Final Report
Harvest and Transportation Plan
for the
Siouxon Planning Area

July 1988

prepared by
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Class of 1988

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Preface

The senior Logging Engineering class at the University of Washington, College of Forest Resources developed a complete timber harvest and transportation plan during Spring Quarter 1988. The plan was produced for the Department of Natural Resources as a class project.

The class as a whole obtained valuable field experience in many of the activities associated with a logging plan and timber sale layout. The students were able to get hands-on experience in planning a comprehensive logging and transportation system for a 2850 acre drainage. Knowledge was also gained in the logistics of logging paper plans, cost estimation and reports for the sequential development of a section of land proposed for timber harvest.

This report is a complete analysis detailing alternatives considered and alternatives recommended. It is a documentation of the preliminary planning, reconnaissance, and design work accomplished by the class.

The following documents were prepared and are part of the overall report:

1. Final Report

2. Appendix material, 6 volumes, including plan profile and cross-section drawings of designed roads

3. Topographic base map, scale 1" = 400' with overlays as follows:
   - soil and stream type overlay
   - timber type overlay
   - proposed road and harvest unit overlay

4. Set of 8 disks for the HP-9836 system containing:
   - design information for the designed road (3 disks)
   - skyline profiles used in analysis (3 disks)
   - transportation analysis (2 disks)

5. Field notes: reconnaissance, profile traverse, road traverse, boundary traverse.
The submitted harvest and transportation plan is seen as a general framework providing the local manager with a rational evaluation and decision basis.
Executive Summary

OBJECTIVES

This report was prepared for the Department of Natural Resources (DNR) by the University of Washington Senior Logging Engineering Class during the Spring of 1988. It contains a comprehensive harvesting plan and road system for most of the Siouxon planning area, Skamania County, south of Cougar, Washington (Township 6N, Range 5E, Willamette Meridian, sections 28, 29, 30, 31, 32 and 33. The Siouxon planning area contains mostly seventy to eighty plus year old conifer stands natural reestablished after the Yacolt burns of the early part of this century and contains approximately 2850 acres.

The DNR’s objective for the Siouxon planning area was twofold: First, to maximize revenues to the trust, and to provide access to an unroaded area for fire protection and proper management. The age and volume of the standing timber was a concern.

With most of the timber in the planning area in the 70-80 year age class, active management of those stands had to begin soon in order to capture the full value of those stands. Also, National Forest lands to the south and east of the planning area were considered for different uses, including a roadless area designation. It was therefore important for the DNR to develop a management and harvest plan which would then allow a thorough analysis of different management objectives.

Second, with the availability of new computer hardware and software packages to regional engineering staff, this project provided an opportunity for a full testing and evaluation of those new tools. The Department was embarking on a new project to introduce new, analytical tools and methods by which harvest- and transportation planning was to be carried out. A software package called Preliminary Logging Analysis Systems (PLANS) developed by the USFS was adapted to the HP-9836 workstation through the Engineering Division of DNR. It was now available in its entirety and this project provided an opportunity to test and evaluate the "PLANS" package and to develop a user’s algorithm for DNR staff.

The University’s objectives are as follows: provide students with the opportunity to apply classroom skills to a real world project, provide the DNR with a harvest plan and road system that will help them fulfill their obligations to their trusts, evaluate tradeoffs between the DNR’s action plan which tries to get in early to capture high volumes and the University’s action plan which tries to maximize revenue by concentrating on minimizing road costs year by year, and provide the DNR with a guideline or system for developing harvest plans and road systems.
ACCOMPLISHMENTS

The planning work resulted in the following:

- a harvest and transportation plan

- field verified road location for major haul roads. A total of approximately 12 miles were reconed of which 8 miles were finally located and blazed:
  
  upper Siouxon road  
  lower Siouxon road  
  backside road

- traversing, staking and designing of the Upper Siouxon road—a total of 75 stations

- the replacement of Trails End #2 sale with a new unit design in order to better fit the overall harvest plan.

- a cost and revenue analysis for three different harvest sequences.

