5.0 Conserving Soil and Water Resources

5.1 Background

Conservation of soil and water resources, is a reflection of the need to maintain soil and water quality enabling forests to remain productive and resilient to the stresses resulting from natural and human activities. As indicated by CCFM (1997a), it is important that in considering the impacts to soil and water resources that potential impacts due to other industrial, recreational, agricultural and urban activities are separated from those due to forest management activities. It must also be kept in mind that natural processes, such as seasonal fluctuation in precipitation and temperature, occurrence of forest fires and insect and disease outbreaks will have impacts upon soil and water resources (CCFM 1997a).

Conservation of soil and water resources can be viewed in the context of two values:

- Physical environmental factors
- Policy and protection forest factors

A single matrix is utilized to cover the conservation of soil and water resources and is presented at the end of this Section in Table 5:

Table 5 Conserving soil and water resources

5.2 Physical Environmental Factors

5.2.1 Introduction

Physical Environmental Factors are reflected in the measurement of the intensity and extent of disturbances to soil and water characteristics that impact upon the long-term resilience of forest ecosystems. Components considered include, geology, topography and landforms, soil productivity and stability and surface and ground water.

Geology, topography and landforms refer to the physical features of the landscape as reflected by the ground surface. Soil productivity refers to the capacity of the soil to provide all the necessary requirements for plant growth and provide a substrate for rooting. These requirements include nutrients, soil porosity, structure and depth and intact organic and surface soil layer. Soil stability is the potential of the soil to resist movement through maintenance of structure and porosity and therefore rooting ability and the maintenance of surface organic and soil layers allowing infiltration of water while minimizing ponding and changes to surface flow. Water resources can be described on a watershed basis including both surface and ground water. Surface water is located in lakes, wetlands, seasonal ponds, continual and ephemeral streams, and rivers. These waters provide essential habitat to terrestrial and aquatic wildlife and are important for domestic consumption. Ground water resources refer to sub-surface and water in aquifers below the ground level, essential for maintaining surface water levels and an important source of water for domestic consumption particularly on the west side of FML 01.

These components are represented in Table 5.

5.2.2 Data Adequacy and Gaps

FSP sources of information include:

- Descriptions of geology, topography, landforms and soils for FML 01 (Sections 3.1.2, 3.1.3 and 3.1.4) and accompanying maps (Figures 3.3, 3.4 and 3.5)
- Description of water resources and watersheds for FML 01 (Section 3.1.11) and accompanying map (Figure 3.12)
- Historical review of timber harvesting for FML 01 (Section 5.1.1) and accompanying map (Figure 5.3 and 5.4) and table (Table 5.1)

Other sources of information include:

- High Conservation Value Forest Assessment report (Kotak et.al. 2009) for FML 01
- Influence of watershed features and disturbance history on water quality report (Kotak et.al 2005)
- Spatial Variation in Water Quality in Rivers report (Kotak and Selinger 2006)
- Experimental Watershed assessment report (MBMF 1997C)
- Effects of Aerial Spraying of Forest Herbicides on Aquatic Ecosystems reports (Jones et.al. 1997 and 1997)
- Recovery Strategy for the Carmine Shiner (*Notorpis percobromis)* in Canada (Fisheries and Oceans Canada 2008)

On-going Operational Data Sources include:

- PHA including tree species, volumes, age class, FEC V-type, soils description and other values
- On-going monitoring (and reporting to MC) of timber harvest and forest renewal levels by Tembec
- Tembec Environmental Compliance Audits (WDS-013) including documentation of occurrences of site disturbance and follow-up actions
- Tembec Pre-crossing assessments of watercourse crossings (WDS-003)

These sources of information represent the best information currently available for the soil and water resources on FML 01. The Environmental Compliance Audit Program (ECA) undertaken by Tembec on an annual basis across FML 01 (WDS – 013) as well as regular monitoring of operations by MC provides input to the Company as to potential impacts of forest management activities upon soil and water resources. The effectiveness of the practices utilized to provide mitigation provides the opportunity for modification of practices and activities to mitigate concerns further as they arise.

The SFM Local Level Indicators (LLI) framework developed by Tembec during the preparation of the FSP provides the framework to be utilized for monitoring of indicators for measurement of progress towards targets established in the FSP. Indicators developed to represent soil and water resources will provide improved data regarding the components referenced in Table 5 as the monitoring program for adaptive management is implemented during the FSP 20 year period.

5.2.3 Forest Management Activities Assessment

Planning

Planning involves the process of joint planning and other public involvement, of infrastructure development, harvest and renewal operations, access management and information collection and application for development of the 20 year FSP. Components within planning include wood supply and habitat supply modeling, forest inventory and GIS updating to determine sustainability modeling for completion of the FSP with annual detail provided through the AORP.

Road and watercourse crossing planning of all-weather roads, and to a lesser extent, dry-weather roads and watercourse crossings may significantly impact local geology, topography and landforms and soil stability, as a result of the need to blast rock, excavate borrow pits and move material to build the roadbed. Decisions about the location of a particular road have an important influence on the impact it will have on the natural physical environment. Information from PHAs allows route planning to consider potential requirements regarding physical ground features, soils and water resources, in addition to other values. Landings, fuel and timber storage sites, camps, pits and quarries all have similar potential impacts as non-permanent roads because of their temporary duration. The existence of roads and associated watercourse crossings can impact surface and ground water resources through alterations to surface water drainage and infiltration. Watercourse morphology, bank stability and aquatic habitat are impacted by watercourse crossings. Through examination of the available timber supply, ground conditions and non-timber values for each operating area, the requirement for access development is determined, including service life (permanent, non-permanent), class of road and type of watercourse crossing structure. Further detailed location and design of each road and crossing considering local conditions and watercourse crossing approach is undertaken at the AORP stage to minimize impact to the physical components.

- At the landscape (watershed) level the impacts of permanent all-weather roads upon geology, topography and landform surface features as well as the related local effects upon soils and water resources are mitigated through planning to limit the density of these roads to 0.58 kilometers per square kilometer as referred to in Indicator 1.1.3.3 of the LLI.

- Impacts to geology, landforms and soil stability are mitigated by the planning process to avoid, to the extent possible, routing roads adjacent or through, significant landform features or through potentially unstable slopes (WDS –009).

- Updated site information provided by the AORP and associated PHAs (WDS – 002) and WCAs (WDS – 003 and 005) provides opportunity for detailed refinement of locations of roads and associated crossings from preliminary corridor routes provided in the FSP.

- In planning the location and design of roads and associated watercourse crossings, guidance is provided through Federal and Provincial guidelines, including, the *Guidelines for Riparian Areas* (MC 2008) and *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO &MNR 1995). Tembec has developed further specific criteria for access development planning relative to securing of Department of Fisheries and Oceans and Canadian Coast Guard water crossing approvals (WDS – 012).

- WDS-003 specifies that watercourse crossings are designed for planned stream flows that do not exceed 1 meter per second.

Harvest and renewal planning for the location, design and scheduling of operating areas including operating blocks and associated cut-blocks and forest renewal activities can have impacts on soil productivity, stability and surface water. Monitoring and limiting, by watershed, the productive forest area in a recently disturbed state, either burned or harvested is an effective planning tool to mitigate these impacts. Measurable increases in surface water discharge occur when 20 to 50% of the forest cover is removed from a watershed (Stednick, 1996). However Plamondon (1993) reports that significant impacts on water quality, temperature and yield do not generally occur if less than 50% of a watershed is in a disturbed state. In assessments conducted on the FML, Kotak et. al. (2005) found that total nitrogen, dissolved organic carbon and sulphate concentrations were directly tied to the percent of a watershed harvested and that these parameters were similar to reference streams when the harvest threshold was below 30 to 40 %. The application of VRL practices allows retention of a component of forest cover to reduce the magnitude of impacts to soil and water. Prompt forest renewal of the cut over blocks reduces the duration of the impact on soil and water.

