Integrated Riparian Assessment for Tembec's East Kootenay Operating Areas

Version 2.1

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Table of Contents

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1.0 Introduction

Tembec Industries Inc. (Tembec) has developed a Sustainable Forest Management Plan (SFMP) and is pursuing Forest Stewardship Council (FSC) certification on its forest lands in the East Kootenays. The management of riparian areas under FSC requires that riparian ecosystems and their functions be maintained or restored (FSC BC Regional Standards 2005; Criterion 6.5bis) as follows:

6.5.bis1 The manager maintains and/or restores riparian functions along rivers, streams, wetlands, lakeshores and marine shores by:

> *a) completing an integrated riparian assessment for the management unit, or each riparian assessment unit within the management unit, according to the framework found in Appendix P6a (Riparian Management), or if not, in a manner that meets the intent and addresses all the issues raised in the framework; and,*
>
> *b) implementing a riparian management regime that is consistent with the results of the assessment and meets or exceeds the retention budgets for Reserve Zones and Management Zones specified in Table 3 of Appendix P6a (Requirements for Riparian Management).*

Based on the guidance provided in an integrated riparian assessment, FSC allows considerable flexibility in the shape, size, and extent of riparian retention areas. Tembec wishes to capitalize on this flexibility to maximize the benefits obtained from riparian retention.

This document provides an Integrated Riparian Assessment designed to address the issues raised in the FSC standards, while also customizing the process for Tembec's East Kootenay operating areas (Kootenay Lake TSA, Cranbrook TSA, Invermere TSA, TFL 14). This document is intended to provide guidance to forest planners on operational implementation of riparian retention. In addition, the project will develop and pilot a GIS procedure for assessing current conditions in Riparian Assessment Units relative to FSC requirements.

2.0 Goals and Objectives

The primary goal of this document is to provide strategic direction to forest planners implementing riparian retention at the operational level such that the result maintains riparian values and meets the intent of the FSC BC Standard. We have endeavored to provide guidelines that maintain or restore healthy riparian ecosystems consistent with natural range of variability concepts. This project was divided into three separate phases, each with their own objectives:

<u>Phase 1: Riparian Values Assessment</u>

- Compile a list/description of biological and physical values associated with riparian conditions that are likely to be present in East Kootenay watersheds and examine how riparian management can influence each value (vulnerabilities).

<u>Phase 2: Development of Riparian Strategies</u>

1. Stratify Tembec's operating area into management regions with similar values and geophysical attributes such that a common riparian management strategy can be applied within each region.
2. Develop riparian management strategies/guidelines for each region relative to the values/issues present.

<u>Phase 3: Develop and Pilot Current Condition Assessment Methodology</u>

- Develop a process for assessing 'current condition' relative to FSC requirements within a given Riparian Assessment Unit (subunits of the management regions defined in Phase 2). This will involve defining the scale of assessment units, developing a means to determine the riparian budget for the unit, and then developing a means to assess current retention levels against the budget.

3.0 Riparian Values and Practices Review

Based on a review of current literature, information sources, and professional opinions, this section presents a summary of riparian values expected or known to occur in East Kootenay riparian ecosystems, and discusses their sensitivities to forest harvesting. The intention is to provide planners with an understanding of the role riparian areas play relative to specific values. The end result should be an understanding of where, when, and why issues are important (e.g., where, when, and why is stream temperature an important consideration in the East Kootenays).

In addition, natural disturbance regimes in riparian ecosystems and their Range Of Natural Variability (RONV) are discussed to provide context for the strategies put forward in Section 4.0.

3.1 Riparian Ecosystems Overview

Riparian areas include the water-land interface from the stream-bank interface to the water table-aerated soil interface and are defined by Kauffman et al. (2001) as "… the three-dimensional zones of direct physical and biotic interactions between terrestrial and aquatic ecosystems; boundaries of the riparian zone extend outward to the limits of flooding and upward into the canopy of streamside vegetation."

This integrated riparian assessment considers the function of riparian areas with respect to:

- Stabilization of stream banks and adjacent valley flat/floodplain through root networks,
- Recruitment of large woody debris (LWD) to the channel that provides snags and log jams which acts as storage sites for bedload and a moderating influence on the rate of sediment transport.
- Providing shade to the water surface and moderating stream temperatures.
- Modification of terrestrial microclimates including light, temperature, and humidity;
- Control and buffering of water flow, sediments, and nutrients;
- Nutrient and organic matter input into channels, including leaf litter, nutrient runoff, and insects;
- Providing habitat for aquatic and terrestrial organisms, and
- Providing Water Suitable for Domestic Consumption.

3.2 Riparian Values of the East Kootenays

Within any given ecosystem, natural riparian areas are valuable, highly productive habitats with abundant and diverse vegetation and wildlife species. About half of British Columbia's forest-dwelling terrestrial vertebrate species are restricted to or favour riparian habitats for breeding and other habitat uses (Bunnell et al. 1999). The main reasons for the high productivity and structural complexity of riparian areas include: rapid vegetation growth, abundant deciduous hardwoods and shrubs, high invertebrate productivity, large-sized live, dead and fallen trees, high rates and diversity of natural disturbances (i.e., flooding, landslides, ice and debris flows, and fires), and diverse geomorphology and microclimates (Bunnell et al. 1999, Kauffman et al. 2001). Interactions between terrestrial and aquatic vertebrates (e.g., ospreys, herons, bears and fish) also contribute to the high ecological value of riparian areas (Cederholm et al. 2001).

The value of riparian areas in Tembec's Operating Area and within the East Kootenay Trench as a whole is particularly high due to their rarity within an abundance of dry ecosystems (i.e., PPdh2, IDFdm2, MSdk, and ESSFdk; Braumandl & Curran 1992). In addition, human-related disturbances have removed or changed many lower elevation riparian areas in recent decades. Degradation can occur as loss of native vegetation and fish species, altered channel morphology, changes in magnitude and timing of flow, increased summer water temperatures, and lowered water table and water storage capacity. The degradation can be caused by climate changes, altered precipitation patterns, heavy streamside grazing, introduced exotic fish, and human activities such as development, water diversions, road construction, mining and timber harvest.

Smyth and Allen (2001) assessed lentic wetlands in dry (NDT4) ecosystems of the Rocky Mountain trench and concluded that the majority of sampled wetlands had to be classified as non-functional or at-risk, mostly due to the activities of livestock. Thus, any riparian management strategy, for forestry or other activities, should consider the generally poor current state of NDT4 riparian ecosystems.

Other authors (e.g., Carey 2003) add fire suppression and the lack of disturbance to the list of riparian ailments. This departure from natural disturbance patterns raises concern about the continued ecological health of some riparian ecosystems. In many areas of the East Kootenay, riparian ecosystem restoration may be as important as conservation of remaining intact areas.

Key riparian values known to occur within Tembec's East Kooteany operating areas are described in Table 1 below and shown on maps included in Appendix B. The basic values provided by riparian areas can be grouped into aquatic habitat, terrestrial habitat, and water supply for domestic consumption.

Table 1. Values associated with riparian areas in the East Kootenays

Value	Key Dependants	Association with Riparian Areas[1]
Aquatic Habitat	Tailed Frog*	Requires clear, cold, swift-moving mountain streams with coarse substrate. Perhaps occurs primarily in older forest sites, but better information is needed; required microclimatic and microhabitat conditions are more common in older forests. May be found on land during wet weather near water in humid forests or in more open habitat. During dry weather stays on moist stream-banks. Lays eggs in long strings under stones in water. Creeks inhabited by Tailed Frogs must remain cool throughout the summer as the species has a narrow temperature tolerance. The eggs require temperatures of 5° to 18.5°C to survive. Adults cannot tolerate temperatures much above 20°C, but have been found in streams with temperatures of up to 16°C (Environment Canada 2006).
	Fish Habitat (general)	Riparian areas provide LWD inputs, temperature moderation (shade), sediment filtration, and nutrient and insect inputs that are critical to fish habitat.
	Bull Trout*	Requires deep pools in cold rivers and large tributary streams, often in moderate to fast currents with temperatures of 7-10°C; also large coldwater lakes and reservoirs. Important habitat elements include stable channels, relatively stable stream flow, clean gravel and cobble substrates, high stream channel complexity with various cover types, temperatures not exceeding about 15°C, and the presence of suitable corridors for movement between suitable winter and summer habitats and for genetic exchange among populations (Rieman and McIntyre 1993). Usually spawns in gravel riffles of small tributary streams, including lake inlet streams. Spawning sites often are associated with springs. Optimum temperatures for incubation are about 2-4°C. Constructs spawning redd. Young are closely associated with stream channel substrates (Rieman and McIntyre 1993). Areas with large woody debris and rubble substrate are important as juvenile rearing habitat (Spahr et al. 1991).
	Westslope Cutthroat Trout*	Small mountain streams, main rivers, and large natural lakes; requires cool, clean, well-oxygenated water; in rivers, adults prefer large pools and slow velocity areas (Spahr et al. 1991). Spawns in small tributary streams on clean gravel substrate at water temperatures near 10°C; mean water depth is 17-20 cm and mean water velocity is 0.3-0.4 m/sec (McIntyre and Rieman 1995).
	Kokanee	Kokanee do best in high, cold, large mountain lakes, where a well-oxygenated stratum is essential. Water temperatures above 15.5°C lead to significant mortality, especially among young. Kokanee usually spawns in tributary stream of lake, often in riffle over gravel substrate; sometimes along gravelly shore of lake where seepage outflows, springs, or wind-induced waves occur.
	Burbot	Prefers cold water, uses hypolimnion or deep river pools in summer; spawns mainly in low velocity areas in main channels or in side channels over fine gravel, sand, or silt, sometimes in small tributary streams. Eggs eventually settle into substrate cracks; young then drift to shoreline areas among rocks and debris (USFWS 2001). In the East and West Kootenays, the only tributary streams that support spawning are the

Value	Key Dependants	Association with Riparian Areas[1]
		Columbia Lake headwater streams and the Lower Goat River, respectively.
	Mottled Sculpin	Seem to prefer cool streams with flowing water, ranging from small streams to large rivers with a sandy or rocky substrate; however, found in higher abundance in areas where the stream bottom did not contain high sediments (Chirico 2005). The male selects a spawning site under a rock or ledge; water temperature at time of spawning has been documented to be10°C (Scott and Crossman 1973).
Terrestial Habitat	Coeur d'Alene Salamander	Primary habitats are seepages, waterfall spray zones, and streamside talus; also inhabits talus far from free water (deep talus mixed with moist soil on well-shaded north-facing slopes); in wet weather, occurs also in leaf litter and under bark and logs in coniferous forest.
	Lewis's Woodpecker	This species uses open forest and woodland, often logged or burned, including open ponderosa forest and riparian woodlands (esp. cottonwood stands). It is strongly associated with fire-maintained old-growth ponderosa pine. Important habitat features include an open tree canopy, a brushy understory with ground cover, dead trees for nest cavities; dead or downed woody debris, perch sites, and abundant insects. Riparian areas are used if they consist of or are adjacent to open canopy stands.
	Grizzly Bear*	Grizzly bears are habitat generalists. Wetland habitat types, especially those with cover, are selected in spring, early/mid summer, and fall. In the Tembec operating area, avalanche chutes and riparian patches are important habitats before and after berry season (McLellan and Hovey 2001).
	Moose*	While all ungulates use riparian areas to some extent, moose are particularly adapted to these ecosystems – particularly wetlands. Their summer diet consists in part of aquatic vegetation and generally moose prefer to feed on broadleaved deciduous trees and shrubs rather than conifers (Eder & Pattie 2001).
	Great Blue Heron	Nest colonially in mature and old trees (black cottonwood as well as conifers), usually near water. Important foraging habitats include aquatic areas such as riverbanks, lakeshores, and wetlands.
	Biodiversity (numerous species)	Riparian areas are naturally associated with large numbers of species and are thus critical to the maintenance of general biodiversity. Important habitat elements associated with riparian forests include: 1. <u>Hygric ecosystems</u>: Maintaining hygric ecosystems helps to maintain the biodiversity on the land base and is therefore a key part of the ecological representation strategy. 2. <u>A range of seral stages / structural stages</u>: Riparian vegetation functions as habitat for terrestrial wildlife species by (i) providing browse (shrubs and young hardwoods) for ungulates, (ii) large-size snags and suitable live trees for cavity nesters (e.g., woodpeckers, bats, bears, squirrels, marten) and platform nesters (e.g., Great Blue Heron, Bald Eagle, Osprey, Great horned Owl), and (iii) coarse woody debris for amphibians, reptiles, and small mammals. It is thought to be key to retain the diversity/extent of seral stages and stand structures within the range of natural variability,to maintain species richness and associated ecological functions. 3. <u>Concentrations of mature and old hardwoods and shrubs</u>: Being deciduous and broadleaved, these trees provide nutrients for the riparian community and many habitat elements required by wildlife. Old and mature hardwoods (esp. cottonwood) are susceptible to heart rot fungi which provide suitable wood condition for cavity excavators, have branching pattern suitable for platform nesters, support large insect populations, and contain large quantities of water that aid in forest fire suppression of riparian areas. 4. <u>Overhanging streamside vegetation</u>: Provides security cover, thermal buffering, and important nutrient and insect inputs into aquatic habitats.
Water Suitable for Domestic Consumption	Humans, Livestock, etc	The vegetation in riparian areas help to maintain water quality by reducing sedimentation inputs into water courses through: - Maintaining bank and channel stability through root networks; - Moderating bedload transport rates through large woody debris supplied to the channel; - Reducing the likelihood of slope failures adjacent to streams; - Filtering water inputs into water courses (seepages, ephemeral streams, ditchline/road runoff, etc); and - Providing shade that helps maintain stream temperatures/water quality.

[1] Species information based on CDC *BC Species Summaries* 2005;
* Indicates Tembec's SFMP focal species.

3.3 Sensitivities of Values and Existing Management Guidance

The sensitivity or vulnerability of each riparian value to forest harvesting in riparian areas is discussed below.

Table 2. Riparian values, sensitivities to forest harvesting, and existing management guidance

Riparian Value	Sensitivity to Forestry in Riparian Areas	Existing Management Guidance (BC)
Tailed Frog Habitat	- Logging practices (e.g., clear cutting, road building, site preparation) that disrupt or disconnect habitat, increase siltation and water temperatures may be detrimental to Tailed Frog populations (Dupuis & Bunnell 1997). Water temperatures above 18.5° and 20°C may be lethal to eggs and adults, respectively. BC Status: Red listed IWMS: yes COSEWIC: endangered SARA: Schedule 1	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - WHAs as per IWMS provisions. - Species Recovery Planning. - Tembec's SFMP Species Management Strategy.
Fish Habitat (general)	- The suitability of spawning areas requires species-specific substrate conditions (e.g., clean gravel and cobble), water temperature and other habitat elements (deep pools, cutbanks, logjams, and overhanging vegetation) for egg and fry survival. - Excessive siltation/sedimentation and temperatures will affect probability of successful spawning while lack of in-stream LWD and simplified channel morphology will decrease suitability of rearing habitat.	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Tembec's SFMP Riparian Strategy
Bull Trout Habitat	- Impacted by siltation of spawning streams. Timber harvest and associated activities may have negative impacts on stream channels through sedimentation and/or increasing flooding or scour events (Rieman and McIntyre 1993). - The species is also highly sensitive to water temperature regimes. Optimum temperature ranges (in degrees Celcius) of specific life history stages are: incubation 2-6, rearing 6-14, and spawning 5-9 (Oliver and Fidler 2001). BC Status: blue IWMS: no COSEWIC: not listed SARA: not listed	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Considered for designation as Identified Wildlife under FPRA (T. Antifeau, pers. comm.). - Tembec's SFMP Species Management Strategy.
Westslope Cutthroat Trout Habitat	- Impacted by siltation of spawning areas, reduction in in-stream and overhead cover and alterations of channel conditions (e.g., reduction of cut out banks). - Optimum temperature ranges (in degrees Celcius) of specific life history stages are: incubation 9-12, rearing 7-16, and spawning 9-12 (Oliver and Fidler 2001). BC Status: blue IWMS: yes COSEWIC: special concern SARA: not listed	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Considered for designation as Identified Wildlife under FPRA (T. Antifeau, pers. comm.). - Tembec's SFMP Species Management Strategy.
Kokanee Habitat	- Impacted by forestry practices that increase sedimentation or water temperature. BC Status: yellow IWMS: no COSEWIC: not listed SARA: not listed	- Standard BC RRZ and RMZ practices specific to water feature riparian classes.

Riparian Value	Sensitivity to Forestry in Riparian Areas	Existing Management Guidance (BC)
Burbot Habitat	- Only present in the river in the winter to spawn and not present for the rest of the year. Optimum temperature ranges (in degrees Celcius) of specific life history stages are: incubation 4-7, rearing 15.6-18.3, and spawning 0.6-1.7 (Oliver and Fidler 2001). Forestry practices not likely to impact winter water temperatures. BC Status: red IWMS: no COSEWIC: not listed SARA: not listed	- Standard BC RRZ and RMZ practices specific to water feature riparian classes.
Mottled Sculpin Habitat	- Unknown BC Status: blue IWMS: no COSEWIC: special concern SARA: Schedule 1	- Standard BC RRZ and RMZ practices specific to water feature riparian classes.
Coeur d'Alene Salamander Habitat	- Logging: slumping, sedimentation and clogging of interstitial spaces, removal of riparian vegetation leading to dessication and higher temperatures - Burning and herbicide application during silvicultural activities - Water diversion leading to desiccation (especially for rock seepages and ephemeral streams that may go unnoticed during upslope logging and road-building activities (sensitivities are potential - no direct observation of these effects on Coeur d'Alene salamander sites in BC) BC Status: blue listed IWMS: yes COSEWIC: special concern SARA: Schedule 1	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - WHAs as per IWMS provisions. - Tembec's SFMP Riparian Strategy
Lewis's Woodpecker Habitat	- Logging of ponderosa pine and cottonwood stands or cutting of large-sized wildlife trees. - Fire suppression which decreases amount of burned trees and associated insects that constitute the main food source for Lewis's Woodpecker. It also leads to forest ingrowth and conversion to Douglas-fir. BC Status: blue IWMS: yes COSEWIC: special concern SARA: Schedule 1	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Wildlife Tree Management Guidelines address Lewis's Woodpecker needs. - WHAs as per IWMS provisions.
Grizzly Bear Habitat	- Removal of cover within or adjacent to wetlands and riparian areas. - Fire suppression in riparian areas. - Road building and associated access to grizzly habitat. BC: blue IWMS: yes COSEWIC: special concern SARA: Schedule 1	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Kootenay-Boundary Land Use Plan provisions: "Retain adequate amounts of mature, and/or old forests … adjacent to important avalanche tracks." - Tembec's SFMP Species Management Strategy

