

# Logging Residue at Landings

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## ABSTRACT

*A survey of New Zealand forest companies in 1996 found that build-ups of logging residue at landings, especially hauler landings, are a growing problem. The survey results highlighted that 45% of the hauler landings used have significant build-ups of residue with consequent costs and risks. Results also showed that there was little information on the volume and type of material in the residue build-ups.*

*A subsequent series of studies of logging operations, measuring the amount of residue created in relation to the extracted volume and harvesting system, found that stem wood is the largest component of the residue. These studies also showed, that despite appearances, the bulk of the estimated branch and needle content of a stand is left on the cutover at harvesting. This was true even in operations where the majority of deliberate delimiting occurs at the landing.*

## INTRODUCTION

There are a number of issues associated with residue build-ups (birds-nests) at logging landings (Figure 1). Initially, these problems are operational as the residue takes up space in areas that are very congested. It also takes time (and therefore money) to remove this material from the landing, even if it is only to push it off the landing edge.

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After logging is completed, the residue build-up may continue to cause problems. These problems include collapse downhill, risk of collapse, potential fire hazard, ongoing fire risk if deliberately burned, and occupation of potentially productive land.

Two of the landing residue issues worthy of investigation were considered to be:

- the scale of the problem — how many landings are created nationally and what costs are attached to post-harvest measures
- the volume and type of residue being created, and the factors that affect these.

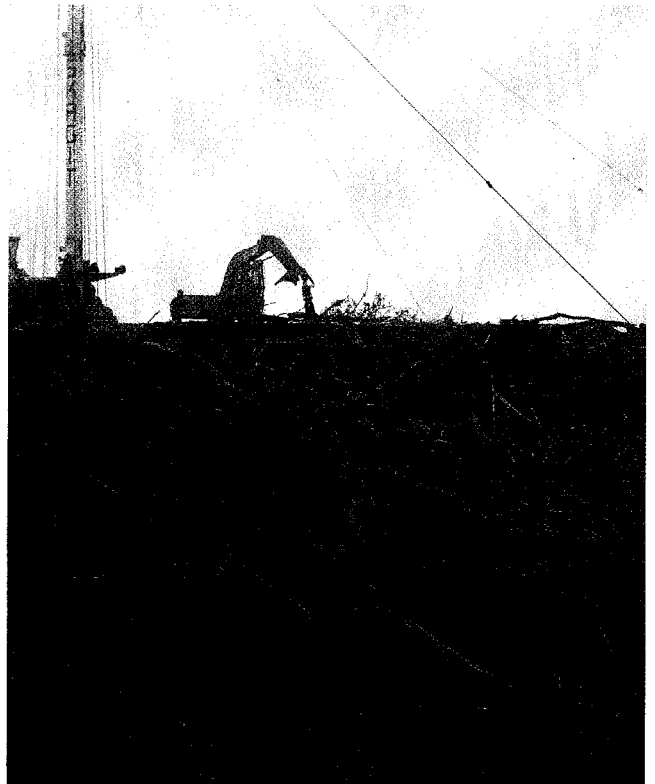
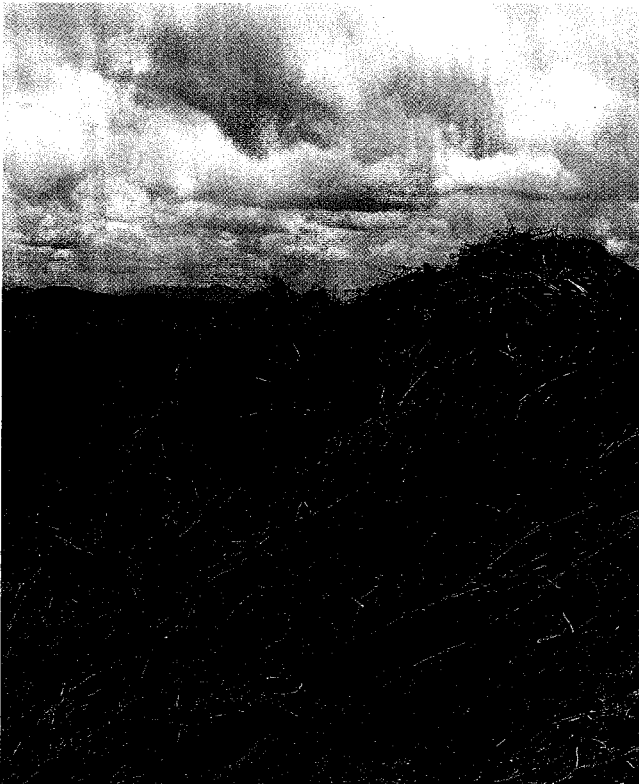
This information was considered to be necessary to allow better planning and management of logging residue, including assessing the potential for residue utilisation.