- Soil productivity and stability may be significantly impacted through harvest planning. Landscape level mitigation is achieved through the spatial arrangement of cutblocks and area of watershed in a recently disturbed state (harvested or burned within the last seven years). Tembec limits this area to no more than 30% of a watershed as identified in Indicator 3.1.4.2 in the LLI (WDS – 010). At the cutblock level, use of the soils information provided in the PHA undertaken for each cutblock allows for scheduling of harvest for the appropriate season to avoid impacts to susceptible soils in an unfrozen state (WDS – 010).

- Surface water is insignificantly impacted by harvest planning but more so by planning of roads. At the planning stage the LLI indicator (3.1.4.2) monitoring total area by watershed in a recently disturbed state and the indicator (1.1.3.3) limiting road construction to 0.58 km/sq. km. provides guidance to mitigate impacts across the landscape. PHA information allows for design of cutblocks to apply VRL practices including reserves, single trees (wildlife trees) or patches to be retained to minimize potential impacts to soil and water as well wildlife habitat (WDS – WI – 004, 005 and 006, 007 and 048). The MC *Guidelines for Riparian Areas* (2008) provides prescriptions for the protection of riparian areas.

- Forest renewal planning is an effective mitigative tool to reduce the duration at the cutblock level, and extent at the landscape level, of the impact to soil and water through prompt renewal of the cutblocks. The period of time an ecosystem takes to recover is dependent upon the severity and frequency of the disturbance. And when managed according to generally accepted principles and practices the impacts from forest harvesting activities can be ameliorated by ecological forces in relatively short periods of time (Archibald *et al.* 1997).

- The AORP and PHA provide opportunity for contingency planning, through updated site information, to make alternate cutblocks available to those scheduled in the AORP. Contingency planning identifies additional replacement cutblocks that can be harvested in the event that planned cutblocks cannot be operated due to unforeseen circumstances, such as unsuitable ground conditions (excessive moisture) with potential for impacts to soil and water resources (WDS-010).

Information collection and application is utilized for the planning process to incorporate areas of unique topography and landforms, as well concerns with soil productivity, stability and surface water resources. Inclusion of this data will identify areas of concern and allow for development of mitigation procedures including avoidance of sensitive locations, scheduling of activities, assignment of suitable operating equipment and other mitigation practices. As with most impacts the key to avoidance is the recognition of those sites that are most sensitive to disturbance. Sites most sensitive to hydrologic impacts are those excessively moist to wet peatland or mineral soil sites (Archibald *et al.* 1997).

- Information collection and application has positive impacts to these components through forest inventory updating for application to planning, PHA and WCA assessments to develop mitigation practices, and results of the ECA process to monitor results and adapt practices related to the LLI indicators.

Planning is an integral component to sustainable forest development to conserve soil and water resources. In general, planning activities provide the basis for implementation of mitigative measures at the operations stages if based on current, appropriate data and sufficient public participation suitable for the decisions being made. There are several levels at which planning can affect resource development and the levels must be considered at the appropriate time to be effective. Tembec incorporates all levels from the FSP at the strategic level, AOPR at the operational level and PHA/WCA at the stand/site level, in its planning process with consideration and inclusion of non-timber values and users of the landbase through joint planning and other forums.

Infrastructure Development

Infrastructure development activities involve the removal and movement of soil and aggregate material and construction of infrastructure for harvesting operations resulting in alterations to landforms, soil and water. Construction standards/practices, decommissioning and road and ROW maintenance activities are utilized to mitigate impacts. The magnitude, extent, duration and frequency of an activity are considered when evaluating impacts. Impacts from infrastructure development occur at the site level with dry-weather and winter roads and associated crossings, camps, timber and fuel storage sites being of a temporary duration and subsequently planned for decommissioning after service.

All-weather and dry-weather road construction results in alterations to local natural topography and extraction and placement of soil materials with contouring and compaction to achieve required construction standards. These activities will lead to specific impacts to soil and water at a local site level as a result of these changes to the original natural terrain.

Insignificant impacts to local geology, topography and landforms will occur as a result of the need to blast rock, excavate borrow and move material to build the roadbed. These activities are necessary in order to construct forestry roads to acceptable grades and alignment for safe use in transportation of people, equipment and timber. These activities result in the removal of bedrock and surficial material for use in constructing the road. Removal of the overburden and vegetation is also necessary exposing bedrock and underlying deposits. These activities are limited in magnitude and extent, occurring in proximity to the road corridors.

- Mitigation is achieved through implementation of practices described in WDS – WI – 024 including rehabilitation of borrow pits utilizing previous overburden and contouring of slopes, following use.

- Construction of roads can have significant impacts to soil productivity and stability through exposure of soil to the forces of erosion. Road construction necessitates removal of vegetation and overburden organic material in order to build up a grade of mineral material that provides a load-bearing surface. These activities are necessary for construction of roads to obtain required loading for transportation of equipment, people and timber. To provide for safe driving conditions and drying of the road surface a road right-of-way is cleared of trees along the road corridor. Potential for erosion is most likely in areas of fine textured soils (silt and clay) where slopes exceed 10%. The topography of FML 01 is such that sustained slopes encountered in road construction are not common. Conditions of concern are generally local in extent and can be mitigated using accepted construction standards and practices. In crossing wetlands with all-weather roads (minimized to the extent possible), retention of root mats and use of re-enforcement blanket materials as well as appropriate placement of drainage culverts will assist in mitigating erosion impacts (WDS – WI - 025).

- All-weather roads will result in soil compaction, removal of topsoil and organic matter and loss of soil nutrients in the development of the road grade. These actions are necessary to obtain stable travel surfaces capable of supporting transportation of people, equipment and timber in a safe and efficient manner. These impacts are non-mitigable; however, they are limited in extent to the roadbed itself, and are insignificant at a landscape level. All-weather roads that are permanent in nature will have an impact in terms of the conversion of forest land to non-forest use. The area taken up by the road grade is essentially removed from forest production. It is in the best interest of Tembec to limit this self-imposed loss of productive land. Consideration of this factor in terms of effect upon sustainable timber and non-timber values, and the economic desire to minimize the costs of road development to that necessary to meet requirements are included in access development decisions. Use of strategic planning to consider access development needs in a long-term context, as described in WDS - 009 help to minimize this impact. Indicator 1.1.3.3 regarding density of roads in conjunction with their associated targets provide planning targets for use by Tembec in mitigating this concern at the landscape level. Given the relatively small percentage of FML 01 taken up by these all-weather roads, this impact is insignificant at a landscape level.

- Techniques described in WDS – WI – 016, 023 and 026 including leveling of rutted areas, re-distribution of cleared debris over exposed areas, minimizing width of right-of-ways, use of grass seeding to rapidly re-vegetate exposed slopes along roads and use of diversion dams to deflect run-off into the adjacent forest will minimize the impacts of exposed soils resulting from road construction to soil and water.

- Construction of dry-weather roads have similar impacts to those described above, however, these impacts are of a shorter term duration and are mitigable in that these roads are not maintained beyond their lifespan and will generally be decommissioned, involving natural re-vegetation or forest renewal in conjunction with adjoining cutblocks (WDS – WI – 037 and 039 and FSP Section 5.13.2).

- Construction of all-weather and dry-weather roads has potential to have a significant impact upon surface water quality as a result of a disruption of surface and sub-surface drainage, ponding, erosion and resulting siltation of soil material due to road construction adjacent to watercourses. Furniss *et.al.* (1991), indicates that road construction, more so than forest harvesting activities, has potential to contribute sedimentation to watercourses.

- Placement and construction methods of roads should be sensitive to potential effects to lateral water flow. Implementation of construction practices such as appropriate use of granular material, proper placement and construction of bridges and culverts (including those required for cross-drainage of wetland areas), ditch construction and diversion of run-off prior to drainage into watercourses and stabilization of the cut and fill within the ROW area as outlined in WDS – 006 and 012, WDS – WI – 025 and 026 will mitigate potential impacts.