Riparian Value	Sensitivity to Forestry in Riparian Areas	Existing Management Guidance (BC)
Moose Habitat	- Removal of cover within or adjacent to wetlands and riparian areas. Tembec and other studies (Poole and Stuart-Smith 2004 and references therein) suggest that early seral vegetation (e.g., willow shrubs and dogwood patches) in riparian areas provides important winter habitat. A mosaic of cover and openings provides most suitable habitat conditions, especially at lower elevations. BC: yellow IWMS: no COSEWIC: not listed SARA: not listed	- Standard BC RRZ and RMZ practices specific to riparian classes. - Cover requirements exist for MF-Wet ecosystems in the new PEM based UWR guidelines. These guidelines maintain cover habitat within riparian areas. - Tembec's SFMP Species Management Strategy
Great Blue Heron Habitat	- Sensitive to human-disturbance including forestry activities, especially during the breeding season (May –July). - Removal of large-sized trees within or near wetlands and riparian areas. BC: blue IWMS: yes COSEWIC: not listed SARA: not listed	- Standard BC RRZ and RMZ practices specific to water feature riparian classes.
Biodiversity (numerous species)	1. Hygric ecosystems: These ecosystems often contain high water tables and sensitive soils that may get degraded in forestry operations and could lead to increased sedimentation of streams. 2. A range of seral stages / structural stages: By targeting late seral stands for logging, forestry can push the natural distribution of seral stages outside their range of variability, which in turn can change riparian species composition and ecosystem functions. Likewise, fire suppression can alter natural seral stage distribution and structural conditions. Forestry operations can have negative effects on habitat elements such as large snags and CWD. 3. Concentrations of hardwoods: Cutting of mature and old hardwoods for commercial processing or to convert stands to conifers, suppression of riparian disturbances, and silvicultural activities to favor conifer regeneration, all have negative impacts on riparian hardwood ecosystems and their dependent wildlife species. Regeneration of hardwoods may be difficult in the absence of disturbances. 4. Overhanging Streamside Vegetation: Removal of streamside vegetation through logging, road building, or vegetation management may increase water temperatures and/or decrease nutrient input, bank stability, and security cover.	- Standard BC RRZ and RMZ practices specific to water feature riparian classes. - Identified Wildlife Management Strategy. - Wildlife Tree Management Guidelines. - Kootenay-Boundary HLP - old and mature seral requirements. - Ungulate Winter Range Guidelines. _ Tembec's SFMP strategies (various).
Water Suitable for Domestic Consumption	- Forest harvesting within watersheds can influence water quality, quantity and timing of flow. Practices within riparian ecosystems can have long-term impacts on water quality by disrupting the linkages between channel processes and riparian vegetation. Removal of riparian vegetation can result in reduced sediment filtering, increased exposure of soils, altered drainage patterns, increased incidence of sloughing or slope failures into the channel and reduced bank and channel stability. - Numerous high value consumptive use watersheds (domestic and community watersheds) exist within Tembec's operating area that are vunerable to changes in water quality associated with disturbances to riparian ecosystems.	- Standard BC RRZ and RMZ practices maintain forested fixed width buffers specific to riparian classes. Tembec's Hydrological Management Strategy

3.4 Range of Natural Variability for Riparian Ecosystems

Considerable attention has been given to assessing and protecting the values unique to riparian areas, yet very little research has been done to determine the role of natural variability in riparian systems. Most riparian conservation efforts have emphasized riparian buffers and other approaches to linear retention along streams and rivers (e.g., Province of BC 1995a – Riparian Management Area Guidebook). However, recent research suggests that riparian ecosystems vary considerably in both space and time. Temporal variability in riparian ecosystems comes from disturbance regimes that are a natural and integral part of riparian systems. Spatial variability in riparian ecosystems is due to the changing dynamics of riparian function with increasing stream size from 1st order headwater streams to large 5th order river systems. Mandating fixed width riparian reserves indefinitely may actually be outside of the range of natural variability and could have negative ecological consequences.

3.4.1 Temporal Variability in Riparian Ecosystems

The most widely cited riparian disturbances are fire and flooding, although landslides, bank failure, debris and/or ice flows, snow avalanches, wind, grazing, diseases and insects can also be significant agents of riparian disturbance. Because fire and flooding are the most prevalent disturbances, much of the following discussion focuses on their effects. We also address windthrow hazard as it can increase due to logging and may have negative impacts on riparian areas undergoing treatments.

FIRE

The role of fire in shaping forested landscapes and ecosystems is recognized by the Canadian Sustainable Forest Management Network as an important consideration in the development of forest management strategies (e.g., Bergeron 2003). Likewise in BC, historic fire regimes and the associated ranges of variability have received much attention in recent years (review in Wong et al. 2003). In 1995, the provincial Forest Practices Code introduced a “natural disturbance type” classification for BC’s landscapes (NDT 1-5; Province of BC 1995b). The NDT categories are based on fire return intervals that can be expected in particular ecosystems (i.e., groups of BEC units). The concept of ecosystem-specific historical fire regimes (i.e., fire frequency and severity) is now widely used to address conservation of landscape biodiversity (e.g., Wilson et al. 2002, 2003; Steeger & Wilson 2005), which is accomplished by emulating the outcomes (e.g., seral stage distribution) expected from natural fire regimes through forest management. This approach is also appropriate for Tembec’s landscape-level riparian management strategy. While Tembec’s operating area includes all five NDT categories, the vast majority is covered by ecosystems that are either fire-maintained (NDT4; 15-20%) or subject to frequent stand-initiating fires (NDT3; 75-80%). In other words, the landscapes included within Tembec’s operating area historically experienced relatively high levels of fire disturbance, with fires of varying size and severity depending on site and ecosystem-specific conditions (Stuart-Smith & Hendry 1998). In this analysis we focus on NDT 3 and 4 ecosystems, which cover almost the entire operating area and timber harvesting land base.

For the dry NDT4 ecosystems of BC, estimates of mean intervals of stand-maintaining surface fires historically ranged from 4 to 50 years (Province of BC 1995b). More specific mean fire return intervals for the East Kootenays (studies from local or nearby ecosystems) indicate a range of 12-32 years. Data from 19 fire history studies in comparable dry forest types within western Montana and northern Idaho indicate a mean fire return interval of 31 years (Cilimburg & Short 2005 and references therein). Stand-initiating fires are rare in the PP zone but may periodically occur on wetter, north-facing IDF sites. However, the frequency of stand-initiating fires in the NDT4 is currently unclear. While the Biodiversity Guidebook indicates a range of 150 to 250+ years, Pollack et al. (1997) calculated a mean return interval of 111 years. The validity of the estimate in the Biodiversity Guidebook was also questioned at several NDT4 workshops (Gayton 2001).

For BC ecosystems with frequent, stand-initiating fire events (NDT3), mean fire return intervals were estimated at approximately 150 years (Province of BC 1995b). Empirical studies indicate mean return intervals ranging from 11 to 220 years. Comparable moist montane forest types within western Montana and northern Idaho have a historical fire regime best characterized as one of moderate-frequency and mixed-severity burns (Cilimburg & Short 2005). Based on data from 51 fire history studies in the

Montana and Idaho forest types, the average stand has a mean fire return interval of 78 years (Cilimburg & Short 2005 and references therein).

Table 3. Fire studies relevant to Tembec's East Kootenay operating areas (adapted from Tembec's SFMP Ecological Draft June 13, 2005)

NDT/BEC	Mean Fire Return Interval (yrs)	Fire severity	Analysis Period	Study Location	Method & Source
IDFdm2 (NDT4)	111	Stand-replacing events	Not indicated	Nelson Forest Region	Mean stand age of inventory age classes, fitted against negative exponential model (Pollock et al. 1997)
IDFdm2 (NDT4)	14 (3-52, Lewis), 19 (1-29, Isadore)	Low-severity fires	1694-1883 1683-1894	Lewis Ridge and Isadore Canyon, Cranbrook Forest District	Dendrochronological analysis of 7-9 trees/site (cross-dated), increment cores from all trees > 20 cm dbh in 50*50m plots (Gray et al. 1999)
IDFdm2 (NDT4)	32 (10-46)	Low-severity fires	1771-2001	Dry Gulch, Invermere Forest District	Dendrochronological analysis (Gray 2001)
IDFun (NDT4)	12	Low severity fire	Not indicated	Castlegar, Arrow Forest District	(Beck 1984, in Gray et al. 2003)
ESSFdk (NDT3)	110	Stand-replacing fire	1421-1931	Kootenay National Park	Regression and graphical analysis (neg. exponential) of age-class distribution (Van Wagner (1995), based on Masters (1990))
ESSFdk (NDT3)	138	Stand-replacing events	Not indicated	Nelson Forest Region	Fitted age classes, negative exponential (Pollock et al. 1997)
ESSFdk (NDT3)	220	Stand-replacing fire	Not indicated	Mt. Assiniboine Provincial Park	Time-since-fire distribution based on stand origin map (Rogeau 1996)
ESSFdk (NDT3)	15-35 35-100 17-31 (N aspect) 11-35 (S aspect)	Not indicated	Not indicated	Not indicated	Fire scar analysis, point and area frequency methods (Gray et al. 2002, Schellhaas et al. 2000a, Schellhaas et al. 2000b)
ESSFdk and MSdk (NDT3)	60 (in 1508-1788) 130 (in 1788-1928)	Stand-replacing fire	1508-1928	Kootenay National Park	Time-since-fire distribution based on ground-truthed stand origin map (Masters 1990)
MSdk (NDT3)	108-124	Stand-replacing events	Not indicated	Nelson Forest Region.	Fitted age classes, negative exponential
MSdk (NDT3)	51 (35-101, 95 % CI)	Stand-replacing fire	Not indicated	MS zone in the Kootenay TSA	Maximum likelihood estimate based on the age-class distribution
ICHmk1 (NDT3)	101	Stand-replacing events	Not indicated	Nelson Forest Region	Fitted age classes, negative exponential (Pollock et al. 1997)
IDFdm2 & MSdk (NDT3&4)	14 (1-43)	Low and mixed severity fire	1756-1979	Lone Peak, Cranbrook Forest District	Dendrochronological analysis, point and area frequency methods (Gray et al. 2002)
IDFdm2 and MSdk (NDT3&4)	18 (2 -44)	Low and mixed severity fire	1763-1942	East side Columbia Lake, Invermere Forest District	Dendrochronological analysis, point and area frequency methods (Gray et al. 2002)
IDFdm2, ICHmk1, ESSFdk (NDT3&4)	4.5-25.5	Low severity fire	1860-1910	South Deep watershed, Colville National Forest, WA	(Schelhaas et al 2000a, in Gray et al. 2003)
IDFdm2, ICHmk1, ESSFdk (NDT3&4)	11-39.4	Low severity fire	Pre- 1860	South Deep watershed, Colville National Park, NE WA	(Schelhaas et al 2000a, in Gray et al. 2003)
IDFdm2 and ESSFdk (NDT3&4)	8.3 (1-23) pre-1886, 5.9 during settlement (1886-1920)	Low severity fire	1670-1920	Quartzite planning area in Colville National Forest, NE WA	(Schelhaas et al 2000b, in Gray et al. 2003)

Based on the studies reported here and reviewed by Wong et al. (2003), very broad ranges of variability are apparent. Some of the differences in reported return intervals are assumed to be due to different methods used in fire history analyses, the temporal and spatial scales considered, site-specific conditions, and stochastic events (Wong and Iverson 2004). Furthermore, present conditions in most landscapes do not necessarily represent the full range of natural variability and may even lie outside of the range. Several descriptions of the range of natural variability have been used in different studies such as the range between the maximum and minimum observed values and the distribution of observed values displayed between standard deviations in histograms, box-plots, or bivariate centroids (e.g., Wong 1999; Dorner 2002). While knowledge of fire regimes and their variability is clearly important for forest management, remaining uncertainties and high variability suggest that the information is best used in general strategic frameworks, with integration of other values and current and future desired conditions (see also Jeakins et al. 2004).

Given the frequent fire history in the East Kootenay region, important questions for Tembec's riparian strategy are therefore:

- How do historical fire regimes differ between upland and riparian areas?
- What are expected future riparian conditions based on historical fire regimes?
- How could riparian management strategies be implemented to reflect historical fire regimes and their range of variability while maintaining riparian values and functions?

Fire regimes in upland versus riparian areas

Fire frequency - Riparian zones are often characterized by vegetation (trees, shrubs and herbs) with increased fire resistance and higher moisture needs. The higher moisture is believed to prolong drought resistance and decrease flammability and in turn fire frequency. Evidence showing longer fire return intervals in riparian areas of the Pacific Northwest is provided by several investigators: Skinner (1997) estimated fire return intervals in riparian areas of Northern California to be double that of upland sites. Agee et al. (1990) calculated fire return intervals in lower elevation draws to be 93 years, compared to upslope Ponderosa pine/Douglas-fir forests that burn, on average, every 52 years, and lodgepole pine/Douglas-fir forests that burn every 76 years. Arno and Peterson (1983) revealed 50-51 year fire return intervals in a 'moist canyon' along the Bitterroot Canyon as compared to 18-23 year intervals on nearby valley edges and mountain slopes. Similarly, Barrett (1982) calculated a mean fire return interval of 47.8 years for the mostly riparian cedar-falsebox site type in the Clearwater National Forest in eastern Idaho, and a 28.7 year interval for the nearby drier grand fir site type. In Douglas –fir forests in eastern Washington, Everett et al. (2003) determined that fire frequency intervals were 3 – 12 years longer in riparian areas than in adjacent upslope forests and in eastern Washington and there were more fires in sideslope forests than riparian areas, regardless of aspect, species composition, or valley type (Everett et al. 2003). For higher elevation, subalpine fir forests of eastern Washington, Camp et al. (1997) provide evidence that riparian areas have higher probability of being "fire refugia" compared to adjacent landscapes.

Conversely, a number of recent fire history studies did not find differences in fire frequencies between riparian and upslope areas: For example, in dry grand fir (ponderosa pine-dominated) forests of northeast Oregon. Olson (2000) found riparian fire return intervals to be similar to those of upslope forest sites in two watersheds. Similarly, for Douglas-fir forests of the southern Cascades in Orgeon, Olson and Agee (2005) could not detect significant differences in fire return intervals between riparian and upslope plots. In general, available evidence suggests that differences in fire frequencies between riparian and upland areas appear to be less pronounced in lower elevation, drier ecosystems compared with higher elevation, wetter ecosystems.

Variability in stream width, seasonal availability of water, and topography are all factors that have been cited as affecting fire behavior and frequency in riparian areas (Olson 2000, Skinner 2003). While slope and aspect may or may not influence fire behaviour, several authors have concluded that differences between riparian and upslope fire occurrence are rare in topographically simple landscapes (Olson

2000, Andison and McCleary 2002). Evidence is sparse for more complex landscapes where it appears that riparian zones burn less frequently in steeper valleys with more incised riparian zones (Olson 2000, Andison and McCleary 2002). In these systems, aspect plays a larger role in regulating moisture conditions (Olson 2000). Turner et al. (1999) also found topography to influence fire behavior.

Lightening causes most natural fires, and most lightening strikes occur in the upper third of a drainage (Olson 2000). Fires that establish in this zone typically burn uphill to the ridge, with less effects downslope from the ignition, although wind patterns may cause the opposite, with intense fires burning downslope, including riparian areas.

Fire severity - While riparian fires may be infrequent in some landscapes, they can be quite intense when they do occur (Agee 1998; Williamson 1999). For example, a riparian zone along the Little French Creek in the Payette National Forest, Idaho, experienced a high severity, stand replacement fire, while much of the adjacent lodgepole pine forest hardly burnt (Agee 1998, Williamson 1999). Similarly, the 1970 Entiat fires (Wenatchee National Forest, Washington) left almost no riparian zone along the Entiat River. Nearby hillslopes showed evidence of historical fires that did not kill the ponderosa pine and Douglas-fir, yet historical fires appeared to have created even-aged classes of lodgepole pine in the riparian zone, suggesting a stand replacement fire near the stream (Agee 1994).

One local fire study conducted along Lamb Creek in Tembec's operating area (Sommerfield and Mooney 2004) corroborates the finding of high-severity fire occurrence in riparian areas. The latter study indicated that the 2003 Lamb Creek fire burnt across the majority of stream segments that were sampled, a pattern that was independent of aspect, slope, or ecological characteristics. This high-severity fire completely or partially burnt the vast majority of the riparian zone, with mostly similar burn patterns on either side of the stream (Sommerfield and Mooney 2004).

Influence of stand types on riparian fire regimes – While comparative fire studies among stands of different vegetation composition are scarce, evidence suggests that typical riparian vegetation composition can create fires of high severity (Gray and Blackwell 2005 and references therein): Deciduous tree species (e.g., cottonwood, aspen, and birch) and conifer species (e.g., Engelmann spruce, western redcedar, and grand fir) that inhabit riparian systems are poorly adapted to fire and are easily girdled. These tree species have relatively thin bark, shallow root systems, and highly flammable foliage. Many understory shrub species associated with riparian systems such as red-osier dogwood (*Cornus stolonifera*), hawthorn (*Crataegus douglasii*), elderberry (*Sambucus* spp.), and rose (*Rosa* spp.) are easily top-killed by fire. Although fire severity can be high in riparian areas, most riparian vegetation is highly adapted to disturbance, including fire, and quickly resprouts from rhizomes, root collars, stolons, and soil-stored seed. The exceptions are conifers, which must reinvade an area if the parent is killed (Gray and Blackwell 2005).

In their review of fires in riparian ecosystems of the western US, Dwire and Kauffman (2003, and references therein) describe that the frequent fires in semi-arid ecosystems periodically burn into the deciduous riparian vegetation, with cottonwood stands along the Oldman River in Alberta showing evidence of up to four low-intensity surface fire events per century. Again, this study corroborates the general result that in drier ecosystems riparian areas show fire regimes and burn patterns similar to upland areas. Dwire and Kauffman (2003) however do point out that generally little is known about the occurrence and ecological roles of fire in deciduous riparian ecosystems.

In summary, analysis of riparian fire regimes is a relatively recent science and generally scarce in the literature. Local topographic, climatic and ecological conditions appear to be factors responsible for some of the variability in the observed or inferred behaviours of wildfires. Despite the scarcity of empirical information, some general trends appear to emerge: (1) riparian vegetation and microclimatic conditions can lead to prolonged fire return intervals in some areas, but when fires do occur they tend to be more severe in riparian areas as compared to upland areas; (2) dry landscapes with relatively simple (usually flatter) topography experience more similar fire regimes between riparian and upland areas than more complex (usually steeper and more variable) terrain; (3) local fire-weather patterns have a strong influence on fire patterns in both upland and riparian areas; and (4) fire regimes in upland areas heavily influence fire patterns in riparian areas.

Expected future riparian conditions based on historical fire regimes

Considering the high historical fire frequencies and variability in frequency and severity reported for riparian areas of the East Kootenay landscape along with the area's diverse topography, one would expect a diverse mosaic of riparian forest patches (i.e., the whole spectrum of successional and structural stages) within the Tembec operating area. Generally, at the scale of our Riparian Management Regions (RMR), the evidence reviewed here suggests that NDT4 landscapes with simple topography such as the Central Rocky Mountain Trench, the Wigwam Flats and Baynes Lake areas, and the lower elevations of Caven, Teepee, and Gold Creek show little difference in fire frequency and severity (due to the high fire frequency) between riparian and upslope areas; hence one can expect, under natural conditions, an open, large-tree stand structure in these riparian areas. Conversely, the other, topographically more diverse RMRs are expected to show larger differences in fire regimes and resulting stand attributes between riparian and upslope areas. With respect to stream size, larger perennial streams (S1-3) are less frequently impacted by fire than smaller or intermittent streams (S4-6), given similar topography. Consequently, stand composition and structure are expected to be more similar between S4-6 stream and upslope areas as compared to S1-3 stream and upslope areas, again given similar topography. For NDT3 ecosystems, the diversity of aspects, slope gradients, and stream sizes make it difficult to generalize differences in fire regimes and stand structure over large areas.

