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## ***Harvest Residue and Forest Stewardship:***



## **An EXAMINATION of Four BC Forest Districts**

**Field review carried out in  
September and October 2006**

For: Ministry of Forests and Range  
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## Executive Summary

High levels of residue or slash as a result of logging is not surprising in old growth forests, particularly BC coastal temperate rainforests. This review was carried out in response to concerns expressed by Forest District Staff and the public. The concern regarding residue may be centered on a perception that either there is a general lack of care (or stewardship) during logging, or that the province is not getting full economic value for provincial timber. This project was designed as an initial exploration of the stewardship concern only. The economic concern was not part of the terms of reference for this project, and therefore is not addressed in this report.

Based on the assessments conducted under this project in four Districts (North Island, North Coast, Fort St. James, and Columbia), it seems that the change in policy (take-or-pay) may have increased the amount of merchantable residue on site (either dispersed or in accumulations), yet the impacts on stewardship for long-term timber management appear to be limited to some localized impacts on Coastal heli-logged sites. Impacts on non-timber resource values, or fire risk were not apparent from this sample. Further study a broader scale may be required to determine if these impacts or risks exist.

Timber management impacts on the Coast were centered on stocking of regeneration, long-term overstory retention, and species management. While high accumulations of slash on Coastal heli-logged sites do not seem to preclude adequate stocking to minimum standards, it does seem to require frequent use of minimum inter-tree spacing to attain minimum stocking, resulting in clumpy tree distribution due to slash loading. However, it is expected that natural regeneration on these sites will result in less clumpy tree distribution at or near target stocking levels. Adjustments in the next timber supply review (TSR) may be necessary if the amount of helicopter logging is significant and if tree distribution is significantly clumpy.

Excessive retention of uneconomic trees in poor general condition within partial cut stands, exacerbated by mistletoe infections, has the potential to impact future economic opportunities by: negating future harvest entries in the near term; influencing understory species composition strongly toward hemlock; and significantly reducing growth in the long term. Some of these partial cut stands are in areas outside the timber harvesting landbase and therefore may not directly impact the timber supply in the area. If there is sufficient scale and scope to this practice, impact on timber supply and future timber values as well as non-timber values in these areas could be substantial. This issue goes beyond waste and residue and is tied to species selection, stocking standards and other questions. The issue should be a priority for continued exploration, discussion, and development of strategic direction. This work may be led by, or coordinated with, the FRPA Coast Region Implementation Team (CRIT) currently investigating it.

Many of the sample areas were either planted or planned for planting. This practice helps to encourage a mixture of species beyond the prolific hemlock that naturally seeds into areas with a high degree of organic residue. Yet, planting in these areas is

expensive. Therefore, species composition in Coastal heli-logged blocks should be monitored to ensure species diversity objectives are being met at the stand and landscape level.

Data collected at the block level did not point to a significant fire risk issue for the sample blocks in the four Districts assessed. However, this doesn't mean that fire issues do not exist. As an initial exploratory assessment for stewardship in general, the sampling approach was not designed for a comprehensive look at the fire risk in BC associated with current harvesting and abatement procedures. A recommendation is included to explore concerns emerging about landscape level impacts of logging residue in the beetle-kill zone, or other broad scale fire risk issues that were not assessed in this project.

Excessive logging residue did not appear to be a stewardship concern for timber management in the interior districts. However, the potential impacts on soil productivity, and ultimately long term growth and yield, of a lack of well-distributed woody debris due to current mechanical harvesting techniques with processing at roadside and the potential soil disturbance impacts from piling this material was identified as a concern and should be investigated further. If significant, strategic direction may be needed to minimize these impacts, balanced by careful consideration of the full range of resource management objectives and potential risks (including fire).

For non-timber values such as cattle, wildlife and biodiversity, logging residue does not appear to be having a significant impact at the block level. Cumulative issues that may occur at the landscape level, such as large scale loss of range due to high slash loads, were not assessed.

For any of the stewardship conclusions in this report, it should be noted that the cutblocks assessed represent a small snapshot in time and space, reflecting the conditions in four Districts (mostly 2005 data with some 2006 data where available) in cutblocks that showed high levels of billable waste. Trends may be emerging in these or other Districts regarding fire risk or other concerns that this sample does not reflect.

## Sampling Methodology

For expediency sampling was done using blocks where high levels of residue were identified, and in Districts with higher proportions of billed residue in general. Using these blocks of identified "high interest", the focus area questions were explored. If concerns were confirmed on individual blocks, the context and scope of these potential concerns were to be explored and extrapolated to the entire District to determine the true nature and extent of these concerns.

Districts with the highest levels of post harvest residue were identified using the harvest billing system and the waste billing system to calculate a ratio of residue to total volume harvested. The top three Districts on the coast, and the top three Districts in the interior with the most billed residue as a proportion of the total volume harvested became the focus for the project. Initial sampling focused on the top two districts on the coast, and the top two in the interior (one from the North and one from the South), with additional Districts to be sampled, if deemed necessary after the initial sampling.

June 4, 2007

Working with the waste and residue specialist in the Districts of Interest, a population of blocks was identified for high levels of residue. Only blocks logged since the implementation of the 'take or pay' policy were considered, focusing on 2005 cutblocks, and those blocks in 2006 for which there is waste billing information. A total of fifteen blocks were randomly chosen from the population of interest in each District. Of this subpopulation of blocks, a potential subsample of ten blocks was targeted for sampling (with a minimum subsample set at five blocks). This approach allowed for: substitution of blocks within the actual sample to ensure efficient sampling and added sampling where time permits.

A further description and details regarding the methodology and evaluation procedures is available in Appendix 2 of this report.

