TYPE 4 SILVICULTURE STRATEGY IN THE KAMLOOPS TSA

DATA PACKAGE

Prepared for:

Paul Rehsler, Silviculture Reporting & Strategic Planning Officer,
Ministry of Natural Resource Operations
Resource Practices Branch
PO Box 9513 Stn Prov Govt, Victoria, BC V8W 9C2

Prepared by:

Ecora
Resource Group Ltd.

579 Lawrence Avenue
Kelowna, BC, V1Y 6L8
Ph: 250-469-9757
Fax: 250-469-9757
Email: Kelly.Sherman@Ecora.ca

March 2016
Version 5

Contract number: 1070-20/FS15HQ090

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1.0 INTRODUCTION

The Kamloops TSA has been selected for a Type 4 Silviculture Strategy project to provide tactical level direction for steering silviculture investment to help mitigate mid-term timber supply impacts created from the mountain pine beetle (MPB) epidemic. Ecora Resource Group Ltd. (Ecora) has been contracted by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to undertake the Type 4 Silviculture Strategy on the Kamloops TSA.

The MFLNRO's Resource Practices Branch (RPB) has recognized the need to define clear timber objectives in the Kamloops TSA and ensure silviculture activities are consistent with objectives for all forest values.

The project plan of action is to:

- Identify present and emerging issues;
- Identify objectives and create targets;
- Create a vision for timber and habitat supply;
- Create and implement a silviculture plan to translate the vision into operational reality; and
- Allow for monitoring and iterative updates in the process.

This has been achieved by holding an inclusive kick-off meeting with a wide range of local and regional participants and utilizing expert input to facilitate the inclusion of specific values. Ecora will facilitate this discussion and tie it all together in an optimization modelling environment that allows for the inclusion of the many complex and overlapping timber and non-timber resource values in the Kamloops TSA.

The main outcomes from this process are:

- 5-year silviculture investment plan: spatial and tactical levels to link strategic level planning to management level actions; and
- To identify, model and monitor the performance of important indicators on the land base.

This Data Package document is the second of four documents to make up this Type 4 Silviculture Strategy for the Kamloops TSA:

1. **Situational Analysis:** describing the general situation for the TSA;
2. **Data Package:** describing the input data, information and assumptions;
3. **Analysis Report:** describing the modelling output and rationale; and
4. **Silviculture Strategy:** providing treatment options, targets and benefits.

2.0 MODELLING APPROACH

2.1 Optimization Modelling

As the demands on natural resource management have increased, modelling processes and techniques have been evolving to more adequately capture the complexity of the situation. The Kamloops Type 4 has endeavored to explicitly model multiple land base objectives while spatially assessing and scheduling silvicultural and harvesting activities. This enables silviculture activities such as fertilization and enhanced reforestation to be scheduled considering a wide variety of values such as forest health, range, hydrology, wildfire risk, and forest carbon in addition to the many traditional values considered in TSR.

A fully spatial metaheuristic optimization approach has been selected for this project. The specific model selected is *Patchworks*, which is developed and commercially available by Spatial Planning Systems Inc. of Deep River, Ontario.

2.2 Model

Patchworks is well suited to the project primarily due to its ability to consider multiple resource values in optimizing a long-term treatment schedule. *Patchworks* was first introduced in 2001 and is still being actively developed. It is currently used by resource analysts across Canada. It is a spatially-explicit model that allows the user to explore trade-offs between a broad range of conflicting management goals.

Patchworks has the flexibility to integrate operational-level considerations into a strategic-level environment and includes an easy to use interface that allows users to access and understand information in real-time.

The *Patchworks* data structure is very flexible. Indicators and targets can be based on any age-based attribute. Users are free to define any age-base curve, and the dependent variables can be continuous (e.g. stand volume or height) or boolean (is or is not 'old seral').

The scheduling model itself, and the associated tools, are all available through a graphic user interface (GUI). This GUI also provides a view of the input spatial data and also configurable views of the spatial results while the model is running. Basic model output consists of graphical and tabular summaries, and an HTML framework for easily viewing them.

More information and documentation on the model can be found on the web at: http://www.spatial.ca/products/index.html.

3.0 DATA SOURCES

Table 3.1 shows the input spatial data sources for this analysis. The Phase 1 Vegetation Resource Inventory (VRI) project was completed in 2014 based on 2011 aerial photography. Age was projected to 2015 and harvest depletions up to December 2014 from RESULTS data were incorporated into the data base.

Table 3.1: Spatial Data Sources

Data Description	Date	Source
Land Base Classification		
ESA	2003	Type II SS
Indian Reserves	2014	LRDW
Land Ownership	2014	LRDW
Old Growth Mgmt Areas	2014	LRDW
Operability	2014	Type II SS
Parks and Protected Areas	2013	LRDW
Riparian Classifications	2014	MFLNRO
Terrain Stability	2013	LRDW
TFL Boundary	2014	LRDW
Timber Licenses	2014	LRDW
Ungulate Winter Ranges (UWR)	2013	LRDW
DRA and FTEN roads	2014	MFLNRO
TSA Boundary	2013	LRDW
Sun Peaks Ski Area	2001	Type II SS
Hudson Bay Trail	2003	Type II SS
Wildlife Habitat Areas (WHA)	2012	LRDW
Woodlots and Community Forests	2014	LRDW
Disturbance Updates		
Fire History	2014	LRDW
Forest Tenure Cut Blocks	2014	LRDW
RESULTS	2014	LRDW
Resource Management		
Biogeoclimatic Zones (BGC) Version 8	2013	LRDW
Forest Health Overview (FHO)	2011	MOF
Mountain Pine Beetle (MPB) Projections	2014	MFLNRO
Vegetation Resource Inventory (VRI)	2013	LRDW
Biodiversity Emphasis Options (BEO)	2013	LRDW
Community Watersheds	2014	LRDW
Landscape Units (LU)	2013	LRDW
Range Units	2014	MFLNRO
VLI Inventory	2014	LRDW
Proposed First Nations W.L.	2014	MFLNRO
Draft Mule Deer	2014	MFLNRO
KLRMP Mule Deer	2003	ILMB archived file
KLRMP Moose	2001	ILMB archived file
Cedar Hemlock Partition Areas	2014	LRDW
Pulpwood Agreement Areas	2013	LRDW
Community Watershed Intake	2006	Type II SS
Seed Planting Units	2012	LRDW
KLRMP Lakeshore Management Zones	2014	MFLNRO
Land Use Plans	2012	LRDW
Kamloops Risk Analysis Watersheds	2014	MFLNRO
Cycle time	2007	Type II SS
Skeetchestn Indian Band S.M.Z.	2014	Ecora
Grazing Leases	2014	MFLNRO

4.0 LAND BASE CLASSIFICATION

The land base classification process starts with the gross area of the TSA and removes area in a stepwise fashion according to classification criteria detailed below. Through this process, area is systematically removed in order to establish both the productive forest and timber harvesting land base (THLB). The productive land base is the forested land that contributes towards meeting non-timber objectives. The land base classification process clarifies area into three broad categories:

- ***Non-Productive***: areas that are non-crown, non-forested or non-productive and unable to grow viable timber;
- ***Productive non-THLB***: productive land base that is unlikely to be harvested for reasons such as inoperability or special environmental protection; and
- ***THLB***: productive land base that is expected to be available for harvest over the long-term.

Table 4.1 shows this step-wise classification of the land base, and the following sections describe the steps that were taken to determine the THLB for the Kamloops TSA. This analysis was benchmarked to TSR 5 where possible based on the published Data Package and feedback from Ministry contacts.

Table 4.1: Land Base Classification Table

Land Classification	Area (ha)
Total Area	**2,771,185**
Non-Crown	412,975
Non-Forest	620,362
Roads	23,846
Transmission Lines	741
Non-productive reductions	**1,057,924**
Crown Forest Landbase	**1,713,261**
Parks	299,823
Trails	420
Inoperable	144,198
Low Site	23,038
Problem Forest	14,915
Deciduous	26,493
OGMA	111,693
WHA	294
WMA	138
Caribou	42,651
ESA	34,959
Terrain Stability	15,696
Archaeological Sites	651
PSP & Research Installations	3,917
Riparian	22,155
WTP	18,770
Productive reductions	**759,811**
Total THLB	**953,450**

4.1 Logging History

Logging history was defined from multiple sources, including:

- Forest tenure cutblocks (BLK_ST_DT);
- RESULTS openings (DST_END_DT and COMPL_DT);
- VRI cutblocks (HARVEST_DATE); and
- Open indicator (OPENING_IND).

Any stand with a harvest history after 1900 or with an opening indicator 'Y' was considered previously harvested.

4.2 Non-Crown

Non-crown items include any private land, federal land, woodlots, community forests, or other forest tenures overlapping with the TSA. These lands were identified using the Ministry's ownership layer, forest tenure layer, TFL layer, and Crown Recreation Area (CRA) layer, which include Sun Peaks Ski Area. The following codes were used to remove areas from the THLB (Table 4.2).

Table 4.2: Non-Crown Ownership Descriptions

Ownership Codes	
40 'PRIVATE'	Private Land
50	Federal Reserve
51	National Park
52	Indian Reserve
53	Military Reserve
54	Government Block
72 99	Tree Farm Licences Crown Miscellaneous Leases
'K' or 'W' CRA field not blank Schedule B	Community Forest Ski / Recreation Areas Woodlot Licences

4.3 Non-Productive and Non-Forest

The non-forest netdown reduces the land base by areas that are non-treed such as rock and water. Non-productive removes areas that are vegetated but will not sustain trees. Non-commercial forests are stands that are currently not merchantable. Areas were identified using the BC Land Classification System (BCLCS) and completely removed from the THLB (Table 4.3).

Table 4.3: Non-Productive and Non-Forest Descriptions

Attributes	Descriptions
Non-Forest	
BCLCS 1 = N	Non-vegetated
BCLCS 2 = N *and* BCLCS 4 not ST or SL	Vegetated but non-treed Excluding shrub areas
BCLCS 2 = N *and* BCLCS 3 = W	Non-treed wetlands
BCLCS 3 = A	Alpine
BEC = IMA *and* No logging history	Alpine
Non-Productive	
Site index < 3 m *and* No logging history	Land base not productive for timber supply or non-forest objectives
Non-Commercial Forest	
BCLCS 2 = T *and* BCLCS 3 = W	Treed wetlands
BCLCS 4 = ST or SL *and* No logging history	Shrub and not already logged

4.4 Existing Roads and Transmission Lines

A consolidated digital road atlas (DRA) and forest tenure (FTEN) roads coverage was received from the Ministry. To be consistent with TSR 5, all roads were buffered by 10 m and removed from the THLB. Transmission lines features were identified from the LRDW's transmission layer. These areas were buffered by 60 m and completely removed from the THLB.

4.5 Crown Forested Land Base

The crown forested land base (CFLB) represents the portion of the land base that contributes to meeting biodiversity objectives but is excluded from the THLB. The CFLB includes all forested crown land within the BLCF and excludes the areas identified in sections 4.2 to 4.4 above.

4.6 Parks

This netdown excludes areas such as ecological reserves, protected areas, and Class A parks from the THLB. These areas were identified using the LRDW's parks and protected areas layer and removed where park name was not blank.

4.7 Hudson's Bay Trail

The Hudson's Bay Trail is designated as a heritage trail which requires a 200 m buffer to be removed from the THLB.

4.8 Inoperable

Inoperable areas include steep slopes, broken topography, difficult road access, soil instability, high elevation, timber quality, and a combination of these. Using the Ministry's operability layer, all areas with an operability of 'I' have been completely removed from the THLB. Areas with a logging history were not included in this step.

4.9 Low Site

Sites may have low growing potential due to inherent site factors such as nutrient and moisture availability, and therefore are unlikely to grow merchantable trees. Low volume areas were identified using the VRI where site index was greater than or equal to 3 m and less than 8 m. Stands with a site index less than 3 m were excluded from this step because they have been removed previously as non-productive.

4.10 Problem Forest Types

Problem forest types are physically operable stands but are not currently utilized or have marginal merchantability. In the Kamloops TSA several non-deciduous problem forest types have been identified, as shown in Table 4.4. These areas are excluded from the THLB unless the stand has a logging history.

Table 4.4: Problem Forest Type Criteria

Leading Species	Age (years)	Height (m)	Other
Balsam and spruce-leading stands	> 140	< 28.5	Crown closure < 36%

4.11 Deciduous

Current practice in the TSA is to leave deciduous stems in conifer-leading stands as wildlife trees or coarse woody debris in order to meet biodiversity objectives. All deciduous-leading stands will be excluded from the THLB where there is no logging history, and volume reductions will be applied to the deciduous component of conifer-leading stands.

4.12 Old Growth Management Areas

Seral stage landscape-level biodiversity objectives are achieved through legally establishment old growth management areas (OGMAs). OGMAs were identified using the LRDW's legal OGMA layer, and areas with an OGMA ID were completely removed from the THLB.

4.13 Wildlife Habitat Areas

Wildlife habitat areas (WHAs) were identified from the Ministry's approved layer using the WHA identification tag. WHAs were removed from the THLB were there was no logging history as are shown in Table 4.5.

Table 4.5: Wildlife Habitat Area Exclusions

Wildlife Species	WHA Identification
Badger	3-117 to 3-120, 3-122, 3-147
Great Basin Spadefoot	3-124, 3-125
Lewis's Woodpecker	3-017 to 3-073, 3-075 to 3-079, 3-084, 3-087, 3-088, 3-102, 3-105 to 3-109, 3-153 to 3-155, 3-157
Spotted Bat	3-115
Western Screech Owl	3-030, 3-031, 3-069
Williamson's Sapsucker	3-096, 3-127
Data Sensitive	3-050, 3-055 to 3-057, 3-059, 3-063, 3-110 to 3-112, 3-114

4.14 Wildlife Management Areas

Two wildlife management areas (WMAs) have been designated in the Kamloops TSA: Tranquille WMA and Dewdrop-Rosseau Creek WMA. These areas were identified from the LRDW WMA layer, and area was removed where the WMA field was not blank.

4.15 Ungulate Winter Range – Caribou

The Ministry has established *Government Action Regulation* (GAR) Orders within the Kamloops TSA to assist the recovery of mountain caribou populations. The LRDW's ungulate winter range (UWR) layer was used to identify areas where harvesting is not allowed in caribou areas. These no harvest caribou areas were identified by selecting areas with an UWR number of 'u-3-005' or 'u-3-004' along with a comment of 'noharvestAmended' or 'NoHarvest' in the notes field. These areas have been completely removed from the THLB.

