PRIVATE
MANAGED
FOREST LAND
COUNCIL

Managed Forest Program:
Effectiveness of the Council Regulation In Achieving the Forest Management Objectives of the *Private Managed Forest Land Act*

October 2013

EXECUTIVE SUMMARY

Created in 2004 under the *Private Managed Forest Land Act* (Act), the Private Managed Forest Land Council (Council) is an independent agency whose mandate under the Act is "to encourage forest management practices on private managed forest land, taking into account the social, environmental and economic benefits of those practices"[1].

In 2012 the Council undertook an effectiveness audit to assess whether the forest management objectives established under the Act are being achieved under the regulatory regime for forest management practices on managed forest land. The Council routinely conducts compliance audits and performance monitoring inspections but this is the first audit that has evaluated the effectiveness of the Private Managed Forest Land Council Regulation (Council Regulation) with respect to the Act. The audit found that forest management objectives were being met and that in many cases the minimum regulatory standards were exceeded. Consequently, several notable practices were identified and they are described in this report. Finally, the report includes cautionary notes, particularly concerning the management of streams in areas with a high potential for windthrow.

The Act establishes forest management objectives for five public environmental values: soil conservation, fish habitat, water quality, critical wildlife habitat and reforestation. The requirements for the protection of these environmental values, except for critical wildlife habitat, are set out in the Council Regulation.

A multi-disciplinary team consisting of foresters with expertise in harvesting operations and reforestation, a geoscientist and a fisheries biologist carried out the audit. All members of the team have previously carried out inspections and compliance audits of the Managed Forest (MF) Program, have familiarity with the objectives of the MF Program and have extensive experience in forestry in other jurisdictions. All members of the audit team were independent of the operations being audited. An audit and evaluation specialist took a lead role in the planning and design of the audit approach and assisted in the analysis and reporting of the results. The field evaluations took place between August 7 and October 26, 2012.

An audit sample of 14 MFs was selected from 42 MFs in the program that reported harvesting, road construction, road deactivation and/or reforestation activities in the primary target period 2007/2008. The secondary target period 2008 – 2010 was included to broaden the sample size and reforestation activity from pre-1997 to 2006 was included to enable assessment of the regulated five year and 15 year reforestation milestones. The audit sample represented MFs both larger than and smaller than 1,000 hectares that had activities near fish streams and/or licensed waterworks intakes, had forests with multiple activities to assess and had forests that had not been audited in the previous two years. The approach allowed assessment of activities that had been completed so that outcomes could be evaluated against the objectives.

The audit process involved an on-site interview with each MF owner. Each interview focused on general forest management strategies and practices for the properties with respect to the environmental values. The field portion of the audit consisted of evaluating selected activities on the ground through observations, measurements, and professional judgment.

Soil Conservation

The forest management objective with respect to conservation of soil for areas where harvesting has been carried out is to protect soil productivity on those areas by minimizing the amount of area occupied by permanent roads, landings and excavated or bladed trails.

The audit found that harvesting activities resulted in acceptable and minimal levels of soil disturbance and site loss. The audit noted very little ground disturbance directly attributed to harvesting. Owners appear to be motivated to maximize the productive ground for reforestation after harvesting and to minimize growing site loss. The regulatory requirement to minimize the amount of area occupied by permanent roads, landings and excavated or bladed trails is being met without having a regulated baseline minimum target. The combination of the best

[1] *Private Managed Forest Land Act* 2003 Chapter 80, Section 5

management practices being implemented and the provisions of Council Regulation contribute to achieving the soil conservation objective of the Act.

Road construction has been carried out without causing levels of soil disturbance or soil degradation beyond minimal levels. Construction practices related to stream crossings and drainage control were effective in minimizing sediment transfer into streams. The report lists a number of notable practices associated with the road construction and maintenance practices being employed. These are equivalent to best management practices generally employed throughout the forest sector in British Columbia.

Erosion and loss of productive growing sites from slides associated with roads built within the past ten years is low. This is credited to the road construction techniques being used. The larger (by area) owners have design protocols for identifying and avoiding unstable terrain. Road construction, maintenance and deactivation practices observed met the requirements of the Council Regulation and are contributing to achieving the objectives for soil conservation, fish habitat, and water quality.

Fish Habitat

The forest management objective for private managed forest land with respect to the protection of fish habitat, both during and after harvesting, is to retain sufficient streamside mature trees and understory vegetation to protect all of the following:

- *a natural variation in water temperatures;*
- *sufficient cover for fish;*
- *a continual source of large woody debris for stream channel stability purposes;*
- *a vigorous mass of roots capable of controlling stream bank erosion;*
- *a filter to prevent the transport of sediment into stream channels;*
- *woody debris sufficient for in-stream habitat; and*
- *a source of nutrients to the stream through litter fall.*

The audit found that for class A, B, and C streams management of the riparian areas was effective in protecting all seven attributes of the fish habitat objective. Moreover, the number of large trees that were retained adjacent to class A, B, and C streams significantly exceeded the minimum requirements of the Council Regulation on all but one of the 24 streams that were assessed. This is a voluntary practice by owners. In view of this the audit team could not determine if the minimum tree retention requirements in the Council Regulation for class A, B, and C streams alone are sufficient to achieve the fish habitat objective of the Act.

Owners are retaining large commercial trees beside class D, E or NC streams assessed even though there is no regulatory requirement to do so. Six of the seven habitat attributes were maintained for the class D, E and NC streams. The practice of exceeding the minimum requirements for retention of large tress was observed on both Coastal and Interior MFs. The report cites the owners reasons for doing so in a list of notable practices.

Although the audit found that forestry practices assessed did not adversely affect fish or fish habitat, three cautionary notes are provided. These are:

- Windthrow in riparian areas is regarded as a potentially serious ongoing threat to the stability of streamside habitat.
- Certain class A streams may not be adequately protected if only the minimum number of large trees are retained adjacent to large, laterally unstable rivers, or active alluvial fans.
- Although there is no regulatory requirement to retain large trees adjacent to class E streams it is possible that this may be needed in some situations to maintain channel stability on larger class E streams in order to protect downstream habitat.

The Council Regulation requires that fish habitat is not materially adversely affected by sedimentation from primary forest activities such as road building and operations. The audit found that soil erosion from roads and road ditches had minimal potential to result in suspended sediment entering fish streams, especially in areas developed within the last five to 10 years. Suspended sediment generation was more likely to occur on older roads, especially those with high traffic volume. There were no cases where the audit team concluded that the fisheries resource was at risk due to sediment into streams from roads.

Water Quality

The forest management objective with respect to water quality is to protect human drinking water, both during and after harvesting.

Communications with licensed waterworks intake holders by MF owners and the protection of water quality at licensed waterworks intakes is being achieved as required by the Council Regulation. However the Council Regulation may be limited in its scope to protect domestic water quality in that the prescribed requirements only apply to licensed waterworks intakes holders that are issued to incorporated water user communities. The Council Regulation does not extend to water licence intakes issued to single users for domestic water consumption. Also, a MF area in many cases covers only a portion of a water catchment area. This may limit the effectiveness of the Council Regulation in being able to meet the water quality objective of the Act because managing the effects of activities outside of MF boundaries is beyond the mandate of the Act.

Critical Wildlife Habitat

The forest management objective with respect to critical wildlife habitat is to facilitate the long term protection of that habitat.

Critical wildlife habitat was excluded from the audit scope. Under the Act, implementing the provisions for critical wildlife habitat protection is the responsibility of the minister responsible for the administration of the *Wildlife Act*. That aside, no critical wildlife habitat has yet been identified on private managed forest land.

Reforestation

The forest management objective with respect to reforestation of areas where timber has been harvested or destroyed is to promptly regenerate the areas with a healthy, commercially valuable stand of trees that is not impeded by competition from plants or shrubs.

Reforestation after logging is being completed on a timely basis, generally within two years, and restocking densities of healthy, well-spaced commercial species exceed the minimum regulatory requirements. Owners appear to be motivated to reforest and maintain vigorous regenerating forests on their properties and demonstrate this by monitoring the young stands and intervening when and if required. Management of restocking density, competing brush and forest health issues is generally resulting in successful reforestation. The auditors assessed young stands beyond the regulated successfully regenerated age of 15 years and concluded that these stands in time will produce another merchantable crop. It is concluded that the Council Regulation for reforestation is effective in achieving the reforestation objective but is not the sole driver.

Although the reforestation objective is being achieved, there are other factors in addition to the Council Regulation that contribute significantly to reforestation success. The report lists a number of notable practices undertaken by the owners that contribute to the successful reforestation results, including the use of carefully selected seedling stock and planting to greater densities than required.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

In 2012 The Private Managed Forest Land Council (Council) conducted an effectiveness audit to assess whether the forest management objectives in the private managed forest land legislation are being achieved. Objectives are established in the *Private Managed Forest Land Act* (the Act) for soil conservation, water quality, fish habitat, critical wildlife habitat and reforestation. These forest management objectives are listed in Appendix 1.