In their recent review on the topic for the provincial Forest Practices Board, Gray and Blackwell (2005) characterize natural fire regimes and range of variability for dry BC forest types as follows:

> *"By combining upland site fire history data with what is known of riparian system fire regimes we can start to develop a sense of the historic range of variability for watershed structure, composition and, most importantly, hydrologic processes. The wealth of historic fire regime data for dry forest types reveals pre-settlement landscapes of very low, but variable stocking. Fires occurred frequently enough that fuel accumulations were kept low and fire-severity and burn-severity effects were minimal and widely dispersed. Both overstory and understory conditions pre- and post-fire would be minimally changed as would soil texture. If the site had strong hydrologic integrity pre-burn the fire would, in fact, help maintain that integrity post-burn. Riparian systems would fit into this ecological response model. The steep gradient stream zone vegetation would simply resprout while the valley bottom, broader riparian systems would see a higher level of spatial heterogeneity in fire effects. Ecosystem diversity, resilience, and sustainability are positive consequences of the historic fire regime."*

Management concerns

The emphasis on riparian reserves has largely been targeted at protecting fish habitat and maintaining in-stream water temperatures. Trees in riparian areas function as buffers providing shade, habitat and LOD inputs. When these buffers burn, varying amounts of trees (depending on fire severity) fall into the stream (Agee 2002), providing structure and complexity for stream flows and aquatic species. However, given that riparian areas are known to burn at variable fire return intervals, excluding disturbance from all riparian areas may be counter-productive to conservation. Arno (2000) suggests that fire suppression is creating situations where fires are more intense and more severe. For example, Hardy et al. (1999) describe streamside vegetation in ponderosa pine forests in the Bitterroot National Forest of Montana as "fire-dependant riparian habitats" where fires likely burned between 2 and 5 times per century. With almost a century of fire suppression, these same riparian areas are now crowded with dense thickets of shade-tolerant trees rather than open grown ponderosa pine and western larch overstories with a deciduous understory. Fires under the current conditions could have detrimental effects on fish habitat and riparian areas by increasing erosion and water quality problems (Arno 2000).

In addition, excluding fire and other disturbances from riparian areas may result in unnaturally high levels of conifer-dominated stands, which would impact wildlife adapted to the deciduous plant associations of riparian areas. Likewise, exclusion of disturbance form riparian areas may result in homogeneous seral stage distributions (mostly late successional), again possibly resulting in negative impacts on wildlife adapted to early-successional riparian conditions (review in Kauffman et al. 2001).

Carey (2003) argues that "systems of reserves and riparian corridors that do not take into account ecological restoration of managed forests and degraded streams may be self-fulfilling prophecies of forest fragmentation and landscape dysfunction." Similarly, Tollefson et al. (2004) suggest that riparian reserves result in concentrated timber management in upland forests and spatial segregation between old and young forests.

Olson (2000) found that historically riparian fires were a result of upslope fires backing down into the riparian zone. With fire suppression increasing both upslope and riparian fuel loadings, Olson recommends treating upslope areas by reducing heavy fuel loading as a means of protecting riparian and fisheries values.

These arguments also hold for the BC forested landscapes and are reflected in Gray and Blackwell's (2005) contention that policies resulting in exclusion of fire, timber harvesting without management of fuels, excessive post-harvest stocking, and maintenance of riparian areas and community watersheds in a static, significantly departed condition, will result in high fire severity impacts on riparian systems. These impacts potentially affect the main riparian values highlighted in this report (i.e., the focal fish and wildlife species and their critical habitat components).

FLOODING

Flooding occurs when high water levels cause a stream to overflow its banks and inundate adjacent areas (floodplains and valley flats) not normally submerged. Floods are the most common agent of disturbance in riparian areas and the main mechanism for recruitment of Large Woody Debris (LWD) to stream channels. Watershed size, hydroclimatic conditions and basin physiography (including geology, soils, slope, drainage density, etc.) all play a significant roll in determining the flood regime of a watershed.

Effect of Scale

Small, low order watersheds that drain steep mountain slopes typically have the greatest variability in peak discharge but a low frequency of channel-forming flood events[1]. This is due to the high spatial and temporal variability of factors controlling snow accumulation and melt. As watershed size increases in mountainous environments the variability in peak discharge decreases and the frequency of channel forming flood events tends to increase. A number of studies have determined that channel morphology provides a clue to the scale at which this transition occurs (Wolman and Miller, 1960, Dodov and Foufoula-Georiou, 2005). The transition from transport-dominated to deposition-dominated morphology in a watershed also appears to be the scale at which the flood regime moves towards a higher frequency of channel-forming flood events.

In the East Kootenay watersheds the transition from transport-dominated morphology to deposition-dominated morphology tends to occur once watershed areas exceed roughly 200km^2 (Green 1997, 2002, 2003, 2004, 2005). In these largest channels, floods that have the capacity to move bedload and shape the channel occur typically (on average) once every 1.5 years or 1:1.5 years (this is referred to as the recurrence interval). In smaller steeper headwater channels the recurrence interval of the channel-forming flood events can be upwards of 1:30 years (Church 2002).

Causes of flooding

Regional analyses of the climatic factors controlling flooding have been undertaken for the Southern Purcell/Rocky Mountain regions (MacDonald et al. 1994, Alila et al., 2005, Green, 2005)

- Solar radiation only floods: This type of flood is most common in the East Kootenay (approx. 70 to 80% of floods) and often regionally extensive (eg. 1948, 1961, 1972, 1974). Radiation driven

[1] Channel forming floods are those floods that are capable of shaping and maintaining the morphology of the channel.

floods typically occurring as a result of a prolonged period of unusually warm spring weather (exceeding approx. 6 days).

- Rain on snow floods: Rain-on-snow flooding is the 2nd most common flood mechanism in the east Kootenay (~11 to 23% of floods). R-O-S floods are generally localized (eg. 1995 – Elk River) and normally occur later in the snow melt period when the snow pack is saturated (late May or June).
    - Low elevation watersheds (where max. elevation less than approx. 2000 m) tend to experience more frequent rain-on-snow driven floods due to warmer, more saturated snow packs earlier in the spring snow melt period that are more responsive to early rain-on-snow events.

- Rain only floods: Rain only floods are generally localized to headwater catchments in the case of mid-summer thunderstorm driven floods or, rarely, more regionally extensive and due to large winter rain-storms (e.g. November 13 1999).

- Ice jam floods: In the southern interior of B.C. ice jam flooding is relatively infrequent but often regionally extensive and occurs as a result of heavy, prolonged rain immediately following mid to late-winter (December – March) 'cold snaps' that have caused rivers and tributaries to develop thick ice layers (e.g. January 18, 2005).

Effects of flooding on riparian condition

Small Streams (<5 metres)

Alpine

Steep (>10% to over 40%), streams typical of high elevations have deciduous shrubs including alder (*Alnus tenuifolia*) and willow (*Salix sp.*) along riparian areas. Colluvial processes including snow avalanches and debris flows occur frequently. Debris flows and snow avalanches result in channels, banks and valley bottoms being repeatedly scoured. Root systems of resilient deciduous shrubs re-establish quickly along channels but slower-to-establish, coniferous species are limited to less active outer margins. Large woody debris (LWD) has limited function in these active colluvial channels.

Non-alpine Headwaters

Steep, non-alpine channels (> ~10%) are still dominated by colluvial processes (debris floods/flows) but typically experience a lower frequency of disturbance events than alpine channels. Lower gradient (~5 to 10%), non-alpine streams lack colluvial processes and experience channel forming flood events very infrequently.

Riparian stands often consist of late seral stage riparian vegetation including spruce (*Picea engelmannii*) and balsam fir (*Abies lasioarpa*) at higher elevations and cedar (*Thuja plicata*), hemlock (*Tsuga heterophylla*) at lower elevations. Alder (*Alnus tenuifolia*) and willow (*Salix sp.*) will often be the dominant riparian vegetation for several decades following a disturbance event.

In mountainous environments these small channels are often incised in steep-sided gullies so that the valley flat is limited to less than 20 metres and LWD functioning in the channel is typically recruited from up to 20 metres upslope.

Steep side slopes supply large volumes of organic debris and sediment that accumulates upstream of LWD for decades or longer until it is transported downstream by debris flows or floods.
Riparian vegetation plays a key roll in these small, non-alpine channels in regulating rates of bedload transport and providing stability to channel banks.

Intermediate Streams (5 to 20 metres)

Intermediate sized streams in the east Kootenay (gradients between 2 and 10 percent) often have linear zones or patches of late seral stage riparian vegetation including large diameter spruce (*Picea engelmannii*) and balsam fir (*Abies lasioarpa*) at higher elevations and cedar (*Thuja plicata*), hemlock (*Tsuga heterophylla*) with cottonwood and apsen (*Populus balsamifera, Populus tremuloides*) at mid and lower elevations.

Geomorphically-effective floods are less frequent (approx 1:10 yrs) in these coarse textured alluvial and forced alluvial channels but, when they occur, typically result in undercutting of banks, recruitment of LWD and channel avulsion. LWD spans the channel as single pieces or forms jams in the confined valley bottoms depending on the size (diameter) of the wood debris and the size of the flood event. LWD jams can last in these intermediate channels for upwards of 2 centuries functioning as long-term sediment storage sites and diversion points for channel avulsion (Faustini and Jones, 2003).

Large Streams (>20 m)

The geomorphic connection between large streams or rivers and their floodplains (and the riparian vegetation on the floodplain) becomes most significant in the east Kootenay once bank-full widths reach 20 metres. At this scale, flooding streams occupy over-flow channels, mobilize existing LWD, scour banks at meanders (resulting in the recruitment of additional LWD), and deposit fine textured over-bank sediments (Abbe and Montgomery, 2003).

The lateral and vertical stability of these large stream and river channels is directly dependant on the function of riparian vegetation. Channels with small diameter, shallow rooted riparian species such as lodgepole pine (*Pinus contorta*) will tend towards, wide, braided or single entrenched (degraded) channels (i.e. channels with high rates of vertical and lateral migration). Channels with deep rooted, large diameter riparian species typically maintain (i.e. low rates of vertical and lateral channel migration) a complex channel structure including anastomosing, meandering channel patterns with alternating pool-riffle morphology (Abbe and Montgomery 2003).

Management concerns

Establishing effective riparian buffers must be based on an understanding of the linkage between riparian vegetation and channel processes. The connection between riparian vegetation and channel processes varies spatially along the length of a channel and temporally in response to disturbance events such as floods, fire and windthrow.

Floods are the most common mechanism for recruitment of LWD in channels. In most intermediate and large streams in the East Kootenay region, LWD plays a critical roll in the moderation of sediment transport rates, which influences water quality, and the development of aquatic habitat.

Floods also influence establishment of cottonwood stands. The latter require exposed mineral soils for regeneration, a process facilitated by the scouring actions of floods. Food control through dyking and simplification of channels has eliminated the potential for cottonwood regeneration in many riparian areas (e.g. lower Lussier River). Aquatic and riparian systems that still function under natural flood regimes are therefore a priority conservation concern.

WIND

Wind is an important agent of disturbance in riparian areas because of the importance of blowdown to in-stream large woody debris (LWD). Where landslides and snow avalanches are rare, windblown riparian trees are the primary source of LWD in streams. Windthrow also has important impacts on the terrestrial characteristics of riparian areas by creating habitat and producing canopy gaps.

Windthrow has been a serious concern in riparian buffers. Rollerson and McGourlick (2001) determined that the most important factors affecting windfirmness of riparian areas on Vancouver Island are the type of treatment applied to the boundary, the character of the leave strip (one-sided versus two-sided strips), strip width, rooting depth, exposure of the boundary to wind, tree height and tree species. Soil drainage, landform morphology, and slope position of the boundary are also important. They found that feathering edges was the only treatment that reduced windthrow; thinning increased windthrow in comparison to no treatment. When character of the leave strip was examined, they found that two-sided riparian strips are generally more vulnerable to windthrow than one-sided riparian strips, and that two-sided buffers experienced almost double the blowdown. The higher windthrow in two-sided leave strips is partly due to increased ‘domino effect’ with windthrown trees knocking over other trees. However, wider leave strips experienced less blowdown.

Management concerns

Windthrow hazard in riparian areas of the East Kootenays is expected to vary widely due to the diverse topography of the landscape. This diversity necessitates windthrow hazard assessments at the stand level rather than at the level of riparian management regions or assessment units. In areas of high windthrow hazard, riparian reserves or management zones may need to be feathered, to avoid large-scale blowdown. In general however, some blowdown of riparian trees, especially at the aquatic interface, is beneficial for riparian ecosystems as it adds large organic debris to streams.

Other Disturbance Mechanisms

While fire, flooding, and, to a lesser degree, windthrow are among the most significant disturbance agents in riparian areas, other disturbances such as insects and diseases can also affect the integrity and health of riparian areas, often in combination with fire and wind. In-stream disturbances include debris and ice flows, which, along with flooding, can alter channel morphology and other physical characteristics. Landslides and avalanches that reach water bodies affect both terrestrial and aquatic areas. Although these disturbances can have significant site-specific impacts, they are generally less of a management concern than fire and windthrow.

Summary

In summary, the historically high fire frequencies in the East Kootenay region, which included riparian areas, have largely been eliminated due to successful fire suppression programs. Consequently, management intervention through fuel reduction, reintroduction of fire, and manipulation of tree species composition and stocking densities will be important for the maintenance of riparian biodiversity, integrity, and health. A dynamic approach with variable-width reserves and management zones is more likely to lead toward desired riparian conditions than a static approach with fixed-width reserves. Especially in low-elevation areas, riparian restoration treatments are required and should be considered at the Riparian Assessment Unit level. Note however that riparian areas are susceptible to disturbances of soils and other habitat elements during forestry operations. While thinning treatments, fuel reduction, prescribed burning, and silvicultural activities may be appropriate in some areas, these activities should be designed such that any existing habitat elements (e.g., large snags, CWD) deemed important for the site are retained, especially if these elements provide habitat for sensitive wildlife species (Machmer 2001).

3.4.2 Spatial Variability in Riparian Ecosystems

The influence of riparian vegetation on channel stability and water quality changes with channel gradient and channel size. In the mountainous Kootenay Region the most significant change in riparian function with stream size is the influence on channel stability. Numerous studies on the influence of riparian vegetation on stream temperature have determined that as stream discharge and velocity increases the influence on riparian vegetation in moderating temperatures decreases. Fast flowing mountain streams are relatively insensitive to the influence of canopy shade for regulating temperatures (Beschta et al., 1987). In addition, as stream width increases beyond approximately 10 metres the influence of riparian vegetation on maintaining stream temperatures also decreases (P.Teti, 2005, personal communication).

In small, steep channels (<1.5m wide and >20% gradient) high stream velocities result in the development of hydraulic steps formed by both coarse bed material (cobbles and boulders) and woody debris. Streamside vegetation supply roots and coarse woody debris (branches) from mature streamside trees that form small woody debris jams. These structures typically last a few years to several decades and, in a cumulative manner, moderate sediment transport rates for fine textured sediment (small cobbles, gravel and finer) along the length of the headwater channel. The most common mechanism of sediment delivery in these steep headwater channels is from the root balls of trees that fall over on the steep slopes or valley flats adjacent to the channels.

In small, low gradient channels (<1.5 metres and < 5% gradient) lower stream velocities do not lead to the formation of cobble steps or debris jams. Woody debris from streamside vegetation falls into the channel and can remain in place for decades. In the Kootenay region small, low gradient streams are typical on the lower slopes adjacent to the Rocky Mountain Trench (eg Gold Creek and tributaries). In these channels sediment transport is generally limited to gravel and finer material that is derived from instream sources (channel banks) and riparian vegetation plays a crucial roll in maintaining stream temperatures.

As stream size increases (>1.5 to <10 metres) and channel gradient decreases (~5 to 20%) channel velocity and discharge increases and only the larger pieces of woody debris (>~30 cm diameter) are large enough to form stable in-stream structures for sediment storage. In these small to intermediate stream channels LWD is typically recruited to the channels on an episodic basis following disturbance events such as large floods or fires and can remain as stable structures in the channels for up to 2 centuries. The dynamics between channel condition and riparian vegetation often alternates between channels choked with woody debris and an adjacent riparian area of immature coniferous and deciduous trees and channels with less frequent but established LWD jams and riparian area with mature deciduous (initially) and coniferous (eventually) vegetation. As stream size increases from 1.5 to 10 metres the influence of riparian canopy on moderating stream temperatures is limited to the lowest gradient channels (~<5%) that are not naturally shaded by steep valley slopes.

As channel gradient drops below approximately 5% and channel width increases to upwards of 15 metres, channel velocity decreases and channel structure and sediment transport is controlled by processes that are dominantly alluvial. In these intermediate channels, LWD plays a significant roll in moderating sediment transport rates and providing channel bed and bank stability as well as complexity to the channel bed for aquatic habitat. Functioning LWD is limited mainly to mature coniferous trees that are large enough to span the channel and have root balls that function to anchor the trees to the channel bank and bed. LWD is recruited more frequently during moderate flood events as the stream shifts around on its floodplain and channel banks are undercut.

Once channel width exceeds approximately 10 to 15 metres the channel is too wide for even the largest mature coniferous trees to function in the channel for any length of time and sediment transport is controlled entirely by alluvial processes. At this scale the most important role of riparian vegetation is the protection of stream banks and adjacent valley sides during flood events by a dense network of roots. LWD that enters the channel is transported downstream and collects at meander bends providing additional protection to channel banks and creating valuable aquatic habitat.

3.5 Review of Riparian Management Approaches and Guidelines

Significant research and effort as gone into the development of riparian management practices currently in use in various jurisdictions. Information was reviewed from a number sources and the ones considered relevant to management in the East Kootenays have been summarized here.

3.5.1 British Columbia (Riparian Management Guidebook)

In British Columbia, management of riparian habitat is currently based on the regulations in the Forest Practices Code and/or Forest and Range Practices Act. The Riparian Management Area Guidebook (Province of BC 1995b) outlines the details of riparian management as it is currenlty applied throughout BC. Sections 47-53 of FRPA’s Planning and Practices Regulation outline practice requirements for riparian areas under FRPA that can be accepted as ‘default’ riparian management strategies – although alternative strategies can be proposed. Both FPC and FRPA defaults require the establishment of riparian management areas (RMAs), which consists of riparian reserve zones (RRZs) that exclude timber harvesting, and riparian management zones (RMZs) that restrict timber harvesting in order to protect riparian and aquatic habitats. Six stream riparian classes (S1A/B-S6) are defined based on presence of fish, occurrence in a community watershed, and average channel width criteria. RMAs (RRZs + RMZs) also apply to wetlands and lakes, and five wetland riparian classes (W1-W5) and four lake riparian classes (L1-L4) are recognized (Province of BC 1995b, FRPA-FPPR sec 47-53).

Table 4. Riparian features buffer widths

Feature Type	Definition	Riparian Class	Riparian Reserve Zone (m)	Riparian Mgmt Zone (m)
Stream	>100m in width >20 up to 100m in width	S1A S1B	0 50	100 20
Stream	5-20 m in width	S2	30	20
Stream	1.5 – 5 m in width (fish bearing or community watershed)	S3	20	20
Stream	<1.5 m in width (fish bearing or community watershed)	S4	0	30
Stream	> 3 m in width (not fish bearing or not in community watershed)	S5	0	30
Stream	≤ 3 m in width (not fish bearing or not in community watershed)	S6	0	20
Wetland	> 5 ha. in area	W1	10	40
Wetland	1-5 ha. in area in PP or IDF	W2	10	20
Wetland	1-5 ha. in area not in PP or IDF	W3	0	30
Wetland	0.25-1 ha. in area in PP or IDF	W4	0	30
Wetland	2 adjacent wetland of > ha. in area	W5	10	40
Lake	> 5 ha. in area	L1	10	*varies*
Lake	1–5 ha. in area in PP or IDF	L2	10	20
Lake	1-5 ha. in area not in PP or IDF	L3	0	30
Lake	0.25-1 ha.	L4	0	30

This management approach is based on fixed width linear buffers along stream, applied consistently along all stream reaches in an equal manner. FSC's approach allowing variable width buffers that correspond with topography, stand, attributes, and riparian values is likely better able to address long term management of riparain values. FRPA allows for this type of approach through approval of an alternative (to defaults) strategy in an FSP.

