Assessment and Comparison of Selected Harvesting Systems with Horse Logging for Riparian Area Management

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Skeetchestn Indian Band

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INTRODUCTION 1

1.1 Background

Timber volume within riparian areas can represent a significant source of high-quality fibre for the BC forest sector. In the past these areas have often been by-passed by conventional logging operations because of steep slopes, poor bearing capacity, or generally difficult access. Conversely riparian areas that have been harvested using conventional logging methods have often sustained significant disruption and unintended impact to the surrounding ecosystem and associated water system.

As pressure on BC's timber supply increases, the question increasingly being asked is how to conduct economically viable operations within riparian areas while protecting the integrity of the riparian ecosystem. Forest management objectives and practices in BC have changed significantly over the past several years. Foresters now are incorporating soil characteristics, residual stand growth and health, plant and animal diversity and productivity objectives. Communities and community stakeholders are also insisting their values and uses be properly considered in forestry activities. These often require incorporation in different ways and magnitudes than can be accomplished using conventional clearcutting systems. It is in this context that this report explores the horse logging and light impact equipment harvest methods in riparian areas.

1.2 Approach

This report follows the principals of Multiple Account Evaluation (MAE) framework.[1] For the past decade, the provincial government has been using the MAE framework as one of its decision making tools in land use planning processes throughout the province. In following the spirit of the MAE approach, this report has investigated values associated with the economic development (i.e., income and employment), provincial government finances, environment, community and First Nations concerns.

Through this approach the report outlines the differences between traditional heavy machinery harvesting systems and lighter equipment/horse logging systems. The objective is to demonstrate the case for considering more horse logging and light equipment skidding and falling activities within riparian areas and other sensitive zones in the Skeetchestn Demonstration Forest proposal area. The Skeetchestn Demonstration Forest is planned approximately 50 kilometres west of the City of Kamloops in south central BC, within Skeetchestn Traditional Territory and is outlined in Figure 1-1.

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[1] Province of British Columbia (August 1993), ***Social and Economic Impact Assessment for Land and Resource Management Planning in British Columbia – Interim Guidelines.***

FIGURE 1-1: SKEETCHESTN TRADITIONAL TERRITORY

1.3 Report Structure

This report is organized as follows:

- Section 1 - Introduction
- Section 2 defines the riparian area and outlines the goals for the Skeetchestn Demonstration Forest and the Cultural and Resource Management Zones
- Section 3 investigates the economic development impacts from different types of popular logging systems;
- Section 4 identifies indirect economic impacts and provincial government revenues for the various harvesting systems;
- Section 5 overviews the environmental values associated with riparian areas and discusses the impacts from the various harvesting systems ;
- Section 6 explores community preference from the Skeetchestn First Nation prospective; and,
- Section 7 provides a summary and conclusions of the report.

The appendices provide detail information on the methodology and data sources used throughout the report.

DEMONSTRATION FOREST RIPARIAN AREA GOALS 2

2.1 Riparian Area Overview

As mentioned, the Skeetchestn Indian Band is working on the development of demonstration forest within their traditional territory. Management of riparian areas has been identified as one of the key priorities in achieving several of the community's objectives. Before looking more closely at the differences between logging systems, it's important to confirm the importance of riparian areas and briefly expand on the Skeetchestn Management approach for riparian areas.

2.2 Riparian Areas

Riparian areas are an important component of a viable watershed, particularly within the ecosystems of the Skeetchestn Traditional Territory. Typically a

watershed can be divided between the upland and the riparian area, although the two are integrally connected. Often a riparian area may represent only one percent of the total land area within a watershed; however, its functionality and health is critical to the overall watershed's viability.

A riparian zone has vegetation that, due to the presence of water, is different from the vegetation of adjacent upland areas. Typically, riparian zones are adjacent to streams or waterbodies, but they also occur adjacent to springs and seeps. Vegetation slows the flow of water on the floodplain, thereby capturing sediment and building banks. A healthy riparian zone acts as a sponge, which slowly releases water to the stream or wetland over the course of the season, thereby maintaining water flow or water levels. A stream in a healthy condition should have ready access to its floodplain during high flow periods.[2]

Good watershed management will result in a good connection between the uplands and the riparian area and between the stream, wetland, or lake and the floodplain or associated riparian area.

2.3 Skeetchestn Riparian Area Management

In the Skeetchestn Demonstration Forest, riparian areas of up to 100 metres on both sides of a water body will be examined. These riparian areas will be known as Cultural Resource Management Zones (CRMZs). Use of CRMZs will maximize economic return by integrating management of timber, water, wildlife, indigenous plants, and fisheries values with traditional ecological knowledge and wisdom.

CRMZs will be operated as a linear style research and demonstration area, highlighting low impact forest harvesting techniques, and emphasizing the relationship between continuous forest cover and continuous economic benefit to all forest resource users. After establishment, research protocols will be developed and experimental design determined in partnership with other occupants of the land. Assignment of CRMZs will effectively increase the operable land area, as riparian reserves will be included in the active management areas. Riparian areas within Reserve boundaries will also be included in the initiative.

Some capacity already exists at the Band in horse logging, and this initiative would expand that opportunity, where research and business plans support it.

[2] Ministry of Forests (2002), ***Assessing Upland and Riparian Areas.*** Rangeland Health Brochure 1.

DIRECT LOGGING AND SILVICULTURE ACTIVITIES 3

3.1 Overview

Logging activities are subject to a range of variables that can significantly impact the costs and numbers employed to harvest the site timber volume. In order to develop comparable cost and employment values for different harvesting systems, the Forest Engineering Research Institute of Canada (FERIC) study of "Date Creek" is used. [3] This study looks at several ground-based harvesting systems and derives costs, employment and employment income for specific logging activities. This study was supplemented with information from other FERIC reports and actual harvesting information from Kamloops area licensees (See Appendix A for detailed methodology description).

For the direct silviculture costs and associated employment and employment income a combination of published Ministry of Forests studies for specific silviculture activities and actual silviculture information from Kamloops area licensees has been used (See Appendix B for detailed methodology description).

From the direct logging and silviculture activities, coefficients were developed that compare the three different logging systems and prescriptions in a hypothetical harvest of 6,354 cubic metres from a 20.6 hectare site.

3.2 Direct Logging and Silviculture Costs

Three different logging systems have been developed into three different scenarios.
The logging method and the associated logging and silviculture costs for the three scenarios include:

- **Scenario 1**: Mechanical falling and mechanical forwarding systems in a clear-cut silviculture prescription. The total direct harvesting cost for Scenario 1 was determined to be **$13.50** per cubic metre or $85,780 to harvest 6,354 cubic metres. Total silviculture treatment costs were estimated at **$4.75** per cubic metre or $30,180 for the entire site. Total logging and silviculture costs were **$115,960**.
- **Scenario 2:** Handfalling with the logs forwarded using mechanical forwarding equipment in a selective tree prescription. The total direct harvesting cost for Scenario 2 was determined to be **$25.45** per cubic metre or $161,710 for the entire site. Total silviculture treatment costs added an

[3] Thibodeau, Krag, Hedin (September 1996), ***The Date Creek Study: Productivity of Ground-Based Harvesting Methods in the Interior Cedar-Hemlock Zone of Britsh Columbia.*** Report No. SR-114. Prepared for FERIC.

additional **$1.00** per cubic metre or **$**6,355. Total logging and silviculture costs were **$168,065**.

- **Scenario 3:** Handfalling with the logs forward by using horses in a selective tree prescription. The total direct harvesting cost for Scenario 3 was determined to be **$33.67** per cubic metre or $213,940. Total silviculture treatment costs estimated at **$1.00** per cubic metre or $6,355 for the total site. Total logging and silviculture costs were **$220,295**.

3.3 Direct Logging Employment and Income

Direct Logging Employment

Employment coefficients were developed for each of the scenarios. Direct logging employment coefficients are based on person-years (PYs) of employment per 1,000 cubic metres of timber harvested.[4]

The employment coefficients in this section are based on all on-site direct logging activities and the labour required to undertake the planning and block layout. From the employment coefficients the associated PYs of employment created by the harvest of 6,354 cubic metres has been developed. The employment required for the three scenarios varied as follows:

- **Scenario 1** had a total employment coefficient of **0.062 PYs** per 1,000 cubic metres, which would generate approximately **0.39 PYs** of employment on a harvest of 6,354 cubic metres. Overall, this would be equivalent to a six person logging crew being employed for just over **14.5 workdays** on the site**.**
- **Scenario 2** had a total employment coefficient of **0.181 PYs** per 1,000 cubic metres, which would create approximately **1.15 PYs** of employment on the site. This is equivalent to **43 days** of work for a six member logging crew.
- **Scenario 3** had a total employment coefficient of **0.421 PYs** per 1,000 cubic metres, which would generate approximately **2.67 PYs** of employment. This is equivalent to **100 days** of work for a six member logging crew on the site.