2.0 BACKGROUND

Created in 2004 under the *Private Managed Forest Land Act*, the Council is an independent agency whose mandate under the Act is "to encourage forest management practices on private managed forest land, taking into account the social, environmental and economic benefits of those practices".

Managed forest land is a BC Assessment property classification established to encourage owners in British Columbia to manage their private land for long-term forest production. An owners participation in the Managed Forest Program is voluntary. The provincial government and forest owners recognize there is more than one approach to protecting key public environmental values in private forests. A results-based regulatory model allows both large and small forest landowners to develop and implement management strategies most appropriate to the scale and geographic location of their operations while focusing on achieving measureable objectives as required under the regulation.

The Council introduced regulations in 2004, establishing a set of practices and desired results with respect to forest stewardship that were designed to meet the objectives in the Act. The 2004 regulations were similar to those in place under the previous *Forest Land Reserve Act*. In 2007, Council completed a review of the private managed forest land legislation which resulted in amendments to the Act and regulations. A number of significant changes to the Council Regulation were made that focused on forest practice requirements, including an updated stream classification system, improved protection of licensed waterworks intakes (LWI)[1] for drinking water and strengthened soil conservation requirements. Appendix 2 lists the private managed forest land legislation.

The Council has been monitoring forest management activities of Managed Forest (MF) owners continuously since 2004 through a combination of compliance audits and site inspections. Between 2004 and 2012, Council carried out 268 inspections, including a site evaluation of every MF in the program, and compliance audits of 45 MFs.

2.1 Scope

The populations of prime interest were comprised mainly of activities reported by owners in 2007/2008. These activities follow implementation of the 2007 Council Regulation, but were early enough to include prior five year reforestation obligations. The level of operational activity varies for many reasons and in order to broaden the sample size, activities reported between 2008 and 2010 were also included. Reforestation obligations for five to 15 years and over 15 years required sampling of regenerated stands established after harvest between 1997 and 2006 or pre-1997 respectively. Note regenerated stands older than 15 years have not been audited previously.

On each MF, the activities that required assessment were harvesting, reforestation, and road construction, maintenance and deactivation, and their performance in relation to the objectives and obligations referred to in the Council Regulation for soil conservation, water quality, fish habitat and reforestation.

Critical wildlife habitat was excluded from the audit scope. Implementing the provisions for critical wildlife habitat protection is the responsibility of the minister responsible for the administration of the *Wildlife Act* under the Act. That aside no critical wildlife habitat has been designated on managed forest land to date.

1 A LWI is a licensed waterworks intake issued under the *Water Act* to an organization distributing domestic water to a water users' community of six or more users. It should be noted that the Council Regulation excludes requirements associated with water licences (WL). These are issued by the Ministry of Environment to single users.

3.0 AUDIT APPROACH

The planning phase of the audit involved developing the criteria to be used in the assessment of practices and results, identifying the target populations on which to apply the criteria, selection of the MFs that had enough activity to efficiently provide the audit data and development of field checklists. This was followed by field testing the criteria and checklists. The audit field work, conducting on-site assessments for the selected MF sample, took place between August 7 and October 26, 2012. The results were then analyzed for the development of this report.

3.1 Target Populations

The following table presents the target populations that were selected to best evaluate forest management practices in relation to the objective(s) and requirements established for each environmental value.

Environmental Value	Target Population
Soil Conservation	• four to five year old cutblocks, to observe the cutblock ground conditions after a few seasons post harvest
Fish Habitat and Water Quality	• four to five year old cutblocks with fish streams within in or adjacent, to observe streamside tree retention, stability of streamside areas and disturbance causing erosion and/or sediment deposition into streams • new roads, including bridges, constructed up to two years ago to observe potential sediment sources into fish streams • existing roads, including bridges, to observe effectiveness of road maintenance and potential sediment sources and deposition into fish streams • deactivated roads, to observe stability and potential sediment sources • four years or older landslides to observe ongoing impacts and results of mitigation measures • licensed waterworks intake locations to observe potential points of sediment initiation and deposition
Reforestation	• areas harvested or destroyed less than five years ago to observe whether the areas have been restocked • areas harvested or destroyed five to 15 years ago to observe whether reforested areas remain restocked, healthy and growing free of brush competition • areas harvested or destroyed over 15 years ago to determine whether the new forest established is growing productively and meets the conditions for successful reforestation

Appendix 3 provides a summary of environmental values, aspects, populations and measurements.

3.2 Selection of Managed Forests

The audit sample was drawn from all MFs that reported harvesting, road construction, road deactivation or reforestation activities as described in the scope above. This approach allowed for the assessment of activities within a reasonable time after they had been completed. The sample selection was based on the following criteria, and resulted in a sample population of 14 of the 42 MFs that reported activity in that period:

- representation of managed forests both larger than and smaller than 1,000 hectares;
- activities carried out near fish streams and/or licensed waterworks intakes;
- forests that had multiple activities to assess; and
- forests that had not been audited in the previous two years.

The selection of the actual sites to be assessed in the field considered the level of activity reported by each owner, with a focus on higher risk activities and consideration of audit efficiency and access. Of the large MFs in the sample, five were on Vancouver Island or adjacent Gulf Islands, and five were in the East and West Kootenays. Of the small to medium sized MFs, all four were on the South Coast and Northern Gulf Islands.

3.3 Conduct of the Audit

Each visit to a MF commenced with an opening meeting with the owner, and presentation of the audit process. An overview discussion was held on forest management strategies and practices in place for each MF, with emphasis on the potential outcomes on the environmental values. Each owner identified cutblocks and operating areas meeting the target objective activities and the audit team selected samples from those available populations. The audit team was reasonably assured that the activity populations provided by the owners for selection of field sampling were complete.

The field audit consisted of evaluating selected activities on the ground through observations and measurements. Information was recorded in evaluation checklists.

The results of the field assessment for each MF were then compiled by entering both quantitative and qualitative data from the checklists into a database. Analysis was carried out to develop preliminary findings for each activity, which were then assessed for each environmental value. This analysis provided the basis for developing the findings and conclusions presented in the audit report.

3.4 Audit Team

A multi-disciplinary team consisting of foresters with expertise in harvesting operations and reforestation, a geoscientist and a fisheries biologist carried out the audit. All members of the team have previously carried out inspections and compliance audits of the MF Program, have familiarity with the objectives of the MF program and have extensive experience with forest practices in the province. All members of the audit team were independent of the operations being audited. An audit and evaluation specialist took a lead role in the planning and design of the audit approach and assisted in the analysis and reporting of the results.

4.0 FINDINGS AND CONCLUSIONS

4.1 Soil Conservation

The forest management objective with respect to conservation of soil for areas where harvesting has been carried out is to protect soil productivity on those areas by minimizing the amount of area occupied by permanent roads, landings and excavated or bladed trails.

The soil conservation objective applies to all operational activities that may result in soil disturbance. The intent is to maintain the productive capacity of the forest land for growing trees and to maximize the net area available to be reforested once harvesting has been completed.

The audit evaluated the area taken up by roads, the amount of soil disturbance due to harvesting or landslides, and the measures taken to stabilize disturbed slopes, logging trails, and road cutbanks. This was used to assess how these activities had affected the area of productive forest land. The audit team examined a total of 48 cutblocks in nine MFs.

4.1.1 Harvesting

Area occupied by roads

In determining access requirements, an owner must consider the potential implications of the harvest method selected, the amount of road required (length, width and location) and the roads needed for access for forest management activities such as stand tending, fire protection and future harvesting.

A revision to the Council Regulation in 2007 removed the specific target of 7%, or less, of productive growing site lost to permanent roads. Nevertheless this target may be considered a benchmark of “reasonableness” for site loss in harvest planning and operational practice.

The audit team examined the area used for roads and trails in a cutblock to determine if the design was appropriate and the area occupied was minimized or appropriate to site conditions. If it appeared higher than minimal, the team examined for possible causal factors.

The audit team found that:

- in 33 of 48 cutblocks, the site loss was less than 5%;
- in 11 cutblocks, site loss was between 5% and 7%; and
- in four cutblocks, site loss was more than 7%.

Of the four cutblocks where site loss was more than 7%, three were less than 8% and one was 10%. The audit team concluded that the site loss of more than 7% in all four of these cutblocks was reasonable based on the cutblock characteristics, timber development factors such as the number and distribution of streams in the cutblock, the need to provide road access to timber outside the cutblock, and steep, rocky terrain. These all have an impact on the location and amount of road constructed.

In all 48 cutblocks examined, the area used for roads and trails was kept to a practical minimum to safely conduct forest management activities. Specifically, owners only built as much road as was needed in order to access timber safely, and the road clearing width and road running surface was kept to a practical minimum.

A fairly common practice when constructing roads on gentle terrain is to excavate large ditches to obtain ballast material to construct the road sub-grade. This can result in a wider-than-necessary road prism (top of cut to toe of fill), but reduces the need to import ballast material, and in so doing reduces the cost of road construction. The increase in area disturbed associated with this practice may result in a small reduction in growing site, but as the results above indicate, are not significant.

