Liro
Forestry Solutions

PROJECT REPORT

PR 85

1999

MANAGEMENT OF LOGGING SLASH IN STREAMS OF NEW ZEALAND
- results of a survey

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EXECUTIVE SUMMARY

Forest Companies

- Forest companies were surveyed to identify the issues, risks and management practices associated with logging slash in streams. The survey covered 60% of New Zealand's pine plantation estate (973,553 ha).
- Debris dams were identified by respondents as the main risk associated with logging slash in streams.
- Stream flow was the main criteria used to determine logging slash management strategies, in particular perennial or ephemeral flow and flood potential.
- Planning considerations to minimise logging slash in streams included the use of skyline systems and carriages, and gully to ridge extraction. In ground-based operations, mechanised harvesting or machine-assisted directional felling are used to harvest along stream edges.
- Manual stream-cleaning was the most common practice used to clear logging slash from streams. Logging slash was left in low priority and inaccessible streams, or where slash removal could further damage the stream environment.
- Culvert and bridge design does not usually provide allowance for logging slash passage.
- Survey respondents reported an **estimated** 80 significant debris flows which had reached the stream channel for the years 1995 to 1998. Landslides and slips, and mobilisation of in-stream log jams or debris dams, were the two main sources of debris flows (48% and 38% respectively). Remedial action and **estimated** costs varied widely.
- The main problem identified by respondents in managing logging slash in streams was the lack of information on the effects of varying levels of slash on the stream environment.

Council Rules

- Information on activity status and rules for harvesting around waterways were collected from Regional Councils and Unitary Authorities.
- For most councils in the northern part of the North Island, harvesting around waterways is usually discretionary, depending on distance and slope from the watercourse. For most other councils, harvesting around waterways is a permitted activity within certain guidelines.
- Council rules focus on minimising slash in waterways. Some consider risk factors such as collapse and mobilisation of debris dams, and potential damage to the stream environment.
- Both forest company and council rules and practices focused on the risk of physical damage to the stream environment from logging slash. Few rules or practices related to aquatic biota, water quality or aesthetics. Lack of information in this area may be a contributing factor.

Decision making processes

- To gain an understanding of the decision making processes used by forest companies to manage logging slash in streams, respondents were given two scenarios to comment on.
- In the first scenario, respondents had to describe the steps taken to manage slash in a perennial stream. Most emphasis was placed on the planning part of the management process.

- In the second scenario, respondents described management of logging slash in a dry gully, ephemeral and perennial stream. Most gave a graduated response with increasing remedial action from the dry gully to the perennial stream. Risk assessment was an important consideration.
- The effects of varying levels of logging slash on the stream environment was identified by survey participants as the main area requiring further research.

INTRODUCTION

One issue when harvesting around waterways is the potential for large amounts of logging slash to end up in the stream channel (Hall and McMahon, 1997; Collier et al., 1998; Baillie and Cummins, 1998; Coker et al., 1990). Management options can include using harvest systems and practices to minimise the amount of logging slash entering the stream, removing the logging slash once it is in the stream channel, or leaving the logging slash in place.

A literature review found very little information on the management of logging slash in streams both in New Zealand and overseas. Information was confined to Oregon State in the United States of America (Froehlich, 1971; Swanson et al., 1976; Smith, 1992).

In a study of flooding damage in Western Oregon (Froelich, 1971), culvert damage from debris blockage was a common cause of road damage during floods. Damage to culverts from debris in harvested catchments was about twice that in unharvested catchments. Practices used to reduce the amount of logging slash in streams included mechanical removal, burning, manual stream-cleaning using chainsaws, and barriers to contain material. Roading specifications sometimes included specific allowances for debris passage such as increased culvert size or extra height on bridges.

Leaving large amounts of logging slash in the stream can potentially pose a risk to downstream areas if the logging slash is mobilised during floods. Some evidence from studies in Oregon, USA, suggests that damage to streams from the mobilisation of logging slash alone has been minimal (Froehlich, 1971; Swanson et al., 1976; Smith, 1992). Rather, it has been other debris flow events such as landslides and slips entering the stream channel which have caused the most significant damage. In these instances, however, the presence of woody debris in the streams has aggravated the damage in the stream, scouring the channel. At the same time, woody debris has sometimes acted as a brake on the debris flow, reducing the travel distance of the flow.

In order to fill the information gap identified in the literature review, a survey was carried out to identify the current practices being used to manage logging slash in New Zealand's plantation forest streams.

The purposes of the survey were to:
- provide a comprehensive picture of current management practices
- provide a benchmark for future surveys
- provide information for future research.

This report presents the results from the survey and outlines:

- survey methodology
- survey coverage
- management of logging slash in streams
  - issues and risk factors perceived by the respondents
  - criteria used to determine slash management strategies
  - harvest and roading practices used to manage logging slash in streams
- debris flows in streams
- future issues in managing logging slash in streams
- Regional Council and Unitary Authority rules pertaining to harvesting around waterways and management of logging slash
- decision making processes used by forest companies to manage logging slash in streams (responses to two scenarios).

SURVEY METHODOLOGY

Twenty-three written questionnaires (Appendix 1) were sent out to eleven major forest companies in New Zealand. The companies were identified from a New Zealand Forest Association publication (NZFOA, 1998). Forestry respondents were identified using the process of snowballing (Birn et al., 1990) whereby initial contacts within the industry were used to identify the most suitable personnel to respond to the questionnaire. Most forest companies received more than one questionnaire so they could reply on a regional basis.