Winter seasonal roads can significantly impact soil productivity and stability as a result of the site disturbance inherent in the preparation of the ground surface for travel. Some localized disturbance will also occur at locations where winter roads, traversing lakes and rivers, are routed back up onto the high ground.

- For the most part these roads are routed through wetland areas under frozen conditions with some crossings of lakes, rivers and streams as well as upland areas as necessary (WDS – 006).

- Road construction across wetlands requires tramping of snow and packing of the surface mat under frozen conditions to achieve a load-bearing surface. Blading of the surface is necessary to provide safe driving conditions. This can result in some local disturbance to the peatland surface. Intermittent crossings of upland sites are necessary to provide through-passage connecting the available wetland corridors. These crossings typically require stumping out of the route, which can lead to decreased soil stability at the site level. Packing and tramping of the surface mat across wetland areas and compaction of surface organic soils can also impact soil productivity of the roadbed.

- Development and use of these roads only under frozen conditions, and additional construction practices outlined in WDS – 006 and WSD-WI-023 to minimize ROW and roadbed widths combined with the seasonal duration and resulting re-vegetation of these routes, provides mitigation for construction and use of these roads.

- Though some winter roads or portions of routes are utilized for more than one winter in accessing areas of substantial timber, many such routes are only utilized for a single entry to individual cutblocks during winter logging operations with prompt follow-up renewal operations to minimize re-use of the road. This results in a very low frequency of occurrence of these roads in any given area over time with natural re-vegetation and decommissioning.

Road & ROW Maintenance has a positive impact on both soil stability and surface water. Control of ROW vegetation through herbicide application can impact surface water quality through mis-application or chemical leaks and spills.

- As outlined in WDS-013 and WDS–WI–025 and 026 maintaining ROW soil stability, cross-drainage and diversion of water from the ROW for surface water control and road and culvert inspection will impart a positive impact on soil stability and surface water by minimizing chance of mass movement of road or ROW surface through culvert blockage or other surface water flow or ponding.

- Mis-application or leaks and spills from herbicide application for ROW maintenance can insignificantly impact surface water, through contamination, as this procedure is used infrequently for ROW maintenance.

    - This is mitigated through WDS - 014, which outlines procedures for the application of herbicides including necessity for qualified personnel, instructions for application window (wind conditions) and maintenance of equipment to prevent leaks and spills and procedures to follow in the event of an accidental spill (Tembec Emergency Response Procedures).

    - Such procedures, combined with the use of mechanical ROW clearing resulting in a very low frequency of herbicide application, and limited extent to only main routes served by Class I and II all-weather roads, results in an insignificant impact that is mitigable.

Construction of permanent watercourse crossings may have impacts to geology, topography, soil stability and surface water in the immediate vicinity of the crossing due to requirements for construction such as blasting of rock and movement of soil and aggregate material for construction of approaches and embankments.

- Geology, topography and landforms may be impacted at the crossing site due to movement of material for the crossing approach. Such impacts are insignificant because of the magnitude and localized extent of the activity.

- Permanent watercourse crossing construction can significantly impact soil stability in the immediate vicinity of the crossing as a result of cut and fill operations to develop the approaches. WDS – WI – 023 and 026 outlines procedures to minimize potentially unstable slopes through minimizing ROW clearing adjacent watercourses combined with temporary and long term erosion control measures.

- Construction of permanent watercourse crossings has potential to significantly impact surface water quality as a result of erosion leading to the introduction of sedimentation into the water at the crossing site. Such concerns are particularly related to periods during snowmelt run-off and summer storm events. Earlier discussion of these impacts and mitigation practices was provided relative to resulting impacts upon aquatic habitats and communities in Section 3.0. WDS – WI – 026, the and *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO/MNR 1995) provide direction for installing these crossings to mitigate impacts on watercourses. Tembec, MC and DFO give watercourse crossings close attention at both the planning and construction stage, which minimizes the potential for impacts from this activity (WDS – 003 and 012).

- Application of permitting procedures, crossing design incorporating information gathered for each crossing site during the WCA assessment (AORP) and construction practices, including erosion control techniques will effectively mitigate these localized impacts.

Temporary watercourse crossings have similar potential to incur soil stability and surface water impacts to those of permanent crossings. These impacts are insignificant and mitigable because of the decreased duration of service as these installations will be removed after use and rehabilitated through bank re-contouring and revegetation as outlined in work instructions WDS – WI – 035 and 036.

Camp, timber storage site and fuel storage site development will all have similar, though much more localized impacts upon geology, topography and landforms, soil productivity, soil stability and surface and ground water to those resulting from dry-weather road construction. These sites all require some degree of local clearing and leveling of the site for use. These activities are generally of short duration and local extent for any given site and in conjunction with practices outlined in WDS–WI–017 and subsequent decommissioning and assessments (WDS–WI–038 and 039, WDS-013) the impacts are mitigated.

- Geology, topography and landforms are insignificantly impacted by development of these infrastructures due to the temporary duration of use, which limits magnitude of development undertaken at these sites. The extent of any given impact is limited to small locations within operating areas.

- Soil productivity, surface water and ground water are significantly impacted from removal of the soil surface, addition of sub-soil and aggregate material and subsequent leveling and alteration to surface water flows and drainage. Construction and decommissioning procedures (WDS – WI – 017, 019, 037 and 039) and the localized extent and temporary duration of the impact mitigate these impacts.

Decommissioning of infrastructure generally has a positive impact on site level components through various mechanisms including removal of construction material, slope recontouring, organic soil/debris respreading and revegetation. Road decommissioning does not remove the road structure, which could result in a continuing longer-term potential impact, but the removal of watercourse and drainage structures, ripping of strategic portions of the road and ROW and spreading debris reduces the potential for access by road and off-road vehicles which allows for natural re-vegetation of the road.

- Decommissioning, as described in work instructions WDS – WI – 035 to 039 has a positive impact on soil productivity, soil stability and surface water. Activities include removal of culverts and other temporary crossings which otherwise may become blocked following road abandonment, road and ROW ripping, respreading of organic soil and debris materials and revegetation (including natural and forest renewal activities in conjunction with adjacent cutblock renewal).

- Impacts on soil stability and surface water can result during the decommissioning process by way of newly exposed soils leading to erosion and soil movement downslope during machine use or heavy follow-up precipitation. This can then lead to siltation where decommissioning is undertaken at crossing approaches or on roads in close proximity to watercourses. These impacts are insignificant and mitigable because of the short duration and extent of these activities and the procedures outlined in work instructions WDS – WI – 035 and 036 specifying erosion control and site stabilization measures.

The construction and maintenance of infrastructure have potential for impact to physical environmental factors. The site-specific localized extent of these infrastructure developments limits the nature of impacts. All-weather roads represent a significant and at times non-mitigable impact on physical environmental factors because of their duration (permanent), however, due to the localized extent; these impacts are not significant in a landscape context. Use of LLI Indicator 1.1.3.3 regarding density of all-weather roads in FML 01 provides a planning tool and follow-up monitoring to assist in this regard. All other infrastructures are temporary and considering the extent, magnitude and duration of the activity and Tembec operating procedures the resulting impacts are mitigated.

Harvesting

Harvesting activities involve the removal and transport of whole trees and tree boles from the forest to the landing or roadside and subsequent transport to the mill. This includes slashing, woody debris management and timber storage. The removal and processing of timber has potential impacts to soil productivity and stability in terms of the removal of biomass (bole and/or limbs and tops). Surface and ground water are impacted in terms of hydrology from the removal of the forest canopy and the resultant change in evapotranspiration and interception rates. The planning process, through the FSP with annual refinement in the AORP (including PHA cutblock assessment) provide procedures to mitigate foreseeable impacts from harvesting activities by incorporating wildlife and other non-timber values.