Direct Logging Wage and Benefits

The direct wages and benefits for the scenarios are driven by the wage percent associated with the total harvesting costs. Typically, the more heavily mechanized a harvest site is, the lower the overall wage component will be. Table 3-1 outlines the wages and benefits per cubic metre and total income associated with a harvest of 6,354 cubic metres.

[4] A person-year of employment is equivalent to 1,800 hours of work.

Table 3-1: Direct Logging Wage and Benefits from a Harvest of 6,354 cubic metres.

	Scenario 1		Scenario 2		Scenario 3	
	($/m^3)	Total	($/m^3)	Total	($/m^3)	Total
Total Wages		$16,200		$63,018		$111,305
Total Benefits		$8,725		$33,932		$59,935
Total Wages and Benefits	$3.92	**$24,925**	**$15.26**	**$96,950**	**$26.95**	**$171,240**

3.4 Direct Silviculture Employment and Income

Direct Silviculture Employment

Direct silviculture employment has been derived from the total wage and benefit income calculations by dividing the total wages by average day rates. Total PYs of employment and total days worked for the silviculture treatment activities have been calculated for the harvest of 6,354 cubic metres. The employment required for the three scenarios varied as follows:

- **Scenario 1,** with a silviculture coefficient of 0.046 PYs per 1,000 cubic metres, would generate direct silviculture employment of approximately **0.29 PYs** of employment on the site. This is equivalent to creating silviculture work for one person for just over **64.5 work-days.**
- **Scenario 2** has a silviculture coefficient of 0.009 PYs per 1,000 cubic metres and could generate total direct silviculture employment of approximately **0.06 PYs**. This would be equivalent to **13.5 days** of work for one worker.
- **Scenario 3** also with a coefficient of 0.009 per 1,000 cubic metres would generate **0.06 PYs**. This would be equivalent to **13.5 days** of work for one worker.

Direct Silviculture Wage and Benefits

The direct wages and benefits for the scenarios are driven by the wage percent that have been generated from average area and costs for silviculture treatments in the Kamloops Forests Region in 1999/2000. Table 3-2 outlines the wages and benefits per cubic metre and total income associated with a harvest of 6,354 cubic metres.

Table 3-2: Direct Silviculture Wage and Benefits from Harvest of 6,354 cubic metres.

	Scenario 1		Scenario 2		Scenario 3	
	($/m^3)	Total	($/m^3)	Total	($/m^3)	Total
Total Wages		$10,200		$2,150		$2,150
Total Benefits		$5,495		$1,155		$1,155
Total Wages and Benefits	**$2.47**	**$15,695**	**$0.52**	**$3,305**	**$0.52**	**$3,305**

3.5 Scenario Comparisons of Direct Activity

Direct Activity Summary

Table 3-3 summarizes the direct logging and silviculture costs and the associated employment income from the harvest of 6,354 cubic metres.

Table 3-3: Direct Logging and Silviculture Costs and Wages.

	Scenario 1		**Scenario 2**		**Scenario 3**	
	($/m^3)	Total	($/m^3)	Total	($/m^3)	Total
Direct Costs						
• Logging	$13.50	$85,780	$25.45	$161,710	$33.67	$213,940
• Silviculture	$ 4.75	$30,180	$ 1.00	$ 6,355	$ 1.00	$ 6,355
Total Costs	**$18.25**	**$115,960**	**$26.45**	**$168,065**	**$34.67**	**$220,295**
Direct Wages and Benefits						
Logging	$3.92	$24,925	$15.26	$96,950	$26.95	$171,240
Silviculture	$2.47	$15,695	$ 0.52	$ 3,305	$ 0.52	$ 3,305
Total Wages & Benefits	**$6.39**	**$40,620**	**$15.78**	**$100,255**	**$27.47**	**$174,545**

Table 3-4 summarizes the direct logging and silviculture employment associated with the harvest of 6,354 cubic metres.

Table 3-4: Direct Logging and Silviculture Employment.

	Scenario 1		**Scenario 2**		**Scenario 3**	
	(PYs/m^3)	Total PYs	($/$m^3$)	Total	($/$m^3$)	Total
Direct Employment						
• Logging	0.062	0.39	0.181	1.15	0.421	2.67
• Silviculture	0.046	0.29	0.009	0.06	0.009	0.06
Total Direct	**0.108**	**0.68**	**0.19**	**1.21**	**0.43**	**2.73**

Direct Activity Comparison

Several observations can be made between the three Scenarios including:

- Scenario 3, which utilized horses and hand falling under a selective tree prescription, generates 6.8 times the labour and 7.1 times the employment wages and benefits as Scenario 1, during the logging phase. Scenario 1 was harvested completely by mechanical means using a clear-cut prescription.
- Silviculture activities for Scenario 1 generate more labour than Scenario 3. However, in total (direct logging and silviculture) Scenario 3 creates 4.1 times the employment and 4.3 times the employment income as Scenario 1 at, 1.9 times the cost.
- In total (logging and silviculture) Scenario 2 costs 1.5 times more than Scenario 1, but generates approximately 1.8 times the employment and close to 2.5 times the employment wages and benefits.

- In total (logging and silviculture) Scenario 3 costs 1.3 times more than Scenario 2. However, Scenario 3 would 2.3 times the labour and 1.7 times the employment wage and income as Scenario 2.

In terms of labour force utilization and employment duration, direct log harvesting of 6,354 cubic metres and the associated silviculture employment varies as follows:

- Scenario 1 generates slightly less than three weeks work for a six person logging crew and a full three months of silviculture activity for one person.
- Scenario 2 creates just over two months direct logging work for a crew of six workers and a further 2.5 weeks of work for one individual in silviculture.
- Scenario 3 creates approximately five months of direct logging employment for a crew of six. Silviculture activities would generate an additional 2.5 weeks of work for one individual.

INDIRECT BENEFITS 4

4.1 Overview

Besides the direct employment and income derived from the three scenarios, other employment benefits accrue to the province from the direct logging and silviculture activities. This section explores the indirect and induced (referred to as indirect from here on) employment and income benefits.

4.2 Indirect Employment and Employment Income

Direct logging and silviculture employment would generate additional indirect employment both locally (within the Kamloops area) and elsewhere in the province. Table 4-1 outlines the direct employment and the associated indirect employment at the local and provincial level. This activity is based on the logging and silviculture for the three scenarios at a harvest level of 6,354 cubic metres. [5] For the purposes of this report, all direct employment has been assumed to come from the local area (See Appendix C for methodology on multipliers).

Table 4-1: Total Direct and Indirect Employment.

	Scenario 1		Scenario 2		Scenario 3	
	(Person-Years)					
	Local	Provincia	Local	Provincia	Local	Provincia
Direct Logging Activities						
• Direct Employment	0.39	0.39	1.15	1.15	2.67	2.67
• Indirect Employment	0.23	0.50	0.68	1.47	1.58	3.43
Total Logging Employment	**0.62**	**0.89**	**1.83**	**2.62**	**4.25**	**6.10**
Direct Silviculture Activities						
Direct Employment	0.29	0.29	0.007	0.007	0.007	0.007
Indirect Employment	0.16	0.16	0.003	0.003	0.003	0.003
Total Silviculture Employment	**0.45**	**0.45**	**0.01**	**0.01**	**0.01**	**0.01**
Total Direct and Indirect Employme	**1.07**	**1.34**	**1.84**	**2.63**	**4.26**	**6.11**

Similarly the direct wage income (benefits are excluded for calculation of indirect impacts) from the logging and silviculture activities would also multiply within the local and provincial economies. Table 4-2 outlines the direct and associated indirect employment wage income that would be anticipated for the three Scenarios.

[5] Indirect employment is calculated using wage income only, therefore values in this section are not comparable to the wage and benefits outlined in section costing discussion on page 7.

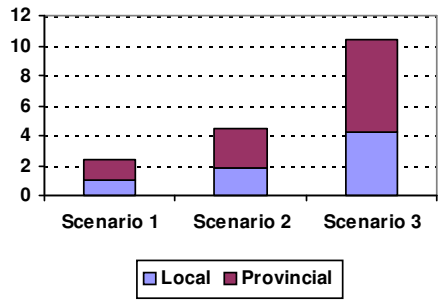
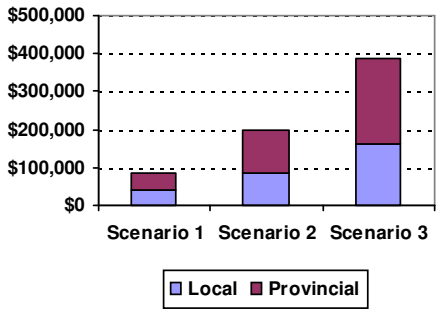
Table 4-1: Total Direct and Indirect Employment Wage Income.