3.5.2 Northwest Forest Plan (USA)

As part of the US Northwest Forest Plan an Aquatic Conservation Strategy (ACS) was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems on public lands (http://pnwin.nbii.gov/nwfp/FEMAT/Chapter_5/). The ACS consists of a system of riparian reserves, a system of key watersheds, requirements and procedures for conducting watershed analysis, and a program of watershed restoration. Here we briefly discuss the main components of the ACS.

Riparian reserves are intended to maintain ecological functions and protect stream and riparian habitat and water quality. They are to be applied along permanently flowing streams, lakes and wetlands > 1 acre, and intermittent streams where riparian-dependent and stream resources receive primary emphasis. Riparian reserves include the body of water, inner gorge, all riparian vegetation, 100-year floodplain, landslides and landslide prone areas. The ACS uses the concept of tree heights and slope distance to provide ecologically appropriate metrics with which to establish riparian reserve widths. For example, tree height distance away from the stream is a better indicator of potential wood recruitment or degree of shade than is an arbitrary distance. Likewise, slope distance is a more meaningful ecological distance than horizontal distance.

Key Watersheds have the function to protect at-risk fish stocks or basins with outstanding water quality. Key watersheds are intended to serve as refugia for fish species and include areas of well-functioning as well as degraded habitat. Well-functional areas are to serve as anchors for the potential recovery of depressed fish stocks. Areas of lower quality habitat have a high potential for riparian ecosystem restoration. One of the guidelines for key watersheds is that no new roads be constructed in currently unroaded areas.

Watershed condition analysis was proposed as a procedure for planning further protection or management, including restoration practices within a basin. Watershed condition includes not only the state of the channel and riparian zone, but also the condition of the uplands, distribution and type of seral stages of vegetation, land use history, effects of previous natural and land-use related disturbances, and distribution and abundance of species and populations throughout the watershed. Watershed analysis is a stratum of ecosystem planning applied to watersheds of approximately 3200-32000 ha (20-200 square miles). This concept is comparable to that of the assessment units used in this project for Tembec's riparian strategy. Restoration efforts may be needed in key watersheds to speed ecosystem recovery in areas of degraded habitat and to prevent further degradation.

3.5.3 FSC Rocky Mountain Region Standards (USA)

Riparian management strategies in the FSC Rocky Mountain Region (Idaho and Montana) focus on the establishment of management zones along watercourses that are intended to preserve water quality and aquatic values. Forestry activities are not excluded in management zones (i.e. no reserves) but are limited to activities that will not degrade water quality or riparian function.

Forest management in the management zones is limited to the following:

Roads are prohibited in SMZs, (streamside management zones) except for permanent roads necessary to cross the stream at a perpendicular or other angle that causes the least ecological disturbance.

- Operation of wheeled or tracked equipment is prohibited in the SMZ, except on permanent roads.
- Temporary roads or designated skid trails across the SMZ may be permitted in rare instances after preparation of a pre-operation plan that protects riparian values.
- Logging operations retain at least half of the merchantable trees, representative of the pre-harvest stand, with heavier retention of bank-edge and leaning trees, shrubs, and submerchantable trees.
- Appropriate techniques are used to maintain existing roads and ditches to prevent adverse impacts to water quality.
- Storage, handling, or use of hazardous materials is prohibited in SMZs.

The width of riparian management zones in the Rocky Mountain region is fixed (i.e. fixed width) but depends on size of stream, slope gradient, the presence of aquatic values (e.g. fish or water supply), as well as the distinction between perennial (flows year round) and ephemeral (carries seasonal flow) channels. Management zone widths range from 150 feet (45m) on both sides of the channel in the most limiting situation (fish bearing or consumptive water supply) to 0 feet along ephemeral stream channels that do not support fish.

4.0 Development of Riparian Strategies

This section of the report provides riparian management strategies for management regions within Tembec's operating area. Management regions were delineated based on geophysical factors that result in a similar approach to riparian management for the watersheds within each region.

4.1 Management Region Delineation

Tembec's operating area has been divided into six Riparian Management Regions (RMR's) that are distinct in their geology, physiography, and climate. These are; the Southern Purcell, Central Purcell, Northern Purcell, South Elk, North Elk and Central Rocky Mountain Regions (see Figure 1). Two of these RMR's; the Southern Purcell and Central Rocky Mountain Regions have been further subdivided into western and eastern zones.

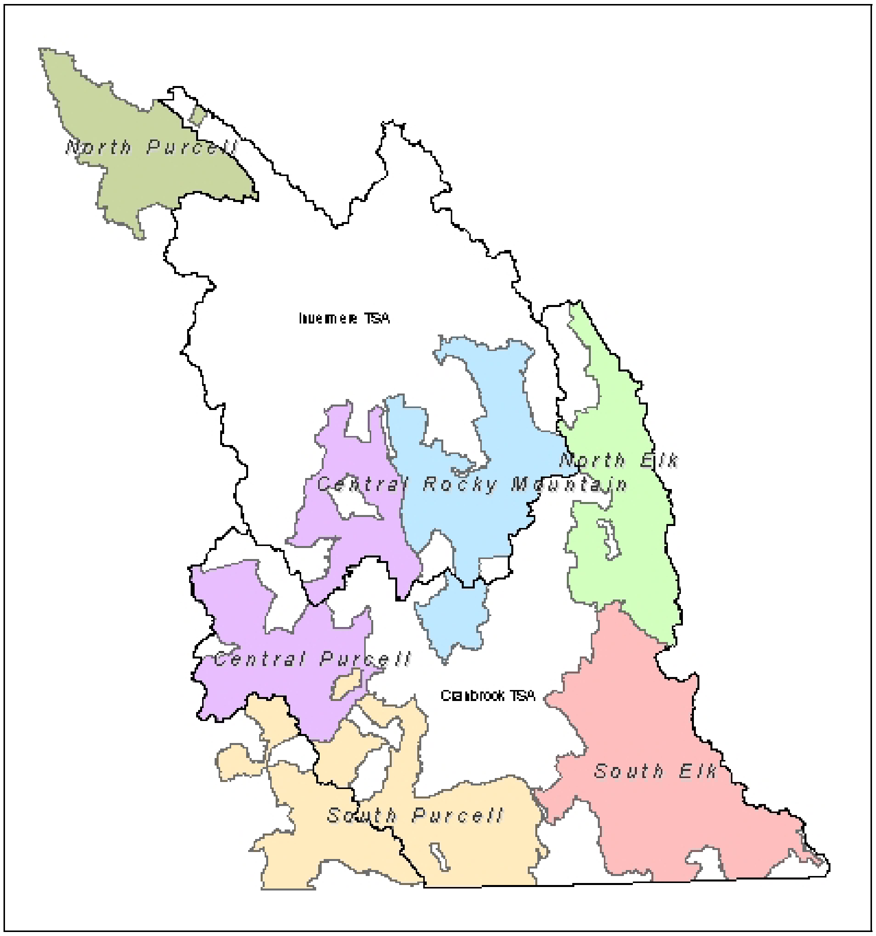

Figure 1. Riparian Management Regions covering Tembec's East Kootenay Operating Areas

The **Southern Purcell Region** is underlain by fine textured (argillite, siltstone) and erodible, metamorphosed sediments of the Middle Proterozoic Purcell Supergroup. This region is charaterized by rounded, moderate to gentle gradient, relatively low relief hillslopes and wide, low gradient valley bottoms.

To the north, the **Central Purcell Region** is also underlain by metasediments of the Purcell Supergroup but in this region the fine textured sediments have been intruded by a series of granodiorite plutons.

These coarse textured intrusive rocks underlie the Central Purcell Management Region along the western boundary and form high-elevation steep-sided mountain peaks and ridges. During the height of the last glacial period valley glaciers descended from the high elevation peaks and filled the main valleys. Broad u-shaped valleys mantled by thick glaciofluvial deposits along the lower elevations charaterize the Central Purcell Management Unit.

Coarse clastic sediments (greywacke and conglomerates) of the Upper Proterozoic Horsetheif Creek Group, locally intruded by granodiorite plutons underlie much of the **Northern Purcell Region**. The coarse-grained meta-sediments form resistant, steep sided peaks and ridges and the Spillimacheen River occupies a wide, u-shaped valley. Glaciers are still present at the headwaters of the Spillimacheen River.

The Rocky Mountain Trench geographically separates the Purcell Mountains from the Rocky Mountains and geologically separates distal sediments of the Purcell Supergroup from continental North American sediments (dominated by bedded carbonaceous sediments and limestone) of the Rocky Mountain fold and thrust belt.

The **Central Rocky Mountain Region** is underlain by folded and thrust faulted sequence of Cambrian to Devonian layered carbonaceous sediments and massive limestone. The thick sequence of Devonian limestone tends to erode easily forming broad valleys bordered by steep, knife-edged ridges that are underlain by more resistant layered carbonaceous sediments. Large valley glaciers occupied all of the major northwest-trending valleys resulting in thick accumulations of glaciofluvial and glaciolacustrine sediments along the valley sides.

Towards the east the strata of the Rocky Mountain fold and thrust belt becomes progressively younger so that the North and eastern portion of the **South Elk Region** are underlain by Devonian limestones through to Jurassic and Cretaceous coal-bearing shales.

The broad valleys of the Elk, Fording and Flathead Rivers are underlain by Permian to Cretaceous, erodible fine textured sediments and coal bearing shales. The trend of ridges and valleys in both the **Elk North** and **Elk South** Management Regions are controlled by major northwest-southeast trending thrust fault systems.

The north-eastern flow of moist coastal air masses from northern California to south central B.C. dominate weather patterns in the East Kootenay Region. The North Purcell Region has the highest annual average precipitation followed by South Elk and Central Purcell. The Southern Purcell, Central Rocky Mountain and Northern Elk Management Regions have the lowest annual precipitation levels due to regional rain-shadow effects from the southern Selkirk, central Purcell and central Rocky Mountains.

4.2 Riparian Management Region Characteristics

The following tables provide detailed descriptions of each Riparian Management Region.

Table 5. South Purcell Riparian Management Region (MR) Characteristics

Management Region	**South Purcell (#1a/b)**
Physiographic Area	**Southern Purcells (a – west of Moyie River; b – east and south of Moyie River)**
Major Drainages	**Moyie River, Gold Creek, Yahk River**
Physical Description	**Elevation Range**: 2200 - 850 m **BEC**: ESSFdk/dm/dm1/wm, MS dk, ICH dm/dw/dw1/mk1, IDF dm2, PP dh2 (NDT 3 and 4). Most valley bottoms and lower slopes are in the MSdk or ICHdw1 except for those that drain into the trench (e.g., Gold Creek), which are IDFdm2. Mid and upper elevation slopes (above 1500m) are ESSFdk in the eastern portion of the MR and ESSFdm1 west of Moyie River and Yahk River. **Terrain and Geology:** The Southern Purcell MR is underlain by Middle Proterozoic Purcell Supergroup argillites and wackes. Carbonate rocks are exposed in north trending belts in the eastern portion of the management unit (Gold Creek). Most of the mountains and ridges were overridden by glaciers at the height of the Frazier Glaciation between 12,000 and 10,000 years ago resulting in rounded, subdued topography in this management unit. Remnant glaciofluvial terraces are present locally. Channels typically occurpy wide meltwater channels. Drainage patterns are complicated by deposits left by stagnating glacial ice (kettles, eskers). **Annual Runoff**: <400mm to < 1000 mm
Channel types	**(1a)** Channels of small and moderate sized watersheds (<5000 ha) are typically steep, forced alluvial to colluvial morphologies (Step pool to cascade) Goat River is main watershed. LWD plays key roll in channels less than ~15% and less than 15 metres wide. Much of riparian in this area was harvested during early mining and forestry activities. **(1b)** Subdued topography of the Purcell Supergroup of metasedimentary rocks underlie this area. Most of hillslopes were overridden by ice and are rounded, gentle to moderate gradients. Streams draining are generally moderate to low gradient (5-15%) and morphologies are commonly forced alluvial to alluvial (step pool to riffle pool). LWD plays very important roll. Valleys are broad so riparian vegetation also plays key roll in shade. Fire has been common in this Region and is often the mechanism for LWD recruitment.
Lakes	Few lakes in this area and generally isolated lakes in steep sided valleys.
Wetlands	Wetlands occur at height of land between Goat and Moyie drainage (Meadow Creek), along most of the length of Moyie River and Moyie Lake, and along the little Moyie River
Sediment Regime	**(1a)** Sediment sources are mostly bank and valley flat erosion during large flood events. Less frequent are debris flows and floods from steep headwater tributaries and snow avalanche chutes. Debris slides from steep sided valleys occur rarely following extreme events. **(1b)** Wider valley bottoms tend to decouple channels from hillsides in this area. Sediment sources are primarily bank and valley flat erosion during flood events.
Disturbance Regime	Most of the landscape is in NDT3 where fires are expected frequently, often of stand-replacing or mixed severity. The generally subdued topography suggests similar fire regimes between riparian and upslope stands. The highest fire frequency with lower severity can be expected in the NDT4 part of the Gold Creek area. Riparian stands with higher fire resiliency are in the steeper, wetter areas of upper Goat River and in the Moyie and Yahk Ranges.
Flood Regime	**Channel forming flood events** The regional flood history based on the maximum daily peak discharge records for 5 long-term gauged watersheds suggests that large regionally extensive, channel-forming flood events occurred in the Creston to Cranbrook area 8 times in the last 50 years (1:6.25yrs). These floods occurred in 1948, 1956, 1961, 1974, 1976, 1997, 1999 and 2002. The November 13th 1999 flood, which is the largest flood on record for the southern Purcell region and the only winter peak flow event was triggered by an extended period of heavy rain.

Table 6. Central Purcell Riparian Management Region Characteristics

Management Region	Central Purcell (#2)
Physiographic Area	Central Purcell Range
Major Drainages	St. Mary, Skookumchuck (Doctor and Findlay and Dutch)
Physical Description	**Elevation Range:** 2600 – 900 m **BEC**: ESSFdk/dk1/dm/dm1/wm, MSdk, ICH mk1/dm, IDFdm2/xk, PPdh2 (primarily NDT 3 and 4). From east to west and low to high: IDFdm2 (dry, mild Kootenay Variant) in lowest reaches and transition to trench. Lower to mid elevation slopes west of trench are MSdk. Towards the west and in more confined valleys, the valley bottoms include ICHmk1 to ICHdm. Mid and upper elevation slopes are ESSFdk in the east and ESSFdm1 to ESSFwm in the western portion of the MR. Parkland above 2000 and AT above ~2100. **Terrain and Geology:** This MU is underlain by Middle Proterozoic Purcell Supergroup argillites, wacke and conglomerates. In the northwestern portion of the MU, the highest peaks are formed by granodiorite intrusives. The main valley bottoms along all major drainages are mantled by glaciofluvial/lacustrine terraces. Valley bottoms towards the trench have very thick glaciolacustrine/fluvial terraces which contribute very large amounts of sediment to lower reaches annually. **Annual Runoff:** ~>400 mm along eastern (trench) to over 1000 mm at headwaters of St. Mary/Skookumchuck.
Channel types	Steep sided valleys draining high elevation mountain ranges. Peak flows are driven by alpine snowmelt and most 4^{th} order tribs and smaller are colluvial with local forced alluvial reaches. Snow avalanche/debris flows are common in headwater tributaries. These streams carry high discharges. Larger streams – Redding, St. Mary and Skookumchuck are meandering, anastomosing and braided in some locations over wide active floodplains. These are higher gradient, active channels that carry large bedloads and high discharges. LWD is key for channel stability in main stems of smaller (< 5000ha) watersheds.
Lakes	Lakes infrequent in steep terrain. Cirque lakes occur in headwaters. St. Mary and Whitetail Lakes are the only significant sized lakes in MR.
Wetlands	A reconnaissance level orthophoto analysis indicates that wetlands occur throughout this MR along Sandown Creek, upper Lavington, upper end of St. Mary lake and locally along upper St Mary River.
Sediment Regime	Smaller lower order watersheds (less than 5000 ha) receive sediment from processes in steep headwater tributaries (often supply limited channel morphologies). Larger order watersheds typically have main stem channels that are bound by glaciofluvial terraces that contribute large amounts of sediment annually.
Disturbance Regime	Most of the landscape is in NDT3 where fires are expected frequently, often of stand-replacing or mixed severity. The generally steep topography in the western parts of the MR suggests that riparian areas are more fire resilient than upslope stands. NDT4 ecosystems in the lower eastern parts of the major drainages exhibit high frequency, lower intensity fire regimes, with riparian areas often burning across streams.
Flood Regime	**Channel forming flood events.** In 63 years of gauging 13 large channel forming flood events have been recorded in the St Mary River area (1:5yrs); these occurred in 1916, 1948, 1955, 1956, 1961, 1967, 1968, 1972, 1974, 1986, 1996, 1997 and 1999, with the 1916 peak flow being the largest peak flow event in the last 100 years.

