Using FPInterface to Estimate Available Forest-Origin Biomass in British Columbia: Williams Lake TSA

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Abstract

Based on inventory information and a 20-year harvest queue, estimates of the amount of biomass produced from forest harvest residues are estimated in $10 increments of delivered cost. For the Williams Lake Timber Supply Area, 258,000 odt/year is projected to be available at $60/odt at three delivery points in the TSA.

Acknowledgements

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1. Executive Summary

In 2011 FPInnovations established a method for estimating available forest-origin biomass in British Columbia's Timber Supply Areas, using FPInterface: the test case was the Quesnel TSA (Friesen & Goodison, 2011). In 2012 this method was applied to the Williams Lake TSA, and the results are reported here. The biomass inventory was based on 20-year harvest data and road network plans for Crown land provided by the British Columbia Ministry of Forests, Lands and Natural Resources, (excluding Woodlot Licenses, Tree Farm Licenses, Community Forests Agreements, and First Nation tenures). Delivery points for biomass (i.e., possible bioenergy mill sites) were designated at Williams Lake, Horsefly, Hanceville, and Anahim Lake. All planned blocks were assumed to be clearcut harvested, processed at roadside, and accessible to comminution operations.

The total biomass available to the four delivery points identified in the Williams Lake TSA over the first 10 years was projected to be 17.9 million ODT. About 2.56 million ODT (or approximately 256 000 ODT/year) was available at $60/ODT. The amount of biomass available in Years 11 to 20 was about 260 000 ODT/year at $60/ODT. If the acceptable price of delivered biomass rises to $90/ODT, then available biomass would be nearly four times greater.

More than half the available volume at $60/ODT in both time frames was in the western half of the TSA, at Anahim Lake. Significant volume was also available at Hanceville. As the price rises, more volume becomes available at each location. Williams Lake and Horsefly, in particular, receive much more volume in the second decade than in the first.

2. Introduction

In order to progress toward full implementation of a bioeconomy in British Columbia a key piece of information is needed—i.e., a detailed inventory of economically available biomass.

To address this need, FPInnovations developed a project in partnership with the Inventory Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). The specific goals of the project were to develop a process for calculating biomass inventories.

In 2011 FPInnovations established a method for estimating available forest-origin biomass in British Columbia's Timber Supply Areas (TSA), using FPInterface: the test case was the Quesnel TSA (Friesen & Goodison, 2011). In 2012 this method was applied to the Williams Lake TSA, and the outcomes are reported here, with the aim of helping decision makers better understand biomass availability when preparing industrial proposals.

Detailed introductory statements describing the background and rationale of this project and the greater project as a whole are in Friesen & Goodison (2011).

3. Objectives

As abridged from the report about the Quesnel TSA, the objectives were:

Calculate biomass supply for volume-based tenures in the Williams Lake Timber Supply Area. The desired outputs are:

a. A map showing delivered cost of biomass from point of origin, by cost gradation.
b. A table showing the amount of biomass delivered at different price points – The market value of 1 oven-dried tonne (ODT) of biomass was not clear, but $60/ODT[1] was set as the agreed-upon threshold at which to determine the commercial availability of biomass.

4. Methods

Overall process

The basic methodology was established during analysis of the Quesnel TSA (Friesen & Goodison, 2011), which was the first TSA to be examined. Any differences or points of particular saliency are noted in the Methods section.

Data acquisition

Data layers for the Williams Lake TSA (excluding Woodlot Licenses, Tree Farm Licenses, Community Forest Agreements, and First Nations tenures), including Vegetation Resources Inventory polygons with attributes and road linework with attributes, were acquired from the MFLNRO. The MFLNRO also supplied a 20-year harvest raster.

The harvest raster for the Williams Lake TSA was in four 5-year periods and not in twenty 1-year periods, which was the case for the Quesnel TSA.

Data transformation

See the report regarding the Quesnel TSA (Friesen & Goodison, 2011) for details about the data-transformation process.

Biomass equations

FPInterface species are tied to biomass equations. In the analysis of the Quesnel TSA (Friesen & Goodison, 2011) these equations were based on the Canadian national tree above ground biomass equations (Lambert et al., 2005). Although this equation set included trees from all across Canada, including western and northern Canada, there were very few samples from British Columbia. More recently Ung et al. (2008) have released tree equations for British Columbia (accepted by MFLNRO) and these were incorporated into FPInterface for the 2011–12 analyses that were undertaken for the Williams Lake, Prince George, and Lakes TSAs.

[1] All dollar values in this report are expressed in Canadian currency.

FPInterface parameters

Tree species associations

Species associations were made (Table 1) using the new set of British Columbia equations that became available in FPInterface. Dedicated equations were provided for some species that had been lumped together in the Quesnel TSA analysis (Friesen & Goodison, 2011).

Table 1. Tree species associations

Vegetation Resources Inventory	FPInterface biomass equation
cottonwood	other poplars
trembling aspen	trembling aspen
subalpine fir	alpine fir
western redcedar	western redcedar
white birch	white birch
Douglas-fir	Douglas-fir (Interior)
western hemlock	western hemlock
tamarack	western larch
western larch	western larch
lodgepole pine	lodgepole pine
spruce	white spruce
white spruce	white spruce
Engelmann spruce	white spruce
Sitka spruce	white spruce
hybrid spruce	white spruce
black spruce	white spruce

Road classes

Unlike the data provided for the analysis of the Quesnel TSA, the road data set for the Williams Lake TSA contained no road classes. However, FPInterface has the ability to assign road classes based on the amount of volume hauled over each section of road. The volume hauled is for merchantable volume, as calculated by FPInterface. The volumes and speeds associated with each road class were assigned according to Table 2.

Table 2. Road class associations

FPInterface road class	Volume		Road speed		
	Minimum (m^3)	Maximum (m^3)	Posted speed (km/h)	Empty haul [a] (km/h)	Loaded haul [b] (km/h)
Paved	5 000 001	50 000 000	90	86	77
Class 1	1 000 001	5 000 000	70	67	60
Class 1 (off highway)	0	0	70	67	60
Class 2	500 001	1 000 000	50	48	43
Class 3	100 001	500 000	40	38	34
Class 4	50 001	100 000	20	19	17
Class 4 (operational)	0	0	20	19	17
Class 5 (winter)	0	50 000	20	19	17

[a] 95% of posted speed. [b] 85% of posted speed.

General parameters

The price of fuel can have significant impacts on the model's results. Some equipment in the model can use diesel while other equipment is eligible for marked fuel. A price of $1.25/L was assigned, which was near to commercial rates for diesel at the time, but was slightly higher than the price of marked fuel.

The program's default values for productivities and costs of forestry equipment rely on a long history of FPInnovations studies and on other information gathered by FPInnovations. If operator-specific values or costs exist they can be used instead of the defaults. For this project the default values were used. To verify their suitability the default values were compared with machine costs listed in the *Interior Appraisal Manual* and were found to be close approximates.

Based on a terrain classification system developed by the Canadian Pulp and Paper Association (CPPA) (Mellgren, 1980), average slope for the Williams Lake TSA was assigned to CPPA Class 3 (20 to 32%). Ground strength was rated as CPPA Class 2 (good), and ground roughness was rated as CPPA Class 2 (slightly uneven).

Topping diameter

Although British Columbia regulations require a topping diameter of 10 cm for most merchantable species, the Quesnel TSA analysis (Friesen & Goodison, 2011) used 12.5 cm to reflect more common industrial practise. Rounding in FPInterface meant the topping diameter was set at 13 cm for the Quesnel TSA analysis. Refinements to the program allowed the topping diameter to be set to 12.5 cm for the Williams Lake TSA analysis.