	Scenario 1		Scenario 2		Scenario 3	
	($Total)					
	Local	Provincia	Local	Provincia	Local	Provincia
Direct Logging Activities						
• Direct Wage Income	$16,200	$16,200	$63,020	$63,020	$111,310	$111,310
• Indirect Wage Income	$7,365	$15,980	$21,650	$46,965	$50,380	$109,295
Total Logging Wage Income	**$23,565**	**$32,180**	**$84,670**	**$109,98**	**$161,69**	**$220,60**
Direct Silviculture Activities						
Direct Wage Income	$10,205	$10,205	$2,150	$2,150	$2,150	$2,150
Indirect Wage Income	5,230	5,230	$ 110	$ 110	$ 110	$ 110
Total Silviculture Wage Income	**$15,435**	**$15,435**	**$2,260**	**$2,260**	**$2,260**	**$2,260**
Total Direct & Indirect Wage Incom	**$39,000**	**$47,615**	**$86,930**	**$112,24**	**$163,95**	**$222,86**

4.3 Scenario Comparisons of Indirect Activity

Figure 4-1 highlights the direct and indirect employment and employment income associated with the three scenarios.

Table 4-1: Scenario Comparison of Total Direct and Indirect Activities.

Person-Years of Employment	Employment Income
	

From the direct and indirect activities associated with the three scenarios the following observations include:

- At the **local level**, Scenario 3 creates direct and indirect employment of 4.25 PYs with associated direct and indirect employment (wage only) income being generated of almost $164,000. At the corresponding **provincial level**, the total direct and indirect employment is estimated at 6.11 PYs and total wage income climbs to $386,815.
- At the **local level**, Scenario 3 creates almost 4 times the direct and indirect employment and 4.2 times the wage income as Scenario 1. When compared to Scenario 2, Scenario 3 creates 2.3 times the total employment and almost 1.9 times the employment wage income.
- At the **provincial level,** Scenario 3 creates 4.6 times the total employment and 8.1 times the employment wage income as Scenario 1. Scenario 3 also creates 2.3 times the employment and 3.5 times the employment wage income as Scenario 2.

GOVERNMENT REVENUES 5

5.1 Provincial Government Revenues

Table 5-1 outlines the provincial government revenues developed for the three scenarios at a theoretical harvest of 6,345 cubic metres. Provincial revenue from forest activity in BC comes primarily from three sources including stumpage and rent, industrial taxes, and direct and indirect employment income tax.

The government revenues are based on stumpage rates from the Kamloops Forest District. Appendix D provides details on the methodology used to derive government revenues.

Table 5-1: Provincial Government Revenues for the Three Harvest Scenarios.

	Scenario 1		Scenario 2		Scenario 3	
	($/m^3)	($ Total)	($/m^3)	($ Total)	($/m^3)	($ Total)
Stumpage and Rent:	$25.82	$164,060	$25.82	$164,060	$15.82	$100,520
Industry Taxes:	$7.60	$ 48,290	$7.60	$ 48,290	$7.60	$ 48,290
Direct, Indirect Employment Ta	$0.63	$ 3,980	$1.49	$ 9,440	$2.90	$ 27,050
Total Provincial Revenue:	**$34.05**	**$216,330**	**$34.91**	**$221,790**	**$26.32**	**$167,240**

5.2 Federal Government Revenues

Table 5-2 outlines the federal government revenues developed for the three scenarios. Federal revenues from forest activities in BC come primarily from personal income taxes. However, the federal government also derives corporate income taxes and employment insurance income from the industry. Based on PrinceWaterhouse Coopers, this can be significant totally over $350 million for corporate income taxes and $187 million for employment insurance in 1999.

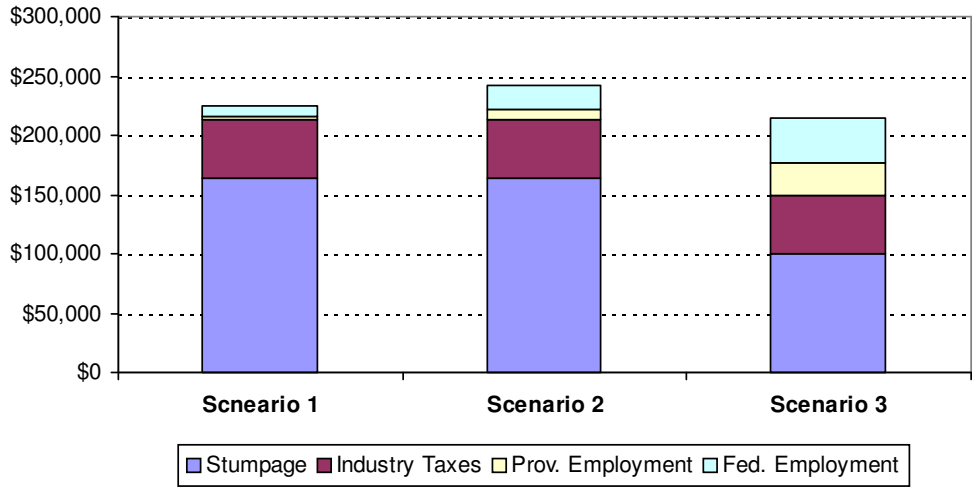
Table 5-1: Federal Government Revenues for the Three Harvest Scenarios.

	Scenario 1		Scenario 2		Scenario 3	
	($/m^3)	($ Total)	($/m^3)	($ Total)	($/m^3)	($ Total)
Direct Employment Taxes	$0.78	$4,655	$1.92	$12,225	$3.35	$21,285
Indirect Employment Taxes:	$0.49	$3,125	$1.09	$ 6,940	$2.54	$16,125
Total Federal Revenue:	**$1.27**	**$7,780**	**$3.01**	**$19,165**	**$5.89**	**$37,410**

5.3 Scenario Comparison

Figure 5-1 highlights the total government revenues for each scenario and outlines the contributions from the various components.

Figure 5-1: Government Revenues from Harvest of 6,354 Cubic Metres.



The following observations can be made concerning government revenues including:

- The greatest proportion of the provincial government revenue comes directly from the stumpage and rent paid for harvesting timber on Crown lands.
- Industry taxes remain constant over the sceanrios
- Scenario 2 generates the greatest total amount of revenue for the combined federal and provincial governments at $240,955. This represents 15 percent more revenue than Scenario 3, which would generate total revenue of $204,650 for government. .
- Scenario 3 is within 5% of Scenario 1 when all revenue sources are considered

RIPARIAN AREAS AND THE COMMUNITY 6

6.1 Community Overview

From the community context there are several important community benefits that can be derived from the careful management and use of the region's riparian areas. Community benefits typically span across social, economic, and community health and well-being. Timber production is only one component of this vast array of values. The following section explores general community and specific Skeetchestn First Nation values that can be derived from riparian areas if properly fostered and protected.

6.2 Community Benefits

Community Interactions with Water

Healthy watersheds and the associated riparian areas are critical to community well-being and health. A watershed should capture precipitation where it falls, store it in the soil profile and move it slowly downslope to the riparian zone, and then slowly and safely release it into streams, rivers, wetlands, and lakes.[6] There are many benefits that a properly function riparian area can provide to a community including:

- Flood protection;
- Pure water;
- Decreased turbidity;
- Minimizes erosion;
- Maintenance of habitats;
- Consistency of water supply; and
- Broadest plant profile

Recent and on-going costs and impacts associated with protecting safe water supplies and guarding against flooding by communities within the Skeetchestn Traditional Territory emphasize the importance of these interests.

Visual Quality Objectives

Viewscapes have become increasingly important to communities in recent years. Residents have become more vocal and concerned about the impacts of altered viewscapes on their community setting. As well, sectors such as the tourism industry have become increasingly involved in identifying the need to

[6] Ministry of Forests (2002), ***Assessing Upland and Riparian Areas.*** Rangeland Health Brochure 1.

ensure the maintenance of "natural" viewscapes to support their economic activities.

Employment Certainty Impacts

Rural communities in the interior of BC have typically experienced the highest unemployment rates within the province. As is the case in the Skeetchestn Traditional Territory, these areas also face fairly high seasonal employment opportunities. Efforts to increase the amount and certainty of log harvesting work would be considered a positive development from both a community stability and workforce certainty perspective. As well, general community attitudes are shifting towards ensuring sustainable economic activities are developed when defining their overall economic goals.

