

C5 Forest Management Unit

Watershed Management Audit of Risks to Regional Water Supply as a Result of Forest Management

prepared for the
Forest Management Branch, Forestry Division,
Alberta Sustainable Resources Development

July 2012

Report for

C5 Forest Management Unit
Watershed Management Audit of Risks
to Regional Water Supply as a Result of Forest Management

Prepared for

Forest Management Branch, Forestry Division
Alberta Environment and Sustainable Resource Development

Attention: Mr. Darren Tapp
Executive Director, Forest Management Branch, Forestry Division
Ministry of Environment and Sustainable Resource Development

Prepared by

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TRANSMITTAL LETTER

July 31, 2012

File: 3021.0008.01

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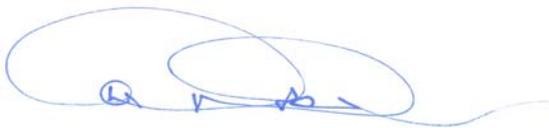
Attention: Mr. Darren Tapp, RPF, Executive Director
Forest Management Branch, Forestry Division

RE: C5 FMU – Confidential Process Audit of risks of forest management on watershed values and regional water supply and water quality

Urban Systems is pleased to provide the final audit report that reviewed the processes currently in place within the Forestry Division of Sustainable Resource Development from policies and plans to operating ground rules and monitoring protocols to mitigate potential impacts of forestry, forest health and wildfires on watershed values. The report includes an overview of the audit process, audit findings and recommendations.

We look forward to having an opportunity to present a summary of our findings to the Forestry Division Executives in Edmonton at your convenience.

Sincerely,
URBAN SYSTEMS LTD.



D.A. Dobson, P.Eng.
Senior Water Engineer

cc: Axel Anderson, PhD, P.Eng., RPF, Water Program Lead, Foothills Research Institute,
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/az

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EXECUTIVE SUMMARY

In March 2012, the Ministry of Sustainable Resource Development (now Ministry of Environment and Sustainable Resource Development (ESRD)) contracted Urban Systems to prepare a confidential watershed management audit for the Executive Director Forest Management Branch, Forestry Division to identify the risks to the regional water supply as a result of forest management in Forest Management Unit (FMU) C5 in southwest Alberta. The C5 FMU has a total area of 252,000 hectares, two-thirds of which is off-limits to timber harvesting. On the remaining one third that is available for commercial forestry, annual harvesting will occur on less than 1% of that area. The C5 FMU is situated within the South Saskatchewan River Basin where the value of water is very high since it is a limited resource and in high demand by downstream users.

The audit was limited to reporting on the risks to the regional water supply as a result of the processes related to forest management planning and practices in the C5 FMU only. The period that the audit was to address was from 2006 to 2012. In addition to timber harvesting impacts the audit also reviewed the department's procedures for addressing the risk to water from mountain pine beetle and wildfires. The audit includes a comprehensive review of relevant current policies and practices as well as an overview of how these practices have been implemented on the ground through site visits of selected areas/blocks developed during the period May 1, 2006 to April 30, 2012.

The risks to regional water supply and quantity have clearly been identified throughout the range of higher-level plans, regional plans, forest management plans and on-the-ground operating rules associated with forest management in the C5 FMU. This recognition of risk was highlighted in early documents such as A Policy for Resource Management of the Eastern Slopes (1984) and appears to have been aligned in all levels of forest planning and practices. All reviewed processes appeared to convey the theme that water supply and water quality were of highest priority in relation to forest management within the C5 Forest as identified in A Policy for Resource Management of the Eastern Slopes (1984). ISO 9001:2008 certification and commitments to follow Z809-02 Sustainable Forest Management: Requirements and Guidance in the C5 Forest Management Plan 2006-2026 also show a commitment to minimizing risk with relevant, measurable, understandable and achievable forest management policies, plans and practices.

Although the IRPs and higher level plans are consistent in highlighting the importance of water the mechanisms for achieving and mitigating the risks to water supply and quantity into the future have not been identified. Furthermore, while the underlying theme and commitment to water supply and quality has been included throughout the forest management processes, a few key process and management concerns were identified that are important to minimizing risks to water. Key audit recommendations are provided for the following areas:

- Roads
- Integrated Land Management and Cumulative Watershed Effects;
- Operations;
- Adaptive Management;
- Public use of Provincial land; and
- Wildfire.

1.0 INTRODUCTION

In March 2012, the Ministry of Sustainable Resource Development (now Ministry of Environment and Sustainable Resource Development (ESRD)) contracted Urban Systems to prepare a confidential watershed management audit for the Executive Director Forest Management Branch, Forestry Division to identify the risks to the regional water supply as a result of forest management in Forest Management Unit (FMU) C5 in southwest Alberta. A copy of the contract is provided in Appendix 1. The C5 FMU has a total area of 252,000 hectares, two-thirds of which is off-limits to timber harvesting. On the remaining one third that is available for commercial forestry, annual harvesting will occur on less than 1% of that area¹. Based on the limited amount of forest development annually it should be expected that, if development is undertaken with appropriate best management practices, that the impacts on water should be limited. The C5 FMU is situated within the South Saskatchewan River Basin where the value of water is very high since it is a limited resource and in high demand by downstream users.

There is an extensive amount of information available on the processes in place across the provincial government agencies and within Sustainable Resource Development in the C5 FMU starting with high-level direction in documents such as *A Policy for Resource Management of the Eastern Slopes (1984)*, the *Land-use Framework and Water for Life*, to the *C5 Forest Management Plan (FMP)* and the *Spray Lake Sawmills and C05 Operating Ground Rules (OGRs)*, to name a few. After extensive review of the process documents from high-level planning to ground rules, meetings with senior operations staff in SRD and a field tour of the C5 FMU area from the air and on the ground to help understand what the actual watershed conditions are, it was decided that the best approach to this audit was to work from the ground up. In other words, based on what the auditors observed for conditions on the ground that actually impact water, they then related what was happening on the ground to the processes that permitted the forest development to occur.

This report includes the following: the objective and scope of the audit, the context for the audit, the audit findings and recommendations.

¹ Forestry Fact Sheets – C5 Planning Hierarchy

1.1 Audit Objective

The objective of the audit is to review the processes currently in place within the Forestry Division of Sustainable Resource Development from policies and plans to operating ground rules and monitoring protocols to mitigate potential impacts of forestry, forest health and wildfires on watershed values, to determine if they are adequate to protect water values from forest development impacts. Special emphasis was to be focused on regional water supply and water quality. ESRD is responsible for managing forest development in the C5 FMU and is accountable for the achieving the objectives set out in the C5 FMP.

The C5 FMU area is heavily used by multiple land users ranging from forest quota holders, recreational users, ranching, and to a limited extent the oil and gas sector. The area has a long history of timber harvesting associated with the early days of mining in the area. Due to the high demand for water downstream and the fact that no new water licenses are being issued in the South Saskatchewan River basin in Alberta, there are significant concerns about maintaining the water supply and water quality in the headwaters areas encompassed to a large part within the C5 FMU forest.

1.2 Scope

The audit was limited to reporting on the risks to the regional water supply as a result of the processes related to forest management planning and practices in the C5 FMU only. The reason that this unit was chosen for the audit was because the C5 FMU is entirely managed by SRD, the department responsible for the administration of provincial forests. The C5 FMP was prepared by ESRD since the C5 FMU area does not fall within a Forest Management Agreement area (FMA). Forest development within the FMU is undertaken by quota holders where the quotas are issued by ESRD. This simplified the audit process since the auditors had only one forest management plan to review for the entire FMU. The period that the audit was to address was from 2006 to 2012. In addition to timber harvesting impacts the audit also reviewed the department's procedures for addressing the risk to water from mountain pine beetle and wildfires.

This is a process audit focusing on current policies and practices that may impact the regional water supply for which ESRD is responsible and accountable with respect to forest development within the C5 FMU. The audit includes a comprehensive review of relevant current policies and practices as well as an overview of how these practices have been implemented on the ground through site visits of selected areas/blocks developed during the period May 1, 2006 to April 30, 2012.

2.0 AUDIT PROCESS

A process audit focuses on “processes” not people or performance. It examines the effectiveness of the relevant procedures. A process is an interrelated set of activities that convert inputs into outputs. This is not a performance audit however in the case of forest development activities, e.g. road construction and maintenance, and harvesting, an examination of the how operations may protect the water resource is, in part, a measure of the effectiveness of the process.

There are two approaches to a process audit either trace the sequence of processes from the higher level plans to the on-the-ground practices or trace them back from the ground up. As indicated previously, after reviewing the extensive list of documents in the process from initial forest management planning to the operations monitoring protocols that relate to watershed management, water supply and quality for the C5 FMU, and completing site visits to selected areas, it was decided to format the audit findings working back from the results on the ground and trace the connectivity to the higher level processes.

The audit procedure involves understanding the forest management processes that address watershed management, water supply and water quality from the higher level policies and plans through implementation of operations on the ground and subsequent monitoring within ESRD, and to determine how ESRD confirms that the processes have been followed, both internally and externally.

The contract included an appendix with a list of key documents to be reviewed. The general categories were:

- Regional Planning;
- Forest Management Planning and Operations;
- Forest Health;
- Environment and Watershed Planning;
- Public Lands; and
- Continual Knowledge Improvement.

In addition ESRD staff resources included the:

- Forestry Program Manager
- Senior Forester
- Section Head, Land Use Management
- Forest Hydrology Specialist
- Area Land Operations Lead
- Land Management Forester
- Area Forester, Blairmore Ranger Station

The audit process involved the following steps.

1. Initial meeting with ESRD staff in Calgary.
2. Assemble key documents.
3. Create a process framework from higher level policies and plans to ground rules related to water.
4. Locate additional documents required to complete the process review.
5. Review key documents and identify relevant elements in each related to water.
6. Meet with ESRD in Calgary to review progress and receive clarification on processes where required.
7. Complete visits of selected sites in the C5 FMU on the ground and from the air.
8. Meet with ESRD staff at the Blairmore field office.
9. Meet with ESRD staff in Calgary following fieldtrip for clarifications of questions arising during fieldtrip.
10. Summarize processes and identify gaps or deficiencies.
11. Prepare draft report.
12. Submit draft report for review.
13. Present summary of audit findings to ESRD Forestry Division executives in Edmonton.
14. Prepare and submit final report.

The process audit was focused on the following assessment criteria.

1. Is the process adequate to mitigate the potential impacts (of forestry, forest health and wildfires) on regional watershed values, water supply and water quality?
2. How do we know that the process is adequate?
3. If it is not, why not? (gaps/deficiencies)
4. Recommendations to address gaps/deficiencies.

3.0 PROJECT CONTEXT

The purpose of this section is to set the audit context. The focus is on the processes used by ESRD to manage forest development, specifically the policies, plans and operating rules used to mitigate potential impacts of forestry, forest health and wildfires on watershed values, with emphasis on potential impacts to regional water supply and water quality. The following is a summary of the relevant processes from the top down, that is, from the provincial policy direction to the operations on the ground.

At the provincial level, the auditors considered the following general forest management policy objectives.

- The Alberta Forest Legacy sets out a management approach that reflects citizens' desire to maintain, on provincially-owned land, their access to the diverse economic, cultural and recreational benefits that are provided by, and dependent upon, sustainable forest ecosystems. (The Alberta Forest Legacy – Implementation Framework For Sustainable Forest Management)
- Cumulative effects management will be used at the regional level to manage the impacts of development on land, water and air. (Land-use Framework, Strategy 3)
- Develop a strategy for conservation and stewardship on private and public lands. (Land-use Framework, Strategy 4)
- Water for Life will be integrated into other policies and plans, such as Land-use Framework planning, ensuring better resource management integration. (Water for Life a renewal)

At the regional level the objectives for forest management relevant to managing risks to water are as follows.

- Ensure a continuous supply of clean water to meet the needs of Albertans and interprovincial users now and in the future. (A policy for Resource Management on the Eastern Slopes)
- Develop options for improving source water protection (e.g. environmental setbacks, wetland protection or restoration and rehabilitation of degraded sources) and other management means to protect watershed integrity, including watershed headwaters. (South Saskatchewan Regional Advisory Council Advice)
- Management emphasis is placed on watershed protection, recreation and tourism priorities. Watershed protection is stressed throughout the plan. Special emphasis is placed on areas of high watershed sensitivity and existing and potential site disturbance. (Castle River Sub-Regional IRP)
- Provide a full range of multiple use activities managed to maintain high watershed quality. (Crowsnest Corridor Local IRP)

- Maintain and improve water quality, quantity and flow regime for aquatic habitat and onstream and downstream users. (Livingstone-Porcupine Hills Sub-Regional IRP)

At the C5 Forest Management Plan level and on-the-ground plans and practices the auditors considered the following.

- The C5 FMP that conforms to direction contained in the Alberta Forest Legacy. Policies, standards and guidelines and requirements adopted by ESRD that pertain to forest management planning, including Alberta's Forest Management Planning Standard. Wherever possible, the Z809-02 Sustainable Forest Management: Requirements and Guidance were followed.
- The Alberta Forest Legacy shifts beyond land management practices designed for single outputs, such as timber and oil. It advocates that a broader landscape level perspective is required that blends all resource values, measurable and perceived, when making resource management decisions in order to move toward sustainability. (The Alberta Forest Legacy – Implementation Framework For Sustainable Forest Management)
- The forest management process used in Alberta is detailed in the standard. In addition to being based on the requirements of CSA Z809-02, the standard provides additional interpretation and details necessary to meet the needs of Alberta. All FMPs prepared by industry in Alberta follow the process described in this standard. (Alberta Forest Management Planning Standard)

Planning and on-the-ground practices that are identified in the Spray Lake Sawmills and C5 Operating Ground Rules were also reviewed.

Monitoring and feedback processes such as the compliance and enforcement process and the forest operations monitoring program were also considered.

How forest health was addressed was based on how the ESRD forest management processes integrated and applied the directions set out in the:

- Mountain Pine Beetle Action Plan;
- Mountain Pine Beetle Management Strategy; and the
- Mountain Pine Beetle Infestation Management Responsibilities.

Finally, the issue of the impacts of wildfire and the risks to water, the auditors considered how directions provided in the following policies were applied by ESRD.

- At the provincial level watershed and soil are one of the five wildfire priorities.
- The C5 FMP integrates the provincial wildfire priorities in:
 - the detailed forest management direction:
 - Criteria 1 – Conservation Biodiversity;

- Criteria 2 – Maintenance and enhancement of forest ecosystem condition and productivity.
- Appendix 10B – C5 Wildfire Threat Analysis;
- The Spray Lake Sawmills OGRs.
- Section 7.3 Debris Management and Wildfire Protection.

4.0 AUDIT FINDINGS

This section provides the process audit findings. The audit findings were organized into five main sections starting with the on-the-ground observations and results of the condition of the C5 forest and its watersheds in relation to water supply and quality. The four remaining sections then trace back through the forest management process from the Forest Operations Monitoring Program, Spray Lake Sawmills C5 Operating Ground Rules, the C5 Forest Management Plan, to higher level plans.

Table 1 provides an overview of the phases of forest development and audit findings. As already described the primary criteria of the audit was to address the following: Is the current process adequate to mitigate the potential impacts (of forestry, forest health and wildfires) on regional watershed values, water supply and water quality? If not, why not?

Table 1: Summary of forest development phases used in the audit, summary of processes and audit findings.

Forestry Development Phase	Processes	Comments – Adequate? Deficient?
Forest Operations Monitoring Program (FOMP)	ISO 9001:2008 certified program Monitoring: <ul style="list-style-type: none"> • AOP • Riparian • Watercourse crossings • Roads • Soils • Protection (fire) • Integration <ul style="list-style-type: none"> • Sensitive sites • Recreation concerns • Operations timing • Reforestation 	This is the final process where ESRD completes its monitoring of timber harvesting. This is an ISO certified process that, in the opinion of the auditors, is adequate. Therefore the auditors accepted this process as adequate and did not carry out a detailed review of the FOMP process.
Harvesting by quota holders	Operating ground rules <ul style="list-style-type: none"> • Annual operating plans • Final harvesting plans • General development plans • Approved forest management plan • Water Act (Watercourse Crossing) • Referral process 	Adequate Adequate Adequate Adequate Adequate Missing Water in referral process
C5 Forest Management Plan	Spatial harvest sequence General development plan Hydrologic modeling MPB Wildfires	No watershed assessment plan (refer to Appendix D for example) Limited integration with other uses and understanding of cumulative impacts
Direction – Higher Level Plans (provincial/regional)	IRPs – Castle, Crowsnest, Livingstone-Porcupine SSRP RAC advice Land-use Framework Water for Life Oldman River Watershed Council (WPAC) Forest Act Water Act The Alberta Forest Legacy	IRPs are old and should be updated All IRPs and higher level plans are consistent in highlighting the importance of water

4.1 Condition of C5 Watersheds and Field Review



A field review and overview flight of the C5 forest was conducted on May 30 and 31st. The field review provided the following information:

- a general overview of the conditions of the C5 forest and watersheds;
- overview of water supply and quality risks and issues;
- review of past and current forest operations and practices; and
- an on-the-ground evaluation of the effectiveness of current forest management processes.

In general, the watersheds in the C5 forest appeared to be in good condition with limited evidence of forest development impacts on watershed processes (i.e. streamflows, channel stability, surface erosion and riparian condition/function). Also no significant hydrologic issues were identified during the review of recent forest harvesting/roads. Recently constructed watercourse crossings appeared to be appropriately designed/constructed and adequate sediment control measures appeared to have been applied. Management of riparian buffers adjacent to recently harvested areas also appeared appropriate. The audit findings were consistent with conclusions made in the Oldman River State of the Watershed Report (2010) that watershed indicators (terrestrial/riparian condition, water quantity and water quality) had an overall good ranking in the upland, mountainous regions of the Oldman River sub-basins.

It should be noted that the auditors were not able to adequately assess cattle impacts on the water resource in the watersheds since cattle were not present at the time of the audit. However, at most field sites there was anecdotal evidence of cattle activity (fecal material) in the riparian zones and along streams.

The primary concerns identified during our field review included the following.

Concerns

- *Old Roads and Public Use– Unless old roads (inactive or no longer used roads) are either decommissioned (permanently or semi-permanently) or maintained, they can pose not only a risk (potentially high to very high) to water supply, water quality and watershed values but of more importantly risks to public safety if left unattended. The current condition of several bridges noted during the audit pose a very high risk to public safety if the structures collapsed with a vehicle on the deck. [Note: Public safety is beyond the scope of this audit but the auditors have a professional responsibility to identify this issue.] In addition if a collapsed structure obstructed the stream flow there is a very high likelihood that there will be significant environmental/watershed impacts.*
- *Although in most cases the general condition of the watershed was observed to be good there is a need for a more integrated management approach to protect watershed processes in the near future. For example, recreation use (e.g. ATV and random camping) appears to pose a significant risk to watershed processes especially if left unchecked. This concern is discussed further in the following sections.*

4.2 Forest Operations Monitoring, Compliance and Enforcement

A key component to mitigating potential impacts of forest management activities is to ensure that forestry activities are being conducted on-the-ground in accordance with approved plans and legislation. Also it is important to have feedback mechanisms in place that allows for continuous improvement (e.g. plan-do-check-act cycle) of various plans, policies and operating rules. In the auditors opinion this current process is assumed to be adequate in mitigating potential impacts at the site level to water supply and quality.

This finding is based on the following information.

- ESRD through the Forest Operations Monitoring Program (FOMP) currently has in place a standardized forest harvesting and reforestation inspection process that is an ISO 9001:2008 quality management certified process.
- Based upon the high level of compliance identified in the C5 forest. (This statement is based upon the assumption that Compliance and Enforcement have been carried out over the past 5 years with the same level of rigour).

- Observed condition of recent harvest areas during the audit overview flight and field review (May 30 - 31, 2012).

Table 4.1: Summary of contraventions identified in the C5 forest from 2007 to June 2011².

Note one penalty in 2010 was non-forestry related and was associated with the Castle Mountain Resort.

Year	Contravention	Penalty
2007	0	-
2008	0	-
2009	5	<ul style="list-style-type: none"> • Unauthorized buffer harvest on watercourse • Unauthorized re-alignment of LOC Creek Crossing • Unauthorized bared area within buffer area of watercourse • Unauthorized buffer harvest of watercourse • Unauthorized buffer harvest of watercourse
2010	2	<ul style="list-style-type: none"> • Unauthorized creek crossing • Unauthorized harvest of watercourse area
2011	0	-

² Personal communication. 2012. Cory Wojtowicz, Forest Officer III, Compliance and Enforcement, Southern Rockies Area, Blairmore Ranger Station

4.3 Spray Lake Sawmills and C05 Operating Ground Rules (2011)



As stated in the ground rules, the FMP addresses water quantity and flow issues. Operating ground rules define operating practices to protect water quality and riparian values. Ground rules are also the practices used in planning and conducting timber harvesting operations that constitute the methods used to implement decisions made in the Forest Management Plan and other higher level plans. As stated in the ground rules if issues or risks are not addressed in the higher level plans or the forest management plan, the operating ground rules will be used to establish practices to minimize the chance of negative impacts from roads, timber harvesting and forest management operations and activities³.

In general the processes described in the operating ground rules are adequate and effective in ensuring risks from forest operations and practices to water quality are minimized. The audit findings specific to particular sections that relate to water quality in the operating ground rules are summarized below.

³ Spray Lake Operating Ground Rules C5 Forest, Page 1

Operational Planning (Section 3.0)

- The entire planning process appears to provide a sufficient level of rigour in planning to ensure forest operations and practices are developed and designed in a manner that will minimize potential impacts to water quality and riparian values. Evidence for this statement include:
 - Appropriate checklists, reporting procedures and standards appear to be in place to ensure thorough review and consideration of potential water quality and riparian issues.
 - The operational planning process provides various levels of review throughout the planning cycle to allow for modification in the event that unforeseen issues arise.
 - Water quality and riparian values are clearly identified and are identified as a critical component in the entire planning process.
 - The operational planning process appears to be well coordinated and provides appropriate rules that translate into actual on-the-ground actions that ensure the protection of water quantity and supply.

Integration with Forest Operators (Section 5.0)

- As described in this section of the OGR the purpose is to ensure that planning, harvesting and reforestation in overlapping dispositions are carried out efficiently and with a minimum of environmental impact.

Concern

- *Although this section provides practical rules to coordinate and integrate activities with various forest operations (e.g. forest recreation and tourism, rangeland resources, trapping and aesthetics) there is little guidance provided in regards to minimizing cumulative effects. Integration with the energy sector is also not included. Presently, there is no well-articulated mechanism to deal with the integrated management of multiple resource development activities as they accumulate at the operational level that is linked to the overall management of the C5 forest or at the watershed level (refer to section 4.4 for further discussion).*

Watershed Protection – Watercourse classification and Operating Beside Streams (Section 6.0)

- A clear and extensive classification system is in place to appropriately identify watercourses that can be used to protect instream water values based on protection of various aquatic habitat needs and physical stream processes (e.g. maintenance of streambank stability).

- Ground rules provide appropriate direction to avoid direct impacts when operating adjacent or near to watercourses. Examples include:
 - avoidance of depositing sediment, logging debris and deleterious material into watercourses (6.0.7);
 - requirement to cross equipment at designated crossings only (6.0.8);
 - avoidance of water source areas during harvesting in non-frozen periods (6.0.12).
- Ground rules have been established that minimize the risk to various hydrologic processes (e.g. peak flows/water yield, surface erosion and riparian condition/function). Examples include:
 - avoidance of large harvest areas or amounts that could affect water yield/peak flows (6.0.2); it should be noted that water yield and peak flows are also addressed in the C5 Forest Management Plan (Appendix 6);
 - measures to minimize erosion and sedimentation into watercourses (6.0.3);
 - standards and guidelines for operating beside watercourses (Table 2);
 - location of roads and landings to watercourses (Table 2).
- Standards and guidelines for operating beside watercourses are generally comparable or wider than most other jurisdictions in North America ^{4,5}.

Soils (Section 9)

- Ground rules provide appropriate direction to minimize soil erosion. This finding is based on rules that consider soil erosion and disturbance at all stages of harvesting (pre-harvest planning, harvesting and post-harvest).

⁴ Lee, P., Smyth, C., and Boutin, S. 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. *Journal of Environmental Management* 70: 165-180.

⁵ Lee, P., Smyth, C. 2003. Riparian forest management: paradigms for ecological management and practices in Alberta. Report produced by the Alberta Research Council (Vegreville, Alberta) and the Alberta Conservation Association (Edmonton, Alberta) for the Northern Watershed Project Stakeholder Committee. Northern Watershed Project Final Report No. 1. 117 pp.