To ascertain management issues relating to logging slash in streams, survey respondents were asked to identify:

a) on-site and downstream issues and risk factors associated with logging slash in streams

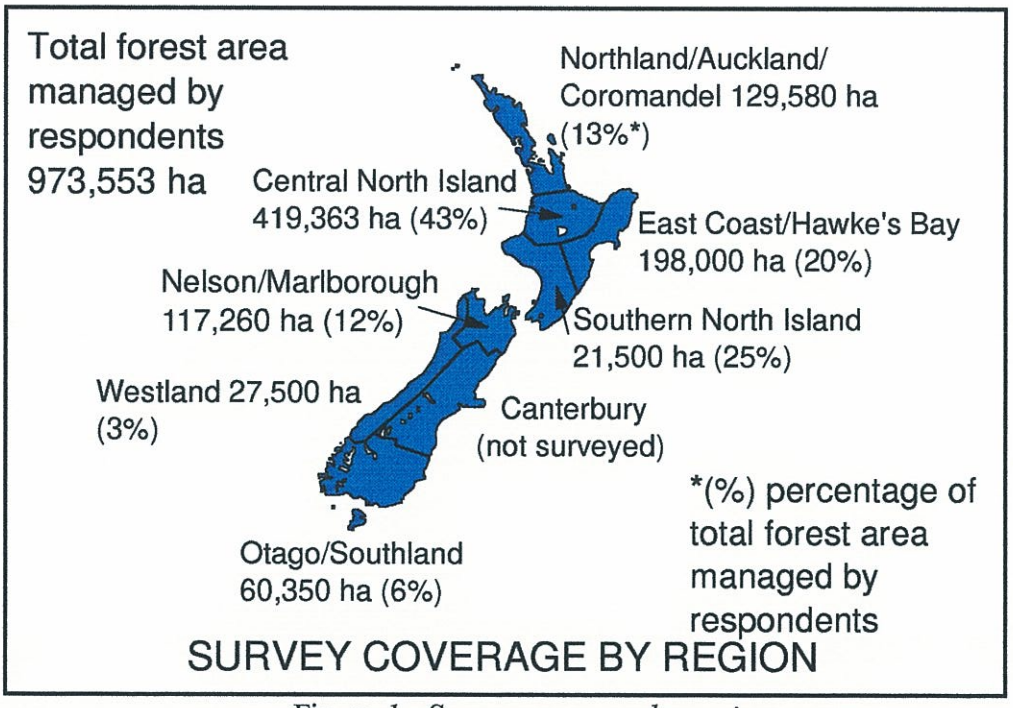

Figure *1 - Survey coverage by region*

b) the criteria used to determine logging slash management strategies
c) harvesting and roading practices used to manage logging slash in streams.

Fourteen Regional Councils and Unitary Authorities provided information on the activity status of harvesting around waterways and any rules relating to logging slash in waterways.

RESULTS AND DISCUSSION

Survey Response and Coverage

Nineteen questionnaires were received from the eleven forest companies that took part in the survey. The area managed by the survey respondents represented 973,553 ha of plantation forests or 60% of New Zealand's pine plantation estate (NZFOA, 1998). Questionnaires were returned from seven regions around New Zealand. The only region not represented in the survey was Canterbury (Figure 1). Canterbury forests have few streams so management of logging slash in streams is a low priority.

Management of Logging Slash in Streams

Issues/risk factors associated with logging slash

The potential physical damage of debris dams on the stream environment was the most important issue identified by respondents. Of particular concern were on-site stream bank erosion, culvert damage and downstream damage to culverts and other infrastructures (Table 1).

Table 1 - Issues/risk factors associated with logging slash in streams

Issue/Risk Factor	On-site % of respondents (n = 19)	% of surveyed area (97,3553 ha)	Downstream % of respondents (n = 19)	% of surveyed area (97,3553 ha)
Debris Dams:				
Stream bank erosion	79	84	47	50
Culvert blockage	74	84	68	68
Downstream infrastructure	74	70	84	64
road user safety	5	8	5	3
Ponding	5	3	0	
Aquatic Biota:				
Fish	58	61	58	57
Aquatic invertebrates	53	63	42	42
Aesthetics	58	77	42	53
Water Quality:				
Dissolved oxygen	42	30	32	29
Temperature	42	26	26	14
Sediment/clarity	32	37	32	37
Nutrients	26	14	32	18

More than 50% of the respondents also identified aquatic biota and aesthetics as important on-site issues. However, aquatic invertebrates and aesthetics did not rate so highly as a down-stream issue. Less than half the respondents saw water quality both on-site and downstream as an important issue.

Criteria to determine logging slash management strategies

Stream flow was the main criteria used to determine logging slash management strategies (Table 2). Seven respondents used perennial flow, while five respondents used both perennial and ephemeral flow as a criteria. Stream size was the next most common criteria, either greater than 1m in width (five respondents) or 3m in width (two respondents). Only three respondents cited catchment area as a management criteria for logging slash: two of the three respondents used catchment size and one used percentage of the catchment harvested. Trout and or native fish were another parameter used to determine in-stream slash management strategies.

Harvest practices to minimise entry of logging slash into streams

In ground-based operations, mechanised or machine-assisted directional felling is used to fell away from stream edges. For yarder operations, planning to maximise the use of skyline systems, carriages, and gully to ridge extraction were commonly cited by respondents as a means of minimising entry of logging slash into the stream. Full or partial suspension of loads across the stream and directional felling (cross-slope, back from stream edge, directly across with full stem extraction) were the most common practices used during harvesting.

Harvest practices to manage logging slash once it is in the stream

In Oregon, mechanical removal, burning, manual stream-cleaning using chainsaws, and barriers to contain debris, were used to manage logging slash in streams (Froelich, 1971). The survey results show that similar practices are used in New Zealand, with stream-cleaning and leaving slash in the stream being the most common practices (Table 3).

All forest companies used more than one practice depending on their logging slash management criteria. The barriers used to contain logging slash included railway irons and eucalyptus poles, a steel grid, a debris dam and even a heavy duty fishing net. Two respondents used a vegetative buffer such as a row of trees or existing riparian vegetation as a barrier to minimise entry of slash into the stream. Another practice was to fine the contractor for leaving slash in streams.

Table 2 - Criteria used to determine logging slash management strategies in streams

Criteria:	Stream flow	Stream size	Catchment area	Trout /native fish	Other
% respondent	74	60	16	20	20
% land area	89	49	27	21	21

NB: Percentages add up to more than 100% as some forest companies used more than one criteria.

Table 3 – Practices used to manage logging slash in streams

Practice:	% of respondents (n = 19)	% of survey area (97,3553 ha)	Average $/km or $/barrier (estimated)	Range $
Leave slash	89	98	-	-
Stream-clean manual	95	86	3000	250 - 10000
Stream-clean mechanical	73	70	4000	400 - 50000
Barriers to contain slash	32	30	1000	700 - 1500

NB: Percentages add up to more than 100% as forest companies used more than one practice to manage logging slash in streams.