6.3 Specific Skeetchestn Community Benefits

Besides sharing similar concerns that would be expressed by the overall regional population. The Skeetchestn Band also has specific concerns that reflect their own development objectives and traditional use of the land.

Reestablishment of Salmon Stocks

The health of riparian areas has played an important role in the health of the region's wild salmon stocks. These riparian areas will also play a critical role in the Skeetchestn Band's goals of reestablishing salmon production within their Traditional Territory.[7] Salmon hold cultural significance for the Shuswap people and the Band would like eventually to reintroduce community harvest of salmon to historical levels.

Ensure Sustainable Resource Use and Benefits

The Skeetchestn Band wants to encourage local employment and training in sustainable resource extraction activities, including implementing alternative forest harvesting strategies, particularly in riparian areas, that increase local jobs and value.

Ensure Traditional Resources are Available

The members of Skeetchestn Band utilize many traditional plants found within the riparian areas, and the community wants to encourage sustainable use of non-timber

[7] Moore, Dave (nd.), ***Through the Eyes of Sk'lep – A Vision of Ecosystem Stewardship in the Deadman Watershed.***

forest products to increase local jobs and value. As well, many of these plants are important to traditional sustenance and cultural awareness.

RIPARIAN AREAS AND THE ENVIRONMENT 7

7.1 Environmental Overview

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Riparian areas are critical environmental habitats. Over time they have also been subject to a disproportionate amount of human impact. This section looks at three environmental issues that can benefit from more sensitive logging approaches.

7.2 Environmental Issues

Protection of Old Growth and Wildlife Habitat

Partial harvesting with light logging system such as horse logging and light equipment has the best opportunity to manage for the distribution of species, age classes and succession levels in a specific riparian harvest area. As the values of old growth forests become better understood, management systems that protect the forest in a more natural condition will help to maintain the overall integrity of riparian areas and the associated watershed. Riparian areas and the associated mature forest types are also critical habitats for the region's wildlife populations. With pressures on riparian areas from a range of human activities the remaining riparian areas across BC are becoming home to more of BC's red and blue listed species at risk.

Retention of site and stand productivity

In a selectively harvested logging area the site and stand productivity remains high. Not only will there be numerous established trees still growing on the site, but the actual logging activity will have significantly less impact on the overall land base when the harvesting is with horses. A study of a horse logged woodlot in the Kamloops area yield a total of approximately 5 percent of mostly pre-compacted areas of the block were subject to severe site degradation. [8] In comparison the Kamloops region allowances for roads and landings within a cut block is 7 percent with a further 8 to 10 percent of the total area usually being subject to machine travel and severe compaction.

Overall, soil displacement and compaction are recognized as common forms of soil degradation caused by ground based skidding and harvesting in BC. A recent study confirmed the impact on tree growth in disturbed areas and that soil degradation from forestry operations.[9] In fact it has been estimated that the annual wood yield in BC has been reduced by over 400,000 m3 over the 10 year period (1976 to 1986) as a result of soil degradation from forestry operations.

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[8] Anderson (August 1996), ***Horselogging on a Woodlot License and It's Implications for Sustainable Integrated Resource Management***. Submitted as part of A.B.C.P.F. Forester training (F.I.T. #2770).

[9] Senyk and Craigdallie (December 1997), ***Effects of Skidroads on Soil Properties and Forest Productivity on Steep Slopes in Interior British Columbia.*** Prepared for Natural Resources Canada, Technology Transfer Note Number 8.

A reduction in degradation of 5 to 15% will improve the availability of future harvesting land base by the same percentage, with a corresponding long-term addition in annual harvest volumes.

Protection of Aquatic Habitats

The functionality of aquatic habitats is integrally linked to the adjoining forest ecosystems. Logging methods that can minimize siltation and mitigate modification of stream temperatures and run off rates will stand the best chance of supporting in-stream environment for fish and other aquatic life. Partial tree removal has been identified as one way to mitigate for these issues, horse logging may further reduce these impacts.

SUMMARY AND CONCLUSIONS 8

8.1 Summary

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Table 8-1 summarizes the findings identified in the report for direct costs, employment and employment income for the three Scenarios of harvesting 6354 m3. Table 8-2 summarizes the findings associated with indirect employment and employment income, government revenues, and community and environmental issues.

Table 8-1: Summary of Direct Costs, Employment and Employment Income for the Three Scenarios.

Issue	Scenario 1		Scenario 2		Scenario 3	
Site Description	Mechanical /clear cut		Hand Falling & Mechanical skidding/ Individual Tree Selection		Hand Falling & Horse skidding/ Individual Tree Selection	
Direct Logging and Silviculture Costs						
	($/m^3)	**($ Total)**	**($/m^3)**	**($ Total)**	**($/m^3)**	**($ Total)**
• Logging Costs	$13.50	$85,780	$25.45	$161,710	$33.67	$213,355
• Silviculture Costs	$ 4.75	$30,180	$ 1.00	$ 6,355	$ 1.00	$ 6,355
Total	**$18.25**	**$115,960**	**$26.45**	**$168,065**	**$34.67**	**$219,710**
Direct Logging and Silviculture Employment						
	(PYs/1,000 m^3)	**(Total PYs)**	**(PYs/1,000 m^3)**	**(Total PYs)**	**(PYs/1,000 m^3)**	**(Total PYs)**
• Logging	0.062	0.39	0.181	1.15	0.421	2.67
• Silviculture	0.046	0.29	0.009	0.06	0.009	0.06
Total	**0.108**	**0.68**	**0.19**	**1.21**	**0.43**	**2.73**
Direct Logging and Silviculture Wage and and Benefit Income						
• Logging	$3.92	$24,925	$15.26	$96,950	$26.95	$171,240
• Silviculture	$2.47	$15,695	$ 0.52	$ 3,305	$ 0.52	$ 3,305
Total Wages & Benefits	**$6.39**	**$40,620**	**$15.78**	**$100,255**	**$27.47**	**$174,545**

Table 8-1: Summary of Indirect, Government Revenues, and Community and Environmental Issues for the Three Scenarios.

•	Scenario 1		Scenario 2		Scenario 3	
Total Direct and Indirect Employment						
	Local	**Provincial**	**Local**	**Provincial**	**Local**	**Provincial**
Logging Employment	**(Person-Years)**					
• Total Direct and Indirect	**0.62**	**0.89**	**1.83**	**2.62**	**4.25**	**6.10**
Silviculture Activities						
• Total Direct and Indirect	**0.45**	**0.45**	**0.01**	**0.01**	**0.01**	**0.01**
Total Logging & Silviculture	**1.07**	**1.34**	**1.84**	**2.63**	**4.26**	**6.11**
Total Direct and Indirect Employment Income						
Logging Employment Income						
• Total Direct and Indirect	**$23,565**	**$32,180**	**$84,670**	**$109,985**	**$161,690**	**$220,605**
Silviculture Employment Income						
• Total Direct and Indirect	**$15,435**	**$15,435**	**$2,260**	**$ 2,260**	**$ 2,260**	**$ 2,260**
Total Logging & Silviculture	**$39,000**	**$47,615**	**$86,930**	**$112,245**	**$163,950**	**$222,865**
Provincial and Federal Government Revenues						
	($/m^3)	**($ Total)**	**($/m^3)**	**($ Total)**	**($/m^3)**	**($ Total)**
• Total Provincial Revenue	**$34.05**	**$216,330**	**$34.91**	**$221,790**	**$26.32**	**$167,240**
• Total Federal Revenue	**$ 1.27**	**$ 7,780**	**$ 3.01**	**$ 19,165**	**$ 5.89**	**$ 37,410**
Total Government Revenue	**$35.32**	**$224,110**	**$37.92**	**$240,955**	**$32.21**	**$204,650**
Community Issues						
• Water/Visual Quality	• Harvest systems need to address water and visual quality issues.					
• Employment	• Sustainable economic and employment stability important community goals.					
• Skeetchestn Objectives	• Redevelop traditional salmon fishery and ensure traditional values and resources available.					
Environmental Issues						
• Protect Old Growth & Wildlife	• Values associated with mature stands within riparian areas are important for wildlife protection.					
• Retention of Site & Stand Productivity	• Logging systems can impact the soil and overall site productivity.					
• Aquatic Habitats	• Logging influence on riparian area will have important linkages to the health of aquatic habitat.					

8.2 Conclusions

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Based on the findings of this report several conclusions have been drawn including:

- Scenario 3 (horse logging) has a higher logging cost than clear cut mechanical (Scenario 1) and selective logging using handfall and mechanical forwarding (Scenario 2), but creates 4 times more labour than Scenario 1 and 2.2 times more than Scenario 2.