Logging activities, through removal of the forest canopy, results in some changes to underlying soil stability, and alters the hydrology of a watershed by changes to interception and evapotranspiration rates. In developing harvest plans cutblocks are set out and designed to approximate natural disturbance patterns with respect to distribution, shape and size across the landscape. As with fire and other natural disturbances, logging of timber results in the removal of forest cover to varying degrees resulting in impacts to underlying soils and water resources.

- Logging and associated equipment use can insignificantly impact soil stability through the removal of the overstory and the subsequent loss of tree root structure (over time) and associated loss of understory vegetative rooting structure. The generally level terrain of FML 01, with few areas of sustained steep slopes, in combination with VRL practices such as retention of wildlife trees and understory vegetation, maintenance of buffers on riparian areas and areas of sensitive soils, cut and leave block harvest designs to retain patches of mature cover, harvest practices to minimize soli disturbance and prompt regeneration of the site as outlined in WDS-

WI- 004, 006, 007, 008 and 048 and MC *Guidelines for Riparian Areas* (2008) will mitigate these impacts.

- Within the LLI framework Indicator 3.1.2.3 regarding treatment of potentially erodible sites, to be tracked through the ECA, Indicator 3.1.2.1 monitoring harvest sites for soil compaction or rutting and Indicator 3.1.2.2 which provides for tracking and reporting of harvested areas successfully reforested and certified as achieving site renewal targets at the 7 year regeneration survey, assist in tracking and follow-up on these impacts.

- Dependent upon site specific variables including slope, soil types, residual vegetation and the intensity of harvest within the watershed, changes to surface and ground water levels can occur following logging. Following logging, water uptake can be expected to diminish on the site due to the decrease in active root systems. This contributes to increased surface run-off and peak flow events which can lead to erosion of surface soils and siltation of watercourses. Harvesting of upland sites can increase discharges by 30 to 80% for up to 15 years (Verry 1986). Forest cover removal also influences the rate of snowmelt in the spring, with cleared areas melting more rapidly than adjacent forested sites. Studies indicate that measurable increases in discharge occur when 20 to 50% of a watershed area has been harvested (Stednick 1996). However, Plamondon (1993) suggests that significant impacts to water quality and yield do not generally occur if less than 50% of a watershed is in a disturbed state. Logging activities when viewed in the context of watersheds can have significant impacts, which are mitigable through application of planning approaches by incorporating landscape units to the planning and monitoring process. Appropriate levels of harvest within a watershed may vary dependent upon the topographical features, slopes, soil types, forest types and ages, and presence of other depletion agents (forest fire, insects and disease). Plamondon (1993) suggests that no more than 50% of a watershed be harvested where previously harvested areas have not yet reached a free-to-grow state. Data collected on the FML (Kotak et.al 2005), suggest that Tembec's limit of no more than 30 % of a watershed in a recently disturbed state could be appropriate and that further assessments would be conducted in order to confirm and develop watershed planning tools for FML 01.

- Changes from year to year in melting conditions and rainfall patterns in combination with natural disturbance events can result in relatively large natural variations in hydrological flows and yields both during snowmelt and summer storms. The proportionally small relative area of FML 01 to be harvested each year of less than 1% is expected to result in localized increases that are within the natural range of variability for the region.

- Indicator 3.1.4.2 of the LLI framework provides a target for planning of no more than 30% of a watershed in a recently disturbed state (WDS – 010), with follow-up tracking for application to future planning of harvest locations.

- At the cutblock level, scheduling of cutblocks includes consideration of the renewal status of adjacent previously logged cutblocks prior to selection for harvest, which assists in this regard (WDS – 010).

- The dilution of water yield increases as sub-watersheds merge combined with the proportionally small disturbance due to harvesting across the productive landbase of FML 01 are expected to result in no significant trans-boundary impacts in terms of accumulated water yield effect.

- During logging operations, the VRL procedures described in WDS – WI – 004, 005, 006, 007 and 048 and the application of the PHA in selecting and scheduling cutblocks for harvest assist in maintaining the root mat and help stabilize soils. Implementation of buffers along riparian zones (MC 2008), in addition to other aesthetic and wildlife habitat benefits, provides a filtering effect for potential siltation from harvested cutblocks. These practices should allow for re-absorption of excess water from cutovers by vegetation from these sources as well as that remaining in adjacent unharvested forest. Though some local ponding of surface water may occur on a seasonal basis within cutovers, these practices are expected to mitigate concerns regarding run-off of water from cutovers to main watercourses.

Slashing and woody debris management may have significant impacts upon soil productivity through the physical removal of biomass resulting in a loss of soil nutrients and thereby the long-term growth prospects of the forest. Youngblood and Titus (1996) indicate that there is little evidence suggesting that harvesting itself leads to long-term loss of nutrients, suggesting that more onus has recently been directed towards the manner in which woody debris management is undertaken. Previous logging and woody debris management practices of whole tree harvesting and transportation to roadside for subsequent delimbing and logging slash disposal have been thought to result in concentration of nutrients at roadside. In a study of nutrient cycling in spruce and mixedwood ecosystems, Gordon (1983) advocated delimbing at the stump to retain nutrient capital, and, in combination with the retained stump and root systems this provides an immobilizing substrate to decrease potential losses due to leaching.

- Significant impacts on soil productivity can result through the removal of woody material (boles and tops) impacting nutrient cycling. Tembec have modified their logging practices to provide for delimbing within the harvest area to allow for distribution of future nutrient capital and seed source. These practices are consistent with MC brush disposal guidelines (2005A) that now require delimbing to be conducted near the harvest site and removing only the bole of the tree to roadside for transport to the mill.

- The LLI framework includes Indicator 3.1.2.4 which provides for tracking and reporting of the retention of nutrient sources on site in the form of tree limbs and tops left from logging activity. This indicator and the associated target of 100% of all cutovers to receive such treatment will be measured in the ECA sampling program by Tembec.

Timber storage has the potential to insignificantly impact surface water, dependent upon location of these activities relative to watercourses.

- Impacts due to timber storage are associated with the potential generation of leachate from the storage of logs. In a study on the storage of softwood logs for the MMF, Farmer et al. (1998) found that black spruce and jack pine logs stored in laboratory and field conditions produced a leachate with varying toxicity to three trophic levels; rainbow trout, water fleas and a luminescent bacteria. This study found that toxicity of leachate increased with decreasing rain events i.e. higher concentration of leachate. This study also investigated effects of softwood log storage on carbon and nitrogen mineralization and the functional diversity of forest soils and found no detectable impacts on these processes. Storage of softwood logs at harvest sites is minimized to the extent possible to maintain the wood supply to the mill in a "fresh" state. Permanent stock pile chipping sites are located away from permanent water bodies and on upland sites dominated by clay soils which reduce the potential for surface water movement into the ground water system.

- Tembec has not indicated any plans for harvest of aspen in the FSP. Quota holders and other permittees have traditionally harvested a relatively small volume (less than 10,000 m^3/year) of poplar, aspen & birch on FML 01. Taylor (1994 *in* Farmer *et al*. 1998) reports that aspen log piles exposed to weather generated significant quantities of toxic leachate over a 23 month period. In general these volumes are not stored on-site beyond the harvest season (generally the winter) mitigating any such impacts.

- Farmer et al. (1998) suggests that in consideration of the identified potential toxic effects of softwood leachate on aquatic environments all remote log storage sites should be placed so that drainage of leachate will not enter water bodies. As described in WDS – WI – 014, log storage sites are located at least 30 metres from drainage areas and100 metres from permanent watercourses to ensure that run-off does not enter adjacent waters.