Utilization of lodgepole pine and mountain pine beetle-attacked wood: considerations

As in the Quesnel TSA, the harvesting of standing trees for biomass purposes is generally considered uneconomic in British Columbia because their recovery must cover the full costs of planning and developing and the harvesting of stands, in addition to the costs for biomass recovery operations. However, because of mortality due to mountain pine beetle infestation, some whole logs were included for biomass chipping (Table 3). Although the timber harvesting landbase (THLB) proportion attribute includes mortality attributed to mountain pine beetle, because of continuing attack by the beetle and the degraded state of mountain pine beetle logs, 30% of lodgepole pine volume was removed from availability as merchantable volume. Half of this (15% of total lodgepole pine volume) was estimated to become available for whole-log chipping or grinding at roadside and the remainder, was counted as loss.

Table 3. Utilization of mountain pine beetle-affected stems

Stems converted to merchantable logs (%)	Stems converted to biomass (%)	Unutilized stems (%)
70	15	15

Time frame

The received data identified 20 years of harvest. Unlike the analysis conducted for the Quesnel TSA (Friesen & Goodison, 2011), an examination of the merchantable output in the Williams Lake TSA did not show that a significant falldown is projected for Years 11 to 20. Nevertheless, to be consistent with the methodology for the Quesnel TSA, the base case was considered to be the 10-year harvest, although results for both the 10-year scenario and the 20-year scenario are presented here.

Mill locations

Because it has the largest population in the TSA, Williams Lake is an obvious delivery point for biomass. Additionally, the communities of Horsefly, Hanceville, and Anahim Lake were selected for their existing populations, relative dispersion, and potential for future development. Biomass transport was optimized in the model for whichever delivery point was closest to a given block, and/or the least expensive to deliver to.

Biomass calculations

The biomass calculations in FPInterface produce an amount of total available biomass once merchantable roundwood has been removed. For this project only biomass transported to roadside was considered recoverable, and biomass likely to remain at the stump was not. Once transported to roadside, some biomass becomes unavailable due to handling and technical losses. The remainder is considered recovered biomass. Figure 1 shows this breakdown for the base case 10-year harvest.

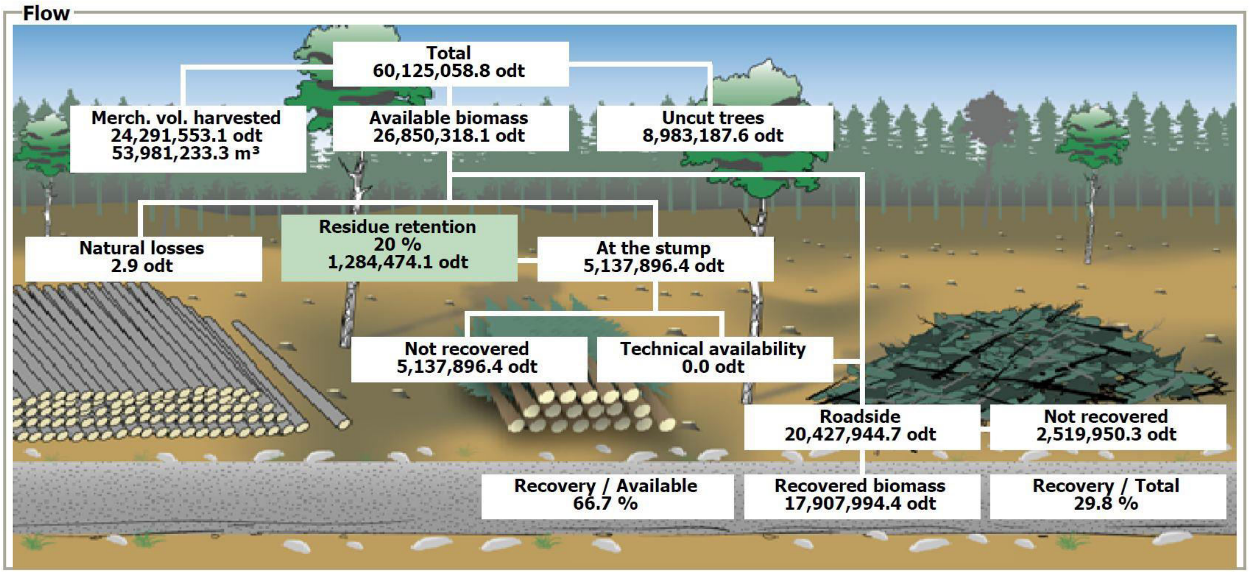


Figure 1. Recoverable biomass, Williams Lake TSA: 10-year harvest base case.

5. Results and discussion

Summary—key results

Key results from the base case runs for 10 and 20 years of harvest are summarized in Tables 4 and 5. More detailed results are in Appendix 2.

Table 4. Harvest availability for bioenergy, by delivery point and cost per ODT: 10-year base case

Delivery point	At $60/ODT (ODT)	At $75/ODT (ODT)	At $90/ODT (ODT)	At $105/ODT (ODT)	Yearly at $60/ODT (ODT)
Hanceville	640 745	3 570 418	5 895 293	7 389 310	64 075
Anahim Lake	1 845 700	2 663 334	3 059 610	3 419 480	184 570
Williams Lake	1 691	297 574	654 146	694 626	169
Horsefly	75 575	134 134	175 859	206 192	7 558
Total	2 563 711	6 665 460	9 784 908	11 709 607	256 371

Table 5. Harvest availability for bioenergy, by delivery point and cost per ODT: 20-year base case

Delivery point	At $60/ODT (ODT)	At $75/ODT (ODT)	At $90/ODT (ODT)	At $105/ODT (ODT)	Yearly at $60/ODT (ODT)
Hanceville	1 214 940	5 659 065	10 094 307	11 767 899	60 747
Anahim Lake	3 150 133	4 435 203	5 290 384	6 301 228	157 507
Williams Lake	284 087	1 295 072	1 824 340	2 139 726	14 204
Horsefly	515 031	1 154 500	1 348 812	1 367 392	25 752
Total	5 164 191	12 543 840	18 557 843	21 576 244	258 210

More than half the available volume at $60/ODT in both time frames is at Anahim Lake. Significant volume is also available at Hanceville. As the price increases, more volume is available at each location. Williams Lake and Horsefly, in particular, receive much more volume in the second decade than the first.

The 10-year base case run (Table 4) showed that a total of 2.56 million ODT are available at the four towns designated as delivery points for the first 10 years at a cost of no more than $60/ODT. But at $90/ODT the available amount nearly quadruples to 9.78 million ODT. The total amount of biomass available at any price in the 10-year base case is 17.9 million ODT.

Annualized, at $60/ODT, the base case shows that approximately 256 000 ODT/year from harvest residue could become available at the four designated delivery points during the first 10 years, provided it is not already fully or partially allocated. During the succeeding 10 years (Years 11 to 20), nearly the same amount, i.e., 258 210 ODT/year, would be available, although the location of availability moves more toward Williams Lake and Horsefly.

The biomass ratio (the ratio of recovered biomass to recovered merchantable roundwood) for the base case is 73.7%. This is higher than usually predicted for harvest residues, partially because 15% of lodgepole pine stems were designated for biomass. If only slash (harvest residues – no stems) is used to produce biomass, biomass ratio becomes 43.2%. Based on other FPInnovations studies, this is higher than a typical biomass ratio for roadside harvesting in the Central Interior. It may indicate that the harvest included a significant amount of small pine, which could contribute a proportionally larger than normal residue amount.