- When all revenue sources are considered, government revenue for Scenario 3 is within 5% of that of Scenario 1.

- Besides the strict monetary values of the logging system, research is pointing to the importance of considering community and environmental values that are becoming critical to the overall sustainable management of British Columbia forest lands.

- If the long-term costs of managing for the multitude of values (i.e., watershed, fisheries, wildlife, recreation, etc.) within riparian areas is higher than that recognized by stumpage systems, allowances should be increased, so that employment benefits in the community are not pushed aside by corporate needs to minimize costs.

- Currently, phase cost is used as the major determinate to decide the 'right' approach to harvesting. When a broader, more inclusive approach is taken to all direct costs and benefits to government, a labour intensive approach in riparian areas is shown to be cost effective and makes sound environmental sense.

APPENDIX A – DIRECT HARVESTING METHODOLOGY

A-1 Methodology Overview

In this section the different magnitudes of employment and employment income associated with operating costs for three different types of harvesting systems are developed and the methodology outlined. The three different harvesting systems include:

- Mechanical falling and mechanical forwarding in a clear-cut silviculture prescription;
- Handfalling and mechanical forwarding using a selective tree prescription; and,
- Handfalling and horse forwarding using a selective tree prescription.

However, in order to compare different harvesting systems it is important to note that each harvest site is unique and the costs and volumes that can be harvested vary considerably from site to site. Table A-1 outlines the range of variables that need to be considered when undertaking a harvest regime.

Table A-1: Factors Affecting Logging Production and Costs.

Stand Variables:	**Operational Variables:**
Volume per acre harvested	Harvesting methods
Dbh of harvested trees	External yarding distance
Site Variables:	Lateral yarding distance
Slope	Logs per turn, volume per turn, weight per turn
Slope profile (concave, convex)	Silvicultural method
Boulders, down timber, brush	Crew size and experience
Soil conditions	Equipment balance (e.g. fellbuncher, yard/skid, swing, process
Weather conditions.	Factors affecting machine mobility (eg. Spacing of residual trees, landing size).

Source: FRDA Report 198.

Therefore, for the critical planning, log falling, and forwarding phases of the harvesting activity the study team chose "The Date Creek Study" which looked at different ground-based harvesting methods in the Interior Cedar-Hemlock zone. [10] This study has allowed the study team to keep as many variables as possible in common while developing employment and cost coefficients.

However, the Date Creek Study does not outline all the typically costs associated with any given logging operation. Therefore, the Harvesting Coastal

[10] Thibodeau, Krag, Hedin (September 1996), ***The Date Creek Study: Productivity of Ground-Based Harvesting Methods in the Interior Cedar-Hemlock Zone of British Columbia.*** Report No. SR-114. Prepared for FERIC.

Second-Growth Forests study[11] has also been used to develop detailed employment and cost coefficients associated with log loading activities. Finally these individual logging activities have been adjusted to observed standard log harvesting costs for the Kamloops area to represent an entire logging operation.

A-2 Site Descriptions

The Date Creek Study compared a range of harvest systems including horse logging and looked at different silviculture treatments for six adjacent sites in Cedar-Hemlock stands within the Kispiox Forest District. From the Date Creek Study, three detailed harvesting systems are developed into scenarios, which included:

- ***Scenario 1:*** This scenario is Case Study B-4 in the Date Creek Study. The prescription on this site was a clear cut using a mechanical harvester and mechanical forwarding machinery using skid roads. The gross area was 18.5 hecatres, on land that averaged 5 percent slope and net merchantable timber (conifer only) volume of between 343 and 360 cubic metres per hecatre with an average of 0.65 cubic metres per tree. The total volume harvested from the site was 7,730 cubic metres with the skidding period taking place over approximately 27 working days.

- ***Scenario 2:*** This scenario used a individual tree selection prescription component from Case Study C-2 in the Date Creek Study. The harvest method was by using hand felling and mechanical forwarding machinery. This 20.6 hectare site had an average slope of 20 percent slope with a range from 0 to 45 percent. Merchantable timber (conifer only) volume of between 524 and 529 cubic metres per hecatre with an average of 0.65 cubic metres per tree. The same harvest contract who undertook the logging activities in Scenario 1 also completed the logging activities in Scenario 2. Total volume removed for purposes of this Scenario was 6,354 cubic metres with skidding taking place over approximately 36 working days.

- ***Scenario 3:*** This scenario is the individual tree selection prescription component from case study C-3 in the Date Creek Study. The prescription was light removal where 30 percent of the tree volume was removed in either single stems or small groups of stems (similar to a single tree or group selection, or a light initial shelterwood). The harvest method was by hand felling with horses being used to forward the logs. The gross area was 22.9 hecatres, on land that averaged 10 percent slope and net

[11] Andersson and Young (March 1998), ***Harvesting Coastal Second-Growth Forests: Summary of Harvesting System Performance.***

merchantable timber volume of between 492 and 502 cubic metres per hecatre with an average of 0.64 cubic metres per tree. Total volume removed from this site was 2,903 cubic metres with approximately 50 working days of horse skidding required.

Table A-2 provides a detail list of the equipment used at each specific site.

Table A-2: Equipment and Labour Complements Involved in Scenarios.

Case Study	Scenario 1 (Case B-4)	Scenario 2 (Case C-2)	Scenario 3 (Case C-3)
Falling	Case 1187 C with Lokomo cone saw feller-buncher head	2 hand fallers	2 hand fallers
Processing/bucking	Stoke delimber	Part of hand fallers' tasks	Part of hand fallers' tasks
Skidding	Clark 668F rubber-tired grapple skidder.	Clark 668F rubber-tired grapple skidder. Clark 668F rubber-tired line skidder Clark 667F rubber-tired line skidder.	9 horses 5 teamsters
Skidding distance	Average 110 metres	(range 90 to 180 metres)	range 50 and 80 metres
Support & Development	Caterpillar D6D crawler tractor line skidder	Caterpillar D6D crawler tractor line skidder	Caterpillar D4E crawler tractor with Hyster winch.
Loader	Caterpillar 225B	Caterpillar 225B	----
Skidding Period	Sept. 8 to Oct 15, 1992. **(approx. 27 working days)**	Aug. 16 to Sept 24 and Dec 2-11, 1992.	July 22 to October 1992. **(approx. 50 working days)**
Percent volume Removed	• **131% of projected cut.**	• **59% for whole site (patch & ITS).**	• **31% of projected cut.**
Estimate of Workers	• **5 to 6 total on site** • **3 for falling, skidding**	• **6 to 7 workers on site** • **4 or 5 for falling and skidding**	• **6 to 8 total on site** • **6 to 7 falling & skidding**

A-3 Log Loading Activities

The Date Creek Site did not look at log loading costs and other site costs, therefore, the log loading costs and labour productivity are derived from another FERIC report undertaken in 1998.[12] In this report it is noted that productivity of log loaders is greatly influenced by the number of trucks being served by the loaders, thus making the loading cost difficult to estimate.

However, the study does derive estimates of 300-600 m^3/shift, when the loader performs no other task (i.e., assisting landing bucking), the loading cost would range from \$2.08 to \$4.15 m^3 with information calculated from a collection of FERIC productivity reports. For this report, the examples of loading equipment, harvesting stems of between 0.5 and 0.7 cubic metres, which are

[12] Andersson and Young (March 1998), ***Harvesting Coastal Second-Growth Forests: Summary of Harvesting System Performance.***

similar in size to the Date Creek stem sizes, an average of 380 cubic metres per shift was developed. This would put the loading cost at $2.63 per cubic metres in 1998 dollars.

A-4 Calculation of Actual Site Labour and Costs

Based on the Scenarios developed above from Date Creek and log loading costs, Table A-3 summarizes the labour and costs identified for the planning and layout, falling, skidding, and log loading for the three scenarios.

Table A-3: Summary of Labour & Costs Associated with the Three Harvest Scenarios.