The primary harvesting activity contributing to impacts on soil and water is the removal of trees. Potential impacts are mitigated through VRL, cutblock layout approximating natural disturbances, watershed monitoring of the area in a recently disturbed state and delimbing within the harvest area to retain nutrient and seed component. Forest harvesting, unlike deforestation for agriculture or other permanent development, represents a temporary impact to the site because of the forest renewal process. LLI indicators have been developed to monitor progress towards several of these impacts. Because it is in the best interest of Tembec and all forest companies, to promptly regenerate these areas to allow the land to be retained as productive forest, the impacts related to this activity are of a short-term duration on a site basis.

Forest Renewal

Forest renewal activities include site preparation, scarification, tree establishment, and stand tending. These activities generally have a positive impact on physical environmental factors as they lead to accelerated establishment of forest cover providing increased soil stability and nutrient cycling. However localized impacts from site preparation and stand tending may occur on soil and water resources. Because of the magnitude and frequency of the activities, procedures developed can mitigate the impacts.

Site preparation and scarification activities, by their very nature, significantly impact soils in terms of ground disturbance and nutrient distribution. In preparing the ground for reception of seed or planting of seedlings, exposure of the mineral soil is required for tree establishment. As well, ground application of herbicide is undertaken in conjunction with mechanical site preparation to control competing vegetation. In undertaking these treatments a variety of equipment is utilized to achieve renewal objectives in conjunction with soil and other site operating conditions. Drag chaining and the disk trenching produce a continuous furrow of exposed soil as compared to a patch type scarifyer. Winter blading removes the non-decomposed litter layer 6 to 8 metres in width and may impact soil productivity significantly if the decomposed humus or upper soil layer is also removed.

Mitigation of these impacts is provided through the PHA and silvicultural planning process, identifying soil types and anticipated moisture conditions as well as expected levels of residual understory vegetation. As described in the FSP Section 5.14.3 and in work instructions (WDS – WI – 027, 028 and 029), maintaining buffers and understory vegetation established and retained during logging operations is important to mitigate potential impacts from site preparation and scarification activities.

- Soil productivity and stability can be impacted by winter blading operations, which is a treatment primarily utilized in renewal of mixedwood sites following harvest. This site preparation treatment is utilized to a very small extent of the FML. Mitigation is achieved through limiting blading during frozen conditions and targeting blading depth to remove only the upper non-decomposed litter layer as described in the WDS – WI – 027. These actions, in addition to the site preparation pattern used in blading of disturbing only alternate strips with leave strips retained in between, provides mitigation for this disturbance technique.

- The exposed soil disturbance that is intentionally created during both patch and furrow mechanical treatments can result in significant impacts to productivity and stability of the soils in the disturbed area dependent upon local site conditions. On slopes, the exposure of the soil could lead to erosion downslope dependent upon the slope and the surrounding rootmat and organic layer (MBMF 1997C). This impact is more of a concern with continuous furrow treatment types and is mitigated by orientating the direction of the rows perpendicular to the slope so that the forces of wind and water erosion are not able to develop a channeling effect downslope. In addition, the depth of treatment is set out to only create the amount of disturbance to provide a suitable planting site for the new seedlings or seed (WDS – WI – 029).

- Site preparation and scarification can have significant impacts upon surface water, as described earlier, due to potential for erosion and resulting siltation into adjacent watercourses. Mitigation, as described in WDS – WI – 029, includes orientating treatment on hilly terrain perpendicular to the slope as opposed to downslope in order to minimize downslope run-off and resulting erosion and siltation. Direct planting of steep slopes and areas directly adjacent to watercourses without site preparation can assist in this regard. These techniques will mitigate potential impacts of site preparation and scarification upon surface water.

- Ground herbicide application may impact surface and ground water from leaks and spills or mis-application. Herbicide application is undertaken only under carefully monitored conditions including calm wind conditions to minimize drift. For site preparation, the use of ground application techniques as opposed to aerial methods decreases the potential for drift while also providing very specific targeted application of the chemical to areas to be planted to decrease the immediate source of competition. Licensed applicators are used, equipment is maintained and checked for leaks and all necessary permits and approvals are obtained (WDS – 014).

- Site preparation, scarification and subsequent tree planting activities contribute in a very positive manner to restoring site productivity and alleviating concerns related to the conversion of forest land to non-forest use. Without these activities natural processes of forest renewal would be expected to result in establishment of forest cover on logged sites, but over a much greater time frame and often to a different forest type to that which was previously on the site. Site preparation and scarification aid in the process of restoring the nutrient component and maintaining soil structure by re-distributing the retained nutrient capital from the logging slash, including limbs and tops, more evenly across the cutover and by accelerating the process of forest regeneration.

Artificial and natural tree establishment has positive benefits to soil productivity and stability and surface and ground water quality for the principle reason as described earlier, that this treatment promotes prompt establishment of forest renewal on previously logged sites. Artificial establishment includes planting of container stock on a site prepared or manually scalped (non-prepared sites) ground surface. Natural establishment involves maintaining the logging debris (tops & limbs). The cones remaining in this debris provide seed for the future forest

- Re-establishment of trees assists in improving soil productivity by maintaining soil structure and addition of organic debris for nutrient cycling. Soil stability is maintained through root establishment, which reduces impacts related to erosion and subsequent siltation into watercourses and assists in the hydrologic recovery of a site and watershed.

- By implementing an active forest renewal program, Tembec promotes more rapid renewal of logged sites, which has many positive mitigating effects. Active forest renewal activities also promote the return of each area to similar stand conditions to that which was previously present. This assists in maintaining the overall forest type and composition as described earlier.

Chemical stand tending can have a significant impact on soil and surface water through drift, runoff, accidental leaks or spills. Chemical stand tending involves the ground or aerial application of chemical herbicides for control of crop tree competition.

- Spray drift and run-off from treated sites have potential to introduce the chemical into watercourses. Chemical spills or leaks from equipment could result in soil contamination and have implications on fish and other aquatic wildlife depending on the quantity of chemical involved.

- The herbicide applied by Tembec for silviculture treatments is glyphosate. Glyphosate is a post-emergent herbicide applied when target species are actively growing. Glyphosate, when put into contact with water and soil, biodegrades into carbon dioxide, water, nitrogen and phosphorus products (Monsanto Canada 1984).A study by Phillips and McEachern (1988) on glyphosate residues in soil north of The Pas, Manitoba, found that over 90% of glyphosate residues had decreased in all sites over a 29 day period following application. They further determined the half life to be between 8 and 9 days at an application rate of 2.5 l/ha for these sites. Other reports on the half life of glyphosate, indicate less than 11 days (Phillips *et al.* 1987) also in Manitoba and 29 days in forest soils in Oregon (Newton *et al.* 1984). Once the chemical has been dispersed and comes into contact with soil and organic particles it begins to break down. Monsanto Canada (1999) reports a half life range of less than 25 days to 141 days depending on application conditions while 90% of the glyphosate will break down into natural components in less than 6 months. Phillips and McEachern (1988) also reported that no glyphosate residues were found at mineral soil depths of 10 to 30 cm, indicating that glyphosate is totally immobilized by absorption to the surface organic layer. A similar study conducted on the FML from 1985 to 1988 (Henderson et. al. 1988) found that glyphosate was completely adsorbed to soil particles in the top organic layer thus preventing downward leaching.

- Chemical stand tending is undertaken only under carefully monitored conditions including calm wind conditions to minimize drift. Planning, permitting and application procedures utilized in the use of chemical stand tending are described in WDS - 014. Relative to potential entry of the herbicide into adjacent watercourses, previously established buffers from the logging phase of the operations are often supplemented with additional buffers and leave patches to assist in mitigation of wildlife objectives for the area. Use of these buffers provides a filtering effect to minimize potential run-off of the chemical into watercourses. In a study near The Pas Manitoba on surface water residues, Beck (1987a) reported that the half life of glyphosate applied aerially at 3 to 5 l/ha, to be less than 24 hours. In another study near The Pas, Beck (1987b) reports similar results and further states that these results were based on the presence of natural sediments in water bodies which is essential for the rapid removal of glyphosate.