4.16 Terrain Stability and Environmentally Sensitive Areas

Environmentally sensitive areas (ESAs) were identified using the ESA layer from the Type 2 Silviculture Strategy. Area was removed where the ESA code equaled soils ('S') and there was no history of logging.
The terrain stability layer was used to identify areas with unstable terrain. areas classified as unstable (U) or very unstable (V) were removed 80% from the THLB and potentially unstable areas classified as 'P' or 'IV' were removed 20% where there was no history of logging.

4.17Archaeological Sites

Archaeological sites contain physical remains of past human activity, and have been identified and protected under the *Heritage Conservation Act*. A Ministry provided layer was used to identify archaeological sites where the archaeological field was not blank. These areas have been excluded from the THLB.

4.18 Permanent Sample Plots and Research Installations

Within the Kamloops TSA exist two research installations: Mayson Lake Research Area and Opax Mountain – Isabel Lake Research Area. These areas have been identified using a permanent sample plot (PSP) layer from the LRDW where the fields 'psp', 'opax' and 'mayson' were not blank.

4.19 Riparian

Riparian management zones are areas that are immediately adjacent to streams, lakes, swamps and wetlands and are managed to restrict or exclude harvesting. Riparian areas were identified using a stream layer and lake layer provided by the Ministry. Table 4.6 taken from Sections 47 to 53 of the *Forest Planning and Practices Regulation* (FPPR) and updated to the Kamloops TSA governs harvesting activities within riparian areas and defined riparian management areas (RMA), riparian reserve zones (RRZ), and riparian management zones (RMZ) for each type of riparian feature.

Using this information and consistent with TSR 5, all riparian features were classified and buffered according to the combined buffer width in Table 4.6. This was determined by calculating the RMZ retention for each riparian type and adding it to the RRZ buffer widths, resulting in the combined RMA buffer:

Total RMA buffer = (RMZ retention % * RMZ width) * RRZ width

These areas were removed from the THLB and represent the combined impact of both the RRZ and RMZ management practices, therefore no further volume reductions are required in the forest estate model.

Table 4.6: Riparian Management Areas

Riparian Class	Reserve Zone Width (m)	RRZ Reduction (%)	Management Zone Width (m)	RMZ Average Basal Area Retention (%)	Combined Buffer Width (m)
S1	50	100	20	25	55
S2	30	100	20	25	35
S3	20	100	20	25	25
S4	0	*n/a*	30	12	4
S5	0	*n/a*	30	12	4
S6	0	*n/a*	20	3	0
W1 / W5	10	100	40	12	15
W2	10	100	20	12	12
W3 / W4	0	100	30	12	3
All 'A' Lakes	200	100	0	*n/a*	200
All Other Lakes – Kamloops	10	100	190	0	10
All Lakes > 1,000 ha – Clearwater	0	*n/a*	200	0	0
L1 Lakes (> 5ha and < 1,000 ha) – Clearwater	10	*n/a*	190	0	10
L3 Lakes (1 – 3 ha) – Clearwater	0	*n/a*	30	12	4
L3 Lakes (3 – 5 ha) – Clearwater	0	*n/a*	200	0	0

4.20 Wildlife Tree Retention

Seral stage stand-level biodiversity objectives are achieved through the establishment of wildlife trees. The *Forest and Range Practices Act* (FRPA) provides a default that a minimum of 7% retention is applied in each cut block. However, WTR's are often located within areas that are already constrained from harvesting, such as riparian areas or inoperable terrain, and therefore the impact on timber harvest from WTR's is likely less than the 7% minimum.

Current practice in the Kamloops TSA suggests that a 1.9% WTR of the THLB is sufficient to retain wildlife trees. This will be applied in the modelled as a 1.9% aspatial THLB reduction.

5.0 GROWTH AND YIELD

A stand's growth in terms of height and volume is predicted over time and the assumptions, inputs and outputs used in this analysis are documented in this section. Stands are either classified as natural or managed, with the age break being determined from the harvest history on the land base. In this case, those stands harvested since 1987 or are less than 28 years are classified as managed, and stands that are older than 28 years are classified as natural.

5.1 Analysis Units

Analysis units (AU) are aggregations of stands with similar species composition, site productivity and treatment regime. The following sections describe how natural and managed stand AUs are defined.

5.1.1 Natural

Natural stand AUs are modelled close to stand level. They are combinations of VRI attribute and values needed for treatment and indicator modelling in the analysis, and include:

- First and second species;
- Pine, Douglas-fir, deciduous/conifer and spruce percentages to the nearest 10%;
- Stand age rounded to the nearest 10 years;
- Inventory site index rounded to the nearest 3 meters;
- BGC zone;
- MPB affected percentage rounded to the nearest 5%;
- Cedar-hemlock partition;
- Crown closure classes (for wildfire modelling);
- Slope classes (ground/ cable);
- Candidate treatment areas (as described in section 8.0); and
- Values for indicator modelling (as described in section 9.0).

5.1.2 Managed

In TSR 5, managed stands are grouped into AUs (Table 5.1) based on biogeoclimatic (BGC) zone, leading species, and site index. For the silviculture analysis, AUs have descriptors for potential treatment pathways in order to accommodate the additional indicator modelling in the analysis. Because of the large number of AUs that occurs when indicators and treatments are introduced, just original managed AU combinations are shown.

Table 5.1: Managed Stand AU Definitions

Managed AU	BGC Zone	Leading Species	Area (ha)
100001	ESSF	Balsam	221,621
100002	ESSF	Pine	38,616
100003	ESSF	Spruce	233,226
100004	ESSF	Douglas-fir	195,928
100005	ICH	Cedar	147,491
100006	ICH	Balsam	37,985
100007	ICH	Douglas-fir	156,111
100008	ICH	Pine	339,116
100009	ICH	Spruce	91,469
100010	IDF	Douglas-fir	30,004
100011	IDF	Pine	117,929
100012	IDF	Balsam	53,734
100013	MS	Douglas-fir	10,858
100014	MS	Pine	15,331
100015	MS	Spruce	22,336

5.2 Growth and Yield

5.2.1 Natural

Natural stands are those considered to have been established prior to the 1987 legislated basic silviculture obligations. This also includes stands without a harvest history. Yield projections are produced using the Ministry's Variable Density Yield Prediction version 7 (VDYP) growth and yield model.

Productivity estimates for natural stands are sourced directly from the VRI using age and height. Natural stand AUs are based on individual forest inventory polygons and a yield curve is generated for each stand. Yield curves are then area-weighted to produce one yield curve for each AU.

5.2.2 Managed

All stands established after 1987 and those with a harvest history are classified as managed stands, with yield projections produced using the Ministry's Table Interpolation Program for Stand Yields version 4.2 (TIPSY) growth and yield model.

Productivity estimates for managed stand yields are sourced from the MFLNRO's provincial site productivity layer version 2. This layer is a province-wide 100 m by 100 m grid that combines and utilizes PEM/ TEM and SIBEC information where available and fills in the gaps with an in-house, bio-physical model. For more information on this layer, see the MFLNRO website at: http://www.for.gov.bc.ca/hts/siteprod/provlayer.html.

The site productivity layer has a site index (height at age 50) estimate for each species. To calculate an average managed site index for each AU, an area-weighted average site

index for the leading planted species was used. In cases where the site index was not populated for the leading planted species, the site index was defaulted to the inventory site index.

5.2.3 TIPSY Input Assumptions

Table 5.2 shows the TSR5 managed stand assumptions by AU. Stems and species composition are averaged into AU from the RESULTS silviculture layer (rslt_forest_cover_silv_svw). Regeneration information was based on summarizing RESULTS data by BGC zone and leading species of original stands. Site index is averaged into AUs using the site index tile based on leading species. Other assumptions that are constant include:

- Operational adjustment factors (OAFs) consistent with TSR 5: OAF1 of 15% and OAF2 of 5% except in ICH Douglas-fir stands where an OAF2 of 10% was applied to account for the uncertainty around root rot in these stands; and
- Utilization levels consistent with TSR 5 of 12.5 cm for pine leading stands and 17.5 cm for all others.

Table 5.2: Managed Stand Input Assumptions

AU	Description	Leading Species	Site Index	RD	stems	sp1	sp1per	sp1g	sp2	sp2per	sp2g	sp3	sp3per	sp3g	sp4	sp4per	sp4g	sp5	sp5per	sp5g
1	ESSF_B	Balsam	15	2.0	1,408	S	93	11.0	B	6		P	1	0.1						
2	ESSF_P	Pine	15	2.0	1,282	P	60	1.4	S	31	9.9	B	7		F	1	0.8	H	1	
3	ESSF_S	Spruce	15	2.3	1,354	S	81	9.9	P	9	0.2	B	9		CD	1				
4	ICH_C	Cedar	15	2.4	1,337	S	52	8.8	C	25		F	14	0.4	P	5	1.5	H	4	
5	ICH_F	Douglas-fir	15	1.9	1,344	F	49	4.6	P	23	4.9	S	15	6.2	C	10		CD	3	
6	ICH_P	Pine	15	1.8	1,338	P	45	6.1	F	34	7.3	S	12	5.6	C	5		CD	4	
7	ICH_S	Spruce	15	1.8	1,314	S	37	9.9	F	28	6.3	P	22	2.7	C	10		H	3	
8	IDF_F	Douglas-fir	15	2.7	1,188	P	47	4.2	F	40	1.7	CD	11		S	1	1.5	L	1	4.2
9	IDF_P	Pine	15	2.4	1,237	P	75	4.3	F	14	0.3	CD	6		S	4	2.9	B	1	
10	MS_F	Douglas-fir	15	1.8	1,240	P	51	8.4	F	32	5.9	S	13	9.8	CD	2		B	2	
11	MS_P	Pine	15	1.9	1,375	P	78	2.7	S	13	7.3	F	7	0.1	B	1		CD	1	
12	MS_S	Spruce	15	1.8	1,283	P	51	2.4	S	33	4.9	F	9	0.2	B	7				
13	SBPS_P	Pine	15	1.8	1,335	P	83	1.7	S	10	7.6	F	7							
14	SBS_P	Pine	15	2.0	1,308	P	57	2.8	S	23	8.2	F	10	0.3	B	7		CD	3	
15	SBS_S	Spruce	15	1.6	1,214	P	53	1.2	S	26	5.1	B	10		F	9		CD	2	

Information of current genetic gains was sourced from the Seed Planning and Registry Application (SPAR) from the Ministry's Tree Improvement Branch. To reflect TSR 5 modelling assumptions, improvements in future genetic worth were not considered in the base case.

6.0 MANAGEMENT CONSIDERATIONS

6.1 Minimum Harvest Age

Minimum harvest age (MHA) is an estimation of the lowest age at which a stand can be harvested economically. MHA is calculated for each AU as the age that a stand achieves 95% of the culmination maximum mean annual increment (CMAI) with a minimum harvestable volume of 100 m^3/ha. The minimum harvest criteria will be the age at which the stands reaches the minimum harvest volume of 100 m^3/ha.

6.2 Harvest Systems

A harvest system characterizes the type of harvesting expected to occur on a stand. Most harvesting in the Kamloops TSA involves clear-cut and clear-cut with reserves. Clear-cut was the only harvesting system modelled on the assumption that reserves are achieved through previous netdown and management constraints. There is interest in partial harvest systems in dry-belt Douglas-fir areas, and will be included as a possible treatment pathway in the base case.

6.3 Harvest Priority

In TSR 5, harvest priorities are modelled based on harvest level targets for identified stands, such as pine-leading. Definition of these targets is to be developed using recent data summaries and discussions with Ministry staff. Currently these stands are defined broadly, and as such harvest priority will be modelled by selecting the oldest available stand first.

6.4 Planning Horizon

A 250-year planning horizon is used in this analysis to ensure the long term sustainability of the harvest level and growing stock.

6.5 Not Satisfactorily Restocked

Not satisfactorily restocked (NSRs) accounts for productive forest land prior to 1987 that has not regenerated to the desired stocking standard. There is a low presence of NSR stands in Kamloops TSA, however they cannot be reliably identified and therefore no management considerations were applied in the forest estate model.

6.6 Non-Recoverable Losses

Non-recoverable losses (NRL) account for reduced timber volumes due to natural causes such as wind, fire, and disease that is not recovered during salvage operations. The calculation of NRLs uses the criteria from TSR 4 because the most current TSR TSA-level estimates are to be determined.

Table 6.1: Estimated Average Unsalvaged Losses

TSR 4	TSR 5	Annual Unsalvaged Loss (m^3/yr)[1]
Cause of Loss		
Bark beetles	Mountain Pine Beetle	3,900
	Spruce Bark Beetle	
	Douglas-fir Bark Beetle	
	Balsam Bark Beetle	
Defoliators	Spruce Budworm	36,130
Wind damage	Blowdown and Landslides	9,250
Fire	Wildfire	12,210
Miscellaneous	n/a	1,100
	Total	**62,590**

[1]Annual unsalvaged loss estimates taken from TSR 4

6.7 Old Cedar-Hemlock Stands

In 1996 the Chief Forester established a partition for old cedar-hemlock forest types; this has been maintained in subsequent AAC decisions. The base case in TSR 5 identifies these stands as done in previous analyses, and sets a harvest limit of 200,000 m^3/year for the first decade, after which any unharvested area is then available to be included in the general harvest profile. Old cedar-hemlock stands were identified where the leading species is cedar or hemlock and age is greater than 140 years.

6.8 Timber License Reversions

Two timber licenses exist in the Kamloops TSA that will expire in 2015 (T0888) and in 2021 (T0713). It has been identified that an additional 1,000 ha will be harvested from the remaining area before these licenses revert back to the Crown by 2024. For this analysis these areas have been included in the THLB and no accounting has been made for the small amount of harvest from these areas in the next decade.

6.9 Reductions

6.9.1 Deciduous Component

Deciduous species are currently not utilized in the Kamloops TSA. Current practice is the retention of deciduous trees to contribute to meeting established biodiversity objectives. Deciduous leading stands are removed from the THLB during the netdown. The deciduous component of conifer leading stands is excluded from yield tables.