Given that about 90% of the available residue biomass consisted of lodgepole pine, and that much of the standing mature pine forest was devastated by mountain pine beetle, production was checked for falldown in Years 11 to 20. These results reflect the harvest plan and show that the harvest in Years 11 to 20 is only 70% of that in Years 1 to 10; however, the distribution of biomass means that there is no falldown in availability at the $60/ODT price point. Further, in the first decade more than 99.9% of the planned harvest is from lodgepole pine stands. In Years 11 to 20, however, 25.5% is from non-pine stands. Lodgepole pine harvest in the second decade is 54.5% of that in the first decade in the received harvest queue.

Base case

Some of the more significant settings in FPInterface for the base case are listed in Table 6.

The topping diameter is discussed above in section 3.5.4. In the Quesnel analysis, the harvest system was set to “full tree” and then processing activities were set to occur at roadside. However, FPInterface has a harvest setting called “full tree with roadside processing” that is backed with a different set of data points, and which was used for runs subsequent to the Quesnel run. The change produced a very small variation in results (<2%), so it was decided to use this new setting because it more accurately describes operations typical to Interior British Columbia.

Figure 2 presents an isometric map of biomass costs and Table 7 presents cost-availability data. The “Merchantable volume” column is biomass from mountain pine beetle stems and the “Residues” column is biomass from tops and branches. The “Residues” are cheaper because the costs of harvest are applied to merchantable stems. For biomass from “Merchantable volume”, all costs of harvest are applied to biomass (instead of being written off against roundwood), making this biomass much more expensive. The table shows that purpose-harvested wood for biomass is expensive and is not economic below $110/ODT.

The output report for the base case (Appendix 2) shows that comminution costs average $31.80/ODT. For the forest residues (slash) component, the remainder of the costs are transport costs. For the full stem (merchantable stems) component, the average harvest cost is $86.63/ODT[2], comminution costs are $31.80/ODT, and transport costs make up the balance.

In Figure 3 the graph of available biomass shows bimodal (two-hump) distribution. The first mode is biomass from forest residues, and the second mode reflects full stems from mountain pine beetle-affected lodgepole pine (merchantable volume).

[2] $25.01 x 17 907 994 / 5 170 292

Table 6. FPInterface parameters: base case[a]

Run descriptor	Base case
run name	WL10yr 14mar2012
output name	WL10yr 14mar2012new
transfer yards	WL, HF, AL, Hanceville
year(s) analyzed	1-10
species attribute linking	BC
haul speeds	graduated
haul speeds at 95% / 85% of posted	y
transport shifts / day	1
transport hours / shift	10
transport days / year	180
transport fuel price / litre	$1.25
average slope	20-32
slash used for biomass	y
full stem used for biomass	n
Pl utilization of THLB merch timber (%)	70
Pl unutilized merch used for biomass (%)	15
Pl stems for biomass chipped where?	roadside
Pl merch stemwood for biomass directed where	closest yard
chips destination	closest yard
topping diameter (cm)	12.5
truck used for chips	3-axle
truck used for logs	B-train
harvesting fuel price / litre (x3)	$1.25
harvesting shifts / day (x3)	1
harvesting hours / shift (x3)	10
harvesting days / yr (x3)	180
harvesting system	full tree with roadside processing
on site biomass treatment (roadside)	comminution
recovery season	winter
slash freshness	fresh
slash pre-piled at roadside	y
grinder size type	horizontal 600 kW
biomass fuel price / litre (x2)	$1.25
biomass hours / shift (x2)	10
biomass shifts / day (x2)	1
biomass days / yr (x2)	180
indirect costs - biomass ($ value)	$0.00
indirect costs - harvesting ($ value)	$0.00

[a] The parameters highlighted in yellow indicate differences from those used for the analysis of the Quesnel TSA (Friesen & Goodison, 2011).

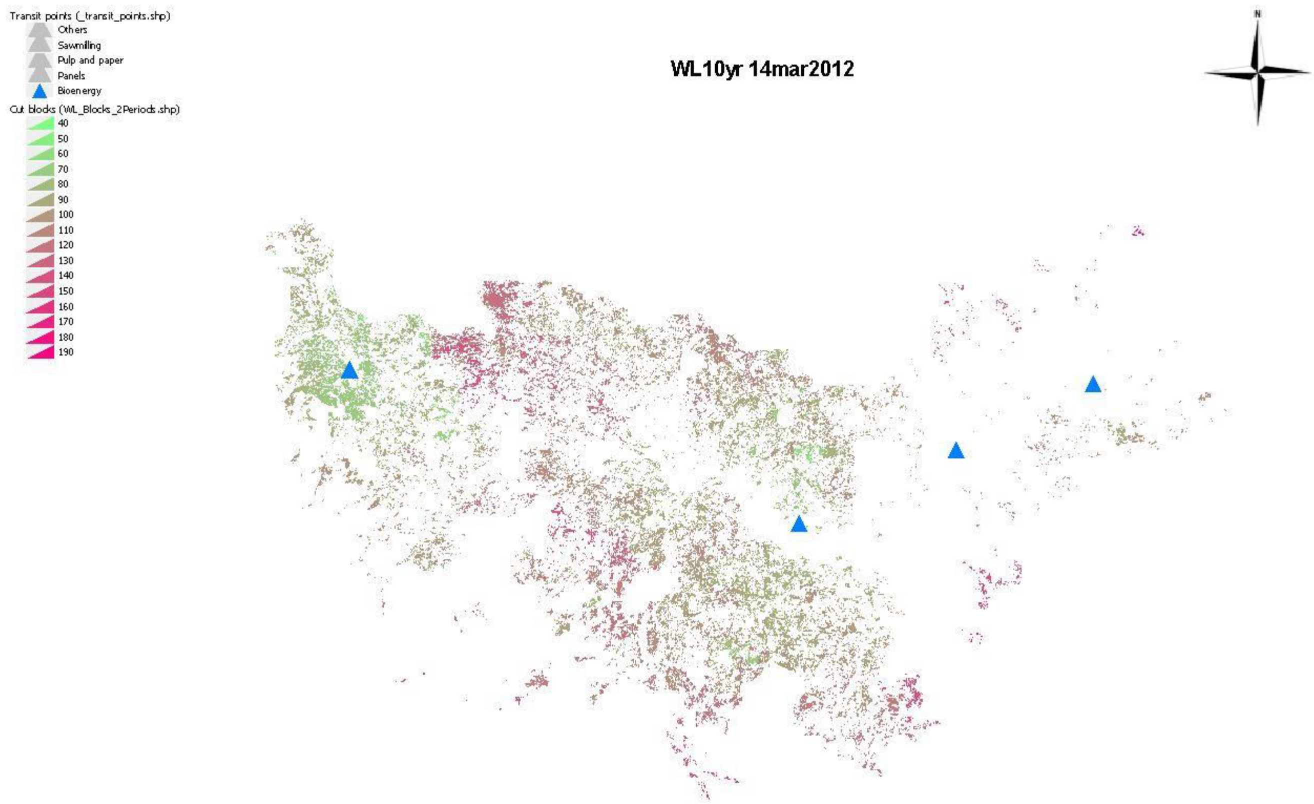


Figure 2. Cost of delivered biomass, from point of origin, in increments of $10/ODT: 10-year base case. L to R: Anahim Lake, Hanceville, Williams Lake, Horsefly. The cost of biomass from roadside residues is averaged with the cost of residue obtained from mountain pine beetle stems. Blocks closest to the delivery points have the lowest delivered costs and are the greenest in colour. Blocks furthest from the mills are the most expensive and the reddest.