Concerns

- *One weakness noted in the ground rules is the subjective nature in applying the rules. The auditors recognized subjectivity should not be completely removed from the process but it is suggested that more guidance into how these rules be interpreted / administered in the field should be identified in the OGRs. Further clarification through detailed protocols, training, guidance documents and development of improved performance measurables would strengthen the application of the rules.*
- *There is also no mention of assessing the risk of blowdown and designing buffers to minimize blowdown.*

Wildfire Protection (Section 7.3) and Forest Health (Section 10.0)

- Large scale wildfires, forest health and/or subsequent salvage harvesting disturbances can pose a significant risk to water supply and quality^{6,7}; therefore, it is critical that the ground rules and higher level forest management plans support planning and practices that ultimately reduce the risk of these disturbances. It is recognized that landscape level issues regarding large scale disturbances are addressed in the spatial harvesting sequence (SHS) and the forest management plan; however, it is suggested that more emphasis be placed on these issues in the operating ground rules. The following points highlight the main audit concerns regarding the Wildfire Protection and Forest Health sections.

Concerns

- *In the ‘purposes’ in both Wildfire Protection Section 7.3 (page 30) and the Forest Health Section 10.0 (page 53) there is no mention of “minimizing the risk to water supply and quality”. If protection of water supply and quantity is one of the key higher level objectives for forest management in the C5 forest the “what” should be emphasized in the FMP and then followed up with the “how” in the operating ground rules.*

⁶ Silins, U. et al. 2009. Southern Rockies Watershed Project: Impact of natural disturbance by wildfire on hydrology, water quality, and aquatic ecology of Rocky Mountain watersheds, Phase 1 (2004-2008).

⁷ Ministry of Forests, Lands and Natural Resource Operations. Undated Summary. Hydrologic sensitivity of watersheds to MPB infestation in the B.C. Interior.
http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/hydrology/

- *In the Wildfire Protection section there is no mention of a wildfire protection plans (e.g. landscape fire assessment) to protect watersheds for water supply and quality. This should be, if not already, an important component of the FireSmart Protecting Your Community from Wildfire process. A component of this process could be to strategically plan harvesting to create firebreaks across the landscape either using natural features or through design of harvesting patterns strategically located across the landscape. It should be noted that mention of this approach (landscape fire assessment) is made in Alberta's Forest Management Planning Standard (Version 4.1, 2006) but does not appear to be included in the operating ground rules.*
- *In the operating ground rules it is stated that: "Landscape level issues regarding the risk of large fires are addressed in the development of the spatial harvest sequences. The FMP shall develop objectives, strategies and tactics that consider the risk of occurrence and spread of fire at the stand and landscape scale (refer to Section 7.3, page 31)". To the auditors it was unclear if risk of occurrence and spread of fire were actually considered at the landscape level in conjunction with mitigation of risks to water supply and quality since this process was not described in the FMP.*

Roads (Section 11.0)

- The ground rules appear to provide appropriate direction in regards to minimizing the risks from road development on water supply and quantity. As identified in this section, roads and watercourse crossings if not properly planned, designed and constructed can pose a significant risk to water supply and quality both in the short and long term. The long-term planning of access for all land uses is critical to ensure access to watersheds does not result into chronic water quality problems.

Concern

- *Throughout the operating ground rules reference is made to "erosion control" and minimizing erosion to reduce the risk to water quality; however, it would seem that the erosion control terminology should be expanded to erosion control and sediment control to better reflect erosion and sedimentation processes and current day terminology. The expanded terminology would also help differentiate between techniques used for erosion control and sediment control. For example, the use of grass seeding or brush mats are a form of erosion control whereas, sediment fence and check structures situated along ditches are a form of sediment control. Ultimately techniques that control erosion in the first place are much preferred over controlling sediment once it has been eroded. This expanded terminology would provide a basis for enhanced effectiveness of erosion and sediment control.*

4.4 C5 Forest Management Plan 2006 to 2026



The C5 Forest Management Plan (FMP) identifies how ESRD manages the C5 forest for the 20-year planning cycle of May 1, 2006 to April 30, 2026. The intended focus of the C5 forest management plan is to manage timber resources, timber harvesting and silvicultural activities while minimizing the impacts of forestry operations on non-timber resource values, land uses and human activities. In regards to minimizing risks to water supply and quality the FMP serves multiple functions.

- Provides detailed direction in achieving the desired future forest within the C5 forest within the context of existing higher level plans, government legislation and policies within a sustainable forest management philosophy.
- Identifies designated areas and resource management units in the C5 forest and coordinates forest management in recognition of these designated areas.
- Provides landscape level direction in managing the C5 forest to minimize risks associated with large scale disturbances related to wildfire and forest health issues.
- Establishes harvest levels based on an assessment of potential changes to water quantity.

- Provides goals and objectives to achieve the desired future forest and to minimize risks to water supply and quality based on standards set by the Canadian Standards Association (Sustainable Forest Management: Requirements and Guidance, CSA Z809-02) and the Canadian Council of Forest Ministers (CCFM) criteria and indicators framework.
- Establishes performance monitoring procedures and adaptive management strategies.

In general the processes described in the C5 FMP are adequate and effective in ensuring risks from forestry, wildfire and forest health are minimized in regards to water supply and quality.

This audit finding is based on the following.

- The majority of objectives set by higher level plans related to water have been incorporated into the forest management plan.
- Forest management is being conducted under an established sustainable forest management framework that is well recognized in Canada and internationally (i.e. CSA and CCFM).
- Clear targets and measurable indicators for water related resource management objectives have been defined and are being applied at the landscape level.
- Landscape level strategies appear to have been incorporated into the plan to minimize landscape level forest health and wildfire disturbances that could have significant effects on watershed values.
- Potential water quantity changes associated with harvesting have been assessed and taken into consideration in developing harvest scenarios for the various watersheds in the C5 forest.

Concerns

- *Cumulative Effects and Watershed Scale Assessments – The C5 Forest Management Plan and lower plans (e.g. operating ground rules) are silent in regards to issues regarding cumulative effects and the linkages between other land use activities that impinge on watershed values. Although the risks to water supply and quality have been addressed at the landscape and site level, there is a lack of a more comprehensive watershed scale (e.g. <500 sq. km) assessment. For example, analysis of proposed harvest levels has been conducted at the watershed scale to assess water yields/peak flows⁸ but the current and potential condition of additional watershed processes have not been assessed. Additional watershed processes include stream channel stability, riparian area function/condition, and erosion processes. None of these processes have been assessed at the watershed scale. These processes in conjunction with all the various land uses (i.e. agriculture, forestry, mining,*

⁸ Appendix 6C. Hydrological Effects of the Preferred Forest Management Scenario in the C5 Forest Management Unit, 2006

recreation, and oil and gas extraction) can interact and result in cumulative effects that can have significant impacts on water supply, water quality and aquatic ecosystems. At present there is no well-articulated mechanism that informs forest management and land use planning of these potential watershed impacts from all land-uses.

- *Landscape Wildfire Risk Reduction - More clarification is required regarding how the risk of occurrence and spread of fire were actually considered at the landscape level in conjunction with mitigation of risks to water supply and quality since this process was not fully described in the forest management plan (refer to concern regarding Wildfire Protection identified in Section 4.3 of this report).*
- *Referral Process and Integration – There appears to be a lack of integration between divisions within ESRD in regards to the referral process. This statement is based upon two observed examples. The first example deals with proposed development within the Hidden Creek (CTL050007, Oldman license) watershed. In this case Spray Lake Sawmills is believed to have followed all the necessary ESRD approval steps in order to proceed with harvest planning and layout but was later asked to defer harvesting in the 2009/10 season so that ESRD would have time to address a bull trout spawning issue located in close proximity to the harvest area. In 2010/11 the majority of harvesting identified on the AOP in this area was also not approved since ESRD was working on updating the designation of Hidden Creek from a Class B to Class A stream. In this case the auditors fully appreciate the importance of the Hidden Creek to bull trout and recognize the cautionary efforts put in place to ensure the proper protection of this resource by ESRD staff. However, it would seem that issues such as these should have been captured and identified earlier in the forest management planning and referral process.*
- *A further example of this lack of integration between divisions within ESRD in regards to the referral process was identified in the South Rockies Area – Referral Matrix 2009 (SRA Committee, June 15, 2011 version). In regards to forest management referrals for the various planning documents there appears to be an identified referral process with the various ESRD divisions associated with forestry, lands, range, wildlife, fisheries and forest protection but there does not appear to be a referral process in place in regards to water. This appears to be either an oversight or a shortcoming of the current referral process.*
- *In Objective 38 (page 157) a completed access development plan for the C5 FMU is identified as a target. To the best of our knowledge this access development plan has not yet been completed for the C5 forest and it doesn't appear to have been identified as a priority. This plan is a necessary and critical element to minimizing risks to watershed values in the C5 forest and should not only focus on forest development access but should provide an integrated plan for all land uses in the C5 forest for now and into the future. Abatement of cumulative effects from access associated with all land uses should be a focal point of this access development plan.*

It was also stated in the forest management plan that a new PLUZ will be established in the C5 forest in the future to more effectively manage motorized recreational activities in the C5 forest (page 32). This zoning process is likely a critical element in creating an effective

access development plan. It is assumed that this PLUZ would be in addition to the three PLUZs that are currently in the C5 forest (Castle Special Management Area, Allison/Chinook area and a portion of the Cataract Creek Snow Vehicle area).

- *In several of the objectives (monitoring procedures) and in the monitoring section (Section 5.6) reference is made to completion of stewardship report to be completed every 5 years as a primary mechanism for documenting the monitoring results. To the best of our knowledge this has not yet been completed with the first report scheduled for 2015⁹. As described in the Stewardship reporting Section (Section 5.7), these reports will be important component in monitoring and providing feedback to the current success and trajectory of the C5 forest management plan. Adaptive management is identified as an important component of the C5 forest management plan to ensure the plan remains relevant and responsive (refer to page 215). The auditors agree that this approach to management is critical but there was limited documented information in place to evaluate whether this plan-do-check-act cycle was in place and was effective. At the site level there appears to be a significant amount of monitoring in place that appears to be influencing on-the-ground practices but adaptive management was not apparent at a broader landscape and watershed level in achieving the desired future forest especially to ensuring that risks to water supply and quality are being minimized.*

An active adaptive management system was also identified as being employed in the C5 forest management plan. This approach should be revisited since by definition¹⁰ active adaptive management is likely not being employed but instead passive adaptive management is being used. For example in the C5 forest management plan only one “best” management plan has been implemented whereas, active management would entail a systematic process of experimentation and monitoring to compare the outcomes of alternate management actions.

⁹ Sustainable Resource Development. 2010. Forest Management Plan Approval Decision, Forest Management Unit C5, Updated October 20, 2010.

¹⁰ BC Ministry of Forests and Range, Defining Adaptive Management, <http://www.for.gov.bc.ca/hfp/amhome/Admin/index.htm#passiveactive>

4.5 Higher Level Plans and Watershed/Environmental Planning



Numerous higher level plans relevant to the C5 forest include:

- A policy for Resource Management on the Eastern Slopes (1984)
- Castle River Sub-Regional IRP (1985)
- Crowsnest Corridor Local IRP (1991)
- Livingstone-Porcupine Hills Sub-Regional IRP (1987)
- Mountain Pine Beetle Management Strategy (2007)
- Mountain Pine Beetle Action Plan (2007)
- Land Use Framework (2008)
- Water For Life A Renewal (2009)
- South Saskatchewan Regional Advisory Council Advice (2011)
- Forest Act and Timber Management Regulation
- Oldman River State of the watershed report (2010)
- OWC Strategic Plan 2011-2013 (2011)
- OWC Priorities for Oldman watershed (2011)

From a process audit perspective all of these documents provide the higher *level focus and context* for policies, plans and operating ground rules to mitigate potential impacts from forestry, forest health and wildfire to watershed values. In combination with each other, all of these plans

appear to be consistent with the general message regarding water and the risks to regional water supply and quantity having been clearly highlighted. This recognition of risk was highlighted in early documents such as *A Policy for Resource Management of the Eastern Slopes (1984)* and is a consistent theme that has been included in the various IRP documents and higher level plans of today. The higher level objectives for water appear to have been included in the lower level plans such as the C5 Forest Management Plan and the Spray Lake Sawmills C5 Operating Ground Rules.

The following concerns were identified.

Concerns

- *It is our understanding that government directive has been given to update the various sub-regional IRPs¹¹. The auditors concur with this decision since the existing IRPs that were prepared in the 1980s do not adequately reflect current resource management pressures (e.g. ATV use, MPB outbreaks and expanded population growth). Consideration should be given to integrating components of the IRPs to ensure cumulative effects issues are addressed across the entire landscape. For example, by excluding or managing recreation use in one sub-region may result in undesired consequences within another sub-region.*
- *As already described above, a more integrated approach is required to manage issues regarding cumulative effects at the watershed level and the linkages between other land use activities that impinge on watershed values.*
- *Closer management attention is required to ensure land use activities (e.g. random camping and ATV use) are not concentrated in areas that will adversely affect water quality and riparian functions.*
- *All IRPs and higher level plans are consistent in highlighting the importance of water but the mechanisms for achieving and mitigating the risks to water supply and quantity have not been identified.*

¹¹ Personal communication, D. Johnson, Acting Area Manager (Prairies Area), May 31, 2012

5.0 RECOMMENDATIONS

The following recommendations are provided in response to the concerns noted in Section 4.0 for the consideration by ESRD to address gaps in the forest management process that would improve watershed management and protection of water supply and quality.

The recommendations are presented in order of priority in the opinion of the auditors and by category of concern.

Roads

1. Old Roads – ESRD should review its policies for old roads that are no longer required for industrial use. Roads should either be maintained to a provincial standard or, decommissioned permanently or semi-permanently based on future access requirements or an access management plan. Not addressing this issue is in complete contradiction to all the established water and environmental values identified in the higher level plans to OGRs.
2. Forest Management Planning Referral process – *Water* should be part of the ESRD referral process for forest development within the C5 FMU. This will require designating a qualified professional the responsibility to provide formal comments to all forestry referrals in a timely manner similar to those set out in the Referral Matrix.
3. Erosion control terminology should be expanded to erosion control and sediment control to better reflect erosion and sedimentation processes. The expanded terminology would also help differentiate between techniques used for erosion control and sediment control. For example, the use of grass seeding or brush mats are a form of erosion control whereas, silt (sediment) fence and check structures situated along ditches are a form of sediment control. Ultimately techniques that control erosion in the first place are much preferred over *controlling* sediment once it has been eroded. This expanded terminology would provide a basis for enhanced erosion management and would better reflect current terminology/practices.

Integrated Land Management and Cumulative Watershed Effects

1. The sub-regional integrated resource plans for the Castle River, Livingstone Porcupine Hills and Crowsnest should be updated to reflect current policies and legislation, present conditions in these areas, and current public priorities for the use of public lands within the C5 FMU.
2. Comprehensive watershed scale (e.g. <500 sq. km) assessments are required that consider a broader set of watershed processes than is currently being employed. Ideally these assessments would consider all land uses on public and private land (i.e. ownership blind) within defined watershed areas to identify current and future risks to water supply and quality. Watershed processes that should be considered should not only include water

yield/peak flows but should also assess stream channel stability, riparian area function/condition, erosion processes and past/future watershed impacts. These assessments could then be used to inform forest management and land use planning to avoid and/or mitigate potential watershed impacts from all land-uses.

3. The management and planning of all land use activities that occur within the C5 FMU need to be integrated in order to both assess and manage cumulative effects on water. Current ESRD procedures are focused on limiting the impacts of forestry on water but without adequate information of the cumulative effects of all other uses within a watershed. In order to achieve this recommendation a well-articulated mechanism needs to be developed that integrates management of multiple resource development activities that is linked to the overall management of the C5 forest and its watersheds.
4. In conjunction with the above recommendation, Forest Management Plans, Range Stewardship Plans, and all other regulated land use planning for natural resource development should be required to produce plans that take into consideration the other activities taking place in a defined watershed area and become part of comprehensive land and resource use management at the watershed and landscape level. This recommendation could likely be addressed as a component in the updating of the sub-regional IRPs that was identified above.

Operations

1. Clarification of the shut-down protocols is required to remove some of the subjectivity in deciding when to halt forest operations. For example, ground rule 9.4 states that operations shall not occur during heavy rainfall or when soil conditions are above field capacity (saturated). In applying this rule what is meant by “heavy rainfall”? The auditors recognize subjectivity cannot be completely removed from the process but it is suggested that more guidance into how these rules should be interpreted/administered in the field should be identified in the OGRs.
2. A procedure is required for assessing the risk of blowdown and designing buffers to minimize blowdown in order to protect water quality.

Adaptive Management

1. An active adaptive management system was identified as being employed in the C5 forest management plan. At the site level there appears to be a significant amount of monitoring in place that appears to be influencing on-the-ground practices. Adaptive management (e.g. monitoring and feedback) was not apparent at the broader landscape and watershed level to achieve the desired future forest especially to ensuring that risks to water supply and quality are being minimized, but it should be. This could include water quality and quantity monitoring at the watershed scale.

2. Adaptive management is identified as an important component of the C5 forest management plan to ensure the plan remains relevant and responsive (refer to page 215). The auditors agree that this approach to management is critical but there was limited documentation available to evaluate whether the “plan-do-check-act” cycle for adaptive management was actually in place or was effective.
3. The first Stewardship Report scheduled for 2015 should include sections on the use of watershed assessments to guide future development, how the adaptive management feedback is being used to improve the protection of the water supply and quality, etc. since the C5 forest management plan (Sections 5.6 and 5.7, page 214) refer to the stewardship report as a primary mechanism for documenting the monitoring results. Refer to Appendix D for an example of a watershed assessment procedure from British Columbia. The procedure is used as a guide for assessments carried out by qualified professionals with extensive experience in watershed processes. As described in the stewardship reporting section (Section 5.7), the report will be an important component in monitoring and providing feedback to the current success and trajectory of the C5 forest management plan.

Public Use of Provincial Land

1. Recreation activities on public lands specifically random camping and the use of OHVs in about water sources should be managed so that these activities do not adversely impact water quality and riparian functions.
2. To the best of our knowledge an access development plan has not yet been completed for the C5 FMU (Objective 38, page 157). This plan is a necessary and critical element to minimizing risks to watershed values in the C5 forest and should be developed to provide an integrated plan for all land uses in the C5 forest for now and into the future. Abatement of impacts from access associated with all land uses should be a focal point of this access development plan.
3. The establishment of a new PLUZ in the C5 FMU to more effectively manage motorized recreational activities (C5 FMP, page 32) should be pursued to assist in providing new opportunities for motorized recreation and to improve the management of this growing activity on public lands.

Wildfire

1. Consideration should be given to establishing procedures to minimize the risks to water supply and water quality when addressing wildfires and forest health issues. For example, consideration should be given to establishing wildfire protection plans (e.g. landscape fire assessment) to protect watersheds, water supply and quality. This should be, if not already, an important component of the FireSmart Protecting Your Community from Wildfire process.

6.0 DOCUMENTS REVIEWED

The following documents were reviewed and considered in this process audit.

A policy for resource management of the Eastern slopes, Revised 1984. Alberta Energy and Natural Resources. 1984. Government of Alberta.

Advice to the Government of Alberta for the South Saskatchewan Regional Plan. 2011. South Saskatchewan Regional Advisory Council.

Alberta Forest Management Planning Standard, Version 4.1. 2006. Sustainable Resource Development, Government of Alberta.

Appendix 6C. *Hydrological Effects of the Preferred Forest Management Scenario in the C5 Forest Management Unit*. Government of Alberta. 2006. C5 Forest Management Plan 2006-2026. Prepared by Watertight Solutions Ltd., Edmonton Alberta.

C5 Forest Management Plan 2006-2026. 2010. Sustainable Resource Development, Government of Alberta.

Castle River Sub-Regional Integrated Resource Plan. Alberta Energy and Natural Resources. 1985. Government of Alberta.

Code of Practice for Watercourse Crossing, Water Act – Water (Ministerial) Regulation. 2007. Government of Alberta.

Crowsnest Corridor Local Integrated Resource Plan. Alberta Energy and Natural Resources. 1991. Government of Alberta.

Describing the Integrated Land Management Approach. Environment and Sustainable Resource Development. 2010. Government of Alberta.

Forest Management and Mountain Pine Beetle. Fact Sheet. Undated. Sustainable Resource Development, Government of Alberta.

Forest Management Plan Approval Decision, Forest Management Unit C5. 2010. Sustainable Resource Development, Government of Alberta.

Forests Act, Revised Statutes of Alberta 2000, Chapter F-22. 2010. Province of Alberta.

Integrated Land Management Outcomes and Principles. 2010. Environment and Sustainable Resource Development, Government of Alberta.

Land-use Framework. 2008. Government of Alberta.

Livingstone-Porcupine Hills Sub-Regional Integrated Resource Plan. Alberta Forestry, Lands and Wildlife. 1987. Government of Alberta.

Mountain Pine Beetle Action Plan. 2007. Sustainable Resource Development, Government of Alberta.

Mountain Pine Beetle Management Strategy. 2007. Sustainable Resource Development, Government of Alberta.

Oldman River State of the Watershed Report Summary. 2010. Oldman Watershed Council (OWC).

Oldman Watershed Council Strategic Plan 2011-2013. 2011. Oldman Watershed Council (OWC).

Priorities for the Oldman Watershed, Promoting action to maintain and improve our watershed. 2011. Oldman Watershed Council (OWC).

Southern Rockies Area – Referral Matrix 2009. Southern Rockies Area Referrals Committee. June 15, 2011.

Southern Rockies Watershed Project: Impact of natural disturbance by wildfire on hydrology, water quality, and aquatic ecology of Rocky Mountain Watersheds, Phase 1 (2004-2008). 2010. Silins et al.

Spray Lake Sawmills and C05 Operating Ground Rules. 2011. Spray Lake Sawmills.

Sustainable Forest Management Current Facts and Statistics, Enforcing Forestry Standards. 2010. Sustainable Resource Development, Government of Alberta.

Sustainable Forest Management Current Facts and Statistics, Monitoring Forest Operations. 2010. Sustainable Resource Development. Government of Alberta.

Timber Management Regulation, Forest Act. 2012. Province of Alberta.

Water for life a renewal. 2008. Government of Alberta.

Water for life action plan. 2009. Government of Alberta.

2012-2013. *General Development Plan*. Spray Lake Sawmills.

APPENDIX A

Contract

BETWEEN:

HER MAJESTY THE QUEEN in right of
Alberta, as represented by the Minister of
Sustainable Resource Development
(the "Province")

- and -

Urban Systems Ltd.
(the "Contractor")

The Parties agree as follows:

1.

- (1) The Contractor agrees to provide to and for the Province the following (the "Services"):

The funding will enable the Contractor to:

- a. Prepare a confidential watershed management audit report for the Executive Director Forest Management Branch, Forestry Division, Alberta Sustainable Resource Development.
 - b. Complete a comprehensive process audit to identify risks to regional water supply as a result of forest management unit C5 in southwest Alberta. The audit will review and report on the policies, plans and operating rules used to mitigate potential impacts of forestry, forest health and wildfire to watershed values, with emphasis on potential impacts to regional (e.g. Oldman River Basin) water supply and water quality.
 - c. Review current policies and practices and make recommendations where these can be improved.
 - d. Independent process analysis is not within the intended scope of the audit.
 - e. Consider in the review the operating Timber Years 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12 beginning May 1, 2006 and ending April 30, 2012.
- (2) Provision of the services shall commence on 2nd April, 2012 and shall be completed on or before 6th July, 2012. Time is of the essence.
- (3) If the services are to be performed by specific individuals list the individuals and a brief description of the portion of the services each of them shall be providing in the space below. If individuals are identified below the services may not be performed by any other individuals except with the prior written approval of the Province:

2. After completion of the services to the satisfaction of the Province, the Contractor shall be paid as follows:

Rate of \$225 per hour plus approved expenses up to maximum of \$50,000.

Notwithstanding any other provision of this Agreement unless pre-approved by the Province in writing, the aggregate amount payable to the Contractor by the Province under this Agreement shall not exceed \$50,000. Payment is subject to the Contractor submitting a satisfactory invoice for the amount earned and approval of the invoice by the Province. The Contractor shall allow the Province to audit and review any and all time records, and all books and records relating to costs, disbursements and expenses, chargeable under this Agreement.

3. Both parties shall designate a representative to serve as their primary contact for purposes of administering this Agreement. Either party may change their designate by written notice.

