Note: This document replaces Section 5 of the *'Detailed Riparian Assessments for FSC Riparian Management Regions in Tembec's East Kootenay Operating Areas, Version 2.0, March 21, 2007 by Forsite Consultants and Apex Geoscience Consultants Ltd.'*

5.0 Development of Detailed Riparian Strategies

Detailed riparian strategies were developed following ground-based reconnaissance field investigations and analysis of high-resolution digital air photographs. A reconnaissance field investigation of each Riparian Management Unit (RMU) was undertaken by Kim Green (P.Geo) of Apex Geoscience Consultants Ltd. The objective of the field investigation was to collect information regarding channel morphology, riparian function and disturbance history for each management unit. This information provides the foundation for the development of unit specific management strategies.

In addition to the field investigation, numerous hydrological and fish habitat assessment reports provided information regarding channel morphology and riparian function in portions of the riparian units not visited during the field investigation (Toews, 2003; Purcell Resources, 2002, Interior Reforestation, 2001, Apex Geoscience REFs). Paul Frasca, RPF, development forester for Tembec's TFL 14 provided information regarding riparian values for Spillimacheen riparian units. Kari Stuart-Smith, RPBio, PhD, Forest Scientist for Tembec, provided the majority of the information in the Key Values sections for the South Purcell, Central Purcell, and Central Rocky Mountain Riparian Units, based on available digital mapping and personal knowledge.

The riparian management strategies presented in this document are developed with the premise that by preserving the physical structure and function of a stream channel and adjacent riparian vegetation, the aquatic and terrestrial ecological functions of the stream and associated riparian area will also be preserved. No buffer widths are specified in this strategy, however, the objectives of the buffers are identified and it is left up to the prescribing forester to identify the appropriate width to achieve the specified objectives of the buffer (i.e. to be wind firm, to limit sediment delivery, to provide shade to the channel).

Retained stems in riparian management zones (RMZ) are intended to be distributed as uniformly as possible along the length and width of the buffer. Where a uniform distribution of stems is not possible along at least 70% of the steam length in the area proposed for development then a site assessment should be undertaken to determine an appropriate management strategy.

5.1 Rational for riparian management strategies in large streams (>10 m; S1, S2)

A) Wide, low gradient floodplain where flooding is the main disturbance mechanism (Examples: Lower Spillimacheen, Skookumchuck, St. Mary, Findlay, Lussier, White R., Lower Goat, Moyie River)
    - Numerous overflow channels on the wide floodplains are inundated during overbank flood events. Overbank floods mobilize existing in-channel LWD and scour channel banks at meanders resulting in the recruitment of additional LWD. Overbank floods deposit fine textured sediments on the floodplain that provide nutrients for riparian vegetation. Riparian vegetation often is dominated by hardwood stands that establish following flood events.
    - Riparian Strategies in these channels
        - Establish reserves on floodplain.
        - Riparian management zones may be necessary along outer edges of floodplains to protect wildlife values (e.g. travel corridors) and provide wind firm edge to riparian reserve.

B) Confined stream/river in steep gradient valley or where there are glaciofluvial and glaciolacustrine terraces (Examples: Lower Redding, Lower Lussier, portions of St. Mary, Goat River and Kidd Cr).
    - These streams have limited floodplain development. Streams confined by steep valley sides typically are fast flowing and have coarse textured channel beds. Channels confined by glacial terraces have exceptionally high rates of sediment delivery to channels and often have anabranching or braided morphologies.
    - Riparian Strategies in these channels.
        - Delineate a riparian reserve over the width of the valley flat[1] or floodplain
        - Delineate a RMZ on steep valley sides or terrace scarps that is of sufficient width to manage for sediment delivery and wind throw hazards.

[1] Valley Flat = A flat area bordering a watercourse, formed by the latter's deposits in times of flood (www.websters-online-dictionary.org/va/valley+flat.html)

5.2 Rational for riparian management strategies in small streams (<10 m; S2, S3, S4, S5 and S6):

A) Streams draining open, low to moderate gradient terrain where fires are main disturbance mechanism (Examples: Caven – Fish Cr., Gold, Upper Gilnockie main stem, Sandown, Lower Findlay area, upper Coyote Cr)