- The use of riparian reserve areas (MC 2008) on harvest areas creates a physical separation of the herbicide treatment areas from aquatic environments. Jones et. al. (1996 and 1997) sprayed highway borrow pits on FML 01 to determine the effects of glyphosate on water chemistry and aquatic vegetation. The data provided no evidence that glyphosate applications affected the water chemistry of the study ponds and that long term adverse effects to vegetation (*Typha spp.)* were not discernable.

- WDS-014 establishes targets that limit the use of herbicides to no more than 25 percent of the area harvested and prescribes that at least 70 percent of herbicide treatments be conducted by ground application techniques which utilize lower volumes/hectare than aerial applications.

- WDS - 014 outlines procedures for obtaining the necessary permits and approvals, requirements for licensed contractors, equipment maintenance to prevent leaks and personnel training to prevent spills. Tembec has an emergency response plan in place for all woodlands operations, which include procedures to respond to herbicide spills that may occur. Application windows and rates are also specified in this procedure, to maintain a component of shrub and ground vegetation and buffer requirements adjacent to watercourses and sensitive habitat. Along with these procedures, the frequency of chemical tending (usually one application will provide the necessary competition control) and the short half-life of the active ingredient mitigate impacts upon surface waters.

The positive impacts from forest renewal activities far outweigh the negative impacts that site preparation and stand tending can have on soil and water resources. Any impacts are local and the frequency and duration along with the operating procedures mitigate the impacts.

Forest Protection

Forest protection involves monitoring damage from insect outbreaks and disease incidence and forest fire control activities.

Fire control can impact soil stability through the construction of firebreaks. Firebreaks necessitate the removal of all vegetation to expose mineral soil. Since there is no further work on the site to control soil movement this presents a potential impact. Contrary to this, fire control has positive impacts through prevention of fire spread and thus maintaining tree and other vegetative cover, which affords site protection as described above.

- Firebreaks are not maintained, except during the fire control phase, and as such are allowed to revegetate. The short duration and infrequent occurrence of this activity in addition to the limited extent of clearing to the fireguard line itself result in an impact that is insignificant and mitigable.

- The positive impacts of fire control are the maintenance of forest cover leading to all of the other related values. In terms of soil and water the maintenance of forest cover allows for the continued cycling of soil nutrients and maintenance of the forest hydrologic cycle.

The application of fire control, as with other forest protection measures, is directed at the maintenance of a variety of timber and non-timber values as described earlier. In terms of soil and water conservation these measures can be viewed as generally positive at a site level for retention of soil stability, particularly in areas of steep slopes that, once burned over may be expected to undergo erosion and siltation, possibly into adjacent watercourses. At the same time it is recognized that fire is the dominant natural disturbance and renewal factor in the boreal forest. Across the landscape the adaptations that are present in terms of nutrient cycling for forest soils and the infrequent (for a given site) potential for erosion and siltation of exposed soils, possibly into adjacent watercourses, is assimilated by the ecosystem.

Equipment Use

Equipment use including all machine operations for harvesting, infrastructure construction, site decommissioning and fuel and waste management can have significant impacts to soil and water resources. Mitigation is achieved primarily through the planning process, operating procedures, equipment specifications and maintenance.

In-block operations through the use of heavy equipment, can have a significant impact on soil productivity, stability and surface water in terms of ground disturbance, soil displacement, channeling of surface water and soil erosion. In-block operations involve heavy equipment use for main network and in-block road construction, logging (including felling and forwarding), roadside processing and loading operations, timber and equipment/fuel transportation and forest renewal.

Magnitude of impacts will vary dependent upon soil texture, moisture, slope and organic layer depth (Kershaw 1996), as well as the season of activity and the type of equipment used. Fine textured (silt and clay) and organic soils, wet moisture conditions and areas situated on slopes greater than 10 % all contribute to more significant impacts on soils (Kershaw 1996). Operations occurring in the frost free period and those that utilize carriers not equipped with tracks, wide tires or other specialized equipment for distribution of machine weight are most likely to cause ground disturbance and soil erosion. The risk of damage by ground disturbance and displacement is greatly reduced when soils are frozen and the load bearing capacity of the soil can support logging equipment (Archibald, *et al.* 1997). Litter, slash and organic material on the soil surface can greatly increase traffic ability of a site.

- Soil productivity is impacted through compaction, which reduces soil porosity leading to increased surface runoff and impeded infiltration, and increasing bulk density which inhibits rooting ability. Impacts to surface organic layers, and understory vegetation may result. These impacts are a result of wheeled or to a lesser extent tracked machine use on the site under unfrozen conditions.

- Soil stability is impacted through soil compaction and displacement (rutting) with potential for surface water channeling and/or ponding. These impacts are a result of wheeled or to a lesser extent tracked machine use under unfrozen conditions.

- Surface water can be impacted, dependent upon terrain and slope conditions leading to watercourses adjacent to operating areas, by ponding, channeling and rerouting of water and potential for siltation into watercourses. This can occur as a result of the disturbance to the surface soil layers through rutting and compaction leading to alterations of natural surface flows and drainage patterns.

  - The following actions taken by Tembec and prescribed in the EMS provide mitigation related to equipment use and are similar in nature to, "best practices", as described by Kershaw (1996) and Archibald (1997) for the maintenance of forest soil productivity, stability and surface water.

    - During PHA (WDS – 002), soil texture, and moisture, slope aspect and, in particular, locations of wet soils are noted. This allows for specifying logging system, machine type, season of operation and anticipated effects of weather conditions. Winter logging is applied as a mitigative tool as frozen ground conditions allow movement of heavy equipment with minimal disturbance to the site and soils in particular. For operations throughout other seasons of the year wide-tired and tracked carriers can reduce the impact of ground disturbance by distributing the weight of the equipment over a greater area. Temporary work stoppages or moving firmer ground can be instituted for operations during this timeframe should heavier than usual rainfall result in saturated soil conditions on susceptible sites (WDS-WI-008).

    - Use of heavy equipment is limited to areas within approved cutblock and road ROW boundaries (WDS – WI – 002) and the AORP (WDS_010) identifies potentially erodable sites for soil and water protection which are monitored through the ECA (WDS-013) and reported in LLI Indicator 3.1.2.3.

    - In the vicinity of in block drainage areas, heavy equipment is limited from travel onto areas where soil disturbance will result in sedimentation downslope into the water (WDS-WI-007). Boom reach and winching capacity of equipment is maximized in these areas to decrease machine entry. In road and watercourse crossing construction, heavy equipment is limited to the road ROW area and any additional approved access points developed in the AORP.

    - In-block roads and forwarding trails are minimized to the extent possible avoiding wet areas.

    - Delimbing and topping at the stump provides distributed logging slash acting as a corderoy effect for additional support structure for in-block equipment use (WDS – WI – 012).

    - Machine use restricted by season for specific sites, that is, wet lowland sites with saturated soils scheduled for frozen ground (WDS – 010).

    - Excessive rutting and compaction will necessitate shut down of operations for the cutblock being operated with associated application and transfer of operations to a contingency cutblock (WDS – WI – 008).

    - Contingency blocks identified in the AORP will be implemented in the event that excessive rutting and compaction from machine traffic or unsuitable ground conditions preventing operations from occurring or continuing. Planning of contingency blocks to provide the option of moving operations will mitigate these impacts.

    - Where rutting and compaction occur as a result of heavy equipment use during harvesting operations to the extent that forest renewal success and site productivity are expected to be impaired, such areas will be reclaimed during the scarification and site preparation operations where soil and operating conditions permit, to allow forest renewal of the site to proceed.

- Within the C & I framework several indicators have been developed with respect to the conservation of soil and water resources during operations with heavy equipment.

    - Indicator 3.1.2.1 provides for tracking and follow-up action relating to the area of harvested sites with significant soil compaction, rutting or displacement through the ECA.