Table 7. South Elk Riparian Management Region Characteristics

Management Region	South Elk (#3)
Physiographic Area	Southern Rocky Mountains – south of Sparwood
Major Drainages	Flathead, Wigwam, Southern Elk River
Physical Description	**Elevation Range**: 2400 – 800 m **BEC:** PPdh2, IDFdm2, ICHmk1, MSdk, ESSFdk/wm (primarily NDT3 and 4). A limited amount of ICHmk1 is identified in the valley bottoms of lower Elk and Wigwam Rivers. Most of the lower hillslopes (1000 – 1500m) are MSdk. Above this is ESSFdk with parkland above 2000m. Locally ESSFwm occurs on north aspect slopes draining into the Lower Elk. **Terrain and Geology:** This MR, situated in the main ranges of the Rocky Mountains, is underlain and ringed by resistant peaks formed by the Mississippian to Permian, Rocky Mountain Group Carbonate rocks. Overlying the carbonates and underlying much of the central portion of this MR are Triassic to Cretaceous fine sedimentary rocks. Coal deposits, that have been mined for the past century occur in the Jurrasic to Cretaceous rocks in this MR. Glaciofluvial terraces occur in the large tributary valleys. Most of the larger stream and rivers flow across wide, active floodplains. Steep tributaries draining from high elevation ridges flow in to the main stem channels along their length delivering sediment via debris floods, debris flows and snow avalanches. Main stem channels are typically braided with multiple channels. **Annual Runoff:** 500mm > 1000 (>1200 mm at Fernie).
Channel types	Fault controlled valleys contain main stem channels. Flathead, Wigwam, Lodgepole etc. in wide glacial valleys. This area experienced extreme flood in 1995 that has affected channel morphology throughout the area. Wide active flood plains have braided, meandering channels typically bound by glaciofluvial terraces. Tributaries drain steep, high alpine areas and commonly carry debris floods. LWD plays important roll in lower reaches of tributary channels. 1995 flood has affect LWD function in many of the larger order main stem channels.
Lakes	There are very few lakes in this management unit.
Wetlands	Wetlands found along margins of floodplains in larger systems.
Sediment Regime	Glaciofluvial terrace scarps are main sediment source to larger systems. Debris flows and snow avalanches are main sediment sources in headwater tribs.
Disturbance Regime	While most of the ecosystems of this MR are NDT3 where fires are expected to be frequently, often of stand-replacing or mixed severity, some south-facing and low-elevation stands experience higher fire frequencies and are fire maintained (NDT4). Ecosystems with infrequent stand-replacement fire regimes (NDT2) are located on the steep, upper elevations in the northern portion of this unit.
Flood Regime	Hydrometric records for the Elk River (at Phillips Bridge, Elko and Fernie) for the last 85 years indicate that the 1995 flood flow was the highest recorded flow for the period of record. Two flood flows of similar magnitude occurred in 1948 (May 24th) and in 1956 (May 22nd). Channel forming flood events occurred on the lower Elk River in 1916, 1933, 1938, 1948, 1954, 1956, 1961, 1964, 1972, 1974, and 1995, (1:7.72)

Table 8. North Elk Riparian Management Region Characteristics

Management Region	North Elk (#4)
Physiographic Area	Main Ranges - Rocky Mountains – North of Sparwood
Major Drainages	Elk River, Fording River
Physical Description	**Elevation Range:** 3000 – 1100m **BEC:** MSdk, ESSFdk (NDT3) – The valley bottom and lower slopes are MSdk. Most of the slopes are classified as ESSFdk. Parkland occurs above 2000 m and AT is identified above ~2200 m **Terrain and Geology:** The geology of this MR is similar in all aspects to that of the South Elk MR. The Elk Valley is bound on both sides by high peaks formed from Devonian and younger Carbonate rocks. The mid and lower slopes of the main Elk River Valley are underlain by erodible fine clastic sediments of Triassic to Cretaceous age that host the coal deposits of the Rocky Mountain Front Ranges. The Elk River flows/meanders over a wide active floodplain bound by gently sloping terraced valley sides. Fording River is confined by bedrock and glaciofluvial terraces. High elevation tributaries along Elk and Fording deliver large volumes of sediment via debris floods and snow avalanches. Glaciers are locally present in some tributary headwaters. **Annual Runoff:** <500 – 1000mm
Channel types	Elk River and Fording river are in fault controlled valleys. Tribs in steep sided valleys and drain from very high elevation mountain ranges (some with glaciers). Peak flows are controlled entirely by snowmelt from high elevations and channel morphology is relatively insensitive to influence of forestry – except for direct impacts to riparian area along lower main stem of tributary channels. Logging has occurred in lower reaches of many tributaries.
Lakes	Lakes are not common in this management region
Wetlands	Wetlands found along margins of floodplains on larger systems (eg Elk River)
Sediment Regime	Sediment sources are primarily from tributary channels and debris flows/snow avalanches in headwaters. Snow avalanches are a dominant hillslope process in this area. Fine textured shale bedrock weathers easily and results in turbid water in some locations
Disturbance Regime	The ecosystems of this MR are NDT3 where fires are expected frequently and are typically stand-replacing. Upper slope riparian areas may be more fire resistant than upslope areas due to steep and rugged topography.
Flood Regime	Gauging over the past 54 years (1951-2004) on the Elk River above Natal indicate that major channel forming floods have occurred 6 times. 1956, 1961,1972,1974,1995 and 1996 (1:9yrs). The 1995 peak flow is the largest flood on record.

Table 9. Central Rocky Mountain Riparian Management Region Characteristics

Management Region	Central Rocky Mountain (#5a/b)
Physiographic Area	Main Ranges of the Rocky Mountains 5a) Central RMT 5b) Eastern RMT
Major Drainages	White River, Lussier River, Kootenay River Columbia Lake, Wildhorse River
Physical Description	**Elevation Range:** 2700 – 900m **BEC/NDT:** PPdh2, IDFdm2, MSdk, ICH mk1, ESSFdk (NDT3 and 4). The lower elevations of the Lussier and White River drainages are in the MSdk while the upper elevations are in the ESSFdk. **Terrain and Geology:** The Lussier/White River are underlain by folded and faulted upper Proterozoic sediments and Cambrian to Devonian carbonates. The prominent peaks of the main ranges are formed by limestone and dolostones. Thick glaciofluvial terraces bound (and confine) the main stem channels of both the White and Lussier Rivers contributing large volumes of sediment to these systems annually. Steep headwater tributaries frequently carry debris flows and snow avalanches to the main stems. **Annual Runoff**: ~400 mm to less than 1000 mm at height of main ranges.
Channel types	**(5a)** Channels in this portion of the MR flow over wide glacial meltwater valleys. Most channels are lower reaches of very large watersheds (eg. Lussier). **(5b)** Similar in character to South Elk but the influence of fire on channel structure is more significant. Main streams/rivers occupy wide flood plains and have low gradient, meandering to braided cobble riffle morphologies. Riparian species are mostly small diameter spruce, balsam and pine, play less significant roll with respect to channel structure than other MR's. Limestone underlying main valleys is factor in site/growing conditions. Tributaries drain from very steep alpine basins and are primarily colluvial channels.
Lakes	Whiteswan and Moose Lakes occur in this management unit. Columbia Lake in the Rocky Mountain trench forms the western boundary of this management unit.
Wetlands	**(5a)** Wetlands occur along the Kootenay River and portions of the lower reaches of Lussier River and Wild Horse River. **(5b)** Wetlands are not extensive in this part of the MR but occur locally in upper reaches of main stem channels and in some locations along margins of channels on valley flat
Sediment Regime	**(5a)** Channels in the central RMT are typically de-coupled from valley sides by wide valley flats that limit the opportunity for sediment inputs. Sediment delivery is primarily through bank erosion during large flood events. **(5b)** Glaciofluvial terraces in the main valleys are major sources of sediment to the main stems annually. Lussier is turbid year round through lower reaches below reach 11. Debris floods and snow avalanches in steep tributaries are major source of sediment in upper reaches.
Disturbance Regime	(5a) The majority of the low-elevation areas in the Central RMT lie within the NDT4 where frequent stand-maintaining fires used to occur. These fires would have created the typical NDT4 stand structure of large-sized, widely-spaced trees. When higher severity fires occurred, riparian stands likely burned similar to upland stands. (5b) The ecosystems of the eastern part of the RMT are NDT3 where fires are expected frequently, often of stand-replacing or mixed severity. Riparian areas may be more fire resistant than upslope areas due to steeper topography than in the Central RMT.
Flood Regime	The flood history of the Upper Kootenay and Lussier Rivers suggests that significant channel forming peak discharges, corresponding roughly to 1:10 yr flood events or greater, occurred 12 times in the past 64 years. The most recent large flood events (approx. 1:10 yr return period floods) occurred in 1996 and 1997. (1:5.5yr)

Table 10. North Purcell Riparian Management Region Characteristics

Management Region	North Purcell (#6) (TFL 14)
Physiographic Area	Northern Purcells
Major Drainages	Spillimacheen River
Physical Description	**Elevation Range:** 2700 – 900m **BEC**: ESSFdk/wm, ICHmk1/mw1, MSdk, IDFdm2 (NDT 2, 3, 4). **Terrain and Geology:** The Spillimacheen area is underlain by coarse clastic rocks of the upper Proterozoic Horsethief Creek Group that are structurally thickened by northwest/southeast trending thrust faults. Glaciofluvial terraces are not present along the main valley of Spillimacheen or major tributaries. The main stem of the Spillimacheen meanders, mostly in a single channel, over a wide floodplain. Snow avalanching and debris flows on steep valley sides are the dominant mass-wasting process that delivers sediment to the main stem channels. Glaciers are present in the headwaters. **Annual Runoff:** ~400 mm in trench to ~1500 mm at headwaters of Spillimacheen
Channel types	Spillimacheen River is the main watershed. Headwaters are in high elevation mountain ranges with glaciers. River is situated on wide valley flat bounded by steep sided valleys sides. Morphology is braided, meandering along almost entire length. Lower mainstem has some single meandering morphology. River has a wide active floodplain with many abandoned channels indicating it moves around frequently. Tributaries are steep avalanche gullies. Riparian vegetation is very important over wide floodplain to provide protection to forest floor during high flow events.
Lakes	Many oxbow lakes on floodplain
Wetlands	A reconnaissance digital orthophoto assessment of the area indicates that wetlands may be present in some locations along margins of the Spillimacheen River (more detailed assessment will be required to confirm).
Sediment Regime	Steep valley sides and glacier outwash are main sediment sources. Lower reaches of Spillimacheen are not bound by glaciofluvial terraces.
Disturbance Regime	TFL 14 consists of a multitude of ecosystems representing most NDTs (2-4). The majority of the area however lies within NDT3 and only small parts are within NDT2 and 4. NDT4 ecosystems are mainly PL stands with more of a NDT3 than NDT4 character. Overall, most of the ecosystems experience frequent fires, often of stand-replacing or mixed severity. Riparian areas in the steep side valleys of the Spillimacheen River may be more fire resilient than upslope areas while in the relatively flat, wide valley of the Spillimacheen River, the difference in susceptibility to fire between riparian and upslope may be lower.
Flood Regime	A return interval of 1:5 years is estimated for the occurrence of channel forming flood events in the Spillimacheen River area based on 56 years of gauged stream flows on the Spillimacheen River.

4.3 Riparian Management Strategies

The riparian strategy outlined in this section is consistent with FSC's variable width buffer approach to Riparian Management and can be consistent with FRPA if implemented as an alternative strategy to meeting the Riparian objective set by government (FPPR Sec 8). There is flexibility to place retention where it is logical, mimics natural disturbance processes, and best protects riparian values within Riparian Assessment Units, as long as retention budget targets are met. General strategies to be considered when implementing riparian retention throughout Tembec's operating area are presented in this section, while Section 4.4 highlights issues and retention priorities specific to each Riparian Management Region. This set of strategies and priorities are intended to guide planners when implementing retention within Riparian Assessment Units.

The management strategies presented here support the generally accepted concepts that forest harvesting in riparian areas has the greatest potential to impact channel stability and water quality in small and intermediate streams and that the function of riparian vegetation changes with channel gradient and channel size. Removal of significant numbers of mature coniferous and deciduous trees along small and intermediate alluvial streams can result in long-term impacts to channel stability and water quality. Channel instability results from the reduction of recruitable LWD needed to provide channel and bank stability. Water quality impacts result from increased erosion of stream banks as root systems from mature trees are lost and through reduction in canopy shade that maintains cool water temperatures. In the Kootenay region, the function of canopy shade regulating stream temperature is most significant in small and intermediate streams (<~10 m) draining moderate to gentle gradient terrain.

Forestry is only one type of resource development that has the potential to impact riparian ecosystems. Cumulative impacts related to the introduction and spread of invasive weeds, cattle grazing, agriculture, mining, recreation, and hydro-electric power installations among others, should be considered when designing retention strategies at the level of Riparian Assessment Units.

The strategies presented here are all premised on the concept that riparian ecosystems are best managed through the delineation of Riparian Management Areas (RMAs) consisting of either Riparian Reserve Zones (RRZs) or Riparian Management Zones (RMZs) or both. In general, RRZs are intended to exclude all forestry operations, while RMZ's limit the extent of forestry operations.

4.3.1 Riparian Reserve Zones

Riparian Reserve Zones should be considered in the following locations:

- Aquatic-terrestrial interface of alluvial streams (i.e. active floodplains along intermediate to large streams and rivers), and lakes / wetlands over 5 ha in size (>1 ha in NDT4 ecosystems);
- Riparian habitats of red, blue or SARA-listed wildlife species;
- Streams or streams segments with high value fisheries habitat and/or consumptive-use water intakes (i.e. HCV4 polygons Ref. BC FSC Doc, Westover, B. 2005);
- Rare or sensitive ecosystem types (Wells et al. 2004) identified in Tembec's SFMP; and
- Mature and old cottonwood stands along streams, and hardwood stands along lakes and wetlands.

Further guidance on implementing RRZ's is provided in Section 4.3.3 below. The above list is meant to provide general guidance only and is to be considered in light of the overall goal of maintaining or enhancing riparian values. If stand level treatments (i.e. restoration works) will achieve these goals better than establishing reserve zones, then Riparian Management Zones (RMZ) with prescribed treatments and clearly defined objectives would be the preferred management approach.

Entry into established RRZs should only be considered in very extenuating circumstances such as severe forest health problems or excessive fuel loadings that may lead to unnaturally catastrophic burns. Tree-parasitic insects and diseases operating at endemic levels are beneficial for the ecology or riparian areas and do not require management intervention. As well, many streams in the Kootenay region rely on disturbance events for the episodic recruitment of woody debris.

The objectives of any entry into a Riparian Reserve Zone should be clearly documented and reviewed with Qualified Registered Professionals.

4.3.2 Riparian Management Zones

Riparian Management Zones should be considered in the following locations:

- Adjacent to RRZs to protect the integrity of the reserve by reducing windthrow and sediment delivery hazard. RMZs can also increase the ecological value of RRZs by increasing the size of habitat patches beyond RRZs or providing habitat connectivity to upland or other riparian areas.
- Adjacent to RRZs where topography/terrain features extend riparian function beyond the obvious valley flat/floodplain slope break. For example, in confined draws/valleys where LWD is

being recruited from upper slopes or, where wildlife trees or wildlife corridors are situated along the outer margins and/or glaciofluvial terrace tops adjacent to riparian areas.

- Adjacent to water features where the conditions for delineation of RRZs do not occur but where riparian vegetation is providing a source of LWD that is functioning to maintain channel stability (eg. small (<5m) streams that do not contain high value fish habitat)

Because forest harvesting is not excluded in Riparian Management Zones, a minimum seven (7) meter[2] no-machine zone should be defined along all classified water features, except as required for designated crossings. The primary objective of the no-machine zone is to reduce the potential for direct disturbance to the forest floor and channel banks from logging equipment.

Forest management in RMZs is intended to:

- Protect the integrity of the adjacent RRZ by reducing windthrow and sediment delivery hazard;
- Maintain or restore riparian ecosystem composition, structure and function. Forest management should include thinning and fuel reduction treatments where required. This consideration especially applies to NDT 4 and the drier NDT3 ecosystems. After thinning, prescribed burning may be considered. Note however that unintended impacts may arise such as introduction or spread of invasive weed species. Weed management may have to be implemented concurrent to or post treatment;
- Retain critical stand-level habitat elements (e.g., trees with sign of current use by wildlife, large snags and defective life trees, large hollow logs, hardwoods, patches of berry-bearing shrubs). Follow the provincial and Tembec's wildlife tree management guidelines when treating RMZs.
- Retain a sufficient percentage of standing timber representative of the pre-harvest stand, with heavier retention of bank-edge and leaning trees, shrubs, and submerchantable trees to allow for continual recruitment of large live and dead trees for stream structure, aquatic habitat and shade.
- Exclude the use of heavy equipment, except to cross streams at designated places, or where the use of such equipment is the lowest impact alternative;
- Avoid disturbance of mineral soil. Where disturbance is unavoidable, mulch and seed are applied at appropriate time of year. Harvesting options that minimize road construction and reconstruction are preferred;
- Avoid the spread of noxious weeds;
- Utilize drainage plans to manage surface runoff where roads and trails are situated on or above potentially unstable or unstable slopes (P or U, Class IV or V);

Forestry activities in RMZ's may also be appropriate to reduce excess fuel loadings, address less severe forest health problems, accelerate succession toward late-successional stand structure, reintroduce disturbance, or salvage trees after catastrophic disturbance.

Further guidance on implementing RMZ's is provided in Section 4.3.3 below.

4.3.3 Delineation of Riparian Reserve and Management Zones

The delineation of RRZs and RMZs should:

- Follow logical topographic breaks, and/or reflect terrain features. Where streams are confined by steep slopes (>50%), RMZs should extend far enough upslope or to a logical topographic break to manage for sediment delivery and windthrow hazards.

[2] As defined in section 6.5.6 of the FSC – BC Regional Standards Revisions (February 27, 2005). No literature supporting this width over others was found. For reference, the BC Forest Practices Code required a 5m NMZ. In all likelihood, this width can vary according to the terrain and associated potential to disturb important aquatic interface structures.

- Reflect natural disturbance regimes (disturbance return intervals and their range of variability), which indicate that a mosaic of forest patches representing all successional stages can be expected in riparian areas;
- Reflect the spatial variability of riparian function relative to stream size;
- Manage for windthrow hazard. While windthrow may compromise the integrity of riparian buffers, only consider special treatments (e.g., feathering of reserve edges, selective removal of susceptible trees, etc.) in areas of high windthrow hazard. Establishment of RMZs with variable retention can prevent windthrow in RRZs. Some windthrow is beneficial for riparian ecosystems, especially if it leads to LWD input into water bodies.

The following table provides general guidance around the delineation of reserve and management zones relative to riparian feature classes and stream/terrain conditions. Site specific characteristics may require deviations from these general guidelines in order to meet the overall goal of maintaining riparian function and protecting riparian values.

Table 11. General riparian management guidance by feature type

FSC Stream Class[3]	Terrain Conditions	Riparian Reserve Zone (RRZ) Rational [4]	Riparian Management Zone (RMZ) Rational[5]
S1a,b Large streams and rivers (>20m) with fish or in a community watershed	Confined by steep slopes (>50%, P, U, Class IV, V)	RRZ for width of floodplain	Delineation of RMZ is beneficial where floodplain development is minimal and/or stream is confined by steep slopes. If a glaciofluvial scarp is present the RMZ should extend to the top of the terrace scarp.
	Unconfined on moderate to gentle slopes	RRZ for width of floodplain	RMZ would be defined specifically to manage wildlife values that extend beyond the RRZ or windthrow hazard along the edge of the RRZ
S2 Intermediate streams and rivers (5-20m) with fish or in a community watershed	Confined by steep slopes (>50%, P, U, Class IV, V)	RRZ includes floodplain or valley flat[6]	Streams of this size have the greatest potential for impacts to water quality and aquatic habitat from road related landslides and debris flows. RMZ should extend upslope beyond RRZ or to topographic break to manage for windthrow and sediment delivery hazards.
	Unconfined on moderate to gentle slopes	RRZ includes floodplain or valley flat	RMZ should extend beyond RRZ to manage for windthrow hazards. RMZ is wide enough to maintain riparian function including LWD recruitment and shade in low gradient channels/watersheds
S3 Small streams and rivers (1.5-5m) with fish or in a community watershed.	Confined by steep slopes (>50%, P, U, Class IV, V)	RRZ includes the valley flat and extends upslope for at least 0.5 tree height.	RMZ extends upslope beyond the RRZ to manage for windthrow and sediment delivery hazards
	Unconfined on moderate to gentle slopes	RRZ of at least 0.5 tree heights either side of stream to maintain shade and LWD recruitment	RMZ where necessary to protect reserve zone from windthrow hazard and/or to manage for wildlife values that extend beyond RRZ.
S4 Very small streams (<1.5m) in community watershed or containing fish)	Confined by steep slopes (>50%, P, U, Class IV, V)	As required to address site specific riparian values.	RMZ should extend far enough upslope to manage for windthrow and sediment delivery hazards. Retention in RMZ must be sufficient to protect channel banks and adjacent valley flat from scour and ensure continual supply of LWD to the channel
	Unconfined on moderate to gentle slopes	As required to address site specific riparian values.	RMZ should extend far enough back from the channel and have sufficient retention to provide shade, protect channel banks and adjacent valley flat from scour and ensure continued supply of LWD to the channel

[3] As defined in FSC – BC Regional Standards Revision (February 26, 2005)

[4] As discussed in Section 4.3.1, reserve zones can be entered for forest health reasons as long as long as aquatic values are not compromised.

[5] Refer to Section 4.3.2 and 4.3.3 for more specific directions regarding appropriate management activities in RMZ

[6] The term ‘valley flat’ use here applies to the low gradient valley bottom that is present in smaller, more confined valleys that the stream flows over and occasionally shifts across during flood events.

