can help achieve a high level of environmental performance with respect to protecting streams from sedimentation. Winter roads function well when frozen, yet are highly erodible during non-frozen periods. This paper presents aspects of planning and construction regarding water management for winter roads and focuses on a trial construction of a cross-ditch beginning with installation of a log bundle during road construction and ending with its removal during road deactivation.

Background

During January 2018, FPInnovations identified a site for a trial installation of a log bundle in a winter road (Figure 1). The intent was to construct the log bundle in a way that allowed for its removal during road deactivation. The removed bundle results in a wide, deep void, which promotes the development of a cross-ditch more readily than excavation alone. The winter road was being constructed near a stream crossing.

The road grade approaching the stream was approximately 14%, and the log bundle was approximately 20 m from the stream crossing. The uphill distance over which water would travel toward the stream (connectivity) along the road surface and ditch was approximately 175 m. A risk rating table (Table 1) presented by Gillies and Belyea (2017) ranked the road section approaching the crossing at a high risk for sediment delivery, and highlighted the need for a water control plan. All moderate- to high-risk ratings for potential sedimentation should be shown on the harvesting and road construction plan. As well, both a construction and deactivation plan should be developed for the water management approach to address the siltation risk.

Figure 1. First two logs of a bundle positioned at a skew in the excavation through the road.

Installation

The log bundle was constructed using 11 logs; each log was approximately 14 m long and was without limbs. The construction took 25 minutes, which included excavating for log placement, placing the logs, backfilling, and building a ditch block at the inlet of the bundle. During backfilling, it was important not to cover the length of logs at the inlet or outlet of the bundle. The inlet logs protruded 2–4 m; the outlet logs protruded 2–6 m. The ditch block was made from competent soil (without snow or ice) and was constructed at the log bundle inlet to direct ditch flow into the log bundle (and eventual cross-ditch) (Figure 2).

Table 1. Winter road risk rating for sedimentation

Gradient and slope class	Risk rating[a]			
	Distance between grade breaks			
	0–20 m	21–40 m	41–60 m	61–80 m
5–9% Gentle	Low	Low	Low	Moderate[b]
10–14% Moderate	Low	Moderate[b]	Moderate[b]	High[b]
≥ 15% High	Low	Moderate[b]	High[b]	High[b]

[a] A higher risk rating should be used where native soils are highly erodible and (or) where the protected water resource has direct connectivity to fish-bearing habitat.

[b] Sites that have a moderate- to high-risk rating for potential sedimentation should have a road construction and water control plan designed, with those measures included in the harvesting and road construction plan and pre-work meeting.

Figure 2. View of inlet of the completed log bundle showing the various log lengths and the position and composition of the ditch block (solid oval).

Deactivation

The log bundle was removed with a 25-ton excavator during deactivation of the winter road. The logs were removed easily, and the cross-ditch was completed within 15 min. The cross-ditch was 1.5 m deep and 2.5 m wide at an approximate skew of 30–45º from the road centerline (Figure 3). The excavator dug into the ditch block slightly while locating and grasping the logs at the inlet. All logs were removed and left on-site. The deactivation at this site included removing the bridge and providing erosion control of the exposed soils.

Figure 3. Cross-ditch with water through the flow path and logs left on-site. The arrow indicates the flow path of ditch water entering the cross-ditch.

Discussion

The cross-ditch constructed during the log bundle removal was much larger (wider and deeper) than non-log bundle cross-ditches along the road. The log bundle cross-ditch was functioning well by directing sediment- laden water from the ditch and road toward the forest floor. The deposition area for the sediment was obvious, and the volume of sediment deposited was estimated to be 1–1.5 m^3 (Figure 4). The amount of deposited sediment was significant, which otherwise would likely have reached the stream channel.

Figure 4. View of the sediment deposition area (dashed oval) immediately downhill from the cross-ditch outlet.

In order to have ditch water directed into the cross-ditch, it is important that the ditch block is made of competent material and is not failing or eroding. This was accomplished by using the mineral soil on-site during the opening of the road. Constructing a ditch block during deactivation is not as favourable, considering that snow and ice are easily mixed with the soil, which produces a less desirable, more erodible ditch block.

Due to soils being frozen during deactivation, the non-log bundle cross-ditches were more difficult to excavate, which resulted in smaller (shallower and narrower) cross-ditches. The smaller cross-ditches are appropriate where there is a low risk of sedimentation reaching a watercourse. Some of the smaller cross-ditches were performing well (directing road and ditch water toward the forest floor); others showed signs of sedimentation within them (Figure 5). The skew and depths of a cross-ditch need to be sufficient to keep sediment from depositing within the cross-ditch (self-flushing/self-cleaning).

Cross-ditches need to be carefully planned and constructed in strategic locations to prevent water from ponding along the road surface. Low areas of a road should be identified as a high likelihood to accumulate water and will require adequate drainage (Figure 6). Standing water will weaken a winter road resulting in the need for remediation before reuse.

Figure 5. Typical cross-ditch constructed by excavating through frozen soils. Note the sedimentation within the cross-ditch, and the ponded water.

Figure 6. Winter road during spring, showing ponded water along the ditch and road surface. This is a good location to plan for the construction of a cross-ditch.

During winter road deactivation, it is important to locate and remove all the log bundles that were designed for removal. The log bundles designed for removal are shallow in the road, and are not constructed with a separation layer to prevent infilling from road material. Over time, a log bundle constructed in this manner can become infilled with sediment and will not function to pass any water (Figure 7).

Figure 7. Dashed line indicates location of a log bundle that was left in place during deactivation. The bundle is not passing ditch water that is accumulating uphill of the inlet, and there are signs of sedimentation in the ditch.

Moderate- to high-risk sites should be identified during the planning phase. These sites should be marked on harvesting and road construction maps, and a water-control plan should be developed. Maps and plans should be discussed with equipment operators and supervisors during pre-work meetings, which will help provide clear direction on sediment management.

Conclusions & Recommendations

Planning ahead for winter road water management can help achieve a high level of environmental performance by preventing sediment delivery into watercourses. Winter roads are highly erodible during non-frozen periods. Scheduling water management construction activities during non-frozen periods was shown to be beneficial. This timing improves the ability to construct a water management feature, such as a cross-ditch, compared to working during frozen conditions. The cross-ditch constructed from the removal of a log bundle was larger and functioned well compared to those constructed by excavating through frozen soils alone. Part of the success of the log bundle cross-ditch was attributed to a competent ditch block, which was built with local soil, and to the planning and timing, which avoided periods with snow or ice.

The following are additional recommendations:

- Plan to install cross-ditches where ponded water may accumulate. Where roads are used annually, mark water-accumulating locations for easy reference.
- Remove all log bundles that were designed and constructed for removal. Leaving them in place can cause negative road and environmental impacts.
- The inlet of the log bundles should be marked to aid in the removal during deactivation. This could be a log placed vertically in front of the ditch block.

References

Gillies, C., & Belyea, D. 2017. *Planning and constructing winter resource roads: a discussion paper on water management needs and solutions.* (Technical Report No. 16364). Vancouver, B.C.: FPInnovations.