- These streams experience periods when riparian areas are burnt. LWD enters the channel in the decades following the fires. In intervening times mature riparian vegetation may provide shade to the stream channels and stability to the channel banks.
- Riparian Strategies in these channels
    - Establish reserves on valley flat where present.
    - In very small (< 3 metres), low gradient (<5%) streams without riparian ecosystems (Examples: S3, S4, S6 streams draining the lower faces of Upper Elk and Central Rocky MR's) retain at least 60% of the stand including under story trees as well as all trees leaning or suspended over the channel. The percentage of stems retained depends on the function of LWD in the channels and the importance of riparian vegetation to channel banks and shade. If LWD is providing protection to channel banks, providing bed load storage sites and occurs with an average frequency of 1 piece for every 2 to 5 metres of channel length then a higher retention is warranted. Where LWD is functioning to retain bed load at a lower frequency (< 1 piece every 5 to 10 metres) then a moderate level of retention is warranted unless the vegetation is providing protection to banks and adjacent forest floor during flood events (this is typically the case in steep gradient streams where the flow velocity is too high for LWD to remain in the channel but mature coniferous trees along banks have well developed root systems that protect banks and adjacent forest floor from scour). If the function of LWD is minor such as where bed load is gravel (<2cm) or finer and riparian vegetation consists of small diameter trees (small shrubs, pine) then a lower level of retention is acceptable – however, low gradient, slow flowing streams are susceptible to temperature increases so retention should be heavier on south or west sides of channels. In all cases avoid mechanical disturbance to stream banks and adjacent forest floor. The riparian management zone should be wide enough (at least half a tree length is suggested) to provide an ongoing supply of LWD and/or shade to temperature sensitive streams.

B) Upper reaches of main stem channels where gradients are typically less than 15% and widths of less than 5 metres. Examples include upper reaches of Wildhorse, Coyote Creek, Nicol, Perry, Hellroaring, Angus, Matthew, Skookumchuck and Findlay Creeks and the main stem channels of the largest tributaries within these basins (Mostly S3 but some S5a streams).

- Disturbance events in these streams are generally limited to debris floods that occur roughly every 1 to 2 decades. Riparian vegetation in the main valleys (if not previously logged) is typically late seral stands of spruce, balsam fir and lesser amounts of hardwoods. Riparian stands generally occupy a relatively wide valley flat that the channel shifts across over time. Riparian function includes the supply of LWD to stream channels that can have long term influence on channel structure and bedload transport rates and protection of channel banks and valley flat from erosion during overbank flooding.
- Riparian Strategies in these channels:
    - A reserve is required for streams with a well defined valley flat.
    - Where stream gradient is higher (~15 to 30%) and/or there is not a well defined riparian area establish a riparian management zone of sufficient width to ensure continued supply of LWD to the stream channel and retain at least 60% of the stand retaining the most wind firm stems.

C) Headwater streams draining steep slopes where debris flows and snow avalanches are the main disturbance mechanism. Examples include S4 to S6 streams of Redding, St. Mary, Lussier, Wigwam and other central Rocky Mountain Region and Upper and Lower Elk region headwater tributaries).
    - These streams experience frequent disturbance events so that riparian vegetation consists primarily of deciduous shrubs (i.e., alder and willow) that are quick to establish on disturbed soil. The root systems of deciduous shrubs provides armor to colluvial deposits and functions as a source of small woody debris to form short-term jams that moderate bed load transport during average runoff events. In lower reaches, once stream gradient drops below 20% colluvial deposits are common and the stream avulses frequently so that it typically occupies multiple channels over a wider valley flat. Mature coniferous trees along these lower gradient stream reaches provide armor to channel banks and protection to the forest floor over the valley flat.
    - Riparian Strategies in these channels.
        - In steep headwater tributaries (> 20%) where deciduous shrubs dominate the riparian area and LWD is not present or functioning in the channel to provide stability a RMZ is not required.
        - In steep headwater tributaries where coniferous trees are present on the confined valley flat (Examples: mid slopes of Sparwood Ridge, Sheep Creek and Mutton Cr (Lussier R)., Matthew Creek and Perry Cr. tributaries) establish a riparian reserve over the valley flat and RMZ's on adjacent gully sides that are sufficient width to protect the reserve from wind throw and increased sediment delivery hazards.
        - Where a valley flat is not present – for example where steep, confined headwater tributaries have deposited large colluvial or alluvial fans on lower valley sides (Examples: Lower slopes of

Sparwood Ridge, lower slopes in western portions of Skookumchuck and Findlay Creeks and lower slopes of Redding and St Mary) the riparian management zone should extend over the extent of the depositional feature and the percentage of stems retained will depend on the importance of root networks for protection of forest floor and banks during flood events and the function of LWD in the channels. In general, the coarser the deposits (eg. large angular cobbles and coarser material (>20 cm)) the less significant is the function associated with riparian vegetation. Riparian vegetation plays a more important role where the fan is lower gradient, the deposited material is cobble sized or smaller and the disturbance occurs frequently. The highest percentage of retention (>60%) should be applied where multiple channels are present over a depositional feature with gradients less than 15% and where LWD is functioning to retain bed load.