6.9.2 Wildlife Tree Patches (WTP)

Wildlife tree patches (WTPs) are groups of wildlife trees (standing dead and live green trees) that are intended to maintain important stand-level structural elements during forest harvesting and silviculture. WTPs will be modelled as a 1.9% reduction. These reductions interact with the reductions for the deciduous component. If the deciduous component was >1.9% it was assumed that WTPs would be placed in the deciduous, and the additional 1.9% WTP reduction would not implemented as it would be double accounting.

6.9.3 Future Road Reduction

To account for the area removed from a productive state by the construction of roads for future harvesting, a 6.5% area reduction will be applied after harvesting for the first time on all natural stands.

6.10 Disturbing the Non-THLB

In the timber supply model, the productive area that is not part of the THLB (non-THLB) will continuously age throughout the planning horizon because harvesting is traditionally the only form of disturbance modelled. This causes concern because eventually, in the model, all the non-THLB becomes old whereas in reality, there will be some level of natural disturbance within the non-THLB. Because the entire productive land base is available to fulfill various retention requirements, this can lead to the non-THLB fulfilling an unrealistic portion of forest cover requirements in the long term. This is addressed by modelling disturbances in the non-THLB.

This section describes the process of disturbing the non-THLB used for this analysis. The intentions are to achieve the early, mature and old seral percentages for each BGC zone in accordance with the natural range of variation defined in the *Biodiversity Guidebook* (MOF, 1995). The method used for this analysis is for each BGC zone to:

1. Impose an annual disturbance to the non-THLB of each BGC zone. The size of the disturbance will be determined from the disturbance frequency in the Biodiversity Guidebook; and
2. A retention requirement on the non-THLB of each BGC variant is applied, which will force the non-THLB to achieve a seral zone distribution similar to the natural rate of variation (NRoV) from the Biodiversity Guidebook.

6.10.1Annual Disturbance

The area in each BGC zone is summarized and the NDT and disturbance return interval are found from the Biodiversity Guidebook (MOF 1995). This information allows the annual disturbance to be calculated by BGC. The annual disturbance is 1% the disturbance interval and the annual disturbance area is this percentage * non-THLB area (as shown in Table 6.2).

Table 6.2: Non-THLB Annual Disturbance

BGC Label	NDT	Disturbance Interval	% Disturbed Annually	Total Non-THLB Area (ha)	Annual Disturbance (ha)
ESSF	1	350	0.003	481,283	1,444
ICH	1	250	0.004	152,857	611
ESSF	2	200	0.005	5,175	26
ICH	2	200	0.005	105,535	528
SBS	2	200	0.005	101	1
ESSF	3	150	0.0066	70,122	463
ICH	3	150	0.0066	110,231	728
MS	3	150	0.0066	85,696	566
SBPS	3	100	0.01	2,765	28
SBS	3	125	0.008	35,874	287
ICH	4	250	0.004	2,994	12
IDF	4	250	0.004	366,936	1,468
PP	4	350	0.003	65,628	197

6.10.2 Retention Requirement

The seral stage distribution is estimated using the negative exponential equation from Appendix 4 of the *Biodiversity Guidebook* (MOF 1995). The negative exponential equation uses the disturbance return interval and gives the percent older than the input age from the equation:

Percent older then specified age = exp (-[age/return interval])

Table 6.3 shows the retention requirements placed on each BGC zone in order to achieve the desired NRoV.

Table 6.3: Retention Requirements for the non-THLB

BGC Label	NDT	Mature Requirements		Old Requirements	
		Minimum Age (years)	Minimum %	Minimum Age (years)	Minimum %
ESSF	1	120	19	250	19
ICH	1	100	17	250	13
ESSF	2	120	14	250	9
ICH	2	100	15	250	9
SBS	2	120	15	250	9
ESSF	3	120	14	140	14
ICH	3	100	14	140	14
MS	3	100	14	140	14
SBPS	3	100	8	140	7
SBS	3	100	11	140	11
ICH	4	100	17	250	13
IDF	4	100	17	250	13
PP	4	100	17	250	13

6.11 Forest Health

6.11.1 Mountain Pine Beetle

The mountain pine beetle (MPB) outbreak in the Kamloops TSA has largely subsided. MPB modeling uses direction from:

1. The Kamloops TSA Forest Health Strategy, which directs forest health management to minimize timber losses and hazard risk from forest health factors (MOFR, 2009);
2. Forest Health Overview (FHO): The BC MFLNRO (formerly MOF / MOFR) has carried out an annual aerial survey on the majority of the forested land to locate and report disturbances from forest health factors. This FHO survey uses experts to perform sketch mapping of disturbances which is then summarized to annual reports and digital maps.
3. BCMPB Projections: Since 1999, the BC Ministry has been projecting the spread of MPB throughout the province and recalibrating the projections each year with the FHO.

The most recent version of the BCMPB model (year 10) (Walton, 2013) is used to identify MPB affected stands. Ecora processes the projections to show the cumulative impact of MPB (instead of the annual outputs provided), which is useful for capturing the total MPB impact to date. Infection levels in 2013 were used in the analysis- as the infestation is assumed to be completed in the TSA no projections for future MPB mortality were included.

Dead standing pine volume resulting from MPB mortality was calculated in VDYP7 using available information from the dead layer[1]. This volume was assumed to be available for the first 5 years of the analysis before becoming unavailable for harvest. Dead volume will be accounted for separately in the analysis.

MPB affected stands that are harvested are regenerated on a managed stand yield curve. Those that are not harvested have the MPB affected volume removed from the yield curve and are treated according to their pine mortality percentage:

- **< 50% mortality**: age is unaffected, death is modeled as volume loss; or
- **>= 50% mortality**: age is reset, 15 year regeneration delay.

6.11.2 Other Forest Health Issues

In addition to mountain pine beetle there are several other forest health damaging agents occurring in the Kamloops TSA. This includes insects, pathogens, animals and abiotic events that have the potential to impact timber supply. Aerial surveys of the TSA in 2013 confirmed the presence of the following:

- Widespread western balsam bark beetle in northern half of TSA;
- Spruce beetle infestations has declined in extent and severity;
- Scattered but widespread Douglas-fir beetle;
- Western spruce budworm has declined in extent and severity;
- Two-year cycle budworm damage was low due to an “off” year in feeding cycle;
- *Dothistroma* needle blight and larch needle blight; and
- Damage caused by other agents, including fire and animal damage.

Douglas-fir beetle, western balsam bark beetle, spruce beetle and spruce budworm are expected to increase in extent and severity. Ministry forest health staff has provided hazard ratings to be included in the indicator modelling, which is described in further detail in section 9.5 below.

In the base case, the impact caused by these forest health agents is modelled through volume reductions applied by operational adjustment factors and identification of non-recoverable losses.

[1] VRI dead stems per hectare, assumed 100% pine at age1 and height 1.

7.0 RESOURCE MANAGEMENT ZONES

Resource management zones (RMZ) are areas that represent distinct resource value for the region, requiring specific resource management. Direction on RMZ modelling documented in the sections below comes from a variety of sources including:

- The 2014 Kamloops Timber Supply Area (TSA) Timber Supply Review (TSR) data package[2];
- The 1995 Kamloops Land and Resource Management Plan (Kamloops LRMP) and subsequent amendments[3];
- Under the Forest and Range Practices Act (FRPA), objectives that are grand parented from the Forest Practices Code (FPC):
    - Ministry of Environment's approved ungulate winter ranges (UWR) and associated orders[4];
    - Wildlife habitat areas (WHA) and associated general wildlife measures (GWM) through the Ministry's identified wildlife management strategy (IWMS)[5].

The following are the RMZs that are previously excluded from the THLB and do not require further consideration in the model

- Lakeshore management zones: these areas are included in the removal of buffered riparian features;
- Landscape-level biodiversity: achieved through legally established OGMAs;
- Wildlife habitat areas: these areas are previously removed during the land base classification;
- Fisheries sensitive watersheds: currently these are not legally established; and
- Mountain goat: proposed GAR order being developed, but expected no to low impact on timber supply.

7.1 Integrated Resource Management

The integrated resource management (IRM) zone covers the THLB and includes considerations for cutblock adjacency and green-up. A maximum disturbance requirement is implemented on the THLB by landscape unit (LU) and biogeoclimatic (BGC) zone, designed to mimic green-up requirements at a strategic level. IRM's are modelled as a maximum disturbance of 33% of the THLB can be less than 3 m in height by each LU/ BGC combination.

7.2 Community Watersheds

Consistent with the most recent TSR, restrictions associated with community watersheds are modelled using the rule that in each community watershed, a maximum of 25.2% of the productive area can be less than 6.6 m in height. This was calculated based on the restrictions applied in the upper 60% and lower 40% of the watershed. The upper 60% requires that mo more than an equivalent clearcut area (ECA) of 20% of the gross land

[2] http://www.for.gov.bc.ca/hts/tsa/tsa11/2014_tsr/11tsdp_14.pdf
[3] http://www.ilmb.gov.bc.ca/slrp/lrmp/kamloops/kamloops/index.html
[4] http://www.env.gov.bc.ca/wld/frpa/uwr/index.html
[5] http://www.env.gov.bc.ca/wld/frpa/iwms/index.html

base be below 3 m, while the lower 40% requires a green-up height of 3 m. Therefore, averaging these practices results in 25.2% of the gross land base could be less than 6.6 m in height.

7.3 Ungulate Winter Range

Within the Kamloops TSA, the KLRMP defined critical deer and critical moose range. Ungulate winter range (UWR) GAR orders have been established for mule deer winter range (MDWR) and mountain caribou. A GAR order is currently being proposed for mountain goat, however no considerations were given in the model as this order has not been legally established. The modelling constraints for each UWR zone are described in further detail in the following sections.

7.3.1 Mule Deer

A 2014 GAR order for MDWR has been proposed in the Kamloops TSA that will be utilized in this analysis. MDWR requirements are applied by each spatially defined MDWR planning cell. Retention area targets are determined by snowpack zone as shown in Table 7.1. A minimum of the listed retention percentage must retained in each planning cell in stands greater than 120 years.

Table 7.1: Snow Interception Cover by Deer Snowpack Zone

Snowpack Zone	BGC Zone	Retention Area Target (% of forested land in each planning cell)
Shallow	IDFxh2, IDFxw, PPxh2	15%
Moderate	IDFdk1, IDFdk2, IDFdk3, IDFmw2, IDFmw2b, IDFmw3	33%
Deep	ICHdw3, ICHmw3, ICHmk2	40%

7.3.2 Moose

KLRMP critical moose winter range (MWR) requires the maintenance of thermal and forage requirements in designated areas. Current management practices in the TSA are expected to fulfill this requirement and therefore no further considerations are modelled in the timber supply analysis.

7.3.3 Mountain Caribou

Mountain Caribou approved GAR ungulate winter ranges (UWR) u-3-004 and u-3-005 are in the Kamloops TSA. Order u-3-005 identifies areas for no harvest, while u-3-004 identifies three zones with different management considerations:

- No harvest zone: these areas are completely excluded from the THLB;
- Modified harvest zone: retain 1,800 ha from the THLB (9,757 ha total) of suitable habitat; and
- Corridor: retain a minimum of 33% of suitable habitat.

The u-3-005 Revelstoke Shuswap Planning Unit is a no-harvest zone and is excluded from the THLB in this analysis. The u-8-004 covers a small portion of the Kamloops TSA, however objectives associated with this order are unlikely to impact timber supply and therefore require no additional consideration. In addition, WHAs 5-096 and 5-117 related to mountain caribou are within the Kamloops TSA but overlap with Wells Grey Provincial Park and therefore are previously excluded from the THLB and do not require further constraints.

7.4 Visually Sensitive Areas

Areas of important scenic value require altered harvesting practices to keep the visible evidence of harvesting within acceptable limits. Visually sensitive areas are modelled according to the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (MoF 1998), which uses planimetric percent alteration ranges for each visual quality objective (VQO) that is modified by Visual Absorption Capacity (VAC).

Visual polygons were sourced from the current visual landscape inventory (VLI) mapping available on the website (www.for.gov.bc.ca/hfp/values/visual/VLI/index.htm). Each visually sensitive polygon is assigned a VQO which defines a maximum allowable percentage of alteration from harvest or disturbance (Table 7.2). Visual requirements are applied by visual polygon and are not modelled where selection harvesting occurs because selection harvesting is assumed to address any visual requirements. A weighted visually effective green-up (VEG) height for each visual polygon is based on slope classes (
Table 7.3). The following VQOs are modelled:

Table 7.2: Visually Quality Objectives

Established VQO	Description	% Alteration by Visual Absorption Capacity (VAC)[1]		
		Low	Medium	High
Preservation (P)	No visible change allowed	0.17	0.5	0.83
Retention (R)	Alterations are not visibly apparent and mimic the characteristic landscape	2.0	3.0	4.0
Partial Retention (PR)	Alterations remain visually subordinate and blend with the characteristic landscape	6.7	10.0	13.3
Modification (M)	Alterations may dominate but borrow from natural line and form to mimic natural disturbance	16.7	20.0	23.3

[1] Modified VACs are reported based on recommendations in TSR 5 from MFLNRO staff

Table 7.3: Slope Classes for VEG Height

VEG Height (m)	Slope Classes (%)												
	0-5	5.1-10	10.1-15	15.1-20	20.1-25	25.1-30	30.1-35	35.1-40	40.1-45	45.1-50	50.1-55	55.1-60	60.1+
	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5

8.0 ACTIVITIES MODELLED IN THE ANALYSIS

Activities are defined as agents of change that affect the land base in some way. Generally, these are human activities such as harvesting or fertilization, but disturbance from wildfire is also modelled in the non-THLB. An important outcome from the meetings was to identify and discuss the range of major activities that are likely to occur on the land base and how they affect values of interest. Activities to be modelled in this analysis include:

- Clear-cut harvesting (MPB salvage/ non-MPB);
- Partial-cut harvesting;
- Fertilization;
- Rehabilitation through the ITSL program;
- Ecosystem restoration (ER);
- Treatment of Balsam intermediate utilization (IU) stands; and
- Commercial thinning.

For each of these activities, two main pieces of information are presented in this section:

- The candidate criteria (i.e. the criteria that decides whether a stand is a eligible to be considered for the given activity); and
- Possible treatment pathways for a candidate stand.

The interaction of the activity with affected indicators will be discussed in detail in the section for each indicator.