The Province's designate is Dr. Axel Anderson, Forest Hydrology Specialist (on Secondment to Foothills Research Institute)

The Contractor's designate is Mr. Don Dobson P.Eng, ~~President~~ Senior Water Engineer

4. Any notice to be made under this Agreement is to be made in writing, and is effective when delivered to the address or transmitted by fax to the fax number, as follows:

The Province:	Forest Management Branch
Address:	Alberta Sustainable Resource Development
	8th Floor, Great West Life Building
	9920 - 108 Street Edmonton, Alberta, T5K 2M4
Attention:	Mr. Robert W. Stokes
Telephone:	780-422-2690
E-Mail:	Robert.Stokes@gov.ab.ca
Fax:	780-427-0085

The Contractor:	Urban Systems Ltd.
Address:	#304 - 1353 Ellis Street
	Kelowna, BC
	V1Y 1Z9
Attention:	Mr. Don Dobson, P.Eng, President Senior Water Engineer
Telephone:	250-762-2517 ext 1252
E-Mail:	ddobson@urban-systems.com
Fax:	250-763-5266

5. The Contractor shall, at its own expense and without recourse against the Province, bear, pay and be responsible for any and all taxes, excise and charges of a like nature that may be imposed on the sale, transfer or provision to the Province of the services or on any goods used or provided in connection with or as part of the services.

6. The Province represents and warrants that, as the purchaser of the Services provided under this Agreement, no amount payable under this Agreement is subject to the Goods and Services Tax (GST) or Harmonized Sales Tax (HST) under Part IX of the *Excise Tax Act* (Canada) as amended. The Government of Alberta's GST Registration Number is 1240 72513 RT0001.

7.
 - (1) Each party shall indemnify and hold harmless the other party, the other party's employees and agents from any third party claims, demands, actions or costs, including those arising out of negligence or wilful acts by the responsible party, its employees or agents. This hold harmless provision shall survive this Agreement.
 - (2) Subject to the above indemnity neither party shall be liable to the other in connection with any claim for any special, incidental, indirect or consequential loss or damage.
 - (3) The Contractor shall indemnify and hold harmless the Province against and from any loss or damage to the real or personal property of the Province for which the Contractor is legally responsible arising from or relating to the performance of Services or any other obligation of the Contractor under this Agreement.

8. The Contractor shall, at its own expense and without limiting its liabilities herein, provide and maintain the following insurance coverage in compliance with the *Insurance Act* of Alberta, with carriers, on forms and with coverage and endorsements satisfactory to the Province in its sole discretion:
 - (1) General Liability in an amount not less than \$2,000,000 inclusive per occurrence, insuring against bodily injury, personal injury and property damage including loss of use thereof. Such insurance shall include non-owned auto liability.
 - (2) Automobile Liability on all vehicles owned, operated or licensed in the name of the Contractor, and used in carrying out the obligations under this Agreement in an amount not less than \$1,000,000.00.
 - (3) If required by the Province, Professional Liability Coverage in an amount not less than \$1 million insuring for liability resulting from errors and omissions in the performance of his professional services under this Agreement. If required by the Province the insurance shall include coverage for claims arising from pollution risks.
 - (4) Such additional insurance policies and coverage as the Province reasonably requests from time to time.
 - (5) The Contractor acknowledges that these are the minimum insurance requirements that have been established by the Province. No representation or warranty of any kind is made by the Province as to the completeness or suitability of this insurance and the Contractor shall determine and satisfy itself that it has appropriate and sufficient coverage to satisfy its own risk and insurance requirements, and to cover its obligations under this Agreement.

9. The Contractor shall have the required insurance in full force and effect prior to execution of this Agreement. At the request of the Province, the Contractor shall provide evidence satisfactory to the Province of all required insurance in the form of the Certificate of Insurance attached hereto as Schedule "A". All required insurance other than automobile coverage shall

be endorsed to provide the Province with thirty (30) days advance written notice of cancellation of coverage.

10. The Contractor shall require and ensure that each Subcontractor provide evidence of comparable insurance to that set forth in section 8 and shall provide evidence of same to the Province upon request.
11. The Province may at any time immediately terminate this Agreement, without cause, upon written notice to the Contractor.
12. Ownership of all Materials including any associated copyright, patent, trade secret, industrial design or trade mark rights belongs to the Province as they are made, prepared, developed, generated, produced or acquired under this Agreement. The Materials shall be delivered to the Province upon completion or termination of this Agreement, or upon request of the Province.
 - (1) Ownership of any work, information, records or materials, regardless of form, including copyright, patent, industrial design or trademark which was owned by the Province, the Contractor or a third party prior to the effective date of this Agreement remain the property of each party respectively.
 - (2) The Contractor
 - (a) irrevocably waives in whole all moral rights, and
 - (b) shall ensure that its employees, subcontractors and agents irrevocably waive in whole all moral rights, in and to the Materials in favour of the Province and the Province's assignees and licensees. Upon request of the Province, the Contractor shall deliver to the Province copies of the waivers obtained from its employees, subcontractors and agents engaged in providing the Services.
 - (3) Prior to reproducing or incorporating any third party copyright materials into Materials, the Contractor must obtain written permission from the copyright holder and provide the Province with copies of the written permissions that are satisfactory to the Province.
 - (4) The Contractor shall cooperate with the Province in protecting the Province's ownership or intellectual property rights in the Materials.
13. The Contractor acknowledges that this Agreement, including the name of the Contractor, the consideration, term and details of the Services, may be subject to disclosure under the *Freedom of Information and Protection of Privacy Act* (Alberta), ("*FOIP Act*"). The Contractor further acknowledges that the *FOIP Act* applies to information obtained, generated, collected, or provided for the Province under this Agreement, and agrees to adhere to the *FOIP Act* in its collection, use and disclosure.
14. The Contractor shall not disclose, authorize or permit disclosure to any person or organization now, or at any time in the future, any information or documents of any kind or other matter or thing which comes into its knowledge or possession by reason of this Agreement, and shall retain all such knowledge as confidential, unless it is expressly authorized by the Province in writing. This clause does not apply to information that is publicly available or becomes publicly available without breach of this clause.

15. No press release, public announcement or other public commentary relating to this Agreement shall be made by the Contractor without the prior written approval of the Province.
16. The Contractor shall comply with the provisions of all laws, now in force or in force after the signing of this Agreement, that expressly or by implication apply to the Contractor in performing the "Services".
17. Contractor shall inform itself, and cause its employees to inform themselves, as to their respective legal responsibilities under the *Occupational Health and Safety Act*, Regulation and Code.
18. When the *Workers' Compensation Act* (Alberta) applies, and upon request from the Province, deliver to the Province a certificate from the Workers' Compensation Board showing that the Contractor is registered and in good standing with the Board.
19. The Contractor shall immediately report to the Province all work related accidents resulting in medical aid, disabling injury or fatality and serious occurrences (defined in section 18 of the *Occupational Health and Safety Act*) as a result of any services provided under this Agreement. The Contractor shall further ensure that, where required by law, accidents shall be reported to the Workers' Compensation Board and to Alberta Employment and Immigration.
20. Where the Province notifies the Contractor that work does not comply with any of the *Occupational Health and Safety Act*, Regulation, Code or the safety plan, that work shall be suspended. That work shall not resume until corrective actions have been taken to the satisfaction of the Province. The Province shall consider a breach of the *Occupational Health and Safety Act*, Regulation, Code or safety plan a breach of the Agreement.
21. The Contractor shall ensure that there is not a conflict of interest or an apparent conflict of interest on the part of the Contractor or its employees, subcontractors or agents in relation to the Services and all Services shall be performed in accordance with high ethical standards. In the event the Contractor becomes aware of any matter that causes or is likely to cause a conflict of interest in relation to the Contractor's performance of the Services, the Contractor shall immediately disclose such matter to the Province in writing. If the Province is of the opinion the Contractor or its employees, subcontractors or agents are in a conflict of interest, the Province may terminate this Agreement.
22. The Contractor shall comply with, and ensure that, its employees, subcontractors or agents comply with, the *Lobbyists Act* (Alberta).
23. The Contractor is an independent contractor and not an employee or agent of the Province.
24. The Contractor shall not assign or otherwise dispose of any of its rights, obligations or interests in this Agreement; or subcontract the Services without the prior written consent of the Province, which shall not be unreasonably withheld.
25. The Province may, from time to time, waive the performance by the Contractor of any provision of this Agreement, either before or after that performance is done, but a waiver
 - (1) is not effective or binding upon the Province, unless it is in writing signed by the Province or under its authority; and

- (2) does not limit or affect the Province's right with respect to any other breach or non-performance, whether prior or subsequent thereto.
26. The Parties may amend this Agreement only by mutual written Agreement signed by the parties.
27. This Agreement shall be for the benefit of and binds the successors and assigns of the Parties.
28. This Agreement is governed by the laws of the Province of Alberta, and the forum for any legal proceedings relating to this Agreement is the Province of Alberta.
29. This Contract may be executed in counterparts, in which case (i) the counterparts together shall constitute one agreement, and (ii) communication of execution by fax transmission or e-mailed in PDF shall constitute good delivery.

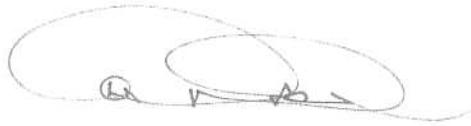
The parties have made this Agreement by the representatives authorized to do so on the respective dates shown below:

HER MAJESTY THE QUEEN IN RIGHT OF ALBERTA, as represented by the Minister of Sustainable Resource Development.

Urban Systems Ltd.

Per:

Per:



Signature

Signature

Robert W. Stokes

Mr. Don Dobson, PEng

Print Name

Print Name

Senior Manager - Forest Planning

~~President~~ Senior Water Engineer

Title

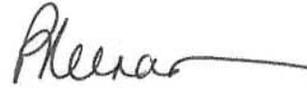
Title

2012.03.29

March 27, 2012

Date

Date



Witness Signature

Patricia Keenan

Print Name

SCHEDULE "A"

Government of Alberta ■
Sustainable Resource Development

**SIMPLIFIED
CERTIFICATE OF INSURANCE**

Name and Address of Named Insured
Name and Address of Agent/Broker
Nature of Work
See attached Appendix A

Mandatory Coverage

Schedule of Coverage	Insurance Company	Policy Number	Effective Date	Expiry Date
A. General Liability				
B. Automobile Liability				

Particulars of Coverage

		Limits of Liability	
A. General Liability <input type="checkbox"/> Non-owned Auto	All the following coverage features are required by the Provincial Contract Agreement. Check to confirm coverage provided.	\$	Inclusive Limits
B. Automobile Liability		\$	Inclusive Limits

Additional Coverage if required by the Province for this Agreement

Professional Liability	Insurance Company	Policy Number	Effective Date	Expiry Date
<input type="checkbox"/> Includes Coverage for Pollution			\$	Limit Insured

The Undersigned hereby represents to the Province that the above policies are accurately described and have been issued to the Named Insured. The Undersigned further represents that the policy described as A. General Liability is endorsed to provide thirty (30) days notice of cancellation of coverage, to the Province at:

Address

This certificate is executed and signed by the insurer, or authorized Agent/Broker.

Signature of Authorized Representative

Name of Insurance Company or Agent/Broker

Name of Representative (Please Print)

Telephone	Date

Appendix A: Nature of Work

The Contractor shall review key documents which include but are not limited to:

Regional Planning

- ✓ i. Sub-regional Integrated Resource Plans
- ✓ ii. Land-Use Framework - South Saskatchewan Regional Plan under development
- ✓ iii. Water for Life processes

Forest Management Planning and Operations

- ✓ iv. C5 Forest Management Plan watershed modeling report
- ✓ v. Forest Industry General Development Plans → C5 FM Plan. 06-26
- ✓ vi. Forest Industry Annual Operating Plans
- ✓ vii. C5 Timber Harvest Planning and Operating Ground Rules
- viii. Timber quotas — see
- ix. Area referral process — ?

Forest Health

- ✓ x. Healthy Pine Strategy
- ✓ xi. Mountain Pine Beetle Control Strategies

Environment and Water Watershed Planning

- ✓ xii. Oldman River Watershed Council, State of the Basin Report

Public Lands

- ✓ xiii. Licenses of Occupation
- ✓ xiv. Public Land Use Zones — 614055 — Castle & Allison (FLU2)

Continual Knowledge Improvement

- ✓ xv. Southern Rockies Watershed Project reports

Site Visits

Field visits will be arranged during snow-free conditions to impart information and gain understanding of the application of C5 Timber Harvest Planning and Operating Ground Rules.

Department Staff Resources

The department shall make available key resource management staff to make presentations on processes and complete interviews in the Calgary office:

- xvi. Senior Area Forester
- xvii. Area Lands Operations Lead
- xviii. Forest Hydrology Specialist - currently on secondment to Foothills Research Institute

Other Resources

As deemed relevant by the contractor, access to Sustainable Resources Development, other GoA staff and academic partners will be arranged to answer questions or provide background information. For example;

- xix. Foothills Research Institute Water Program;
- xx. University of Alberta – Southern Rockies Watershed Program;
- xxi. Dr. John Pomeroy;
- xxii. Dr. Sarah Boon University of Lethbridge;
- xxiii. Alberta Environment and Water;
- xxiv. Alberta Agriculture and Rural Development;
- xxv. Alberta Tourism, Parks, and Recreation;
- xxvi. Sustainable Resource Development Fish and Wildlife, Public Lands, Rangeland Management, Forest Protection.

The Contractor shall submit to the Executive Director, Forest Management Branch, a complete report which shall include:

Audit Methodology and Process

Audit Findings (Discuss watershed risks and hazards not processes for :)

Forest vegetation: timber harvest levels, mountain pine beetle infestation and control treatments

Roads, crossings and other access features

Riparian management

Other sensitive areas

Wildfire risks and hazards, watershed responses to wildfire

Forest Management Planning

Operations Implementation

Integration with other operations and programs

Potential Impacts to regional water supply

Mitigation

Monitoring and Reporting

Recommendations

Planning and operations improvements

Process improvements

To be referenced where scientific reports exist that support recommendations

A draft report is to be received by the Executive Director, Forest Management Branch on or before June 15, 2012. Three copies of the draft report shall be produced in digital and paper formats to:

Mr. Darren Tapp, RPF
Executive Director
Forest Management Branch
Forestry Division
Alberta Sustainable Resource Development
7th Floor, Great West Life Building
9920 – 108 Street
Edmonton, Alberta, T5K 2M4

A summary presentation of the draft report shall be made in Edmonton to the Sustainable Resource Development Forestry Division Executives as a contract deliverable at a mutually acceptable date to be determined prior to June 30, 2012.

The final report is to be received by the Executive Director, Forest Management Branch on or before July 3, 2012. Three copies of the final report shall be provided in digital and paper format



Insurance Corporation
of British Columbia

**Owner's
Certificate of
Insurance
and Vehicle
Licence**

DCID 340151915

Owner's BC driver's licence no.

Owner

TOYOTA CREDIT CANADA INC
(LESSOR)
URBAN SYSTEMS LTD (LESSEE)
304-1353 ELLIS ST
KELOWNA BC
V1Y1Z9

Effective date 29DEC2011
Expiry date 28DEC2012
Registration no. 09813343
Decal no. 97729522
Plate no. 194SJB
VIN JTDKN3DU1A0086719
Fleet no. Unit no.
Veh. insp. decal
Veh. insp. expiry
NSC no. and name

P.T. ref. no.
Driver's licence address change request NO

Proof of Insurance

The owner and/or the operator of the vehicle described herein is insured against liability for bodily injury and property damage by reason of the operation of such vehicle. The coverage provided by this certificate also satisfies the minimum limits set out by the respective legislation governing vehicle insurance in any area of Canada and the USA.

Vehicle use: BUSINESS USE, PILOT CAR, FUNERAL HOME LIMOUSINE, COURTESY CAR OR DRIVING SCHOOL VEHICLE 5000KG GVW OR LESS. INCLUDING PLEASURE USE. VEHICLE MAY ALSO BE USED ON NOT MORE THAN 6 DAYS IN A CALENDAR MONTH FOR COMMERCIAL USE UNDER 5001 KGS GVW.

Declaration of entitlement: PRINCIPAL OPERATOR WILL BE BELL MARTIN T
DRIVERS LICENCE NUMBER 5349864

Conditional factor:

This card to be carried in the insured vehicle as proof of insurance.

By signing here, you:

- apply for a Vehicle Licence and Registration under the Motor Vehicle Act or Commercial Transport Act;
- apply for an Owner's Certificate of Insurance under the Insurance (Vehicle) Act and Regulation (the Regulation);
- apply for optional insurance for which a premium is shown, in accordance with the terms and conditions of the ICBC Autoplan Optional Policy (the Optional Policy);
- acknowledge receipt of a copy of the Optional Policy, if optional insurance is purchased;
- certify that the principal operator is correct for all new plate and renewal Autoplan transactions;
- certify that coverage, use, territory and where applicable, location address are correct;
- acknowledge that the description of vehicle use set out is a summary of permitted uses in the indicated rate class and that complete details are available to you from your Autoplan agent or ICBC;
- certify that you are a resident of British Columbia, and/or the vehicle is not currently required to be registered and licensed in another jurisdiction;
- certify that you, if under 18 years of age, have the consent of a parent or (legal) guardian to license and register this vehicle;
- certify that all information on all pages of this form is true and agree that you are responsible for any inaccuracies on any page or pages of this form.

Under section 75 of the Insurance (Vehicle) Act, your claim is invalid if at any time you fail to provide complete and accurate information, violate a term or condition of your policy or commit fraud. This is a summary. For full information, see section 75 of the Insurance (Vehicle) Act.

If the lessee signs this form, the lessee agrees to be jointly and severally liable with the lessor for all premium or premium-related debt.

NOT VALID UNLESS STAMPED BY AUTHORIZED ISSUING OFFICE

DEC 06 2011

Customer Copy
Signature(s) Not Required

Customer Copy
Signature(s) Not Required

OWNER'S SIGNATURE(S)

**Vehicle
Registration**



Insurance Corporation
of British Columbia

Registered Owner

TOYOTA CREDIT CANADA INC
(LESSOR)
URBAN SYSTEMS LTD (LESSEE)
304-1353 ELLIS ST
KELOWNA BC
V1Y1Z9

Registration no. 09813343
Plate no. 194SJB
Year 2010
Make TOYOTA
Model PRIUS
Body style HATCH
VIC J6B718
Colour WHITE
VIN JTDKN3DU1A0086719
Fuel type GAS-ELECTRIC
Net weight (kg) 01330
GVW(kg)/Disp.(cc)
Seating capacity N/A
Vehicle type PASSENGER
Anti-theft device PASSIVE IMMOBILIZER
Vehicle status
Import code
Right-hand drive
AirCare expiry

This certificate must be carried in the vehicle. This certificate must be signed by the owner as seller if the vehicle is sold.

Number of owners: 1

When you sell the vehicle, the buyer must take the Registration and submit it with an application for transfer within 10 days of the purchase. Contact your Autoplan agent for details.

OWNER'S SIGNATURE(S)

[Signature]

42DF1BAM

APV250L (062011)

CUSTOMER



Insurance Corporation
of British Columbia

TXN 2 BF 4 DCID 340151915

Owner: TOYOTA CREDIT CANADA INC
(LESSOR)

Plate no. 194SJB
Decal no. 97729522

Effective date 29DEC2011
Expiry date 28DEC2012

LOCATION ADDRESS: 304-1353 ELLIS ST KELOWNA BC V1Y 1Z9

Location address means the place where a vehicle is kept when not in use. Your location address is used to determine your territory and premiums. Complete details about your territory are available from your Autoplan agent or ICBC.

Coverages
Fees and
Premiums

		Base	Your Cost
BASIC COVERAGE: TERR L AS PER INSURANCE (VEHICLE) ACT AND REGULATION	RATE CLASS 007	967	551
THIRD PARTY LIABILITY (REGULATION PART 6, OPTIONAL POLICY, DIVISION 4)	\$ 5,000,000 LIMIT	401	185
COLLISION (OPTIONAL POLICY, DIVISION 5)	RATE GROUP 17 \$ 300 DEDUCTIBLE	1,125	483
COMPREHENSIVE (OPTIONAL POLICY, DIVISION 5)	RATE GROUP 18 \$ 300 DEDUCTIBLE*	585	246
REPLACEMENT COST (OPTIONAL POLICY, DIVISION 9)	APV286A (MODEL YR#2) COLLISION	96	96
REPLACEMENT COST (OPTIONAL POLICY, DIVISION 9)	APV286A (MODEL YR#2) COMPREHENSIVE	39	39
ROADST*R PACKAGE (OPTIONAL POLICY, DIVISION 6)	(MINIMUM & RETAINED PREMIUM \$15)	42	21
ANNUAL INSURANCE TOTALS		3,255	1,621

ADDITIONAL LOSS OF USE DECLINED
ROADSIDE PLUS COVERAGE DECLINED
No Excess UMP purchased on this Transaction
Other Coverages _____

The above coverages have been explained to me.

Customer Copy
Signature(s) Not Required
CUSTOMER'S SIGNATURE

Customer Copy
Signature(s) Not Required
CUSTOMER'S SIGNATURE

Customer Copy
Signature(s) Not Required
AGENT'S SIGNATURE

LICENCE FEE 53.00
TOTAL AMOUNT DUE \$ 1,674.00

TPL TO 5 MILL DEC ROADSID
E+, EXC UMP, EQUIP &
MORE

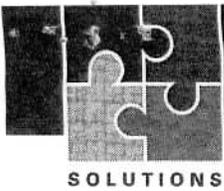
CASH/CHQ/DP/CR PAYMENT \$ 1,674.00
TOTAL AMOUNT \$ 1,674.00

*Comp Coverage with \$300 deductible includes a \$200 deduct for any claim for windshield damage caused by missiles or flying objects.

Your annual insurance costs include the following savings:

CLAIM-RATED SCALE DISCOUNT: 43% (-20)	\$ 1,324
ROADST*R GOLD SAVINGS:	\$ 266
ANTI-THEFT DEVICE DISCOUNT:	\$ 23
ROADST*R PACKAGE DISCOUNT:	\$ 21

BAM



Certificate of Insurance

Date: March 31, 2011

Named Insured: Urban Systems Ltd ,
#200 - 286 St Paul Street, Kamloops, BC V2C 6G4

Operations: Engineering Firm
Policy #: 31314
Insurer: Lloyds of London as arranged through Guardian Risk Managers
Effective: April 1, 2011 to April 1, 2012

Commercial General Liability Limit \$10,000,000 (\$2,500 Deductible)
\$10,000,000 *per occurrence*, \$10,000,000 *aggregate limit*
Forest Fire Fighting Expense \$1,000,000
Bodily Injury & Property Damage
Personal Injury Included
Medical Expense Limit \$25,000
Non-Owned Automobile Included
Standard Terms & Conditions Apply
*Contract #CCC100750

For the purposes of the Insurance Companies Act (Canada), this document was issued in the course of Lloyds insurance business in Canada.

Dated at Kamloops, BC March 31, 2011
Underwriters Insurance Brokers (B.C.) Ltd.

Per:

Commercial Account Executive

**This policy contains a clause(s)
that may limit the amount payable.**

ACCORD TM	CERTIFICATE OF LIABILITY INSURANCE	DATE (MM/DD/YY)
BROKER N.G. Williams & Associates 502 – 850 West Hastings Street Vancouver, B.C. V6C 1E1	THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.	
	INSURERS AFFORDING COVERAGE	
INSURED URBAN SYSTEMS LTD. 200-286 St. Paul Street Kamloops, B.C. V2C 6G4	COMPANY A	LLOYD'S LONDON
	COMPANY B:	
	COMPANY C:	
	COMPANY D:	

COVERAGES

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES, LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS
	GENERAL LIABILITY <input type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE <input type="checkbox"/> OCCUR GEN'L AGGREGATE APPLIES PER: Policy	NOT APPLICABLE			GENERAL AGGREGATE PRODUCTS –COMP/OR AGG PERSONAL & ADV INJURY EACH OCCURRENCE FIRE DAMAGE (Any one fire) MED EXP (Any one person)
	AUTOMOBILE LIABILITY <input type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRED AUTOS <input type="checkbox"/> NON-OWNED AUTOS	NOT APPLICABLE			COMBINED SINGLE LIMIT BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE
	EXCESS LIABILITY <input type="checkbox"/> OCCUR <input type="checkbox"/> CLAIMS MADE <input type="checkbox"/> UMBRELLA LIABILITY <input type="checkbox"/> OTHER THAN UMBRELLA FORM	NOT APPLICABLE			EACH OCCURRENCE AGGREGATE
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY THE PROPRIETOR/ PARTNERS/EXECUTIVE <input type="checkbox"/> INCL OFFICERS ARE <input type="checkbox"/> EXCL	NOT APPLICABLE			<input type="checkbox"/> WC STATUTORY LIMITS <input type="checkbox"/> OTHER EL EACH ACCIDENT EL DISEASE – POLICY LIMIT EL DISEASE – EA EMPLOYEE
A	OTHER ARCHITECTS & ENGINEERS PROFESSIONAL LIABILITY	BGH P1 280	07/31/2011	07/31/2012	EACH CLAIM AGGREGATE DEDUCTIBLE \$10,000,000 \$10,000,000 \$25,000

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL Provisions
 CERTIFICATE HOLDER

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL MAIL 30 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE

N.G. Williams & Associates Ltd.