Table 7. Cost-availability, delivery to receiving centres in the Williams Lake TSA: 10-year base case [a]

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	0.0	0.0
50 $/odt	0.0	953,112.3	953,112.3
60 $/odt	0.0	2,483,790.1	2,483,790.1
70 $/odt	0.0	5,255,477.4	5,255,477.4
80 $/odt	0.0	7,600,295.1	7,600,295.1
90 $/odt	0.0	9,691,777.8	9,691,777.8
100 $/odt	0.0	11,419,802.5	11,419,802.5
110 $/odt	139.5	11,851,215.1	11,851,354.6
120 $/odt	12,031.4	12,637,020.6	12,649,052.0
130 $/odt	190,598.9	12,703,530.1	12,894,129.0
140 $/odt	663,557.1	12,721,162.6	13,384,719.7
150 $/odt	1,509,641.7	12,731,819.0	14,241,460.7
160 $/odt	2,610,599.7	12,737,701.4	15,348,301.2
170 $/odt	3,365,753.9	12,737,701.4	16,103,455.3
180 $/odt	4,324,707.7	12,737,701.4	17,062,409.1
190 $/odt	4,738,021.5	12,737,701.4	17,475,723.0
200 $/odt	5,017,798.5	12,737,701.4	17,755,499.9
210 $/odt	5,126,550.7	12,737,701.4	17,864,252.2
220 $/odt	5,167,325.8	12,737,701.4	17,905,027.3
230 $/odt	5,167,432.4	12,737,701.4	17,905,133.9
240 $/odt	5,169,764.3	12,737,701.4	17,907,465.8
250 $/odt	5,170,292.9	12,737,701.4	17,907,994.4

[a] The amount of biomass delivered is divided into $10 increments based on delivered cost.

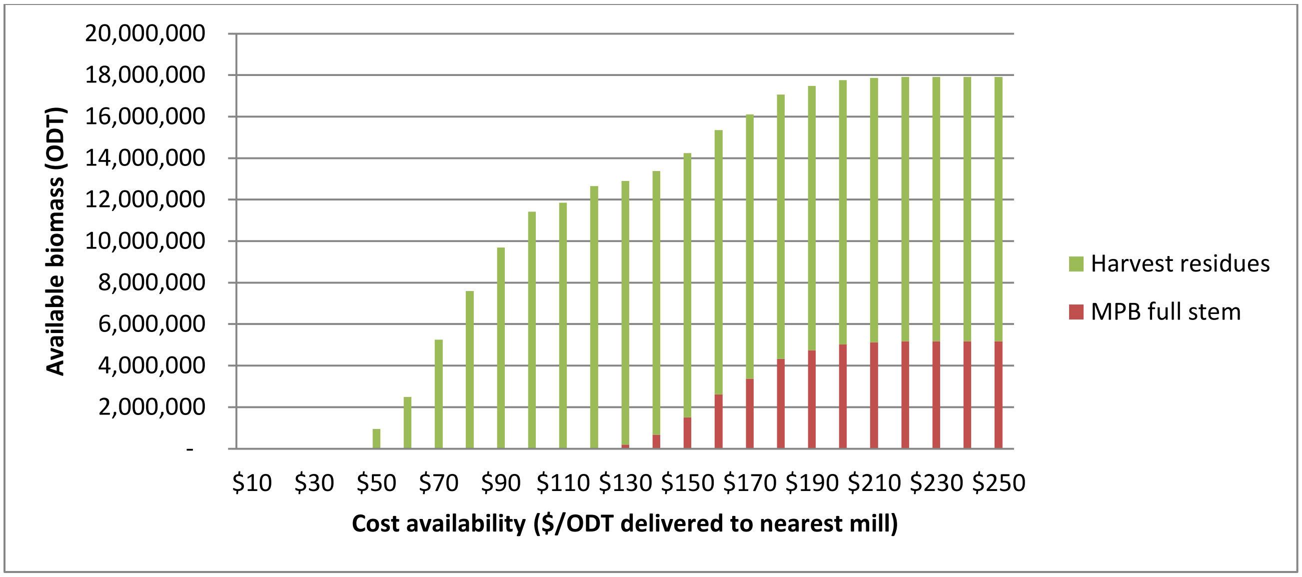


Figure 3. Cost availability of biomass in the Williams Lake TSA: 10-year base case.

Residue cost calculator, by mill

Based on the Excel output from FPInterface, it was now possible to see how much biomass was available at each mill at a price point specified by the user. Appendix 1 consists of an Excel workbook, "Residue Cost Calculator, by Mill". A snip of the sheet can be seen in Figure 4. The amount of ODT available at a particular price point was determined for each mill (labelled "Transfer yards") by entering a target price for delivered biomass (dollar amount in green).

The calculator shows the available biomass from residues only. Because full stem biomass (15% of lodgepole pine volume) does not become available until prices rise above $110/ODT, amounts up to $110/ODT also reflect total biomass available.

Calculators for both the 10-year base case and the 20-year scenarios are included in Appendix 1

	A	B	C	D	E	F	G	H	I	J	K
1	**Williams Lake - 10 year harvest**				amounts available at		$60	/odt	Transfer yard: Hanceville	640,745	odt
2									Transfer yard: Anahim Lake	1,845,700	odt
3	(does not include biomass from 15% Pl full stem - min price $110/odt)								Transfer yard: Williams Lake	1,691	odt
4									Transfer yard: Horsefly	75,575	odt
5									Total	2,563,711	odt
6											

Figure 4. Snip of "Residue cost calculator, by mill"

Issues and improvements since the Quesnel TSA analysis

Some of the issues encountered during the runs for the Quesnel TSA were addressed and they evolved toward being resolved during the analyses of the Williams Lake TSA and the Prince George TSA (Friesen, 2012).

The structure of the Vegetation Resources Inventory data remained essentially unchanged since the Quesnel analysis. The sorting of species into columns by leading species, second species, etc, in a received data set was not made available, but FPInnovations developed a way to perform this task that minimized processing time.

Similarly, the block aggregation process, which was necessitated by the immense size of the data set that proved too unwieldy for productive run processing and scenario-building in FPInterface, was brought into a manageable time frame through experience and repetition. This aggregation process could still be codified and, if possible, automated for future projects.

The MFLNRO's road data set contained many unjoined road intersections and overly long segments that required extensive data cleaning. This proved very time-consuming. As much as possible road snapping should be accomplished before new projects are undertaken. Perhaps a protocol for snapping should be established.

The road snapping completed by FPInterface was targeted, i.e., not all roads in the data set were snapped. In order to speed processing, many roads were eliminated from the dataset. It is possible that sub-optimal paths resulted and estimated costs for delivery were too high, although much effort was directed to avoiding this situation.

A significant improvement was made to FPInterface in that targeted British Columbia biomass equations are now available in the program. These equations, in combination with other improvements to the program, should have improved the accuracy of the predicted results.

The multiple delivery point function, allowing blocks to be delivered to the nearest mill, which had not been working for the Quesnel runs, was repaired. This allowed construction of the "Residue Cost Calculator, by Mill"; the isometric map showing colour-coded costs to each mill by block of origin is now produced directly in FPInterface. Continued enhancement of the program is encouraged in order shorten the model's run time in future projects.

6. Conclusions

We devised a method for estimating available forest-origin biomass for British Columbia Timber Supply Areas, using Quesnel TSA as the test case (Friesen & Goodison, 2011). Based on that experience, estimates were then made for the Williams Lake TSA. The biomass inventory was based on 20-year harvest data and road network plans for Crown land that were provided by British Columbia Ministry of Forests, Lands and Natural Resources (excluding Woodlot Licenses, Tree Farm Licenses, Community Forests Agreements, and First Nation tenures). Williams Lake, Anahim Lake, Hanceville, and Horsefly were designated as delivery points for biomass. All planned blocks were assumed to be clearcut harvested, processed at roadside, and accessible to comminution operations.