8.1 Clear-cut Harvesting

Clear-cut harvesting is the predominant harvesting method in Kamloops. In order to be considered a candidate for clear-cut harvest, a stand must satisfy the following criteria:

- THLB;
- MHA: the stand must be old enough to have enough predicted volume to be viable for harvest (as described in section 6.1) and in the case of an MPB-affected stand, it must also have enough non-degraded wood to be viable; and
- A clear-cut stand (not in PP and BG BGC zones that can only be partial-cut).

Figure 8.1 shows the possible treatment pathways for a clear-cut stand in a MPB context. There are three possible paths that a MPB-affected stand can take in this analysis:

1. No treatment;
2. Clear-cut (salvage logged and subsequently replanted to fulfill silviculture obligations); and
3. Rehabilitation planting.

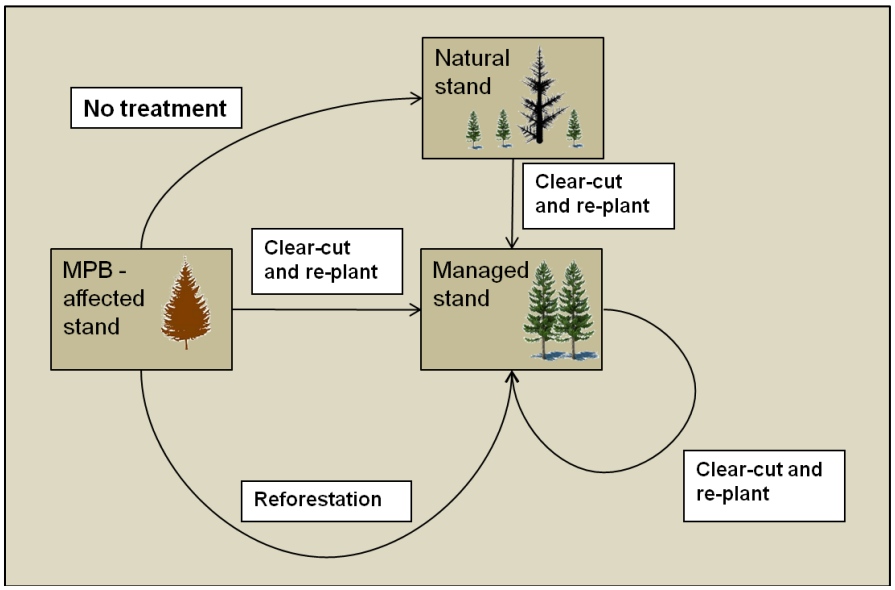

Figure 8.1: Clear-cut Treatment Modelling Paths

8.2 Partial-cut Harvesting

In the base case, partial-cut harvesting will be utilized in dry-belt Douglas-fir areas. During the process, there was much discussion around which silviculture systems (i.e. clear-cut/ partial-cut) should be considered where. In some of the wetter dry-belt BGC zones, current performance suggests that clear-cut may be utilized sometimes and partial-cutting may be utilized at other times. In order to be considered a candidate for partial-cut harvest, a stand must satisfy the following criteria:

- THLB;
- Douglas-fir leading;
- BGC: in PP and BG zones only partial-harvesting can occur; and
- BGC: in IDFxh, IDFxw, IDFdk, or MSxk both clear-cut and partial-cut harvesting paths are allowed to occur in the model.

Figure 8.2 shows the possible treatment pathways for a candidate clear-cut/ partial-cut stand. Stands are eligible for a second treatment 30 years after the first entry.

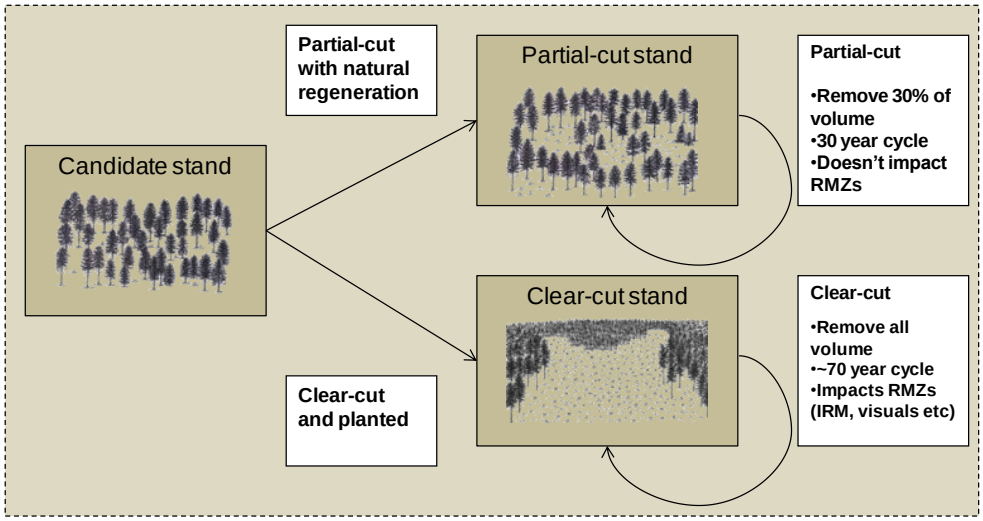

Figure 8.2: Partial-cut Treatment Modelling Paths

8.3 Fertilization

A fertilization program is one method to increase volume on existing mature stands that will be available for harvest in the near future. In order to be considered a candidate for fertilization, a stand must satisfy the following criteria (from the LBIS MFLNRO 2013/14 to 2017/18 LBIS Silviculture Funding Criteria for Forests for Tomorrow (FFT)):

- THLB;
- Leading species: Douglas-fir, larch or spruce;
- Age from 15 – 80 years;
- Inventory site index ≥ 15;
- Minimal forest health hazard (i.e. MPB mortality projected at < 20%);
- Excludes stands in the Interior Douglas Fir (IDF); and
- Large enough contiguous areas to be operationally viable for fertilization (to be controlled by input block size and the patching functionality in *Patchworks*).

Figure 8.3 shows the possible treatment pathways for a candidate fertilization stand.

The growth response from fertilization is assumed to be 15 m^3/ha. A stand cannot be harvested for at least 10 years after treatment in order to allow for the growth response to be realized.

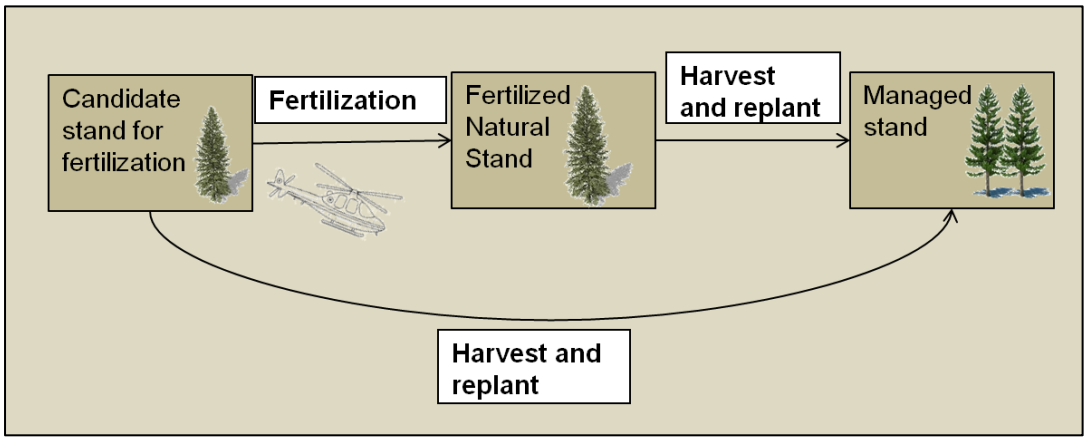

Figure 8.3: Fertilization Treatment Modelling Paths

8.4 Innovative Timber Sale License

Forests for Tomorrow (FFT) and British Columbia Timber Sales (BCTS) have partnered through the Innovative Timber Sale License (ITSL) initiative to market MPB-attacked timber that would otherwise be uneconomic to harvest.

To define where ITSLs would be considered, the BCTS/ FFT ITSL stand selection criteria will be utilized as closely as possible. There are data limitations with the strategic-level data sets available that make some of the criteria impossible to use at this scale.

ITSL treatment can be considered where:

- THLB (i.e. not a park or some other similar factor that would not allow harvest);
- Must be > 70% Pli (species composition from VRI will be used);
- Must be > 70% MPB-affected (BCMPB projections will be used);
- Silviculture expenditure must be less than threshold based on site index. Using average silviculture cost assumptions, means that the stand ≥ 12 SI; and
- Will use < 0.16 m^3/ tree piece size (VRI merchantable volume/ stems per ha will be used to approximate this).

Figure 8.1 shows the potential pathways identified for an MPB-affected stand in general. Stands that undergo the ITSL treatment will follow the 'reforestation' pathway in this figure.

A rehabilitation (planting) program has been a major focus to get MPB-affected stands back to productivity earlier in order to address the mid-term timber supply shortage. In order to be considered a candidate for rehabilitation, a stand must satisfy the criteria from the LBIS MFLNRO 2013/14 to 2017/18 LBIS Silviculture Funding Criteria for FFT.

In the Kamloops TSA, the majority of salvage operations have been completed and little rehabilitation post-MPB salvage activity is occurring. Stands remaining on the land base that fit this criteria are captured in the ITSL program and therefore do not require a specific treatment option.

8.5 Ecosystem Restoration

Ecosystem restoration (ER) is the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed by re-establishing its structural characteristics, species composition and ecological processes[6] and in this analysis refers to the fire maintained ecosystems in the TSA. As part of ER planning, a Desired Future Condition (DFC) map was built that designates areas as desired to be open range or open forest in the NDT 4. Major drivers of these categories were aspect and slope, and were further identified by:

- Open Range:
  - NDT 4;
  - Site index < 13 m;
- Open Forest:
  - NDT 4;
  - All PP BGC units (except those in open range);
  - Site index < 17 m;
- Managed Forest:
  - All other NDT 4 areas.

Figure 8.4 illustrates the potential pathways for a candidate ER stand. Post treatment, open range ecosystems have a target stocking of 0 – 75 stems/ ha and open forest have a target stocking of 76 – 400 (150 target) stems/ ha. Managed forest is described as business as usual and does not require a distinct treatment.

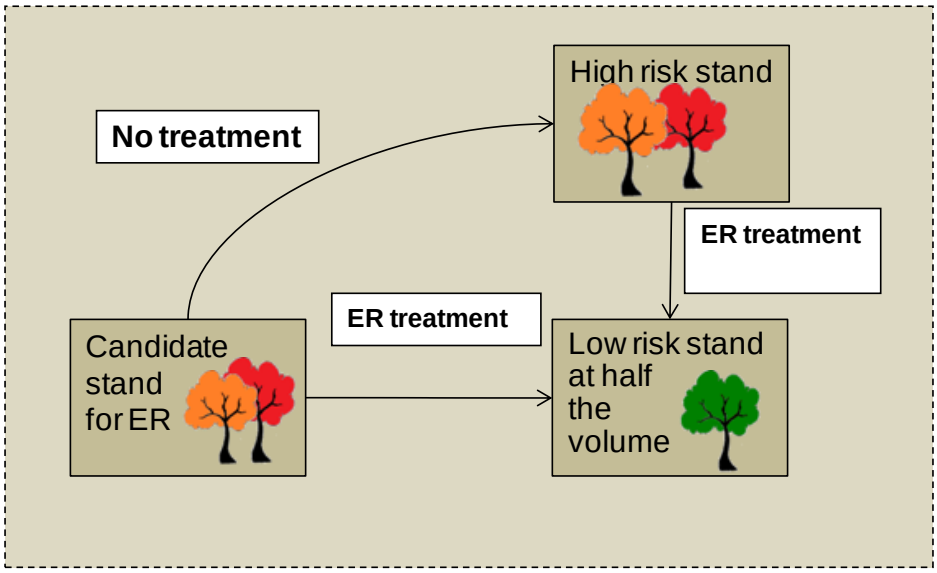

Figure 8.4: ER Treatment Modelling Paths

[6] http://www.for.gov.bc.ca/HRA/Restoration/index.htm

8.6 Intermediate Utilization Stands

Balsam intermediate utilization (IU) stands are identified as those that have logging disturbances from 1960 – 1987 and are balsam-leading. In the past these stands would have had their spruce volumes removed and the low residual volumes may mean that currently some of these stands are outside the current low volume threshold (40 m^3/ha) used to define IU stands. Because of the logging history and poor regeneration, treatment of these stands would involve removing existing cover and replanting.

Figure 8.5 illustrates the potential pathways identified for a candidate IU stand.

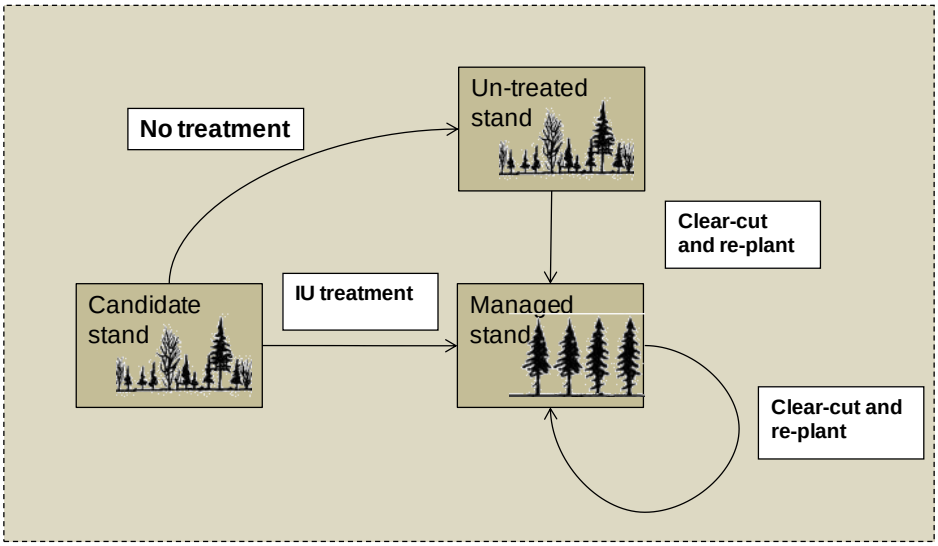

Figure 8.5: IU Treatment Modelling Paths

8.7 Commercial Thinning

Commercial thinning has the potential to mitigate mid-term timber supply shortfalls by making some timber volume available from existing managed stands sooner than those same stands would otherwise come online for clearcutting. The eventual clearcut will be delayed, but this set back could potentially be outweighed by the improvement in mid-term timber supply. Candidate stands for commercial thinning will be identified from VRI attributes and definition of the THLB:

- THLB - must be classified as harvestable;
- Pine leading (VRI species 1 = PL/PLI/PLC/PA);
- Not in IDF biogeoclimatic zones (VRI BGC zone) ; and
- Must be on slopes less than 35%.