## Table of Contents

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<b>EXECUTIVE SUMMARY .....</b>	<b>I</b>
<b>SAMPLING METHODOLOGY .....</b>	<b>II</b>
<b>TABLE OF CONTENTS .....</b>	<b>IV</b>
<b>INTRODUCTION: .....</b>	<b>1</b>
<b>Goal and Monitoring Starting Point.....</b>	<b>1</b>
<b>RESULTS .....</b>	<b>2</b>
<b>Amount of Residue on Sample Blocks .....</b>	<b>2</b>
<b>Stewardship Impacts .....</b>	<b>4</b>
<b>CONCLUSIONS .....</b>	<b>15</b>
<b>RECOMMENDATIONS .....</b>	<b>18</b>
<b>APPENDIX 1: <i>THE STEWARDSHIP FACTORS AND ASSOCIATED QUESTIONS</i>.....</b>	<b>20</b>
<b>Focus area 1: Level of CWD for biodiversity .....</b>	<b>20</b>
<b>Focus area 2: Stand productivity .....</b>	<b>21</b>
<b>Focus area 3: Fire Hazard .....</b>	<b>22</b>
<b>Focus area 4: Impacts on wildlife or habitat.....</b>	<b>23</b>
<b>Focus area 5: Mobility and potential hazards to cattle.....</b>	<b>24</b>
<b>Focus area 6: Forest Health.....</b>	<b>25</b>
<b>Focus area 7: Public perception .....</b>	<b>25</b>
<b>APPENDIX 2: METHODS .....</b>	<b>27</b>

## **Introduction:**

This review was undertaken to assess stewardship implications with high levels of post harvest residue. Post harvest residue may have either positive or potentially negative consequences. The present policy for managing post harvest residue is meant to balance the economic values of the stand with the positive aspects of retained coarse woody debris (CWD).

Various amounts and distribution of residue levels can be remain on site after harvest. For example, on the Coast after helicopter-logging, high levels of residue may be found over the entire harvest area. In contrast, in cable harvested areas residue may be concentrated at the roadside, or as standing residue in partial-cut stands with a high composition of low value species and/or grades. In the Interior high post harvest residue may be found on beetle-salvage blocks with cut-to-length (in block residue) or full-tree roadside harvesting systems – leaving the residue piled along the roadsides. Partial-harvested stands with a high composition of low value species and/or grades may have high levels of standing low value timber.

### ***Goal and Monitoring Starting Point***

The present waste policy is based on a balance between economic factors and the biologically appropriate level of residue to be left on site. Currently, ‘waste’ of a merchantable sized log is billed and charged against the AAC. Please note that this project is targeted at blocks with high levels of slash. The waste billing system was used to help identify those blocks by targeting blocks with high levels of billable waste. However, the relationship between total slash loading and billable waste is not correlated, as billable waste can be insignificant, while total slash loads can be significant (tops, branches and small stems).

#### The goal of this study was:

- to determine what, if any, positive or negative consequences (for forest stewardship) are resulting from the present policy for waste and residue.

#### Monitoring question was:

- What, if any, unanticipated consequences to provincial objectives and stakeholder values have resulted from the levels of post harvest residue (all slash) being left in different jurisdictions under the present policy?

The resulting analysis attempts to determine if the actual levels of post harvest residue in various parts of the province are impacting resource management objectives, and if those impacts are positive or negative. The analysis is based on a series of key stewardship factors and associated questions for residue (Appendix 1). The methodology used to collect data is detailed in Appendix 2.

## Results

### ***Amount of Residue on Sample Blocks***

- The two coastal Districts (North Island and North Coast) reflected high levels of harvesting slash in terms of assessed metrics (Table 1) and visual appearance (Fig 1). Blocks in both Districts were mostly helicopter logged, except for several grapple yarded blocks.
- North Island District blocks had the most slash, in terms of depth (or height) and % horizontal coverage, at 97 cm and 57% respectively (Table 1). Note: all sampling in this District was on the mainland and islands of the central coast.
- The North Coast District sample blocks had less than half the horizontal cover of slash found on the North Island blocks. As well the North Coast slash was not quite as deep as those on the North Island. This may be due to a difference in site productivity, general stand condition, and the harvesting pattern, as more than half of the North Coast blocks were partial cut.
- The sampling trend confirmed the waste billings, which showed the North Island blocks to have significantly more avoidable waste than in the North Coast blocks. Note that much of this material in both cases was in pulp material. Also note that total slash loading and billable waste are not necessarily correlated, as some blocks can have low amounts of billable waste but high slash loads (tops, branches etc.).



Fig 1. Examples of the amount of slash found in plots on Coastal sample blocks.

- Fort St. James mostly showed typical low levels of slash loading after harvesting lodgepole pine with ground-based systems. Slash loading was generally low with less than one third of the area covered with slash only 18 cm deep. On several spruce-balsam sites slash loading was higher (Fig, 2).
- In Fort St. James the amount of residue > 7.1 cm in diameter was 16% lower than for both coastal districts (Table 1), where waste billings were much higher.

June 4, 2007

- The Columbia District, in the wet Interior Cedar-Hemlock zone, had slash loads between what was found on the Coast, and Fort St. James (Table 1). While the percentage of horizontal cover approached coastal proportions, depth was much lower.



Fig 2. Examples of the amount of slash found in plots on Fort St. James sample blocks – typical lodgepole pine site (left) and a spruce-balsam site (right).



Fig 3. Examples of the amount of slash found in plots on Columbia sample blocks – the left shows slightly higher levels of slash (CP291-blk3), and the right illustrates the more typical slash loads (Bush River blk 414). Note that little difference is apparent in the photographs due to the significance of tops and branches.

Table 1. Slash conditions observed in sample blocks in the four Districts examined.

District	Summary Statistic	Ave. Slash Depth (cm)	% slash > 7.1 cm diam	% horiz cover of slash	Vertical arrangement
NORTH ISLAND (5 blocks)	Average =	97	25	57	Partially elevated
	Absolute range =	64 - 132	19 - 33	43 - 69	Partially elevated
	Mid range for > 50% of blocks =	82 - 106	21 - 27	56 - 61	Partially elevated
NORTH COAST (7 blocks)	Average =	84	25	23	Partially elevated
	Absolute range =	51 - 130	18 - 37	18 - 29	Partially elevated
	Mid range for > 50% of blocks =	74 - 105	20 - 29	20 - 27	Partially elevated
FORT ST. JAMES (8 blocks)	Average =	18	21	29	On ground
	Absolute range =	7 - 26	13 - 31	13 - 46	On ground
	Mid range for > 50% of blocks =	16 - 25	17 - 23	19 - 31	On ground
COLUMBIA (4 blocks)	Average =	26	33	40	Ground to Part elevated.
	Absolute range =	15 - 35	26 - 45	31 - 53	Ground to Part elevated.
	Mid range for > 50% of blocks =	Na – sample too small			Ground to Part elevated.

