Memekay River

Watershed Status Evaluation Report

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Natural Resource Sector **Monitoring**

BRITISH COLUMBIA

FREP *WSEP Extension Note #1*

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Key message: *Largely the result of natural instability and legacy effects of old forest harvesting, the Memekay Watershed Status Evaluation showed the functioning condition of the watershed to be impaired. While current practices meet regulatory standards, opportunities exist to promote recovery from historic impacts and improve the watershed's status.*

INTRODUCTION

In British Columbia, statutes such as the *Forest and Range Practices Act (FRPA)*, *Oil and Gas Activities Act*, and the *Land Act* can be used to augment standard regulatory requirements emphasising additional conservation requirements in watersheds with fish and fish habitat values. For example, under the *FRPA* and *OGAA*, the provincial government can legally designate an area as a fisheries sensitive watershed (FSW) if it has significant fish values and sensitivity to disturbance. As part of the designation land use management objectives are established to protect fish habitat in the FSW by requiring forest and range managers prevent impacts to fish habitat arising from their activities (Figure 1). Assessing watershed status is critical to conserving fish, water, and other associated values, and for continually improving management practices within these important watersheds.

Working with a range of partners, the provincial government developed the "Watershed Status Evaluation Protocol" (WSEP) to help understand the pressures and conditions in watersheds with important fish values. The WSEP employs assessment methods that are repeatable and rapidly deployable, thereby cost-effectively improving our understanding of a watershed's status and relationships among watershed components, including water quality, fish habitat connectivity, and riparian/stream-channel condition (Pickard et al. 2014; Porter et al. 2013). The protocol uses a two-tiered approach where: Tier I brings together the best available spatial information to assess the level of potential-risk associated with disturbance; and Tier II uses Forest and Range Evaluation Program (FREP) and other field assessment protocols applied using a randomized spatially distributed sample-design to understand a watershed's fish habitat condition. The WSEP also distinguishes between old (pre 1995) and new practices (post 1995 – the year when legislation was enacted requiring forest management operations to protect fish habitat). Field surveys undertaken in the Memekay watershed represent the second of a four-watershed pilot used to establish the application and utility of WSEP methods.

Figure 1. *Logged 30–40 years ago, this site (above the mouth of the Middle Memekay) provides an example of a natural erosional process that likely was affected by the type of harvesting practices prevalent before 1995. Ongoing sloughing at this site adds large volumes of fine and coarse sediment to the channel (riparian sample site M306—see Figure 4, page 3).*

The FREP WSEP methods used in this assessment are aligned with government's Cumulative Effects Framework (CEF) assessment of Aquatic Ecosystems. The CEF assessment shares GIS methods and indicators of potential risk. While the CEF is an analysis of all (predefined) watersheds across the province, the WSEP is a targeted analysis (i.e. targets FSWs, or watersheds with high fish values, rather than the standardized CEF watersheds) of both risk (tier I) and condition (tier II) used to understand the status of a specific watershed, including the influence of cumulative disturbances (natural and human) on fish habitat. The WSEP can also be used to inform the condition of CEF analysis units.

This extension note provides land managers, decision makers, First Nations and the public with WSEP results for the Memekay watershed. It summarizes information about the status of fish habitat in the watershed and, as warranted, offers generalized direction aimed at conserving and improving the condition of fish habitat. Section 1 provides a general overview of the watershed, including summary statistics and risk ratings for some habitat pressure indicators. Sections 2–4 outline key riparian, fish passage, and sediment delivery monitoring results. Section 5 offers a brief summary discussion of the watershed's status in 2012, including generalized management recommendations. The final section contains references and data sources to help interested readers access additional details regarding the report.

*The **Watershed Status Evaluation Protocol** (WSEP) is a science-based watershed monitoring tool that ties together landscape level GIS assessment with a series of existing on-the-ground sampling protocols. The WSEP is focused on legal "fisheries sensitive watersheds" and can also be used to monitor other watersheds with fish values.*

1 WATERSHED OVERVIEW

1.1 BACKGROUND

The Memekay River watershed, located north of Campbell River on Vancouver Island, hosts significant fish values including steelhead trout, Coho salmon, resident cutthroat trout, rainbow trout, and Dolly Varden Char (Stewardson et al. 2000). Important habitat for Chinook, chum, pink, Coho salmon and steelhead also exists in the Salmon River downstream of the confluence of these rivers. The watershed was designated a Fisheries Sensitive Watershed (FSW) under the *Forest Practices Code Act*, and again in 2005 under the FRPA. The designation requires that primary forest activities do not result in adverse impacts to fish habitat. Forest harvesting in the watershed was first documented in 1946 but likely occurred earlier, and continues to be the primary activity in the watershed. Satellite imagery from 2006 indicates a substantial portion of the watershed has been harvested (Figure 3).