A stand must have at least 100 m^3/ha to be eligible for commercial thinning and then 100 m^3/ha to be eligible to be subsequently clearcut. Figure 8.6 shows the possible treatment pathways for a stand considered for commercial thinning.

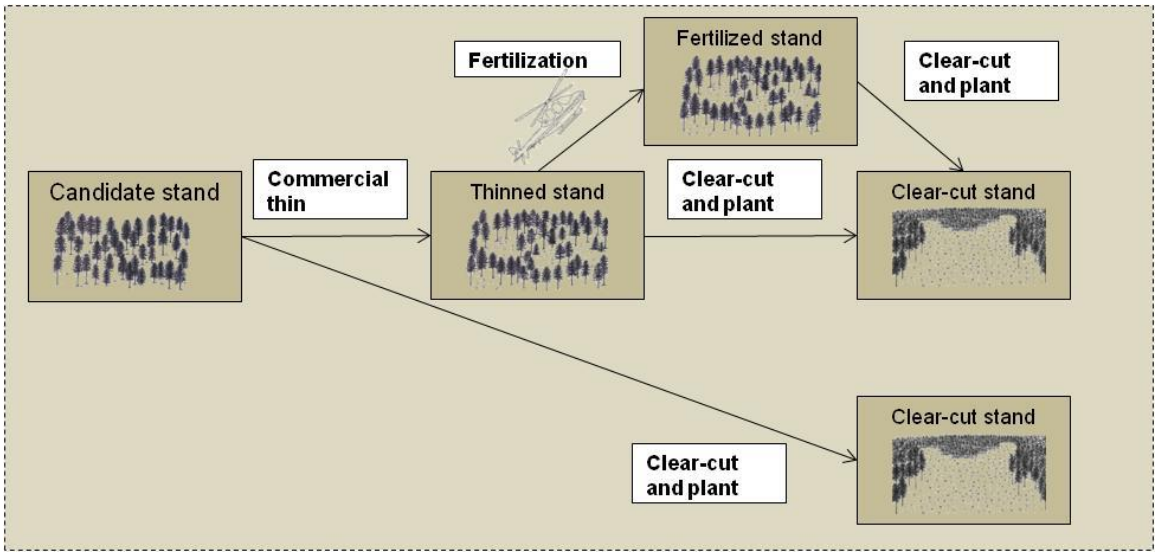

Figure 8.6: Treatment Pathways

Figure 8.7 shows an example of the effect of the two treatment pathways on merchantable volume and the MHA. MHA for clearcutting is defined as a minimum harvestable volume of 100m^3/ha and at least 95% of CMAI. In the case of the no-treatment pathway in Figure 8.7, this is at 110 years. In contrast, a commercial thinning treatment can be implemented when the stand reaches 100 m^3/ha at 110 years, and then clearcut at 130 years old. All remaining trees are assumed to continue growing on the same trajectory as the original stand. After clear-cut harvesting, stands are regenerated on a standard managed stand yield curve as outlined in the silviculture strategy assumptions.

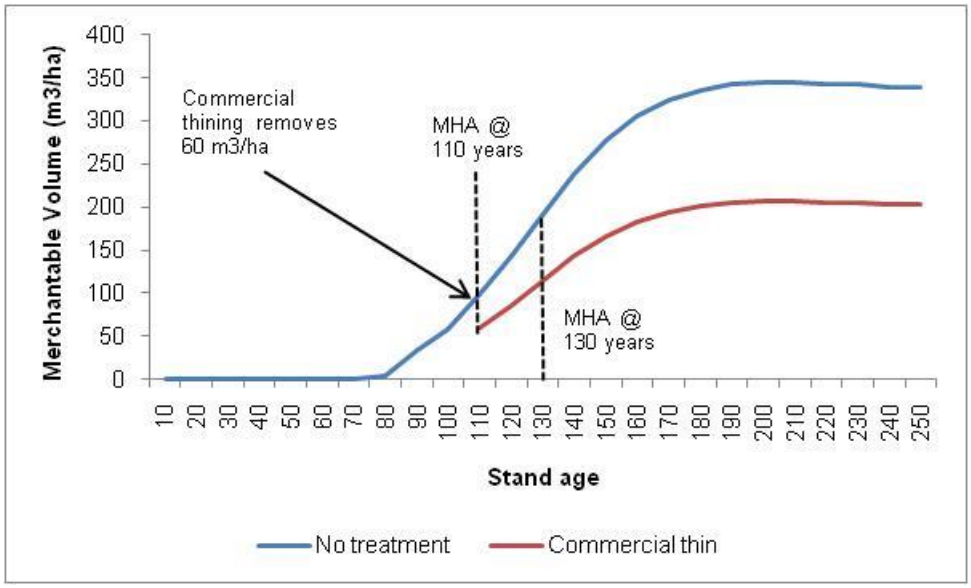

Figure 8.7: Example Treatment

The assumed cost and value to carry out the commercial thinning varies by volume harvested as described for clear-cut harvesting in Section 9.1. There are no associated costs of planting at the time of the first commercial thin treatment. Reforestation costs are applied when the stand is clear-cut.

The commercial thinning treatment is assumed not to affect minimum disturbance requirements such as IRM and visuals.

9.0 INDICATOR MODELLING

Indicators are key attributes that are represented in the analysis to characterize important land base values. This section lists the indicators that are being modelled in this analysis and describes how they are being represented. The assumptions, sources and how various activities affect the given indicator are described. Additional to the TSR resource management zones (RMZs) as described in section 7.0 the following indicators are being modelled:

- Timber volume: sawlog and fibre flow;
- Economic factors: value and harvesting cost;
- Hydrology: EDA above and below the H50 line;
- Range: forage supply by pasture;
- Harvesting profile:
    - Terrain: cable vs. conventional logging;
    - Harvesting type: clear-cut vs. partial-cut;
- Forest health hazard;
- Wildfire hazard;
- Timber supply from First Nations Woodland License (FNWL); and
- Climate change indicators.

9.1 Timber and Economic Factors

Sawlog volume and fibre volume will be tracked separately in this analysis to account for the potential for non-dimensional lumber and fibre supply. Haul distance will be accounted for using a cycle time layer. Sawlog volume will be calculated using merchantable volume from TIPSY and VDYP. Non-dimensional volume will be accounted for using the difference in gross to merchantable volume.

In order to capture the economic component in this analysis, every activity will have a cost and/ or value associated with it, including:

- Activities:
    - Cost of fertilization;
    - Cost of treating balsam IU stands;
    - Cost of ITSL treatment;
    - Cost of ecosystem restoration;
    - Cost of commercial thinning.
- Harvesting:
    - Cost broken into overhead, harvesting, silviculture (including the use of tree improvement) and road-related;
    - Value of harvested wood (sawlog and fiber).

Silviculture Activities

Fertilization cost estimates for silviculture activities are based off LBIS guidelines for 2012/ 13.

Fertilization costs include:

- Planning and prescriptions: $20/ ha;
- Fertilizer purchase, implementation, and application: $430/ ha;

- Total: $450/ ha.

Treatment of IU stands cost include:
- Harvesting: same cost as clear-cut harvesting
- Timber value: pulp products at $38/m^3

Assumed costs incurred for the ITSL program are[7]:
- Harvest cost: $20/ m^3 (ranges between 18-24 $/ m^3 based on piece size);
- Haul cost: $8.50/ m^3 (ranges between 7-10 $/ m^3 based on piece size);
- Road access: $0.50/ m^3;
- Overhead: $6/ m^3;
- Silviculture costs (FFT incurred): $1,415/ ha.

The modelled cost of ecosystem restoration:
- Planning and prescriptions: $20/ ha;
- Mechanical removal ~ $2,000/ ha;
- Fire is approx. $500/ ha;
- Assume that mechanical removal is used in 75% of cases;
- Total average cost of $1,645/ha.

Commercial thinning costs include:
- Same harvesting cost as clear-cut harvesting;
- Planting cost deferred until second entry into the stand.

Harvesting Cost

Harvesting cost is broken into the following categories:
- Overhead;
- Harvesting;
- Silviculture; and
- Road-related costs including: construction, hauling and maintenance.

Overhead cost is assumed to be $5.90/ m^3 based on the average THLB slope of 25% and the formulae below from the interior appraisal manual (MFLNRO, effective July 1, 2013):

$$\text{FMA } (\$/m^3) = 0.8457 + (0.1998 * \text{CP slope } \%)$$

Harvesting cost is assumed to vary by harvest method (ground skid/ cable) and harvest type (clear-cut/ partial-cut) as shown in Table 9.1. Partial cutting costs are applied per hectare and assumed to be 25% higher than clear-cutting costs.

Table 9.1: Harvesting Cost by Harvest Type

Slope Classes	Method	Cost ($/ m^3) by Harvest Type	
		Clear-cut	Partial-cut

[7] Harvesting cost for ITSLs incurred by the licensee will be calculated at overhead + harvesting + road-related costs. Silviculture cost is incurred by FFT and includes disc trenching ($300/ ha), seedlings ($476/ ha), planting ($600/ ha) and surveys ($40/ ha).

0 - 35 %	**Ground skid**	21	26.25
35 - 70 %	**Cable**	38	47.50

Basic silviculture cost estimates from Table 4-5 of the interior appraisal manual and vary by BGC zone as shown in Table 9.2

Table 9.2: Silviculture Cost - header from Table 4-5 From Appraisal Manual

Interior Appraisal Manual *Ministry of Forests, Lands and NRO*

Table 4-5 BEC Silviculture Cost Estimates*

BEC Zone	Subzone	Variant	$/ha
BWBS	dk	1	1238
BWBS	dk	2	1238
BWBS	mw	1	1177
BWBS	mw	2	1537
BWBS	**un**		**1238**
BWBS	vk		1238
BWBS	wk	1	1009
BWBS	wk	2	1112
BWBS	wk	3	1112
CWH	**un**		**579**
CWH	vh	1	579
CWH	vh	2	579
CWH	vm		579
CWH	vm	1	579
CWH	vm	2	579

BEC Zone	Subzone	Variant	$/ha
ESSF	mcp		1174
ESSF	mk		1174
ESSF	mkp		1174
ESSF	mm	1	1174
ESSF	mm	2	1174
ESSF	mmp	1	1174
ESSF	mmp	2	1174
ESSF	mv	1	735
ESSF	mv	2	1094
ESSF	mv	3	932
ESSF	mv	4	920
ESSF	mvp	1	1174
ESSF	mvp	2	1174
ESSF	mvp	3	1174
ESSF	mvp	4	1174

For the silviculture cost estimates for partially cut stands, a factor similar to that applied in appraisal manual (formula below) will be applied using the % of area partial cut (30%) and multiplication factor of 1.25.

$$\text{Basic Silviculture } (\$/m^3) = \frac{[NMA * Cost * (CAPCUT\%/100) * 1.25] + [(GSA - NMA) * Cost]}{(TNCV \text{ or } NMV)^1}$$

Road-related costs to be implemented include road access and hauling cost. Values from the ITSL innovative economic impact analysis (SR Management Services, 2013) have been used to estimate these costs:

- Haul cost: \$8.50/ m^3 (ranges between 7-10 \$/ m^3 based on piece size); and
- Road access: \$0.50/ m^3.

Range Costs

Costs associated with grazing include the following:

- Forage site preparation;
- Seed and seed application cost;
- Grazing fees;
- Grazing harvesting costs (cost of running the cows); and
- Grazing overhead costs.

Table 9.3 lists the cost assumptions by forest and harvesting type. These costs are applied at the stand level at the time of treatment and to the resulting AUM forage supply. They are summed to the pasture - level and then a TSA total.

Table 9.3 Range Cost Assumptions

Forest Type	Harvesting Type	Forage Site Prep Cost ($/Ha)	Seed & Application Cost ($/Ha)	Grazing Fees ($/AUM)	Grazing Harvesting Costs ($/AUM)	Grazing Overhead Costs ($/AUM)
Dry Forest	Clear-cut	0	0	3.20	37.17	18.58
	Commercial Thin	0	0	3.20	37.17	18.58
High Elevation ESSF	Clear-cut	0	0	3.20	37.17	18.58
	Commercial Thin	0	0	0.96	11.15	5.57
Wet Forest	Clear-cut	0	0	3.20	37.17	18.58
	Commercial Thin	200	30	3.20	37.17	18.58
	Type 2	500	55	3.20	37.17	18.58
Open Forest	Clear-cut	0	0	3.20	37.17	18.58
	Commercial Thin	200	30	3.20	37.17	18.58
	Type 1	0	55	3.20	37.17	18.58
	Type 2	500	55	3.20	37.17	18.58

Wood Value

The value of timber is species based as shown in Table 9.4 (source: MFLNRO 2014 Interior Logs Data August-October 2014, rounded to the nearest dollar).

Table 9.4: Value By Species ($/m^3)

Products	SPF[1]	Fir/ Larch	Hemlock[2]/ Balsam	Cedar[2]	Deciduous
Sawlog	63	67	58	93	
Peeler	82	76	-		
Poles/ House	92	-	-	114	
Pulp	36	-	38		36

[1] SPF = spruce, pine and balsam fir
[2] Assumed old cedar and hemlock fetch pulp prices

Range Value

The value associated with range is based on the following formula:

Value = AUMs (AUM) * calf price ($/lb) * calf weight gain efficiency (%) * daily calf weight gain (lb/AUM)

A calf price of $2.00 (live weight $/lb) was assumed. The variable calf weight gain efficiency ranged from 100% on areas with > 2 AUMs/ha to 50% on areas with <0.5 AUMS/ha, and daily calf weight gain ranges from 0.5 to 2.4 lb/AUM based on forest type as shown in Table 9.5. These values are applied at the stand level to the resulting AUM forage supply. They are summed to the pasture - level and then a TSA total.