Owners do not calculate or estimate the area converted to roads and logging trails on a MF basis. However, the audit found that owners make a conscious effort to restrict the amount of productive forest land permanently converted to roads and logging trails. Harvest maps often tabulate gross and net areas to harvest, allowing for features such as roads, trails, reserves (e.g. riparian zones, wildlife tree patches), and an estimate of net area to reforest. These are useful metrics that owners use to track the amount of site loss.

The audit finding that the productive forest area lost to roads was low (well below 7%) in part demonstrates that owners pay attention to minimizing the length and width of roads necessary to harvest cutblocks. The regulatory requirement to minimize the amount of area occupied by permanent roads, landings and excavated/bladed trails is being met without a regulated baseline target. Owners serve their best interests in maximizing the area available on their properties for the growing and harvesting of trees.

The cutbank on this new road supplied much of the surfacing material; reduces cost but does make the road area wider.

Soil disturbance

In addition to the amount of road needed to access timber in a cutblock, harvest methods also influence the net area available to reforest after harvesting as a result of possible soil disturbance from yarding. For MFs in the Interior region, ground-based systems observed were typically feller-buncher and forwarder or skidder. In the Coastal region, ground-based harvest methods were typically hoe-forwarding using tracked excavators or loaders. On steeper terrain, harvest systems used were primarily cable systems such as skyline configurations in the Interior and grapple yarding on the Coast.

The audit team visited sufficient area in each cutblock and assessed whether harvesting was completed without significant detrimental soil disturbance to the site (forest floor). The auditors looked for areas of soil compaction and soil displacement that would adversely affect regeneration and productivity.

The audit team observed that harvesting was completed without significant soil disturbance to the forest floor. The general absence of any visible soil compaction and soil displacement noted is a favourable outcome in the opinion of the auditors. This favourable outcome might be attributed to planning decisions made related to soil properties, harvest method/equipment selection, and seasonal timing to minimize the risk of soil disturbance and road location.

Logging trails

Owners determine the need for logging trails by considering a number of factors, including the length and location of roads constructed, harvest methods selected, terrain and timber size. The Council Regulation requires an owner to rehabilitate logging trails not required for future operations to stabilize the disturbed area and to enable reforestation.

The audit team examined logging trails used in harvesting, and not required to access future timber, to see if they had been rehabilitated, and evaluated the quality of rehabilitation work.

The audit found that logging trails were kept to the minimum necessary for safe and efficient harvesting operations. Owners cited operator training and experience as the reasons that there was little or no visible soil disturbance or soil compaction. A common strategy was for operators to vary machine routes to avoid creating trails or compaction. Logging trails on steeper ground in the Interior region were sometimes bladed.

Logging trail has been rehabilitated by back hoe and reforested.

The audit team observed that logging trails used in harvesting and not required to access future timber had been rehabilitated. Logging trails had been either rehabilitated and planted, or had regenerated naturally. Three of six cutblocks where the owner plans to re-use the trails in the future were left to reforest naturally. This rehabilitation is a good stewardship practice, as it ensures that the site disturbance due to the construction and use of logging trails was temporary and did not result in a permanent loss of area for growing trees.

Terrain stability measures

Landslides and erosion can reduce the land area available for reforestation. The audit team examined areas to see if any landslide activity or erosion processes contributed to area lost to future production of trees.
With one exception, the audit team found no evidence of potential instability caused by road construction or harvesting, and roads had remained stable after harvesting operations were completed in 47 of 48 cutblocks. The exception involved a slide that initiated at a road prior to the completion of harvesting. This road section had been repaired and has remained stable since. The road is now in use by a mining company and has not been deactivated as originally planned by the MF owner.

Soil disturbance can result from landslides, either associated with harvesting or road construction, or naturally occurring on unstable terrain. Four slides were assessed as part of the field audit: two were small slides within cutblocks; one was a recent slide outside a cutblock but initiated in-block; and one slide impacted a built road but not the productive forest land below.

The two slides that impacted the area available for reforestation resulted in little loss of plantable area. For both of these slides, the MF owners retained a qualified professional to review the causes of the slides and recommend remedial action. These qualified professionals were of the opinion that the causes of the two slides were not obvious, although they concluded that sub-surface water seepage was a likely contributor in both cases. One slide originated at a road in an active cutblock and the other slide initiated away from any road, and neither appears to be related to forest harvesting activity. For one slide, the recommended action was to reserve an area of timber adjacent to the slide from harvesting; the other occurred two years post-harvest and no additional remediation was required.

Initial measures were taken by owners to minimize the risk of erosion and landslides in the 17 of 48 cutblocks where it was considered appropriate or necessary. These included seeding cut-slopes and ditches with grasses and/or clover, use of cross-drain culverts, straw bales to filter sediment in ditches and general water management practices to maintain the natural drainage pattern and water volume. Such measures may not be necessary in areas

The slide area has been stabilized by planting and natural regeneration and is now growing trees again.

of low risk, usually involving low slope, stable terrain and/or the absence of streams (31 of 48). It was concluded that the initial measures taken were effective as there was no evidence noted of harm to the environment. Similarly, where no measures were considered necessary, the evidence supported that no action be taken.

Notable practices

The audit team noted that harvesting is being carried out well and that care and attention is taken to avoid excessive soil disturbance. There was no evidence of site loss due to harvesting or yarding (i.e. soil compaction, rutting, erosion). The practices described following were observed on the medium to larger size MFs in the audit sample and all contribute to achieving the objective for soil conservation:

- the area occupied by road is minimized by controlling the width built;
- road density is managed by minimizing the length and spacing needed for the harvest method and terrain;
- ground disturbance from skidding and yarding is minimal /low impact;
- after harvesting is completed, in-block roads not required for future use are de-built/rehabilitated;
- logging trails are returned to productive site condition and planted or restocked naturally; and
- owners select harvest equipment and seasonal timing to minimize soil compaction.

4.1.2 Road Construction

The selection of the road location in regards to slope, natural drainage and other topographical features and the construction practices used can affect the achievement of the objectives for soil conservation, fish habitat and water quality. The proximity of roads adjacent to streams and stream crossings, maintenance of natural surface drainage patterns, and measures to stabilize exposed or erodible soils are all aspects of locating or constructing roads that can influence these environmental values.

The audit team assessed road location, general construction practices, stream crossings and drainage structures in order to evaluate road construction in relation to these objectives. Construction practices on roads and stream crossings primarily built between 2006 and 2008 were examined in 45 cutblocks. Of these 45 cutblocks, 26 had class A to E streams within or adjacent to the cutblock, ten cutblocks had only non-classified streams (NCs) and nine cutblocks had no associated stream(s).

Roads are located to work with terrain and leave tree reserves and kept to the minimum necessary.

Road location

Roads and road drainage structures need to be located in a manner that maintains the natural drainage pattern, whenever practical to do so. By doing this, the risk of causing harm to fish habitat or water quality from erosion and sediment deposition is lessened.

The audit team examined road location to see if the natural drainage pattern in a cutblock had been maintained.

In the 26 cutblocks with class A to E streams, the roads were located well away from streams such that there was little likelihood of an adverse effect. These road locations exceeded the regulatory minimum setbacks of more than 30m from class A or B streams and 10m from class C, D or E streams. In addition, four roads that were located upslope of domestic water diversion intakes (two licensed waterworks intakes, two water licences) were all more than 100m from the intakes and it was observed that there was no disturbance to the intakes.

The audit team found that in all cases, the roads were located sufficiently far away from streams that the objectives for fish habitat and domestic water quality were met.

Construction practices

The audit team assessed construction practices by evaluating road drainage, avoidance of unstable terrain, sidecast management and stability of the road prism.

Approximately 34 kilometers of roads were audited in 45 cutblocks. The number of in-block roads or road sections and the length of road examined varied by cutblock. Each road was evaluated and assigned one of three possible ratings:

- Satisfactory - generally good practices but may include minor deficiencies with no significant consequence;
- Inadequate - deficiencies are more frequent and/or have the potential to adversely impact the achievement of objectives; and
- Significantly deficient - poor practices are common and deficiencies are significant enough that the achievement of objectives is unlikely.

In all 45 cutblocks the road construction was rated as satisfactory. Natural drainage patterns were maintained in 42 cutblocks, including six with no streams present but with culverts located in natural draws as a safeguard to convey overland flow that may occur during intense rain storms. The other three cutblocks had no streams or evidence of overland water flow. This finding means that the natural flow patterns of streams, seeps and other sources of water were maintained.

Filter fabric on wood box culvert to minimize the amount of sediment entering the stream at the crossing.

Stream crossings

Stream crossings should be located and constructed in a manner that protects the stream channel at the crossing point and does not result in any disturbance to the stream channel or bank.

The audit team observed roads constructed to assess whether the number of stream crossings was minimized and that construction of the crossings did not result in harm to the stream channel or to the bank.