Natural terrain instability occurs throughout the Memekay watershed and this characteristic, along with its high fish values, would have been the basis for the original FSW designation. The combination of natural instability and pre-1995 forest harvesting practices has resulted in excess sediment, large woody debris (LWD) deficits, stream-channel and bank destabilization (Appendix I, Table A1 & A2). Higher gradient stream channels in the upper portions of the watershed easily transport sediment to fish habitat downstream, and old riparian logging in many areas throughout the watershed has resulted in extensive localized impacts. Consequently, mass wasting and stream bank destabilization have adversely affected stream channel morphology and fish habitat. Elevated levels of sediment deposition are evident in the main channels, as streams continue to move additional volumes of streambed material through the system.

1.2 TIER I AND TIER II SYNTHESIS

Figure 2 provides an analysis of remotely sensed habitat pressure indicators (Porter et al. 2013) available for the Memekay watershed. All indicators with available data show moderate (yellow) to high (red) potential risk ratings. Data deficiencies depicting Tier I harvest history indicators under-represents the actual extent of harvested area, thus influencing the magnitude or utility of most Tier I indicators that use vegetative data (Porter et al. 2015). Alternatively, Figure 3 provides a simplified, yet more current overview of harvest and disturbance history in the watershed.

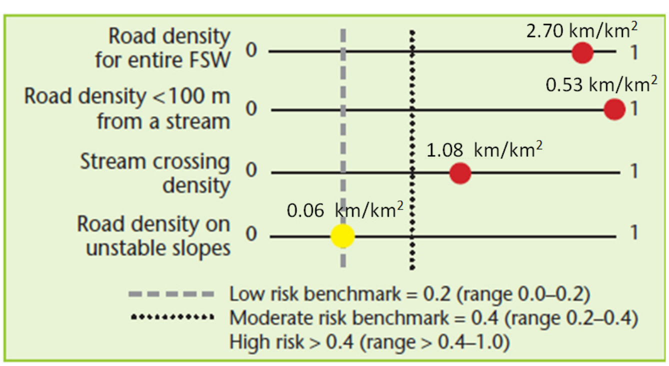

Figure 2. *Tier I remotely sensed metrics.*

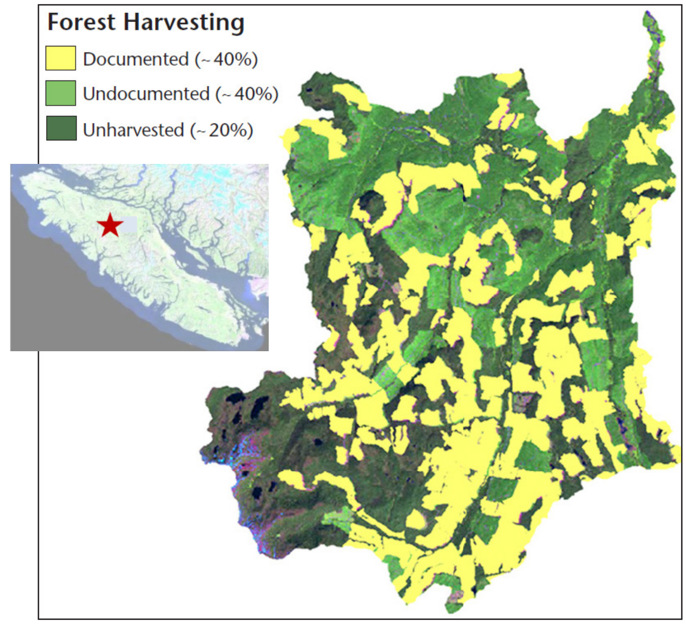

Figure 3. *Documented versus actual forest harvest in the Memekay watershed study area. Documented represents all known areas harvested since 1946. Green areas are from a 2006 LandSat image. The light green areas represent areas disturbed (harvested), and dark green represents areas undisturbed.*

Tables 1 and 2 provide a synthesis of Tier II field data, showing the watershed-scale evaluations of condition for riparian, fish passage, and fine sediment delivery components. A green score indicates the condition is within an acceptable range of variability and a red score indicates that the high benchmark has been reached or exceeded, and therefore the component condition is impaired (Pickard et al. 2014). Given that each of the components and subcomponents is independently important to watershed-level condition of fish habitat, one or more red scores are sufficient to support a closer look at the watershed for causal factors and specific remedies.