## METHODS

Information was collected in two ways. The first was via a questionnaire to forest companies. The questionnaire collected information on the number of landings, area harvested, current management and treatment of "birds-nests" of residue around hauler landings, current costs and regulatory conditions. The survey covered the major forestry companies in New Zealand, and the replies received represented approximately 70% of the total area harvested annually.

The second was a series of studies carried out on active logging operations where the volume and type of logging residue

Figure 1 — Build-up of logging residue at hauler landings



was measured as it was created. There were two types of operation studied; delimiting at the landing (12), and delimiting at the stump (3). The residue volume was then related to the extracted volume, and to the harvesting system. The volumes of stem and branch material were collected by measuring all the stem residue, and weighing a sample of branches (75 per study). For a sub-sample of the branches, the needles were stripped off and weighed (25 per study). Cutover waste assessment was carried out by line intersect sampling (van Wagner 1968) to measure the volume of stem and branch material left at the stump. Estimates of the branch and needle content in each stand were made from the DRYMAT model (Hollinger, McClaren, Beets & Turland, 1993).

## RESULTS

### Questionnaire Survey

A summary of the replies showed that the annual total harvest area is rising, and the area of hauler logging is also increasing. The proportion of the total area to be harvested by hauler logging was estimated at 36% in 1996 and rising to 42% by 1998.

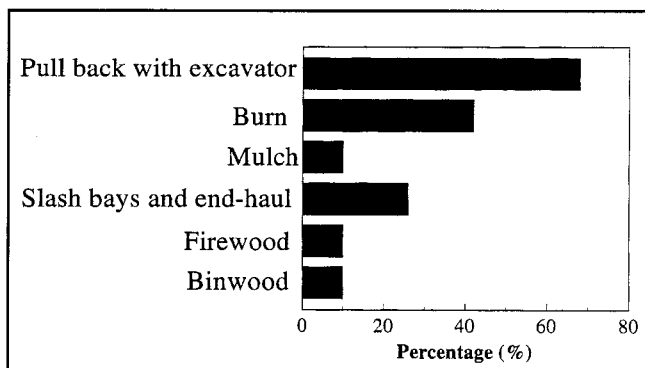
From the replies received the total number of hauler landings used in 1996 was 869. This was projected to rise to 1030 by 1998. Of the hauler landings used in 1996, 45% had a significant birds-nest or residue build-up. If these figures are adjusted by the 30% of harvested area not covered in the replies, the figures rise to 1130 in 1996 and 1330 in 1998.

For the harvested area covered in the replies received, over the period 1994 to 1996 an average of 29 birds-nests collapsed per year. This is 6% of the landings with a significant birds-nest, or 2.8% of all hauler landings. Of the collapses reported in 1996 (24), half caused a significant problem. The most common problems reported were sediment in streams, land lost from production, and stream blockages. The costs of cleaning up after a collapse were reported as ranging from \$2000 to \$50,000. Other issues related to birds-nests reported were: blocked culverts, poor public relations, ugly appearance, fire and safety hazard, and increased risk of erosion. Regulatory conditions specific to landing residue were common and were focused on keeping residue and sediment out of water ways.