## Stewardship Impacts

### Timber Management

The stewardship focus for timber, was the impact of slash or residue on the ability to manage for timber within the sample blocks.

### General Differences between Coast and Interior Blocks

- There was a significant difference between blocks surveyed on the Coast and those in the Interior, falling in line with the amount of slash observed in those respective areas. The significant differences between the two areas were:
  - Harvesting on the Coastal blocks was mostly in stands that were more than 300 years old (since last replacement disturbance), with highly variable piece sizes and amounts of decay.

June 4, 2007

- The Coastal sample blocks utilized mostly helicopter logging with a small amount of grapple yarding. A significant number of these blocks on the North Coast left moderate levels of overstory retention behind.
- The Interior sample was more variable in terms of logging method with heli-logging and cable blocks in the Columbia District and mostly mechanized ground-based harvesting systems in the Fort St. James District. As expected, in most Interior blocks the piece size was smaller and much less variable than on the Coast, especially in Fort St. James, which was dominated by uniform pine stands.

### **Availability of Plantable Ground on Coastal Blocks**

- A reduction in plantable spots/ha due to slash was noted on the Coast, however, all blocks had sufficient plantable spots to reach minimum stocking standards with planted trees, based on average coastal survival rates and anticipated natural infill, likely mostly from hemlock (Table 2). The greatest number of plantable spots/ha on the Coast was found on grapple-yarded blocks. Observations for plantability on heli-logged blocks on the Coast:
  - Planting heli-logged blocks was common practice –most heli-logged blocks had been planted, or would be planted in the near future (according to the SP), contributing to the diversification of tree species on these sites.
  - Planting difficulty was probably underestimated – The provincial planting difficulty assessment procedure with these very high levels of slash loading probably underestimated the level of difficulty/cost of planting. Because of slash loading, human movement on many heli-logged blocks was extremely difficult. Planting costs on these blocks are likely very high, and could result in a trend away from planting these areas. Species composition should be monitored to see if such a trend emerges.
  - Plantable spots often required frequent use of minimum spacing- This means that planted trees will be clumpy in distribution. As well, unplantable slash accumulations will likely require twenty years or more before they can provide a potential substrate for natural hemlock regeneration. The resulting increase in clumpiness should be considered in TSR. This may be as simple as natural rather than planted yield curves for these types of sites.

Table 2. Assessment of impacts on timber stewardship for the sample blocks in the four Districts examined.

District	Summary Statistic	Plantable Spots per ha	P-spots per ha limited by slash <sup>1</sup>	Planting Difficulty		
				% low	% Mod	% High
<b>NORTH ISLAND</b> (5 blocks)	<b>Average =</b>	<b>734</b>	<b>371</b>	<b>15</b>	<b>55</b>	<b>30</b>
	Absolute range =	569-860	180-569	-	-	-
	Mid range for > 50% of blocks =	709-760	273-514	-	-	-
<b>NORTH COAST</b> (7 blocks)	<b>Average =</b>	<b>883</b>	<b>173</b>	<b>24</b>	<b>54</b>	<b>22</b>
	Absolute range =	640-1000	40-400	-	-	-
	Mid range for > 50% of blocks =	740-980	100-220	-	-	-
<b>FORT ST. JAMES</b> (8 blocks)	<b>Average =</b>	<b>1205</b>	<b>28</b>	<b>52</b>	<b>48</b>	<b>0</b>
	Absolute range =	1200-1240	0-160			
	Mid range for > 50% of blocks =	1200	0			
<b>COLUMBIA</b> (4 blocks)	<b>Average =</b>	<b>1120</b>	<b>80</b>	<b>30</b>	<b>70</b>	<b>0</b>
	Absolute range =	920-1200	0-280	-	-	-
	Mid range for > 50% of blocks =	NA – sample is too small				

- Accumulations of Slash on the Coast – accumulations accounted for 1-5% of the block area on some units (mostly grapple yarded blocks). These accumulations generally consisted of merchantable-sized low-value hemlock, often pulp-grade. The cost of transport likely made these logs uneconomic to recover and the logs were subsequently left on site. In some cases these accumulations could not be successfully burned, contributing to a reduction in productive area. If such a reduction in productive forestland is significant in scope, it should be considered in TSR (Fig. 4).

<sup>1</sup> NOTE: There may be some slight overlap in plantable spots and plantable spots limited by slash (over and above the number of trees normally planted due to use of minimum inter-tree spacing and uncertainty with planting densities relative to target stocking rates.



Fig 4. Roadside accumulations on grapple yarded sites on the Coast.

#### **Poor condition, low value standing trees**

More than half of the blocks examined in the North Coast District (4 of 7 blocks) were partial cut and helicopter logged, leaving a significant amount of residual overstory standing. While stewardship issues from partial cutting go beyond the specific intent of this project, there is some overlap. All four blocks had residual trees that were uneconomic and not specifically required to meet management objectives. In this regard there is a slight similarity to logging residue (except trees are standing rather than cut). In any case, some exploration of this practice was deemed worthwhile within the context of this report. Basal area was estimated using 5- 9 prism plots in each of these blocks. The limited information gathered provides a rough picture of residual stand conditions:

- These blocks had an average of 20-25% residual overstory basal area, 60-90% of which was in poor condition and uneconomic, due to size, vigor, and defects. The low amount of basal area in general, and quality of the residual timber in particular, reduces the potential for harvesting in the future.
- Roughly 10-40% of the area in each block had open growing conditions, suitable to a full range of species, unrestricted by overstory shade.
- Approximately 50-90% of the growing space in each block had a moderate stocking of overstory trees (20-40 m<sup>2</sup>/ha) providing significant local shade, likely impacting understory species performance over time. It is likely that the hemlock that normally seeds into these understories will have an advantage over other species for growth and development.

June 4, 2007

- As well, it is estimated that growth of hemlock in all four blocks will be negatively impacted by mistletoe, which on average was observed at a moderate to severe incidence on 33% (10-50%) of the overstory basal area<sup>2</sup>.



Fig 5. Examples of partial cut blocks which had 20-25% of the original overstory basal area left onsite, concentrated (60-90%) in poor condition and uneconomic timber, due to size, vigor, and defects.

**Note:** Many areas with this type of harvesting (in the North and Mid Coast) are outside the Timber Harvesting Landbase and/or are in constrained areas (visual objectives).