A limitation of manual stream-cleaning is how far and high the logging slash can be moved by hand (Figure 2). If it is not lifted high enough, floods overflowing the banks or immediate channel can transport wood off the hillsides and floodplains. Barriers, to be successful, have to hold the logging slash back without adversely restricting the water flow. They also need to be located where they can be accessed by machinery to remove the slash. Logging slash is often left in low priority and inaccessible streams, or where slash removal could further damage the stream environment.

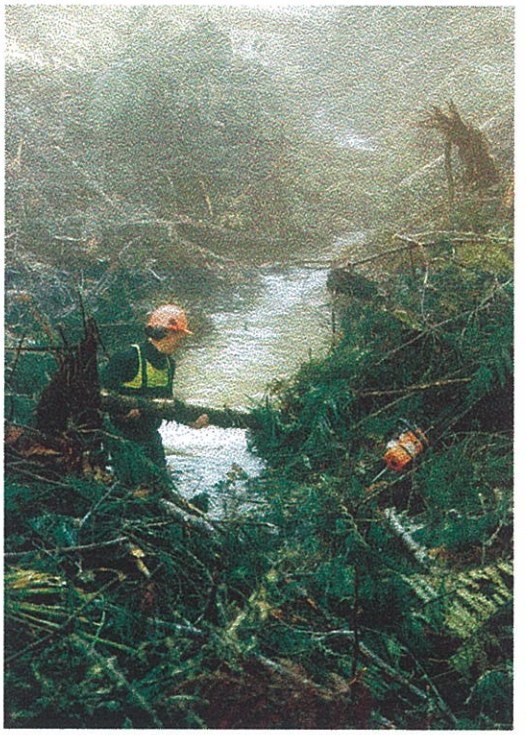

Figure 2 – Manual stream-cleaning

Roading practices to manage logging slash in streams

Although damage to culverts from debris during flooding was identified as a common cause of road damage in Oregon (Froelich, 1971), specific allowances for debris passage were only sometimes included in culvert and bridge design. The situation is similar in New Zealand:

- four respondents used larger culverts to cope with logging slash in the stream channel
- three respondents used fords instead of culverts
- one respondent considered additional bridge height to allow for the passage of logging slash
- no respondents considered installing a bridge instead of a culvert.

Debris Flows In Streams

Debris flows are loosely defined as mass movement of sediment, rocks, boulders, organic material and other debris down a slope. These are usually initiated during rainfall events of high duration and intensity (Selby, 1993).

Survey respondents were asked to identify the number of debris flows that had originated within their forests in the last five years (1994 to 1998) and which had either reached the stream channel or originated within the stream channel. They were also asked to identify the source of the debris flows, any remedial action taken, and associated costs.

Please note that identifying the number of, and costs associated with, debris flows is difficult. Few, if any, records are kept of these events so the number of debris flows and costs presented in this report are a best estimate only. Respondents were asked to use their judgement and confined their replies to significant debris flows only.

Sources of debris flows

Landslides or slips entering the stream channel, and mobilisation of log jams or debris dams within the stream channel, were the two main sources of debris flows (Table 4).

The Northland/Auckland/Coromandel and Nelson/Marlborough regions reported the most debris flows, particularly landslides and log jams/debris jams. This is possibly a reflection of these two region's susceptibility to frequent flood events (McKerchar and Pearson, 1989) and unstable soils and geology on the steeper hill country. Although the East Coast/Hawke's Bay area is also subject to frequent flooding and unstable geology, the reported number of debris flows from this region was low (eight). Possible reasons could be the reporting system or that much of the East Coast/Hawke's Bay is in new plantings. This is an area that may require further research.

Table 4 - Sources of debris flows by region

Region	Landslide /slips	In-stream log jams/ debris dams	Landing/ bird's nest failure	Road Collapse	Total	%
Northland/Auckland/ Coromandel	21	14	2	0	37	46
Central North Island	4	1	2	2	9	11
East Coast/Hawke's Bay	6	1	1	0	8	10
Southern North Island	0	0	0	0	0	0
Nelson/Marlborough	5	12	3	0	20	25
Westland	1	0	0	2	3	4
Otago/Southland	1	2	0	0	3	4
Total	38	30	8	4	80	
%	48	38	10	5		

NB: Due to rounding conventions total % does not always equal 100%.

Figure 3 – Debris dam from mobilisation of logging slash

In an evaluation of two study sites in Oregon, USA (Swanson et al., 1976), analysis of 53 debris flows showed 44 (83%) were triggered by hillslope slides. Contrary to the Oregon study, mobilisation of logging slash into log jams and debris dams within streams, is a significant source of debris flows in New Zealand (Table 4) (Figure 3).

Remedial action and estimated cost

In the Northland/Auckland/ Coromandel region, where landslides/slips are numerous, these are monitored and only those posing a potential hazard to downstream users are removed. Remedial action also included aerial grass seeding and restocking of the landslide and clearing blocked road crossings. Costs were not available for this region.

For the remaining regions, the material was usually removed using diggers or excavators. In one area a helicopter and grapple were used. Follow-up remedial action included improving drainage, repair to any infrastructures such as culverts, and bank reinforcement or stabilisation with plantings. Estimated costs to remove material from the stream and remedial action averaged $3200 per event (Table 5).

In most cases where log jams and debris dams were perceived to be a risk, the debris was mechanically or hand removed from the stream. Estimated costs averaged $6,700 per event. Planting for stabilisation was the main follow-up action on landing/bird nest failures. In two instances, debris was removed from the stream or held in debris traps downstream. Estimated costs of remedial action averaged $1,400 per event. Remedial action for roading collapse included culvert and road repair, bank reinforcement and plant stabilisation. Estimated costs averaged $2,650 per event.

Table 5 - Estimated costs of remedial action

Debris Flow Source	Average Cost/event ($)	Range ($)
Landslide/slips	3200	300 - 10000
In-stream log jams/ debris dams	6700	6000 – 90000*
Landing/bird's nest failure	1400	1500 - 6000
Road collapse	2650	300 - 5000

*The $90,000 culvert and road repair cost was met by a local council.

Issues and Problems Relating to Logging Slash in Streams

To help focus future research in New Zealand, respondents were asked to list what they identified as the main issues and problems in managing logging slash in streams. These are detailed in Appendix 2. The main issues were: the need to determine how much slash was acceptable in a stream, and the impact of varying levels of slash on the stream environment.