FSC Stream Class[3]	Terrain Conditions	Riparian Reserve Zone (RRZ) Rational [4]	Riparian Management Zone (RMZ) Rational[5]
S5a Small to intermediate streams and rivers (>3m) outside CWS's and with no fish and: a) In a domestic watershed, and/or b) <500 m upstream of fish-bearing stream[7], or c) Wider than 10m.	Confined by steep slopes (>50%, P, U, Class IV, V)	RRZ includes floodplain or valley flat	In the East Kootenays streams of this size are draining areas of approx. 10km2 (10,000 ha) and larger and most likely are flowing over a floodplain or valley flat of at least 10 meters wide. Streams of this size are generally highly dependant on LWD for stability. RMZ should extend upslope beyond the RRZ to manage for windthrow and sediment delivery hazards.
	Unconfined on moderate to gentle slopes	RRZ includes floodplain or valley flat	RMZ where necessary to protect reserve zone from windthrow hazard and/or to manage for wildlife values that extend beyond RRZ.
S6a Very small streams (0.5-3m) outside CWS's, with no fish and: a) In domestic watershed and/or b) <=250m upstream of a fish stream[7].	All	As required to address site specific riparian values.	In the East Kootenay streams of this size are generally headwater streams draining areas of less than 1000ha. A RMZ will be necessary along many of these channels (particularly in channels of < 20% gradient) to maintain riparian function including shade and LWD recruitment
S5b Small to intermediate streams (3-10m) not in a consumptive use watershed, not fish bearing, and > 500m upstream from a fish stream[7].	Confined by steep slopes (>50%, P, U, Class IV, V)	Reserves over floodplain or valley flat	Where necessary, RMZ should extend far enough upslope to manage for windthrow and sed. delivery hazards.
	Unconfined on moderate to gentle slopes	Reserves over floodplain or valley flat	Where necessary to protect values or channel stability, RMZ wide enough to maintain riparian function including shade and LWD recruitment
S6b (<3m) Very small streams (0.5-3m) not in a consumptive use watershed, not fish bearing, and > 250m upstream from a fish stream[7].	All	As required to address site specific riparian values.	Where necessary to protect values or channel stability, RMZ wide enough to maintain riparian function including shade and LWD recruitment

FSC Lake and Wetland Class[8]	Terrain Conditions	Riparian Reserve Zone (RRZ) Rational	Riparian Management Zone (RMZ) Rational[9]
Lakes L1 (> 5 ha) L2 (1-5ha in PP/IDF)	Confined by steep slopes (>50%, P, U, Class IV, V)	Reserve to include aquatic-terrestrial interface to protect lakeshores and overhanging vegetation	RMZ should extend upslope beyond RRZ or to topographic break to manage for windthrow and sed. delivery hazards.
	Adjacent slopes are moderate to gentle	Reserves include the aquatic-terrestrial interface.	RMZ is sufficiently wide to manage for windthrow hazard and wildlife habitat requirements (eg. travel corridors) that may extend beyond RRZ.

[7] Upstream distance is not a practical measure for defining risk to fisheries values. In smaller, lower order streams, the gradient of a stream plays a more important role with respect to potential for down stream impacts than distance upstream. High gradient tributaries (>20%) have the potential to transport debris flows and fine textured sediment for kilometres. Riparian management strategies should apply over the length of the tributary where steep gradients are present.

[8] As defined in FSC – BC Regional Standards Revision (February 26, 2005). They are also consistent with the FPC Riparian Management Guidebook definitions (MoF 1995).

[9] Refer to Section 4.3.2 and 4.3.3 for more specific directions regarding appropriate management activities in RMZ

FSC Lake and Wetland Class[8]	Terrain Conditions	Riparian Reserve Zone (RRZ) Rational	Riparian Management Zone (RMZ) Rational[9]
Lakes L3 (1-5ha not in PP/IDF) L4 (0.25-1ha in PP/IDF)	Confined by steep slopes (>50%, P, U, Class IV, V)	Reserve to include immediate aquatic-terrestrial interface to protect lakeshores and overhanging vegetation	RMZ should extend upslope beyond RRZ or to topographic break to manage for windthrow and sed. delivery hazards.
	Adjacent slopes are moderate to gentle	Reserve to include immediate aquatic-terrestrial interface to protect lakeshores and overhanging vegetation	RMZ is sufficiently wide to manage for windthrow and sediment delivery hazard and wildlife habitat requirements.
Wetlands W1 – W5	Confined by steep slopes (>50%, P, U, Class IV, V)	Reserve defined around perimeter of wetland to include aquatic-terrestrial interface.	RMZ should extend upslope beyond RRZ or to topographic break to manage for windthrow and sed. delivery hazards.
	Adjacent slopes are moderate to gentle	Reserve defined around perimeter of wetland and extends outwards include aquatic-terrestrial interface.	RMZ is sufficiently wide to manage for windthrow hazard and wildlife habitat requirements.
Unclassifed Lakes and Wetlands	All	As required to address site specific riparian values.	RMZ is sufficiently wide to manage for windthrow and sediment delivery hazard and wildlife habitat requirements.

4.4 Region Strategies

Riparian management strategies for each of the delineated Riparian Management Regions in Tembec's operating area are provided in the tables below. Included are the major aquatic and terrestrial management issues, discussion of ecosystem restoration potential, a priority ranking scheme, and general management guidance. There are limitations however with respect to management guidance and evaluating the need for restoration treatments. For example, the current state of riparian ecosystems in each region is generally not known or is variable within the region.

The guidance provided in Tables 12 to 19 is general in nature and intended to be used in conjunction with information provided in Tables 5 to 10 to develop general riparian strategies at the assessment unit level. Regional specific guidance (in the form of guidebooks etc.) should be developed for each management region as part of more detailed, strategic level planning activities.

Maps illustrating the spatial location of most riparian values are included for each Region in Appendix B.

Table 12. South Purcell (west[10]) Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	High	Ongoing supply of LWD is important to maintain channel and bank stability in all stream classes in this MR. RRZ are recommended for all S3 and larger streams and should include the valley flat (floodplain) and extend upslope or away from the channel for at least half a tree height. RMZ should extend a sufficient distance beyond the RRZ to manage for windthrow and sediment delivery hazards. On smaller stream classes (S4, S5 and S6) that are dependent on LWD for channel bed and bank stability[11] a RMZ with sufficient retention and size (eg. >50% basal area and half of a tree height) to ensure ongoing supply of LWD and protection of channel banks is recommended in this MR.
Sediment Delivery	Low	Saprolitic sands from weathered intrusive rocks are main sediment source in tributaries of Goat River. Avoid road and trail construction in riparian management areas where there is a high likelihood of sediment reaching stream channels.
Stream Temperature	Low	Confined valleys draining steep slopes are relatively insensitive to forestry related impacts to stream temperature. Streams draining lower gradient terrain, including Little Moyie and Meadow Creek will require RRZ and/or RMZ's that are sufficiently wide and have adequate retention to provide shade to the channels.
Aquatic Values - Fish	Low - Moderate	Burbot spawning and rearing habitat (Lower Goat River below dam): stream temperature is important but not significantly affected by forestry. Westslope Cutthroat, all life stages (Upper Goat River above dam): avoid stream sedimentation, retain overhanging vegetation, and ensure LWD input.
Terrestrial Values – Late-successional forests (LSFs)	High	The amount of LSFs is likely outside the range of variability due to past mining and logging activities and fires. Place remaining LSF patches in RRZs and RMZs. Consider partial cutting treatments with large-tree retention in RMZs to accelerate growth of trees and progression to late-successional structural conditions.
Terrestrial Values - Hardwoods	High	Major existing riparian hardwood values that should be retained are along the Lower Goat River, Kitchener Creek, Little Moyie River and in the Glenlily and Curzon areas.
Terrestrial Values - Wildlife	Low	Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs. Moose: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	High	Mining and logging activities in the early 1900's have had major impacts on riparian ecosystems in this management region. Restoration treatments are needed in many areas to speed up succession and create habitat elements.

[10] West of Moyie River

[11] Additional region-specific guidance material (such as field charts and/or guidebooks) will be necessary to enable technicians to identify key riparian – channel interactions and develop appropriate site-specific RMZ prescriptions.

Table 13. South Purcell (east[12]) Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	High	Ongoing supply of LWD is critical to maintenance of channel and bank stability along all stream classes in this MR. RRZ's are recommended for all S3 and larger streams and should include the valley flat (floodplain) and extend upslope or away from the channel for at least 0.5 tree heights. RMZ should extend a sufficient distance beyond the RRZ to manage for windthrow and sed. delivery hazards. On smaller stream classes (S4, S5 and S6) that are dependent on LWD for channel bed and bank stability a RMZ with sufficient retention and size (eg. >50% basal area and 0.5 tree heights) to ensure ongoing supply of LWD and protection of channel banks is recommended in this MR.
Sediment Delivery	Moderate	Relatively low natural rates of sediment delivery in this MR. Riparian Management Areas should extend upslope where slopes adjacent to water features exceed 50 % or in areas mapped as Class IV, V, P or U to reduce the risk of landslides related to diversion and concentration of intercepted surface and subsurface drainage along roads and trails situated on or above potentially unstable and unstable slopes.
Stream Temperature	High	Canopy cover is critical to maintaining stream temperature along many of the streams in this MR. Lower discharge and wider valleys make streams more likely to experience temperature increases following removal of riparian shade. Streams draining lower gradient terrain, including most of the tributaries to the Moyie River will require RRZ and/or RMZ's that are sufficiently wide and have adequate retention to provide shade to the channels.
Aquatic Values - Fish	High	Bull Trout spawning and Westslope Cutthroat, all life stages (Gold Creek): avoid sedimentation and maintain LWD inputs and overhanging vegetation. Kokanee (Moyie Lake; Lamb, Cotton, and Barkshanty Creeks: maintain canopy cover to avoid stream temperature increases.
Terrestrial Values – Late-successional forests (LSFs)	High	In fire-maintained ecosystems (NDT4 and NDT3 steep south aspect) retain or restore late-successional stand structure (i.e., large, widely-spaced trees). In true NDT3 ecosystems, retain LSFs where their abundance has significantly been decreased.
Terrestrial Values - Hardwoods	High	Major existing riparian hardwood values that should be retained are along the Moyie River (and Moyie Lake), Hawkins Creek, Irishman Cr. and Gold Creek
Terrestrial Values - Wildlife	High	Tailed Frog (Yahk River): observe WHA provisions and Tembec's SFMP guidelines. Coeur d'Alene Salamander (Yahk River[13], Irishman Creek): conduct further inventories and establish RRZs in suitable habitats. Great Blue Heron (Gory Creek): establish WHA at breeding colony and protect nearby lakes and wetlands foraging habitat through RRZs and RMZs. Lewis's Woodpecker (Gold Creek): observe WHA provisions and Tembec's SFMP guidelines (WHA not in Tembec operating area). Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs. Moose: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	High	The riparian areas of many of the streams were harvested in the early 1900's as rail tie reserves. Large-scale fires in the 1930's have also affected the riparian areas. Restoration treatments are needed in many areas to speed up succession and create habitat elements.

[12] East and south of Moyie River
[13] Based on Ted Antifeau, pers. comm. and requires more work to be confirmed. I suggest to follow up with Ted later. He's away right now.

Table 14. Central Purcell Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate to High	Small, low order headwater tributaries in this MR are commonly alpine-sourced, colluvial channels. Bank stability is provided by mature coniferous vegetation but only the largest LWD (~>40cm diameter) functions in these upland channels to maintain channel stability. Lower gradient intermediate-sized streams (>5m – 20 m) are entirely dependant on LWD and riparian vegetation (mature coniferous and deciduous species) to provide channel and bank stability.
Sediment Delivery	Low	This MR has relatively high natural rates of sediment delivery to main stem channels from steep, alpine sourced tributaries and extensive glaciofluvial terrace scarps
Stream Temperature	Low	Alpine sourced tributaries and steep confined valleys make this management region relatively insensitive to forestry related impact to stream temperature. Exceptions occur along the lower elevations at the eastern edge of this MR
Aquatic Values - Fish	High	Bull Trout spawning and/or rearing (St. Mary River, Findlay and Skookumchuck Creeks): avoid forestry-caused sedimentation in addition to high natural rates. Westslope Cutthroat, all life stages (St. Mary River, Findlay, Skookumchuck):
Terrestrial Values – Late successional forests (LSFs)	High	In fire-maintained ecosystems (NDT4 and NDT3 steep south aspect) retain or restore late-successional stand structure (i.e., large, widely-spaced trees). In true NDT3 ecosystems, retain LSFs where their abundance has significantly been decreased.
Terrestrial Values - Hardwoods	High	Major existing hardwood values that should be retained are along the St. Mary River, Redding Creek, and lower Skookumchuck and Findlay Creeks.
Terrestrial Values - Wildlife	High	<u>Coeur d'Alene Salamander</u> (Mark and Perry Creeks): conduct further inventories and establish RRZs in suitable habitats. <u>Lewis's Woodpecker</u>: observe WHA provisions and Tembec's SFMP guidelines. <u>Grizzly Bear</u>: maintain existing forage patches with adjacent tree cover in RMZs. <u>Moose</u>: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	Low - Moderate	Remoteness and steep slopes have limited the access into most of this MR in the past (Perry Creek riparian area has been heavily impacted by placer mining since the early 1900's as has Findlay Creek in the mid-sections).

Table 15. South Elk Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate to High	Small, low order headwater tributaries in this MR are commonly alpine-sourced, colluvial channels that experience frequent snow avalanches and debris flows. Bank stability is provided by mature coniferous vegetation but LWD functions to a limited extent in these upland channels to maintain channel stability. However, lower gradient (<20 %) intermediate streams (>5m – 20 m) are entirely dependant on LWD to provide channel and bank stability. Floods and fire are dominant recruitment mechanism in main stem channels situated on broad valley bottoms.
Sediment Delivery	Moderate	Bull Trout spawning habitat in the Wigwam is situated immediately downstream from chronic natural sediment sources. Glaciofluvial terraces provide major natural sediment sources during high flow periods. Sediment delivery to channels during low flow periods is highly detrimental to aquatic values.
Stream Temperature	Low	Alpine sourced tributaries and steep confined valleys make this management region relatively insensitive to forestry related impact to stream temperature.
Aquatic Values - Fish	High	Bull Trout, all life stages (Elk River above Elko dam, Flathead River): avoid stream sedimentation. Westslope Cutthroat, all life stages (Elk River & Tribs above Elko dam; Flathead & Wigwam Rivers, Bighorn Creek lower 2 km, Lodgepole Creek downstream of falls, Morrissey & Michel Creeks): avoid stream sedimentation, retain streamside and overhanging vegetation, and ensure LWD input. Mottled Sculpin, all life stages (Flathead River; Commerce, Burnham, Couldrey, Cabin, Howell, Sage, and Kishinena Creeks): maintain canopy cover on sun-exposed sides along creeks to avoid increase in stream temperature. Kokanee (lower Wigwam): maintain canopy cover on sun-exposed sides along river and tributaries to avoid increase in stream temperature.
Terrestrial Values – Late-successional forests (LSFs)	High	In fire-maintained ecosystems (NDT4 and NDT3 steep south aspect) retain or restore late-successional stand structure (i.e., large, widely-spaced trees). In true NDT3 ecosystems, retain LSFs where their abundance has significantly been decreased.
Terrestrial Values - Hardwoods	High	Major existing riparian hardwood values that should be retained are along the Lower Elk and Flathead Rivers. Hardwood stands are beginning to re-establish along Wigwam.
Terrestrial Values - Wildlife	High	Tailed Frog (Couldrey, Cabin, and Boyd Creeks): observe WHA provisions and Tembec's SFMP guidelines. Lewis's Woodpecker (Silver Spring Lakes area[14]): observe Tembec's SFMP guidelines. Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs; Moose: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	Moderate	Large, stand-replacing wildfires occurred in the 1930's in many of the broad valleys (Elk, Wigwam, Flathead) of this MR and salvage logging has impacted some riparian areas in Cabin/Cauldry/Ram Creeks.

[14] Cooper found a nest a few years ago between Silver Spring Lakes and the east end of the BCHydro property (Cooper et al. 2004 report for the CBFWCP on NDT4 red and blue listed species).

Table 16. North Elk Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate to High	Small, low order headwater tributaries in this MR are commonly alpine-sourced, colluvial channels. Bank stability is provided by mature coniferous vegetation but LWD functions to a limited extent in these upland channels to maintain channel stability. However, intermediate streams (>5m – 20 m) are entirely dependant on LWD to provide channel and bank stability.
Sediment Delivery	Moderate	This MR has relatively high natural rates of sediment delivery to main stem channels from steep, alpine sourced tributaries. Lower reaches of intermediate streams (~10 m) are sensitive to direct inputs of fine textured sediment.
Stream Temperature	Low	Alpine sourced tributaries and steep confined valleys make this management region relatively insensitive to forestry related impact to stream temperature.
Aquatic Values - Fish	High	Bull Trout, spawning (Line and South Line Creeks): avoid stream sedimentation Westslope Cutthroat, spawning (Elk River & Tribs above Elko dam; Fording River, outlet of lower Elk Lake, Line Creeks): avoid stream sedimentation, retain overhanging vegetation, and ensure LWD input.
Terrestrial Values – Late-successional forests (LSFs)	High	Retain LSFs in drainages where past resource developments and/or wildfire have significantly decreased their abundance.
Terrestrial Values - Hardwoods	High	Existing riparian hardwood values that should be retained are along the Upper Elk River just north of Sparwood.
Terrestrial Values - Wildlife	Low	Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs. Moose: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	Moderate	Logging has impacted riparian ecosystems along several of the larger tributary channels.

Table 17. Central Rocky Mountain Trench (central[15]) Management Region Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate to Low	Large systems that flow through this MR are generally insensitive to disturbances to riparian areas due to extensive fire history and wide floodplains. Local impacts to channel stability occur where there has been clearing for agriculture along the banks of the Lower Lussier above reach 4. Smaller streams in this MR are primarily ephemeral and subject to frequent disturbance events (fires). One exception to this is the area north of the Whiteswan FSR that drains north to the Kootenay River. These small, low gradient channels are moderately dependent on LWD for channel bed and bank stability.
Sediment Delivery	Low	Stream are flowing over wide, low gradient valleys and are generally de-coupled from valley sides.

[15] To the west of the ridge dividing upper and lower Lussier Rivers (Sharktooth Mtn) and to the west of Whiteswan lake. (Lower Lussier, Kootenay River).

Stream Temperature	Low to Moderate	Small streams flowing through this area are typically ephemeral but could be sensitive to canopy related (where present) temperature influences due to the low gradient (i.e. small streams north of the Whiteswan FSR as noted above). Large systems such as the lower Lussier and Kootenay Rivers are entirely insensitive to canopy related temperature influences.
Aquatic Values - Fish	Low	Burbot spawning (SW corner tributary of Columbia Lake): maintain canopy cover upstream from spawning areas, to avoid increases in stream temperature Westslope Cutthroat, all life stages (Kootenay River): avoid stream sedimentation, retain overhanging vegetation, and ensure LWD input.
Terrestrial Values – Late-successional forests (LSFs)	High	In fire-maintained ecosystems (NDT4 and NDT3 steep south aspect) retain or restore late-successional stand structure (i.e., large, widely-spaced trees). In true NDT3 ecosystems, retain LSFs where their abundance has significantly been decreased.
Terrestrial Values - Hardwoods	High	Existing riparian hardwood values that should be retained are along the Kootenay River.
Terrestrial Values - Wildlife	Moderate	Great Blue Heron (Saughum Lake): monitor colony status and protect colony site and surrounding foraging habitat. Lewis's Woodpecker: observe WHA provisions and Tembec's SFMP guidelines. Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs. Moose: maintain mix of tree cover and forage sites in RMZs.
Need for Riparian Ecosystem Restoration	Moderate	The main valley floor and lower tributaries have experienced long-term logging and other resources developments. Fire suppression has significantly altered stand structure in the trench.