#### **Availability of Plantable Ground on Interior Blocks**

- Slash loading had little impact on plantability for most cutblocks (Table 2). In Fort St. James these blocks were mostly harvested pine stands, mechanically harvested and skidded full-length to roadside for processing, where most of the slash was found in post harvest piles commonly burned shortly after harvest completion.

Several cutblocks in Fort St James were in spruce balsam stands, where it appears that there was a significant amount of dead balsam prior to harvest (common for these stand types). These blocks showed higher levels of slash, but were found to be highly plantable when minimum inter-tree distances were occasionally used. A similar situation was found in Columbia with a range of wet-belt species.

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<sup>2</sup> Note: basal area was used as the metric to report the incidence of mistletoe. This was intentional as larger trees influence basal area more than smaller trees. Such is the case with mistletoe, which spreads more effectively from taller trees.

- Note: many of the blocks were listed as having moderate planting difficulty – these were assessed as “moderate” because of terrain and soil features. Yet these blocks were much less difficult for planting than the areas rated as having “moderate difficulty” on the Coast. This was a function of a lack of consideration for very heavy slash loading within the ranking criteria of the planting difficulty rating system.
- Accumulations of Slash in Fort St. James – Slash accumulations were significant in most blocks (Fig.5). Based on observations of surrounding blocks most accumulations appear to be successfully burned and planted. This is based on limited observation that should be confirmed with more rigorous data if desired.
- Accumulations of Slash in Columbia – Accumulations of slash in Columbia may in some cases approach the concern for the Coastal sites if not successfully burned, although no data were available to confirm this (Fig 5).



Fig 5. Roadside accumulations in Fort St. James District (left) and Golden (right).

### **Nutrients and Site Productivity**

- An imbalance in the carbon:nitrogen ratio creating a reduction in timber productivity and growth is not anticipated on the areas evaluated. While logging places very high levels of woody debris on the forest floor, the slash loads sampled may vary from those experienced in the past only by having more large woody pieces that will decompose relatively slowly.

June 4, 2007

- High slash loading (even higher than those experienced the sample blocks) is not unprecedented in nature. Current catastrophic mountain pine beetle outbreaks in the Interior and windthrow on the Coast are evidence of that.
- There is a higher concern with the lack of woody debris on some Interior pine sites mechanically harvested with a high degree of woody material (large pieces and fines) skidded to roadside and piled (Fig 6). These sites are often inherently low in productivity, and therefore the potential exists for lower timber yields over time, as a result of piling. In addition to concentrating nutrients, piling activity was observed on some blocks (many of which were not included in our sample) that exhibited significant soil disturbance in the form of rutting, with potential associated compaction.



Fig 6. Logging residue piled post harvest on Interior pine blocks showing some soil disturbance that could also raise soil productivity concerns.

### **Cattle, Wildlife and Biodiversity**

- Management values associated with cattle, wildlife or biodiversity did not appear to be threatened by slash loading on the Coast or in the Interior (Table 3). On the Coast, where slash loads were high, there was evidence of wildlife movement through cutblocks and an estimated moderate (occasionally high) local impact to movement. However, when put into perspective with the general steep and rough terrain, and the numerous opportunities to move around the blocks in what is a mostly unlogged matrix, the review team did not feel that this was a significant management concern.

Table 3. Assessment of impacts on non-timber stewardship for the sample blocks in the four Districts examined.

District	Summary Statistic	Restriction to Wildlife Mobility	Restriction to Cattle Mobility	Fire Hazard	% of blocks with action required to lower fire risk <sup>3</sup>
<b>NORTH ISLAND</b> (5 blocks)	Average =	Moderate	Na	Significant	None – 100%
	Absolute range =	Moderate	Na	Significant	
	Mid range for > 50% of blocks =	Moderate	Na	Significant	
<b>NORTH COAST</b> (7 blocks)	Average =	Moderate	Na	Significant	None – 100%
	Absolute range =	Mod-High	Na	Low - Significant	
	Mid range for > 50% of blocks =	Moderate	Na	Significant	
<b>FORT ST. JAMES</b> (8 blocks)	Average =	Low	Na	Low	None – 88% Minor action <sup>4</sup> – 12% (one block)
	Absolute range =	Nil - Low	Na		
	Mid range for > 50% of blocks =	Low	Na		
<b>COLUMBIA</b> (4 blocks)	Average =	Low	Na	Significant	Minor action <sup>5</sup> – 75% (3 of 4 blocks)
	Absolute range =	Low-Mod	Na	Low - Significant	
	Mid range for > 50% of blocks =	-	Na	-	

- Significant amounts of slash billed as waste may actually be beneficial for a number of small vertebrates and invertebrates, by creating small protected habitats and modifying microclimate.
- Uneconomic trees in poor condition left after harvesting, such as those found in some blocks on the North Coast, may provide benefits to stand level biodiversity. However, there are many different partial-cutting silvicultural

<sup>3</sup> NOTE: Hazard is related to the nature of fuels on site, while risk considers the likelihood that a fire may occur. The need to lower risk brings in consideration of consequences for a range of values as well as the level of risk. Our consideration of risk and values was as per the BC Hazard and Risk Assessment Manual. Risk and values were not considered where the hazard ranking was low (score of less than 14).

<sup>4</sup> Minor action – mechanical site prep to align slash and improve contact with soil, and or spot burning.

<sup>5</sup> Minor action – spot burning or burn accumulations within 30 m of road.

systems and corresponding harvesting patterns that can be used to provide this same benefit. Such trees should be retained without jeopardizing other stewardship values.

- No Districts had active cattle grazing permits on any cutblocks in the sample. The only District that had blocks suitable for cattle grazing, based on the terrain and vegetative community, was Fort St. James. However, if permits for grazing had been in place, the impact on cattle movement from logging slash would have been estimated as low (occasionally moderate).

### **Fire Hazard and Risk**

This study was not a comprehensive assessment of fire hazard and risk due to harvesting waste in the province. The goal for the assessment was to determine what “positive or negative consequences (for forest stewardship) are resulting from the present policy for waste and residue”. With this as a starting point, sample blocks were chosen by looking for the blocks with the highest levels of billable waste in Forest Districts with higher average levels of billable waste. A comprehensive study of the impacts of harvesting residue specifically on fire hazard and risk would require a different sampling approach beyond the scope of this project.