Table 1. *Tier II riparian and fish passage data synthesis.*

Stream Category	*Riparian*	*Fish Passage*
Non-fish	✗	N/A
1st & 2nd Order	✗	✓
≥ 3rd Order	✗	✓

Table 2. *Tier II water quality field data synthesis.*

Road Use Category	*Sediment*[1]
Heavy	✓
Moderate	✓
Light	✓
Deactivated	✓

[1] *Chronic-source sediments require additional consideration (see section 4.2)*

2 RIPARIAN MONITORING RESULTS

2.1 RIPARIAN SURVEY SITES

Figure 4 shows the 47 randomly selected sites where riparian reaches were assessed in the Memekay watershed. Field data collection followed a WSEP-adapted (Pickard et al. 2014) version of FREP's Riparian Management Evaluation Protocol (Tripp et al. 2009), which uses 15 distinct indicator-based questions to assess the relative "health," or ecological functioning condition of a survey stream and its adjacent riparian area. The box plots in Table 3 display the range of riparian functioning condition ratings across surveyed stream sites within different habitat categories. Survey results are further refined by evaluation question (Table A1) and causal factor (Table A2) in the Appendix.

2.2 KEY RIPARIAN SURVEY RESULTS

Many stream reaches surveyed showed the effects of old forest harvesting adjacent to, and upstream of, sample reaches (Figure 5), as well as old mass-wasting events (Figures 1 and Table A2). These impacts have resulted in unstable substrates, channel widening, and atypical wood composition and distribution throughout stream channels. Compounding these factors, many harvested riparian areas are too young to be fully functional, and currently lack the forest structure necessary to supply LWD that would stabilize stream banks and provide habitat complexity. In some situations these conditions were exacerbated where old and second growth harvesting occurred on the same stream reach (i.e., on S4, S5, and S6 streams) because pre-harvest LWD has become degraded with no sources of new functional LWD. Many affected riparian areas do not represent natural conditions (Figure 5), whereas unlogged riparian areas are typically fully functional providing a wide range of processes benefiting stream channel condition (Figure 6).

Key Riparian Findings *– Riparian and stream channel condition impaired due to legacy effects of old harvesting; measures promoting riparian recovery recommended.*

Management Opportunities *– To promote recovery, future operational activities should consider retention on all streams and restoration of impacted riparian areas throughout the Memekay watershed.*

Figure 5. *Riparian field survey site M300 – Properly Functioning Condition at high risk (PFC–I). This site is an example of how masswasting upstream has affected the condition of a well-buffered stream reach downstream.*

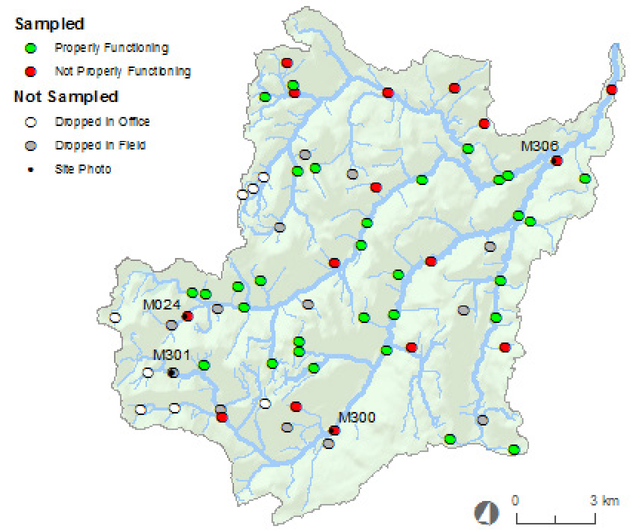

Figure 4. *Riparian survey locations in the Memekay watershed, showing functioning condition ratings, including site identifiers for photos used in the report.*

	PFC			PFC-L		PFC-I		NPF				*n*
	0	1	2	3	4	5	6	7	8	9	10	
NFH		1	4	1	1		2	1				10
FH 1&2	2	1	3	2	3	2	1	2	1		1	18
FH ≥ 3	1	1	3	5	3	3	2		1			19

Riparian samples with corresponding number of "no" answers.