Table 18. Central Rocky Mountain (east[16]) Management Region Management Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate	Tributary channels are dominated by colluvial processes (snow avalanche and debris flows). Low gradient mainstem channels are dominated by alluvial processes. Riparian vegetation provides bank stability along most of the main stem channels although fires and poor site conditions have generally limited the influence of riparian vegetation on channel condition in this MR.
Sediment Delivery	Low	Actively eroding glaciofluvial terrace scarps bound all of the main river systems in this MR.
Stream Temperature	Low	Alpine sourced tributaries and steep confined valleys make this management region relatively insensitive to forestry related impact to stream temperature.
Aquatic Values - Fish	High	Bull Trout, spawning (White & Lussier[17] Rivers, Blackfoot[17] & Thunder Creeks): avoid sedimentation of streams Westslope Cutthroat, all life stages (White River & tribs; Lussier River): avoid stream sedimentation, retain overhanging vegetation, and ensure LWD input.

[16] To the east of Whiteshwan Lake and including the upper Lussier, Wildhorse and Fenwick River watersheds.

[17] Chirico, A. 2005. High Conservation Value (HCV) Fisheries Watersheds in the Rocky Mountain and Kootenay Lake Forest Districts. MSRM, Nelson, BC.

Terrestrial Values – Late-successional forests (LSFs)	High	Retain LSFs in drainages where past resource developments and/or wildfire have significantly decreased their abundance.
Terrestrial Values - Hardwoods	High	Existing riparian hardwood values that should be retained are along the Lussier River and White River just northof Whiteswan Lake.
Terrestrial Values - Wildlife	Low	Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs Moose: maintain mix of tree cover and forage sites in RMZs.
Integrity of Riparian Ecosystem Function (Need for Restoration)	Low	The riparian ecosystems of larger systems in this MR have historically been limited by natural fire regime and relatively poor site conditions.

Table 19. North Purcell Management Region Management Priorities and Guidance

Management Issues	Priority Rank	Management Guidance
Channel and Bank Stability	Moderate	Channel stability on the wide floodplain of the Spillimacheen will be locally dependant on the mature coniferous vegetation.
Sediment Delivery	Moderate	This MR has relatively high natural rates of sediment delivery to main stem channels from steep, alpine sourced tributaries.
Stream Temperature	Low	Alpine sourced tributaries and steep confined valleys make this management region relatively insensitive to forestry related impact to stream temperature.
Aquatic Values - Fish	Low	Westslope Cutthrout Trout can be found in the TFL's only non-glacier fed stream (Driftwood Creek). Use RRZs and/or RMZs to prevent sediment input and maintain shade.
Terrestrial Values – Late-successional forests (LSFs)	High	Retention of the oldest age-classes will benefit riparian ecosystems. Late-seral patches in this management region are included in HCVF reserve areas.
Terrestrial Values - Hardwoods	Low	There are no extensive hardwood stands along the Spillimacheen River and its major tributaries.
Terrestrial Values - Wildlife	Low	Grizzly Bear: maintain existing forage patches with adjacent tree cover in RMZs. Moose: maintain mix of tree cover and forage sites in RMZs. Note: HCV1-3 mapping may help to further define values spatially.
Need for Riparian Ecosystem Restoration	High	There is a general lack of LSFs in the TFL. Much of the THLB burned <100 years ago creating a current seral stage distribution that is likely outside the range of natural variability (see Utzig and Holt 2002). Consider partial cutting treatments with large tree retention in RMZs to accelerate tree growth and progression to late-successional stand structure.

5.0 FSC Current Condition Assessment

To assess compliance with FSC requirements for riparian retention, a process for assessing 'current conditions' within a Riparian Assessment Unit is required. This section of the document details how riparian retention requirements (budgets) were determined for four sample assessment units and evaluated against current conditions.

5.1 Riparian Assessment Units

The first step in evaluating consistency with FSC requirements is to define the geographic areas over which an evaluation would occur. FSC appendix P6a refers to these areas as a Riparian Assessment Units and describes them as 'watersheds or other landscape level ecological units of 5,000-50,000 ha" in size (Table 3 in Appendix P6a).

One of the objectives of this project was to define the appropriate size/scale of Assessment Units to be used in Tembec's operating area. In general, larger units would allow more flexibility to deploy retention where important values exist and are administratively more efficient, while smaller areas ensure more even spatial distribution across the land base and are administratively less efficient. As one of the key elements of FSC's approach to riparian management is to allocate retention where it will provide the best value, larger units are preferred. In addition, Table 3 in Appendix P6a limits the amount of flexibility associated with riparian reserves as follows: "*total reserve zone area should never be below 80% of the budget for any specific class*". This ensures a basic level of spatial distribution within watersheds (by stream class) is occurring, even in larger units.

Riparian Assessment units should ideally be full watersheds even when multiple licensees operate within a watershed. Ideally, riparian assessments are to be integrated with other managers in these cases, but where not possible, FSC states that "*the manager can proceed with an assessment limited to the management unit, but the assessment must still define an appropriate assessment unit, and take into account the context of the whole assessment unit when developing a riparian management strategy*"[18]. Because no other licensees are pursuing FSC certification in the management units in which Tembec operates, the assessment of budgets and compliance will be limited to Tembec's areas, but outside context will be considered when detailed strategies are developed.

For these reasons, it is recommended that Riparian Assessment Units be:

1. Within a single Riparian Management Region,
2. Confined to Tembec's operating area (for budgets and compliance)
3. A logical watershed unit with a forested area of around 30,000 - 50,000 ha in size, or groups of smaller watershed units of similar character that have a total forested area in this size range.
4. Be developed in a coordinated manner to ensure that all areas of Tembec operating areas are included in a logical assessment unit (4-6 units per Riparian Management Region).

This project delineated four test Riparian assessment units for the purpose of piloting a methodology to determine retention budgets and assess current conditions relative to budgets. The units were selected to achieve variation in geographic locations, size, logging history, level of inventory information, and ownership types. The four areas mapped in Appendix C and are listed below.

1. Lower Spillimacheen Subbasin (TFL 14)
2. Skookumchuck Watershed (Invermere TSA)
3. Meachen-Hellroaring Creek Watersheds (Cranbrook TSA)

18 Appendix P6A pg 58 – Identification of Riparian Assessment Units and Riparian Issues

4. Teepee Creek (Cranbrook TSA – Tembec portion of watershed. This unit includes a small portion of Gold creek because it would have been isolated otherwise)

These areas are not all consistent with the objectives for defining assessment units discussed above but the process of working with these units helped to develop these guidelines. It is recommended that these units be revisited such that each of the Regions discussed in Section 4 is logically broken up into four to six assessment units.

5.2 Riparian Retention Budgets

FSC criterion 6.5.bis1 (b) requires that a riparian management regime meet or exceed the retention budgets for Reserve Zones and Management Zones specified in Table 3 of Appendix P6a (Riparian Management). A simplified version of this table is provided below.

Table 20. Minimum budgets to be deployed during implementation of integrated riparian assessments. Budgets are to be applied at the Riparian Assessment Unit Level.

Riparian Class	Riparian Budget Minimums[1]	Equivalent Default Widths
S1 and S2	RRZ: 6 ha/km RMZ: 8 ha/km with 65% BA retention	RRZ: 30m each side RMZ: 40m each side (65% retention)
S3 and S4	RRZ: 6 ha/km RMZ: 4 ha/km with 65% BA retention	RRZ: 30m each side RMZ: 20m each side (65% retention)
S5a and S6a	RRZ: 4 ha/km RMZ: 4 ha/km with 65% BA retention	RRZ: 20m each side RMZ: 20m each side (65% retention)
S5b and S6b	NDT 1,2,4: RMZ: 3 ha/km with 30% BA retention NDT 3: RMZ: 3 ha/km with 10% BA retention	NDT 1,2,4: RMZ: 15m each side (30% retention) NDT 3: RMZ: 15m each side (10% retention)
W1-W5	RRZ: 2 ha/km RMZ: 1.5 ha/km with 30% BA retention	RRZ: 20m from edge of wetland RMZ: 15m from edge (30% retention)
L1-L4	RRZ: 1.5 ha/km RMZ: 1.5 ha/km with 30% BA retention	RRZ: 15m from edge of wetland RMZ: 15m from edge (30% retention)
Other Lakes & Wetlands	RMZ: 1.5 ha/km with 30% BA retention	RMZ: 15m from edge (30% retention)

[1] Budgets are to be calculated and applied at the Riparian Assessment Unit level using the forested area of the unit. The intent of the flexibility is to allow limited tradeoffs between the reserve and management zones and between classes, as long as the 'equivalent total retention' is comparable; however, total reserve zone area should never be below 80% of the budget for any specific stream class.

The table footnote indicates that achieving the total budget (ha of retention) for an assessment unit is only one of the requirements, as the following minimum reserve budgets must also be met within each riparian class (see table footnote above):

S1	4.8 ha/km of RRZ within the assessment unit
S2	4.8 ha/km of RRZ within the assessment unit
S3	4.8 ha/km of RRZ within the assessment unit
S4	4.8 ha/km of RRZ within the assessment unit
S5a	3.2 ha/km of RRZ within the assessment unit
S6a	3.2 ha/km of RRZ within the assessment unit
W1-5	1.6 ha/km of RRZ within the assessment unit for each wetland class
L1-4	1.2 ha/km of RRZ within the assessment unit for each lake class

The sections below outline the methodology used for determining the riparian budgets for the test assessment units and the results of these calculations.

5.2.1 Methodology

The following methodology was used to determine the riparian retention budgets for each of the test assessment units. The budget is expressed in terms of a minimum area (ha) that must be designated for riparian retention in each assessment unit. This area is based on 100% retention so if management is anticipated in certain zones additional area must be left behind to leave an equivalent amount of retention. For example, a 10m reserve is equivalent to a 20m RMZ with 50% BA retention.

1. Assemble all water features in the assessment unit and assign riparian classes.
    a. Obtain lakes and wetland GIS coverages from Tembec and fill in unknown riparian classes based on FSC criteria (common with Forest Practices Code). Classes based on size (ha) of the water feature, BEC zone, fish presence/absence where available and proximity to other water features (complexes).
    b. Obtain streams GIS coverage from Tembec and fill in unknown riparian classes. Most of the major water features have defined classes and the coverage is continually being updated with streams as they are classified so future analysis will have less to fill in (most streams still do not have a class). Obvious extrapolations between currently classified reaches were manually assigned for major streams. An expert system was built upon currently existing data (fish presence/absence, stream gradient, Community watershed/domestic watershed desginations, and length of stream above reach) to assign the balance of classes. Fish presence, stream gradient, and CWS data was used to group streams into S1-4 vs S5-6 and then the length (meters) of stream contributing to the reach in question was used to predict riparian class (surrogate for width). Width was not predicted directly because no width data was available to the project but there were 782 km's of streams within the pilot assessment units with defined riparian classes through watershed assessment work or forestry development work. These were used to define the following thresholds for use in stream classification:

Table 21. Stream classification predicted by upstream contributing length

Stream Class	Upstream Contributing Length[19]	% Sample Captured by Upstream Length Class	Km's of Stream in Sample
S1	250,000+ m	89%	49
S2	29500 -249,999 m	49%	172
S3	4,500 – 29,499m	70%	105
S4	0 – 4,499 m	84%	54
S5	3,500+ m	59%	113
S6	0 - 3,499 m	86%	289
		Total	782

    c. The S5 and S6 classifications were then broken down into a/b's using the presence of domestic watersheds and proximity to fish streams. S5's were assigned an S5a status if they were inside a domestic watershed or were <=500m upstream of a fish stream. S6's were assigned an S6a status if they were inside a domestic watershed or were <=250m upstream of a fish stream.

2. Buffer water features using widths defined by FSC in Table 3 of Annex P-6A (Table 20 above) for both reserve and management areas.
3. Limited to Tembec's operating area, determine the crown forested area with RRZ's and RMZ's for each riparian class without double counting overlapping areas. Assign reserve designations over management designations where overlaps occur. Where all else is equal, tally overlaps toward

[19] This length was determined by routing the stream network and establishing sinks at the top end of each stream reach – this included creating centrelines through lakes and wetlands so the network was not broken. All upstream branches were tallied and assigned to each sink as the 'upstream contributing length' for that reach. Where the full upstream extent was not included in the assessment unit, an approximate additional length was added to the relevant reaches.

lakes first, then wetlands, and finally streams. Multiply the RMZ area within each class by the required percent retention for that class (i.e. for S3, 100ha of RMZ x 65% = 65ha of equivalent 100% retention). Sum the RRZ area and the equivalent RMZ retention area for each class to get a total retention budget for the Riparian Assessment Unit.

4. Calculate 80% of the RRZ area associated with each riparian class to identify the minimum RRZ thresholds for each riparian class.

5.2.2 Results

The results of the budget assessments for each of the pilot Riparian Assessment Units are provided below. Budgets for the units have two components:

1. An overall Assessment Unit budget expressed as hectares of full retention, and
2. A riparian class specific budget (80% of the total reserve zone budget for the class).

Both of the budgets must be met to be consistent with FSC requirements. The first is a broad budget that specifies the overall level of retention required in the unit, and the second is a minimum level of reserve that must be maintained within each riparian class. The budget system allows significant flexibility to move retention around within a riparian class and limited flexibility to move between classes.

The budget values presented here represents hectares of 100% retention and are only relevant to Tembec's operating areas within the assessment unit. Actual retention strategies implemented on the ground will consist of both reserves (100% retention) and management zones (partial retention). The management zone areas contribute toward budgets based on a prorated area basis. For example, an area with 70% retention would have 70% of its area contribute toward meeting budget requirements.

5.2.2.1 Lower Spillimacheen

The overall budget for this assessment unit is 785 ha of retention, with 52% of this required in specific riparian classes (Table 22). S4 streams make up the single biggest component of the retention requirement.

Table 22. Lower Spillimacheen Riparian FSC Retention Budgets

Riparian Feature	Riparian Class	RRZ ha*	RMZ ha*	Retention Percent	Effective RMZ ha	Total Effective Retention ha	Class Specific Budget ha
Lake	L1	10.5	10.8	30	3.2	13.7	**8.4**
	L2	-	-	30	-	-	**-**
	L3	11.1	9.1	30	2.7	13.9	**8.9**
	L4	-	-	30	-	-	**-**
	NC	-	3.4	30	1.0	1.0	**-**
Wetland	W1	41.2	28.4	30	8.5	49.7	**33.0**
	W2	-	-	30	-	-	**-**
	W3	39.7	28.6	30	8.6	48.3	**31.8**
	W4	-	-	30	-	-	**-**
	W5	-	-	30	-	-	**-**
Stream River	S1	73.1	85.8	65	55.7	128.9	**58.5**
	S2	1.2	2.5	65	1.6	2.9	**1.0**
	S3	75.4	49.8	65	32.4	107.8	**60.4**
	S4	195.5	132.8	65	86.3	281.8	**156.4**
	S5a	11.9	11.8	65	7.7	19.6	**9.6**
	S5b	-	1.2	30	0.4	0.4	**-**
	S6a	51.9	58.3	65	37.9	89.7	**41.5**
	S6b	-	90.7	30	27.2	27.2	**-**
Assessment Unit Retention Budget						**784.9**	409.3

* Calculated using GIS buffering techniques to avoid double counting of overlap areas between streams, lakes and wetlands. Calculations based off feature lengths would give inflated estimates.

5.2.2.2 Skookumchuck

The overall budget for this assessment unit is 4196 ha of retention, with 50% of this required in specific riparian classes (Table 23). S4 streams make up the single biggest component of the retention requirement.

Table 23. Skookumchuck Riparian FSC Retention Budgets

Riparian Feature	Riparian Class	RRZ ha*	RMZ ha*	Retention Percent	Effective RMZ ha	Total Effective Retention ha	Class Specific Budget ha
Lake	L1	14.0	14.4	30	4.3	18.3	**11.2**
	L2	2.6	3.0	30	0.9	3.5	**2.1**
	L3	7.9	7.9	30	2.4	10.3	**6.3**
	L4	3.0	2.0	30	0.6	3.6	**2.4**
	NC	-	4.8	30	1.4	1.4	**-**
Wetland	W1	59.5	39.7	30	11.9	71.4	**47.6**
	W2	2.0	1.6	30	0.5	2.5	**1.6**
	W3	42.6	29.8	30	8.9	51.6	**34.1**
	W4	-	-	30	-	-	**-**
	W5	1.7	1.4	30	0.4	2.1	**1.4**
Stream River	S1	252.9	324.3	65	210.8	463.7	**202.3**
	S2	263.1	286.0	65	185.9	449.0	**210.5**
	S3	507.8	313.2	65	203.6	711.4	**406.3**
	S4	1,014.1	688.8	65	447.7	1,461.8	**811.2**
	S5a	98.8	105.6	65	68.6	167.5	**79.1**
	S5b	-	9.3	30	2.8	2.8	**-**
	S6a	375.9	450.9	65	293.1	668.9	**300.7**
	S6b	-	354.2	30	106.3	106.3	**-**
Assessment Unit Retention Budget						**4,196.2**	2,116.9

* Calculated using GIS buffering techniques to avoid double counting of overlap areas between streams, lakes and wetlands. Calculations based off feature lengths would give inflated estimates.

5.2.2.3 Meachen/Hellroaring

The overall budget for this assessment unit is 2484 ha of retention, with 48% of this required in specific riparian classes (Table 24). S4 streams make up the single biggest component of the retention requirement.

Table 24. Meachen/Hellroaring Riparian FSC Retention Budgets

Riparian Feature	Riparian Class	RRZ ha*	RMZ ha*	Retention Percent	Effective RMZ ha	Total Effective Retention ha	Class Specific Budget ha
Lake	L1	12.7	11.2	30	3.4	16.0	**10.1**
	L2	-	-	30	-	-	**-**
	L3	2.7	2.5	30	0.8	3.4	**2.1**
	L4	-	-	30	-	-	**-**
	NC	-	2.4	30	0.7	0.7	**-**
Wetland	W1	1.9	1.0	30	0.3	2.2	**1.5**
	W2	-	-	30	-	-	**-**
	W3	0.3	0.3	30	0.1	0.4	**0.3**
	W4	-	-	30	-	-	**-**
	W5	-	-	30	-	-	**-**
Stream River	S1	63.2	75.5	65	49.1	112.3	**50.6**
	S2	275.9	310.4	65	201.7	477.7	**220.7**
	S3	322.3	184.5	65	119.9	442.2	**257.9**
	S4	454.5	306.9	65	199.5	654.0	**363.6**
	S5a	88.2	93.8	65	61.0	149.2	**70.6**
	S5b	-	23.4	30	7.0	7.0	**-**
	S6a	278.2	336.3	65	218.6	496.8	**222.5**
	S6b	-	406.3	30	121.9	121.9	**-**
Assessment Unit Retention Budget						**2,484.0**	1,200.0

* Calculated using GIS buffering techniques to avoid double counting of overlap areas between streams, lakes and wetlands. Calculations based off feature lengths would give inflated estimates.

5.2.2.4 Teepee (Tembec Portion)

The overall budget for this assessment unit is 1464 ha of retention, with 52% of this required in specific riparian classes (Table 23). S4 streams make up the single biggest component of the retention requirement.