HARVEST UNITS AND ROADING REQUIREMENTS

The final, proposed harvest unit- and road system plan evolved out of the Skyline Paper plan and its field verification. Based on road reconnaissance, final road locations were either accepted, rejected or modified. The proposed road system, showing field-verified and paper located roads is shown in Figure I. With a field verified road plan in place the landings and harvest unit boundaries were reconsidered one more time. In this step the intent was to fully utilize the required roads for additional landings where appropriate. The objective was to shorten the AYD’s of existing units by adding additional landings without adding more roads. For example, the number of landings increased from 65 to 78 with a corresponding decrease in setting size and AYD from 41 to 36 acres and 612 to 556 ft., respectively (Table I). Similarly, roading requirements were reduced significantly especially in the 50-70% slope classes (109 station down to 60 station).

Table I also compares roading requirements of the Final Harvest Plan with and without a bridge across a type 3 stream requiring an 80 ft. span. Besides eliminating the bridge a total of 29 stations of roads are eliminated as well, including most of the access roads to the bridge.
Table I. Summary of harvest unit and roading requirements for the Final Harvest and Transportation Plan.

<table>
<thead>
<tr>
<th></th>
<th>With Bridge</th>
<th>w/o Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area harvested (acres)</td>
<td>2850</td>
<td>2850</td>
</tr>
<tr>
<td>Total Volume harvested (MMbf)</td>
<td>114.6</td>
<td>114.6</td>
</tr>
<tr>
<td>Average Volume/acre (Mbf/acre)</td>
<td>40.2</td>
<td>40.2</td>
</tr>
<tr>
<td>Number of settings and landings</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Average setting size (acres)</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Average slope AYD (ft.)</td>
<td>556</td>
<td>556</td>
</tr>
<tr>
<td>Total road length proposed (miles) (station)</td>
<td>18.5</td>
<td>17.9</td>
</tr>
<tr>
<td>Road density (miles/section)</td>
<td>4.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Volume accessed/station (Mbf/station)</td>
<td>117.5</td>
<td>121.1</td>
</tr>
<tr>
<td>Road length by slope class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-30% (station)</td>
<td>422</td>
<td>419</td>
</tr>
<tr>
<td>30-50% (station)</td>
<td>493</td>
<td>467</td>
</tr>
<tr>
<td>50-70% (station)</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

During the field reconnaissance attention was also paid to the bridge crossing and road locations leading to it. As discussed in Chapter 4, there is some concern about the perceived stability of the east bank and slope in the vicinity of the bridge. The bridge location itself is stable (bedrock foundation for piers and abutment). However, a recent (approximately 2-5 year old), slope failure with stream entry was found about 800 ft. above the proposed bridge location. Furthermore, all of the eastern bank and slopes through which the proposed access road is located shows similar signs of past, local slumps and earth movement. Using a "stability rating system" developed by St. Duncan, Weyerhaeuser Co., a stability index of 32 was calculated, putting the proposed road into the category of "maximum engineering" with an estimated 75% failure risk.

The volume per unit area for the various settings was again revised based on field information and personal communication with the District Manager. This information proved to be one of the most elusive facts; however, it is one of the most crucial harvest planning input there is.
HARVEST SCHEDULES AND COSTS

A major cost determinant besides road and harvest costs is the cost of time, that is, when a particular project, be it a road/bridge construction or harvesting cost, is incurred. The basic approach here is to defer high-cost projects into the future as long as possible to avoid the "penalty" of interest rates that is carried on expended capital funds.

This approach has to be weighted against revenue or income generation. Here, the basic approach is to harvest high-volume timber-stands as early as possible. The indicators here are net revenues, or stumpage. The higher the perceived stumpage per unit for a particular sale or unit, the earlier should its harvest be scheduled.

Three final harvest schedules were formulated for analysis. The first schedule was formulated by the UW. The second was formulated using the DNR’s initial five year plan for the planning area, and the third schedule was formulated as a combination of both. These schedules are referred to as the Late Access solution, the Early Access solution, and the Combo solution.