Table 3. *Rollup of riparian samples. Each number in table represents number of survey sites receiving a corresponding number of survey "no" answers (x axis) by strata (y axis). Colored columns represent functional condition categories. (See Table 5 section 5.1 for riparian outcome.)*

Figure 6. *Riparian field survey site M301 – While this sample reach was dropped it is a good example of well managed stream (Properly Functioning Condition (PFC) with riparian buffering, stable banks, sufficient LWD recruitment, etc.) located adjacent to, and downstream of, a series of old cut blocks.*

3 FISH PASSAGE MONITORING RESULTS

3.1 FISH PASSAGE SURVEY RESULTS

Figure 7 shows the 27 crossings where fish passage was assessed in a 2012 census within the Memekay watershed (Nowak et al. 2013). Field data collection followed the Ministry of Environment's "Field Assessment for Fish Passage Determination of Closed Bottom Structures" to assess fish passage at stream crossings throughout the watershed (MOE 2011). This protocol uses a cumulative scoring approach that involves a suite of indicators (e.g., culvert length, slope and embedment, stream width ratio, outlet drop, etc.) to determine the likelihood that a road structure crossing a stream provides safe fish passage. Table 4 displays the distribution of fish passage ratings across surveyed stream crossings by stream category. Observed (i.e. confirmed) and modeled (MOE n.d. and Mount et al. 2011) fish distribution was used to indicate stream crossings with observed, or modeled, fish presence.

3.2 FISH PASSAGE SURVEY SITES

Analysis of road crossings showed that all crossings on observed fish streams (n=12) passed fish. Of all the passable fish stream crossings for observed and modeled (n=19), 17 used open-bottom structures (Figure 8). Eight of the modeled fish stream crossings (n=15) were assessed to be barriers to fish passage. Modeled habitat suggests the eight crossings have suitable lengths of habitat above the stream crossing and two were located on streams with low gradients indicating a probability of being high quality fish habitat (Figure 9). All eight barrier sites on modeled fish habitat used closed-bottom structures and were located on 1st & 2nd order streams. These should be confirmed as fish habitat and prioritized for restoration suitability.

Key Fish Passage Finding *– Open-bottom structures are ensuring fish passage on all stream classes. Eight crossings on 1st or 2nd order modeled fish streams with closed-bottom culverts scored as barriers and need fish presence and habitat quality confirmation prior to restoration.*

Management Opportunities *– To maintain connectivity and accessibility to fish habitat, continue using bridges, open-bottom, properly embedded closed-bottom culverts, and log box culverts at stream crossing sites with fish presence.*

Figure 8. *Located in the North Memekay, this small bridge (Crossing ID# 102823) crosses a 3rd order stream that has over 3km of upstream observed and modeled habitat, and is a good example of a crossing that easily passes fish, storm flows and debris.*

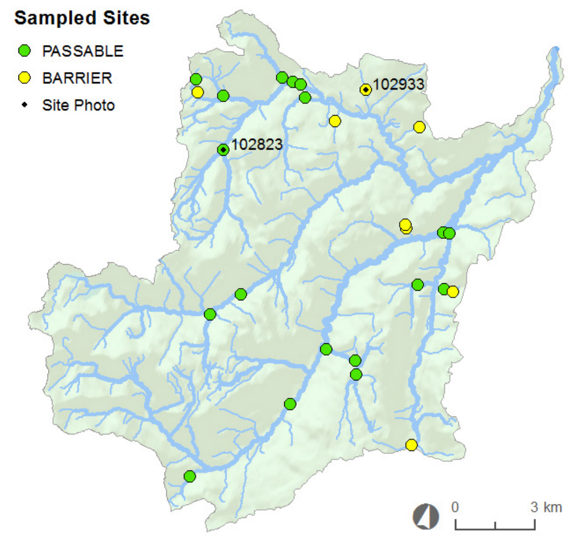

Figure 7. *Fish passage survey locations in the Memekay watershed, showing passage ratings, including site identifiers for photos used in the report.*

	Stream Order	*n*	Passable	Potential Barrier	Barrier
Confirmed Habitat	> 4th Order	6	6	0	0
	3rd order	4	4	0	0
	1st & 2nd Order	2	2	0	0
	Sub Total	**12**	**12**	**0**	**0**
Modeled Habitat	> 4th Order	0	0	0	0
	3rd order	2	2	0	0
	1st & 2nd Order	13	5	0	8
	Sub Total	15	7	0	8
	TOTAL	**27**	**19**	**0**	**8**

Table 4. *Table depicting results of fish passage census throughout Memekay River watershed.*