Out of a total of 96 streams and 107 stream crossings, 70 stream crossings were assessed in 30 different cutblocks. Of the 30 cutblocks assessed that had stream crossings, the number of crossings installed was no more than necessary to efficiently develop an area for harvesting. This is a positive finding, as each crossing installation can introduce some risk of harm to fish habitat or water quality. Culvert sizing and placement were done in accordance with standard practices in 24 of 27 cutblocks. Minor deficiencies were noted in four crossings in three cutblocks:

1. culvert pipe was shorter than desirable for the road width, and one culvert was partly blocked;
2. two crossings were not armoured, but the wood box culverts easily accommodated the stream flow; and
3. culvert size was under the capacity for high stream flows, but the road prism was stable and there was no evidence of erosion.

Use of appropriate best management practices at crossings, such as armouring, catchment basins, erosion control through vegetation and/or filter cloth were noted in 21 of 22 cutblocks where the audit team considered that such measures were needed to protect fish habitat or water quality. The one exception was where the road grade dipped and was rutted deeply at the crossing approaches, resulting in minor sediment transfer to a low gradient stream.

There was no evidence of significant bank instability at crossings in any of the 30 cutblocks with streams examined. The audit found that road construction practices at stream crossings resulted in little ground disturbance. This is consistent with the objectives for fish habitat and water quality.

Exposed soils

The audit team examined road construction areas to see if measures to stabilize exposed or erodible soils were either needed or implemented to conserve soil or protect water quality.

The audit found that measures such as grass seeding, and to a lesser extent planting, were being used to revegetate and stabilize road banks in 21 of the cutblocks where the audit team considered such measures necessary. Such practices help reduce soil erosion and the subsequent transport of sediment in ditches and streams. The audit team

Ditchline has been seeded with grass and planted; such revegetation minimizes erosion and sediment transport.

concluded that revegetation measures were not necessary in the other 24 cutblocks due to gentle terrain, stable banks, or an absence of streams.

Sediment transfer

The audit team assessed drainage structures on roads constructed to see if practices were completed without significant detrimental impact on water quality.

There was no evidence of sediment entering streams from road surfaces or ditches in 32 of the 36 cutblocks that had streams within or adjacent to the cutblock. The four exceptions are similar in nature in that water was accumulating in low points on the road surface at, or near, crossings. This water was either being splashed by traffic into a nearby stream, or the excess surface water was flowing into the stream. In all four cases, the sedimentation was occurring seasonally and all were of low consequence in terms of meeting the objectives for fish habitat or water quality. It should be noted that a cumulative impact of multiple crossings with similar deficiencies on the same stream or multiple water crossings on different streams in the same watershed could be a problem. However in this case these were four different streams in different watersheds.

Overall, the audit found that road construction practices related to stream crossings and drainage control were effective in minimizing sediment transfer to streams. This is the result of practices such as well located and installed culverts to handle surface water, keeping water in natural drainage channels, using ditch blocks to help control ditch volume and reduce erosion energy potential, frequent use of sumps or settling ponds in ditches around culverts where fish streams are nearby, armouring culverts/bridges and use of filter fabrics to control sediment entering streams, use of seeding/vegetative controls to protect exposed soils and selection of good locations for roads and crossings. These practices contribute significantly to the effective protection of fish habitat and water quality.

Notable Practices

The audit team noted that roads are being constructed well and that particular care and attention is being made at stream crossings. The practices described below were observed on most of the MFs in the audit sample. These are equivalent to best management practices generally employed throughout the forest sector in British Columbia. They all contribute to meeting the objectives for soil conservation, protecting fish habitat and maintaining water quality:

- road running surface widths are controlled to minimize both cost and productive site loss;
- roads to be built on steep side-slope are generally reviewed by qualified professionals pre-construction;

Culvert inlet armoured and clear/free flowing; size may appear narrower than stream but evidence shows capacity is sufficient.

- use of experienced contractors and trained crews;
- ditches are well built and effective where required;
- open bottom culverts are generally used to cross fish streams;
- the larger MF operations use a rainfall shut down process to minimize the operational risk of erosion/siltation;
- short in-block spur roads are generally rehabilitated in preparation for reforestation.

4.1.3 Road Maintenance

Forest roads need to be maintained in a structurally sound condition and drainage systems kept properly functioning to avoid causing sedimentation or deposits of debris that could adversely impact fish habitat or water diverted by a licensed waterworks intake until the roads are permanently deactivated. Regular maintenance often includes seasonal deactivation activities undertaken to maintain the integrity of the road prism and minimize sedimentation for the winter season when active maintenance cannot be done. The audit team examined 18 roads in 10 MFs to assess the efficacy of road maintenance practices.

Road prism and road surface

In all 18 road sections audited for maintenance, the structural integrity of the road prism was found to be sound. There were no indicators of instability in the road surface. Road running surfaces were being adequately maintained for safe operation by grading, as needed, and visibility was maintained by controlling roadside brush. Minor erosion of the road surfaces was observed, such as rilling or potholes, but not to the extent of making the road unsafe or posing a risk to water quality.

Drainage systems

The drainage systems were found to be functioning properly on 17 of the 18 roads assessed. The one exception was a road where ditch water was draining directly into a small non-fish stream. However, the volume of sediment relative to the stream size was minor and with the low stream gradient, any suspended sediment would be able to settle out before the stream flowed into fish habitat. Consequently, the risk of affecting fish habitat is low.

Road cutbanks and exposed soils at stream crossings can be potential sediment sources into streams. Of the 15 roads where crossings were examined, the banks and areas disturbed from construction work were found to be stable with no or minimal evidence of erosion. Three of 18 road sections observed had no crossings.

Puddles on road surface over wooden box culvert; minor problem where sediment may enter stream.

Sediment entering fish streams

Five instances were found where sediment was being deposited into fish streams from puddles on the road surface. The audit team considered these deficiencies to be of minor significance as the volume of sediment-laden water that was entering the streams was very small in relation to the volume of stream flow. This amount of sediment was considered minimal and was not resulting in a detrimental effect on fish habitat or water quality. Sediment entry was occurring during wet weather when sediment laden surface water collects in dips in the road surface over a stream crossing and is either splashed directly by traffic into the stream or surges into a ditch and then flows into the stream. It is noted that this is a common industry-wide problem for which there are no easy solutions.

The owners inspect roads and maintain a list of needed repairs; priorities are often set based on safety, economics and environmental risk. Four out of five of these instances were associated with roads constructed before 2004, i.e. pre-date the Council Regulation.

Overall, the audit found that in the 18 road sections observed, road maintenance practices were satisfactory in achieving the objectives of soil conservation, fish habitat and water quality.

Notable Practices

The audit noted that roads are being maintained well. The notable practices listed below cumulatively contribute to achieving the objectives for soil conservation, protecting fish habitat and maintaining water quality:

- frequency of maintenance is based on road use and risk management; grading, ditch maintenance, culverts, bridges, brush control, cross-ditches, water bars;
- road patrols are undertaken by staff or security contractors in the spring and fall and/or after major storm events;
- roads are gated to limit access, especially where recreational use can cause surface damage;
- maintenance projects and upgrades are prioritized on a risk basis (safety and environmental) to address on-going maintenance needs;
- road network and main road access are maintained throughout; and
- seasonal deactivation is frequently used to reduce the risk of damage over the winter.

Road deactivated (road prism recontoured and culverts removed) and some woody debris (log chunks and some stumps) placed on top of soil. Area is scheduled for planting.

4.1.4 Road Deactivation

An owner may decide to deactivate a road when it is no longer required for regular use, rather than allow it to deteriorate. Deactivation minimizes the likelihood of sediment or debris affecting fish streams or water quality. The audit team assessed eight deactivated roads, or sections of road.

In all eight cases the completed deactivation work was sufficient to maintain a stable road prism. In addition, stream-crossing structures had been removed. There was no evidence of any detectable amount of sediment flowing into the streams. In seven of the eight roads, the deactivation practices included erosion control measures such as grass seeding and replanting.

The one exception was where a stream crossing had been restored to its natural channel but the down-slope edge of the road area was not armoured, leaving the exposed soil area vulnerable to future erosion and possible sediment transfer to the stream. The audit team assessed the risk as low in this case.

The audit team noted that the amount of road deactivation completed was limited because owners wished to maintain access on road systems for on-going forest management activities, such as reforestation and fire protection.

The deactivation practices were acceptable and the results effective in satisfying the objectives for fish habitat and water quality.

4.1.5 Conclusions

The audit found that harvesting activities resulted in acceptable and minimal levels of soil disturbance and site loss. The audit noted very little ground disturbance directly attributed to harvesting. Owners appear to be motivated to maximize the productive ground for reforestation after harvesting and to minimize growing site loss. The combination of the best management practices being implemented and the Council Regulation contribute to achieving the soil conservation objective of the Act.

Road construction practices observed met the requirements of the Council Regulation and contributed to achieving the objectives for soil conservation, fish habitat, and water quality. Road construction has been carried out without causing levels of soil disturbance or soil degradation beyond minimal levels. Construction practices related to stream crossings and drainage control were effective in minimizing sediment transfer to streams. Practices being employed are equivalent to best management practices generally employed throughout the forest sector in British Columbia.