Table 9.5 Daily Calf Weight Gain

Forest Type	Harvesting Type	Daily Calf Weight Gain (lb/AUM)
Dry Forest	**Clear-cut**	1.75
	Commercial Thin	1.75
High Elevation ESSF	**Clear-cut**	2.00
	Commercial Thin	2.00
Wet Forest	**Clear-cut**	0.50
	Commercial Thin	2.40
	Type 2	2.40
Open Forest	**Clear-cut**	1.50
	Commercial Thin	2.40
	Type 1	2.00
	Type 2	2.40

9.2 Hydrology

Operationally, hydrological impacts are tracked at the basin or sub-basin level using Peak flow index (PFI). This concept will form the basis for hydrological modelling in this analysis. PFI is a measure of the proportion of a watershed that has not yet achieved hydrological green-up, placing a higher weight (1.5 times) on disturbances occurring at higher elevations (above the H50 line).

Equivalent Disturbance Area (EDA) is an extension of the ECA concept in that it includes contribution from not only clear-cut harvesting but other disturbances as well (e.g. MPB mortality and fire). EDA uses established relationships between vegetation growth post-disturbance and hydrological recovery rates. EDA is calculated using the area disturbed within a watershed multiplied by the hydrological recovery of each stand. As stand height increases, hydrological recovery increases with full recovery achieved once the stand reaches 12 meters in height (after clear-cut).

Peak flow index (PFI) is a measure of the ratio of ECA to total watershed area. PFI threshold values are set at 30%.

Harvesting: EDA recovery curves have been developed for each treatment and that is modelled in the analysis based off recovery curves from the interior watershed assessment procedure guidebook (IWAP)[8] as shown in Figure 9.1.

[8] http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/iwap/iwap-toc.htm

Average height of the main canopy (m)	% Recovery
0–<3	0
3–<5	25
5–<7	50
7–<9	75
9+	90

Figure 9.1: EDA Recovery Curves - from Table 8-1 from the IWAP Guidebook

MPB Mortality: The concept of ECA from a post MPB harvested stand versus un-salvaged stand is shown in Figure 9.2 from Huggard and Lewis, 2007. In this analysis, we have constructed multiple EDA curves post-MPB mortality that vary with two factors:

- Mortality severity (i.e. the proportion killed). MPB mortality severity ranges from 0 to 100% in 10% increments; and
- Understory regeneration potential. Stands were characterized as either having good, moderate or poor understory regeneration potential by BGC zone as shown in the table below. In areas with good understory regeneration potential the un-salvaged EDA contribution is mitigated by 10% to account for the hydrological effect of understory regeneration. In moderate understory regeneration potential areas it is assumed to be mitigated by 5% and in BGC zones with poor understory regeneration there is no assumed EDA contribution mitigation.

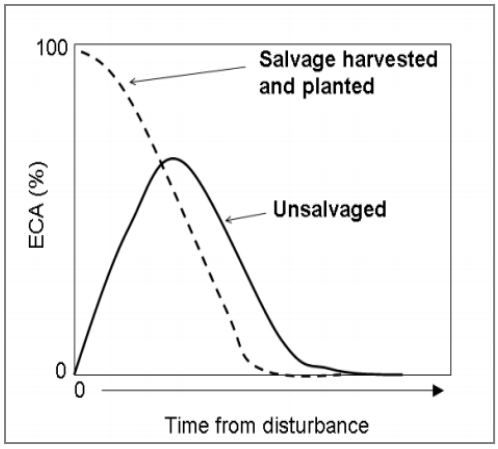

Figure 9.2: ECA harvested and un-harvested from Huggard and Lewis, 2007

Table 9.6 shows a BGC zone list by good, moderate or poor understory regeneration potential.

Table 9.6: Understory Regeneration Potential by BGC Zone

Poor	Moderate	Good
BG	ESSFw	ESSFdc
ESSFv	IDFdm	ESSFx
IDFdk	IDFm	ICH
IDFx	MS	-
PP	SBSP	-
-	SBS	-

Figure 9.3 shows this concept for selected mortality and understory potential combinations.

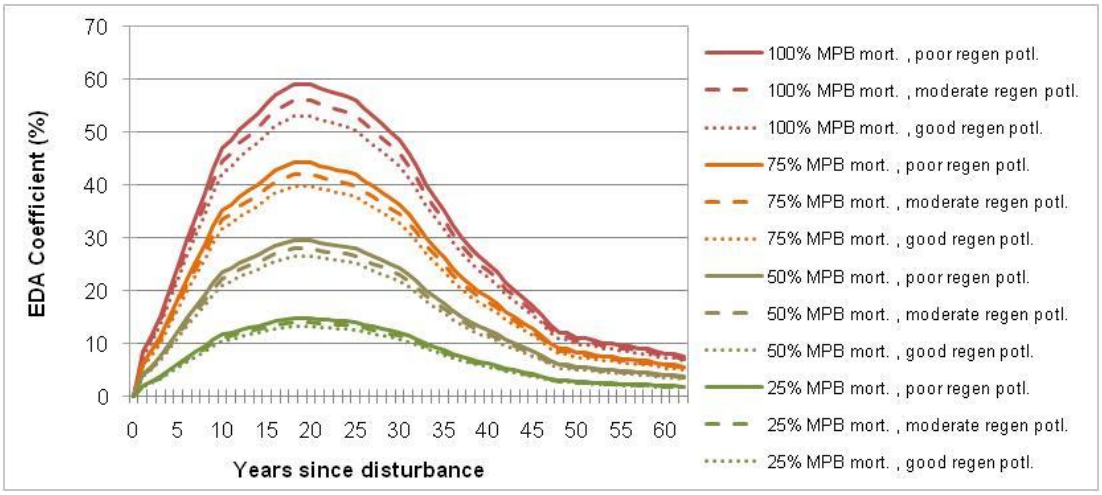

Figure 9.3: Post MPB EDA % at Varying Mortality and Understory Regeneration Potential

H50 Line: In snow-hydrology dominated watersheds, hydrological responses to disturbance vary at different elevations. The term "H50" refers to the elevation line that 50% of the watershed is above. Harvesting in this zone can have a greater influence on peak flow due to the change in snow accumulation and snowmelt when the forest canopy is removed. The H50 elevation will be calculated for each watershed in the analysis.

Stand-level values will be summarized up to the reporting units - units are based on the BC digital Freshwater Atlas Assessment Units from the Kamloops TSA watershed risk analysis[9]. Special focus will be given to the top 10 environmental and social risk reporting units from this report.

The reporting unit boundaries that are used in this analysis are shown in Figure 9.4 (source: Figure 2 - Kamloops TSA watershed risk analysis).

[9] ftp://ftp.geobc.gov.bc.ca/pub/outgoing/Kamloops%20TSA%20Watershed%20Risk%20Analysis%202012/Kamloops%20TSA%20Watershed%20Report%20Final%20June%2018%202012%20(with%20maps).pdf

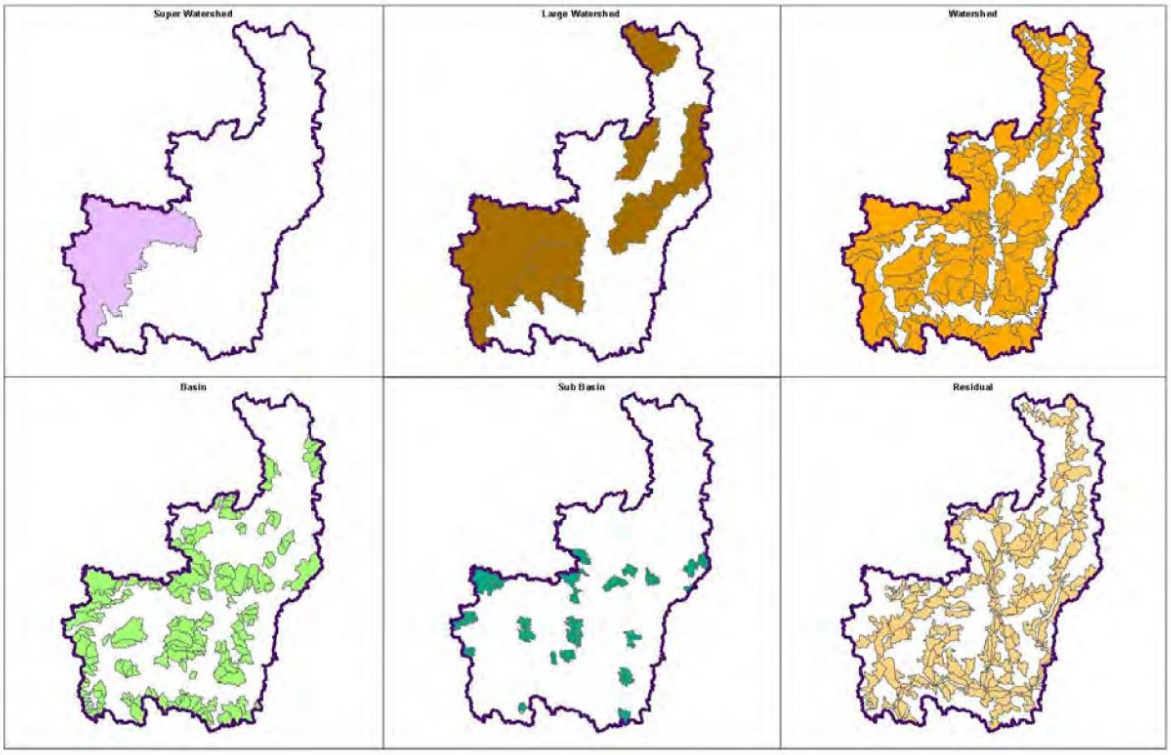

Figure 9.4: Kamloops TSA Watershed Risk Analysis Assessment Units

9.3 Range

The BC range program allocates and supports grazing and hay-cutting agreements on crown land through licenses, permits and leases. Range agreements are broken down into pastures (areas for use during a particular season) that have a target forage requirement. Forage requirements are measured in animal unit months (AUMs) which is the amount of forage necessary for the sustenance of one cow or its equivalent for 1 month (450kg/AUM).

The range modelling in this analysis will use the concept of forage supply in a way that is similar to the traditional concept of timber supply. AUM targets by pasture are supplied by the MFLNRO range agrologist based on range name, pasture name and grazing lease. There are 131 ranges modelled in the analysis, containing a total of 758 pastures and 112 grazing leases. The total forage target is 10,706 AUMs per year.

Criteria to identify candidate stands for alternative harvest systems focused on range treatment includes areas within BGC zones IDFdk1/2/3, IDFxh2, and IDFxw.

The following table outlines the BGC zones where no harvesting should occur in the range specific scenario.

Table 9.7: BGC Zones with No Harvesting for Range Objectives

BEC Unit			
BGxh2	ESSFdcp	ESSFwcp	IDFxh2a
BGxw1	ESSFmmp	ESSFvcp	PPxh2
IMAun	ESSFvcp	IDFdk1a	PPxh2a

Forage growth after harvesting

Assumed forage growth is dependent on the type of harvesting system utilized, site ecology (characterized by BGC zone), and year since the stand was harvested.

The types of harvesting systems modelled for range include clear-cut, partial-cut, patch cut and strip cut. The intent is to model resource integration between timber and forage objectives through different harvesting options.

BGC units (to phase) are used to spatialize estimations of forage growth potential. Assumed forage growth for forested BGC units is dependent on BGC unit and year since stand was harvested, and silviculture treatment type. Assumed forage growth for non-forested BGC units is dependent on BGC unit alone and does not change over time.

Assumed forage growth by forest type and silviculture system was provided by the MFLNRO range agrologist expert in tabular form and collated in Figure 9.5.

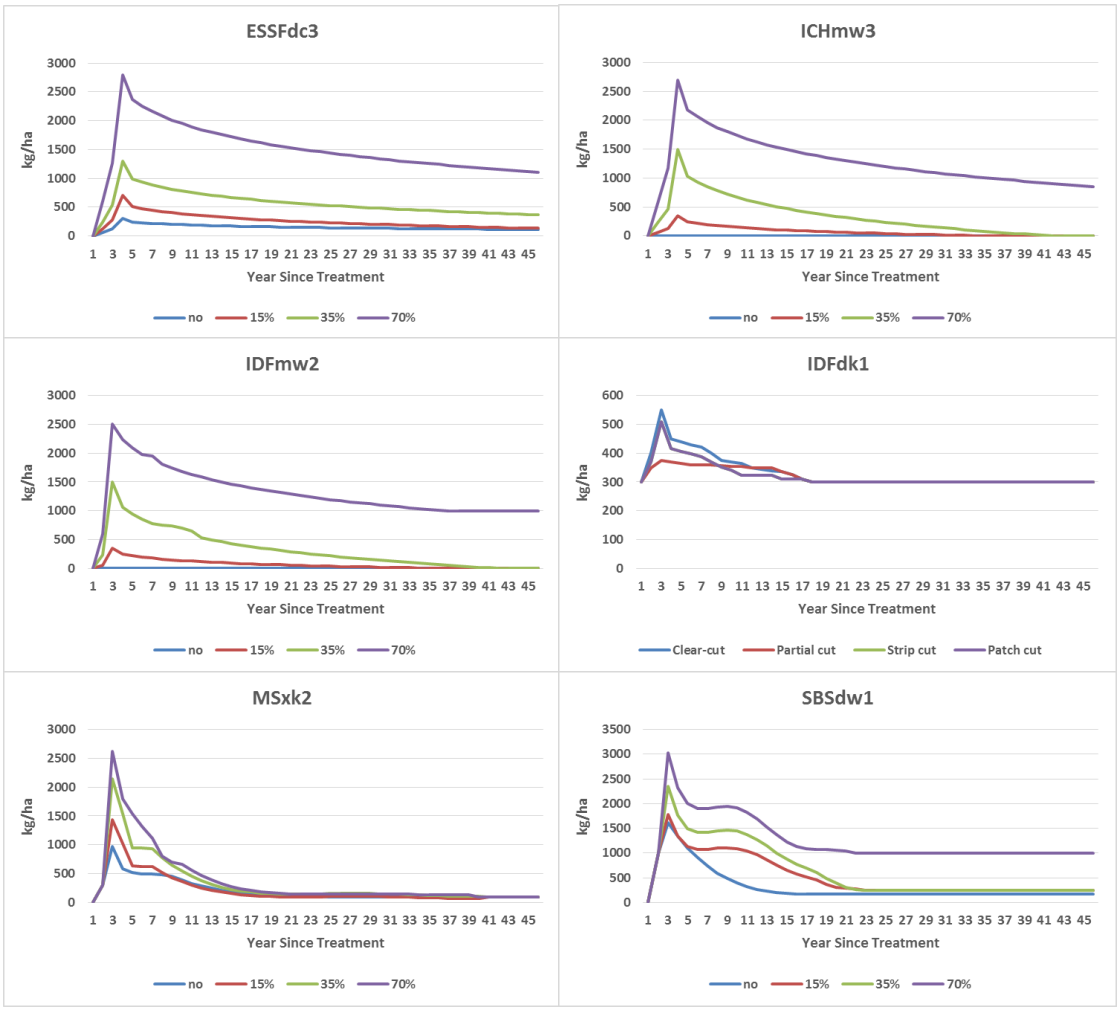

Figure 9.5: Forage Growth by BEC Unit and Silviculture System or Forage Option (% Seeding of Domestic Species)

AUM targets are provided by the MFLNRO range agrologist. Because of the large number of pastures, it is not feasible to show all in this document. A few example range and pasture combinations have been shown in Table 9.8.