Table 25. Teepee Riparian FSC Retention Budgets

Riparian Feature	Riparian Class	RRZ ha*	RMZ ha*	Retention Percent	Effective RMZ ha	Total Effective Retention ha	Class Specific Budget ha
Lake	L1	-	-	30	-	-	**-**
	L2	-	-	30	-	-	**-**
	L3	0.9	0.8	30	0.3	1.2	**0.8**
	L4	-	-	30	-	-	**-**
	NC	-	0.7	30	0.2	0.2	**-**
Wetland	W1	4.8	2.8	30	0.8	5.6	**3.8**
	W2	-	-	30	-	-	**-**
	W3	10.5	7.0	30	2.1	12.6	**8.4**
	W4	-	-	30	-	-	**-**
	W5	-	-	30	-	-	**-**
Stream River	S1	58.1	63.7	65	41.4	99.5	**46.5**
	S2	116.2	135.3	65	87.9	204.2	**93.0**
	S3	148.7	84.9	65	55.2	203.9	**118.9**
	S4	503.9	323.4	65	210.2	714.1	**403.1**
	S5a	1.5	1.7	65	1.1	2.7	**1.2**
	S5b	-	-	30	-	-	**-**
	S6a	108.1	126.6	65	82.3	190.4	**86.5**
	S6b	-	100.0	30	30.0	30.0	**-**
Assessment Unit Retention Budget						**1,464.4**	762.2

* Calculated using GIS buffering techniques to avoid double counting of overlap areas between streams classes, lakes buffers and wetlands buffers. Calculations based off feature lengths would give inflated zone areas.

5.3 Current Condition Analysis

In order to understand how current riparian conditions measure up against the FSC retention budgets for each of the pilot assessment units, a current conditions analysis was preformed. This analysis utilized GIS tools with forest cover data, logging history information, and the riparian information generated during the budget calculation stage. A detailed description of the methodology used is provided below.

5.3.1 Methodology

To assess current condition for riparian retention in each assessment unit, the following steps were used:

a. For each stream class, an area adjacent to riparian features was defined using buffers and ecosystem data. 'Adjacent to riparian' will be defined as twice the width of the FSC default reserve and management zone areas plus any forested hydric and hygric sites from the PEM occurring outside this area (only TFL and Invermere units had ecosystem data of sufficient accuracy for use in this project). The objective for defining this area is to allow recognition of riparian retention occurring beyond the default FSC widths. Twice the default RRZ+RMZ width was chosen because it likely represents the outer limit of where retention can be linked with riparian values (terrestrial riparian values become less likely to occur). The FSC default widths are somewhat arbitrary so the intent was to extend these areas by some reasonable amount for accounting purposes. The width suggested here likely represents a reasonable balance between including stands that we know have no relationship with riparian areas (i.e. 2km away) and those that can potentially contribute to riparian values or protect the area providing riparian values. It also reflects varying widths associated with different classes of streams.

b. The area of non-logged forest within this 'adjacent' buffer was tallied as existing riparian retention. Stands of all ages were eligible to count toward riparian goals as long as they have not been logged because younger stands still provide some riparian values. If a stand was partially logged, a portion of the stands area was tallied as retention based on the percent of the stand retained (as defined by the % logged field in the forest cover data). For the most part, retention left along riparian areas in blocks could not be recognized in the analysis because the digital data used does not capture information at this scale.

c. The total hectares of retention by stream class is summed for the assessment unit and compared to the overall budget.

d. The hectares of retention occurring with the RRZ for each stream class is summed and compared to the class specific minimum thresholds for RRZ's.

5.3.2 Results

The results of the current conditions analysis for each of the pilot Riparian Assessment Units are provided below. In each case, the budget minimums were compared with current (Aug 2005) retention levels to assess consistency with FSC requirements. Both riparian class specific requirements and overall assessment unit requirements were examined.

5.3.2.1 Lower Spillimacheen

The results of the current condition assessment for the Lower Spillimacheen assessment unit are provided in the table below and mapped in Appendix C.

Table 26. Lower Spillimacheen Current Conditions Relative to Targets

Riparian Feature	Riparian Class	Class Specific Budget (ha)	Retention Area (ha)	Class Specific Surplus / Deficit		Assess Unit Budget (ha)	Assess Unit Retention (ha)	Assess Unit Surplus / Deficit
Lake	L1	8	33	**25**		785	1,376	**591 Surplus**
	L2	-	-	**-**				
	L3	9	36	**27**				
	L4	-	-	**-**				
	NC	-	2	**2**				
Wetland	W1	33	90	**57**				
	W2	-	-	**-**				
	W3	32	100	**68**				
	W4	-	-	**-**				
	W5	-	-	**-**				
Stream River	S1	58	234	**175**				
	S2	1	8	**7**				
	S3	60	186	**126**				
	S4	156	371	**215**				
	S5a	10	30	**20**				
	S5b	-	2	**2**				
	S6a	41	158	**117**				
	S6b	-	126	**126**				

Area requirements are current met with significant surpluses occurring in all riparian classes.

5.3.2.2 Skookumchuck

The results of the current condition assessment for the Skookumchuck assessment unit are provided in the table below and mapped in Appendix C.

Table 27. Skookumchuck Current Conditions Relative to Targets

Riparian Feature	Riparian Class	Class Specific Budget (ha)	Retention Area (ha)	Surplus / Deficit		Assess Unit Budget (ha)	Assess Unit Retention (ha)	Surplus / Deficit
Lake	L1	11	56	**45**		4,196	8,749	**4,553 Suplus**
	L2	2	13	**11**				
	L3	6	30	**24**				
	L4	2	9	**7**				
	NC	-	4	**4**				
Wetland	W1	48	157	**110**				
	W2	2	7	**5**				
	W3	34	116	**82**				
	W4	-	-	**-**				
	W5	1	6	**4**				
Stream River	S1	202	977	**775**				
	S2	210	841	**631**				
	S3	406	1,320	**914**				
	S4	811	2,889	**2,078**				
	S5a	79	323	**244**				
	S5b	-	17	**17**				
	S6a	301	1,333	**1,033**				
	S6b	-	649	**649**				

Area requirements are current met with significant surpluses occurring in all riparian classes.

5.3.2.3 Meachen/Hellroaring

The results of the current condition assessment for the Meachen/Hellroaring assessment unit are provided in the table below and mapped in Appendix C.

Table 28. Meachen/Hellroaring Current Conditions Relative to Targets

Riparian Feature	Riparian Class	Class Specific Budget (ha)	Retention Area (ha)	Surplus / Deficit		Assess Unit Budget (ha)	Assess Unit Retention (ha)	Surplus / Deficit
Lake	L1	10	45	**35**		2,484	5,090	**2,606 Surplus**
	L2	-	-	**-**				
	L3	2	12	**10**				
	L4	-	-	**-**				
	NC	-	2	**2**				
Wetland	W1	2	5	**3**				
	W2	-	-	**-**				
	W3	0	1	**1**				
	W4	-	-	**-**				
	W5	-	-	**-**				
Stream River	S1	51	218	**167**				
	S2	221	826	**605**				
	S3	258	727	**469**				
	S4	364	1,245	**881**				
	S5a	71	284	**213**				
	S5b	-	42	**42**				
	S6a	223	961	**739**				
	S6b	-	723	**723**				

Area requirements are current met with significant surpluses occurring in all riparian classes.

5.3.2.4 Teepee (Tembec Portion)

The results of the current condition assessment for Tembec's portion of the Teepee assessment unit are provided in the table below and mapped in Appendix C.

Table 29. Teepee Current Conditions Relative to Targets

Riparian Feature	Riparian Class	Class Specific Budget (ha)	Retention Area (ha)	Surplus / Deficit		Assess Unit Budget (ha)	Assess Unit Retention (ha)	Surplus / Deficit
Lake	L1	-	-	**-**		1,464	2,132	**667 Surplus**
	L2	-	-	**-**				
	L3	1	3	**3**				
	L4	-	-	**-**				
	NC	-	1	**1**				
Wetland	W1	4	8	**4**				
	W2	-	-	**-**				
	W3	8	21	**13**				
	W4	-	-	**-**				
	W5	-	-	**-**				
Stream River	S1	46	166	**120**				
	S2	93	334	**241**				
	S3	119	310	**191**				
	S4	403	929	**526**				
	S5a	1	0	**(1)**				
	S5b	-	-	**-**				
	S6a	86	250	**163**				
	S6b	-	109	**109**				

Area requirements are current met with significant surpluses occurring in almost all riparian classes. The S5a class specific target is not currently met but this should be considered inconsequential because of the small associated area (<1 ha).

5.4 Conclusions and Recommendations

The results of the current condition analyses indicate consistency with FSC minimum requirements even though riparian retention within logged blocks was generally not reflected in the data used. This result provides planners with general guidance on the status quo and an indication of the amount of flexibility available when implementing riparian retention strategies based on values/vulnerabilities. Where significant surpluses exist, more flexibility exists around retention widths and/or shifting retention hectares between specific riparian classes. Planners can refer to the Current Condition Maps in Appendix B to see where retention statistics were derived from. This can be a starting point for identifying a retention strategy for the unit that meets the defined FSC budget. Each of the units assessed in this project would require planners to decide how to best pair down the mapped retention from its current surplus to the target level. This process would be informed by the riparian values and risks identified in previous sections of this report and the values maps in Appendix B.

During the course of completing these assessments, the following issues were recognized:

- This approach does not adequately recognize the riparian retention strategies implemented within blocks because the current cutblock harvest data does not have sufficient spatial resolution. Stratums for RRZ's and RMZ's with % retention attributes are not captured in the data and it is unlikely that this level of data will be collected in the current data-capturing environment. Where available, the overall block retention level was used to determine retention levels adjacent to water features (even reserve zones) so this approach should be considered conservative.
- The buffer width chosen here to assess current levels of retention is somewhat arbitrary and has a significant impact on analysis results. This buffer is not intended to be a RRZ or RMZ, but was established only as an area where riparian retention may be occurring. It is felt that the width selected is appropriate for this coarse level assessment of conditions, but as detailed spatial retention plans are put in place based on values, a more accurate result will be obtained. It is expected that actual retention widths will vary, with some larger than what was assumed here and some smaller than what was assumed here.
- Challenges exist in defining budgets and assessing current conditions because of unknown stream classes and/or inaccurate mapping of streams (missing streams / mapping of non classified drainages, inaccurate mapped stream locations relative to GPS's block boundaries).

The following recommendations are made for ongoing tracking of consistency with FSC requirements:

- Ideally, spatially explicit retention strategies for S1-S3 streams and larger lakes/wetlands are completed within each assessment unit based on the strategies provided in this document, local knowledge, and topography considerations. The GIS analysis process developed in this report can be used to illustrate compliance with FSC minimum targets until this spatial mapping of retention is completed. The GIS results provide a starting point from which planners can produce a customized retention strategy for the unit.
- Because of the high degree of uncertainty around small stream (S4-S6's) locations and classifications, it may be necessary to move away from GIS methods for assessing compliance (current condition) and implement a tracking mechanism at the operational level. As streams are encountered in development activities, implement retention based on the strategies provided in this document, and then record the amount of retention (ha/km) by riparian class for each cutting permit(could range from 0 up). This data can likely be tracked in Tembec's existing riparian database with only minor modifications. At the end of the year, the retention targets for each stream class (expressed in ha/km) can be assessed against actual on the ground retention levels. This practice would be less effective for larger streams because they are encountered less and a

yearly sample would not likely provide the flexibility to address retention priorities within assessment units. This is why the pervious point suggests the reliance on GIS analysis or spatial mapping of retention areas for these larger features. The drawbacks of this approach are the additional administration for operational crews and the somewhat reduced flexibility to move retention between riparian classes.

6.0 Implementation at the Riparian Assessment Unit Level

Once a budget has been defined for a Riparian Assessment Unit, the following steps are recommended for implementing the budget spatially into a Retention Plan for the unit as a whole.

1. Identify which of the riparian values/sensitivities from Table 1 / Table 2 occur in the assessment unit using the maps in Appendix B, local knowledge, and the appropriate Regional Priorities and Guidance table (Tables 12-19).
2. Create more detailed mapping of the assessment unit if required to show key issues, sensitivities, and relevant base information (topography, fish barriers, rare riparian ecosystems, etc). General descriptions of the Management Region it falls in can be obtained from the Regional Characteristics tables in Section (4.2) and much of the spatial information is shown on the Riparian Values maps for each region (Appendix B).
3. Review general management strategies (Section 4.3) and region specific management guidance (Section 4.4) to define strategies to conserve values or mitigate impacts. Issues such as existing riparian condition (ecosystem integrity and health) and sources of impacts (past and present) in the unit (range, mining, development, etc) are discussed here but should be refined specific to the Assessment Unit being worked on.
4. Consider the unit's values/sensitivities/characteristics (Step 1 & 2), recommended strategies (Step 3), and the existing riparian condition (Step 3) to finalize management priorities specific to the assessment unit.
5. Spatially allocate the class specific budgets within each riparian class based on the priorities. Then define where the remaining budget is best allocated across classes. As discussed in Section 5.4, it may be best to spatially allocate retention only for large features at this stage and leave the small features to be tracked separately based on field data. A starting point for this exercise would be to use the buffers shown on the Current Condition maps and then begin to shave surplus area away in the least valuable riparian areas until the retention targets are reached.
6. Map and implement retention strategy.
7. Monitor implementation and effectiveness.

Once a retention plan was in place, operational activites would simply avoid harvesting in areas designated for riparian retention and follow any partial retention strategies identified in the plan.

If retention plans for Assessment Units have not yet been developed, the following guidance can apply at the operational level (meant as interim guidance until retention plans are in place). For a given riparian class (S1, L3, etc):

1. If an Assessment Unit's current condition has been assessed relative to FSC budgets:
    a. And, the riparian class in questions shows a surplus and the unit as a whole shows a surplus, planners/layout crews can decide what level of retention makes operational sense relative to the terrain, values, and risks associated with a stream/lake/wetland. If it's a low priority for retention (Section 4.4 will help to define this) then something less than the FSC default widths could be retained. If there are high values associated with a riparian area, then the values should be addressed through whatever retention makes sense. Keep in

mind that implementing the FSC default width will still reduce the surplus because the current condition numbers give credit to any area within twice the default width.

b. Or, if the riparian class in questions shows a surplus and the unit as a whole is close to target or in a deficit situation, options exist to retain less than twice the default width for this class and look for additional retention to be implemented on other deficit classes. Maintaining twice the default widths will maintain the status quo for both the class and the assessment unit as a whole.

c. Or, if a riparian class shows a deficit within an assessment unit then at least twice the default widths should be retained at the cutting permit level. Where deficits are present, it is because other riparian areas in the Assessment Unit are heavily impacted. If riparian values are present or it makes good operational sense, additional area beyond these widths should be left. Looking at retention at the cutting permit level should allow some flexibility in putting the retention where the highest values exist. For example, if a permit has 12 S6 streams and S6's are currently in a deficit situation, significant retention may be identified on a subset of the streams while little of no retention is left on the rest – but overall the retention level is at least twice the default widths.

d. Or, if a riparian class is close to its target then retention should be left at the cutting permit level to make up retention equivalent to twice the default widths. This will maintain the current status for the riparian class.

2. If an Assessment Unit has not been defined for the area or no 'current condition' has been defined, then FSC defaults should be managed for at the cutting permit level. For each stream class, the appropriate ha/km of stream should be identified where it will capture the highest riparian values. For example, if a permit has 12 S6b streams, retention may be identified on a subset of the streams with higher values while little or no retention is left on the rest – but overall the retention level is at least equal to the FSC default ha/km of retention (defined in Table 20) and riparian values/functions have not been comprised on any of the streams. A form similar to the following could be completed for each cutting permit to show compliance.

CP 123 (Blocks 1-5)

Rip Classes Present in the CP	Length/Perimeter Within or Adjacent to CP (km's)	Ha of RRZ in CP	**Ha/km of RRZ Retained**	FSC RRZ 80% Min Reqmt (ha/km)	Ha of RMZ in CP	Avg % Retn in RMZ	Equv. Ha/km of RMZ Retained	**Total Equivlent Full Retn (ha/km)**	FSC Total Req'd (ha/km)
S1	0			4.8					11.2
S2	0			4.8					11.2
S3	0.255	1.450	**5.7**	4.8	1.15	65%	2.9	**8.6**	8.6
S4	0.566	2.750	**4.9**	4.8	4.25	50%	3.8	**8.6**	8.6
S5a	0			3.2					6.6
S5b (NDT3)	0			0.0					0.3
S5b (NDT1,2,4)	0			0.0					0.9
S6a	0.133	0.425	**3.2**	3.2	1.8	25%	3.4	**6.6**	6.6
S6b (NDT3)	0			0.0					0.3
S6b (NDT1,2,4)	1.150	0.000	**0.0**	0.0	3.3	30%	0.9	**0.9**	0.9
W1	0			1.6					2.5
W2	0			1.6					2.5
W3	0			1.6					2.5
W4	0.595	0.95	**1.6**	1.6	1.75	30%	0.9	**2.5**	2.5
W5	0			1.6					2.5
L1	0			1.2					2.0
L2	0			1.2					2.0
L3	0			1.2					2.0
L4	0			1.2					2.0
Other L or W	0			0.0					0.5

For example: S3 streams total 255m in length in the permit and 1.45 ha of RRZ has been established (~57m each side) and 1.15 ha of RMZ has been established with an average retention level of 65%. This translates into 5.7 ha/km of RRZ (above target of 4.8) and 8.6 ha/km of total equivalent reserve (on target). Both targets have been met so this stream class is consistent with FSC requirements.

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Appendix A – Digital Data Sources for Riparian Values

Inventory Category	Riparian Characteristic/Value	Inventory / Mapping Data
Aquatic Habitats/Species	Spawning , rearing, & over-wintering areas	Bill Westover's maps digitized by Forsite August 2005. (GIS Cover)
	HCV4 Fisheries Watersheds	HCV4 maps digitized by Forsite in Sept 2005 (GIS Cover)
	Stream classifications	Tembec's stream inventory data
Terrestrial Habitats/Species	Forest Cover / Seral Stages	Forest Cover Inventory Data Tembec seral stage maps OGMA/ MMA data (GIS cover)
	Hardwood (deciduous, broad-leaved) forests	Hardwood stand data provided by Amy Waterhouse with Columbia Basin Fish and Wildlife Program. (GIS Cover)
	UWR - moose	EK PEM based UWR (GIS Cover)
	Wildlife Habitat Area	MoE Section 7 Notices for Lewis Woodpecker (GIS Cover) Tailed Frog (GIS Cover) ftp://ribftp.env.gov.bc.ca/pub/outgoing/cdc_data /Approved_FRPR_sec7_WLPPR_sec9_Notices_and_Supporting_Info/
	HCV1-4 Maps	HCVF GIS coverages provided by Tembec
High Value Consumptive-use Community and Domestic Watersheds	Water Intakes	Point of diversion (GIS cover from MoE)
	Consumptive use watersheds	Community and Domestic watersheds (GIS cover developed during TSR3)

Appendix B – Riparian Region Maps

Riparian Regions Overview Map

Riparian Regions Values Maps
- Southern Purcell Values Map
- Central Purcell Values Map
- Northern Purcell Values Map
- South Elk Values Map
- North Elk Values Map
- Central Rocky Mountain Values Map

Appendix C – Assessment Unit Maps

Riparian Assessment Unit Maps

- Lower Spillimacheen Assessment Unit
- Skookumchuck Assessment Unit
- Meachen-Hellroaring Assessment Unit
- Teepee Assessment Unit