The total biomass available to these four communities for Years 1 to 10 was projected to be 17.9 million ODT, of which 2.56 million ODT (or approximately 256 000 ODT/year) would be available for $60/ODT. The amount of biomass available in Years 11 to 20 was projected to be about 260 000 ODT/year at $60/ODT. If the acceptable price of delivered biomass rose to $90/ODT, then available biomass would be nearly four times greater.

More than half the available volume at $60/ODT in both time frames is at Anahim Lake. Significant volume is also available at Hanceville. As the price increases, more volume is available at each location. Williams Lake and Horsefly, in particular, receive much more volume in the second decade than in the first.

Improvements to the method that was devised using the Quesnel TSA as a test case centered around the use of British Columbia-specific biomass equations and efforts to speed up the transformation of MFLNRO data into a format that was usable by FPInterface. Since then, enhancements have led to improvement in results handling and presentation. Data cleaning associated with the roads layer (road snapping) proved to be very time consuming, so further enhancements related to this are still needed. Run time would be faster if polygon data could be acquired from the MFLNRO in a format more compatible with FPInterface. Generally, further enhancement and development of FPInterface is encouraged, in order to speed up the run time of future projects.

7. References

Friesen, C. (2012). Using FPInterface to estimate available forest-origin biomass in British Columbia: Prince George TSA (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C., & Goodison, A. (2011). Using FPInterface to estimate available forest-origin biomass in British Columbia: Quesnel TSA (Technical Report). Vancouver, British Columbia: FPInnovations.

Lambert, M.-C., Ung, C.-H., & Raulier, R. (2005). Canadian national tree aboveground biomass equations. *Canadian Journal of Forest Research* 35:1996–2008.

Mellgren, P.G. (1980) *Terrain classification for Canadian forestry*. Woodlands Section, Canadian Pulp and Paper Association (CPPA).

Ung, C.-H., Bernier, P., & Guo, X.-J. (2008). Canadian national biomass equations: New parameter estimates that include British Columbia data. *Canadian Journal of Forest Research* 35:1123-1132.

8. Appendix

Appendix 1

Residue cost calculator, by mill

Appendix 2

Output maps and cost-availability tables

2.1 10-Year Base Case

2.2 20-Year Base Case

FPInterface™

Summary report
Biomass
[WL-9mar2012 14th]

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	904,551.0 ha
Number of cut blocks	1592
Recovered biomass	30,438,261.8 odt
Recovery rate	33.7 odt/ha
Biomass odt / Merchantable m³	0.2780 odt/m³
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	31 : 1
Available energy	112,038,051 MWh
Fuel consumption	13.6 L/odt

Cost

Harvesting	23.42 $/odt
Biomass recovery	31.80 $/odt
Transfer yard	0.00 $/odt
Transportation	38.83 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	0.72 $/odt
Indirect costs	0.00 $/odt
Total	**94.77 $/ odt**

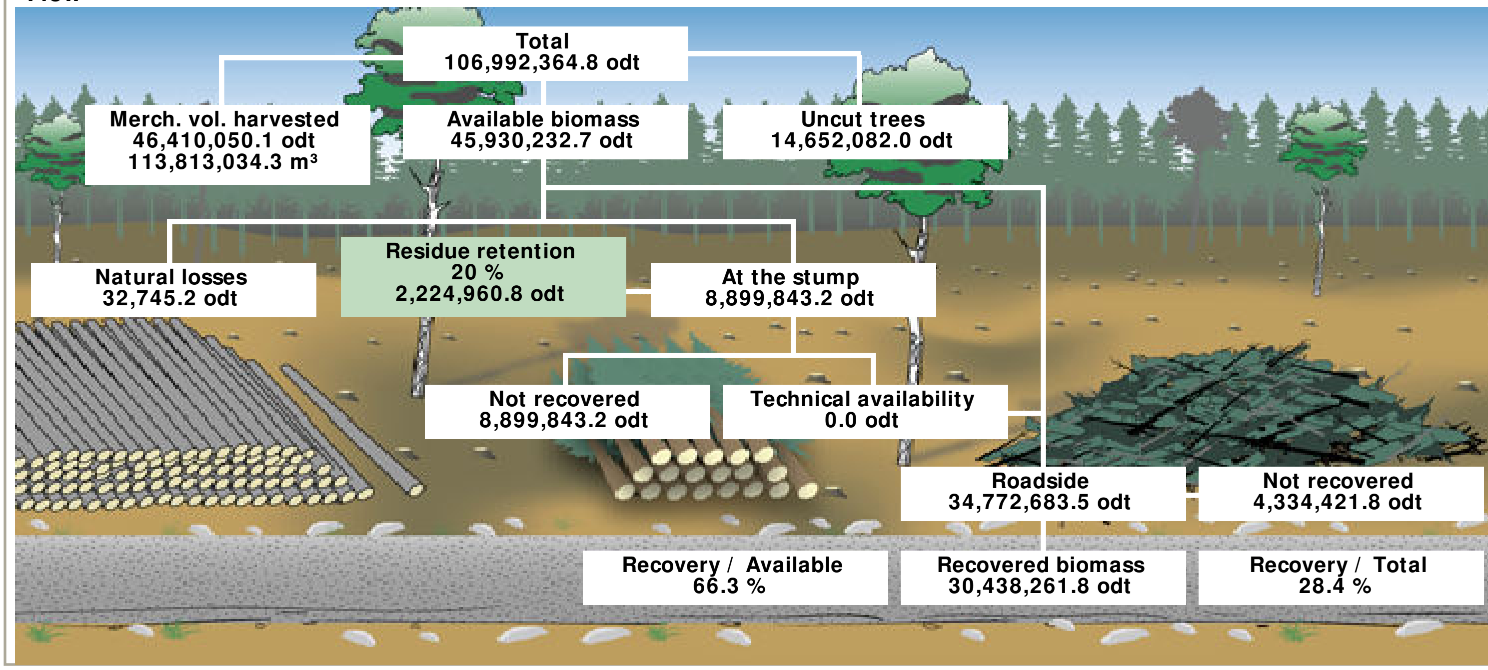
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