The observations presented here merely reflect what was observed on a selection of blocks with the highest levels of billable waste. While block-level fire hazard was relatively straightforward to assess, ranking the fire risk was less so.

Complete information on risk factors such as: industry operations present or planned within 5 yrs within 1 km of the site; and access present or planned in next 5 yrs within 1 km of the site was not available. Also, it was difficult to determine exactly where the site was located (particularly in the Interior) on the fire incidence maps provided by the provincial handbook for hazard and risk. For this reason, the assessment of risk can at best be considered a rough estimate, generally rounding up to a higher risk category where considerable uncertainty was present. Gathering the contextual information required to make better risk judgments were outside the scope of the project. In the various portions of the province assessed, issues regarding fire hazard and risk may exist, but were not apparent within this sample.

#### Coastal Observations:

- Using the provincial fire hazard and risk assessment procedure at the block level, fire hazard was estimated to be high on the Coast due to the slash loads, the amount of fine fuels (tops and branches), the partially elevated nature of the slash, and the redcedar content.
- However, the fire risk on the Coast and concern for values nearby at the block level was always estimated as low, due to the history of fire, the isolated nature of the cutblocks (mostly helicopter-logged), and their position on the landscape. For this reason, no action to lower risk would be required on any of these blocks.

#### Interior Observations:

June 4, 2007

- In the Fort St. James District, fire hazard was generally found to be too low (at the block level) to require further action to lower risk (beyond burning accumulations), except for one block where minor action would improve the risk sufficiently.
- It should be noted that while dispersed slash levels were generally low in Fort St. James, significant accumulations were often found piled at roadside (Fig 6). It is not known if this slash will be disposed of in a timely fashion, although accumulations in blocks within the vicinity had already been burned.
- Columbia District showed a more significant concern for fire hazard and risk. Fire hazard factors could be assessed on site with the information we had.
- Considering the rough estimate of risk on the Columbia blocks, it appears that some minor action may be required on most blocks to reduce hazard to acceptable levels. It is not known if these hazard reduction activities are being conducted in a timely fashion, although some hazard reduction activities were observed in nearby blocks. (Fig 7).



Fig 7. A late-season, low intensity broadcast burn for hazard abatement and plantability in the Columbia District.

June 4, 2007

- The sampling approach used in this study did not target areas heavily harvested for mountain pine beetle. Fort St James is just on the edge of the enormous mountain pine beetle epidemic zone in central BC. A number of concerns are currently emerging in the beetle zone related to accelerated harvesting, extensive small scale salvaging and different approaches to harvesting and processing practices. These issues are of particular interest at a landscape scale. This study did not explore these issues.
- The BC hazard and risk assessment procedure has been in use for some time. It integrates numerous elements into a structured framework for ranking both hazard and risk in a stand. Yet, some elements such as decomposition rates of various species and sizes of residue may be useful additions to the procedure. As well, while the procedure is useful to design tactics to reduce hazard and risk at the stand level, a broader landscape-level assessment procedure may help answer some of the questions emerging at that level, and help design strategies to deal with potential concerns.

## Conclusions

High levels of residue or slash as a result of logging is not surprising in old growth forests, particularly BC coastal temperate rainforests. This review was carried out in response to concerns expressed by Forest District Staff and the public. The concern regarding residue may be centered on a perception that either there is a general lack of care (or stewardship) during logging, or that the province is not getting full economic value for provincial timber. This project was designed as an initial exploration of the stewardship concern only. The economic concern was not part of the terms of reference for this project, and therefore is not addressed in this report.

Based on the assessments conducted under this project in four Districts (North Island, North Coast, Fort St. James, and Columbia), it seems that the change in policy (take-or-pay) may have increased the amount of merchantable residue on site (either dispersed or in accumulations), yet the impacts on stewardship for long-term timber management appear to be limited to some localized impacts on Coastal heli-logged sites. Impacts on non-timber resource values, or fire risk were not apparent from this sample. Further study a broader scale may be required to determine if these impacts or risks exist.

Timber management impacts on the Coast were centered on stocking of regeneration, long-term overstory retention, and species management. While high accumulations of slash on Coastal heli-logged sites do not seem to preclude adequate stocking to minimum standards, it does seem to require frequent use of minimum inter-tree spacing to attain minimum stocking, resulting in clumpy tree distribution due to slash loading. However, it is expected that natural regeneration on these sites will result in less clumpy tree distribution at or near target stocking levels. Adjustments in the next timber supply review (TSR) may be necessary if the amount of helicopter logging is significant and if tree distribution is significantly clumpy.

Excessive retention of uneconomic trees in poor general condition within partial cut stands, exacerbated by mistletoe infections, has the potential to impact future economic opportunities by: negating future harvest entries in the near term; influencing understory species composition strongly toward hemlock; and significantly reducing growth in the long term. Some of these partial cut stands are in areas outside the timber harvesting land base and therefore may not directly impact the timber supply in the area. If there is sufficient scale and scope to this practice, impact on timber supply and future timber values as well as non-timber values in these areas could be substantial. This issue goes beyond waste and residue and is tied to species selection, stocking standards and other questions. The issue should be a priority for continued exploration, discussion, and development of strategic direction. This work may be led by, or coordinated with, the FRPA Coast Region Implementation Team (CRIT) currently investigating it.

Many of the sample areas were either planted or planned for planting. This practice helps to encourage a mixture of species beyond the prolific hemlock that naturally seeds into areas with a high degree of organic residue. Yet, planting in these areas is expensive. Therefore, species composition in Coastal heli-logged blocks should be

monitored to ensure species diversity objectives are being met at the stand and landscape level.

Data collected at the block level did not point to a significant fire risk issue for the sample blocks in the four Districts assessed. However, this doesn't mean that fire issues do not exist. As an initial exploratory assessment for stewardship in general, the sampling approach was not designed for a comprehensive look at the fire risk in BC associated with current harvesting and abatement procedures. A recommendation is included to explore concerns emerging about landscape level impacts of logging residue in the beetle-kill zone, or other broad scale fire risk issues that were not assessed in this project.