Regional Council and Unitary Authority Rules Regarding Harvesting Around Waterways and Management of Logging Slash in Streams

For most councils in the northern part of the North Island, harvesting around waterways is usually discretionary, dependent on distance and slope from the watercourse (Appendix 3). Other considerations included the area to be harvested, soil type and whether the soil was erosion prone. For most other councils, harvesting around waterways is a permitted activity within certain guidelines. Three councils allowed harvesting around waterways without any resource consent conditions or specific rules in relevant land management plans. Where rules were specified, either in plans or as a consent condition, there were similarities between the councils (Appendix 3). Most rules and conditions were aimed at managing the risk associated with logging slash in streams, in particular collapse and mobilisation of debris dams and subsequent damage. Rules and consent conditions to manage logging slash for water quality or aquatic biota were minimal. As commented by one council, this is due to either lack of information or inconclusive evidence in this area. This has also been identified as an issue by the forest companies.

Decision Making Processes in Managing Logging Slash in Streams

Survey respondents were presented with two scenarios regarding harvesting around waterways for comment. The purpose was to gain an understanding of how the practices identified earlier in the survey were used in decision making processes to manage slash in waterways. Fourteen replies were received for both Scenario 1 and 2.

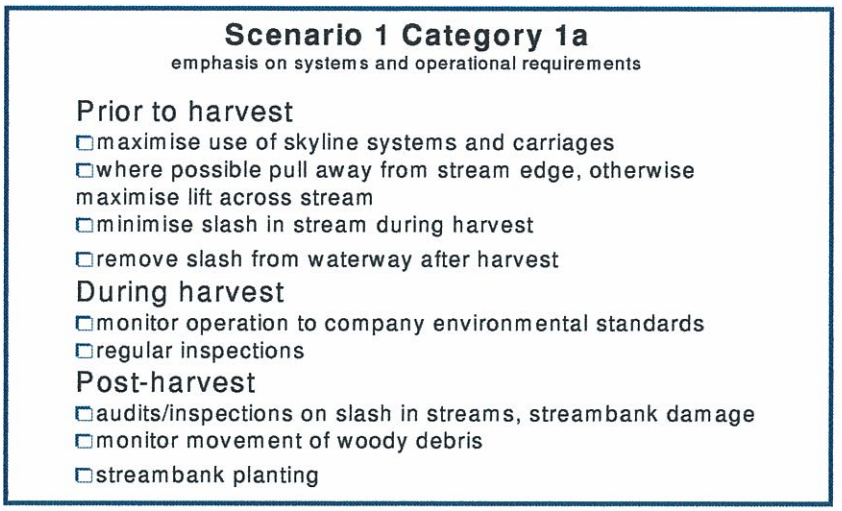

Figure 4 - Scenario 1 Category 1a

Scenario 1

The first scenario read:

There is a perennial stream flowing through a catchment which is due for harvest. Side slopes in this gully average 25-30°. The stream flows downstream through farmland and past a small town before emptying into a harbour. Describe the steps you would take from planning to post-harvest to manage the logging slash in this stream. Use diagrams or flow charts if this is more suitable than words.

All replies placed the most emphasis on the planning phase prior to harvest, with a lesser focus on the operational and post-operational phases. The replies fell into three main categories:

- Category 1 a) - Respondents replied directly to the parameters given in the scenario (perennial stream, side slopes 25 - 30°). Planning prior to harvest focused on harvest system and operational requirements (six respondents) (Figure 4).
- Category 1 b) - Respondents replied directly to the parameters given in the scenario. Planning prior to harvest focused on the Resource Management Act (RMA) requirements and consultation processes (five respondents) (Figure 5).

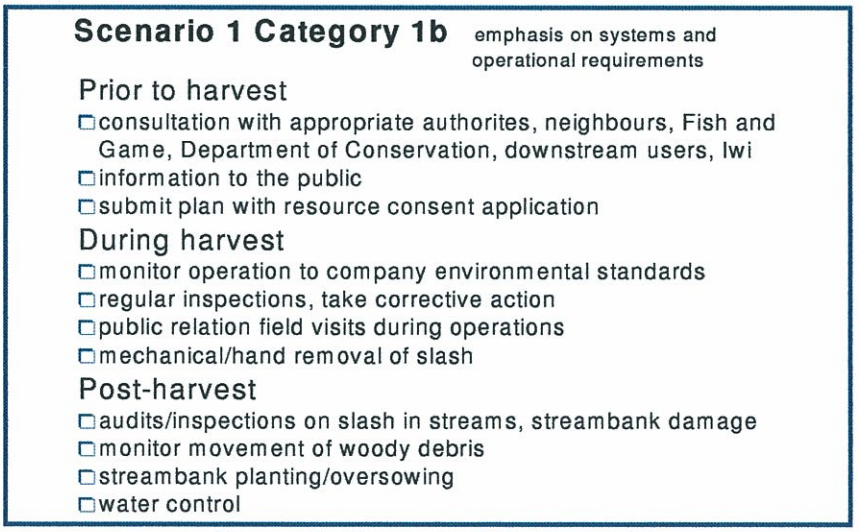

Figure 5 - Scenario 1 Category 1b.

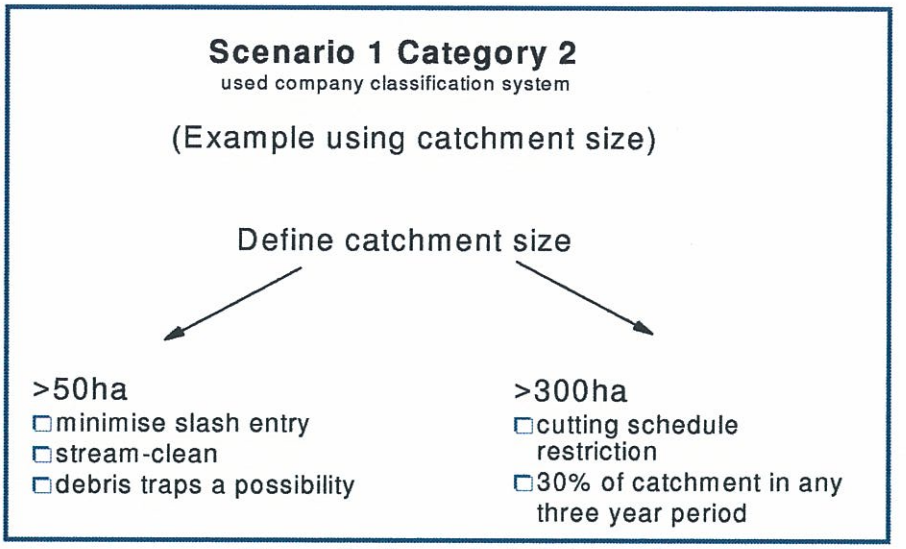

Figure 6 - Scenario 1 Category 2

Category 2 - The remaining three respondents used the parameters given in the scenario to classify the stream within their own company classification system. This defined the course of action in managing harvest operations around the stream (Figure 6). Other parameters used to classify streams included hydrology (stream power and flow regime), catchment size, and fish values.