Five replies, representing 27% of the reported harvest area, stated that they were assessing the logging residue at landings for merchantable material. There was only one reply that mentioned assessment for biomass content, and this was for a study not as an ongoing assessment practice.

The respondents to the questionnaire were asked what methods they used to treat birds-nests. Most companies used more than one method, choosing whichever was the cheapest or most appropriate for each landing. The methods and extent to which they are used are summarised in Figure 2.

**Figure 2 — Companies use of methods to treat birds-nests**



The estimated cost per landing of the treatments were:

- \$1,180 for excavator retrieving
- \$ 600 for burning
- \$2,000 for end hauling
- \$2,600 for mulching

Based on the reported numbers of landings needing treatment, and weighted average costs of treatment of landings and cleaning up collapses, it was estimated that at least \$670,000 was spent by New Zealand forest companies in 1996 on treating logging residue at hauler landings, and cleaning up collapses. Based on the increasing number of landings, this figure is likely to rise to \$810,000 by 1998. If the 1998 figure is increased for the 30% of area not represented in the replies, the estimated cost rises to over \$1 million.

From the survey findings, it can be seen that there are a number of issues associated with birds-nests, most of them risks and costs.

Avoiding the creation of build-ups of logging residue would be the ideal solution. Unfortunately, in the case of hauler operations, delimiting on the slope to reduce the amount of branch residue brought to the landing is not a viable option. Therefore, alternative methods of dealing with the residue at the landing need to be considered. One of the options is to utilise the residue, thus avoiding the treatment costs, and increasing value recovery and resource efficiency. However, to do this, it is necessary to know the volume and type of residue that is being put into the birds-nests. One of the findings of the survey was that there is very little assessment being carried out of residue around landings. The reason for this is that assessing residue once it is in a deep pile surrounding a landing on a steep slope is very difficult. Therefore, a series of studies were carried out to assess the residue as it was created.

### Logging Residue Studies

The results are presented in Table 1. The volumes of residue produced at the landing are expressed as a percentage of the extracted volume (EV). This allows the percentages to be applied to any harvest volume, to enable a predictive estimate of a residue volume for a specific situation.

**Table 1 — Study results, proportions, type and location of residue**

	Delimb at Landing Hauler (n = 12) Average (95% CL)	Delimb at stump Ground based (n = 3) Average (95% CL)
Stem residue at landing, % of EV	5.5 (1.2)	4.3 (4.2)
Branch residue at landing, % of EV	3.0 (2.0)	0.5 (0.6)
Needle residue at landing, % of EV	0.2 (0.2)	0.0007 (0.1)
Total residue as % of EV	8.7 (2.2)	4.9 (4.1)
Cutover stem residue, m <sup>3</sup> /ha	25 (10.6)	49 (25.5)
Cutover branch residue, m <sup>3</sup> /ha	52 (18.4)	58 (29.5)
Cutover total residue, m <sup>3</sup> /ha	77 (27.0)	107 (53.8)
Total needles in stand (DRYMAT), t/ha (adjusted to field moisture content)	18 (1.4)	15 (1.7)
% of total needles on cutover	92 (5.7)	98 (4.2)
% of total branch on cutover	84 (10.3)	97 (1.9)
% of Total Standing Volume on truck	91 (2.3)	88 (6.2)
% of Total Standing Volume on cutover	3.6 (1.4)	7.6 (3.8)
% of Total Standing Volume at landing	5.5 (1.2)	4.3 (2.6)
% of stem residue at landing >1m long	57 (8.9)	58 (12.4)

**Note: These results apply to mature forest regimes, with higher final stockings (300 to 400 stems per hectare). The residue factors should not be applied to low-stocked or immature stands.**

The data in Table 1 show that stem residue was 5.5% of the EV when delimiting at the landing (DL), and 4.3 % when delimiting at the stump (DS). Branch residue was 3.0 % of EV in DL systems, and 0.5 % of EV in DS systems. This shows that even with delimiting at the stump, some branches (and therefore needles) are extracted. It also shows that less stem residue is brought out to the landing in DS operations due to the removal of slovens and unmerchantable heads as part of the delimiting. The total volume of residues created at the landing were 8.7% of the EV for DL systems and 4.9% of the EV for DS systems.