Table 9.8: Example AUM Targets by Range and Pasture Name

Range Name	Pasture Name	AUM Target
ANDYUNIT	ANDYPASTURE	400
ANDYUNIT	CORNERPASTURE	4
ANDYUNIT	FLEETMOUNTAINPASTURE	60
ANDYUNIT	LOLOMOUNTAINPASTURE	100
ANDYUNIT	PAWCAMPPASTURE	80
ANDYUNIT	REDROCKPASTURE	300
ANDYUNIT	TEELAKEPASTURE	200
HIGHLANDVALLEYUNIT	SHULAFLATSNORTHPASTURE	15
HIGHLANDVALLEYUNIT	SHULAFLATSSOUTHPASTURE	150
HIGHLANDVALLEYUNIT	STUDHORSECREEKPASTURE	400
HIGHLANDVALLEYUNIT	TREMONTCREEKPASTURE	136
HIGHLANDVALLEYUNIT	UPPERMORRISONPASTURE	400
HIGHLANDVALLEYUNIT	WILLARDLAKEPASTURE	130
HIGHLANDVALLEYUNIT	WOODSCREEKPASTURE	987

9.4 Harvesting the Profile- Cable Terrain

AAC levels are set assuming that all THLB is viable for harvest at some point in the future. Concern has been raised that if past and current harvesting patterns are not distributed proportionately across stand types, then at some point in the future harvesting will be forced heavily into the under-utilized type. The term “cable cliff” describes the anecdotal evidence that there has been a lack of harvesting in cable terrain in the recent past.

Average stand slope will be used to classify each stand as either conventional (0 - 35% slope) or cable (35+% slope) and harvest at the stand level will be summarized up to the TSA level by each class so that it can clearly be seen what proportion of the harvest is coming from each factor. Depending on the scenario and performance of the indicator, the amount being harvested from cable terrain may need to be controlled or just monitored.

9.5 Forest Health

The impact and timing of forest health factors (FHFs) is complex and challenging to predict spatially, especially over a long term planning horizon. The main instrument for including forest health factors into this analysis is ‘hazard ratings’. Hazard ratings in the analysis can be used in two main ways:

- Summarize the hazard across the land base that results from a given series of activities; or
- Use hazard ratings to drive land base activities and decisions to minimize hazard.

The Ministry has a well-developed hazard rating systems for selected FHF that are generally based on factors such as vegetation, location and site productivity. Hazard ratings will be based upon these systems. The following FHF hazard ratings will be modelled in this analysis: mountain pine beetle, Douglas-fir beetle, and spruce beetle.

Mountain Pine Beetle Hazard Rating

MPB hazard rating is based upon the Pine Beetle Hazard Rating Documentation Version 1.2 (ILMB, 2006) which can be viewed for detailed documentation. In general, MPB hazard is calculated using the following formula as described in ILMB, 2006. The MPB hazard rating will be updated to include attack on young pine stands- as it has been shown that anything with DBH > 15 cm is susceptible.

MPB hazard = P * A * D * L

Where:
P = proportion of pine
A = age factor
D = density factor
L = location factor

Douglas-fir Beetle Hazard Rating

DFB hazard rating is based upon the Douglas-fir Beetle Hazard Rating Documentation Version 1.2 (ILMB, 2007) which can be viewed for detailed documentation. In general, DFB hazard is calculated using the following formula as described in ILMB, 2007.

DFB hazard = A * D * G * P

Where:
A = age factor
D = diameter factor
G = growth factor
P = proportion of Douglas-fir

Spruce Beetle Hazard Rating

SBB hazard rating is based upon the Spruce Beetle Hazard Rating Documentation Version 1.1 (ILMB, 2007b) which can be viewed for detailed documentation. In general, SBB hazard is calculated using the following formula as described in ILMB, 2007b.

SBB hazard = 10 * (Q * A * P * L * S2) ^ 0.5

Where:
Q = site quality factor
A = age factor
P = proportion of Spruce
L = location factor
S2 = stand density and growth rate

Stand-level hazard ratings will be summarized up to the TSA level for reporting purposes in the analysis.

Western Spruce Budworm

Western spruce budworm (WSB) is an important defoliator of Douglas-fir in the Kamloops TSA. There is no hazard rating equation available at this time, however a layer showing the maximum consecutive years of defoliation has been incorporated into the analysis database to give an idea of the current damage in the stand and the current hazard of the stand. Area summaries by age class within this layer will be summarized throughout the planning horizon. IDF is the primary ecosystem of concern for WSB. A key of hazard ranking by BGC zone can be used to prioritize treatments and minimize hazard as shown in Table 9.9, however this will be applied operationally rather than in the analysis.

Table 9.9: Western Spruce Budworm Ranking by BGC Zone

BGC Zone	Ranking
IDFdc	3
IDFdk	1
IDFms	3
IDFmw	2
IDFww	3
IDFxc	4
IDFxh	1

IDFxm	2
IDFxw	4

Defoliator Spraying Program

Spraying for defoliators in the IDF is common practice in the BC interior and the Ministry has had a spray program since 1987. The area treated varies by year, but in the last few years approx. 50,000 ha have been treated per year. Spraying is current practice and therefore built into the base case and not modeled as a separate treatment in this analysis.

With an assumed average cost of $30-35/ha, an economic analysis (Burleigh & Machlauchlan, 2009) showed a significant internal rate of return (IRR) from spraying-estimated at 10-12%.

Western Balsam Bark Beetle

Western Balsam Bark Beetle (WBBB) primarily attacks subalpine fir in the ESSF BGC zone that are > 70 years until approximately 120 years (from data provided by MFLNRO's Forest Entomologist). Additionally, a key of hazard ranking by BGC zone can be used to prioritize treatments and minimize hazard as shown in Table 9.10, however this will be applied operationally rather than in the analysis.

Table 9.10: Western Balsam Bark Beetle Ranking by BGC Zone

BGC Zone	Ranking	BGC Zone	Ranking
ESSFdc1	1	ICHmw2	2
ESSFdc2	1	ICHmw3	2
ESSFdv	1	ICHvk1	2
ESSFmw	1	ICHwk1	2
ESSFvc	1	IDFww1	4
ESSFwc1	1	IDFww2	4
ESSFwc2	1	MSdc	2
ESSFwc4	1	MSdm2	2
ESSFxc	1	SBSmm	3
ICHmk1	2		

Armillaria

Armillaria root rot disease heavily impacts the Interior Cedar Hemlock zone (ICH) BGC zones. The uncertainty around the impact of *Armillaria* is addressed by increasing the OAF2 to 10% in ICH FD stands. Hazard can be reduced by planting a variety of species where appropriate. Stumping is another silviculture treatment that can be applied post-harvest (the cost is approximately $1,200/ ha) to reduce the impact of *Armillaria*, however the effectiveness of this treatment is uncertain and can have a range of incidence reduction. This treatment was not modeled in this analysis.

9.6 Wildfire Hazard

Wildfire hazard is an important landscape-level factor to be considered in resource management decisions in the Kamloops TSA, however it is complex to quantify and predict as it depends on many factors such as fuels, topography, ignition location, ignition probability and weather. In this analysis framework, wildfire hazard is one of many landscape-level values to be taken into consideration when deciding how to manage the land base.

Wildfire hazard was included as a modelling indicator in order to drive treatment options to stands that will best result from decreased fire hazard, especially in the urban-wildland interface. In the Type 4 Silviculture Analysis, wildfire hazard will be captured as follows:

1. Analysis results such as proposed silviculture activity can be compared with detailed existing wildfire risk rating maps to be cognoscente of wildfire risk prior to recommending silviculture investment;
2. A sensitivity analysis that identifies high risk stands to be prioritized for treatment, especially in the urban interface; and
3. The schedule of activities could feed back into a more detailed wildfire model, such as Burn P3, to provide a more detailed burn probability map.

Wildfire Hazard Modelling

This section describes how simplified wildfire hazard modelling will be implemented in the forest estate model. This involves simplifying the concepts of wildfire hazard, with the intent to enable the model to consider fire hazard as well as the many other resource values.

Wildfire layers were provided by Ministry wildfire experts and include spatial delineation for fire threat, fire head, fire spotting, fire year, and historical fire data. Fire threat rankings were primarily used to target areas of higher threat to be prioritized for treatment. High wildfire threat areas were identified where the threat rating equaled 4 or 5 which represented very high threat. Area was also targeted for treatment in the urban-wildfire interface.

A key concept that is captured in the modelling is how treatment decisions impact the wildfire hazard. Treatments including harvesting, ecosystem restoration, and MPB mortality will affect the wildfire hazard. This wildfire hazard rating is incorporated dynamically into the *Patchworks* analysis, creating a lever to minimize wildfire hazard within the model over time through placement and timing of activities.

9.7 First Nation Woodland License

There are 5 pending or potential First Nations Woodland Licenses (FNWLs) in the Kamloops TSA. In this analysis, the AAC and timber supply from within each FNWL boundary will be tracked. Opportunity for silviculture activities and other indicators may be of interested and summarized.

9.8 Climate Change

The global changing climate affects BC's forests and other natural resources. Climate change presents not only risks, but also opportunities to adapt if we base the forest management decisions made today on information of our future climate- viewing forest management through a 'climate change lense'.

The Pacific Climate Impacts Consortium (PCIC) has released a summary of current and future climate projections for the Thompson-Okanagan region[10]. There has been considerable work done on climate change, potential risks and mitigation strategies during the Future Forest Ecosystems Scientific Council of British Columbia (FFESC) future forest strategy (FFS) project[11].

The objectives of this project was to "articulate the vision of what the desired forest condition is to be towards ensuring / mitigating more resilience to ecological, economic and/or social issues and/or drivers such as climate change, and mountain pine beetle".

The project included summaries of current management regimes, climate modelling and future ecosystem climate mapping, summaries of possible future forest conditions based on climate change scenarios and management strategies for dealing with the scenarios.

After extensive consultation with an active working group about how to integrate climate change into this project, it was decided that the following high risk BEC zone and species combinations would be tracked and targeted for harvesting:

- Current BEC zone: IDFdk;
- BEC 2050 zone: IDFxh; and
- Pine leading stands.

[10] http://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-Thompson-Okanagan.pdf
[11] http://www.for.gov.bc.ca/hcp/ffs/kamloopsFFS.htm#Final_Report

10.0 REFERENCES

10.1 Analysis

BC Ministry of Forests. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia Act. Strategic Planning Regulations Operational Planning Regulation.http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm

BC Ministry of Forests. 1995 b. Interior Watershed Assessment Procedure Guidebook (IWAP). Forest Practices Code of British Columbia Act. Operational Planning Regulations. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/iwap/iwap-toc.htm

BC Ministry of Forests. 1998. Factoring Visual Resources into Timber Supply Analyses. March 17, 1998. 12 pp.

BC Ministry of Forests. 1998 b. Kamloops Timber Supply Area Information Report. November 1998. 14 pp.

BC Ministry of Forests. 2001. Kamloops Timber Supply Area Analysis Report. July 2001. 140 pp.

BC Ministry of Forests. 2001 b. Kamloops Timber Supply Area Public Discussion Paper. July 2001. 8 pp.

BC Ministry of Forests. 2003. Kamloops Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination. January 1, 2003. 78 pp.

BC Ministry of Forests. 2004. Kamloops Timber Supply Area In response to a request for a temporary increase, Rationale for Allowable Annual Cut (AAC) Determination. January 1, 2004. 8 pp.

BC Ministry of Forests and Range. 2006. Kamloops TSA Type 1 Silviculture Strategy. March 22, 2006. 43 pp.

BC Ministry of Forests and Range. 2007. Timber supply review for the Kamloops timber supply area Public Discussion Paper. October 2007. 19 pp.

BC Ministry of Forests and Range. 2008. Kamloops Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination. June 1, 2008. 62 pp.

Forsite. 2004. Cranbrook Timber Supply Area Timber Supply Review #3 Analysis Report. Version 3.0. May 11, 2004. 159 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2012. 100 Mile House Timber Supply Area Timber Supply Review. Data Package. January 2012. 41 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2013. 100 Mile House TSA Public Discussion Paper. January 2013. 17 pp.

Ministry of Forests and Range. 2003. Bulletin - Modelling Visuals in TSR III. December 12, 2003. 4 pp.

Resource Practices Branch. 2012. Species Monitoring Report Kamloops TSA. Summary Charts and Graphs. May 2012. 9 pp.

Skeetchestn Indian Band. 2008. Skeetchestn Cultural Resource Management Zones (CRMZ). Updated May 1, 2008. 3 pp.

Timberline Natural Resource Group Ltd. 2007. Kamloops TSA Timber Supply Review 4 Information Package. July 2007. 52 pp.

Timberline Natural Resource Group Ltd. 2007 b. Kamloops TSA Mountain Pine Beetle Horizontal Initiatives Project. Prepared for Forests for Tomorrow, Southern Interior Forest Region, Ministry of Forests and Range. March 2007. 148 pp.

University College of the Cariboo/Thompson Rivers University. 2005. Skeetchestn Indian Band: Research and Development in Riparian Zone Management. March 2005. 152 pp.