Scenario 2

The second scenario read:

A landing has collapsed. Soil and slash from the landing has travelled downhill and into:

a) a dry gully

b) an ephemeral stream (only flows for part of the year)

c) a perennial stream (flows all year round)

Describe the steps you would take for each.

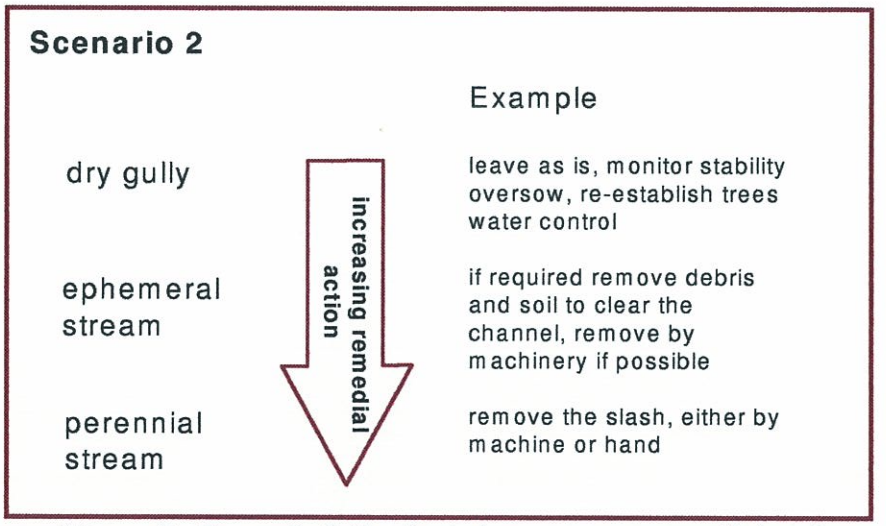

Figure 7 - Scenario 2 Graduated response to remedial action

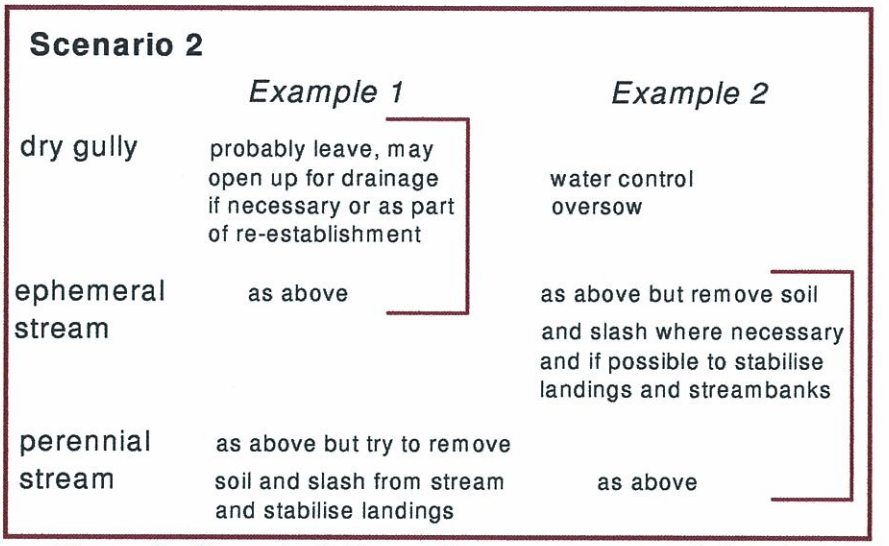

Figure 8 - Scenario 2 Grouped response to remedial action

Nine responses gave a graduated response, with remedial action increasing from the dry gully through to the perennial stream (Figure 7).

Five respondents combined the remedial action for either the dry gully and ephemeral stream (three of the five respondents) or the ephemeral and perennial stream (two respondents) (Figure 8).

Risk assessment was considered an important factor by most respondents. Risk assessment included appraising whether the ephemeral stream was dry or flowing at the time of the event and whether remedial action would incur further environmental damage. In most cases respondents did not associate a high risk with the dry gully scenario.

One respondent used an investigative approach, identifying underlying causes, remedial action and communicating results to relevant people. Three respondents specifically referred to the involvement of the appropriate Councils in the process.

SUMMARY

This report presents a summary of slash management practices currently used in New Zealand's pine plantation streams.

This information is however, limited by a number of factors. Obtaining accurate information on incidents such as debris flows is difficult due to the lack of reporting systems and the difficulties of isolating costs attributable to these incidents. There are also limitations in using a questionnaire with 'black and white' questions to collect information on the complex issue of managing logging slash in streams.

In recognition of this, respondents were given the opportunity to respond to two different harvesting around waterways scenarios. These identified some of the decision making processes used by respondents in their slash management strategies.

Management of logging slash in streams in New Zealand's pine

plantations focuses primarily on the risk of physical damage to the stream environment, in particular stream bank erosion and damage to culverts and other infrastructures. Stream biota and water quality still rate highly but are of a secondary concern. This may be due to the lack of information on the effects of varying slash levels on stream biota and water quality, a key issue raised by the forestry respondents and one Regional Council.

The need to consider the risk of physical damage to the stream environment from logging slash was highlighted in the analysis of sources of reported debris flows. Although landslides and slips were the primary source of debris flows in streams (48%), mobilisation of logging slash within streams is still a significant source of debris flows (38%).

Planning and risk identification were two important considerations in the decision-making processes used by survey participants when responding to the two harvesting around waterways scenarios

Specific management practices to deal with logging slash in streams focus more on harvesting than roading. Harvest practices used to manage logging slash in streams are similar to those being used in Oregon in the 1970s. Stream-cleaning and leaving slash in the streams are the two most common practices used in New Zealand. Similar to Oregon, specific allowances for debris passage are only sometimes included in culvert and bridge design.