Cutover waste assessments of the harvested sites showed that there was little difference in the amount of branch waste left on the cutover between the two types of harvesting system. This is due to felling breakage. A felling breakage study (Murphy 1984) found that 78% of trees broke at felling with a relative mean break height (RMBH) of 0.83 (83% of total tree height). Average tree height in this study was 37m. Trees could break into up to five pieces above the first break, and most of these were unmerchantable. A larger study (Fraser, Palmer, McConchie and Evanson, 1997) found relative mean break height to be 0.67, with up to 98% of trees breaking at felling. Tree height was found to be the most significant factor in determining breakage. These studies confirm casual observation that it is the head of the tree (where the bulk of the green crown is located) that tends to break off into unmerchantable (and therefore unextracted) pieces. During extraction, more branches may be broken off and remain on the cutover. For the total estimated branch material in the stand prior to harvest (DRYMAT), 84% was left on the cutover with DL operations, and 98% with DS operations.

The percentages of the needles that were left on the cutover were estimated at over 90% for both delimiting at landing and delimiting at stump.

In both systems, approximately 90% of the total standing volume (TSV) was extracted and ended up as logs. Just over 5% of the TSV was left at the landing in DL operations, and 4% in DS operations. The rest remained on the cutover. Further analysis of the stem residue at the landing showed that over 50% was in sections greater than 1m in length.

## DISCUSSION

There were a number of points raised by the findings in both studies.

Birds-nests at hauler landings cause problems and incur costs. The piles also appear to be very large. However, the appearance of the heaps is deceptive, as although they look large they typically have a low density. That is, of the total bulk volume of the heap only 20% to 25% (Hardy, 1996, Hall Unpublished data) is actually wood residue of some form, the rest is airspace.

This low density may contribute to the instability of the heaps. Compaction of the residues may be possible in some cases, which would reduce storage space and may reduce the risk of collapse.

The proportion of the total branch material in a stand that is extracted is quite low. The problem of residue at landings is one of concentration. The typical area harvested to a landing is 8 to 10 ha (Hall and McMahon, 1997) but can be as high as 25 ha. The residue created at the landing from harvesting is then piled in an area of 0.1 to 0.2 ha (Hall, 1993) around the landing edge.

Most of the branch material in a stand was left on the cutover. Even in hauler operations with delimiting at the landing, over 80% of the branch material was not extracted. The situation with needles is similar, and obviously related. Concerns over the removal of nutrients from forest sites by "whole tree" harvesting in hauler operations with delimiting at the landing would therefore seem to be unjustified. Genuine "whole tree" harvest-

ing of mature radiata pine off steep slopes is unlikely to occur, due to felling breakage.

Of all the residue produced at the landings, 66% ( $\pm 14.7\%$ ) was stem wood in DL systems, and 80% ( $\pm 25.3\%$ ) in DS systems. Of this material, over half was in sections greater than 1m in length. This material is suitable for recovery of pulp chip, but requires a specialist transport and handling system (Hall, 1995).

## CONCLUSIONS

Hauler logging accounts for a significant component of New Zealand's forest harvest (34% in 1996 and rising to 42% by 1998).

Of the 800 to 900 hauler landings being used annually, 45% have a significant build-up of logging residue. These build-ups have problems, risks and costs associated with them.

The amount and type of logging residue at landings was dependent on whether the harvesting system operated with delimiting at the landing or delimiting at the stump.

Stem wood was the largest component of the residue by solid volume, comprising 60% to 80%, depending on the harvesting system. Over half of this material was in sections longer than 1 m.

The size (bulk volume) of the residue piles could be substantially reduced by utilisation of the stem wood greater than 1m in length, and compaction of the remainder.

The bulk of the branches (80% to 90%) and the needles (90%+) estimated to be in the stand were left on the cutover as a nutrient resource for the next rotation.

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