N.G. WILLIAMS & ASSOCIATES LTD.

APPENDIX B

Photos

Forest Management



Foothills



Hidden Creek



Leave trees



Lost Creek Fire



Mature stand



Stand structure



Variable block size



Watercourse buffers

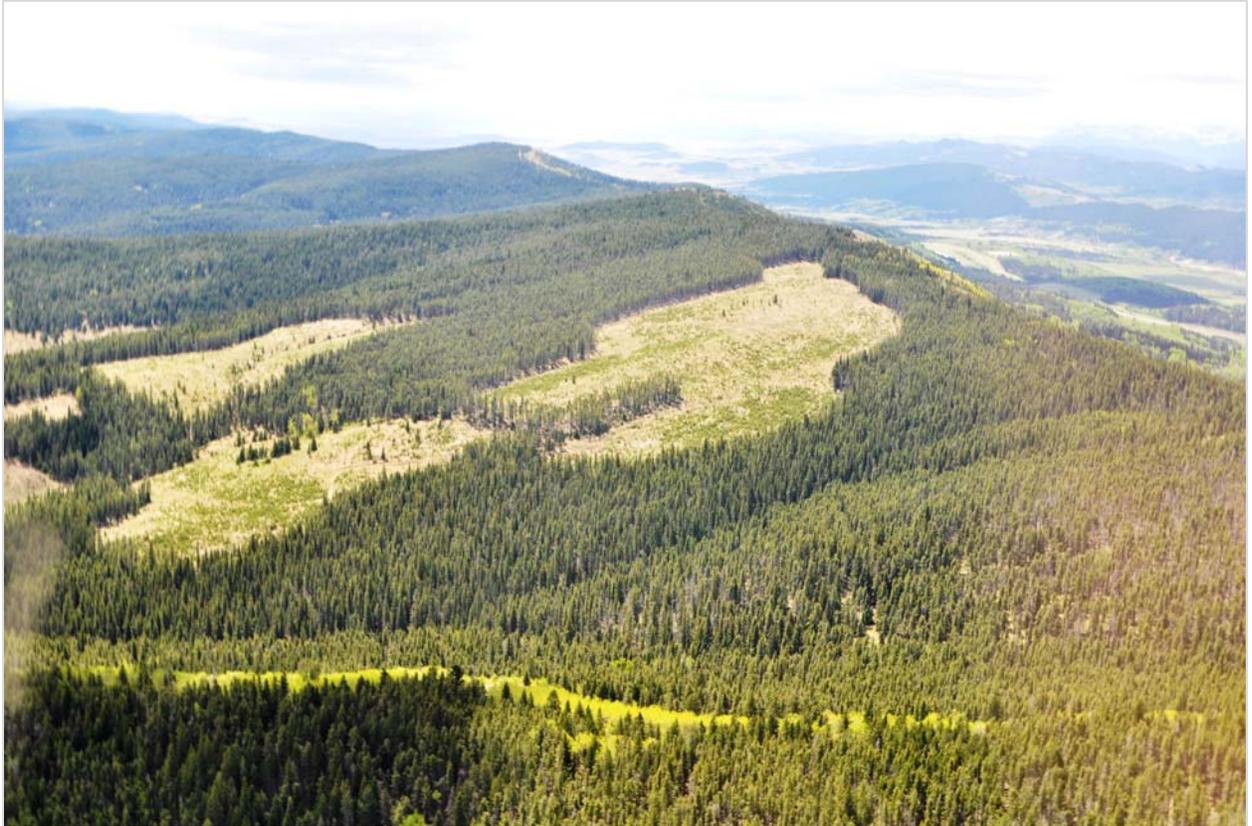
Operations



Stand structure



Recent harvesting



Regenerating stands



Rehabilitated roads



Stream crossing



Stream buffers and residual structure

Other Land Uses



ATV bridge



ATV trails



Drill pad

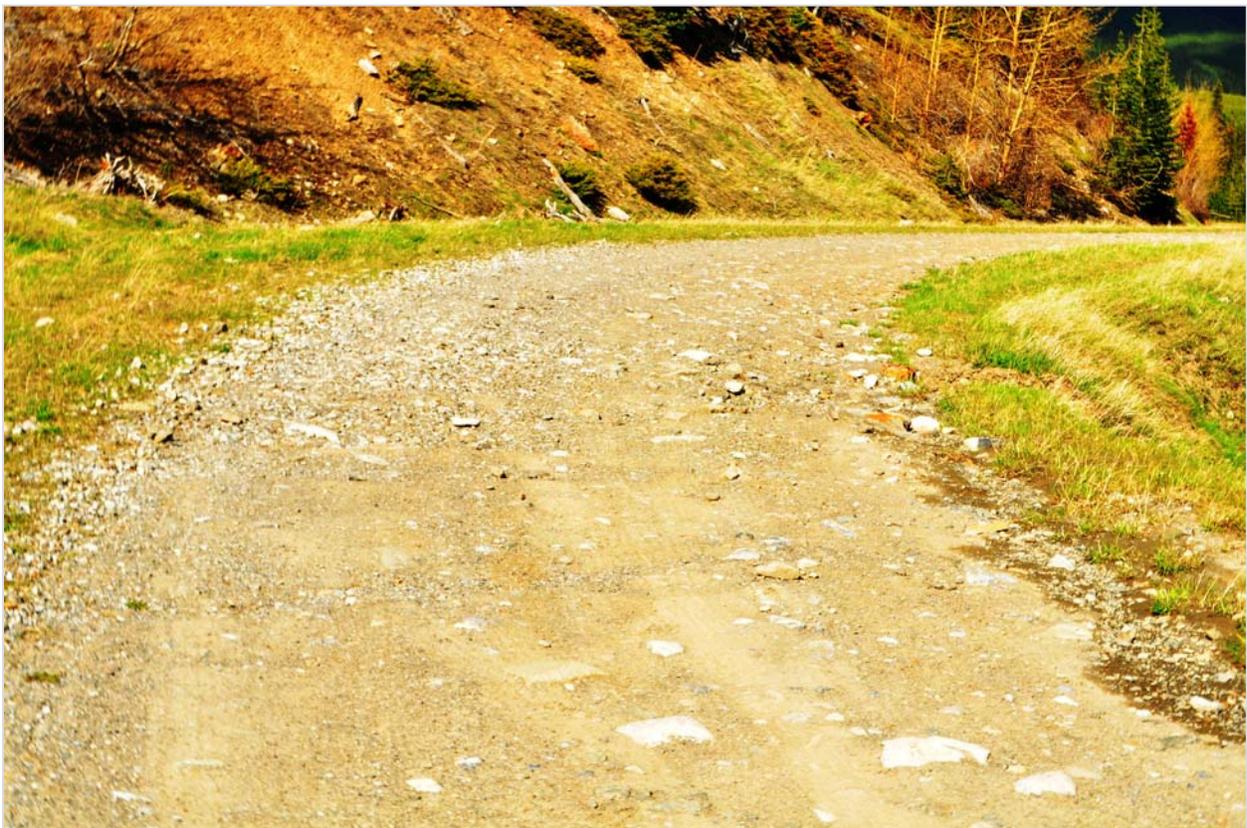


Random camping

Roads



Active road



Inactive road



Removed crossing



Stable road

Streams



Allison Creek



Small stream in recent harvesting



Unnamed tributary



Water source area

APPENDIX C

**Document Summary
of key processes and references
related to watershed management,
water supply and water quality**

Appendix C.1

Regional Plans and Higher Level Planning

1984 A policy for Resource Management on the Eastern Slopes

- Water Management–To ensure a **continuous supply** of **clean water** to meet the needs of Albertans and interprovincial users now and in the future (page 2).
- The highest priority in the overall management of the Eastern Slopes is placed on watershed management (page 4).
- Integrated Resource Planning System – ...decisions on the allocation and use of public lands and resources be made through an integrated resource planning system (page 4).
- Referral Process – ...requests are subjected to intensive referral procedures (page 5).
 - Regional Objectives – Watershed Management (page 6).
 1. To manage and develop natural resources in the region to maintain or increase the volume of water yield and natural timing of surface and sub-surface discharge.
 2. To manage headwaters in the region to maintain the recharge capabilities and protect critical fish habitat.
 3. To manage the South Saskatchewan River Basin for water supply stability.
- Integrated resource management (glossary definition)-A co-operative and comprehensive approach to the establishment of plans and the delivery of benefits from the resource base in an efficient and effective manner.

NOTE: Water management or watershed management is not defined.

1985 Castle River Sub-Regional IRP

(Note: IRPs have no legal status)

- Plan includes Resource Management Objectives and Guidelines for the Caster River Sub-region.
- Management emphasis is placed on watershed protection, recreation and tourism priorities. Watershed protection is stressed throughout the plan. Special emphasis is placed on areas of high watershed sensitivity and existing and potential site disturbance (page v).
- Objective – Preservation of watershed values and wildlife and fisheries habitat (page 1).
- Water and Watershed resource management objectives (page 16).
 - To recognize watershed protection as the highest priority in the Castle River area. To maintain and to improve water quality, quantity and flow regime for aquatic habitat, on stream and downstream users.
 - To prevent vegetation changes that could cause extreme fluctuations in stream flow resulting in erosion of channel materials, high sediment loads or property damage.
 - To maintain the water quality of lakes.
 - To prevent or minimize soil erosion associated with land-use activities.
 - To monitor and correct soil erosion and sedimentation problems as they occur.
- The Caste River Sub-Regional Integrated Resource Plan has been prepared to instate the watershed protection and recreation priorities for the Castle River area (page 20).
- Eastern Slope Policy Refinement regarding Watersheds (page 25).
 1. The Castle River area receives the highest annual precipitation and snowfall in the Eastern Slopes region. The Eastern Slopes Policy states watershed protection and management are the highest priorities. The Castle River plan subsequently ensures these priorities are recognized regardless of zoning. Watershed protection and management are key considerations in all zones.
 2. The Prime Protection Zone protects important high snow fall areas and slopes where soils are thin and vegetation is slow to recover from disturbances.
 3. Erosion potential is highest in alpine and sub-alpine areas where slopes are excessive and vegetation growth is slow and sensitive disturbance. Land-use activities will subsequently be concentrated along lower slopes and valleys where erosion potential is relatively lower but still of some concern. Increased involvement of watershed managers will be required in reviewing operating plans and resource development applications to ensure the plan's watershed management objectives are met.
- The Front Range creeks have significant trout fisheries. Critical Wildlife Zone designation of these valleys will help to ensure that watershed values in headwaters of these trout streams will be protected (page 27-7).

- Broad resource management guidelines (page 32-33).
 1. Alberta Environment will monitor water yield and quality in the planning area to ensure the maintenance of a high-quality water resource.
 2. Land or resource uses that may alter water quality, quantity and flow regime of surface water and groundwater should be brought to the attention of Alberta Environment so that adverse impacts on the water resource can be assessed and cooperatively minimized in conjunction with the Alberta Forest Service.
 3. Fluctuations in water yield and stream flow will be minimized. This will be achieved by adherence to operating restrictions on timber harvesting and existing forest protection policies.

1991 Crowsnest Corridor Local IRP

- Planning Background–To provide a full range of multiple use activities managed to maintain high watershed quality (page 1).
- Watershed Objective (page 19).
 1. To maintain or enhance water quality where possible.
 2. To maintain or improve habitat for the existing fishery.
 - Guidelines – AB Forestry...will consult with AB Environment on land and resource uses that affect water quality or quantity (page 19 -4).

1987 Livingstone-Porcupine Hills Sub-Regional IRP

- Water and Watershed (page 9).
 1. To maintain and improve water quality, quantity and flow regime for aquatic habitat and onstream and downstream users.
 2. To prevent vegetation changes that could cause extreme fluctuations in streamflow resulting in erosion of channel materials high sediment loads, property damage or water supply problems.
 3. To prevent or minimize soil erosion occurrences associated with land use activities.
- Broad Resource Management Guidelines.
 1. The Livingstone-Porcupine Hills planning area will be included as a portion of a watershed management plan to be prepared for the Bow/Crow Forest.
 2. Forest management activities including timber harvesting and land clearing for range improvement will be conducted in a manner conducive to the maintenance or improvement of water yields. The use of tested procedures to predict water yield changes resulting from vegetation changes will guide resource management programming.

3. Soil erosion associated with land use activities, throughout the planning area, will be addressed through ground rules established for resource development and the internal referral systems of the provincial government throughout the planning area regardless of zoning. Watershed protection and management are key considerations in all zones.
- Implications pertaining to the entire planning area (page 31).
 1. Watershed protection and management are recognized as priorities throughout the planning area regardless of zoning. Watershed protection and management are key considerations in all zones.
 2. Erosion potential is highest in alpine and sub-alpine areas where slopes are excessive and vegetation growth is slow and sensitive to disturbance. Such areas have been designated Zone 1 where many land uses are not permitted because of terrain sensitivity. Land use activities will subsequently be concentrated along lower slopes and valleys where erosion potential is relatively lower but still of some concern. Increased involvement of watershed managers will be required in reviewing operating plans and resource development applications to ensure watershed objectives are met.
 - Resource Management Areas (7 areas in total) – Specific Resource Management Objectives for Individual Areas.

Livingstone – Upper Oldman (Area A)

- Resource Management Objectives
 1. The broad watershed management objectives apply.
- Resource Management Guideline
 1. Reclamation projects proposed for the Ridge creek, Beaver Creek and Deep Creek will be evaluated and undertaken subject to reclamation policies and funding according to availability and provincial priorities. Access in the Hidden Creek area will be reclaimed following the timber harvesting operation in the area.

West Livingstone (Area B)

- Resource Management Objectives
 1. The broad watershed management objectives apply.
- Resource Management Guideline
 1. The broad watershed management guidelines apply.

East Livingstone (Area C)

- Resource Management Objectives
 1. The broad watershed management objectives apply.
- Resource Management Guideline

1. The reclamation projects proposed for the Ernst/Todd Creek and Beaver Creek areas will be evaluated and undertaken subject to reclamation policies and funding according to availability and provincial priorities.

Willow Creek – Lower Oldman (Area D)

- Resource Management Objectives
 1. To maintain a high quality water supply for onstream and downstream users.
 2. To minimize soil erosion and sedimentation from activities located near streambanks.
- Resource Management Guideline
 1. The location of resource use activities adjacent to streambanks will be regulated in accordance with normal operating conditions.

North Porcupine Hills (Area E)

- Resource Management Objectives
 1. To maintain a reliable, high quality water supply for onstream and downstream users.
- Resource Management Guideline
 1. The Alberta Forest Service, Fish and Wildlife Division, Alberta Environment, and Alberta Recreation and Parks will examine the feasibility of small water impoundments in the North Porcupine Hills to sustain a recreational fishery, provide a ready water source for forest fire suppression, domestic grazing and to augment downstream water use.

South Porcupine Hill (Area F)

- Resource Management Objective
 1. To maintain a reliable, high quality water supply for onstream and downstream users.
- Resource Management Guideline
 1. The Alberta Forest Service, Fish and Wildlife Division, Alberta Environment, and Alberta Recreation and Parks will examine the feasibility of small water impoundments in the Porcupine Hills to sustain a recreational fishery, provide a ready water source for forest fire suppression, domestic grazing and to augment downstream water use.

Crowsnest Watershed (Area G)

- The primary intent of the Crowsnest Watershed resource management area is to provide a full range of multiple use activities managed to maintain watershed quality, and to recognize the social and economic needs of the Crowsnest pass.

2008 Land Use Framework

- Strategy 3 (page 3): Cumulative effects management will be used at the regional level to manage the impacts of development on land, water and air. Our watersheds, airsheds and landscapes have a finite carrying capacity. Alberta's system for assessing the environmental impacts of new developments has usually been done on a project-by-project basis. This approach worked at lower levels of development activity. However, it did not address the combined or cumulative effects of multiple developments taking place over time. A cumulative effects management approach will be used in regional plans to manage the combined impacts of existing and new activities within the region.
- Strategy 4: Develop a strategy for conservation and stewardship on private and public lands. Clean water and air, healthy habitat and riparian areas, abundant wild species and fisheries are all "public goods" that Albertans enjoy and value. The costs of supplying these goods on private lands are left largely on the shoulders—and pocketbooks—of our ranchers and farmers. Public lands that are managed for a variety of purposes also supply these goods. If Albertans value these landscapes and the benefits they provide to all of us, we have to find new ways to share the costs of conserving them. To do this, the Government of Alberta will develop new policy instruments to encourage stewardship and conservation on private and public lands.
- Public lands in the Green Area were to be managed primarily for forest production, watershed protection, fish and wildlife management, and recreation (page 6).
- The Eastern Slopes Policy identified watershed integrity as the highest priority use for this region of the province, followed by public recreation and tourism. It stated that the management of renewable resources would be the priority, but that non-renewable resource development – primarily oil and gas – would be encouraged in areas where it was compatible.
- The policy also mandated detailed subregional and local integrated resource management plans (IRPs) for its subregions. These IRPs included multiple objectives – timber, minerals and agriculture in addition to watershed, wildlife, fisheries, and recreation – but noted that "not all objectives will necessarily be achieved in all areas."
- It complements the province's water and air policies – Water for Life (2003), the Clean Air Strategy for Alberta (1991) both of which have been updated, and Alberta's 2008 Climate Change Strategy. What uses are permitted on land – or more precisely, how they are done – clearly impact adjacent watersheds and airsheds (page 7).
- Through these consultations, Albertans told us that they want the following improvements (page 8): Integration and co-ordination of provincial policies governing air, water and land.
- Supported by a land stewardship ethic (page 16) – This means accepting the responsibility to ensure that our land-use decisions are mindful of consequences for future generations. This responsibility applies to urban planning, forestry and agriculture, habitat and wildlife, watersheds and riparian areas, and all other decisions affecting land use. Where appropriate, market mechanisms will be used to promote stewardship practices.
- The regional plan will ensure that planning for land use, water and air quality are aligned with each other (page 23).

2011 South Saskatchewan Regional Advisory Council Advice

- Water (Page 2) – Develop options for improving source water protection (e.g. environmental setbacks, wetland protection or restoration and rehabilitation of degraded sources) and other management means to protect watershed integrity, including watershed headwaters.
- Strategic principles (page 7) – Plan for water – It is essential to determine the feasibility of all water conservation, supply and storage options. Because the supply and quality of water is so important, demand is likely to increase, and supply may be challenged in the region under any scenario. Headwater and source water protection and the need to manage land use to sustain water production and water quality are critically important.
- Forestry (page 14) – Forestry should contribute to the management of wildlife habitat, forest fuels and water resources in addition to supplying fibre.
 - Recommendations
 1. Implement an integrated planning process that reduces redundancy and incorporates the management of forestry with water production, biodiversity, recreation and tourism and energy production.
 2. Support industry innovations that reduce water use, land disturbance and carbon footprint, and that work towards a zero-waste goal.
- Water management (page 22)
 - Primary issues – Source water is critical to the security of water supply and the health of aquatic ecosystems. Development and extreme natural events, such as drought, wildfire, disease and insect outbreaks, affect the region’s headwaters and the sustainability of water quality and quantity.
 - Objectives
 1. To protect source waters through the maintenance of watershed integrity and ecosystem function.
 2. To achieve watershed integrity through the implementation of provincially-approved: watershed management plans; water management plans; and environmental management frameworks.
 3. To protect source water from pollution to ensure the ability to derive good quality water for people and other uses.
 4. To recognize and manage land use for the headwater values where rivers and streams and groundwater originate. Especially in critically sensitive areas.
 5. To support watershed integrity by maintaining, developing and, where possible, restoring wetlands and riparian areas in appropriate areas.
 6. To maintain, where reasonably possible, the health and function of aquatic ecosystems affected by disturbance, erosion, invasive species and contamination.
 7. To maintain and restore, where reasonably possible, riparian areas to support watershed integrity.

8. To maintain the health and function of riparian areas affected by disturbance, erosion, invasive species and contamination.
- Recommendations
 1. Take measures to ensure source water quality and quantity are sustained in coordination with measures taken concerning groundwater, riparian areas, wetlands, aquatic biodiversity and headwaters. The priority is to ensure areas that are currently in a desired condition are kept that way.
 2. Using a risk management approach, identify and facilitate the implementation of practices that reduce point and non-point sources of water pollution.
 3. Facilitate the co-operative development of watershed management plans and support their implementation.
 4. Develop a mechanism for regular monitoring, reporting and public engagement.
 - Headwaters (page 25)
 1. Manage land in the headwaters (e.g., Eastern Slopes and Cypress Hills areas) so that maintaining watershed integrity is given highest priority by considering impacts of land disturbance in management decisions.
 - Manage land uses on their compatibility to ensure the maintenance of watershed integrity and function.
 2. Manage the cumulative effects of activities in headwaters so the volume and timing of water quantity and water quality is maintained or enhanced.
 3. Require best management practices by land users in headwater areas, and expand ongoing public engagement and education programs.
 4. Integrate planning for access and resource management in headwater areas with watershed management plans, objectives and values, and ensure effective enforcement. Watershed planning and advisory councils and watershed stewardship groups should be actively involved in developing and implementing watershed plans.
 - Riparian (page 26)
 1. Develop new regional riparian area management policies and strategies.
 2. Maintain and, to the greatest degree possible, restore riparian function. Filling in the flood plains is not an acceptable practice.
 3. Encourage improved stewardship by increasing education and outreach, and providing stewardship opportunities.
 4. Develop and encourage practices that restore native plant and animal communities by reducing the spread of noxious and restrictive species.

5. Evaluate and improve existing regional co-ordination efforts among government, private organizations and individuals for ensuring protection and maintenance of riparian function.
 6. Improve our mapping and knowledge of riparian areas.
 7. Include riparian restoration or retention as part of a broader program to develop an ecological goods and services revenue stream.
- Recreation and Tourism (page 43)
 - Objective (6.4.4) To manage recreation in the region to reduce, minimize and mitigate, where feasible, negative impacts on land, water and biodiversity while maintaining safe, respectful and enjoyable opportunities.
 - Land-use Direction and Management Intent (page 52) – In all cases, land-use decisions must meet water security objectives.

2009 Water for Life, a renewal

- Water for Life (page 3): Alberta's Strategy for Sustainability has been the vehicle for managing Alberta's water resources since 2003. In this renewed strategy, the Government of Alberta not only continues to build on the good work already undertaken, but also reaffirms its commitment to the Water for Life approach for the wise management of Alberta's water quantity and quality for the benefit of Albertans now and in the future.
- Principles
 1. Alberta's water resources must be managed within the capacity of individual watersheds.
 2. Citizens, communities, industry and government must share responsibility for water management in Alberta and work together to improve conditions within their local watershed.
 3. Knowledge of Alberta's water supply and quality is the foundation for effective decision-making.
 4. Healthy aquatic ecosystems are vital to a high quality of life for Albertans and must be preserved.
 5. Best available practices and market-based tools will be used in order to maintain flexible and adaptive water management.
 6. Finally, a new principle has been added – Water for Life will be integrated into other policies and plans, such as Land-use Framework planning, ensuring better resource management integration.
- Goals
 1. Albertans are assured that Alberta's aquatic ecosystems are maintained and protected.
 2. Albertans will be assured that water is managed effectively to support sustainable economic development.

3. Key Direction – All sectors understand how their behaviours impact water quality, quantity and the health of aquatic ecosystems, adopt a “water conservation ethic” and take action.
- Recommendations
 1. Address aquatic ecosystem degradation.
 2. Integrate water and land management.
 3. Create, enhance, and use innovative tools and best practices.
 4. Clarify roles, responsibilities, and accountabilities.
 5. Enhance data collection, analysis, and reporting.
 6. Expand public awareness programs to build shared commitment.
 - Direction
 1. We need to ensure reliable water resources, promote the health and integrity of our aquatic ecosystems, and safeguard Albertans from risks associated with water quality and quantity.
 - Key Actions
 1. Update water quality programs to support source protection information and planning.
 2. Work with Watershed Planning and Advisory Councils to incorporate drinking water source protection into watershed planning.
 3. Develop information on sector best management practices.
 4. Establish a data management support and reporting system integrated with Land-use Framework and cumulative effects information systems Integrate watershed management with the Government of Alberta’s Land-use Framework regional planning and cumulative effects management system.
 5. Develop a watershed management planning framework and a guidebook for implementation.
 6. Review and update legislation as required.
 7. Develop core indicators and reporting tools for watershed and regional planning.
 8. Develop watershed management plans for the Milk, Oldman, South Saskatchewan, Bow, Red Deer, North Saskatchewan, Battle, Cold Lake-Beaver, and Lesser Slave Lake.
 9. Integrate priority water management frameworks into watershed management plans (e.g. Industrial Heartland and mineable oil sands).
 10. Complete and implement watershed management plans for all major watersheds.
 11. Assess the effectiveness of watershed management planning system achieving desired outcomes.