    - Indicator 3.1.2.3 provides a follow-up sampling mechanism to monitor the percentage of potentially erodible sites treated according to WDS Departmental Procedures and Work Instructions during the ECA that are assigned for application for each such site at the AORP planning stage in response to the findings of the PHA for the cutblock.

    - Indicator 3.1.4.1 provides for sampling of sites where operations have occurred adjacent to waterbodies to monitor exposure of ground surface related to potential erosion and resulting sedimentation into the water. The sampling of such sites is included in the ECA.

Fuel storage and handling and non-hazardous and hazardous waste poses potential impacts to soil productivity, surface water and ground water. Fuel storage and handling impacts include leaks/spills from storage and handling. Hazardous waste impacts include soil and water contamination and landfill depletion.

- Potential for run-off from waste disposal and fuel storage sites into surface water or local aquifers and thereby to ground water is mitigated through the same practices described earlier with reference to surface water impacts including location of such sites away from watercourses. Retention of understory vegetation, establishment of buffers and prompt site decommissioning and forest renewal will minimize changes to groundwater infiltration resulting in insignificant impacts, which are mitigable in the landscape context.

- Equipment is inspected daily for leaks of fuel or other hydraulic based fluids and follow-up corrective action as per the Tembec Emergency Response Plan provides mitigation of concerns related to soil and water contamination (WDS – WI – 020).

- Handling, disposal and spill clean-up of waste and fuel products is managed in compliance with provincial regulations and sites are located to maintain a minimum distance from adjacent watercourses. Tembec has put into place an Emergency Response Plan within the EMS. Use of these mitigation procedures results in insignificant impacts from these activities.

- As part of the LLI framework indicators have been developed to track the control of hazardous waste in terms of reportable spills and through sampling of operations during the ECA program, assess actual levels of reporting:
  - Indicator 3.1.5.1 monitors the number of reportable spills, reported to Manitoba Conservation, associated with transport, storage and handling of fuel and operation of equipment.

In-block equipment use can have significant impacts on soil and water depending on such variables as soil texture/drainage, slope, season of activity and equipment type. Mitigation of impacts from equipment use is primarily achieved through planning, operating procedures, equipment specifications and maintenance. LLI have been developed by Tembec to monitor the effectiveness of planning criteria and operating procedures. Fuel storage and non-hazardous/hazardous waste management impacts relate to potential leaks and spills of fuel and chemicals. Tembec has an emergency response plan to deal with fuel and waste management and reporting.

5.3 Policy and Protection Forest Factors

5.3.1 Introduction

Policy and protection forest factors, is reflected in the establishment and effectiveness of policies in place for conserving soil and water quality. The components, riparian zones and planning and operating practices and approvals are represented in Table 5.

5.3.2 Data Adequacy and Gaps

FSP sources of information include:

- Tembec Environmental Policy (EIS Section 11)
- Tembec Forever Green Guiding Principles (EIS Section 11)
- Reference to relevant provincial policies and guidelines (FSP Section 1.6)
- Tembec Environmental Management System (EMS) (EIS Section 14)

Other sources of information include:

- Province of Manitoba Sustainable Development Policies
- Manitoba's Submission Guidelines for Twenty Year Forest Management Plans (MC 2007)
- Planning and Submission Requirements for Annual Operating Plans (MNR 1996B)
- Forest Management Guidelines for Riparian Areas (MC 2008)
- Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat. (DFO/MNR 1995)
- Forestry Road Management guidebook (MC 2005B)
- Wildlife Guidelines for Forest Management in Manitoba (MNR 1984)
- Timber Harvesting Practices for Forestry Operations in Manitoba (MNR 1996)
- Recovery Strategy for the Carmine Shiner (*Notorpis percobromis)* in Canada (Fisheries and Oceans Canada 2008)
- Forest Stewardship Council, Canadian Working Group, National Boreal Standard (FSC 2004)

These sources of information represent the best information currently available relevant to policies and guidelines regarding conservation of soil and water resources on FML 01. On-going review and update of Provincial guidelines occurs through the Manitoba Conservation Forest Practices Committee.

The SFM C & I framework developed during the preparation of the FSP provides the framework to be utilized for monitoring of indicators for measurement of progress towards targets established in the FSP. Indicators developed to represent soil and water resources will provide improved data regarding the components referenced in Table 5 as the monitoring program for adaptive management is implemented during the FSP 20 year period. LLI Indicators 3.1.2.1, 3.1.2.3, 3.1.2.4, 3.1.4.1, 3.1.4.2, 3.1.4.3, 3.1.5.1 and 3.1.6.1 will provide enhanced data as time moves forward relative to policy and protection forest components indicated in Table 5.

5.3.3 Forest Management Activities Assessment

Planning

The planning process can have significant impacts on riparian zones and other sensitive sites. Through provincial and Company procedures, however, impacts can be positive particularly for public participation, sustainability modeling and information collection and application. Joint planning, forest inventory and updating and information collected through the AORP and PHA provide data on and identify riparian and other sensitive sites such as; parks, protected areas, ecological reserves, heritage rivers, provincial forests and wildlife management areas.

Forest management planning has significant impacts and obvious benefits to planning and operations and practices and approvals. Tembec has developed an ISO 14001 Environmental Management System (EMS) which includes Policy Directions, Departmental Procedures and Work Activities for undertaking all stages of forest management activities. Tembec has also achieved Forest Stewardship Council (FSC) certification to the boreal standard (FSC 2004), for FML 01. Complementary to these systems Tembec has developed LLI indicators to monitor performance of their operations. These voluntary commitments compliment and in some cases exceed Provincial and Federal legislation and policies in achieving soil and water quality conservation. In developing the procedures to undertake forest management activities, provincial policy and guidelines as set by MC, other provincial departments and relevant federal departments have been taken into account. Reference to these government guidelines continues to provide guidance to the Company in developing plans and implementing operations.

Public participation and joint planning procedures as outlined in the FSP and various MC policy, procedures and guidelines and Applying Manitoba's Forest Policies (Province of Manitoba) are mitigative tools that involve interested parties in the planning process. The LLI process itself, was developed through a public participation process. The C&I framework developed by the CCFM (1995 and 2003) has subsequently been utilized by Tembec to provide the overall framework for the Company's FSP, including the setting of objectives and targets, for FML 01 and the establishment of a monitoring and research process to track progress made towards these targets.

Road and watercourse crossing planning procedures developed by Tembec take into account guidelines as outlined in the *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO/MNR 1995) and *Forest Management Guidelines for Riparian Areas* (MC 2008). Strategies for the conservation of STE aquatic species, occurring on FML 01, is provided by *Recovery Strategy for the Carmine Shiner (Notorpis percobromis) in Canada* (Fisheries and Oceans Canada (2008). These guidelines continue to be directly utilized in a complementary fashion by the Company in addition to the specific areas covered by the FSP.

Harvest and renewal planning procedures developed by Tembec take into account guidelines as outlined in *Timber Harvesting Practices for Forestry Operations in Manitoba* (MNR 1996), *Wildlife Guidelines for Forest Operations in Manitoba* (MNR 1984), *Planning and Submission Requirements for Annual Operating Plans* (MNR 1996B), *Forest Management Guidelines for Riparian Areas* (MC 2008) and other guidelines. As in the case of road and watercourse planning these government guidelines are viewed as continuing requirements and complementary to the specific areas covered by the Departmental Procedures, Work Instructions and FSP.

In developing plans for road development as well as harvest and renewal planning particular regard is placed upon riparian areas which, are important in terms of soil and water conservation by providing flood control and streambank stability. These areas provide the zone of interaction between land and soil processes that occur in response to forest management activities with the water resources that can also be impacted. In addition to their role in soil and water conservation, riparian areas represent important values for wildlife and other values. The policies and procedures of Tembec in conjunction with the guidelines of MC and other government departments recognize the importance of these areas with special emphasis upon buffers and other management actions. Suggestions from Hunter (1990), for management of buffers excluding roads, except at crossings, include partial (≤25%) cutting throughout the entire buffer zone or a two tier approach with no cutting in the first 10m and a wider zone where limited harvesting could take place. Tembec also recognizes the role of natural disturbance across the landscape and the need for disturbance and renewal in these riparian areas as well. Within the LLI framework, Indicator 3.1.4.3 provides for tracking and reporting of buffer widths established within harvested areas.