10.2 Climate Change, Carbon and Wildfire

BC Ministry of Forests and Range Wildfire Management Branch. 2009. Climate Change and Fire Management Research Strategy. A synthesis of the research forum in Victoria, BC, February 17-19, 2009. 31 pp

Bruce Morrow Forest Consulting Ltd., Wildland Solutions, and Davies Wildfire Management Inc. 2008. Rating Interface Wildfire Threats in British Columbia. Prepared for the Ministry of Forests and Range Protection Branch. April 22, 2008. 75pp.

ENAR ESDE Inc.2006. Southern Interior Strategic Regional Restoration Plan. Prepared for the Ministry of Environment. August 2006. 68pp.

FERIC 2002. Fuel consumption for ground-based harvesting systems in western Canada.

Forestry Canada Fire Danger Group. 1992. Development and Structure of the Canadian Forest Fire Behaviour Prediction System, Information Report ST-X-3. 66pp.

Forsite Consultants Ltd. 2010. The Provincial Ecosystem Restoration Program and its Contribution to Timber Supply. Final version October 13, 2010. Prepared for Ministry of Forests and Range. 35pp.

Forsite, EcoRessources, ESSA, Jim Thrower. 2011. Implementing Forest Carbon Offset Projects at the Management Unit Level in British Columbia. Results and Recommendations from Testing on Pilot Areas in BC's Interior and Coastal Regions. Prepared for Forest Sector Climate Action Steering Committee, Forest Carbon Subcommittee. June 6, 2011. 181 pp.

KFFS TSA Team. 2009. Adapting Forest Management in the Kamloops TSA to Address Climate Change. The Kamloops Future Forest Strategy Final Report. June 8, 2009. 186 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2010. British Columbia Wildland Fire Management Strategy. September 2010. 21pp.

Ministry of Forests, Lands and Natural Resource Operations. 2012. Integration of Landscape Fire Planning and Management into Type 4 Silviculture Strategies, Wildfire Management Branch Discussion Paper. 3pp.

Ministry of Forests, Lands and Natural Resource Operations. 2012 b. A Guide to Fuel Hazard Assessment and Abatement in British Columbia. Wildfire Management Branch. April 2012. 19pp.

Neal, A. and G.C. Anderson. 2009. Draft Ecosystem restoration provincial strategic plan. B.C. Min. For. Range, Range Br., Kamloops, B.C. 23pp. Available at: www.for.gov.bc.ca/hra.

Pacific Climate Impacts Consortium. Unknown. Climate Summary for: Thompson/Okanagan Region. 4 pp.

Regional District of Central Okanagan. 2010. RDCO Parks Operational Wildfire Protection Plan Part A. March 2010. 94pp.

Resource Practices Branch. Unknown. Silviculture Regimes for Fuel Management in the Wildland Urban Interface or Adjacent to High Landscape values- Guidance. Version 2.3 9 pp.

Rocky Mountain Trench Ecosystem Restoration Steering Committee. 2006. Fire-maintained Ecosystem Restoration in BC's Rocky Mountain Trench. Principles, Strategy, Progress. Blueprint for Action. 32pp. Available at: http://www.trenchsociety.com/whatsnew.php.

University of British Columbia, Symmetree Consulting, Forsite, 2011. Future Forest Ecosystems Scientific Council (FFESC) Interdisciplinary Climate Change Adaptation Research for Forest and Rangeland Ecosystems. Validating Impacts, Exploring Vulnerabilities, and Developing Robust Adaptive Strategies under the Kamloops Future Forest Strategy. 2009-2011 Final Report, December, 2011. 111 pp.

University of British Columbia, Symmetree Consulting, Forsite, 2012. Guidance to Adapt Forest Management for Climate Change in the Kamloops TSA. First Approximation (June 7, 2012). 46 pp.

10.3 Forest Health

Burleigh & Maclauchlan. 2009. Budworm Simulation Results with Economic Analysis. 20 September 2009. 10 pp.

Coates, DeLong, Burton, Sachs. 2006. Report for the Chief Forester August, 2006. Abundance of Secondary Structure in Lodgepole Pine Stands Affected by the Mountain Pine Beetle. 17 pp.

Coates, Glover, Henderson. 2009. Abundance of secondary structure in lodgepole pine stands affected by the mountain pine beetle in the Cariboo–Chilcotin. Mountain Pine Beetle working paper 2009-20. MPBP Project # 7.22. 47 pp.

Coates, K.D. and Sachs, D.L. 2012. Current State of Knowledge Regarding Secondary Structure in Mountain Pine Beetle Impacted Landscapes. MPB Impacted Stands Assessment Project January 2012. Ministry of Forests, Lands and Natural Resource Operations. 35pp.

Dhar, A. and C.D.B. Hawkins. 2011. Regeneration and growth following mountain pine beetle attack: A synthesis of knowledge. BC Journal of Ecosystems and Management 12(2):1–16. 17 pp.

ILMB. 2006. Mountain Pine Beetle Hazard Rating Documentation Version 1.2. Last Update: December 20, 2006. 7 pp.

ILMB. 2007. Douglas-fir Beetle Hazard Rating Documentation Version 1.2. Last Update: February 15, 2007. 6 pp.

ILMB. 2007b. Spruce Beetle Hazard Rating Documentation Version 1.1. Last Update: January 5, 2007. 8 pp.

Kamloops and Headwaters Forest Districts. 2009. Kamloops TSA - Forest Health Strategy. March 2009. 39 pp.

Lewis, Thompson. 2008. Wood decay and degradation in standing lodgepole pine killed by mountain pine beetle. University of Northern British Columbia. MPBP Project # 7.18. 24 pp.

Lewis. 2010. Forest health and mortality of advance regeneration following canopy tree mortality caused by the mountain pine beetle. Mountain pine beetle working paper; 2010-03. PBP Project # 7.25. 32 pp.

Maclauchlan. 2006. Status of Mountain Pine Beetle Attack in Young Lodgepole Pine Stands in Central British Columbia. Report prepared for the Chief Forester, Jim Snetsinger. January 23, 2006. 26 pp.

Maclauchlan. 2007. Determining susceptibility of young pine stands to the mountain pine beetle, Dendroctonus ponderosae, and manipulating future stands to mitigate losses. FSP Project #Y072003. April 30, 2007. 27 pp.

Maclauchlan, Brooks. 2008. Impacts and susceptibility of young pine stands to the mountain pine beetle, Dendroctonus ponderosae. FSP Project #M085169. April 30, 2008. 46 pp.

Maclauchlan, Brooks. 2010. Four year evaluation of mountain pine beetle impact in twenty four young lodgepole pine permanent sample plots established throughout the core outbreak area in central British Columbia. 25 pp.

Maclauchlan. 2013. Southern Interior Area Forest Health Program Pest Management Plan 2013-2017. Prepared February 18, 2013. 59 pp.

Magnussen, Harrison. 2008. Assessing the shelf life attributes of mountain pine beetle-killed trees. Mountain pine beetle working paper; 2008-27. MPBP Project #7.46. 30 pp.

Resource Practices Branch. 2011. Current Knowledge of Stocking Status after the Mountain Pine Beetle. Resource Practices Branch Backgrounds. July 2011. 20 pp.

Walton, A. 2007. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update of the infestation projection based on the 2006 Provincial Aerial Overview of Forest Health and revisions to the "Model" (BCMPB.v4). BC Forest Service. April 30, 2007. 10 pp.

Walton. 2009. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update of the infestation projection based on the 2008 Provincial Aerial Overview of Forest Health and revisions to the "Model" (BCMPB.v6). BC Forest Service. May 26, 2009. 15 pp.

Walton. 2011. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update of the infestation projection based on the 2010 Provincial Aerial Overview of Forest Health and the BCMPB model (year 8). BC Forest Service. June 22, 2011. 15 pp.

Walton. 2013. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update of the infestation projection based on the Provincial Aerial Overview Surveys of Forest Health conducted from 1999 through 2012 and the BCMPB model (year 10). BC Forest Service. April 12, 2013. 13 pp.

Wiensczyk, Merrick. 2008. Mountain pine beetle: linking recent and current projects to identified needs -- Version 3. Forrex. 45 pp.

10.4 Resource Management Zones

B.C. Forest Service. 2000. Lakes Local Resource Use Plan. Lakeshore Management Guidelines. 56 pp.

B.C. Ministry of Forests. 2001. Watershed assessment procedure guidebook. 2nd ed., Version 2.1. For. Prac. Br., Min. For., Victoria, B.C. Forest Practices Code of British Columbia Guidebook. Available at: http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/iwap/iwap-toc.htm

Ecora Resource Group Ltd. 2012. Incorporating Forest Carbon and Hydrology into a Framework for Modelling Multiple Forest Values. Prepared for Ministry of Forests, Lands and Natural Resource Operations. 114 pp.

Forsite, Milne. 2012. Kamloops TSA Watershed Risk Analysis. Submitted to BC Ministry of Forests, Lands and Natural Resource Operations. May 24, 2012. 64 pp.

Huggard and Lewis, 2007. Summary of: ECA Effects of Options for Mountain Pine Beetle Salvage – Stand and Watershed Level Reports, Unpublished Report, Ministry of Forests and Range.

Kamloops Interagency Management Committee. 1995. Kamloops Land and Resource Management Plan. July 1995. 162 pp.

Ministry of Agriculture and Lands. 2009. Ministerial Order. Kamloops Higher Level Plan Order Cancelling the Caribou management Objective from the Kamloops Higher Level Plan Order. 6 pp.

Ministry of the Environment. 2007. Order- Wildlife Habitat Area #3-071 to 3-073, 3-076 to 3-078, 3-084, 3-087 and 3-088 Lewis's Woodpecker- Kamloops Forest District. 25 July 2008. 4 pp.

Ministry of the Environment. 2007 b. Order- Wildlife Habitat Area #3-030, 3-031 and 3-069 Interior Western Screech Owl - Kamloops Forest District. 26 April 2007. 2 pp.

Ministry of the Environment. 2008. Order- Wildlife Habitat Area #3-115 Spotted Bat - Kamloops Forest District. 25 July 2008. 4 pp.

Ministry of the Environment. 2008 b. Order- Wildlife Habitat Area #3-075, 3-102, 3-105, 3-106, 3-107, 3-108 and 3-109 Lewis's Woodpecker- Kamloops Forest District. 18 April 2007. 2 pp.

Ministry of the Environment. 2008 c. Order- Wildlife Habitat Area #3-079 Lewis's Woodpecker- Kamloops Forest District. 17 March 2008. 4 pp.

Ministry of the Environment. 2008 d. Order- Wildlife Habitat Area #3-124 and 3-125 Great Basin Spadefoot- Kamloops Forest District. 30 October 2008. 4 pp.

Ministry of the Environment. 2008 e. Order- Wildlife Habitat Area #3-096 and 3-127 Williamson's Sapsucker- Kamloops Forest District. 25 July 2008. 4 pp.

Ministry of the Environment. 2009. Order- Ungulate Winter Range #U-3-004. Mountain Caribou- Wells Gray Thompson Planning Unit. 9 December 2009. 3 pp.

Ministry of the Environment. 2009 b. Order- Ungulate Winter Range #U-3-005. Mountain Caribou- Revelstoke Shuswap Planning Unit. 9 December 2009. 8 pp.

Ministry of the Environment. 2009 c. Order- Wildlife Habitat Area #3-117 to 3-120 and 3-122 Badger - Kamloops Forest District. 23 July 2009. 4 pp.

Ministry of the Environment. 2010. Order- Wildlife Habitat Areas #3-153, 3-154, 3-155, 3-157 Lewis's Woodpecker- Kamloops Forest District. 25 August 2010. 4 pp.

Ministry of the Environment. 2014. Draft Order- Ungulate Winter Range #U-3-00X. Kamloops TSA Mule Deer. 10 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2013. Ministerial Order under the Land Act - Land Use Objectives Regulation. Old Growth Management Objectives for the Kamloops Land and Resource Management Plan Area. 4 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2013 b. Order to identify a resource feature adjacent to Mayson Lake and in the Opax Mt. -Isobel Lake area within the Kamloops Forest District aka Thompson Rivers District. December 23, 2013. 6 pp.

SFM Advisory Group. 2013. Nicola Thompson Fraser Sustainable Forest Management Plan. Annual Monitoring Report. Released April 2013. 57 pp.

SFM Advisory Group. 2014. Nicola Thompson Fraser Sustainable Forest Management Plan. January 2014. 195 pp.

10.5 Silviculture

Auditor General. 2012. Report 11: February 2012. An Audit of the Ministry of Forests, Lands and Natural Resource Operations' Management of Timber. Office of the Auditor General of British Columbia. 23 pp.

British Columbia Timber Sales. 2009. Advisory Bulletin No 0./23/09- Innovative TSL Initiative. File: 10765-01. 4pp.

British Columbia Timber Sales. 2012. BCTS & FFT Innovative Timber Sale Licences (ITSL) Stand Selection Policy- Revised – September 17, 2012. 5 pp.

British Columbia Timber Sales. 2013. Internal excel titled 'FFT Sales bids 12-13 rate vs TCU-VOL-ha .xlsx'. (provided by John Hopper).

Forests for Tomorrow. 2011. Current Reforestation and Timber Supply Mitigation Strategic Plan 2011 to 2015. 13 pp.

Forest Genetics Council of British Columbia. 2013. Forest Genetics Council of BC Business Plan 2013/14. 32 pp + appendices.

FP Innovations. 2012. Harvesting cost versus tree size for BC Interior harvesting systems. Draft. 8 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2011. Cost Cap Guidelines 2012/13. Draft. [12-13 Cost Benchmarks Draft Template Oct 19 2011.xls]

Ministry of Forests, Lands and Natural Resource Operations. 2013. Provincial Timber Management Goals and Objectives. 6/25/2013. 20 pp.

Ministry of Forests, Lands and Natural Resource Operations. 2013 b. 2013/14 to 2017/18 Silviculture Funding Criteria. Version 4.0. 25pp.

Ministry of Forests, Lands and Natural Resource Operations. 2013 c. Interior Appraisal Manual, Effective July 1, 2013. Available at: http://www.for.gov.bc.ca/hva/manuals/interior.htm.

Ministry of Forests, Lands and Natural Resource Operations. 2014. Harvest Billing System Report. Available at: https://www15.for.gov.bc.ca/hbs/opg/emailReport.do.

SR Management Services. 2013. FFT ITSL Initiative Economic Impact Analysis (2012-2013). Draft. Original: April23, 2013, revised November 26, 2013. 14pp. (provided by Bernie Peshke)