Road maintenance and deactivation practices are meeting the requirements of the Council Regulation. These practices are contributing to achieving the soil conservation objective and also to achieving the objectives for water quality and fish habitat. There is no evidence that the regulatory requirements are ineffective or inconsistent with achieving the forest management objectives.

4.2 Fish Habitat

The objective with respect to the protection of fish habitat, both during and after harvesting, is to retain sufficient streamside trees (both large and non-commercial) and understory vegetation to protect all of the following:

- *a natural variation in water temperatures;*
- *sufficient cover for fish;*
- *a continual source of large woody debris for stream channel stability purposes;*
- *a vigorous mass of roots capable of controlling stream bank erosion;*
- *a filter to prevent the transport of sediment into stream channels;*
- *woody debris sufficient for in-stream habitat; and*
- *a source of nutrients to the stream through litter fall.*

In addition to requirements to protect fish habitat and water quality during road construction and maintenance, the Council Regulation requires that riparian areas beside all streams are managed in a manner that will not cause a material adverse effect on fish habitat or water that is diverted by a licensed waterworks intake.

This requirement includes the retention of a minimum number of large trees on each side of fish streams and streams upstream (within 1,000m) of licensed waterworks intakes that have an average channel width greater than 1.5 meters. The minimum number of large trees that must be retained is based on stream class. The Council Regulation also provides guidance concerning the retention of non-commercial trees and understory vegetation for all stream classes.

4.2.1 Streamside retention

The audit team examined 39 streams in 36 cutblocks. Twenty-four streams were classified as A, B or C streams (table below). The Council Regulation stipulates that a minimum number of trees must be retained on each stream bank for these three stream classes. The retained trees must be within a specified distance of the stream, and must have the same range of sizes and the same proportion of coniferous to deciduous trees as the pre-harvest stand. In addition, the retained trees must be evenly distributed along the stream. For example, harvesting adjacent to a class A stream must be done such that at least 30 large riparian trees are retained along each 100 meters of stream channel length.

Summary of streams assessed by stream class

Stream Class	Average Channel Width (m)	Fish Bearing and/ or Diverted by LWI*	Number of Streams Assessed	Requirement to Retain Large Riparian Trees
A	≥ 10	Yes	10	Yes: 30 per 100m
B	≥ 3 to < 10	Yes	8	Yes: 25 per 100m
C	≥ 1.5 to < 3	Yes	6	Yes: 15 per 100m
D	< 1.5	Yes	6	No
E	≥ 1.5 and is a direct tributary to a class A, B, C, or D stream	No	4	No
NC	All other streams	No	5	No

* Stream reach must be upstream of a licensed waterworks intake and within a 1,000 m radius.

There is no regulatory requirement to retain large trees (> 20 cm diameter) within the riparian area of class D (< 1.5m channel width) and class E streams. In addition to large tree retention, the Council Regulation stipulates that all non-commercial trees and understory vegetation must be retained within 30 m of class A and B streams and within 10 m of class C, D and E streams. However, there are a number of exemptions that allow an owner to fall non-commercial trees or disturb understory vegetation provided that it is necessary for road development or harvesting, and there is not a material adverse effect to fish habitat or the quality of water diverted by a licensed waterworks intake.

Non-classified (NC) streams are streams that do not support fish, are not within 1,000 m (upstream) of a licensed waterworks intake, and do not flow directly into a class A, B, C or D stream. There are no regulatory requirements to manage riparian trees or vegetation adjacent to NC streams.

The audit team assessed 39 streams to determine how each stream class was managed and to ascertain whether or not the requirements related to streamside tree retention and understory vegetation were sufficient to protect these seven habitat attributes.

Class A, B, and C Streams:

The number of large trees retained adjacent to class A streams exceeded the regulatory minimum requirements for all ten streams assessed, and by at least 100% in nine of the ten streams. For class B streams, the number of trees retained exceeded the regulatory requirements on all eight streams assessed. The number of large trees retained exceeded the Council Regulation by more than 10% on one stream, by more than 40% on two streams and by more than 100% on five streams. The number of trees retained adjacent to five of the six class C streams exceeded the regulatory requirements by 100% or more and by 33% for the remaining stream.

The audit team noted that retained trees were fairly evenly distributed and had the same size range as the pre-harvest stands for all class A, B and C streams assessed. In addition, the same ratio of deciduous to coniferous tree species was retained.

The regulatory requirements for the retention of non-commercial trees and understory vegetation adjacent to all class A, B and C streams inspected were also met.

Class D, E and NC Streams:

Although there is no regulatory requirement for large tree retention adjacent to class D, E or NC streams, large trees were retained beside 13 of the 15 streams assessed. Trees were retained on five of the six class D streams, on all four of the class E streams, and on four of the five NC streams. Non-commercial trees and understory vegetation was maintained in a manner compliant with the Council Regulation for all streams inspected.

Retention of Large Trees

The regulatory requirement for retaining large trees on class A, B, and C streams, and non-commercial trees and understory vegetation on all stream classes was met or exceeded on all 39 streams assessed. The effectiveness of observed activities within stream riparian areas in meeting the objective for fish habitat is discussed below.

The audit team found that for the class A, B, and C streams assessed, management of the riparian area was effective in protecting all seven attributes of the fish habitat objective. Moreover, the number of large trees that were retained adjacent to class A, B, and C streams significantly exceeded the minimum requirements of the Council Regulation on all but one of the 24 streams that were assessed. The single exception is one class A stream where the minimum number of large trees was retained.

Consequently, the audit team could not determine if the minimum tree retention requirements described in the Council Regulation for class A, B, and C streams are sufficient to achieve the fish habitat objective since only one stream was managed to this minimum.

Large commercial trees were retained beside 13 of the 15 class D, E or NC streams assessed, even though there is no regulatory requirement to do so. The audit team observed that six of the seven habitat attributes were maintained for all class D, E and NC streams. The other habitat attribute, the natural variation of water temperature, is discussed following.

Riparian retention above Class A stream.

Natural Variation of Water Temperature

The audit team found that the natural variation of water temperature was likely not maintained on three class D streams and one class E stream. This is based on the observation that these stream channels would receive an increased amount of solar radiation until such time that the existing streamside vegetation provides pre-harvest levels of shade. Increases in water temperature would likely be small, perhaps not even measurable in some cases, since the understory vegetation was providing a significant amount of shade. In addition, none of the streams were considered temperature sensitive (natural pre-harvest temperature regime at, or near, limits tolerated by fish), and so it is concluded that fish habitat within the class D streams, or downstream of the class E stream, was not adversely affected. Finally, it is noted that protecting the natural variation of water temperature may not always be achieved on some stream classes even when riparian vegetation retention requirements are met.

Cautionary Note Regarding Class A streams

Although not assessed during this audit, the long term stability of certain class A streams may be compromised if only the minimum number of large trees required by regulation is retained. For example, retaining more than 30 large trees along each 100m of channel on large, laterally unstable rivers, or active alluvial fans, may be required to achieve the fish habitat objective.

Cautionary Note Regarding Class E Streams

There is no regulatory requirement for retaining large trees adjacent to class E streams, which can be any size wider than 1.5m. Although not observed by the audit team, it is possible that the retention of large trees may be needed in some situations to maintain channel stability on larger class E streams in order to protect downstream resources.

Notable Practices

The minimum regulatory requirement for the retention of large riparian trees was consistently exceeded, often substantially, both on Coastal and Interior MFs. Owners are retaining additional trees adjacent to streams for a number of reasons including:

- topography (e.g. falling boundary placed along an escarpment, or at the top of a ravine);
- windthrow considerations;
- social values (e.g. additional retention on a important recreation river);
- forest certification scheme criteria;
- plans for future select tree harvest within an expanded riparian area;
- timber type (i.e. low value trees within the riparian area); and
- operability constraints (i.e. wet ground or poor deflection).

Owners consider a wide range of factors in addition to the Council Regulation when harvesting adjacent to streams. The retention of additional riparian trees, particularly on the larger streams, provides increased protection to fish habitat and water quality. This increased level of protection, although not mandatory, serves to lower the risk of harvesting impacts, particularly adjacent to sensitive streams, or adjacent to streams that may support suppressed or rare fish stocks.

Retention of Non-commercial Trees and Understory Vegetation

The audit team found that the retention of non-commercial trees and understory vegetation is effective in contributing to the protection of habitat attributes for class A, B, and C streams. Since class D stream channels are less than 1.5 meters wide, the long term channel form and function can be maintained by retaining non-commercial trees and understory vegetation within the 10m riparian zone.

Owners endeavor to minimize windthrow risk by using local knowledge of weather patterns and historic windthrow to design cutblock boundaries and by implementing pre-harvest treatments, such as tree topping or pruning, where warranted.