D) Streams draining moderate gradient, forested slopes where flooding and stand-replacing fires are equally occurring mechanisms of riparian disturbance (Examples S2 to S6 streams in the Yahk, Hawkins, Moyie and Little Moyie drainages.
    - These streams represent very dynamic environments and tend to display the greatest temporal and spatial variability in riparian function. These streams also have the greatest potential for long term impacts associated with development because LWD can function in these streams for centuries so that removal of recruitable mature riparian vegetation can influence channel condition for centuries. Due to the moderate to gentle gradient slopes sediment delivery to these channels is primarily through tree turns along channel banks.
    - Riparian Strategies for these streams
        - Streams between 5 and 10 metres establish a RRZ over the valley flat.
        - For streams from 1.5 to 5 m establish a high retention riparian management zone over the valley flat where at least 60% of stems are retained. Management zones must be wide enough to manage for wind throw or sediment delivery hazards. To reduce the potential for large increases in sediment delivery to the stream following harvesting, some (not exceeding 50%) of the largest trees in that are susceptible to blow down may be topped.
        - For streams < 1.5 metres establish a riparian management zone over the valley flat and retain a minimum of 30% of the standing timber and all of the trees leaning or suspended above the channel. Percentage of retained trees will depend on the function of LWD in the stream channel, the importance of root networks to maintaining protection to channel bank and adjacent forest floor and the susceptibility of the stand to wind throw. If LWD

and root networks of riparian trees appear to play an important role in channel structure then a higher level of retention is warranted.

- Where streams are intermittent (portions where there is no obvious channel) or ephemeral (seasonal) retain at least 30 % of the standing timber over the valley flat and avoid mechanical disturbance to stream banks. Retained stems should be as wind firm as possible (this may limit retained stems to only small diameter trees).

E) Beaver influenced aquatic environments including streams, wetlands and lakes. The presence of wetlands in the mountainous environment of the Kootenays and southeastern Rockies is highly dependant on the presence of beavers and beaver dams. The massive reduction in beaver populations throughout North America through the 1800 and 1900 has made the remaining populations of beaver vulnerable to environmental disturbance. Beavers require an ample supply of deciduous species including aspen, cottonwood and birch to maintain a viable population.

- Riparian Strategies for beaver influenced environments
    - Establish Riparian Management Zones up to 100 metres wide on low to moderate gradient slopes (< 50%) from the edge of the aquatic – terrestrial interface. Managed for a mixed stand of deciduous and coniferous species with a heavier percentage of deciduous species closer to the aquatic feature.

5.3 Rationale for riparian strategies for Wetlands and Lakes

A) In the mountainous Kootenay – Columbia region riparian function adjacent to lakes and wetlands is often limited to a relatively narrow 'interface' area defined by the gradient of the surrounding hillsides. Lakes in areas of low relief have wider interface areas that are a function of the variability of groundwater levels. The objectives of the riparian management strategy for lacustrine environments is to preserve the integrity of the interface area – this primarily focuses on maintaining a wind-firm buffer around the water feature that is of sufficient width to preserve the terrestrial habitat values as well as the functions of LWD recruitment and shade for aquatic habitat. LWD recruited to lakeshores from the margins of lakes is very important for maintaining aquatic habitat values. Trees along south, west and eastern lakeshores contribute to aquatic habitat by providing shade to shallow littoral environments along the lake margins. As discussed above, the presence of wetlands as well as many lakes in the mountainous environment of the Kootenays and southeastern Rockies are often highly dependant on the presence of beavers and beaver dams.

- Riparian strategies for natural lakes and wetlands
    - The width of riparian reserves around lakes and wetlands will depend primarily on slope gradient. Where lakes and wetlands are confined by moderate to steep valley sides (> 30%) the primary objective of the

reserve will be to protect the lakeshore from increases in sediment delivery and ensure an on-going supply of LWD to the littoral area. A riparian reserve may not be necessary where soils are coarse textured and the likelihood of instability on adjacent slopes is low. Where reserves are not present retained stems in the management zone should be windfirm. The width and percent retention of the management zone will depend on the shade function of the canopy and the presence of terrestrial values such as travel corridors and nesting sites. Where lakes and wetlands are situated on low gradient areas reserves are required around the margins of lakes where there is evidence for variable groundwater levels. Where coniferous species are present to the lake margins a wind firm reserve is required to maintain shade, LWD recruitment and terrestrial habitat values.

- Riparian Strategies for beaver influenced lakes and wetlands
    - Establish Riparian Management Zones up to 100 meters wide on low to moderate gradient slopes (< 50%) from the edge of the aquatic – terrestrial interface. Managed for a mixed stand of deciduous and coniferous species with a heavier percentage of deciduous species closer to the aquatic feature.