	Scenario 1 (B-4)		Scenario 2 (C-2)		Scenario 3 (C-3)	
Prescription System	Clearcut		Individual tree selection		Individual tree selection	
Harvesting	Mechanical harvest, skid roads		Hand felling, mechanical moving		Hand felling, horse	
Volume	7,730 m^3		6,354 m^3		2,903 m^3	
	Hours	**\$/ m^3**	**Hours**	**\$/ m^3**	**Hours**	**\$/ m^3**
From Date Creek Study (\$1996)						
Planning & Layout	73.6	\$0.71	214.4	\$2.53	180.1	\$4.66
Falling	149.4	\$2.84	847.2	\$6.67	566.4[13]	\$9.71
Skidding	186.3	\$2.30	516.1	\$7.93	1,393.3[14]	\$14.58
From Coastal Second-Growth Study (\$1998)						
Log skidding	162.5	\$2.63	133.7	\$2.63	162.5	\$2.63

A-5 Total Logging Cost Calculations

Adjustments of Direct Harvesting Costs to Current Dollars

The Date Creek research was undertaken in 1992, however, with follow-up with Forest Engineering Research Institute it was determined that the report values are adjusted to 1995 values. Therefore, between 1995 and 2001 the general BC consumer price index has been used to adjust the Date Creek values to 2001 values. Similar steps were taken with the Coastal Second-Growth Forest study, which was undertaken in 1997 and also adjusted to 2001. Table A-4 outlines the adjustments to 2001 values for the three different scenarios.

Table A-4: Summary of Adjusted Costs for the Three Harvest Scenarios.

	Scenario 1 (B-4)		Scenario 2 (C-2)		Scenario 3 (C-3)	
	1995 costs	**2001 costs**	**1995 costs**	**2001 costs**	**1995 costs**	**2001 costs**
Date Creek Study	**(\$ per cubic metre)**					
Planning & Layout	\$0.71	\$0.76	\$2.53	\$2.70	\$4.66	\$4.98
Falling	\$2.84	\$3.03	\$6.67	\$7.12	\$9.71	\$10.37
Skidding	\$2.30	\$2.46	\$7.93	\$8.47	\$14.58	\$15.57
Coastal Study	**1997 costs**	**2001 costs**	**1997 costs**	**2001 costs**	**1997 costs**	**2001 costs**
Log Loading	\$2.63	\$2.76	\$2.63	\$2.76	\$2.63	\$2.76
Total:	**\$8.48**	**\$9.01**	**\$19.76**	**\$21.05**	**\$31.58**	**\$33.67**

Adjustment of Costs for Actual Kamloops Logging Site

The preliminary costing by specific equipment and activity from the FERIC studies is required to determine employment and employment income

[13] Includes bucking and delimbing.
[14] Actual volume moved in Date Creek study was 2,592 m^3, skidding time adjusted to reflect 2,903 m^3 moved.

coefficients associated with the different components of the logging activities. However, it is recognized that these production activities do not represent the total cost of contract log harvesting faced by licensees. As well, logging contractors typically have other pieces of equipment such as foremen and support equipment on any given logging site.

Discussions with licensees in the Kamloops area suggest that the total direct logging cost is closer to $13.50 per cubic metre. Therefore, the following adjustments have been made to total costs:

- **Scenario 1** – Productivity activities come to $9.01 per cubic metre, this has been adjusted by $4.41 for a total of **$13.50** per cubic metre. Calculations for employment and employment income have been adjusted by the site productivity coefficient components.
- **Scenario 2** – Productivity activities come to $21.05 per cubic metre, this has also been adjusted by $4.41 for a total of **$25.45** per cubic metre. Calculations for employment and employment income have also been adjusted by the site productivity coefficient components.
- **Scenario 3** – Due to the nature of horse logging sites, it is felt that the management and support activities are already captured. Therefore the horselogging Scenario remains at **$33.67** per cubic metre.

Reasonableness: The total costs have been derived using a combination of specific site research and then balanced against actual observed costs from Kamloops area licensees. As well, the total costs for the different types of equipment were compared with the equipment rental guide for 1994-1997 rate. Equipment rates developed from the Date Creek and log loading study generally fit within going rates that would be paid under the rental rates.[15]

A-6 Logging Wage Proportions By Activity Type

Planning and Site Layout

For planning and site layout no wage percentage was outlined by the FERIC reports reviewed. The study team has directed 90 percent of costs towards wages. This is similar to other consulting activities.

Log Falling Employment Determination

The equipment costing and ratios associated with wages and other operating and ownership costs of tree falling and specific skidding activities have been derived directly from data in the Date Creek report.

[15] Province of British Columbia, BC Hydro and BC Rail Ltd. (nd), ***Equipment Rental Rate Guide: 1997-1998.***

Table A-5 outlines the wage percentage associated with direct log falling activities.

Table A-5: Determination of Log Falling Wage Percentages.

	Case 1187 C Feller	Hand Feller
	($/hour)	
• Ownership Costs	$57.23	$0
• Operating Costs (non wage)	$58.26	$3.25 (chainsaw cost)
• Wage and Benefits	$31.32	$47.06
Total All Costs	**$146.81**	**$50.31**
Overall wage percentage	**21.3%**	**93.5%**

The Case 1187 Feller buncher was used in Scenerio 1 with wages representing 21.3 percent of total costs. Scenario 2 and 3 used hand fellers, which saw 93.5 percent of total costs go towards wages.

Log Skidding Employment Determination

Table A-6 outlines the data and costing calculations for the different skidding types.

Table A-6: Determination of Wage Percentage from Skidding Costs

	Clark 668F rubber-tired grapple skidder	Clark 668F rubber-tired line skidder	Clark 667F rubber-tired line skidder	Horse Team
	($/hour)			
• Ownership Costs	$31.07	$23.98	$20.17	$1.61
• Operating Costs (non wage)	$36.17	$32.42	$29.92	$6.21
• Wage and Benefits	$28.49	$28.49	$28.49	$28.49
Total All Costs	**$95.73**	**$84.89**	**$78.58**	**$36.31**
Overall wage percentage	**29.7%**	**33.5%**	**36.3%**	**78.4%**

In Scenario 1 (Case B-4), the clear cut system, only a Clark 668F was used and resulted in 29.7 percent of total costs going to wages. In Scenario 2 (Case C-2) the two line skidders where used for the Individual Tree Selection component generating a combined wage percentage of 33.8 percent. In Scenario 3 (C-3) horse logging system was used and created a wage component of 78.4 percent of total skidding costs.

Log Loading Employment Determination

Log loader costs and wage percentage have been derived from the charge-out rate determination from FERIC's Coastal Second-Growth Forest study.[16] Table A-7 outlines the total costs and the wage percentage.

[16] Andersson and Young (March 1998), ***Harvesting Coastal Second-Growth Forests: Summary of Harvesting System Performance.*** See Appendix II.

Table A-7: Determination of Log Loading Wage Percentages.

	Log Loader
• Ownership Costs	$71.86
• Operating Costs (non wage)	$65.13
• Wage and Benefits	$36.06
Total All Costs	**$173.05**
Overall wage percentage	**20.8%**

Summary of Wage Percentages and Wage Cost Determination

With the wage percentages (wages and benefits) determined for each specific activity the total wage component for each logging activity was determined by multiplying the wage percentage by the per cubic metre cost. Table A-8 summarizes the wage percentages and outlines the corresponding total wages on a per cubic metre bases.

Table A-8: Determination of Wage Percentage from Skidding Costs.

	Scenario 1		Scenario 2		Scenario 3	
Planning and Layout	90.0%	$0.68/$m^3$	90.0%	$2.43/$m^3$	90.0%	$4.48/$m^3$
Falling	21.3%	$0.65/$m^3$	93.5%	$6.66/$m^3$	93.5%	$9.69/$m^3$
Skidding	**29.7%**	**$0.73/**$m^3$	**33.8%**	**$2.95/**$m^3$	**78.4%**	**$12.20/**$m^3$
Loading	20.8%	$0.57/$m^3$	20.8%	$0.57/$m^3$	20.8%	$0.57/$m^3$
Additional Labour Adjustment	29.06%	$1.29/$m^3$	59.93%	$2.64/$m^3$		$0/$m^3$
		$3.92/ m^3		15.26/m^3		$26.95/$m^3$

Reasonableness: The FERIC studies depended predominantly on International Woodworker Association (IWA) rates in their calculations. These ranged from $21.10 an hour to $23.20 an hour for equipment operators wages plus 35 percent for benefits. Hand felling IWA rates were $402.49/day (faller rates, 35% benefits, and $26/day for chain saw). These value were adjusted to 2001 values to remain consist with other costs used in the report.

Checking current IWA rates[17] with recent work in the interior on contract logging suggests that hourly compensation for conventional ground based systems for the interior would typically be slightly below IWA rates.[18] Horse logging rates are felt to be similar throughout the province.

[17] Forest Products Industries Coast Region British Columbia (June 2000), ***Coast Master Agreement 2000-2003.***
[18] PriceWaterhouse Coopers (2000), ***The Forest Industry in British Columbia 1999.***

A-7 Direct Employment Coefficients

Employment Coefficients

The employment coefficients have been developed directly from the hours of labour derived from the specific logging activities collected from the FERIC studies. This labour has then been adjusted upward for the Scenario 1 and 2, the two conventional logging scenarios to reflect expenditures common in the Kamloops area. The upward adjustment coefficient is based on a blended average of the observed activities and adjusted upward by the same percent as the observed cost adjustment.