4.2.2 Windthrow

Windthrow within stream riparian areas was frequently observed and the observations by stream class are summarized in the table below. Large streamside trees were retained on 37 of the 39 streams that were assessed. Windthrow of retained trees was observed adjacent to 22 (60%) of these streams. Windthrow adjacent to some of these streams, however, was very minor and sometimes consisted of just a few trees. The number of streams where 5% or more of the retained large trees blew down was 17 (46%).

The degree of windthrow was highly variable ranging from just a few trees on some streams to 80% on one NC stream. Based on the audit results, windthrow appears to be less extensive in class A stream riparian areas and highest in the riparian areas of NC streams. However, this pattern is not considered to be statistically significant due to the high variability of windthrow observed and the small audit sample size of each stream class.

Summary of windthrow and sediment delivery due to windthrow by stream class

Stream Class	Number of Streams Assessed	Percentage of Streams with Windthrow ≥ 5%	Average Percentage of Trees blown down	Sedimentation From Windthrow		
				Forest Floor Disturbance	Stream Bank Disturbance	Ongoing Sediment Source
A	10	30 (n=3)	5	0	0	0
B	8	36 (n=3)	22	1	1	1
C	6	50 (n= 3)	30	1	2	0
D	6	50 (n=3)	32	1	2	0
E	4	75 (n=3)	25	1	2	0
NC	5	40 (n=2)	43	0	0	0

Windthrow and Sediment

The audit found that windthrow resulted in sediment delivery to seven streams, either from disturbance to the forest floor, or from stream bank disturbance when trees were uprooted during periods of high wind. Windthrow-related sediment delivery was ongoing for one of these streams. In-channel sediment accumulations that could be attributed to windthrow were not observed in any of the seven streams. In addition, there was no indication of large volumes of sediment entering the stream channel from forest floor disturbance. For the one stream where ongoing sediment delivery was observed, the amount of sediment was deemed to be very small and is expected to stop as the exposed mineral soil is naturally revegetated.

In the audit team's opinion, sediment delivery from windthrow did not materially affect fish or fish habitat for the following reasons:

- There was no evidence of channel alteration, such as pool infilling, due to increased sediment inputs. Based on this observation, the audit team concluded that fine sediment was flushed downstream during high flows and the volume of coarse sediment, such as gravel and cobble, entering the channel was too small to physically alter the channel morphology.
- Some localized bank erosion occurred where trees growing on the edge of the stream were uprooted. This bank erosion, however, was minimal and confined to the root-ball footprint.
- The likelihood of future channel de-stabilization due to the observed windthrow (i.e. loss of live root systems in the channel bank) was deemed highly unlikely. This conclusion is based on the evaluation of channel characteristics including bank material, stream power, evidence of natural bank erosion, and an estimate of lateral erosive forces. In all cases, the remaining trees and understory vegetation were considered to be sufficient to maintain long-term channel stability.
- Fish can tolerate elevated levels of suspended sediment as long as concentrations are not too high and the duration of the elevated sediment concentration is not too long. It was not possible to accurately determine how windthrow influenced suspended sediment in these streams, since there is no water quality data, or even anecdotal information, available. However, the audit team concluded that the concentration of

suspended sediment was likely elevated during the windthrow event but that these elevated levels would have been of short duration.

- Ongoing sediment delivery was observed in just one stream. Suspended sediment levels were deemed to be very minor and temporary in nature.

Windthrow Management

Windthrow management is a major factor in planning for and establishing tree retention adjacent to streams. The audit team found that owners had considered the risk of windthrow when designing cutblock boundaries. Pre-harvest windthrow assessments were completed on 27 of the 39 streams assessed. Of the 12 streams for which owners did not complete a pre-harvest windthrow assessment, 11 streams had no windthrow and one had an estimated windthrow level of 3%.

The strategies adopted by owners to minimize windthrow included leaving additional streamside trees, strategically placing falling boundaries, tree topping, tree limbing (pruning), and post-harvest monitoring. The effectiveness of these treatments can be variable. It is beyond the scope of this audit to quantify the efficacy of the various windthrow management strategies employed, since a detailed comparison of treated and untreated riparian zones would be required. For example, tree topping and limbing was conducted on five streams. Windthrow was minimal (≤ 5%) on two of these streams. However, the average percent of windthrow for the remaining three streams was 51%. It is possible that the topping and pruning treatments did not significantly affect the amount of windthrow, but it is also possible that windthrow would have been more extensive if there had been no treatment.

Cautionary Note Regarding the Effect of Windthrow

Although it is concluded that the fish habitat objective was achieved for all class A, B, and C streams, windthrow is seen as a potentially serious ongoing threat. The objective is to protect seven habitat attributes, two of which are: a continual source of large woody debris for stream channel stability purposes; and a vigorous mass of roots capable of controlling stream bank erosion. Windthrow can compromise both attributes.

The audit identified a reduction of large woody debris supply on one class B stream. In addition, the windthrow of trees growing on the edge of the channel resulted in some disruption of the vigorous root mass growing in the stream bank on the same class B stream and two class C streams.

The three streams were, however, low gradient, low velocity stream reaches in which reduced large woody debris and localized loss of root mass would not affect the long-term stability of the channel or result in increased bank erosion. Accordingly, the fish habitat objective was not, in these cases, compromised. However, if windthrow was more extensive, or the streams channels sensitive to large woody debris input or bank disturbance, the objective might not have been achieved.

Windthrow can be an issue on both the Coast and Interior regions, and if extensive enough, it is considered to be a serious problem, especially on the Coast. Of particular concern are the vulnerability of narrow riparian buffers to windthrow and the risk of damage on certain naturally unstable channel types, where fish habitat protection may not be achieved as a result.

Practice Improvement Note

In areas susceptible to windthrow, retaining large trees adjacent to class D, E and NC streams may not have the desired effect in terms of fish habitat protection. For example, of the seven streams where windthrow resulted in sediment delivery to the stream channel, the retention of large trees was required on only three streams. Owners might consider stream channel stability when setting streamside management prescriptions that include the retention of large trees on non-fish streams, particularly in windthrow-prone areas. This includes the practice of assessing the lateral stability of large class E streams where a site-specific management strategy may be needed to achieve the fish habitat objective.

4.2.3 Sedimentation from other sources

The audit team noted two instances where disturbance to the forest floor and/or stream bank resulted in sediment delivery to a stream. Neither of these sediment sources was related to windthrow, or was the direct result of forest management practices. For one stream, there was significant bank disturbance and disturbance of the forest floor on the stream's floodplain from a frequently used all-terrain vehicle trail. This disturbance had created an on-going sediment source to the class A stream that the audit team ranked as moderate. The second on-going sediment source (class C stream) was very minor, and was due to an active deer trail causing some minor stream bank disturbance.

4.2.4 Conclusions

The audit found that for class A, B, and C streams owners' management of the riparian areas was effective in protecting all seven attributes of the fish habitat objective. Moreover, the number of large trees that were retained significantly exceeded the minimum requirements of the Council Regulation on all but one of the 24 streams that were assessed. This is a voluntary practice by owners. In view of this the audit team could not determine if the minimum tree retention requirements in the Council Regulation for class A, B, and C streams alone are sufficient to achieve the fish habitat objective of the Act.

Also owners are making a practice of retaining large commercial trees beside class D, E or NC streams assessed even though there is no regulatory requirement to do so. Six of the seven habitat attributes were maintained for the class D, E and NC streams assessed. The practice of exceeding the minimum requirements for retention of large trees was observed on both Coastal and Interior MFs.

Although the audit found that practices assessed did not adversely affect fish or fish habitat, three cautionary notes are provided. These concern:

- Windthrow in riparian areas is regarded as a potentially serious ongoing threat to the stability of streamside habitat.
- Certain class A streams may not be adequately protected if only the minimum number of large trees are retained adjacent to large, laterally unstable rivers, or active alluvial fans.
- Although there is no regulatory requirement to retain large trees adjacent to class E streams it is possible that this may be needed in some situations to maintain channel stability on larger class E streams in order to protect downstream habitat.

The audit found that soil erosion from roads and road ditches had minimal potential to result in suspended sediment entering fish streams, especially in areas harvested within the past five to 10 years. Suspended sediment generation was more likely to occur on older roads, especially those with high traffic volume. There were no cases where the audit team concluded that the fisheries resource was at risk due to sediment input from roads.

4.3 Water Quality

The forest management objective with respect to water quality is to protect human drinking water, both during and after harvesting.

4.3.1 Licensed Waterworks Intakes

The Council Regulation contains a number of provisions intended to protect water quality used for human drinking water in streams that have a licensed waterworks intakes[2] installed downstream. For example, there are restrictions concerning road locations, and there is a requirement to retain riparian trees on both banks of a non-fish stream if the cutblock is located upstream of a licensed waterworks intake and is less than one kilometer away.

The audit team visited licensed waterworks intakes and assessed whether harvesting was completed without harm to water quality for domestic consumption.