Excessive logging residue did not appear to be a stewardship concern for timber management in the interior districts. However, the potential impacts on soil productivity, and ultimately long term growth and yield, of a lack of well-distributed woody debris due to current mechanical harvesting techniques with processing at roadside and the potential soil disturbance impacts from piling this material was identified as a concern and should be investigated further. If significant, strategic direction may be needed to minimize these impacts, balanced by careful consideration of the full range of resource management objectives and potential risks (including fire).

For non-timber values such as cattle, wildlife and biodiversity, logging residue does not appear to be having a significant impact at the block level. Cumulative issues that may occur at the landscape level, such as large scale loss of range due to high slash loads, were not assessed.

It is assumed that the level of concern recently expressed by District staff and the public in various portions of the province regarding residue is visually-driven, as excessive residue generally "looks bad" to most people. The recent increase in concern we speculate is a function of the possible increase (compared to past levels) of merchantable material added to non-merchantable material that can be observed at roadside when driving by, or throughout a block when flying past. It is important to point out that residual wood "waste" is not an ecological concern. The ecosystems in BC have experienced much higher levels of woody debris through natural disturbances in the past. Windthrow in Stanley Park and the mountain pine beetle epidemic are highly publicized reminders of this fact.

For woody logging residue to be viewed as "waste" and labeled as "bad", a human perception of value is required. As a public resource, it is not unusual for many people to feel some degree of ownership when it comes to the forest. Accordingly, the concern regarding residue may be centered around a perception that either there is a general lack of care (or stewardship) during logging, or that the province is not getting full economic value for provincial timber.

This project was designed to assess the stewardship concern, finding most conclusive impacts from levels of woody residue following logging to be confined to some coastal situations. The economic concern more specifically is that merchantable material left on site represents a waste of the provincial timber resource, as there may be an opportunity to utilize it with enhanced economic benefits. Testing whether this

June 4, 2007

perception of “waste” matches reality was not part of the terms of reference for this project, and therefore is not addressed in this report.

For any of the stewardship conclusions in this report, it should be noted that the cutblocks assessed represent a small snapshot in time and space, reflecting the conditions in four Districts (2005 data and some 2006 data where available) in cutblocks that showed high levels of billable waste. Trends may be emerging in these or other Districts regarding fire risk or other concerns that this sample does not reflect.

## Recommendations

1. If Coastal heli-logging is considered to be significant enough in some Coastal TSAs, the distribution of stocking through time should be carefully monitored so that it can be appropriately modeled for TSR. Roadside accumulations (where they exist) also need to be accounted for and appropriately modeled.
2. The practice of excessive retention of uneconomic trees in poor condition within partial cut stands (often exacerbated by mistletoe infections), requires some strategic direction for Coastal BC. This issue goes beyond waste and residue and is tied to species selection, stocking standards and other questions. The issue should be a priority for continued exploration, discussion, and development of strategic direction. This work may be led by, or coordinated with, the Coast Region Implementation Team (CRIT) currently investigating it. It should involve:
  - a. Gaining an understanding of how this issue is also tied to species selection, stocking standards and other practices and concerns;
  - b. An investigation of the current and potential scope of this practice;
  - c. If either current or potential scope is significant, an investigation of the potential impacts of this practice on future flow of timber volumes and values, as well as other values such as cultural heritage and biodiversity;
  - d. Strategic direction to ensure the practice minimizes such impacts.
3. Continue to monitor species composition in Coastal heli-logged blocks, for a potential reduction in species diversity due to a possible increase in reliance on natural regeneration of hemlock, as a result of current market pressures.
4. The potential impacts in the Interior on soil productivity, and ultimately long term growth and yield, of a lack of well-distributed woody debris due to current mechanical harvesting techniques with processing at roadside and the potential soil disturbance impacts from piling this material should be investigated further. If significant, strategic direction may be needed to minimize these impacts.
5. Consider a follow-up project to more comprehensively assess fire hazard concerns in the mountain pine beetle impact zone. Such an assessment should be at a landscape level, going beyond the standard BC hazard and risk assessment procedures, with a sampling approach that would target potentially high risk zones. The assessment should also integrate the soil productivity concerns expressed in #4 (above), and consider factors influencing hazard and risk beyond logging residue such as species composition and climate change. Also, this project may be used to inform the development of a standard procedure to periodically assess landscape level fire risk, and inform strategic decision-makers and planners to help balance fire risk against management objectives and other risk factors.

June 4, 2007

6. Consider reviewing the BC hazard and risk procedures to determine if there are factors, such as decomposition rates of various sizes and species of residue that should be incorporated into decision making.

## APPENDIX 1: *The Stewardship Factors and Associated Questions.*

The following emerged as the key factors and questions to explore with this monitoring project.

<p><b>Focus area 1:</b> <i>Level of CWD for biodiversity</i></p>	<p><b>Geographic Context:</b> Provincial</p>
<p><b>Situation:</b></p> <ul style="list-style-type: none"> <li>• High levels of residue may benefit numerous species by providing increased niches and decay organisms. As well, travel pathways could be increased along with protection of some animals from prey. This may occur:             <ul style="list-style-type: none"> <li>○ <u>On the Coast</u> – Helicopter logging where high logging costs encourage less valuable species (such as hemlock and balsam) and/or grades to be left standing or felled on the ground.</li> <li>○ <u>In the Interior</u> – Beetle-killed pine stands mechanically harvested with cut-to-length systems leaving residue on-site rather than roadside. In some cases, this slash is used as puncheon, embedded in the ground.</li> <li>○ <u>Also in the Interior</u> – Any logging where less valuable species (broadleaf species and/or hemlock and balsam) and/or grades are left standing in excessive amounts<sup>6</sup>.</li> </ul> </li> </ul>	

### **Background:**

Residue left as CWD is being assessed by the Ministry of Forests Resource Stewardship Monitoring program. There are numerous studies examining the importance of CWD for the near and long term.

### **Potential Questions to Explore<sup>7</sup>:**

- Is the amount and size of CWD consistent with pre harvest or benchmark levels?
- Is the orientation and amount in accordance with policy direction?

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<sup>6</sup> Sometimes when less valuable trees are left standing they are designated as second pass volume in a multi-entry silvicultural system explicitly or implicitly and therefore not assessed as residue, even though a second pass is highly unlikely given the species, quality and vigour of the trees.