Further research is required to better understand the effect of varying logging slash levels on the stream environment.

ACKNOWLEDGEMENTS

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REFERENCES

Baillie, B.; Cummins, T (1998): Harvesting practices - effects on woody debris in streams and channel bank disturbance. *Liro Project Report No 71*

Birn, R.; Hague, P.; Vangelder, P.(1990); A Handbook of Market Research Techniques. Kogan Page Limited, London.

Coker, R. J.; Pearce, A. J.; Fahey, B. D. (1990): Prediction and prevention of forest landing failures in high intensity rainfall areas of northern New Zealand. *In*: Research needs and applications to erosion and sedimentation in tropical steeplands. Edited by R. R. Zimmer, C. C. O'Loughlin, L. S. Hamilton. IAHS Press: 311-317.

Collier, K. J.; Bowman, E. J.; Halliday, J. N. (1998): Changes in water quality and benthic invertebrate faunas following post-harvest manipulation of woody debris in some Whirinaki streams. *NIWA Client Report: FOR60203.*

Froehlich, H. A. (1971): Logging debris managing a problem. *In* J. T. Krygier and J. D. Hall (eds.), Forest Land Uses and Stream Environment, A Symposium, p. 112 - 117 Oregon State University, Corvallis.

Hall, P. and McMahon, S. (1990): Logging residue at hauler landings – results from an industry survey. LIRO Report Vol.22. No. 2.

McKerchar, A. I.; Pearson, C. P. (1989): Flood Frequency in New Zealand. Publication No. 20 of the Hydrology Centre, Division of Water Sciences, Department of Scientific and Industrial Research, Christchurch.

New Zealand Forest Owners Association Inc 1998: NZ Forestry Facts and Figures '98.

Selby, M. J.(1993): Hillslope Materials and Processes. Oxford University Press. New York.

Smith, R. D. (1992): Geomorphic effects of large woody debris in streams National Hydrology Workshop Proceedings. Phoenix, Arizona.

Swanson, F. J.; Lienkaemper, G. W.; Sedell, J. R. 1976: History, physical effects and management implications of large organic debris in western Oregon streams. *USDA Forest Service General Technical Report (PNW-56).* 15p.

Appendix 1 : Questionnaire used in survey on logging slash in streams

Survey on Logging Slash in Streams

Background

Liro is currently undertaking a research programme on the effects of logging slash on waterways. This research is part of a government funded project looking at the Environmental Impacts of Forest Management. One of the issues when harvesting around waterways is management of logging slash which can potentially enter the streams during harvest operations. This survey aims to identify:

- risk factors and management issues associated with logging slash
- methods used to manage the logging slash

This research will provide the forestry industry with a review of current issues and practices associated with logging slash in streams. The results will be reported back to the industry via meetings and reports and will assist in future research on logging slash management options in streams.

Confidentiality

Individual responses from the survey will remain completely confidential. Results will be summarised in such a way as to also maintain the confidentiality of individual companies.

Contact person

For any queries or concerns regarding this survey, please contact:

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e-mail brenda.baillie @fri.cri.nz
Direct line ph (07) 347 5506

Please return the completed survey in the reply paid envelope attached by
16th December 1998

RESPONDENT DETAILS

Name:_____

Position:_____

Company:_____

Contact Phone Number/E-mail:_____

SURVEY

1. What forests or regions will you be covering when responding to the questions in this survey?

_____

2. What is the total forest area for the region described in Question 1?

_____(ha)

3. What was the total harvested area within this region for the last 5 years?

1994 _____(ha)
1995 _____(ha)
1996 _____(ha)
1997 _____(ha)
1998* _____(ha)
*estimate to the end of the year

The next three questions relate specifically to debris flows. Debris flow = mass movement of slash/sediment downstream usually during floods.

4. Have any debris flows either, **originated within** your forests and reached the stream channel or, **originated in the streams in your forests,** in the last 5 years? (*tick one box*)

YES *Please complete the next two questions*

NO *Proceed to Question 7*

5. If YES, state the source and number of these debris flows, which in your opinion, have had a significant impact on the stream.

Source	Number
Landslides/debris flows	_____
Roading collapse	_____
Landing/birds nest collapse	_____
Logging slash/debris dams in the stream	_____
Other: _____	_____
_____	_____

6. For each debris flow described in Question 5, what remedial action (if any) was required and what was the estimated cost?

	Source	Action	Cost
1.			
2.			
3.			

The next set of questions relate to issues and risk factors associated with, and management of, logging slash in streams.

7. What are the issues/risk factors associated with logging slash in your streams (*tick appropriate boxes*)

	On-site	Down-stream
Debris dams		
- stream bank erosion		
- blockages to culverts		
- damage to downstream infrastructure/environment		
- other (describe) _____		
_____		

	On-site	Down-stream
Water quality:		
-dissolved oxygen levels		
-nutrients		
-temperature		
-other (describe) _____		
Fish (native, trout)		
Aquatic invertebrates		
Aesthetics		
Other (describe) _____		
_____		

8. What criteria are used to determine logging slash management strategies in your streams: (*tick appropriate boxes*)

stream size (*state criteria*)

stream flow (*state criteria*)

catchment area (*state criteria*)

other criteria eg trout spawning (*state criteria*)

9. Briefly, what rules affect your company's management of logging slash in streams?

9.1 Regional/District Council rules (*list*)

9.2 Forest Company rules (*list*)

10. What **harvesting** practices does your company use to reduce the amount of logging slash entering streams?

10.1 Harvest systems (*list details*)

10.2 Felling/extraction practices (*list details*)

11. What practices does your company use to manage logging slash that has entered the stream?

11.1 Mechanical removal of logging slash? (*tick appropriate box*)

NO

YES

If YES what was the estimated average cost/km of stream for mechanical removal of logging slash? $_____

11.2 Manual removal of logging slash (man power and chainsaws)? (*tick appropriate box*)

NO

YES

If YES what was the estimated average cost/km of stream for manual removal of logging slash? $_____

11.3 Barriers to contain logging slash? (*tick appropriate box*)

NO

YES

If YES what type of barrier did you use and what was the estimated cost to establish the barriers?