[2] Issued to incorporated water users' community

The population consisted of 14 licensed waterworks intakes within or downstream of nine MFs. Two licensed waterworks intakes were assessed in the field and information on how the other licensed waterworks intakes are considered was assembled from interviews with each owner. Although the protection of water licence[3] diversions was not within the audit scope as they are purposely excluded from the Council Regulation, some information on how owners may document and communicate with water licence holders was collected as well. The interviews provided an overview of forestry practices related to the protection of licensed waterworks intakes and water licence intakes for domestic use in general. Two licensed waterworks intakes holders were interviewed to verify that owners had contacted them and to assess their views of any impacts to water quality from activities upstream.

The licensed waterworks intakes sample size was relatively small, as the MFs in the sample did not have any active operations in proximity to the water intake that warranted a field evaluation. The audit team found that the licensed waterworks intakes in some cases were located off the property and downstream. A MF area may comprise only part of the catchment area for a licensed waterworks intake. The balance may consist of other private property or Crown land, which is outside the jurisdiction of the PMFL legislation.

The audit found that owners were aware of the presence of water intake locations for both licensed waterworks intakes and water licences on, or downstream of, their properties. Several MF owners used the provincial government's web-based iMap system to confirm the presence and location of the intakes. Owner information systems included mapped locations of licensed waterworks intakes and, in many cases, most water licences in their databases. Owners were also generally aware of locations where neighbours rely on wells for domestic water supply.

Owners interviewed advised that contact with licensed waterworks intakes holders has been established and that licence holders are notified before commencing road construction or harvesting in all cases. The two licensed waterworks intakes examined by the audit team had roads or trails within 300m of the intake point, but there was no evidence of any disturbance or sediment affecting the natural water quality or damage to the intake itself.

4.3.2 Conclusions

The management objective for water quality in the *PMFL Act* is to protect human drinking water, both during and after harvesting. The Council Regulation is specific about protecting licensed waterworks intakes and activities that may adversely affect water quality for a licensed waterworks intake. The Council Regulation is limited in its scope to protect domestic water quality, as it excludes a requirement to protect single water licence intakes,

[3] The provincial government excluded individual water licences from the Council Regulation in 2004

Licensed waterworks intake dam and intake, reservoir surrounded by well established second growth.

regardless of consumptive use. There is some risk that the activities of a MF owner may impact water quality of a stream with a water licence diversion. In this event, a water licence holder would have to seek redress protection under the *Water Act* or the *Drinking Water Protection Act*. This may limit the Council Regulation in being able to meet the water quality objective of the *PMFL Act*.

In addition, the catchment area of a licensed waterworks intake may be wholly within or partially within a MF. In situations where a MF covers only a portion of a licensed waterworks intake catchment, there may be other activities taking place in the catchment beyond MF boundaries that can potentially impact water quality. Such activities are outside of the jurisdiction of the Council Regulation. The Council Regulation does not make provision to assess the potential cumulative effects from activities on water quality within the MF portion in a water catchment. These factors may limit the Council Regulation in being able to fully meet the water quality objective of the *PMFL Act*.

4.4 Reforestation

The forest management objective with respect to reforestation of areas where timber has been harvested or destroyed is to promptly regenerate the areas with a healthy, commercially valuable stand of trees that is not impeded by competition from plants or shrubs.

The Council Regulation stipulates two requirements for reforesting areas harvested or destroyed: restock disturbed areas within five years with a minimum number of well distributed, healthy trees; and establish a successfully regenerated stand within 15 years with a minimum number of healthy trees, well distributed and free from competing vegetation.

The objective for reforestation was evaluated by examining three age group populations: defined by the time since harvest of less than five years, between five and 15 years, and more than 15 years.

For each of the three reforestation populations, the audit team assessed the owners' activities to reforest harvested areas and to manage newly reforested stands to be successfully regenerated. Activities include planting, surveys to assess stocking and tree health, and stand treatments needed to achieve the reforestation objective of a fully stocked, healthy regenerated young forest growing unimpeded from brush competition.

4.4.1 Restocking: less than five years since harvesting

These areas are required to be restocked with commercial trees within five years either by planting, by relying on natural regeneration or a combination of both. The audit team evaluated 65 cutblocks in 11 MFs.

The audit found that 64 cutblocks had been planted, most in the first or second year after harvesting and were considered restocked within one to four years. The remaining cutblock was not restocked, as the owner's strategy of relying on natural regeneration had not been successful. The restocking density ranged from 600 to 1,600 stems per hectare (sph), with most cutblocks ranging from 850 to 1,200 sph combining both planted and natural seedlings.

The areas were restocked with the original species in 60 of 65 cutblocks, although there was some change in percentage species composition. The five exceptions included some original species plus additional native species that are all ecologically suited to the site. The species planted were commercially valuable.

The survival and growth of regenerated seedlings, either planted or naturally regenerated, can be adversely impacted by ungulate browsing, snow breakage, frost, drought conditions and slash accumulations. Owners monitor reforestation success on a regular basis by conducting systematic surveys, and/or walk-through visual assessments. The frequency, method, and timing of surveys were often determined by site conditions, such as competing brush or forest health (pathogen) concerns.

The slash generated from log processing is piled randomly along roadsides and/or in the cutblock, ready for burning in the fall. The audit team observed small and scattered areas that could not be planted due to accumulations of unburnt slash or processor waste. Occasionally, unsuitable fall weather or the smoke

management requirements results in unburned piles. Old piles are often difficult to burn; and are sometimes broken up mechanically to create plantable spots. The audit team did not measure such slash accumulations, since in these cases it was concluded that the area involved was a small percentage of a cutblock area.

Site preparation, where necessary to create plantable spots, is primarily limited to dispersing and/or piling slash that is disposed of by burning.

The audit team noted situations where slash piles were not burned and the slash covers otherwise plantable area. Although cumulatively the area is not substantial, it is a loss of growing site. To mitigate this loss, owners may use backhoes to redistribute slash piles to create spots for fill-planting.

There were forest health concerns with the restocked areas in about half of the cutblocks (35 of 65), and in 15 cutblocks the concerns were significant, meaning there is a risk of not achieving the reforestation milestones if no intervention is undertaken to address the health issues. In 14 of the 15 cutblocks the owner was aware of the issue, had completed an assessment, and had a follow-up strategy. For the remaining cutblock, needle blight affecting western red cedar was noted during the audit, and the owner indicated that a survey would be scheduled to assess the problem.

Pathogens such as Armillaria root disease and Phellinus laminated root rot, larch needle blight, western gall rust, white pine blister rust and mistletoe were the prime health risks observed or reported by the owners. Additionally, competition from brush species such as fireweed, bracken fern, salmonberry, and red alder can affect newly planted and regenerating cutblocks. The audit team found that owners are monitoring for pest risk and evaluating site conditions regularly, and determining if action is necessary to achieve successful regeneration. Actions could include brushing, fill-planting and/or using alternate species more resistant to the pathogens.

In summary, the audit found that the restocking of cutblocks after harvesting is being achieved well ahead of the five-year milestone required by the Council Regulation.

Practice Improvement Note

Planting is the preferred restocking strategy by the majority of owners. Where a natural regeneration strategy is relied on for restocking, success can be poor due to lack of seed source or from competing brush suppressing one to two year old germinants and other site factors. To avoid compromising the restocking milestone, regular monitoring and early intervention such as fill-planting should be considered.

Slash pile ready for burning when conditions permit.

Notable Practices

The audit team found that reforestation is being completed in an exemplary manner consistent with industry standard best practices. The practices noted following contribute to achieving the reforestation objective and reflect the approach of almost all MF owners:

- restocked densities greatly exceed the minimum specified in the Council Regulation;
- planting is completed as soon as possible after harvest, generally within one to two years. This is especially beneficial in areas prone to competing brush;
- attention is given to seedling stock quality ordered from nurseries;
- brush competition, ungulate (deer and elk) browsing and pathogens can be significant problems. Owners are diligent in monitoring seedling survival and intervening as required to ensure stocking is achieved; and
- monitoring of regeneration is on-going from planting to the successful regeneration stage, and attention is given to stands after this milestone is reached, if there are issues.

4.4.2 Successful regeneration: five to 15 years since harvesting

Areas harvested or destroyed between five and 15 years ago should be restocked with well-spaced, healthy, commercially valuable tree species and outgrowing any competing brush. During this stage of stand development, owners typically monitor the stand and undertake brushing, if necessary, to ensure successful regeneration status is achieved by age 15. Completing this second regeneration milestone would mean that the reforestation objective of re-establishing a young healthy forest has been met.

The audit team assessed a sample of 35 cutblocks in 14 MFs, and found that the areas were restocked and likely to be successfully regenerated in 33 of 35 cutblocks. The stocking density range was 800 to 1,600 sph, and most were 900 to 1,200 sph. These densities are well above the minimum requirement of 400 or 600 sph specified in the Council Regulation. One of the two exceptions was the result of low stocking numbers, poor distribution and damage from extensive deer browse. The second exception was a cutblock that was largely restocked but had competition from non-commercial species, impacts from heavy deer browse, and gall rust infection of Sitka spruce.

Thirty-four cutblocks were restocked with the original tree species, while one cutblock included new tree species ecologically suited to the site. The percentage distribution of the species differed from the original stand in some cutblocks, but all species were commercially valuable.