Appendix C.2

Forest Planning and Regulations

1997 Forest Act

- No information regarding watershed management, water supply or quality.

1973 Timber Management Regulation

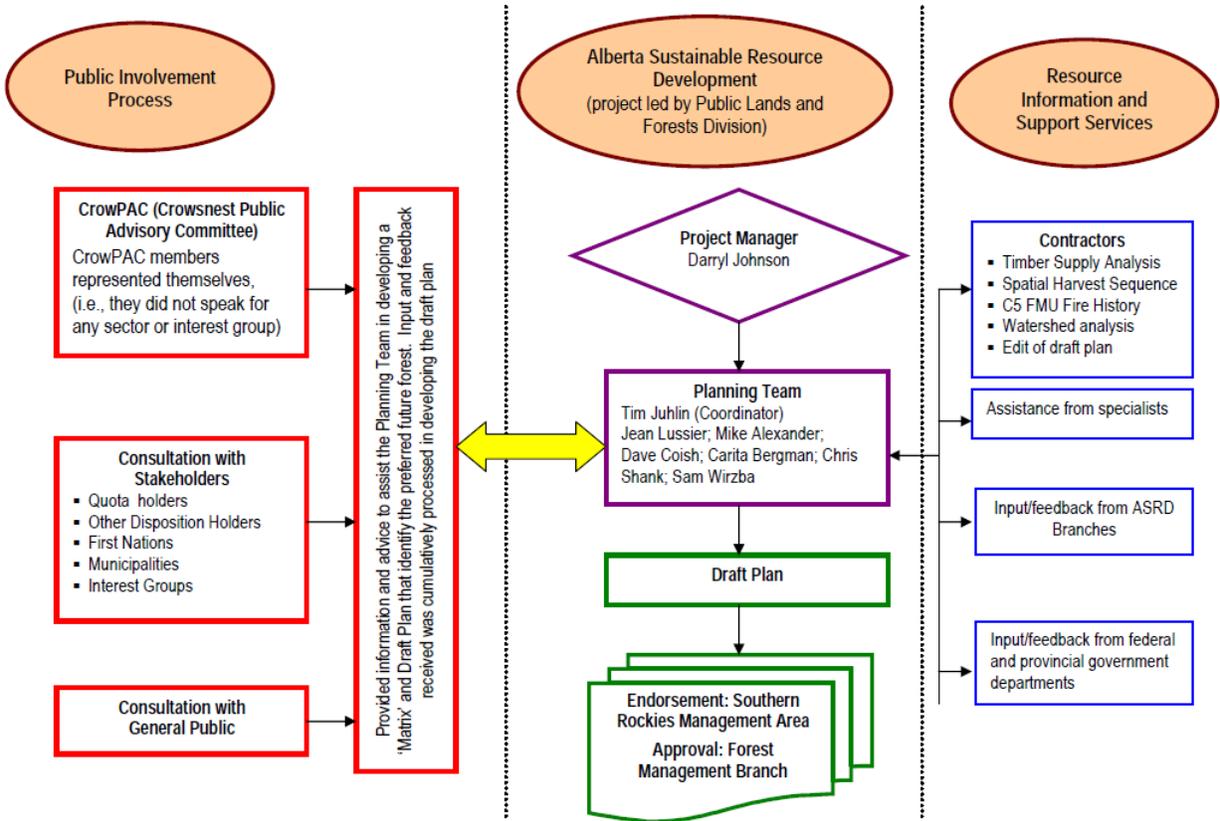
- Sec. 100(1) Every person who harvests timber on public land shall:
 - (i) ensure that
 - (i) the disposal of any refuse or debris, or
 - (ii) the location of any structure or excavationis in a place and is done in a manner that does not impede the natural flow of water in any watercourse or contaminate or pollute any river, stream, lake, well or other body or source of water.
- Sec. 142.8 A person who conducts reforestation on public land shall:
 - (e) ensure that
 - (i) the disposal of any refuse or debris, or
 - (ii) the location of any structure or excavation is in a place and is done in a manner that does not impede
 - the natural flow of water in any watercourse or contaminate or pollute any river, stream, lake, well or other body or source of water.
- Sec. 146 A person clearing land for industrial use shall take all necessary precautions to minimize soil erosion and to avoid pollution of waters and waterways and shall keep records of all timber produced, sold or transported.

2010 (Revised) C5 Forest Management Plan 2006-2026 (20 year plan)

- The C5 FMP conforms with direction contained in the Alberta Forest Legacy. Policies, standards and guidelines and requirements adopted by ESRD which pertain to forest management planning, including Alberta's new Forest Management Planning Standard. Wherever possible the Z809-02 Sustainable Forest Management: Requirements and Guidance (CSA 2002) were followed. At this time the Government of Alberta will not pursue certification of the C5 forest at this time.
- Forest Management in AB (Section 1.3.4, page 16) describes the three tenures systems used in Alberta (Timber Permits, Quotas and Fore Management Agreements).

- Figure 1 Organizational structure adopted in developing the C5 FMP (page 18):

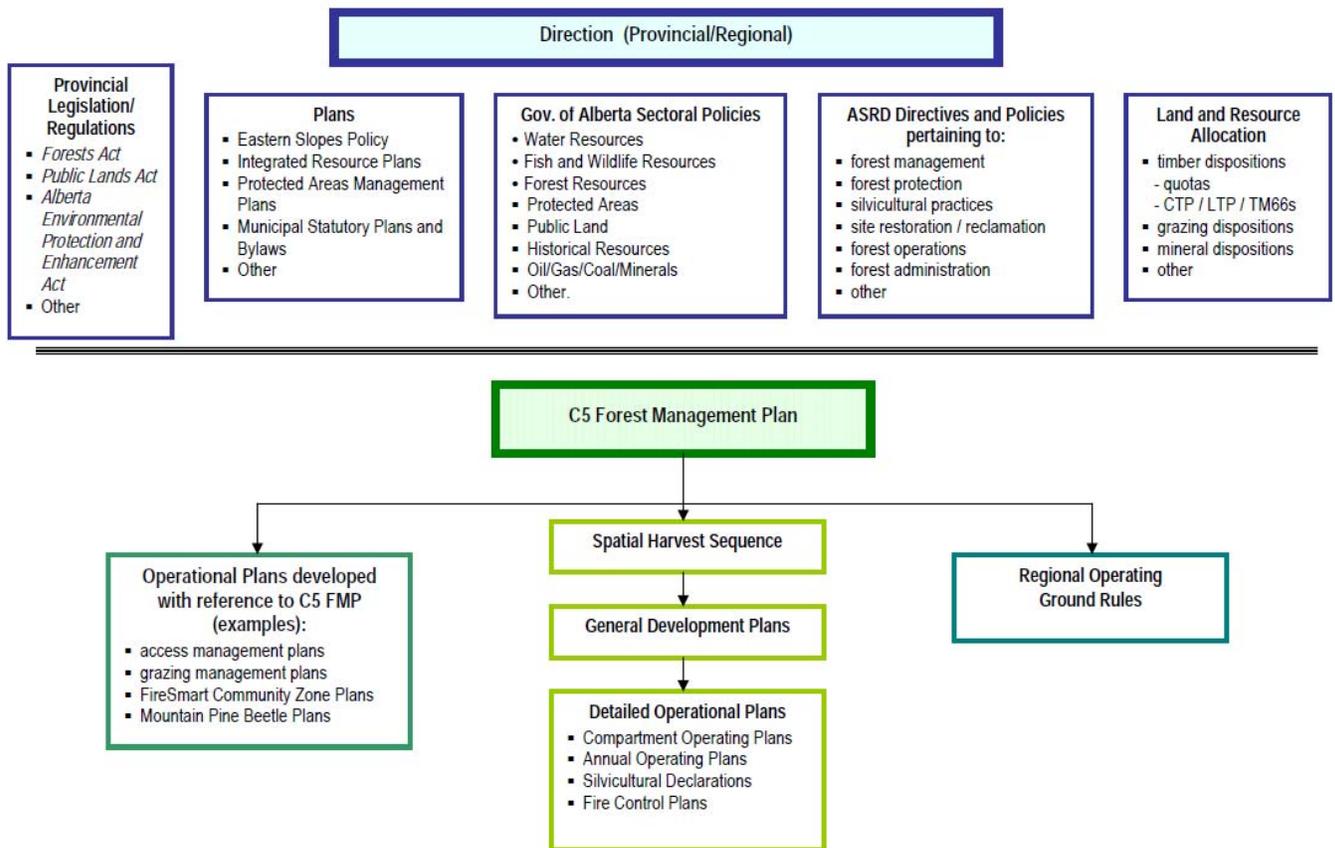
Figure 1. Organizational structure adopted in developing the C5 Forest Management Plan.



- The C5 FMU is not contained within a provincial FMA area. As a result, ESRD has the mandate for managing timber resources in this forest management unit. Most of the ASC is allocated through timber quotas, with quota holders allocated a specific volume of wood as a percentage of the available AAC. The remaining portion is allocated through the competitive timber permit program through a bid process and the Community Timber Program to local community manufacturers and loggers (page 24).
- Refer to 3.1.1 (page 27) Provincial Direction regarding key instruments and direction that affect decision making on the C5 forest.

- Figure 2 (page 29). Linkages between the C5 FMP and provincial/regional plans, policies and operation activities:

Figure 2. Linkages between the C5 FMP and provincial/regional plans, policies and operational activities.



- Designated Areas and Resource management Units (page 30).
 - Rocky Mtns Forest Reserve – created in 1910 to conserve critical headwaters of North and South Saskatchewan River basins and is situated in Alberta’s Green Area. The Green Area is generally managed under a multiple-use philosophy for fish, wildlife and watershed protection, timber and minerals production, recreation, domestic livestock grazing and resource conservation.
 - Protected Areas – Seven protected areas currently exist with the C5 FMU.
 - Provincial Recreation Areas – Twelve situated in C5 FMU.
 - Public Land Use Zones (PLUZs) – Two PLUZs exist fully in the C5 (Castle SMU and Allison/Chinook).
 - Additional Resource management units - mechanisms to achieve provincial objectives include IRPs, WMU, Grazing allotment, watershed management units, etc.
 - C5 FMP Environmental/Ecological Values – Conserve soil, water, forest and rangeland resources and the wildlife habitat they provide (page 40).
 - C5 FMP Economic Values – Clean water and air (page 42).

- Detailed Forest Management Direction (page 43) – section provides detailed direction in achieving the desired future forest with C5 FMU.
- Refer to C5 Forest Management Objectives Table 6 (page 44).
 - To minimize losses to human life, communities, soil, watersheds, natural resources and infrastructure from wildfire (FMP Unique Number 15).
 - To ensure that all industrial practices are conducted in a manner that places a priority on the protection of water quality (FMP Unique Number 23).
 - To manage forest cover in a manner that places a priority on the conservation and protection of watersheds (FMP Unique Number 24).
- CRITERION 1 – Conservation Biodiversity (page 48).
 - Objective 3: To minimize the impacts of motorized access (FMP Unique Number 3).
 - INDICATOR = Open road density values.
 - TARGET = Open road density values for chosen a management unit.
 - MONITORING = see Objective 32, Criterion 5.
- CRITERION 2 – Maintenance and enhancement of forest ecosystem condition and productivity (page 85).
 - Objective 15: To minimize losses to human life, communities, soil, watersheds, natural resources and infrastructure from wildfire.
 - INDICATOR: Percentage reduction in Fire Behaviour Potential across the defined forest area (DFA) now and over planning horizon.
 - TARGET: Reporting on reductions in area (ha) of extreme and high Fire Behavior Potential rating categories by X% across the DFA.
 - MONITORING: Forest Protection Division will maintain yearly fire statistics for the C5 FMU.
 - Objective 16: To minimize the impacts of pests (i.e., insects and disease, which have the ability to kill healthy trees (page 93).
 - INDICATOR: Aerial extent of trees killed each year by mountain pine beetle, spruce beetle and Douglas-fir beetle and other pests.
 - TARGET: Contain pests within 1 km radius of known outbreak area.
 - MONITORING: ESRD shall actively track pests. Stewardship reports will provide update on pests and actions.

- Objective 17: To maintain the long-term sustainability of the landbase by managing those forest health agents that can reduce growth, alter form, or kill trees after several years of infection/attack (page 96).
 - INDICATOR = Change in forest health before and after harvesting...to determine pest spread.
 - TARGET = Decrease (or no increase) in forest health incidence after harvesting and throughout second rotation.
 - MONITORING = Ground and aerial monitoring and info will continue...
- CRITERION 3 – Conservation of soil and water resources (page 104).
 - Elements
 - 3.1 Soil quality and quantity – Conserve soil resources by maintaining soil quality and quantity (CSA SFM Element 3.1).
 - 3.2 Water quality and quantity – Conserve water resources by maintaining water quality and quantity (CSA SFM Element 3.2).
 - Values: Water is a resource of great importance.
 - Objective 22: Minimize soil erosion and slope failure.
 - INDICATOR: a) conformity with operating ground rules (OGRs), b) Erosion control and reclamation strategies in place.
 - TARGET: a) Zero erosion or slumping events from roads or harvesting; b) Presence of erosion control and reclamation strategies in approved AOPs. Acceptable variance is zero.
 - MONITORING:
 - ESRD staff inspections;
 - Quota holder self-reporting;
 - Should an erosion or slope failure event take place, the operator assuming responsibility will need to monitor the effects (i.e. success) of any remedial actions that was undertaken.
 - Objective 23: To ensure all forest practices are conducted in a manner that places a priority on the protection of water resources.
 - INDICATOR: a) Degrees of compliance with federal and provincial regulations, standards, and policies pertaining to road construction and maintenance, stream crossings and retention buffers, b) Adverse changes to fish habitat.
 - TARGET: 100% adherence to requirements; no HADDs from operations unless approved.

- MONITORING: ESRD to do one audit per disposition holder per 5 years; Timber disposition holders to complete one self-inspection where agreements exist with ESRD to do so.
- Objective 24: To manage forest cover in a manner that places a priority on the conservation and protection of watersheds.
 - INDICATOR: Effective disturbance area (as expressed in ECA AB); compliance with stream crossing requirements; integrity of source areas, watercourses and water bodies.
 - TARGET: 100% compliance with provincial stream crossing requirements; protect all hydrological features (e.g. wetlands springs, streams, rivers, lakes, groundwater/water table) from disturbance-related impacts.
 - MONITORING: Timber disposition holders are to report on their conformity with the spatial harvest sequence which is based on ECA AB outputs; Five-year stewardship reports shall identify the degree to which the spatial harvesting sequence was followed.
- CRITERION 5 – Multiple benefits of forest to society
 - Elements
 - Timber and Non-Timber Benefits – Manage the forest sustainably to produce an acceptable and feasible mix of both timber and non-timber benefits.
 - Communities and Sustainability – Contribute to the sustainability of communities by providing diverse opportunities to derive benefits from forests and to participate in their use/management.

Objectives that integrate land and resource management between various sectors

Integrated land and resource management continues to be a fundamental principle of the provincial government, and is recognized in the provincial Timber Harvest Planning and Operating Ground Rules.

- Objective 35: To integrate recreational activities with forest management practices.
 - Focus primarily on recreational activities within Allison/Chinook PLUZ and bordering affected lands within 1 km of the west and northwest.
- Objective 36: To integrate rangeland management activities with forest management practices such that long-term relationships between grazing disposition holders and forest operators are developed to sustain fiber and forage resources
 - Integrated land and resource management continues to be a fundamental principle of the provincial government, and is recognized in the provincial *Timber Harvest Planning and Operating Ground Rules*.
- Objective 38: To integrate energy/mineral (exploration and development) activities with forest management practices.
 - Integrated land and resource management continues to be a fundamental principle of the provincial government, and is recognized in the provincial Timber Harvest Planning and Operating Ground Rules.
 - INDICATOR: a) Integrated access development plan; b) Number of action requests issued by the Minister's office of ESRD.
 - TARGET: a) Complete an access development plan for the C5 FMU; b) ESRD managers and staff shall complete all assigned Action Requests.
 - MONITORING: Concerns between the two sectors and any actions taken to mitigate concerns will be summarized in annual summaries and stewardship reports; ESRD staff shall complete AOP checklists to ensure that energy sector concerns have been addressed.
- Objective 39: To integrate the commercial recreation and tourism sectors with forest management practices.

Timber Supply

- Preferred Forest Management Strategy (page 186).
 - High probability of MPB infestation; therefore, forest management highly influenced by MPB.
 - Forest Development is focused on high susceptibility pine stands.
 - Headwater basins were deferred due to past heavy logging.
 - Watertight Solutions retained to complete analysis of hydrologic effects of proposed harvest sequence.

- ECA Alberta was completed for the FMU.
- WRENS-AB hydrologic model was applied to 7 sub-basins in Crowsnest River watershed.
- Refer also to App 6 for modeling results.
- For impacts of key objectives in the FMU on the TSA see Table 22, page 205.
- AAC = 120% in 2005-2026; 90% after 2026:
 - as a precautionary measure, and based on advice from forest health experts dealing with the MPB epidemics in BC, the decision was made to choose an increased harvest level with a focus on pine removal (page 194).

Performance Monitoring

Alberta's Forest Management Assessment System – Area Forest Stewardship Report

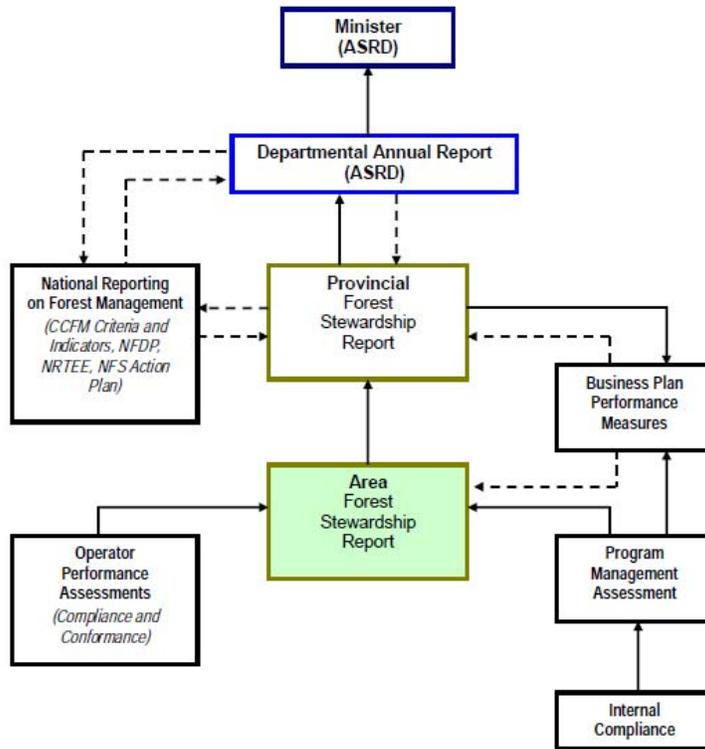


Figure 9. Alberta's Forest Management Assessment System.

- Operating ground rules – new regional Timber Harvesting and Operating Ground Rules will be developed for C5 FMU (Refer to Spray Lakes OGRs (2011)).

- Access planning compared to Spatial Harvesting Sequence to (page 213).
 - Forecast industrial access requirements.
 - Identify and coordinate key industrial access routes in the FMU.
 - Identify preferred road corridor locations to access future timber stands.
- Monitoring (page 214).
 - Monitoring will occur at various temporal and spatial scales.
 - As part of operational activities (i.e. during field inspections, when completing resource inventories, when preparing General Development Plans, Compartment Plans and Annual Operating Plans, when completing Silvicultural Reports, etc.).
 - As part of administrative reporting activities (i.e. ARIS, LFPD Internal monitoring protocols, Land Use System).
 - As part of normal agency activities.
 - More specific monitoring requirements may need to be developed in the future for several objectives.
 - Stewardship reporting completed every 5 years to document progress made in fulfilling the plan's objectives etc. (page 214).
- Adaptive Management for Continual Improvement (page 215).
 - An **active adaptive management system** that will be employed for the C5 FMP.
 - Refer to Figure page 216 for C5 Adaptive Management Plan.
 - See definitions regarding active adaptive management – <http://www.for.gov.bc.ca/hfp/amhome/Admin/index.htm#passiveactive>

2006 Appendix 6C. Hydrological Effects of the Preferred Forest Management Scenario in the C5 Forest Management Unit

ECA-AB (Excerpts from Report)

Water Yield (page 14)

Simulated maximum increases in water yield for all except one watershed were very low with values ranging from 1-4% in 10 watersheds, and less than 1% in 8 watersheds (Table 4). These values in practical terms are close to zero indicating an almost nil response to harvesting.

The only exception to the above was Beaver Creek where the simulated water yield increase was 13.8% (11.1 mm) (Table 4, Figure 6). The larger increase was largely due to low level of water yield from this watershed, which is more of a prairie than forest environment. The

The simulated increases for all watersheds were also less than the informal “15%” rule often cited as a limit on increases in water yields. Adoption of a limit for increased water flows is a difficult task because of the high variability of annual and peak flows, and the absence of definitive data that links the effects of changes in flows to downstream flooding and changes in aquatic habitats. The “15%” rule was initially suggested (by J. Taggart, *Alberta Environment*) as the amount of water yield increase that could “be added to a unit hydrograph³ (for a watershed) without an undue increase in peak flow” (Swanson 2002).

Summary

The results from this analysis indicate that projected yield increases were very low, with absolute values ranging from less than 1 mm to a maximum of 11 mm. Percentages increases showed a similar trend with values of less than 1% up to 13.8%. It's likely that the small increases (<1%) in generated runoff will be retained as soil moisture or go to groundwater and not to the stream channel. However, if all extra water were routed to the stream channel, the increase in yields for all nineteen watersheds would not be significant and likely undetectable using standard hydrometric techniques.

In conclusion, the simulated increases in annual water yield for all watersheds were small, not significantly different from long term average flows, and would be extremely difficult to detect by normal hydrometric methods.

WRENS (Excerpts from Report)

Summary

The results of this analysis indicated that simulated increases in water yield were very low, ranging for most watershed from less than 1% to 3.5% (2.5-13 mm). It was anticipated that the effects of forest harvesting on these small sub-basins would be greater than for the large watersheds analyzed with ECA-AB. Previous experience has found that simulated water yield increases on small to medium watersheds (50-100 km²) or less are often greater than for the same amount of harvesting on a large watershed (>100km²).

In conclusion, analysis show that the simulated maximum increases in annual yield and maximum daily flows for the Preferred C5 Scenario were low and should fall with the range of natural variability and in practical terms are not detectable by direct measurement using standard hydrometric techniques.

The magnitude of water yield increases generated by forest harvesting is a function of the extent of harvesting and timing of sequential harvests in a watershed. Experience in

conducting hydrologic assessments with WRENSS (Watertight Solutions Ltd unpublished reports) indicates that simulated water yield increases for first harvest entries into watersheds are usually less than 15%-20%, where the percent of harvesting in watersheds ranged from 10% to 35%.

Reliability of Results

The results from both models are still considered to be reasonable even with these data problems. It should be remembered that the WRENSS methodology was developed to provide managers with a tool to assess the potential for change in water yield and not to provide a highly precise prediction. Few models that describe or simulate natural process are capable of doing this. The advantage of both of the models is that data is usually available and they are easy to use. The results from the WRENSS methodology should be interpreted as estimates of relative change and described or thought of in terms of small, medium, and large increases, with small to medium as acceptable and large as questionable or unacceptable.

Water Quality Impacts

Increased peak flows could affect water quality by increasing sediment loads through scouring of streambeds and stream banks. As mentioned earlier, observations by Verry (2005), Guillemette et al (2005) and others suggest that a 50% increase in bankfull discharge has the potential to change stream morphology. Verry noted that increases to bankfull discharge associated with conversion of forest to agriculture in the Midwestern United States reduced the sinuosity and aquatic habitat of streams. Such changes occurred over a 60-100 year period.

It is doubtful that such changes would occur as the result of forest management, where forest cover is retained over the long run. However, a limit of some kind is probably warranted to minimize the potential for less dramatic effects of forest cover removal on peak flows. Limits or guidelines should be based on some measure or index of "natural" variability of flows for forest regions in the province (e.g. southern and northern foothills, and boreal regions).