The Late Access solution was formulated with intent to minimize road construction costs for every three-year harvest period. In addition, the plan tried to accommodate some of DNR’s objectives by hastening the access towards the east and southeast parts of the drainage. Rather than taking DNR’s approach of building a bridge, an alternative over the "back side" was selected whereby timber sales were scheduled somewhat earlier down the backside (Figure II).

The Early Access solution was formulated using DNR’s initial five year harvest plan and completing the schedule using the criteria implemented in the Late Access solution. This initial five year plan is illustrated in Figure III.

The Combo solution was formulated using only part of the DNR initial five year plan and then continuing the scheduling using the criteria implemented in the Late Access solution. Only the sales along the upper Siouxon Road and west of the proposed bridge crossing were scheduled during the first harvest period.

One of the central questions underlying the three different harvest schedules was the evaluation of the need for a major bridge crossing in order to access some high volume timber stands in the southeast corner of the drainage. Or, in very general terms, which harvesting sequence results in the highest "net revenues", or stumpage to the trust.

A network analysis was carried out for the three harvest schedule sequences. The objective was to determine which of the three schedules resulted in the highest stumpage. Here stumpage was defined as mill price minus total costs. Total costs included yarding costs (fall, buck, yard and load) haul cost and required road construction costs.
For analysis purposes two mill prices were considered, a high of $450/Mbf and a low of $300/Mbf. A discount rate of 5% was utilized.

The highest stumpage or revenue is produced by the Late Access plan without the bridge link (Table II). The lowest stumpage is produced by the Early Access plan with the bridge being built. The difference between the two plans amounts to $450,000, a mill price of $450/Mbf ($320,000 for a mill price of $300/Mbf). Any solution that does not utilize the bridge (even the Early Access plan) provides higher returns than when the bridge is built.

The Early Access plan has overall lower yarding and haul cost (30.75/17.98 $/Mbf versus 32.70/18.52). However the cost of the bridge makes it the plan with the most expensive road construction costs (6.71 versus 4.97 $/Mbf). Nevertheless, total costs are slightly lower for the Early Access plan than for the Late Access plan (55.44 and 56.19 $/Mbf) primarily the result of lower yarding costs. However, total mill prices paid, a result of volume brought to the mill is highest for the Late Access plan by a larger margin making it the best solution.

A sensitivity analysis was carried out to see at what mill price the two plans would become equal. The mill price had to drop to $100/Mbf in order for that to happen.

RECOMMENDATIONS

Bridge

The inclusion of the bridge link results in higher costs under any scenario. A bridge decision should be deferred as long as possible, such as 16 or 22 years, the first time when it could be utilized either by the Combo or the Late Access plan. Cost differences at that time are not as significant anymore. This allows a better assessment of the slope stability of the cut bank through which one bridge access road leads. The whole eastern bank and slopes are considered marginally stable with a potential road failure risk calculated at 75%.

Harvest Plan Schedules

The Late Access plan with its forced harvest schedule down the backside road should be reconsidered. The low timber volumes there harvested early on result in higher, discounted yarding costs. A rescheduling could improve the cost picture. In any case, DNR management should consider additional harvest schedule variations.
Timber Sale Trails End #2

Local management had outlined a number of sale units, among them the Trails End series. Trails End No. 1 and 3 can be incorporated in the overall developed harvest plan without compromising future settings. However the No. 2 unit posed serious problems for future, surrounding units. Therefore a new layout was recommended and its new boundaries marked in the field.

Upper Siouxon Road

As part of the Trails End sale units a road was located and traversed by local management. As part of the overall harvest plan and map study a higher, but better road location was found and confirmed in the field. The new location was approved, traversed and designed.

Traffic and haul volume, however, will be greatly affected by any bridge decision. If no bridge is built, total volume hauled over the road is only 13 MMbf of which almost 9 MMbf will be hauled during the first 10 years. If a bridge is built (e.g. under any one of the scenarios) then the timber volume hauled over this road approaches 34 MMbf evenly distributed over the time periods. Obviously road standard and design will be affected by such a decision.