12 yr old plantation of Douglas-fir planted in 2001. It is well established, growing vigorously free of competition from brush and will reach the milestone of successfully regeneration in three years.

Brushing treatment was needed in 14 cutblocks; of which 13 had been completed, and one was planned for 2013. Forest health concerns were noted in 12 of the 35 cutblocks. Some health issues in regenerated stands are expected, and the key is monitoring and taking required action. Three of the health concerns were considered significant by the audit team. In one cutblock, the owner took action by planting an alternate species more resistant to root rot. For the other two cutblocks the regeneration success was being affected by pathogens (root rot or gall rust) and, perhaps more significantly, deer browsing. This needs to be addressed if successful regeneration status is to be achieved.

In summary, the audit found that in 33 of 35 cutblocks, the regenerated stands are well established with healthy, well-distributed trees, and the expectation is that they will achieve the milestone of a successfully reforested stand before year 15. The two exceptions will likely need intervention in order to accomplish this milestone.

4.4.3 Successful regeneration: over 15 years since harvesting

The cutblocks in this population were harvested in 1997 or earlier, and pre-date the *Private Managed Forest Land Act* of 2004. At this stage, past the second milestone, the forest stands are now successfully regenerated and beginning to exhibit the characteristics of an established young forest. This is the first time that the reforestation status of the older reforested stands has been assessed by the Council.

The audit examined 18 cutblocks in nine MFs, and found that stands were healthy with stocking well distributed in all 18 areas. The stocking density range is 600 to 1,400 well-spaced sph; and most are near 1,000 sph. All 18 cutblocks are restocked with the original species, which are commercially valuable.

Competing brush was present in eight of 18 cutblocks, of which one was considered to be of high significance, three were moderate and four minor as follows:

- the cutblock with high brush competition was the result of a large number of deciduous stems left in the stand to help reduce conifer losses from Armillaria root disease, a strategy selected by the owner monitoring the stand;
- in the instances of moderate brush competition, brush presence was not likely to impede the commercial species because they were now starting to dominate; and
- in the cutblocks with minor brush competition, the brush was not expected to impact on the maintenance of successful regeneration.

Forest health (pathogens) concerns were noted in six of 18 cutblocks. This incidence of pathogens is considered by the audit team to be typical of harvested areas in British Columbia. Two are considered significant (Armillaria, western gall rust, blister rust). In both cases the owner was aware of the issue and was taking appropriate action. The action taken was successful in one cutblock and the outcome in the other is yet unknown. In the cutblock where the outcome is unknown, the owner is retaining hardwood regeneration to offset potential conifer mortality from Armillaria root rot infection. It is too early to determine if this strategy will be successful.

The use of fertilizer was discussed with the owners, who indicated that aerial fertilizer had not been applied on any of the 18 reforested cutblocks. It was noted that this practice was discontinued during the poor log market conditions in recent years. Some owners use a “tea-bag” fertilizer application at the time of planting to boost initial growth. This technique is used in areas where ungulate browse is a known risk to seedling survival and on dry sites, where “tea-bag” fertilizer with moisture retaining gel has proven beneficial.

4.4.4 Conclusions

Reforestation meets or exceeds the regulatory requirements and is being completed on a timely basis. As the observed higher stocking levels exceed the minimum in the Council Regulation, it is not possible to conclude that the Council Regulation alone is effective in achieving the reforestation objective.

It is likely that the minimum stocking standards are being exceeded, in part, to improve log quality and to offset potential losses due to mortality. This risk is real, as shown by the instances of pathogens and brush. It is concluded that owners appear motivated to reforest and monitor the re-established forests based on the audit evidence of reforestation performance noted.

APPENDIX 1 Environmental Values[1]

Environmental Value	*Private Managed Forest Land Act* Objective
Soil Conservation	The forest management objective for private managed forest land with respect to conservation of soil for areas where harvesting has been carried out is to protect soil productivity on those areas by minimizing the amount of area occupied by permanent roads, landings and excavated or bladed trails.
Water Quality	The forest management objective for private managed forest land with respect to water quality is to protect human drinking water, both during and after harvesting. Nothing in subsection (1) requires an owner to retain additional streamside trees or additional understory vegetation to address problems with water quality that originate outside of the owner's private managed forest land.
Fish Habitat	The forest management objective for private managed forest land with respect to the protection of fish habitat, both during and after harvesting, is to retain sufficient streamside mature trees and understory vegetation to protect all of the following: (a) a natural variation in water temperatures; (b) sufficient cover for fish; (c) a continual source of large woody debris for stream channel stability purposes; (d) a vigorous mass of roots capable of controlling stream bank erosion; (e) a filter to prevent the transport of sediment into stream channels; (f) woody debris sufficient for in-stream habitat; (g) a source of nutrients to the stream through litter fall. Nothing in subsection (1) requires an owner to retain additional streamside trees or additional understory vegetation to address problems with fish habitat that originate outside of the owner's private managed forest land.
Critical Wildlife Habitat	The forest management objective for private managed forest land with respect to critical wildlife habitat is to facilitate the long term protection of that habitat by: (a) providing a reasonable opportunity for a person designated in writing by the deputy minister to the minister responsible for the administration of the *Wildlife Act* to assess whether critical wildlife habitat is present on private managed forest land, and (b) fostering efforts of the government and the owners to enter into agreements for the protection of any critical wildlife habitat identified under paragraph (a).
Reforestation	The forest management objective for private managed forest land with respect to reforestation of areas where timber has been harvested or destroyed is to promptly regenerate the areas with a healthy, commercially valuable stand of trees that is not impeded by competition from plants or shrubs.

[1] http://www.bclaws.ca/Recon/document/ID/freeside/00_03080_01#section5

APPENDIX 2 Private Managed Forest Land Legislation

Legislation	Application
Private Managed Forest Land Act	Establishes the following: • The Private Managed Forest Land Council, including its objectives, scope of operations, and authority • Managed forest land objectives for soil conservation, water quality, fish habitat, critical wildlife habitat, and reforestation
Private Managed Forest Land Regulation	Includes the following: • Determination of exit fees • Provisions for critical wildlife habitat, including appeals • SCHEDULE A: list of forest management activities with respect to restrictions on local government authority regarding land use • SCHEDULE B: Exit fee adjustment factors based on number of years property is assessed as Managed Forest • SCHEDULE C: list of species at risk with regard to establishment of critical wildlife habitat
Private Managed Forest Land Council Matters Regulation	Includes the following: • Establishment of water quality objectives • Council review of requests with respect to administration and exit fees • Remediation orders • Offences
Private Managed Forest Land Council Regulation, 2007	Includes the following: • Council powers and administrative requirements • Owner requirements with regard to: – Administration – Soil conservation – Structures and activities near streams – Fish streams and water supply areas – Reforestation

APPENDIX 3 Environmental Values, Aspects, Populations and Measurements

Environmental Value	Aspect	Population	Measurements
Reforestation	Regenerated stand	Areas harvested > 15 years ago	Stems per ha, and compare to requirements
	Satisfactory restocking	Areas harvested 5-15 years ago and areas harvested 4-5 years ago	Stems per ha, and compare to requirements
Soil Conservation	Minimize conversion of productive forest land	Macro level assessment of road network	% non-productive area, and compare to 7 %
		Cutblock level – area occupied by roads & trails Sample observation of road and trail widths	% non-productive area, and compare to 7 %
	Results & practices in harvested areas	Condition of harvested areas for recent and 4-5 years	Measurements of scale and volume if instability or erosion (at source)
		Trail rehabilitation in 4-5 year harvested areas	Number and length of trails not rehabilitated
Fish & Water Quality	Streamside tree retention	Streamside areas – required number of trees – recent harvesting	Count number of trees and compare to requirements – whether they have been met (exceeded by < 10%), or exceeded (by > 10%)
	Streamside understory	Streamside areas – required retention of non-commercial trees and understory vegetation – recent harvesting	Measure distance of retention and compare to requirements (metres by stream class)
	Stability of streamside areas	Areas harvested 4-5 years ago	Measurements of scale and volume if bank disturbance, erosion or windthrow
	Erosion into streams	Recent harvesting and areas harvested 4-5 years ago	Distance of disturbance (erosion source) to fish habitat or LWI, and estimates of sediment volume and timing (at/from source)
	Construction near licensed waterworks intakes	LWIs in the MF or within 1 km downstream Road construction is not allowed within 100 metres of an LWI	Identify from maps etc. – number and location Identify road construction within 300 metres of an LWI, and visit site
	Sediment transport into streams	New roads < 2 years, existing roads and deactivated areas	Distance of disturbance (erosion source) to fish habitat or LWI, and estimates of sediment volume and timing (at/from source)

PRIVATE
MANAGED
FOREST LAND
COUNCIL

Address: 305 – 1627 Fort Street, Victoria, BC V8R 1H8
Telephone: 250-386-5737
Facsimile: 250-721-3392
Email: execdirec@pmflc.ca
Web: www.pmflc.ca