Type of barrier (*describe*)	Estimated cost

11.4 Leave woody debris in stream? (*tick appropriate box*)

NO

YES

11.5 Other practices to manage logging slash in streams? (*list*)

12. What modifications (if any) has your company made to **roading** practices in a response to risks associated with logging slash in streams?

12.1 None? (*tick appropriate box*)

NO

YES

12.2 Larger culverts to minimise blockage from logging slash? (*tick appropriate box*)

NO

YES

12.3 Installed a bridge instead of a culvert? (*tick appropriate box*)

NO

YES

12.4 Additional height in bridge design? (*tick appropriate box*)

NO

YES

12.5 Fords instead of culverts? (*tick appropriate box*)

NO

YES

12.6 Other (*list*)

13. Have I missed anything? Are there any other planning or operational considerations relating to logging slash in streams? (*List*)

14. To help focus future research, what do you consider to be the main problems in management of logging slash in streams? (*list*)

15. General comments on management of logging slash in streams (*optional*)

Finally:
So far you have been asked to list or describe the rules and practices used in managing logging slash in streams. Because we recognise that management of logging slash is site specific, we wish to pose two scenarios for you to comment on. This will give us an understanding of how you use those rules and practices in decision-making when responding to a given situation.

Scenario 1

There is a perennial stream flowing through a catchment which is due for harvest. Side slopes in this gully average 25-30°. The stream flows downstream through farmland and past a small town before emptying into a harbour. Describe the steps you would take from planning to post-harvest to manage the logging slash in this stream. Use diagrams or flow charts if this is more suitable than words.

Scenario Two

A landing has collapsed. Soil and slash from the landing has travelled downhill and into:
A: a dry gully
B: an ephemeral stream (only flows for part of the year)
C: a perennial stream (flows all year round)

Describe the steps you would take for each
A: a dry gully

B: an ephemeral stream (only flows for part of the year)

C: a perennial stream (flows all year round)

THANK-YOU
Please return in the reply paid envelope attached by
16th December 1998

Appendix 2 Respondents comments on issues and problems associated with management of logging slash in streams

Main problems managing slash
Determine what size and how much slash leads to future problems
There are no clear guidelines on how much slash is acceptable and how much isn't
If slash can be left in a stream then what is an acceptable level/quantity
Lack of information on streams where nothing has been done ie no removal of slash
How to determine what levels of slash in a stream is OK and how to measure them
We need to know the benefits and detriment's of slash in streams - don't assume its all bad, then what size/type should be avoided
Understanding effects on aquatic life of short term increases in nutrient levels - how much is too much?
Long term implications of leaving slash in waterways as regards breakdown, nutrients, aquatic changes
Effects of slash on stream values over time
Slash causing culvert blockage and downstream erosion
Collapse values for birds nests ie 2m high or 4m high is stable?
Types of barriers used and criteria for building Ranking stream values to help with planning/slash management
Do planning approaches (gully to ridge,, manage bird nests, full/partial suspension over stream etc) really make a difference in an environment where there isn't a clear water resource, flows are intermittent and aquatic life is of apparently low intrinsic value
The problem is so variable and affected by so many factors that there isn't an easy answer, guidelines that work in one place don't necessarily work in another
Difficult to avoid slash entering streams in upper catchments which can move in extreme storm events, easier to manage and control slash in the larger waterways
Where is the limits of impact on the waterway ie is riparian management zones limits correct, too much/not enough?
Conflicting reports on the effects of slash on the trout fishery
Perception that slash in streams is bad. In many circumstances the saying 'in moderation' is just fine Methods of slash removal - to achieve the best result environmentally and financially The inevitability of it all and the understanding of outside agencies the acceptability of it at say certain levels Harvesting cutover inspections, ensuring contractor compliance

Shaded area highlights comments relating to the impact of varying logging slash levels on the stream environment

Appendix 3: Activity status, and consent conditions for harvesting around waterways in pine plantations*

Consent Authority	Activity status for harvesting around waterways	Plan	Consent conditions/matters to be considered pertaining to management of logging slash around waterways
Northland Regional Council	Permitted for land designated as not erosion prone and where harvesting is >3m from the water body Discretionary <3m from a water body	Revised Proposed Regional Water and Soil Plan (Nov 98) - Section 32 and 35.	Section 32 - No slash shall be allowed to enter or shall be placed in a position where it could readily enter, or be carried into a permanently flowing water body. Section 35 - No trees shall be intentionally felled into the major watercourse. Machine -assisted felling techniques shall be used to achieve this. Should a trees be unintentionally felled into a watercourse then it shall be removed along with any limbs.
Auckland Regional Council	Within Sediment Control Protection Area (SCPA), (within 50m of watercourse or wetland = 1000m^2): all soils area < 0.25ha - permitted, all soils > 0.25ha - restricted discretionary. Outside SCPA: sand soils - permitted, all other soils <10ha - permitted, >10ha controlled or discretionary depending on slope.	Proposed Regional Plan: Sediment Control.	Consent conditions - Felling of vegetation into watercourses should be avoided by using directional felling techniques. If unavoidable, trees shall be hauled out full length before delimbing or heading. All logging debris of a length ≥ 1m and small end diameter ≥ 10cm shall be removed from all watercourses and placed in a position where it cannot be transported off-site by any flood flow.
Waikato Regional Council	Transitional Regional Plan (1991) - any vegetation destruction >1 ha per 12 month period within the ex-Waikato Catchment Board, area is discretionary requiring a consent. Proposed Regional Plan (1998) - vegetation destruction within 5m of perennial waterbody of 50 - 100m in length/km/12 month period, controlled activity requiring a consent; if >100m in length /km/12 month period, discretionary activity requiring consent.	Transitional Regional Plan Proposed Regional Plan	Permitted activity - All disturbed vegetation, soil or debris shall be deposited or placed in a position where it will not enter any waterbody or coastal water or cause diversion or damming or erosion of any river or stream, impediment to fish passage, destruction of any habitat in any water body or coastal water body. Consent conditions - slash shall not be deposited in any perennial watercourse or left in a position where it may enter a watercourse. All logging slash exceeding 2 metres in length or exceeding 100mm in diameter shall be removed from all watercourses with a normal flow width of greater than 1.0 metre and placed in a manner where it is unlikely to re-enter a perennial watercourse.