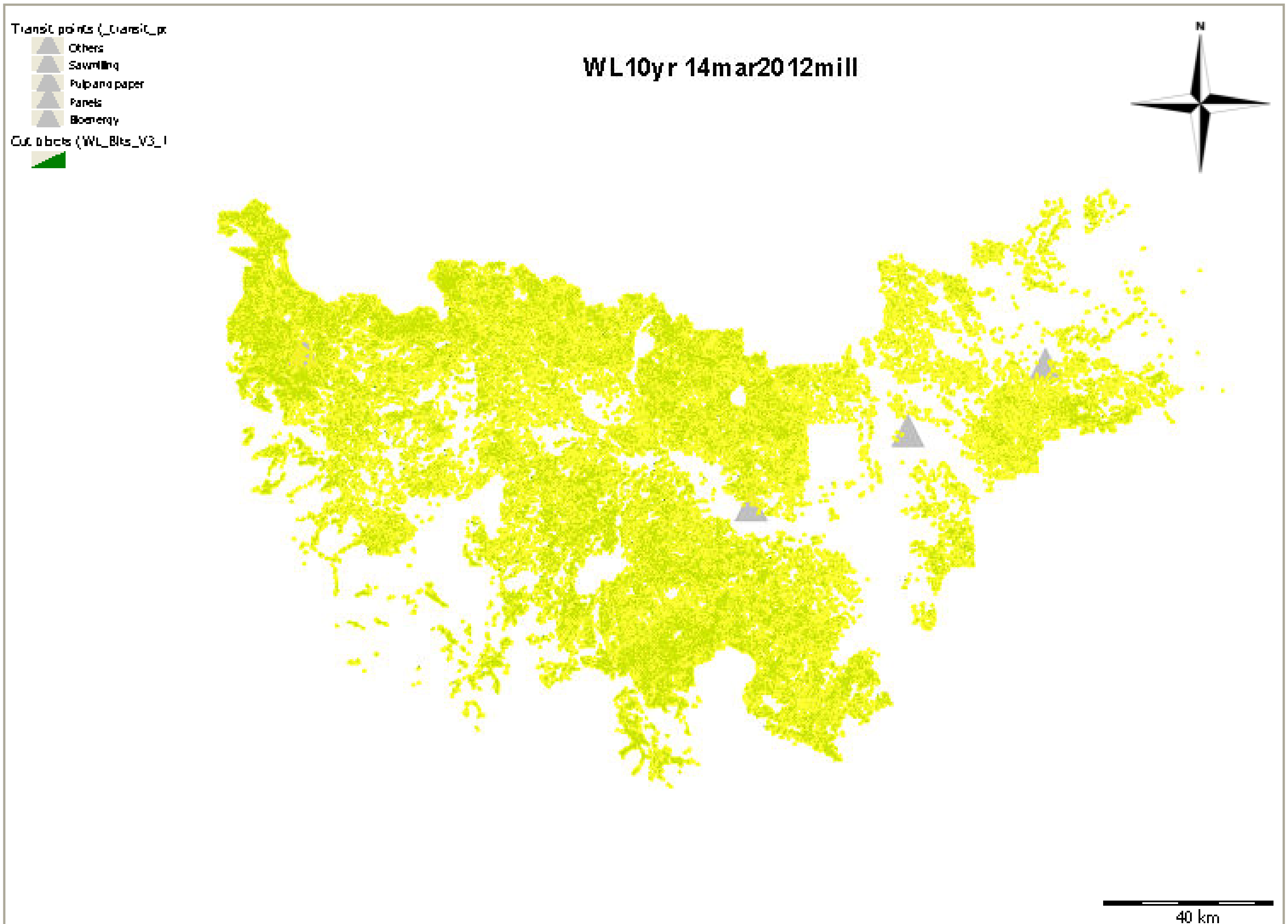
Profit	-94.77 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
LPine (residues)	16,208,165.0	0.2028	17.92
LPine-biomass	8,374,067.3	86.0494	9.26
LPine-biomass (residues)	3,473,178.2	0.2028	3.84
Spruce (residues)	1,306,703.2	0.1926	1.44
DFir (residues)	703,355.7	0.2375	0.78
Aspen (residues)	243,836.2	0.1352	0.27
Abies lasiocarpa (residues)	106,999.4	0.1598	0.12
Paper birch (residues)	18,388.0	0.1970	0.02
WHemlock (residues)	2,293.8	0.1401	0.00
Western redcedar (residues)	1,275.0	0.1392	0.00
	30,438,261.8	**0.2780**	**33.65**



1592 selected site(s) / 1592

Area covered: 904,551 ha / 904,551 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	30,438,261.8	904,551.0	1,592
• Recovery season			
Summer	0.0	0.0	0
Winter	30,438,261.8	904,551.0	1,592
• Residue freshness			
Fresh	30,438,261.8	904,551.0	1,592
Brown	0.0	0.0	0
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	0.0	0.0
50 $/odt	0.0	1,609,592.8	1,609,592.8
60 $/odt	0.0	5,164,192.7	5,164,192.7
70 $/odt	0.0	10,261,619.5	10,261,619.5
80 $/odt	0.0	14,914,795.2	14,914,795.2
90 $/odt	0.0	18,557,846.2	18,557,846.2
100 $/odt	0.0	20,816,181.7	20,816,181.7
110 $/odt	983.2	21,967,830.2	21,968,813.3
120 $/odt	129,370.0	22,063,842.5	22,193,212.6
130 $/odt	1,009,361.1	22,064,194.5	23,073,555.6
140 $/odt	2,377,082.6	22,064,194.5	24,441,277.1
150 $/odt	3,962,157.9	22,064,194.5	26,026,352.4
160 $/odt	5,438,639.8	22,064,194.5	27,502,834.3
170 $/odt	6,881,244.4	22,064,194.5	28,945,438.9
180 $/odt	7,774,081.4	22,064,194.5	29,838,275.9
190 $/odt	8,241,503.3	22,064,194.5	30,305,697.9
200 $/odt	8,339,809.4	22,064,194.5	30,404,003.9
210 $/odt	8,374,067.3	22,064,194.5	30,438,261.8
Maximum cost	**205.39 $/ odt**	**120.84 $/ odt**	

FPInterface™

Summary report

Biomass

[WL10yr 14mar2012]

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	533,017.9 ha
Number of cut blocks	722
Recovered biomass	17,907,994.4 odt
Recovery rate	33.6 odt/ha
Biomass odt / Merchantable m³	0.3060 odt/m³
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	29 : 1
Available energy	65,140,274 MWh
Fuel consumption	14.3 L/odt

Cost

Harvesting	25.01 $/odt
Biomass recovery	31.80 $/odt
Transfer yard	0.00 $/odt
Transportation	43.11 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.10 $/odt
Indirect costs	0.00 $/odt
Total	**101.02 $/ odt**

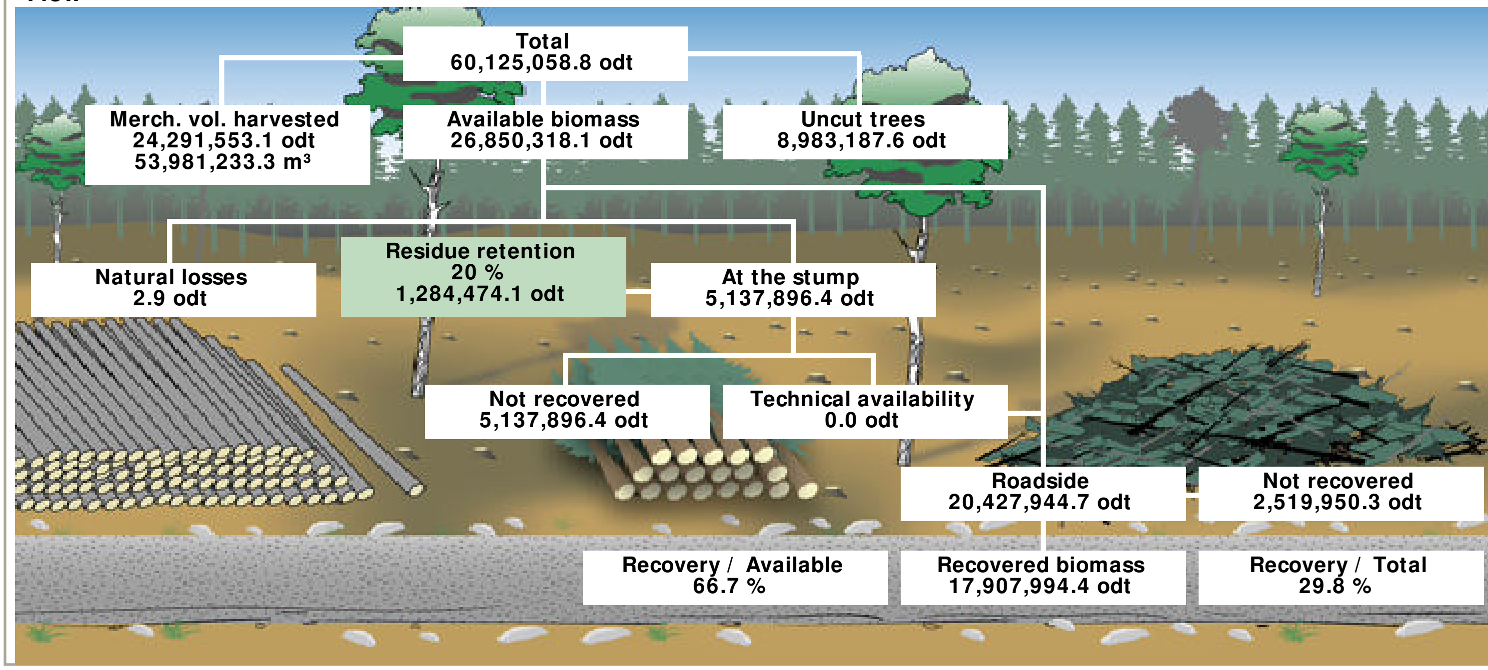
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