<sup>7</sup> These are not intended to be comprehensive, or to necessarily be part of a further analysis and discussion paper, but they may become so depending on the focus of the project.

<b>Focus area 2: Stand productivity</b>	<b>Geographic Context:</b> Provincial
<p><b>Situation:</b></p> <ul style="list-style-type: none"> <li>• High levels of post harvest logging residue may preclude the ability to fully restock the site with healthy trees. This may occur:             <ul style="list-style-type: none"> <li>○ <u>On the Coast</u> – Helicopter logging where high logging costs encourage less valuable species (such as hemlock and balsam) and/or grades to be left standing or felled on the ground<sup>8</sup>.</li> <li>○ <u>In the Interior</u> – Beetle-killed pine stands mechanically harvested with cut-to-length systems leaving residue on-site rather than roadside. In some cases, this slash is used as puncheon, embedded in the ground.</li> <li>○ <u>Also in the Interior</u> – Any logging where less valuable species (broadleaf species and/or hemlock and balsam) and/or grades are left standing in excessive amounts<sup>9</sup>.</li> </ul> </li> </ul>	

**Background:**

Productivity can be affected by residues both positively and negatively. Residues may provide nutrients through decay and may help modify or provide potential growing sites. If post harvest residues are high, they may act as a physical impediment to planting. Licensees have a legal obligation for reforestation, and must carry out treatments to achieve the stocking standards. However, some licensees may propose significantly reduced stocking standards for sites with excessive slash. If these standards are used, results could be: lower growing site occupancy, volume production and long term harvest levels, longer green-up periods and possibly reduced visual or hydrologic recovery<sup>10</sup> (where those objectives apply).

Even where post harvest residue levels do not constitute a physical impediment to planting, some level of residue can provide for long term nutrient supply. However, excessive loading of organic material can act as a nitrogen sink, increasing the C:N ratio onsite, in effect reducing productivity over the short term<sup>11</sup>.

Some level of decaying wood helps retain moisture and provides habitat and other benefits that include enhanced site productivity on some sites.

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<sup>2,9</sup> Sometimes when less valuable trees are left standing they are designated as second pass volume in a multi-entry silvicultural system explicitly or implicitly and therefore not assessed as residue, even though a second pass is highly unlikely given the species, quality and vigour of the trees.

<sup>10</sup> NOTE: hydrologic benefits may be cited by some since the increased slash loading may help break the overland flow of surface water, reducing runoff and sedimentation.

<sup>11</sup> SEE: Raija Laiho and Cindy E. Prescott Can. J. For. Res./Rev. can. rech. for. 34(4): 763-777 (2004)

**Potential Questions to Explore<sup>12</sup>:**

- Is a reduction in stocking standards occurring – if so:
  - to what extent?
  - What are the potential impacts on timber yields and other resource values?
  - What specific situations and circumstances, stand types, logging techniques are mostly associated with reduced stocking? Over what area? Where?
- Is it possible for excessive slash to lead to an imbalance in the C:N ratio?

<b><i>Focus area 3: Fire Hazard</i></b>	<b>Geographic Context:</b> Mostly in the Interior
<p><b>Situation:</b></p> <ul style="list-style-type: none"> <li>• Post harvest residue being left as a result of harvesting beetle-killed pine.</li> <li>• In the Interior – Beetle-killed pine stands mechanically harvested with cut-to-length systems leaving residue broadcast across the site rather than at landings, has the potential to contribute to the start and spread of fire. On-site slash embedded in the ground may result in persistent ground fire and present added suppression difficulties and associated costs.</li> <li>• Possibly a concern on the South Coast where high levels of residue are left on site – most likely mixed stands where hemlock, broadleaf species and others are left. – more likely problematic where material has been fallen but is left on site</li> <li>• Depending on the volume of material, arrangement and decomposition rates, fire hazard may be elevated on site for a very long time.</li> <li>• Course woody debris defaults are not apt to be problematic from a fire hazard perspective, but no upper limit is specified and this creates conflict.</li> <li>• Dead and down fine fuels are more problematic than course fuels (&gt; 7 cm) from a fire behaviour perspective; however the volume and arrangement of course woody debris on the ground may also physically impede suppression efforts.</li> </ul>	

**Background:**

High levels of post harvest residue can increase the intensity of a potential fire, pose a physical impediment to fire suppression efforts, and result in a subsequently higher

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<sup>12</sup> These are not intended to be comprehensive, or to necessarily be part of a further analysis and discussion paper, but they may become so depending on the focus of the project.

impact on site productivity. As well, such fires are more difficult to control and therefore pose a greater risk to adjacent unlogged timber.

**Potential Questions to Explore<sup>13</sup>:**

- Is the potential fire hazard a significant issue on the ground? What can be learned from past experience (in terms of fire starts, and severity) in areas with high levels of logging residue?
- How significant is the fire hazard issue outside of pine beetle salvage areas?
- Are hazard abatement requirements being met and enforced?
- What are the options to avoid this situation?
- Is current legislation sufficient to address this issue?
- Can fire hazard assessment and mensuration procedures be streamlined to relate to waste scaling or CWD mensuration work. Are fine fuel volumes related to CWD volumes.

<b><i>Focus area 4: Impacts on wildlife or habitat</i></b>	<b>Geographic Context:</b> Provincial – but likely most pronounced in the Interior
<b>Situation:</b> <ul style="list-style-type: none"><li>• Where excessive amounts of felled wood are left on site. It is likely more of an issue where such practices are found over extensive areas as in large beetle salvage units.</li></ul>	

**Background:**

High levels of post harvest residue can reduce mobility for deer, elk, bears and other large wildlife. As well, some feel that felled, billable residue is better left standing (alive or dead) to help meet biodiversity objectives. In areas where such logging is not extensive it may be outweighed by benefits such as: increased niches for those species that utilize CWD as a home, hiding cover, or an energy source and utilization of large slash pieces as travel pathways.

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<sup>13</sup> These are not intended to be comprehensive, or to be part of a further analysis and discussion paper, but they may become so depending on the focus of the project.

**Potential Questions to Explore<sup>14</sup>:**

- Is it possible to get a sense of the range of situations (especially those that are unrelated to beetle salvage) where this could be significant (outweighing the benefits provided), and how much residue will become a serious impediment to movement? If so, can the scope of this issue be determined?
- In which situations might billable standing timber actually benefit biodiversity long-term, without creating negative impacts on other resource values? Note: marginally merchantable trees often grow poorly if left onsite and may be more susceptible to blowdown or breakage.