Table A-9 outlines the actual observed hours worked and the steps required to develop comparable employment coefficients for the three different scenarios.

The employment coefficients have been converted into person-years (PYs)[19] of employment per 1,000 cubic metres. A PY of employment is a standard that allows comparison between labour effort required to complete different work tasks.

Table A-9: Calculation of Person-Years of Employment for the Three Harvest Scenarios.

Observed Hours	Scenario 1 (B-4)	Scenario 2 (C-2)	Scenario 3 (C-3)
Planning & Layout	73.64 hours	214.4 hours	180.06 hours
Falling	149.4 hours	847.2 hours	566.4 hours
Skidding	186.3 hours	516.1 hours	1,393.3 hours
Log Loading	162.5 hours	133.6 hours	61.1 hours
Adjustment Factor for PYs:	**(1,800 hours)**		
Planning & Layout	0.041 PYs	0.119 PYs	0.100 PYs
Falling	0.083 PYs	0.471 PYs	0.315 PYs
Skidding	0.104 PYs	0.287 PYs	0.774 PYs
Log Loading	0.090 PYs	0.090 PYs	0.090 PYs
Labour Adjustment Factor	0.158 PYs	0.199 PYs	0.000 PYs
Total Site PYs:	**0.476 PYs**	**1.150 PYs**	**1.223 PYs**
Adjustment to PYs/1,000 m^3:	**7,730 m^3**	**6,354 m^3**	**2,903 m^3**
Planning & Layout	0.005 PYs/1000 m^3	0.019 PYs/1000 m^3	0.034 PYs/1000 m^3
Falling	0.011 PYs/1000 m^3	0.074 PYs/1000 m^3	0.108 PYs/1000 m^3
Skidding	0.014 PYs/1000 m^3	0.045 PYs/1000 m^3	0.267 PYs/1000 m^3
Log Loading	0.012 PYs/1000 m^3	0.012 PYs/1000 m^3	0.012 PYs/1000 m^3
Labour Adjustment Factor	0.020 PYs/1000 m^3	0.031 PYs/1000 m^3	0.000 PYs/1000 m^3
Total PYs/1,000 m^3:	**0.062 PYs/1000 m^3**	**0.181 PYs/1000 m^3**	**0.421 PYs/1000 m^3**

[19] A person-year of employment is based on the Ministry of Forests standard measurement used in the Timber Supply Review process. One person-year of employment consists of 1,800 hours of work.

Reasonableness: The Ministry of Forests recently used a harvesting coefficient of 0.24 PYs per 1,000 cubic metres of timber harvested in the Kispiox TSA.[20] This coefficient is not directly comparable to the values developed from the Date Creek study and for four specific reasons including:

- Licensee staff labour is included in the Ministry of Forest coefficient.
- Log transportation by logging truck to mill site, which is usually performed by a separate contractor from the harvester, is included in the Ministry of Forests harvesting coefficient and not in the above calculations.
- The licensee woodlands company staff are full time jobs engaged in other activities besides strictly harvesting activities. While this is appropriate it does have the effect of inflating the strictly harvesting coefficient above those observed for this study.
- The Ministry of Forest's harvesting coefficient is made up of a collaboration of all harvesting types used by the licensees in a particular area so it represents a blend harvesting type.

A recent study found that the employment coefficient for the contract logger portion (including all on site labour) on interior harvest sites using ground based systems (excluding horse logging) averaged about 0.084 person-years per 1,000 cubic metres.[21]

[20] Ministry of Forests (May 2002), ***Kispiox Timber Supply Area Analysis Report.***
[21] Resource Systems Management International Inc., Sunderman & Associates, and Guidelines Consulting (October 1998), ***The Contract Harvesting Industry in British Columbia.*** Prepared for the Science Council of British Columbia.

APPENDIX B – SILVICULTURE METHODOLOGY

B-1 Silviculture Costs

Silviculture costs have been obtained from Kamloops area licensees. The average per cubic silivculture costs was determined to be approximately $4.50 per cubic metre harvested using a clear-cut prescription and $1.00 per cubic metre for selectively logged site.

Reasonableness: Based on local area actual values.

B-2 Determination of Silviculture Activities

In order to determine employment and employment income it was necessary to assess the type of silviculture activity that would likely take place. Using the Ministry of Forests summary of silviculture activity for 1999/2000 the percentage, share based on cost, of specific silviculture activities was determined.[22] Table B-1 highlights the percentage share based on expenditure estimates for the Kamloops Forest Region.

B-1: Silviculture Percentage Share of Activity for the Kamloops Forest Region.

Silviculture Accomplishments	Hectares	Average Costs ($/ha)	Total Cost	Percentage Share
Surveying	99,404	$13.00	$1,292,252	4.67%
Preparing Sites	15,520	$617.00	$9,575,840	34.59%
Planting	24,316	$379.00	$9,215,764	33.29%
Brushing	5,521	$476.00	$2,627,996	9.49%
Forest Health	827		$0	0.00%
Spacing	3,185	$1,440.00	$4,586,400	16.57%
Fertilizing	279	$277.00	$77,283	0.28%
Pruning	437	$701.00	$306,337	1.11%
	149,489		**$27,681,872**	

Reasonableness: Based on actual activity and average costs in the Kamloops Forest Region.

[22] Ministry of Forests (2001), ***Annual Report Ministry of Forest – Fiscal Year Ended March 31, 2000.***

B-3 Determination of Employment and Wages

Determination of Wages Percentages

The wage rates were determined by using the IWA wage rates for tree planters. This rate is $22.57 an hour plus approximately 35 percent in benefits for a total hourly rate of $30.47 per hour or $243.75 a day.

The Ministry of Forests, Forest Practices Branch has also developed detailed silviculture employment factors for BC. The silviculture employment factors for specific activities were multiplied by the IWA rates to yield a total employment cost. From this the employment cost was divided by total costs for the Kamloops region by activity to yield a wage percentage. For those activities that equalled 100 percent wage component or more, a downward adjustment was made to 85 percent to ensure materials and transportation were considered. Table B-2 highlights the wage percentages that were developed.

B-2 Wage Percentage Based upon Kamloops Forest Region.

Silviculture Rates	Average Costs ($/ha)	Worker days/ha	Wage Rate Amt	Wage Percent
Surveying	$13.00	0.1	$24.38	**85.00%**
Preparing Sites	$617.00	0.3	$73.13	**11.85%**
Planting	$379.00	1.8	$438.76	**85.00%**
Brushing	$476.00	1	$243.76	**51.21%**
Forest Health		0	$0.00	**0.00%**
Spacing	$1,440.00	3.5	$853.15	**59.25%**
Fertlizing	$277.00	0.1	$24.38	**8.80%**
Pruning	$701.00	6	$1,462.54	**85.00%**

Determination of Wages Per Cubic Metre

To determine wage share per cubic metre, the share of total costs had to first be allocated and then the wage percentage were applied to yield a per cubic metre wage cost. Table B-3 outlines the total cost per cubic metre and the associated wage cost per cubic metre.

B-3: Determination of Wage Component for Silviculture in the Kamloops Forest Region.

	Total Silviculture Costs		Wage Share of Costs	
Silviculture Accomplishments	Clear-cut Cost ($/m3)	Selective Cost ($/m3)	Clear-Cut Wages ($/m3)	Selective Wages ($/m3)
Surveying	$0.22	$0.05	$0.19	$0.04
Preparing Sites	$1.64	$0.35	$0.19	$0.04
Planting	$1.58	$0.33	$1.34	$0.28
Brushing	$0.45	$0.09	$0.23	$0.05
Forest Health	$0.00	$0.00	$0.00	$0.00
Spacing	$0.79	$0.17	$0.47	$0.10
Fertilizing	$0.01	$0.00	$0.00	$0.00
Pruning	$0.05	$0.01	$0.04	$0.01
Total	**$4.75**	**$1.00**	**$2.47**	**$0.52**

Determination of Labour Per Harvest Site

The determination of the PYs and person-days of employment has been done by dividing the total wages and benefits by the average wage rates. The current IWA wage rates for tree planters has been used as a wage rate proxy. This rate is $22.57 an hour plus approximately 35 percent in benefits for a total hourly rate of $30.47 per hour or $243.75 a day.

Reasonableness: The Ministry of Forests uses a proxy of $100,000 in silviculture spending to equate to 1 PY of direct silviculture employment. Calculations on the hypothetical harvest yield relatively similar numbers of person days generated using either methodology.