Overall Summary and Conclusions

The results from ECA-AB and WRENSS indicate that simulated increases in annual yield, ECA, and peak flows based on the proposed harvesting plan are likely not significant, and well below the detection limit using standard hydrometric techniques. As a result, the simulated increases in annual water yield and maximum daily flows should not be a significant threat to aquatic habitats or fauna.

The protection and maintenance of water quality is best protected by focusing on the design and construction of road-stream crossings, prompt revegetation and erosion control of disturbed sites and stream crossings, monitoring of water quality at disturbed sites or watersheds and periodic inspections to determine effectiveness of management practices.

In conclusion it is recommended that work be undertaken to develop guidelines to minimize potentially adverse effects of water yield and peak flow increases. Such information is needed by government and forest industry by the requirements in the current forest management planning manual, which specifies the prediction of water yield increases in detailed forest management plans. Guidelines should be based on regional climatic and hydrologic differences within the Province (e.g. foothills versus boreal). Guidelines or limits would be scaled to reflect regional (e.g. forest management units) annual water yield and peak flows with respect to local variability, as currently defined by available hydro-meteorological data. Such guidelines to be designed to recognize existing methods used to estimate/simulate hydrologic changes. It is anticipated that any guidelines developed will be modified as better information and methods evolve. Special attention should be given to testing ECA or other similar measures as a parameter that can be used to monitor potential impacts and in reporting/assessments in detailed forest management plans.

2011 Spray Lake Sawmills and C5 Operating Ground Rules

- Grounds results (page 1) – These are definitive statements of the desired results to be achieved and a clear indication of what is expected. **The ground rules shall be relevant, measurable, understandable and achievable.**

- 3.1 Planning Process (page 2)

The planning process includes five main components:

1. **Approved Forest Management Plan (FMP)**

- Spatial Harvest Sequence (SHS) for first two 10-year periods
- Approved Long Term Road Network

2. **Compartment Assessment (CA)** – A CA shall be required when information or major issues are identified that in Alberta's opinion, have not been addressed in the FMP. In the event that the SHS is deemed by Alberta to be inappropriate due to a significant change in circumstances since the approval of the FMP, a compartment assessment describing current issues, shall be required. (see section 3.2)

3. **General Development Plan (GDP)** - The GDP gives a comprehensive description of a forest operator's proposed harvest strategy, road building plans, and reclamation operations for a five-year period, and includes all active licences and permits. The GDP is used to guide integration of activities. (see section 3.3)

4. **Final Harvest Plan (FHP)** – The FHP is a map and associated report describing the laid out harvest plan. (see section 3.4)

5. **Annual Operating Plan (AOP)** – The AOP describes operations in detail through a series of components that shall be submitted together at the same time, or as individual submissions on a schedule approved by Alberta:

- a) Operating Schedule and Timber Production;
- b) Applicable Final Harvest Plans;
- c) General Development Plan;
- d) Compartment Assessments as required;
- e) Reforestation Program;
- f) Forest protection supplement;
- g) Road Plan.

(see section 3.5)

- 3.4-Final Harvesting Plan (FHP) (page 5)

- Appendix 5 Checklist

➤ 3.4.6(g) watercourse crossings (page 6)

➤ 3.4.8(j) crossing types (page 6)

- 5.0-Integration with other users (page 16 to 19)

- Includes integration with forest operators, forest recreation and tourism and rangeland.

- 6.0 Watershed Protection (refer to pages 20 to 26)

- Table 1 – Watercourse Classification

- Table 2 – Standards and Guidelines for operating beside watercourses

- intermittent channels >20% shall be treated as Intermittent in Table 2.
- 10.0 Forest Health (page 53)
- 11.0 Roads (page 54)
 - Table 3 Road Classification (page 56-57)
 - 11.3.3 Erosion Control/Prevention
 - 11.4 Watercourse crossings – Table 4 – Acceptable crossing structures (page 63)
- 12.0 Reporting (page 70)
- Appendix 5 – FHP/AOP Checklists (page 90)
- Field Operations Inspections Form (page 97)

Appendix C.3 Forest Health

2007 Mountain Pine Beetle MANAGEMENT STRATEGY

- Objectives – sustain Alberta’s pine forests.
- Water Management Outcomes.
 - Minimal impacts on watersheds.
 - Maintain quality and quantity.

2007 Mountain Pine Beetle ACTION PLAN

- Objectives
 - Timely detection.
 - Effective expedient response.
 - Useful communications and liaison.
- Strategies
 - 3 zones
 - Leading edge – prevent spread – *no reference to water.*
 - Holding – reduce or hold population – *no reference to water.*
 - Salvage – use timber harvesting to achieve other forest management goals – e.g. protect watersheds – *does not say how this would be achieved.*
- Research requirements
 - Short and long-term impacts to watersheds.
 - The government wants trees in infested areas where timber is not harvested to be managed rather than left to stand as dead timber. This management may address fire hazard, watershed or habitat concerns. *Does not define what ‘managed’ means.*
 - AAC will be adjusted to reflect current conditions.

If harvesting exceeds areas scheduled in FMPs, SRD will temporarily remove from the THLB those areas not harvested for the Salvage Strategy.

Appendix C.4

Environmental & Watershed Planning

1. 2010 Oldman River State of the watershed report

- Objective – This report provides a snapshot of the entire Oldman watershed: its current accounting and how well our watershed is working.
- State of watershed
 - Land use activities in the watershed include agriculture, forestry, mining, recreation, and oil and gas extraction and affect 60% of the land base. The Prairie and Southern Tributaries sub-basins are the most disturbed. Integrating results from the terrestrial and riparian indicators for land cover, soil erosion, riparian health and land use provides an overall ranking of “FAIR ” for the Oldman watershed.
 - Overall, the water quantity of the Oldman watershed is “FAIR” based on the results of analysis of flow variability, licensed allocation and actual use, as well as water use efficiencies within irrigation districts and municipalities.
 - Integrating the results of water quality analysis for nitrogen, phosphorus, total suspended solids (TSS) and fecal coliforms gives an overall rank of “GOOD” to “FAIR” for the Oldman watershed.
- Indicators and Thresholds – refer to Table 2 on next page.
 - **Mountain Sub-basins** – 64% forests – rated as GOOD.
 - Soil erosion from forestry – no data on soil erosion potential for 64% of the area.
 - Riparian health – 26% healthy, 56% healthy but with problems, 18% unhealthy.
 - Recreation – <1% of area designated for recreation use.
 - Extensive random recreation use but no data to quantify affected areas. Water quantity.
 - Crowsnest River – significant decrease in April flows observed.
 - Castle River – no significant trends in annual or monthly flows.
 - **Water quality**
 - Nitrogen – total nitrogen loadings generally higher in the Castel than the Crowsnest – typically less than guideline from 74-09 (except at 2 sites in 05).
 - Phosphorus
 - Total P typically less than guideline.

- Total Suspended Solids
 - “Extreme” levels recorded in 2005 due to heavy rain.
 - Data for 91-00 showed Crowsnest consistently lower than Castle.
- Fecal coliforms
 - Typically Crowsnest lower than Castle. Crowsnest steady decrease from 91-01.
- OVERALL WATER QUALITY INDICES upstream of Oldman Reservoir was EXCELLENT.
- ISSUES AND TRENDS
 - Terrestrial/Riparian – Continued linear developments may add to cumulative impacts.
 - Water Quantity – no significant change to annual trends in Crowsnest or Castle but Crowsnest shows significant decreasing trend in April.
 - Water Quality – largely within guidelines.
- SUMMARY – Terrestrial – GOOD, Water quantity – GOOD, Water Quality – GOOD.

Table 1: Overall State of the Watershed Ranking for all Indicators by Sub-basins

Indicator	Sub-Basins						
	Mountain	Foothills	Southern Tributaries	Prairie		Mainstem	Oldman Watershed
Terrestrial and Riparian	Good	Good	Fair	Poor		Good	Fair
Water Quantity	Good	Fair	Poor	Fair	Poor	Poor	Fair
Water Quality	Good	Fair	Fair	Fair	Poor	Good	Fair
Overall	Good	Fair	Fair	Fair	Poor	Fair	Fair

Legislation and Policies for Land Use Management on Crown Land

Forestry:

- Forest Act
- Timber Management Regulations
- Forest Management Agreements
- Alberta Timber Harvest Planning and Operating Ground Rules Framework for Renewal
- Alberta Regeneration Survey Manual
- Mountain Pine Beetle Management Strategy
- Mountain Pine Beetle Action Plan

Grazing:

- Forest Act
- Public Lands Act
- Grazing Lease Stewardship Code of Practice
- Riparian Health Assessment for Lakes, Sloughs and Wetlands

Recreation:

- Recreation on Agricultural Public Land
- Respect the Land
- Forest Recreation Regulation

Source: ASRD website.

- Foothills sub-basins – 20% forests – rated as FAIR.
- Oldman mainstem – rated as FAIR.
- Soil Erosion – not an issue.
- Riparian – 197 monitored sites – 14% healthy, 63% healthy but problems, 23% unhealthy.
- SUMMARY - Terrestrial – GOOD, Water Quantity – FAIR, Water quality – FAIR.
- **Recommended BMPs**
 - Planning
 - Develop adaptation plans.
 - Undertake monitoring programs to support adaptive plans.
 - Consider development of “riparian policies”.
 - Update State of Watershed report every 5 years.
 - Instream objectives (IOs) & Water Conservation Objectives (WCOs).
 - Castle and Lee Creeks don’t meet IOs and WCOs that are set higher than natural flows.
 - Instream targets should be set to realistic values.
 - Stewardship
 - Reclamation and Restoration
 - Support Cows and Fish program with respect to riparian health on the mainstream.
 - Implement drainage erosion control measures as soon as possible following disturbance.

2. 2011 OWC Strategic Plan 2011-2013

Goals

- Stakeholders have defined the desired outcomes for integrated watershed management.
- Practices that are beneficial to the health and function of the watershed are adopted.

Monitoring and Evaluation

- OWC will continue to monitor its progress.

3. 2011 OWC Priorities for Oldman watershed

Management Principles

- Watershed planning process needs to be community-based and inclusive of all stakeholders.
- Monitoring and research are an essential part of water management.

Table 2: Indicators and Thresholds used for the Oldman River State of the Watershed Report

Indicator	Threshold
Terrestrial and Riparian Ecology	
Land Cover	<ul style="list-style-type: none"> • Good: >50% combined land cover of forest, grassland, shrubland and rock/barren land • Fair: 25 to 50% combined land cover of forest, grassland, shrubland and rock/barren land • Poor: <25% combined land cover of forest, grassland, shrubland and rock/barren land
Soil Erosion Rates	<ul style="list-style-type: none"> • Good: <25% of area at risk of erosion • Fair: 25 to 50% of area at risk of erosion • Poor: >50% of area at risk of erosion
Riparian Health	<ul style="list-style-type: none"> • Good: riparian class healthy • Fair: healthy but with problems • Poor: unhealthy
Land use Linear Developments Total Land Use Disturbance	<ul style="list-style-type: none"> • Good: linear disturbance <2% • Fair: 2 to 3% linear disturbance • Poor: >3% linear disturbance • Good: <50% total land use disturbance • Fair: 50 to 90% total land use disturbance • Poor: >90% total land use disturbance
Water Quantity	
Trends in Natural Flow	Thresholds for assessing water quantity within the Oldman watershed have not been established. Water quantity thresholds were assessed by a relative comparison among stations for each of the Sub-basins with assignment of rankings of good, fair or poor.
Licensed Allocation and Actual Use vs Natural Flow	See above
Performance in Meeting IO and WCO in Recent Years	See above
Irrigation and Municipal Water Use Efficiency	See above
Water Quality:	
Nutrients - nitrogen	<ul style="list-style-type: none"> • Good: no exceedances or less than 10% within the data set and neutral or decreasing trends in concentration particularly over the last decade • Fair: the number of exceedances not more than 50% of the analyzed data set with increasing trends in concentration for one or two indicators • Poor: exceedances occur in more than 50% cases and increasing trend in concentration pronounced in more than two indicators
Nutrients - phosphorus	See above
Total Suspended Solids (TSS)	See above
Fecal Coliforms	See above

Appendix C.5

Public Lands

1. *Disposition of public lands*

- Lands is responsible for the disposition of public lands under the *Public Lands Act* for:
 - forest grazing licenses;
 - licence of occupation (e.g. access roads).

2. *Public Land Use Zones*

- A Public Land Use Zone (PLUZ) is an area of public land to which legislative controls apply under authority of the Forests Act, Forest Recreation Regulation (343/1979) to assist in the management of industrial, commercial, and recreational land uses and resources.

A PLUZ is created for a specific land base and the unique conditions that exist within that land base.

A PLUZ is established to better manage Alberta's busy landscape and the land use activities, including recreation that occurs in a specific area.

PLUZ conditions are designed primarily to protect areas containing sensitive resources and manage conflicting land-use activities.

PLUZs are not designated as parks or protected areas.

Refer to Ghost FLUZ map for more details

3. *Integrated Land Management*

- Outcome
 - Human caused disturbance on the land is reduced in relation to the disturbance that would have occurred without integration.
 - A stewardship ethic is demonstrated by all land users.
- **Principles** – comprehensive and balanced; collaborative and inclusive; responsible and accountable; consistent with direction; informed by knowledge and science; use adaptive management.

Appendix C.6

OTHER WATERSHED RESEARCH

1. 2009 *Southern Rockies Watershed Project*

- Summary
 - Lost Creek wildfire assessment of impacts on hydrology, water quality ...
- Key findings
 - Hydrology
 - 35% increase in total runoff.
 - 70% increase in peak flows.
 - 3-4 week advancement of onset of snow melt.
 - Water quality
 - Greater sediment production (up to 80% greater in some years).
 - Salvage logging impacts had larger impacts than the fire alone.
 - Some of the highest nitrogen levels recorded in the literature.
 - Large increases in phosphorus.
 - Aquatic ecology
 - Increased nutrients in water resulted in growth of algae.
 - Change in species abundance and diversity.
 - Increased rate of growth of Cutthroat and Rainbow trout.
- Take home message
 - Wildfires have long-term impacts on hydrology, water quality and aquatic ecology – manage forests to reduce wildfire risks!
 - Some impacts from wildfires can be positive – increased growth rate in fish.
 - Post-fire salvage logging can incrementally increase impacts – balance the economic, social and environmental costs and benefits.

Appendix C.7

CASTLE SPECIAL MANAGEMENT AREA

1. 1998 Castle Public Land Use Zone (PLUZ)

- Recommended that OHV use be restricted to designated trails.
- Timber harvesting guide by the C5 FMP.
 - Protecting water quality is a top forest management priority.
 - 2/3rds of the area is off limits for harvesting.

APPENDIX D

Watershed Assessment Procedure Example

This Forest Practices Code Guidebook is presented for information only.

It is not cited in regulation. The Forest and Range Practices Act and its regulations took effect on Jan. 31, 2004. This replaced the Forest Practices Code of British Columbia Act and regulations. For further information please see the [Forest and Range Practices Act](#).



of
BRITISH COLUMBIA

Coastal Watershed Assessment Procedure Guidebook (CWAP)

Interior Watershed Assessment Procedure Guidebook (IWAP)

Second edition

Version 2.1

April 1999



BRITISH
COLUMBIA

Ministry of Forests



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Preface

This guidebook has been prepared to help forest resource managers plan, prescribe and implement sound forest practices that comply with the Forest Practices Code.

Guidebooks are one of the four components of the Forest Practices Code. The others are the *Forest Practices Code of British Columbia Act*, the regulations, and the standards. The *Forest Practices Code of British Columbia Act* is the legislative umbrella authorizing the Code's other components. It enables the Code, establishes mandatory requirements for planning and forest practices, sets enforcement and penalty provisions, and specifies administrative arrangements. The **regulations** lay out the forest practices that apply province-wide. **Standards** may be established by the chief forester, where required, to expand on a regulation. Both regulations and standards are mandatory requirements under the Code.

Forest Practices Code guidebooks have been developed to support the regulations, however, only those portions of guidebooks cited in regulation are part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable. Except where referenced by regulation, guidebooks are not intended to provide a legal interpretation of the *Act* or regulations. In general, they describe procedures, practices and results that are consistent with the legislated requirements of the Code.

The Watershed Assessment Procedure Guidebook is referenced in the Operational Planning Regulation (OPR) for the procedures and protocols required for a watershed assessment for the purpose of providing watershed-level management recommendations for forest development plans in an area where a watershed assessment is required.

The following parts of this guidebook must be followed exactly as detailed in order to complete a watershed assessment for the purpose of the OPR section 14:

1. Section 2: WAP Components, the subsection The Watershed Advisory Committee, pages 3–5; and the subsection Watershed Report Card, page 11. The other subsections of Section 2 must be addressed but there is a range of options or outcomes available to the professional practitioner.
2. Section 3: Administrative Issues, pages 14 – 19.

These portions of the Watershed Assessment Procedure Guidebook which are to be followed exactly as stated **are identified by a bar along the page margin labeled with the specific regulation being referenced, as well as a change in the text typeface.**

The information provided in each guidebook is intended to help users exercise their professional judgement in developing site-specific management strategies and prescriptions designed to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered to be acceptable under varying circumstances.

Where ranges are not specified, flexibility in the application of guidebook recommendations may be required to adequately achieve land use and resource management objectives specified in higher-level plans. A recommended practice may also be modified when an alternative could provide better results for forest resource stewardship. The examples provided in many guidebooks are not intended to be definitive and should not be interpreted as being the only acceptable options.

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* Operational Planning Regulation

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Introduction

Operational
Planning
Regulation
14(1)

OPR 14(1) A watershed assessment is required before any forest development plan is prepared for a community watershed. Assessments may also be requested jointly by a Ministry of Forests district manager and a designated environment official in watersheds that are determined to have significant sensitivity, significant downstream fisheries values, or licensed domestic water users. A district manager can also require a watershed assessment for any situations in which he or she deems it to be necessary.

The Watershed Assessment Procedure (WAP) is an analytical procedure to help forest managers understand the type and extent of current water-related problems that may exist in a watershed, and to recognize the possible hydrological implications of proposed forestry-related development or restoration in that watershed.

The WAP considers the cumulative effects of forest practices on the aquatic environment. The assessment of hydrological impacts focuses on: 1) the potential for changes to peak streamflows; 2) the potential for accelerated landslide activity; 3) the potential for accelerated surface erosion; 4) channel bank erosion and changes to channel morphology as a result of logging the riparian vegetation; 5) the potential for change to the stream channel; and 6) the interaction of all of these processes, an evaluation of which indicates the sensitivity of the watershed to further forest development. The assessment also draws attention to natural processes occurring in the watershed. Using the results of a WAP, forest managers can make recommendations to prevent or mitigate the impacts of forestry-related activities in the watershed. Results can also be used to guide watershed restoration activities.

Operational
Planning
Regulation
14(2)a

OPR 14(2)a To accommodate the hydrological differences that exist between the coast and the interior of the province, the WAP differs slightly in some of its components. These differences are indicated in text by “CWAP” (Coastal Watershed Assessment Procedure) and “IWAP” (Interior Watershed Assessment Procedure).

This guidebook is intended to provide direction to all professionals—hydrologists—required to conduct watershed assessments. It is assumed that the individual conducting the assessment will use his or her professional judgment and experience in selecting methods best suited to the specific goals of the assessment and the characteristics of the specific watersheds and clients. It is also assumed that he or she will use judgment to determine how to incorporate non-forestry land uses, such as cattle ranging, recreation or mining, into the assessment.

Section 1: Watershed Assessment Procedure Overview

The purpose of the WAP is to provide watershed-level recommendations for forest development plans, based on an assessment of the potential for cumulative hydrological effects from past and proposed forest harvesting and road building. The WAP can also be used to provide integrated watershed information to other planning and operational programs. Presented in this guidebook is a description of the procedure as it is used in the preparation of forest development plans. Users may adjust the procedure as needed when applying it to watershed restoration projects and non-forest development plan uses.

There are six fundamental WAP components:

1. **Watershed Advisory Committee:** a technical group formed to provide specific watershed information.
2. **Compilation of Existing Information:** a compilation of aerial photographs and 1:20 000 scale map information of the development history of the watershed and inventories.
3. **Field Assessments:** reconnaissance-level, field-based assessments of stream channel stability, sediment sources and riparian condition.
4. **Watershed Report Card:** a tabular summary of the field assessment results.
5. **Watershed Report:** a comprehensive report by the hydrologist of the watershed's state of health, based on field assessments and review of existing information.
6. **Forest Development Plan Recommendations:** specific recommendations made by the hydrologist for the forest development plan.

Size of watershed appropriate for WAP

The watershed assessment procedure is most suitable for watersheds between 500 and 50 000 ha in area (5–500 km²). Watersheds smaller than 5 km² can be better assessed through a detailed field assessment, because impacts are usually site specific rather than cumulative at this scale (e.g., erosion sites, potential impacts to springs). Larger watersheds must be divided into component sub-basins for the method to be meaningful.

The technical components of the WAP are to be completed by a “qualified registered professional,” as described in Section 3: Administrative Issues, under “Professional Qualifications.” Throughout this guidebook, the hydrologist is the qualified registered professional.

Section 2: WAP Components

The Watershed Advisory Committee

Operational
Planning
Regulation
14(2)

The Watershed Advisory Committee is not a regulatory requirement of the WAP, but it is usually included in the WAP process under Ministry of Forests or Ministry of Environment, Lands and Parks policy.

A first step of the WAP is to organize a Watershed Advisory Committee. The committee is a technical group, typically made up of about 10 members representing resource interests in the watershed. Its purpose is to focus on the hydrological implications of forest development in the watershed and to make recommendations for the forest development plan based on these implications. **The committee is not a public participation forum.**

Role of the Watershed Advisory Committee

The committee has three main tasks:

1. To identify issues and provide background information to the hydrologist conducting the watershed assessment.
2. To review the hydrologist's report to check that the information provided and issues raised by the committee during technical meetings have been satisfactorily addressed.
3. To provide additional advice to the prescribing forester about how the hydrologist's recommendations can be incorporated into the forest development plan to best protect watershed values, if appropriate.

Members and Responsibilities

Membership in the Watershed Advisory Committee and member responsibilities are recommended as follows:

Forest licensee

- provides meeting logistics
- contracts the hydrologist who will carry out the watershed assessment
- prepares the forest development plan

Ministry of Forests

- chairs Watershed Advisory Committee meetings

Ministry of Environment, Lands and Parks

- may jointly chair committee meetings with the Ministry of Forests in joint approval areas
- provides information on licensing, flood histories and water quality

Water-user representative (preferably one, but at most two)

- represents the water licensees and is selected by the management group for the community water system
- provides history of water use, water quality and flooding, as well as relevant local knowledge about the watershed

Department of Fisheries and Oceans representative (if anadromous fish are present in the watershed) and/or *Ministry of Fisheries representative* (if other coded fish are found in the watershed)

Environmental health officer or alternate representative

Additional members can be added where they contribute to the technical nature of the WAP (e.g., range users, riparian landowners). Participation on committee is voluntary. If any agency, licensee or user group representative chooses not to participate, the process can proceed without that input. In addition, the roles identified above should be considered flexible. For example, the Watershed Advisory Committee may select any individual member it wants to chair the process.

Position of the Hydrologist

The hydrologist is not a member of the Watershed Advisory Committee, but participates in all of its meetings. His or her responsibilities are to:

- complete the assessments and the watershed report in a timely and cost-effective manner;
- make specific recommendations concerning the forest development plan; and
- assist the forest licensee in incorporating the recommendations into the forest development plan.

Meetings

The forest licensee should initiate the WAP process by sending a letter to the prospective members of the Watershed Advisory Committee, inviting their participation. This letter should identify the members of the committee and the professional hydrologist who will undertake the technical work. An information session for water users may be required before the WAP is officially initiated.

All meeting decisions should be documented in minutes.

The decisions of the committee should be reached by consensus. Where this is not possible, consensus also includes the “lack of dissension” by all participants—that is, any one party may disagree with a decision but choose not to “block consensus.” Dissenting opinions should be documented in the minutes.

Technical Meeting #1

The first meeting is important because it outlines for all members the correct course to be followed. However, it is optional, depending on the circumstances. It is also possible to consider more than one non-community watershed at this meeting. A formal meeting is not always required. In some cases, it is appropriate for the hydrologist to use other means such as phone calls, e-mail and fax to obtain the necessary background information from Watershed Advisory Committee members.

Objective:

To familiarize the hydrologist with all the relevant issues, and to decide on the points of interest and watershed sub-basins to be the focus of the WAP (see Appendix 1). The discussion should include:

- the history of resource development and natural disturbances;
- the history of water quality and quantity issues and availability of monitoring, research or inventory data;
- the history of downstream flooding and debris-flow implications;
- a description of the water systems;
- identification of the location of fish habitat;
- an overview of the watershed restoration planned and completed;
- a description of the proposed development; and
- the delineation of sub-basins (or the review of sub-basins already delineated) with a clear understanding of how residual areas will be assessed.