<b><i>Focus area 5: Mobility and potential hazards to cattle</i></b>	<b>Geographic Context:</b> Interior
<b>Situation:</b> <ul style="list-style-type: none"><li>• In extensive beetle-salvaged areas where cut-to-length harvesting has left high levels of post harvest residue.</li></ul>	

**Background:**

This has been identified as an issue and has been lodged as a formal complaint to the Forest Practices Board.

**Potential Questions to Explore:**

- How significant is this issue? – reported problems and potential scope. The Forest Practices Board is the logical starting point to answer this question.

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<sup>14</sup> These are not intended to be comprehensive, or to necessarily be part of a further analysis and discussion paper, but they may become so depending on the focus of the project.

<b><i>Focus area 6: Forest Health</i></b>	<b>Geographic Context:</b> Mostly Interior (and interior-coast transition)
<b>Situation:</b> <ul style="list-style-type: none"><li>• Where significant amounts of Douglas-fir, spruce and pine residue are being left on the ground.</li></ul>	

**Background:**

Douglas-fir beetle, spruce beetle and Ips beetle (in pine) may be attracted to areas with significant amounts of recently downed green logs of a significant size. This situation may spread into adjacent healthy stands, if beetle populations are allowed to build to high levels.

**Potential Questions to Explore:**

- Is this occurring right now? Are regional entomologists concerned about this possibility, and if so, what conditions and ecosystems are of most concern?
- What is the potential for additional losses from this situation?

<b><i>Focus area 7: Public perception</i></b>	<b>Geographic Context:</b> Provincial
<b>Situation:</b> <ul style="list-style-type: none"><li>• Areas where post harvest residue levels contribute to high slash loads. Particularly those areas close to towns, or travel routes, and blocks that are logged to roadside (grapple yarding on the Coast, and full tree skidding with roadside processing in the Interior).</li></ul>	

**Background:**

Public perception studies have shown the public has a negative response to high levels of post harvest residue. While areas close to towns and along travel routes may be the highest profile, digital photographs are shared easily and quickly and therefore allow broad access to even the most remote situations.

June 4, 2007

**Potential Questions to Explore<sup>15</sup>:**

- How great is this concern right now? Does it have a potential to increase over time?
- Are there options to reduce the negative response? There are positive aspects to CWD on sites that could be communicated.

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<sup>15</sup> These are not intended to be comprehensive, or to necessarily be part of a further analysis and discussion paper, but they may become so depending on the focus of the project.

## **APPENDIX 2: Methods**

For expediency sampling was done using blocks where high levels of residue were identified, and in Districts with higher proportions of billed residue in general. Using these blocks of identified “high interest”, the focus area questions were explored. If concerns were confirmed on individual blocks, the context and scope of these potential concerns were to be explored and extrapolated to the entire District to determine the true nature and extent of these concerns.

### **Determining Districts of Interest**

We first identified the Districts with the highest levels of post harvest residue using the harvest billing system and the waste billing system to calculate a ratio of residue to total volume harvested. The top three Districts on the coast, and the top three Districts in the interior with the most billed residue as a proportion of the total volume harvested became the focus for the project. Initial sampling focused on the top two districts on the coast, and the top two in the interior (one from the North and one from the South), with additional Districts to be sampled, if deemed necessary after the initial sampling.

### **Determining Population of Interest and Sample Blocks**

Working with the waste and residue specialist in the Districts of Interest, a population of blocks was identified for high levels of residue. Only blocks logged since the implementation of the ‘take or pay’ policy were considered, focusing on 2005 cutblocks, and those blocks in 2006 for which there is waste billing information. A total of fifteen blocks were randomly chosen from the population of interest in each District. Of this subpopulation of blocks, a potential subsample of ten blocks were targeted for sampling (with a minimum subsample set at five blocks). This approach allowed for: substitution of blocks within the actual sample to ensure efficient sampling and added sampling where time permits.

### **Assembling Data Packages**

Next, logging maps, waste and residue survey summaries, and site plans (for prescriptive context) were acquired, along with a general access map to help in locating blocks within each District.

### **The Evaluation protocol**

On each site the reported residue was checked against what was reported as billed waste. An initial checklist /data form was designed using the questions generated for each of the focus areas identified in the scoping document to help determine potential stewardship concerns. Sampling was not intended to fit a statistical model, but rather to provide a rough picture of the condition of the block in terms of residue. The evaluation procedure on-site then proceeded as follows:

- Normally from two points well-distributed within the cutblock, sampling commenced with five sample points along a transect which enabled reasonable sampling of the range of conditions on-site. Often these transects crossed contours, or were oriented in opposite directions to sample two different

edaphic situations. Occasionally only one transect (five sample points) were used on-site.

- A distance between sample points was chosen (from 20 m to 50 m) depending on the block size.
- At each sample point the following was assessed:
  - The amount, distribution and nature of the residue (or slash) was assessed using metrics for determination of fire hazard and risk.
  - the ranking for fire hazard was determined.
  - On-site fire risk and value indicators.
  - Plantability – including: plantable spots<sup>16</sup>; plantable spots limited by slash; planting difficulty ranking; and number of seedlings currently established.
  - Amount of overstory retention (standing waste or otherwise) in basal area, its estimated impact on growing conditions for regeneration, and any potential opportunities for a future harvesting entry in the near term or mid-rotation to further remove overstory timber.
  - Any observations that may be relevant to coarse woody debris management – not enough? Too much?
  - Added metrics for slash in terms of continuity and associated estimates of the impediment it presents for cattle and wildlife.
  - Potential issues that may arise with the public regarding residue levels.
- Photographs were recorded for each block to get a visual record of conditions.

### **Follow-up Investigations**

Where stewardship concerns were identified on specific cutblocks, the nature and the scope were explored to determine the significance of the concern. In this way a site level concern could be placed in context with what is happening on the surrounding landscape, other management challenges, and potential benefits that may be provided by the level of residue on site.

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<sup>16</sup> The assessment of plantable spots was really more an assessment of available growing sites, as we disregarded the presence of established trees. The purpose was to then help determine the amount of growing space excluded from timber production (for some time) due to the presence of slash.