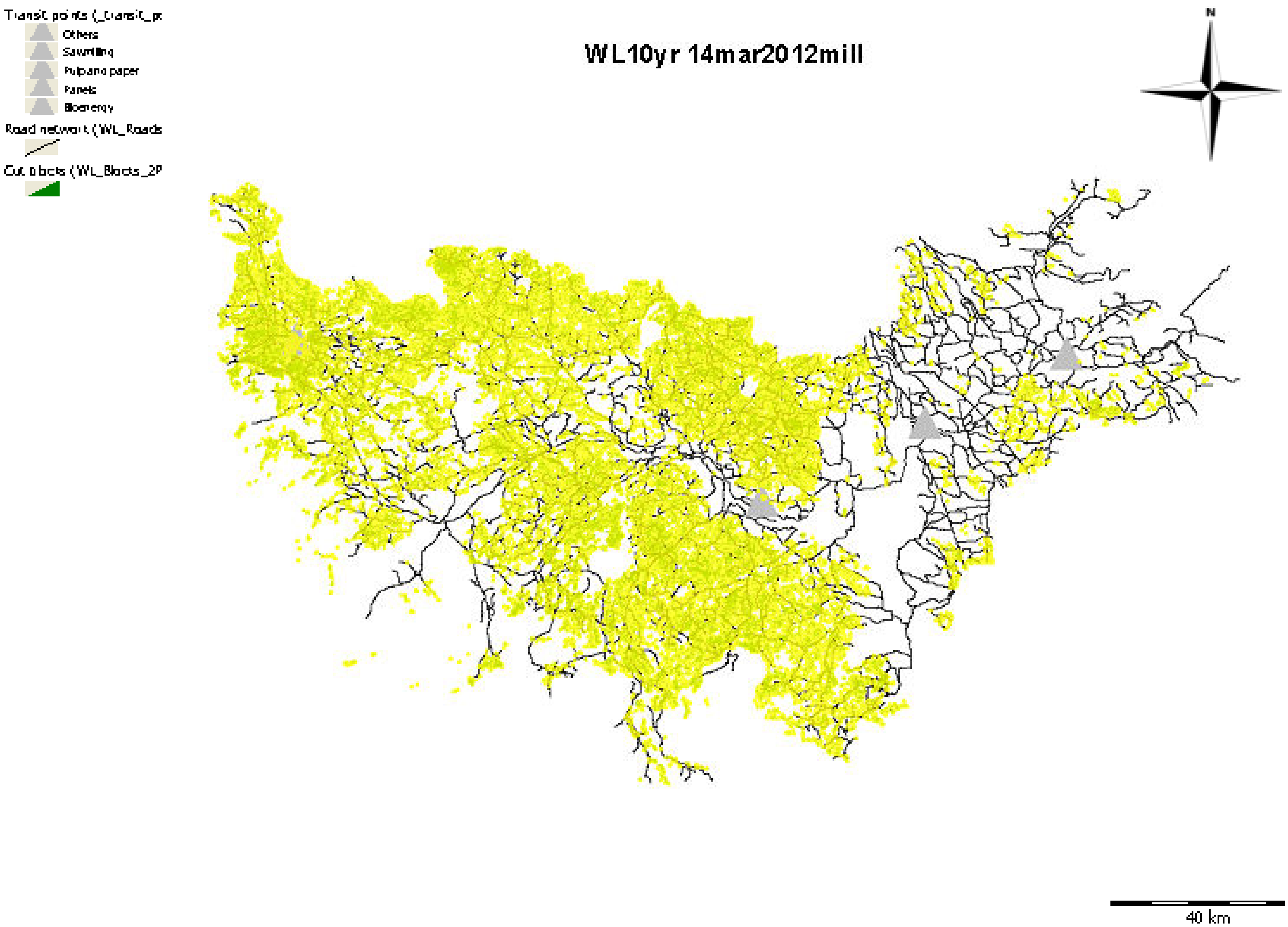
Profit	-101.02 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole pine (residues)	10,489,850.2	0.2179	19.68
Lodgepole pine-biomass	5,170,292.9	104.3078	9.70
Lodgepole pine-biomass (residues)	2,247,825.0	0.2179	4.22
Trembling aspen (residues)	26.2	0.3593	0.00
	17,907,994.4	**0.3060**	**33.60**



722 selected site(s) / 722

Area covered: 533,018 ha / 533,018 ha

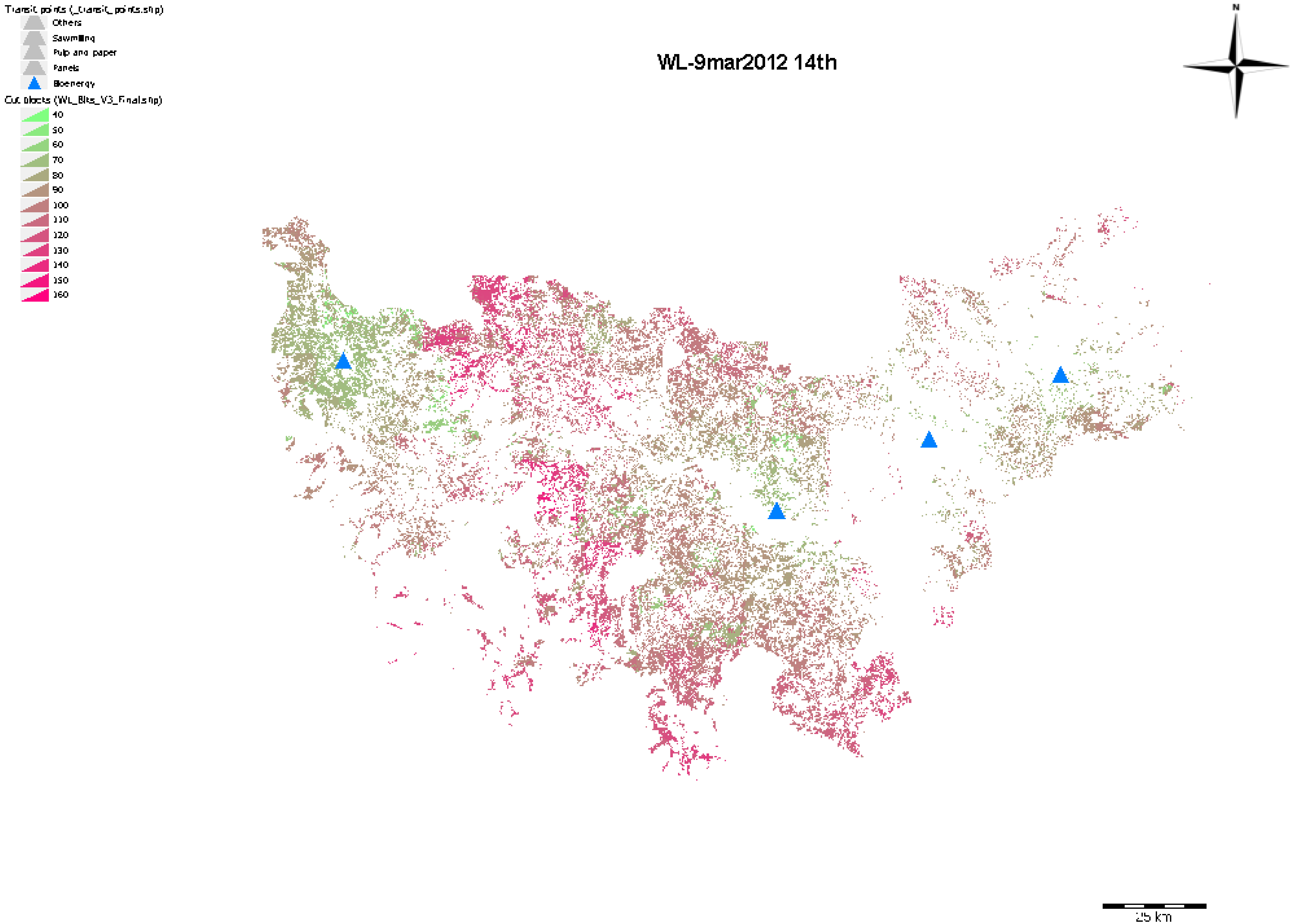
Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	17,907,994.4	533,017.9	722
• Recovery season			
Summer	0.0	0.0	0
Winter	17,907,994.4	533,017.9	722
• Residue freshness			
Fresh	17,907,994.4	533,017.9	722
Brown	0.0	0.0	0
Brittle	0.0	0.0	0