Technical Meeting #2

After the draft watershed report and hydrologist's recommendations have been reviewed by the Watershed Advisory Committee, the committee and the licensee forester who is preparing the forest development plan should meet.

Objective:

To discuss the findings and provide additional input to enable the licensee forester to prepare the forest development plan. The watershed report and the recommendations should be made available to the Watershed Advisory Committee at least 2 weeks before the meeting.

The following background information for all completed WAPs should be kept on file with the forest development plan:

- minutes of all decisions and dates of meetings;
- names and telephone numbers of committee members;
- copy of the hydrologist's report; and
- all written comments provided by the committee to assist the licensee forester with preparing the forest development plan.

Compilation of Existing Information

This component of the WAP involves compiling the available biophysical, resource and forest management data to provide an overview of the watershed. Most of this information can be compiled by the forest licensee. Once the watershed overview is complete, the maps and data are given to the hydrologist to use in the final assessment.

The following data are normally compiled:

- the most recent aerial photograph coverage available;
- 1:20 000 TRIM topographic maps with 20-m contours;
- descriptions of areas of unstable and potentially unstable terrain (such as five-class terrain stability mapping);
- descriptions of populated flood and known debris flow hazard areas;
- the contours corresponding to zones dominated by rain, transient snow and snowpacks (CWAP);
- the contours corresponding to dominant snowmelt zones (IWAP);
- locations of community water intakes;
- all aquatic features, including all known fish streams;
- watershed and sub-basin boundaries;
- tenure or private land boundaries;
- forest cover maps showing areas of past harvesting and all existing roads (including their name and number, ownership, active or inactive status, licensee obligation vs. non-status, and level of deactivation complete);
- where available, geographic information system (GIS) reports with data on ages of logging and tree heights in second growth, to allow computation of equivalent clearcut areas (ECA);
- location and description of other significant water diversion structures (e.g., dams, dikes);
- proposed cutblocks (by opening number, area, elevation range) and proposed road construction for the period covered by the plan; and
- access plans showing roads proposed for deactivation and roads to be kept for long-term access.

Assessment Component

In conducting a WAP, the hydrologist will normally undertake the following assessments:

- peak flow and hydrological recovery
- sediment source survey
- reconnaissance channel assessment procedure
- riparian assessment

Suggested methods for the assessments are described below. Additional example methodologies are described in the appendices. The hydrologist should select methodologies and methods of data presentation that are best suited to the goals of the assessment. The methods discussed here illustrate the level of detail and accuracy expected in each assessment.

Peak Flows and Hydrological Recovery

The peak flow hazard, which takes into account an estimate of the equivalent clearcut area (ECA) index of the watershed and the total non-deactivated road network in the watershed, is one way of describing the potential risk for channel change. Note: The ECA methodology (outlined in Appendix 2) produces an approximated outcome based on limited data. The results should not

be used in isolation, but considered with other factors when the impact of timber harvesting on stream channels is being assessed.

Information on stand height and canopy closure of regeneration is required in order to estimate the hydrological recovery of second-growth stands. Usually the stand height information available from forest inventory databases is adequate. However, if it is not, a field reconnaissance may be needed. There are cases where ECA is not a consideration—for example, where there are low levels of logging or where streamflows are artificially controlled. The hydrologist will need to judge whether the ECA estimation is relevant. In some situations, the hydrologist's efforts may be better focused on other important factors.

The hydrological recovery table (Table A2.2, Appendix 2) assumes full stocking of the stand. Corrections may be needed if there are significant areas that do not have full stocking.

An assessment of peak flow hazard would typically take into account the following for the entire watershed and at the basin or sub-basin level, depending on the point of interest:

- historical flood frequency and timing of significant major flood events;
- natural disturbance regime and implications on peak flows;
- peak flow hazard from openings in the watershed by elevation band;
- peak flow hazard from the road network; and
- evidence in the stream channel about the influence of peak flows on channel form and processes, and the implications of further harvesting or road development on peak flows.

Sediment Source Survey

The sediment source survey is a reconnaissance-level inventory of significant contributors of fine-grained and coarse-textured sediment within the watershed. Forestry-related sediment sources are primarily associated with landslides, gullies, stream channel bank erosion, and the road network.

The survey is completed by using a combination of input from the Watershed Advisory Committee, aerial photographs, road inventories, ground surveys and aerial over-flights to identify sediment point sources and those portions of the road network that have a potential to deliver significant and/or persistent sediment loading to a stream. Additionally, the hydrologist may conduct ground truthing surveys of suspected sources of significant sediment loading. It is not necessary to field survey all roads—only portions of the road network—to confirm the sediment hazard.

An example methodology for a road sediment source survey is described in Appendix 3. Other methods that arrive at a map product with a similar accuracy and level of detail are acceptable.

Typical outputs from the sediment source survey are:

- A 1:20 000 map showing:
 - major point sources of sediment (material originating from relatively localized areas, commonly streambanks, gullies and landslides); and
 - the road network that identifies road elements with high chronic sediment delivery to streams.

- A spreadsheet that lists the following information for each point source:
 - type of disturbance (e.g., landslide, gully, terrace bank, etc.);
 - location of disturbance;
 - origin (clearcut, road, natural);
 - degree of revegetation on disturbed areas; and
 - sediment delivery to a stream.

The survey report should discuss:

- the spatial distribution, nature and severity of sediment sources in each of the sub-basins;
- a comparison of logging-related sources to natural sources and other resource developments;
- the primary fate of the sediment (e.g., how much of the sediment is delivered to the stream network, sediment routing characteristics of the receiving channel);
- the terrain types of special concern (e.g., erosion-prone terrain);
- the extent and success of rehabilitation efforts; and
- opportunities for rehabilitation.

The written evaluation should be used to rank the sediment hazard for each of the sub-basins as Low, Moderate, High or Very High; and the evaluation must include a clear justification for the assigned hazard level.

Reconnaissance Channel Assessment Procedure (ReCAP)

In a ReCAP, channel stability is evaluated along mainstem alluvial stream reaches and major tributary channels of the watershed and its sub-basins. The assessment involves examining historical aerial photographs, conducting an overview field inspection, and carrying out site visits to selected channel reaches to identify any obvious changes in stream morphology.

Components

1. *Historical aerial photographic analysis* of alluvial stream reaches to document obvious channel disturbances, locations of major sediment sources and locations of disturbed riparian areas.

This is not required on streams too small to be seen on aerial photographs. Appendix 4 is an example of a classification system commonly used for categorizing disturbance type. Historical aerial photographs, scanned and displayed at a common scale, provide an effective method of illustrating and measuring rates of channel change in selected reaches.

2. *An overview field survey* of the mainstem and major tributary streams in each sub-basin and the mainstem stream of the watershed.

On larger streams this can be effectively conducted by helicopter. On smaller streams, where tree canopy obscures the channel, the field overview should be conducted by ground survey of selected reaches. Reaches should be selected based on the following criteria:

- their susceptibility to disturbance (alluvial reaches);
- their accessibility;
- their sensitivity (e.g., reaches occurring at tributary junctions or gradient breaks, reaches below landslides, reaches with riparian logging).

The following information should be recorded for each reach:

- channel type, using a suitable stream classification system (an example is the classification system described in the Forest Practices Code Channel Assessment Procedure [CAP] Guidebook, 1996);
- extent and type of channel disturbance by reach; and
- the overall level of disturbance, based on the field indicators of disturbance identified in that reach (e.g., CAP guidebook has a suitable description of field indicators that can be used to identify the channel type and disturbance state).

3. *A more detailed investigation.* If a high level of channel disturbance is observed, the hydrologist may decide that visits to selected channel reaches are warranted to investigate channel conditions, upslope causes or the two.

Outputs

The outputs of the ReCAP should include:

- a map showing all disturbed reaches, disturbance types, and the extent of disturbance for all mainstem streams;
- a description of the stream channel types and the general sediment transport and deposition processes in the watershed;
- a description of historical flood flows, historical channel change and trends in stream channel stability;
- a reach-by-reach description of current stream channel stability and disturbance types and of the impacts of that instability on aquatic resources and property;
- probable causes of any identified stream channel instability; and
- hazard evaluation of each sub-basin mainstem.

The ReCAP outputs are used by the hydrologist in preparing the specific WAP recommendations. The written evaluation must rank the level of stream channel disturbance for each of the sub-basins as Low (undisturbed), Moderately disturbed, or Severely disturbed. The evaluation should also include a clear justification for the assigned disturbance level.

Riparian Assessment

A riparian assessment for a WAP determines the role of riparian vegetation and wood debris in maintaining channel stability and channel structure, and how, in the watershed in question, this role has been affected by logging.

Components

A riparian assessment would normally include:

- an initial assessment of logged riparian areas from aerial photographs and forest cover maps;
- identification of reaches where riparian vegetation has a critical role in channel stability (alluvial reaches either previously logged or identified on future plans);
- field observations (during the ReCAP) of channel bank erosion of logged alluvial reaches, the effectiveness of second growth to stabilize channel banks, and the presence or absence and function of large woody debris jams; and
- a comparison of historic aerial photographs to determine the temporal trend in channel stability as the riparian zone has been logged or has revegetated.

Outputs

The outputs of the riparian assessment should include:

- a map (using the ReCAP map as a base map) showing all mainstem and sub-basin mainstem reaches where logging of the riparian vegetation has resulted in impacts to the channel (i.e., bank erosion, channel widening, loss of functioning large woody debris, etc.);
- a written evaluation in which the impacts related to loss of riparian vegetation are ranked as None, Low, Moderate or High; with a clear justification for the assigned level; and
- recommendations for riparian protection in areas of proposed logging.

Watershed Report Card

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The watershed report card is a summary of specific environmental indicators compiled by the hydrologist from the field assessments and resource maps. It provides a quick reference of consistently measurable indicators that: aid the hydrologist in making interpretations; allow comparisons to be made between watersheds; and provide a measure for checking or auditing watershed assessment results. Suggestions on how to prepare a report card are provided in Appendix 5. The final step is to compile all of the data for each sub-basin of the watershed. See Table 1 as an example.

The hydrologist will use the report card, together with the field assessment maps, to develop hazard ratings for peak flow, sediment sources, riparian function and channel stability. He or she will then use these ratings in making specific recommendations for the forest development plan.

Table 1. Typical watershed report card

1. Percentage of watershed harvested, corrected for ECA (%)
2. ECA by important elevation bands (% and ha)
3. Total road density (km/km²)
4. Length of road as High sediment source (km)
5. Total number of landslides (total numbers of point sources, road related, etc.) entering streams
6. Length of road on unstable slopes (km)
7. Number of stream crossings
8. Length of stream with non-functional riparian forest (km and %)
9. Length of stream with disturbed stream channel (km and %)

Cumulative Effects and Discrete Effects

The hydrologist's assessment must also consider the cumulative effects of sediment sources, riparian conditions and peak flow increases—as well as the effects of discrete events at specific sites—on stream channel stability and on the sensitivity of the watershed to further forest development. Because these factors vary with location in the watershed, their relative significance should be discussed, particularly at the point of interest.

The hydrologist should identify:

- the implications for channel stability of the combined effects of landslides, riparian conditions and peak flows; and
- the implications for sediment production and delivery of the peak flow hazard and surface erosion hazard.

Watershed Report

The hydrological assessment is documented in the watershed report, prepared by the hydrologist. The report should allow readers to follow the logic of the analysis easily, from the characterization of the watershed to the specific recommendations and conclusions.

Included in the watershed report should be a discussion of the following points:

- issues that triggered the analysis and resource concerns specific to the watershed;
- the dominant hydrological processes;
- the basic morphological characteristics of the watershed (hillslope/upland attributes important to downslope/downstream coupling), of the streams, and of the general sediment erosion, transport and deposition processes;
- the current hazard levels for each hydrological category and the evidence for each hazard level;
- the natural condition expected for the watershed as a result of disturbance regime and recent climatic events;
- changes in the watershed and their probable causes;
- the implications of all of the above for watershed management, including specific recommendations for each component of the proposed forest development plan (these must enable reviewers to address amendments to the forest development plan between WAP updates);
- the hydrological risks of further timber harvesting or road construction in the watershed;
- specific recommendations for hazard mitigation (these should state clearly how the recommended actions will reduce hazards); and
- recommendations for the 3-year updating of the WAP.

The hydrologist should choose methods of presenting data that best suit the specific watershed and goals of the assessment.

Generally, the watershed report will also include the following appendices:

- watershed map showing sub-basins, important runoff generation elevation bands, points of interest and fish streams;
- sediment source map;
- ReCAP map showing channel reaches and riparian conditions;
- a summary of proposed roads and cutblocks for forest development plans;
- hazard tables for each sub-basin and the entire watershed; and
- watershed report card.

Monitoring

Monitoring is not normally an outcome of a WAP. Only in rare situations may a monitoring program be justified, to detect changes in the watershed that are the result of site-specific or cumulative upstream impacts. Even then

it should only be initiated with careful consideration of time and space scales, methods and the financial implications of setting up and continuing such a program.

Where a monitoring program is recommended, the design must be explicit with respect to identifying objectives, methods and feedback mechanisms to forestry operations. Responsibilities and funding must also be clear.

Forest Development Plan Recommendations

The hydrologist's recommendations for the forest development plan should consider the following:

- the severity of the hydrological risk;
- the hydrological implications for water quality in the community watershed water supply and fish habitats;
- the trend of the watershed condition (including disturbance regime hazards);
- future harvesting opportunities and road infrastructure; and
- remedial work for high hazard sediment sources, if needed.

The forester preparing the forest development plan should advise the hydrologist of relevant objectives in higher level plans. For example, if bull trout conservation has been identified as an objective in a land and resource management plan, then recommendations that conserve the unique water quality and stream channel stability requirements of bull trout are appropriate.

Recommendations coming out of the watershed assessment should be limited to the hydrological management of the watershed specifically as it concerns the preservation of water and aquatic values as affected by peak flows, sediment sources, riparian condition or channel stability.

As well, recommendations for the forest development plan can be linked to remedial work, if problems in the watershed (such as high sediment loads from roads or logging-related landslides) persist from past forest development. For example, further logging may be supportable if watershed restoration measures are implemented and determined to be effective in addressing the logging-related sediment sources.

Once the hydrologist has prepared the recommendations, they must be reviewed by the Watershed Advisory Committee. The hydrologist, the committee and forester preparing the forest development plan may then decide to meet to consider the hydrological implications of the recommendations. The plan is then completed and submitted to the district manager.

Section 3: Administrative Issues

Completing the Forest Development Plan with a WAP

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The following steps are required for completing a forest development plan in an area where a watershed assessment is required:

1. The district manager notifies a licensee that a WAP is required for the watershed (e.g., a community watershed, a watershed with significant downstream values, or another critical watershed identified by the district manager and, where required, the designated environment official).
2. The district manager and the licensee identify a coordinator for the WAP process.
3. The licensee contracts with a hydrologist.
4. If Ministry of Forests or Ministry of Environment policy requires that a Watershed Advisory Committee be involved, the coordinator contacts the committee members and organizes a meeting to review the watershed history and to provide the hydrologist with watershed assessment information.
5. The hydrologist completes the WAP report and hydrological recommendations and distributes them to the prescribing forester and Watershed Advisory Committee members for review before the final committee meeting.
6. The committee members notify the hydrologist if they have concerns with the report or hydrological recommendations and let the coordinator know if they would like to hold a final meeting.

If they agree with the report and hydrological recommendations and there is no need for a final committee meeting, the hydrologist can then simply forward the report and recommendations to the prescribing forester, adding a note that a final meeting is not requested by the committee.

If a final Watershed Advisory Committee meeting is deemed necessary, the hydrologist presents the WAP report and hydrological recommendations to both the committee and the prescribing forester preparing the forest development plan. The committee can also provide additional comments to the prescribing forester during this presentation, with a follow-up written summary. The hydrologist may choose to revise the WAP report and hydrological recommendations if new information has become available or if alternative risk management strategies are desirable.

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7. The prescribing forester prepares the forest development plan. In doing so, he or she must consider both the hydrologist's recommendations and the comments received from Watershed Advisory Committee.
8. The licensee makes the forest development plan available for review under Section 27 of the Operational Planning Regulations. The plan must state that it is consistent with the results and recommendations of the WAP.
9. The prescribing forester submits the forest development plan to the district manager and designated environment official for approval, together with a statement that the plan is consistent with the hydrologist's WAP report results and recommendations (or, as appropriate, the reasons that the plan is not consistent) for community watersheds or portions of watersheds designated as community watersheds.
10. The district manager (and designated environment official, where required) reviews the licensee's summary of how the WAP recommendations were incorporated into the forest development plan, as part of making a determination about the plan.

Forest Development Planning

When to Do a Watershed Assessment

OPR 14(2) As of December 15, 1998, all WAPs must be completed before any forest development plan in a community watershed is submitted, unless the district manager and designated environment official agree that one is not required.

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OPR 14(1) A watershed assessment must be redone every three years. It is not necessary to redo those components of the assessment that are not expected to have changed in the intervening period.

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OPR 14(4)(a) Assessments may be requested jointly by a district manager and designated environment official in watersheds that are determined to have significant watershed sensitivity and that have significant downstream or licensed domestic water users. A district manager can also require a watershed assessment in situations where it is determined to be necessary.

WAPs may also be requested for other watersheds where the district manager determines an assessment is necessary. This may include watersheds where there is a risk to human life, public infrastructure and public and private property associated with flooding, or where there is stream channel instability that may be the result of cumulative effects in the watershed.

Definitions

Significant watershed sensitivity means the watershed has a history of landslide, erosion or channel stability problems, or it has had a sufficiently high rate of cut in the past 20 years that hydrological problems are anticipated by the district manager and designated environment official. In some physiographic areas, mass wasting and channel instability may be so common that all watersheds in that zone are designated as sensitive. The WAP is best applied on a watershed where a potential for cumulative impacts exists—for example, usually a watershed where:

- at least 20% of the watershed's area has been logged during the past 25 years (or the 25 years that include the 5 years of proposed development); **and**
- a significant number of landslides that entered the stream channel are known to have occurred; **or**
- stream channel stability problems are evident; **or**
- over 25% of the riparian forest along either bank of the main stream channels has been logged over the past 40 years; **or**
- landslide problems are anticipated due to recent harvesting on unstable terrain.

Significant fisheries values means the watershed has been identified by the district manager and designated environment official as having a unique or important fish stock. Direction can be taken from a higher level plan, such as a land and resource management plan or a landscape unit plan, where conservation of a specific fish stock has been identified as one of the objectives of the plan.

Prioritizing Watersheds

All community watersheds must have a WAP, unless they have been exempted by the district manager and designated environment official. WAPs carried out in other watersheds are discretionary. It is not worthwhile to assess watersheds in which there are no forest development plans, only a low level of past forest development has occurred, or no apparent hydrological problems exist. However, it is desirable to schedule discretionary watersheds for WAPs based on the likelihood of hydrological problems (see the definition of “significant watershed sensitivity”).

It is recommended that representatives from the Ministry of Forests, Ministry of Environment, Lands and Parks and the Department of Fisheries and Oceans, with the advice of forest licensees where appropriate, cooperatively develop annual work plans for completing the discretionary WAPs over a 5- to 10-year period.

Watersheds with More Than One Licensee

Responsibility for conducting a WAP lies with the licensee who is submitting the forest development plan. Where there are two licensees operating in a watershed, both of whom are submitting plans, then they should cooperate in conducting a single WAP, with a single Watershed Advisory Committee and both licensees represented. The licensees should discuss the cost of the assessment and determine an equitable cost-sharing arrangement.

In situations where two licensees have tenure in a watershed, but only one is active, the inactive licensee should still be encouraged to participate in the WAP. Recommendations made by the Watershed Advisory Committee may have operational implications for both licensees, so both should be represented on the committee.

Private Land

While WAPs apply only to forest tenures on Crown land and not to private land, it is highly recommended that information on other land uses be obtained during a WAP. The entire contributing drainage basin must be considered when the hydrological functions of a watershed are under evaluation.

If possible, information about roads, cutblocks and sediment sources within the private lands portion should be obtained. This may involve consulting landowners or seeking their voluntary participation on the Watershed Advisory Committee. The best option, however, may simply be to take the information from the most recent aerial photographs of the watershed. If the private land is Private Managed Forest Land, a management plan can be made available from the BC Assessment Authority, with the consent of the owners. See Appendix 2 for recommendations on including private land in peak flow hazard calculations.

WAPs Completed Before April 1998

Between June 15, 1995, and April 2, 1998, a large number of WAPs were completed, both for forest development planning and for watershed restoration purposes. These WAPs followed the first methodology presented in the 1995 Forest Practices Code CWAP and IWAP guidebooks.

The previous WAPs fall into one of the categories below:

OPR 14(1) WAPs with round tables and low hazard Level 1 results

If the WAP was conducted under the guidance of a round table, or the Level 1 results (except for surface erosion) all indicated hazard scores less than 0.5, then the WAP is considered to be valid for 3 years after the date of completion. When that time period is over, a new WAP should be conducted using the 1999 procedures.

OPR 14(1) Code-required WAPs with no round table and low Level 1 results

The recommended procedure is to create a round table in each district that can “batch process” the old completed Level 1 results. For example, a district Watershed Advisory Committee can be set up to deal with all of the community watersheds in a licensee’s chart area. The committee should include the community watershed representatives

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from each affected watershed. Where all of the hazard scores are less than 0.5 and the results have been reviewed by this district round table, then the WAP is considered to be valid for 3 years from the date of completion. When that period is over, a new WAP should be conducted using the 1999 procedures.

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OPR 14(5) Code-required WAPs completed to Level 1, but hazard scores are greater than 0.5

Where WAPs have been completed, with or without round tables, and any hazard indicator is greater than 0.5, there is an option to field-verify the Level 1 scores. If the high hazard scores are confirmed, then a Level 2 is required. If the Level 2 is completed and the round table has made its recommendations, then the WAP is considered to be complete and is valid for 3 years. After the WAP is updated, the 1999 procedures should be followed.

Where field-verified WAP Level 1 hazard scores are greater than 0.5 and no Level 2 has been completed, then the WAP is not considered to be complete. The Watershed Advisory Committee should determine whether further work is required and, if it is, the assessment should be completed following the 1999 procedures.

OPR 14(5) WAPs required where significant forest development has occurred since a previous WAP

A new watershed assessment may be requested by the district manager if there has been a significant amount of terrain instability within the watershed, or if the extent of timber harvesting or road construction or modification operations within the watershed has been significantly greater than was considered in the original WAP.

WAPs not required under the Code (including Watershed Restoration Program WAPs)

Many WAPs were completed under the Watershed Restoration Program, but usually only to Level 1. The results from these WAPs may be used to fulfill Forest Practices Code obligations in community watersheds and designated fishery watersheds, according to the rules described above. Other WAPs have been conducted to investigate various land management concerns in watersheds that were not required under the Code. There is no obligation to revise the results of these WAPs.

Professional Qualifications

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The person completing the watershed assessment report must be a qualified registered professional, qualified in forest hydrology and with experience in watershed cumulative effects assessment. It is also desirable that he or she have expertise in mapping slope processes, terrain types and fluvial geomorphology.

Definition

Qualified registered professional means, with respect to an activity for which this procedure requires a hydrologist, a person who:

- (a) has appropriate education and experience to carry out the activity, and
- (b) is a member of, or is licensed by, a regulatory body in British Columbia that has a legislated authority to regulate its members or licensees performing the activity.

The hydrologist must have a basic knowledge of forest harvest systems and forest road engineering. The watershed assessment report must be signed and sealed by the hydrologist who carried out or accepts responsibility for the work; and the hydrologist conducting the watershed assessment should understand that reviews are anticipated.

Conclusion

This version of the Coastal and Interior Watershed Assessment Procedures represents another advance for watershed management in British Columbia. The increased reliance on hydrologists now allows assessments to be based on professional judgment that fully integrates watershed processes and forest land use.

This document describes the level of detail and scope expected in watershed assessments. It also outlines the composition and role of the Watershed Advisory Committee, which is established to provide the complete range of water resources input to the hydrologist and specific suggestions to the forester completing a forest development plan. The result will be comprehensive plans and prescriptions that are tailored to maintain the hydrological integrity of individual watersheds.

References

- B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995. Coastal watershed assessment procedure guidebook (CWAP). Victoria, B.C. 66 p.
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- B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1996. Channel assessment procedure guidebook and field guidebook. Victoria, B.C.
- B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1998. Riparian assessment and prescription procedures. Watershed Restoration Program Tech. Circular No. 6. Victoria, B.C.