Sustainability modeling has been undertaken incorporating the MC Forest Inventory. The MC Forest Inventory database provides Tembec with information for strategic level planning including sustainability assessment of the timber supply. This database also provides the framework for more detailed timber investigations through PHA and inventory updating through annual monitoring of harvesting and renewal activities.

Information collection and application is undertaken throughout the planning, monitoring and reporting processes associated with forest management. With regard to the policies and guidelines of Tembec and MC, the ECA program in particular includes sampling of roads and cutblocks with respect to a number of indicators. Many of these indicators relate to the implementation of Departmental Procedures, Work Instructions on the ground in terms of those planned to mitigate potential impacts.

Within the LLI framework, indicators have been developed to track and report upon all approvals, permits and licenses as well as any disciplinary action required as a result of a non-conformity to an approved plan.

Infrastructure Development, Harvesting, Forest Renewal, Forest Protection and Equipment Use

Riparian zones are a valuable and sensitive component of the landscape and indeed necessary to maintain function and structure of a watercourse (Hunter, 1990). These zones provide important habitat for many species of furbearers, small mammals, birds, and larger game animals in addition to the role they play in terms of the adjacent aquatic habitats and associated recreational and aesthetic values. Tembec recognizes the importance of aquatic and riparian areas to the overall health of the ecosystem procedures specific to the retention of these areas to protect identified values. The Company also seeks to incorporate such areas in an overall landscape pattern of harvest and renewal to approximate natural disturbance patterns.

Infrastructure development may have significant impacts to riparian zones. Roads and watercourse crossings have potential to impact riparian zones and other sensitive sites primarily through the alteration of surface water levels at crossing sites. Site decommissioning and tree establishment, both have a positive effect on riparian areas through the re-establishment of natural hydrologic processes. Buffer widths and active buffer management activity are established for each class of stream or waterbody and management may vary from these general guidelines dependent upon the landscape, site-specific wildlife and aesthetic values present.

All weather roads and winter roads can have a significant impact to riparian zones at the point at which these routes approach watercourse crossings.

- All-weather roads may alter natural drainage patterns of wetland areas associated with some riparian areas through the existence of the roadbed.

- Mitigation is achieved through location of the route within these areas to minimize wetland locations crossed and design to integrate placement of appropriate cross drainage structures as outlined in WDS – 003 and 006, WDS – WI – 023 and 025.

Winter roads are routed through some riparian areas in crossing from wetlands to upland sites as required to meet the route required for access to operating areas.

- At approaches to wetlands and watercourses, winter roads will cross through riparian zones where it is necessary to traverse upland areas in routing through wetlands to operating areas. At such locations, blading of the vegetation and removal of any trees in the ROW is necessary leading to potential for subsequent erosion and sedimentation into the watercourse once thawing occurs. Mitigation is achieved through limiting construction and operations to periods when the ground is frozen to reduce site disturbance. Blading of any surface organic materials and the root mat is minimized to retain the stability of the soils at these sites. Locations to approach uplands are selected to minimize cutting of banks. Additional mitigation can be undertaken as necessary to control erosion and aid in establishment of re-vegetation through use of measures such as placement of straw bales and rolling back of woody debris materials to assist the root mat in soil retention (WDS-WI-026 and 035) and *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO/MNR 1995).

Permanent watercourse crossings have potential for impact to riparian zones during the construction process and service life. Permanent crossings can significantly impact riparian areas through alteration of banks and siltation of water, as well seasonally impeding water flow periodically changing water levels. In terms of siltation effects, a study by Hall and Lantz (1969) found that bedload sediment in the form of fine sediment, may fill in the interstitial spaces between rock and gravel suffocating Coho salmon egg or fry. In stream construction activity should be limited during spawning and incubation periods. Adamson and Harris (1992) advise the completion of sediment control plans at water crossing sites that have potential to affect critical fish habitat.

- Mitigation is achieved through scheduling construction activities during times that avoid fish spawning and migration and crossing specifications and construction requirements for the crossing as outlined in WDS – 003, 006 and 012, WDS – WI – 023 and 026 and *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO/MNR 1995).

    - Locations of crossing sites are selected to minimize requirements to alter slopes and banks.

    - Equipment activity in-stream during construction is minimized to the extent possible.

    - ROW widths are narrowed and minimized at crossing site in riparian areas to decrease disturbance to root mats and vegetation. In follow-up monitoring the LLI framework includes Indicator 3.1.4.1 relating to sampling of sites to examine and report upon exposure of ground surfaces adjacent to waterbodies that could impair water quality

    - Planning and approvals of crossings receive particular attention by Tembec and MC in response to the importance of riparian areas to a number of values and the potential for impact to these values. Indicator 3.1.7.1 relates to the tracking of all approval, including MC and Navigable Waters Act approval processes for crossings (WDS – 015).

Temporary watercourse crossings have similar potential impacts as permanent crossings although they are considered to be insignificant due to the short-term duration of service and the magnitude of crossing locations generally used for temporary crossings. Mitigation is achieved through the same actions as for permanent crossings as well through decommissioning, with subsequent re-vegetation, after use.

Site decommissioning of infrastructure has positive impacts to riparian zones as a result of the nature of the activity. Decommissioning involves re-spreading of the surface organic layer and woody debris, slope recontouring and revegetation. In riparian areas particular attention must be provided to erosion control measures following up on decommissioning of temporary crossings to minimize siltation from banks, exposed after infrastructure removal, into adjacent watercourses. Such actions are included in work instructions (WDS – WI – 035 and 036) and in *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* (DFO/MNR 1995).

Logging can have impacts from the removal of forest cover adjacent to or within riparian zones in conjunction with harvesting efforts to approximate natural disturbances. As indicated earlier, buffers are prescribed for riparian areas in conjunction with the values of the location and the potential for impact upon these values. In other areas variable buffer widths may be prescribed, corresponding to natural disturbances.

- These impacts although potentially significant are mitigated through practices and procedures outlined in FSP Section 5.11.1 and WDS-WI-048, including the application of buffers to protect identified values as per the *Forest Management Guidelines for Riparian Areas* (MC 2008).

- Where buffers are prescribed, widths for riparian areas, established from the high water mark, will vary dependent upon the riparian class, slope, aquatic and riparian wildlife, recreation and aesthetic values present along each specific watercourse as per the *Forest Management Guidelines for Riparian Areas* (MC 2008).

- Buffers may be actively managed and involve VRL, with follow-up prompt forest renewal, to minimize impacts in these situations.

- In all cases no roads or landings will be established within 100 metres of any watercourse without joint approval of MC

- LLI Indicator 3.1.4.3 tracks and reports on buffer widths established in harvest areas as per the FSC boreal standard (FSC 2004).

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Tree establishment has a positive impact on riparian zones through the re-establishment of forest cover.

- As with all harvested areas, the Company will renew any managed buffer areas where advanced softwood growth is insufficient to provide regeneration. In these areas site preparation or scarification will only occur where slope and soil conditions will not lead to erosion and siltation into the watercourse. Such areas will be lightly dragged but are generally direct planted with no site preparation. Forest cover moderates infiltration rates and runoff and provides increased cover for wildlife and shading for streams.

In-block machine use may have significant impacts on riparian zones through direct machine travel on riparian areas.

- The provincial and Tembec policies and procedures outlining requirements for limited machine travel in riparian buffers as stated above mitigate these impacts.

- Winter operations under frozen conditions may also be prescribed for buffer management where wet soil conditions will lead to rutting and compaction.