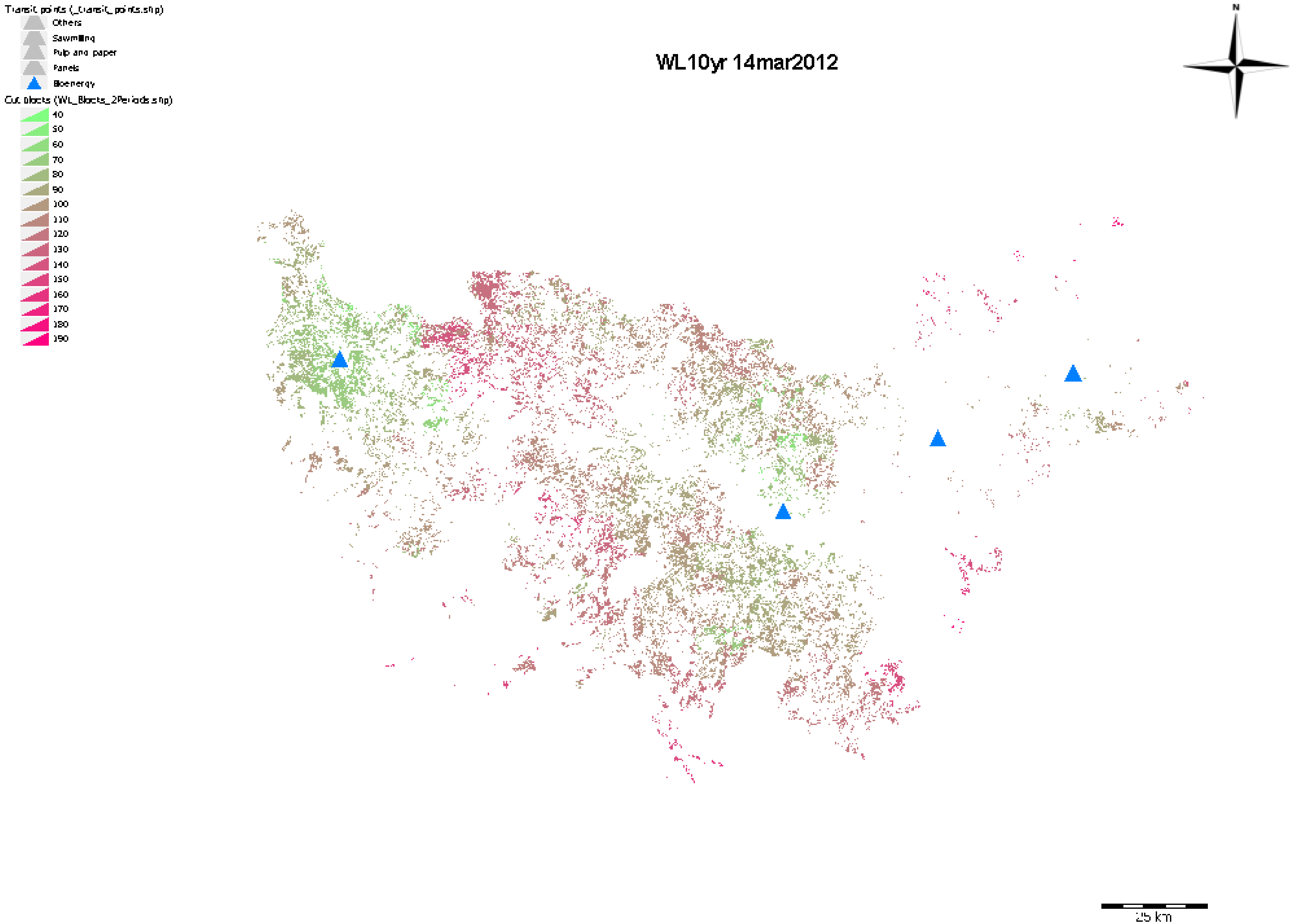
Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	0.0	0.0
50 $/odt	0.0	953,112.3	953,112.3
60 $/odt	0.0	2,483,790.1	2,483,790.1
70 $/odt	0.0	5,255,477.4	5,255,477.4
80 $/odt	0.0	7,600,295.1	7,600,295.1
90 $/odt	0.0	9,691,777.8	9,691,777.8
100 $/odt	0.0	11,419,802.5	11,419,802.5
110 $/odt	139.5	11,851,215.1	11,851,354.6
120 $/odt	12,031.4	12,637,020.6	12,649,052.0
130 $/odt	190,598.9	12,703,530.1	12,894,129.0
140 $/odt	663,557.1	12,721,162.6	13,384,719.7
150 $/odt	1,509,641.7	12,731,819.0	14,241,460.7
160 $/odt	2,610,599.7	12,737,701.4	15,348,301.2
170 $/odt	3,365,753.9	12,737,701.4	16,103,455.3
180 $/odt	4,324,707.7	12,737,701.4	17,062,409.1
190 $/odt	4,738,021.5	12,737,701.4	17,475,723.0
200 $/odt	5,017,798.5	12,737,701.4	17,755,499.9
210 $/odt	5,126,550.7	12,737,701.4	17,864,252.2
220 $/odt	5,167,325.8	12,737,701.4	17,905,027.3
230 $/odt	5,167,432.4	12,737,701.4	17,905,133.9
240 $/odt	5,169,764.3	12,737,701.4	17,907,465.8
250 $/odt	5,170,292.9	12,737,701.4	17,907,994.4

Maximum cost	**244.66 $/ odt**	**154.32 $/ odt**



WL-9mar2012 14th
Transit points (_transit_points.shp)
Others
Sawmilling
Pulp and paper
Panels
Bioenergy
Cut blocks (WL_Blts_V3_Final.shp)
40
50
60
70
80
90
100
110
120
130
140
150
160
N
25 km


WL10yr 14mar2012
Transit points (_transit_points.shp)
Others
Sawmilling
Pulp and paper
Panels
Bioenergy
Cut blocks (WL_Blocks_2Periods.shp)
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
N
25 km

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