Appendices

Appendix 1: Identification of stream orders, sub-basins, and the point of interest

For many applications of the WAP, it will be necessary to subdivide large watersheds into smaller units. In cases where the watershed of analysis is relatively small (e.g., approximately 1000 ha), subdividing it into smaller sub-basins will not likely be necessary. Although all hydrologists will be fully knowledgeable with identifying stream orders and sub-basins, it is important that all practitioners use common terminology and similar methods (e.g., dealing with face units in a uniform manner). Furthermore, since stream ordering is map scale dependent, the required map scale must be specified.

Sub-basin Identification

Maps at 1:20 000 scale are to be used for watershed assessment purposes.

A watershed will commonly include sub-basins and face units:

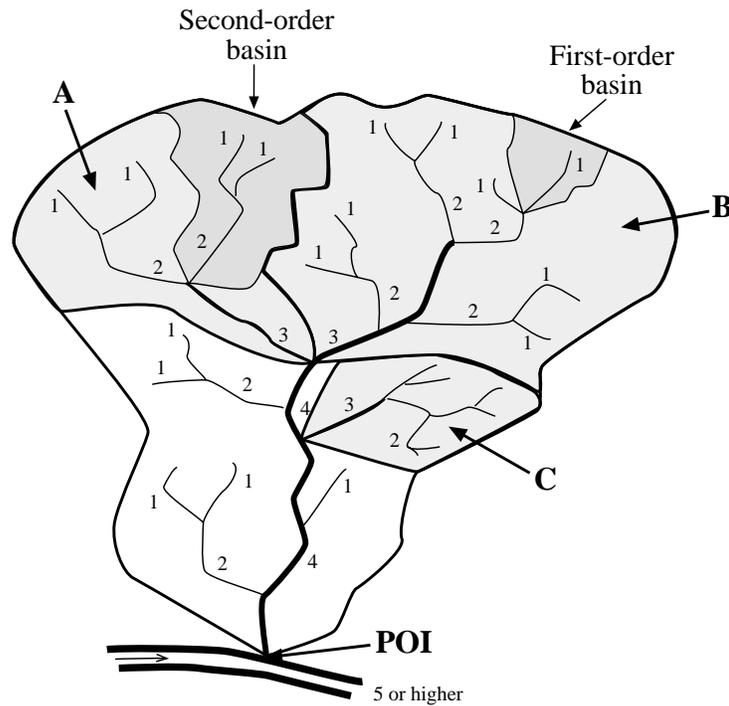
- In watersheds being assessed for fishery concerns, it is most common to consider the watershed area upstream of the most upstream fish-bearing reach to be a single sub-basin and not to further divide that sub-basin into smaller units. However, in addition, any sub-basin that discharges directly into a fish-bearing stream reach should be assessed individually.
- Face units are those hillslope areas that drain directly into the length of stream containing the point of interest (POI), but have no mapped channel (i.e., no first-order stream mapped at 1:20 000 scale). These areas drain either by subsurface flow or by very small ephemeral (seasonal) streams. Small, lower-order tributaries and face units should be included in Level 1 calculations in the residual category.

In the example given in Figure A1.1, Dome Creek is a salmon-bearing river that flows directly into the Fraser River. The POI is the confluence of Dome Creek and the Fraser River. Dome Creek at this point is fourth order. Here then, the Dome Creek watershed should be subdivided into:

- sub-basin A
- sub-basin B
- sub-basin C
- the residual

The residual in this case is everything outside sub-basins A, B and C, but within the Dome Creek watershed.

Figure A1.1. Stream ordering technique. **The entire watershed is a fourth-order watershed. Sub-basins A, B and C are third-order watersheds.**



Point of Interest Determination for Community Watersheds

The following are guidelines for establishing the POI for a community watershed. Information on how to determine where water system intakes are and how to determine water use is also included. The final decision on where to locate the POI should be made at the initial round table meeting.

Point of Interest Determination for Intakes on Streams

- When there is only one community intake on a stream, the POI is at the water intake. If there is more than one licensed community intake, the POI is established at the lowest intake on the system.
- If a cluster of licenses exists some distance downstream of a community intake and meets criteria set out, the POI should be moved downstream. If there is more than one intake associated with the community watershed, the POI should be set at the lowest intake in the cluster.

Point of Interest Determination for Intakes on Lakes

Although the WAP was developed to assess stream watersheds, it may also be applied to lake watersheds. Two examples of where it may be used:

- for a community intake in a very small lake (lake surface area less than 5 km²); and
- for a community intake situated in a lake close (within 0.5 km) to a point where a stream enters the lake.

In the first example, it may be appropriate to set the POI at the outlet of the lake. In the second, it may be appropriate to set the POI at the confluence of the stream or streams that could impact the water quality at the intake (or intakes). Deciding the lake POI will have to be undertaken on a site-specific basis. The Watershed Advisory Committee should make the determination.

Point of Interest Determination for Fisheries Watersheds

In watersheds being assessed through the WAP for fishery concerns, it is common to establish two POIs:

- The first POI is established at the most downstream fish-bearing stream reach in the watershed. This is commonly the ocean or a lake, or at the stream's confluence with another river.
- The second POI is established at the farthest upstream reach of a fish-bearing stream. The watershed area upstream of this upper POI is commonly considered a single sub-basin for analysis, and is not usually subdivided further unless the Watershed Advisory Committee considers it necessary to do so. Any sub-basin discharging directly into the fish-bearing stream reach (i.e., between the lower and upper POIs) is considered to be an individual sub-basin and should be assessed separately.

Appendix 2: Peak flow factors: equivalent clearcut area (ECA) and road density

The ECA methodology used here to estimate changes in peak flow produces an approximation based on limited data; it must not be used in isolation, but can be useful in combination with other factors to assess the impact of timber harvesting on stream channels. There is little evidence to link channel disturbance with ECA alone, in isolation from other effects such as riparian logging and changes to sediment supply. ECA values should not be a management target.

Definitions

Streamflow is surface runoff, flowing in a stream channel, which is derived from rainfall, snowmelt or a combination of the two.

Peak flow is the maximum flow rate that occurs within a specified period of time, usually on an annual or event basis.

Low flow is the minimum streamflow that occurs during the course of the year, as a result of summer drought or winter freezing.

Hydrological recovery is the process by which regeneration restores the hydrology of an area to pre-logging conditions. Complete hydrological recovery incorporates many hydrological components, including the recovery of snow accumulation and melt characteristics, recovery of precipitation interception during storms, and recovery of evapotranspiration. In British Columbia, the most important component of the hydrological recovery involves snow accumulation and melt characteristics (snowmelt recovery) because peak flows in both interior and coastal areas tend to be generated by conditions of radiation snowmelt and rain-on-snow. Therefore, snow-pack recovery is used as an index of true hydrological recovery.

Equivalent clearcut area (ECA) is the area that has been harvested, cleared or burned, with consideration given to the silvicultural system, regeneration growth, and location within the watershed.

ECA and road density are the two primary factors considered in an evaluation of the potential effect of past and proposed forest harvesting on peak flows. This appendix suggests a method of collecting and presenting the appropriate information for interpretations.

Equivalent Clearcut Area

Refer to Table A2.1 to characterize harvested or disturbed areas in the watershed.

Table A2.1. Assumptions for ECA calculations

Not satisfactorily restocked areas:	Clearcut with 0% recovery.
Individual tree selection: <20% basal area removal 20–40% basal area removal 40–60% basal area removal 60–80% basal area removal >80% basal area removal	Assume 100% recovery. Assume 0.2 of area harvested (e.g., 1 ha of 35% removal = 0.2 ha ECA). Assume 0.4 of area. Assume 0.6 of area. Clearcut with 0% recovery.
Small opening: < 1H ^a (<0.05 ha) ^b 1H–3H (0.05–0.5 ha) 3H–5H (0.5–1.2 ha)	Assume 0.5 of area (e.g., 20 x 0.05 ha openings = 1 ha cut = 0.5 ha ECA). Assume 0.7 of area. Assume 0.9 of area.
Strip cuts: <2H (50 m) 2H–3H (50–75 m) width 3H–4H (75–100 m) width > 4H (>100 m) width	Assume 0.6 of area (e.g., 1 ha = 0.6 ha ECA). Assume 0.7 of area. Assume 0.8 of area. Assume 1.0 of area.
Private land:	Include in total sub-basin area and ECA.
Open range:	Include in total sub-basin area, but do not include range land as ECA (most range land is naturally open grassland and should not be tallied as ECA).
Burn sites:	Clearcut with recovery factors for regeneration. If a burn produces a stand similar to a partial cut, use the partial cutting recovery factors.
Large landslides:	Clearcut with the appropriate recovery factors.
Utility corridors:	Clearcut with 0% recovery.

a H refers to average tree height.

b This assumes a tree height of 25 m. If tree height is substantially greater, opening sizes can be increased by calculating the opening size for circular openings.

The rationale for Table A2.1 is as follows. Harvesting systems that maintain a canopy are not weighted as heavily on an ECA per unit of basal area removed as a clearcut, because the remaining canopy shades the snowpack. There is a moderate hydrological benefit in maintaining a canopy and this is reflected in Table A2.1. Therefore, twenty 0.05-ha openings are considered 0.5 ha of clearcut rather than 1 ha. The basis for this lower ECA is the reduced melt rates in these openings.

Model results conducted by the Ministry of Forests indicate that about 1 tree height (1H) opening on flat ground receives less than 10% of the incident light that a full opening would receive.¹ A 2H opening would receive 30% of incident light and a 3H opening about 65% of incident light. These model results are also reflected in empirical snow accumulation and melt rate measurements. Although the small openings collect more snow, that snow melts very slowly and a reduced ECA is appropriate. The hydrologist should recommend various partial cutting systems on a site-specific basis. Small openings are most appropriate in watersheds where low flow is a problem and the water user wishes to prolong the melt season. It should be used with caution upslope of unstable terrain where the objective is not to prolong the melt season.

Table A2.2 shows snowpack recovery factors resulting from forest regeneration. Research is currently being conducted in British Columbia to better understand and quantify snowpack recovery. This work is exploring the relationship between tree canopy development, stand canopy height and snow accumulation and melt. Revisions to Table A2.2 will be considered as new information becomes available.

Table A2.2 indicates that below a height of 3 m, trees are not effective at providing interception storage or at providing a buffer from radiation snowmelt or rain-on-snow processes. Thus, recovery starts at a stand height of 3 m. At a canopy height above 9 m, the regenerating stand begins to approach full recovery. However, full recovery is unlikely in second-growth plantations, because canopy structure will be different than in old growth, even at rotation ages. Note, too, that the recovery relationship given in Table A2.2 assumes full stocking. Often, regeneration is patchy, particularly at heights below 7 m. If this is the case, then the coverage of that regeneration must be taken into account.

¹ Based on the Clearcut Light Model (CLIMO) work done by Ralph Adams (1999), Light in small forest openings, Internal Report, B.C. Ministry of Forests, Kamloops, B.C.

Table A2.2. Hydrological recovery for fully stocked stands that reach a maximum crown closure of 50%–70%.

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

Location of harvested, cleared or burned areas within a watershed is the third key factor in determining ECA.

For the CWAP, three elevation bands are chosen to represent the dominant streamflow generation processes operating in the watershed being assessed. In the lower elevation band, peak flows tend to be generated by rainfall (the rain-dominated zone); in the middle band, by rain-on-snow (the transient snow zone); and in the upper band, by a combination of radiation snowmelt and rain-on-snow (the snowpack zone).

The hydrologist must determine the elevational ranges of these bands for the area in which the watershed is located. For example, studies at Russell Creek on northeast Vancouver Island and at Chapman, Gray and Roberts creeks on the Sunshine Coast have shown that the rain-dominated zone corresponds to the 0- to 300-m band, the transient snow corresponds to the 300- to 800-m band, and the snowpack zone corresponds to the area above 800 m. Different elevational bands may apply on other parts of the coast. For instance, on the west coast of Vancouver Island, the elevational bands are generally higher and lower on the North Coast. Farther north (e.g., in the Kitimat area), the highest instantaneous peak flows are generated by autumn rain-on-snow events. In this area, snow is characteristically present at sea level, so there is no rain-dominated zone. The hydrologist may choose to weight the ECA calculated within each elevational band differently, depending on the important peak flow generating mechanism, but the weighting factor must be justified.

For the IWAP, watersheds are also divided into elevational bands to account for the vertical variability in runoff generating mechanisms. Although this is commonly based on the location of the “H60” line—defined as that elevation above which 60% of the watershed lies (the watershed area above the H60 line is considered to be the source area for the major snowmelt peak flows)—other values can be used, provided the hydrologist justifies the decision.

Calculating the ECA

To calculate ECA, use 1:20 000 forest cover maps to locate logged or disturbed areas. Determine the location of the areas relative to the specific bands for the IWAP or the CWAP. Determine the height of regeneration in each logged or disturbed polygon. Heights may need to be extrapolated if reference material is not up-to-date (ensure that these extrapolations are field verified). Refer to Table A2.1 for factors relating to the type of disturbance. The area of each opening will then have to be reduced by the appropriate percent snowpack recovery, as shown in Table A2.2. The following relationship relates the ECA of an opening to its recovery status and the area of opening:

$$ECA = A \cdot C (1 - R/100)$$

where A is the original opening area, C is the proportion of the opening that is covered by functional regeneration, and R is the recovery factor from Table A2.2.

Use Form 1 or Form 2 to calculate ECA.

Form 1. ECA calculations by sub-basin for the IWAP.

Sub-basin name	Below specific elevational line			Above specific elevational line (major snowmelt zone)			Snowmelt index (C+F)
	A ECA (km ²)	B ECA ÷ total sub-basin (km ² /km ²)	C Weighted ECA (B X I1)	D ECA (km ²)	E ECA ÷ total sub-basin (km ² /km ²)	F Weighted ECA (E X I2)	
Residual							
Total watershed							

Note: The *I_n* is a factor that accounts for the vertical variability in snowmelt within the watershed. The *I* value used must be justified by the hydrologist.

Form 2. ECA calculations by sub-basin for the CWAP.

Sub-basin name	Rain-dominated zone			Transient snow zone			Snowpack zone			Snow melt index (C+F+I)
	A ECA (km ²)	B ECA ÷ total sub-basin (km ² /km ²)	C Weighted ECA (B X C1)	D ECA (km ²)	E ECA ÷ total sub-basin (km ² /km ²)	F Weighted ECA (E X C2)	G ECA (km ²)	H ECA ÷ total sub-basin (km ² /km ²)	I Weighted ECA (E X C3)	

Note: The C_n is a factor that accounts for the vertical variability in runoff generation mechanisms within the watershed. The C value used must be justified by the hydrologist.

Road Density

Roads can influence peak flows in several ways. Ditchlines intercept sub-surface flows and transfer the water to streams much faster than through the soil. The compacted surfaces of roads reduce infiltration and transfer intercepted precipitation and snowmelt to ditchlines, and hence to streams. Roads can also intercept and transfer surface water. While adequate cross-drain structures should reduce the impact of this on peak flows, an effect can still be possible. Determining road density is therefore an approach to assessing the potential impact on peak flows. As with harvested areas, the location of a road within a watershed is considered to be significant. Use Form 3 or Form 4 to present road density information for interpretations.

Form 3. Road inventory and density information for the IWAP.

Sub-basin name	Sub-basin area (km ²)	Road in major snowmelt zone		Road for entire sub-basin	
		Length (km)	Density (km/km ²)	Length (km)	Density (km/km ²)
Residual					
Total watershed					

Form 4. Road inventory and density information for the CWAP.

Sub-basin name	Sub-basin area (km ²)	Road in major snowmelt zone		Road for entire sub-basin	
		Length (km)	Density (km/km ²)	Length (km)	Density (km/km ²)
Residual					
Total watershed					

Appendix 3: Sediment source survey

The sediment source survey is a field assessment carried out by the hydrologist to estimate the surface erosion hazard in a watershed. The objectives of the survey, presented in Section 2 of this guidebook under the heading “Assessment Component,” can be met through a number of different field procedures. This appendix describes one method that results in an acceptable level of detail. However, other methods shown by the hydrologist to be appropriate can also be used.

Point Source Survey

The first step is to identify the significant sediment sources observable on 1:20 000 scale (or larger scale) aerial photographs in the following categories:

- landslides and debris flows larger than 0.05 ha;
Each landslide should be marked from initiation point to terminus. Each landslide should also be numbered and this number cross-referenced to the spreadsheet on which is recorded landslide type, initiation point (including reference to cause-natural, forestry related, or other land use), delivery route, magnitude of past and ongoing sediment delivery, surficial materials, disturbed area, and degree of revegetation.
- torrented stream channels;
- gullies with evidence of sidewall or channel failure; and
- large ravelling streambank terraces.

The second step is to plot this sediment source survey information on a 1:20 000 TRIM base map, using symbols to represent the sediment sources.

Sediment Hazard from Roads

One method of assessing surface erosion hazard is described below; the intended level of detail is evident. Other methods shown by the hydrologist to be appropriate can also be used.

The first step is to identify sediment sources from roads, observable on 1:20 000 (or larger scale) aerial photographs. These sources might include:

- slides from road fills;
- long unvegetated road fillslopes;
- unstable or large unvegetated cutslopes;
- erosion at crossing structures;
- road sections with steep grades that connect to streams; and
- road sections close to or encroaching on stream channels.

The second step is to plot this information on a 1:20 000 TRIM base map. It is useful to overlay terrain stability or soil erosion mapping on this map, showing areas of moderate to high hazard of instability or erosion.

A table or suitable legend should accompany the map, describing each source and the relative level of sediment delivery. Note that the significance of a sediment source depends on the capability of the receiving water to transport the incoming sediment downstream. Relatively small sediment sources can have a major effect on small streams, whereas much larger sources can have minimal effect on large stream channels. The assessment report must discuss the relative significance of the various sediment sources on the streams within the watershed.

Tables A3.1 and A3.2 suggest methods of describing sediment production and delivery. Note that some sources produce sediment on an ongoing basis, such as wash from an active haul road or chronic erosion of a road fill, whereas others are discrete events that produce a large quantity at the time of occurrence but little after that. The description of the sediment sources should indicate which sources are chronic and which are discrete events.

Table A3.1. Potential sediment production from forest roads

Class	Annual sediment production: median (m ³ /km of road element)	Annual sediment production: range (m ³ /km of road element)	Average road rill length by width (cm ²)	Description
1	0.1	<0.3	10 x 0.1	almost unnoticeable rills
2	1	0.3 – 3	10 x 1	light erosion (typical of well armoured low-use roads)
3	10	3 – 30	50 x 2	moderate erosion (typical of erodible materials, average maintenance, high use roads)
4	100	30 – 300	100 x 10	severe erosion, access difficult with a 4x4 but not impossible
5	1000	300 – 3000	200 x 50	severe gullying, impassable but repairable
6	10 000	>3000	1000 x 100	total washout, road gone

Each road element should be assigned a potential sediment production class.

The photographs used in Figures A3.2 through A3.6 illustrate typical examples of each road erosion class.

Figure A3.1. Example of sedimental production class 1, see Table A3.1
(sediment production = $0.1 \text{ m}^3/\text{km}/\text{yr}$).



Figure A3.2. Example of sediment production class 2
(sediment production = $1.0 \text{ m}^3/\text{km}/\text{yr}$).



Figure A3.3. Example of sediment production class 3
(sediment production = $15 \text{ m}^3/\text{km}/\text{yr}$).



Figure A3.4. Example of sediment production class 4
(sediment production = $70 \text{ m}^3/\text{km}/\text{yr}$).



Figure A3.5. Example of sediment production class 5
(sediment production = 1,000 m³/km/yr).



Only sediment that is delivered to the stream is important for WAP purposes. Sediment delivery classes are shown in Table A3.2.

Table A3.2. Classification of sediment delivery from forest roads to stream channels

Class	Description
1	No or minimal delivery of sediment from roads to any stream system. Sediment commonly delivered to forest floor, with no surface runoff evident or expected during the wet season.
2	Moderate level of sediment delivery. Sediment delivery partially is connected from the stream network. Disconnected by flat terrain and/or discontinuous drainage routes. Low gradients and discontinuous nature of the connecting drainage routes lead to deposition of most of the sediment originating on the roads.
3	High level of sediment delivery. Sediment delivered intermittently to the stream network via either or both ditch drainage or surface runoff routes. Low gradients and intermittent nature of the connecting drainage routes lead to partial deposition of the sediment originating on the roads.
4	Very high level of sediment delivery. Sediment delivered either directly to the stream network or along efficient ditch drainage or surface runoff routes.

With the values derived from Table A3.1 and Table A3.2, use Table A3.3 to determine the sedimentation hazard. Only the high (H) and very high (VH) road elements need to be coloured on the sediment source survey map. This is not intended to be an inventory of the entire road network

Table A3.3. Sedimentation Hazard

	Sediment Delivery			
Sediment Production	1	2	3	4
1	L	L	L	L
2	L	L	L	M
3	L	L	M	H
4	L	M	H	H
5	M	H	H	VH
6	H	H	VH	VH

Note that the L, M, H and VH rankings can be revised for each sediment production-delivery combination by the hydrologist, based on local experience, but all revisions must be justified.

Appendix 4: A method for classifying stream channel stability

The WAP describes the outcomes required from a reconnaissance stream channel stability survey. Different methods exist for conducting this survey and for making the stability interpretations. This appendix describes one method, which is based on an overview application of the principles discussed in the Channel Assessment Procedure (CAP) Guidebook. Other methods shown by the hydrologist to be appropriate can also be used.

Methodology

The reader must be familiar with the CAP guidebook to use this methodology.

Map Exercise

- Construct a longitudinal profile of the mainstem channel (plot of elevation versus horizontal distance) using 1:20 000 TRIM maps.
- Identify and label major channel reach breaks on the longitudinal profile and topographic map, according to the methodology in the CAP guidebook.
- Identify the location of the following features on the profile:
 - major stream junctions,
 - domestic water supply intakes,
 - reach numbers, and
 - average reach gradient.

Aerial Photograph Analysis

- Compare the most recent, large scale (e.g., larger than 1:20 000 scale) aerial photographs of the watershed with those taken just before logging. If at all possible, use three ages of photography. Look for the following characteristics:
 - the likely CAP classification (where this can be discerned from the aerial photographs) of all reaches;
 - any reaches with obvious channel disturbances;
 - locations of major sediment inputs; and
 - locations of disturbed riparian areas.

Field Procedures

- Using the map of the channel network and labeled reaches, conduct a helicopter survey or ground survey of the sensitive alluvial reaches.

- For each reach of the mainstem, record:
 - the channel type according to the CAP guidebook;
 - the channel width category;
 - extent of channel disturbance; and
 - the channel state, or overall level of reach disturbance, based on the field indicators identified in that reach. The channel state ranges from stable or undisturbed (S), through moderately disturbed (DM and AM) to severely disturbed (DS and AS). The typical types of disturbance associated with each channel type are summarized in the CAP guidebook.

- Complete the aerial survey of all mainstem and important tributary channels.

- On the basis of the aerial photograph and map exercises and helicopter overview flight, decide which reaches need to be visited to make a detailed CAP classification. These are usually restricted to the severely disturbed reaches. See the CAP guidebook for the procedures for conducting a detailed CAP investigation.

Appendix 5: Completing the watershed report card

The hydrologist completes the watershed report card after finishing the field assessments. The report card information is tabulated for each sub-basin and residual area as well as for the entire watershed. Instructions for completing the form are given below. It is expected that the hydrologist may modify the report card as necessary for specific watershed conditions, while still ensuring that the basic elements of the report card are addressed.

1. **Total area harvested.** Report as a percent of the watershed harvested.
2. **Equivalent clearcut area by elevation band.** Refer to Appendix 2 for suggestions on determining ECA, particularly concerning the different runoff generating elevation bands.
3. **Total road density.** Report by (1) total kilometres of road and (2) total kilometres of road divided by total watershed area.
4. **Length of road in High and Very High erosion class.** Report the total length of road mapped as H or VH on the sediment source map.
5. **Total number of landslides.** Count the number of landslides mapped on the sediment source map.
6. **Length of roads on unstable terrain.** Measure the length of road that occurs on areas with terrain stability class 4 or 5 (done on detailed maps) or that is classified P or U (as done on reconnaissance maps) as shown on the forest development plan map.
7. **Number of stream crossings.** On the forest cover map or a TRIM base map, count all stream crossings by mapped roads.
8. **Percent of S1, S2, S3 or S4 streambanks logged.** From the riparian assessment map, report the total high riparian impact stream length. Report the length of “one side logged” streams and “two sides logged” streams separately.
9. **Length of disturbed stream channel.** From the Reconnaissance Channel Assessment Procedure (ReCAP) survey, report the total length of disturbed stream channel in kilometres and as a percentage of the total channel.