APPENDIX C – INDIRECT ACTIVITY METHODOLOGY

C-1 INDIRECT EMPLOYMENT BENEFITS

Indirect and Induced Employment Estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly in the basic forestry sector (for example, those who build or maintain roads for log transportation). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). For simplicity indirect and induced activities are referred to as indirect in this report.

Indirect and induced employment figures were calculated using local and provincial multipliers developed by Ministry of Finance and Corporate Relations. For the local area the Kamloops local area employment multiplier for logging has been used.

Indirect and Induced Logging Employment Estimates

The local multiplier for logging activity is 1.59.[23] The provincial employment multiplier was derived using the logging industry multiplier from the large aggregation tables from the BC Input-Output Model. This provincial multiplier is 2.28.[24] Table C-1 outlines the indirect and induced employment calculations.

Table C-1: Indirect and Induced Logging Employment Calculations.

Local Indirect Activity	**Logging**		**Scenario 1**	**Scenario 2**	**Scenario 3**
Kamloops Local Area - Migration					
Harvesting Employment Coefficient:	0.59	Direct	0.391	1.150	2.676
		Indirect	0.231	0.678	1.579
		Total:	**0.622**	**1.828**	**4.255**
Provincial Indirect Activity			**Scenario 1**	**Scenario 2**	**Scenario 3**
Provincial Logging Multiplier.					
Harvesting Employment Coefficient:	1.28	Direct	0.391	1.150	2.676
		Indirect	0.501	1.472	3.426
		Total:	**0.892**	**2.622**	**6.102**

[23] Ministry of Finance and Corporate Relations (May 1999), ***British Columbia Local Area Economic Dependencies and Impact Ratios – 1996.***
[24] Ministry of Finance and Corporate Relations (May 2001), ***British Columbia Provincial Economic Multipliers and How To Use Them.***

Indirect and Induced Silviculture Employment Estimates

The local multiplier for silviculture has followed the same methodology as logging. However, at the provincial level the multiplier for forestry services industry the provincial multiplier is 1.565.[25] This is higher than the local multipliers for any of the forest sector activities (logging, manufacturing, pulp and paper), therefore, the local silviculture has been adjusted to the provincial level value. Table C-2 outlines the indirect and induced employment calculations for silviculture.

Table C-2: Indirect and Induced Silviculture Employment Calculations.

Local Indirect Activity	**Silviculture**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Kamloops Local Area - Migration	TSA			
Silviculture Employment Coefficient:	0.565	0.290	0.006	0.006
	Indirect	0.164	0.003	0.003
		0.454	**0.009**	**0.009**
Provincial Indirect Activity		**Scenario 1**	**Scenario 2**	**Scenario 3**
Provincial Logging Multiplier.	Provincial			
Silviculture Employment Coefficient:	0.565	**0.290**	0.006	0.006
		0.164	0.003	0.003
		0.454	**0.009**	**0.009**

C-2 Indirect and induced employment income estimates

The employment income was derived by multiplying the indirect and induced employment by the average indirect and induced wages identified in the Kamloops TSR Analysis. [26] This wage was $30,800 which has been adjusted to a 2001 or $31,905.

Indirect and induced Logging Employment Income

Table C-3 outlines the indirect and induced employment income calculations associated with direct logging activities. For the purposes of indirect and induced employment income only wage income is used.

Table C-3: Indirect and Induced Logging Income Calculations.

Indirect Employment Income	**Scenario 1**	**Scenario 2**	**Scenario 3**
Direct Calculation from above. **Logging**			
Total Wages and Benefits:	$24,924.40	$96,950.99	$171,242.80
Total Wages (65% of total):	**$16,200.86**	**$63,018.14**	**$111,307.82**
Indirect Activity	**Scenario 1**	**Scenario 2**	**Scenario 3**

[25] Ministry of Finance and Corporate Relations (May 2001), ***British Columbia Provincial Economic Multipliers and How To Use Them.***
[26] Ministry of Forests (July 2001), ***Kamloops Timber Supply Area Analysis Report.***

$30,800.00 Kamloops SEA	Indirect Local:	$7,365.45	$21,647.41	$50,378.88
$31,905.72 Inflated 2001	Indirect Prov.:	$15,979.28	$46,963.87	$109,296.56
	Total Local:	**$32,289.85**	**$118,598.40**	**$221,621.69**
	Total Prov:	**$40,903.68**	**$143,914.85**	**$280,539.36**

Indirect and induced Silviculture Employment Income

Table C-4 outlines the indirect and induced employment income calculations associated with direct silviculture activities.

Table C-4: Indirect and Induced Silviculture Income Calculations.

Indirect Employment Income		**Scenario 1**	**Scenario 2**	**Scenario 3**
Direct Calculation from above.	**Silviculture**			
Total Wages and Benefits:		$15,697	$3,305	$3,305
Total Wages (65% of total):		**$10,205**	**$2,150**	**$2,150**
Indirect Activity		**Scenario 1**	**Scenario 2**	**Scenario 3**
$30,800.00 Kamloops SEA	Indirect Local:	$5,230	$110	$110
$31,905.72 Inflated 2001	Indirect Prov.:	$5,230	$110	$110
	Total Local:	**$15,435**	**$2,260**	**$2,260**
	Total Prov:	**$15,435**	**$2,260**	**$2,260**

APPENDIX D – GOVERNMENT REVENUES METHODOLOGY

D-1 Provincial Government Revenues

Overview

Provincial government revenues from the forest industry include stumpage, royalties and rent payments; other taxes such as logging, corporate capital, sales, property and electricity taxes; and income taxes from direct, indirect and induced employment. The methodology to calculate provincial government revenue is similar to that used by the Ministry of Forests in the Timber Supply Review.

Stumpage, Rents, and Royalties

From 1998 to 2001 the average stumpage and rent payments for Crown timber in the Kamloops Forest District were approximately $50.3 million per year or $25.82 per cubic metres. Horse logging which is typically done outside the water bed appraisal system, which licensees with timber allocations over 30,000 cubic metres must follow, typically pay $8 to $10 a cubic metre less. Therefore, Scenario 1 and 2 have been calculated paying a stumpage of $25.82 per cubic metre, while Scenario 3 is based on $15.82.

Industry Taxes

Indirect taxes have been derived from Price Waterhouse Coopers forest industry values and the average provincial rate of $7.6 per cubic metre has been attached. Much of this will come at the processing end of the industry but can still be considered associated with the timber harvested.

Total Provincial Income Taxes on 6,354 cubic metres

Those in indirect and induced occupations earned about approximately $31,900. Income taxes were calculated based on marginal tax rates of 23 – 28 percent with one-third of the total income tax paid accruing to the province. Table D-1 highlights the values for by cubic metre and total harvest.

Table D-1: Total Provincial Taxes Paid for Each Scenario and By Cubic Metre.

		Scenario 1	Scenario 2	Scenario 3
Stumpage and Rent per cubic metre:		$25.82	$25.82	$15.82
Total Stumpage and Rent:		**$164,060.28**	**$164,060.28**	**$100,520.28**
Industry Taxes per cubic metre:		$7.6	$7.6	$7.6
Total Industry Taxes:		**$48,290.40**	**$48,290.40**	**$48,290.40**
Provincial Income Tax (at 33%)	Cubic metres	$0.63	$1.49	$2.90
Direct Employment income at 28% tax:		$2,440.00	$6,021.35	$10,483.32
Indirect Employment income at 22% tax:		$1,539.63	$3,417.43	$7,942.78
Total Direct and Indirect employment taxes:		**$3,979.63**	**$9,438.78**	**$18,426.10**
Per Cubic Metre Totals:		**$34.05**	**$34.91**	**$26.32**
Total Stumpage, Rent, Industry tax, income tax:		**$216,330**	**$221,790**	**$167,240**

D-2 Federal Government Revenues

Overview

Federal government revenues from the forest industry are based on direct and indirect employment income. These calculations are based on accruing two-thirds of the personal income tax paid to the federal government. The federal government also derives benefit from industrial income taxes and employment insurance benefits. However, these have not been calculated here, although could add significantly more revenue to the federal government totals.

Federal government Employment income share

Table D-2 outlines the employment income taxes paid to the federal government.

Table D-2: Federal Government Employment Income Taxes.

Federal Income Tax (at 67%)			
Direct Employment income at 28% tax:	$4,953.37	$12,225.17	$21,284.31
Indirect Employment income at 22% tax:	$3,125.92	$6,938.42	$16,126.26
Total Direct and Indirect employment taxes:	**$3,979.63**	**$9,438.78**	**$18,426.10**
Per Cubic Metre Totals:	**$1.27**	**$3.01**	**$5.88**

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