Bay of Plenty Regional Council	Not an Erosion Hazard Zone and within the RMZ: 0 - 7° slope - permitted >7 - 25 ° - controlled > 25 ° - discretionary (restricted) Erosion Hazard Zone - discretionary	Proposed Bay of Plenty Regional Land Management Plan	Consent conditions - Where practicable and safe, trees shall be directionally felled or pulled back to prevent them from damaging native riparian vegetation. All logging debris of a length ≥ 10 cm shall be removed from those watercourses identified as 'major permanent'. All other RMZ's shall have slash accumulation managed to avoid any erosion or instability. The debris removed shall be placed in a position where it can not be transported off site by bank full flow. The removal of any trees or slash shall be undertaken so as to minimise the damage or disturbance to the streambanks. Not withstanding the above rules, consent holder shall use the best practicable option to manage logging slash and debris when directed by the council, to avoid, remedy or mitigate any potential or actual offsite effects.
Gisborne District Council	Controlled	Proposed Gisborne District Combined Regional Land and District Plan	Discretion is restricted to: timing and duration, area and location, vegetation to be retained, means necessary to maintain natural character, biodiversity, amenity and landscape values, effect on water quality, cultural heritage issues, shading effects on aquatic biota, other habitat effects, stream bank erosion
Hawke's Bay Regional Council	Permitted activity	-	No landuse consent required
Manawatu/ Wanganui Regional Council	Permitted activity	Proposed Regional Plan for Land and Water	No trees shall be felled into rivers or lakes. No trees shall be dragged through river or lake beds. No slash shall be deposited in streams or left where it may enter rivers or lakes. No slash shall be deposited in streams or left where it may enter rivers or lakes. Any piece of slash > 10cm in stem diameter or 2 m in length that inadvertently enters rivers or lakes shall be removed.
Wellington Regional Council	Permitted activity within the conditions of Rule 4 other wise restricted discretionary activity	Proposed Regional Soil Plan	Permitted activity - no vegetation or slash with a diameter of > 100mm shall be allowed to remain in any watercourse and when removed, shall be placed in a position where that material cannot enter any watercourse. Discretionary activity - Council has discretion over any steps taken to ensure the minimisation of vegetation, soil, slash or any other debris entering any water body. Forest operators guidelines - Hauler settings should be laid out to avoid sweeping slash and soils into watercourses. Slash should not be placed in a position where it, or its residue can enter a watercourse, however, where for safety reasons felling into watercourses is necessary all debris should

			be removed following completion of the operation.
Marlborough District Council	Discretionary where woody debris greater than 100mm diameter or sediment will enter waterway. Discretionary for dragging logs through bed of river Discretionary where operation of machinery within 8m Discretionary for removal (or damage of indigenous riparian vegetation within 8m	Marlborough Resource Management Plan – Land Disturbance Control.	Standard Conditions: That when weather or soil conditions are such that sediment is generated during operations and is able to move into waterways, the operation must stop until the risk of sediment moving into waterways has dissipated. That no woody vegetation greater than 100mm diameter shall be left in any permanently flowing waterway, wetland, lake or the sea, as a result of any commercial forestry operation. That stream crossings are to be stable and suitable for fish passage and maintained accordingly at all times. That woody vegetation (except for plantation trees and noxious plants under the Noxious Plants Act) shall not be removed by chemical, fire or mechanical means within 8 metres of any permanently flowing river, or any lake, wetland or the sea. Plantation trees within 8 metres of any permanently flowing river, or the margin of any wetland, lake or the coast shall be directionally felled away from the waterbody, except edge woody vegetation, or woody vegetation leaning over a waterbody, which may be felled in accordance with safety practices. Except for direct approaches to bridges, crossings and fords no vehicle may be operated within 8 metres of any permanently flowing river, or the margin of any wetland, lake or the coast. That all temporary crossings shall be completely removed immediately after logging is completed. Matters to be considered: The effects on the natural clarity of any river, lake, wetland or the sea. The effects of the entry of any woody material into any river, lake wetland or sea. The effect on natural hazard management, including stability of riparian management zones and river control matters. Protection of riparian habitat diversity. Protection of instream habitats. Provision of physical public access where legal public access is provided for.
Tasman District Council	Permitted	Regional Plan (land)	All disturbed vegetation, soil, or debris shall be deposited or contained in such a manner that any: (a) diverting or damming of any river or stream; or (b) erosion of the bed of any river or stream; or (c) destruction of any habitat in any water body or coastal water; does not result from the movement of that disturbed vegetation, soil, or debris into any water body or coastal water.

Canterbury Regional Council*	Permitted on slopes < 15 ° and >10m from watercourse; discretionary on slopes > 15 ° and < 10m from a watercourse or vegetation clearance within incised watercourses	Land and Vegetation Management Regional Plan; Part 1 Kaikoura East Coast, Part 2 Port Hills Transitional Regional Plan - Control of Land and Vegetation Clearance Notice	Land and Vegetation Management Plan - Permitted rule - No disturbed soil or vegetation shall be discharged into a watercourse where it is likely to give rise to: (a) the diversion or obstruction of a continually flowing river or stream; or (b) any significant induced erosion of the bed or banks of any stream; or (c) any significant adverse effects on any aquatic ecosystem. Discretionary rule - Must take into account the potential for adverse affects on the quality of water in rivers, lakes or seas and on the banks or bed of a watercourse or on its flood carrying capacity. Transitional Regional Plan - Written approval is required for particular areas delineated in the plan, where felling or clearing of trees is likely to facilitate soil erosion or floods or cause deposits in water courses.
Otago Regional Council	Not controlled by any plans	-	No consent required and no specific rules, but disturbance of streams and discharge of slash and debris must still be avoided.
West Coast Regional Council	Permitted	No specific rules for logging slash in plans	Consent condition - harvest systems and road construction shall be carried out in accordance with logging industry codes of practice designed to avoid or mitigate adverse impacts on waterways in accordance with best practicable means.
Southland Regional Council	Permitted	No specific rules in plan	No rules

* Please note that the information in this Table contains extracts only. To keep this information in context readers should refer to the relevant plans and documents for full details and definitions. Many of the plans are either proposed or transitional and may be subject to change. The rules in this table are not necessarily applicable to all sites and may be considered on a site by site basis.

** The rules relating to vegetation clearance vary over the Canterbury region. Rules given in the Table are a sample only. Please contact Canterbury Regional Council for a complete list of restrictions relating to vegetation clearance.