Figure 9. *Periodically occupied by beaver, this stream crossing is located in the North Memekay. This site (Crossing ID# 103933), estimated to have >800m of modeled upstream fish habitat, is an example of habitat requiring confirmation of (i) fish values and (ii) restoration. While once a small log bridge, the replacement culvert constricts the channel and encourages beaver dam construction. This, and similar closed-bottom metal culvert crossing-sites, are examples of good candidates for replacement with open bottom structures less prone to beaver blockages (Jensen et al. 2001) and better able to pass storm flows and debris.*

4 FINE SEDIMENT DELIVERY MONITORING RESULTS

4.1 FINE SEDIMENT SURVEY RESULTS

Figure 10 shows the 58 sites where fine sediment surveys were completed in the Memekay watershed. Field data collection followed FREP's "Water Quality Effectiveness Evaluation Protocol" (Carson et al. 2009). WQ data was used to assess the extent and nature of fine sediment generation from roads and its probable effect on streams in the watershed (Carson 2015). The box plots in Figure 11 display the range of risk associated with estimated annual fine sediment generation and delivery to streams by road-use classification. Specific remedies intended to improve water quality are provided in the Appendix (see Table A3).

4.2 FINE SEDIMENT SURVEY SITES

Road related fine sediment generation sample-sites with significant impacts were lower than provincial FREP averages. Water quality monitoring showed that 84% of the 58 survey sites had low to very low risk ratings. A single high-risk site (#320) located on a branch line was assessed as generating 5.4 m3 of fine sediment (Figure 12). The eight medium-risk sample-sites had problems related to grader berms, road locations too close to wetlands or streams, and poorly placed or maintained culverts (Figure 13). Impacts at most medium risk sites can be corrected with grader berm management, focussing attention on bridge locations, and the design and location of culverts.

***Key Sediment Delivery Finding** – Most road-related survey sites had a very low or low risk of affecting water quality.*

***Management Opportunities** – Maintain sediment control practices. Most sites of concern can be corrected by improving grader operator training, berm management, culvert design, and road location changes.*

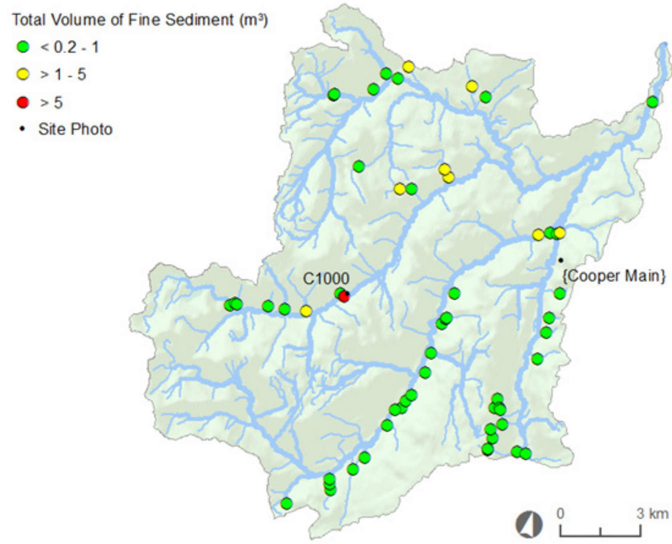

***Figure 10.** Sediment survey locations in the Memekay watershed, the sediment delivery rating at each site, and site identifiers for photos used in the report.*

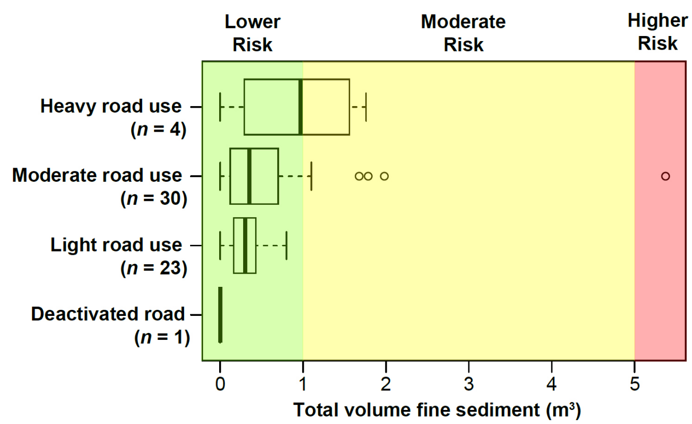

***Figure 11.** Distribution of risk ratings (lower, moderate, higher) from water quality survey sites associated with estimated annual fine sediment generation by road-use classification. (See technical note regarding box plot interpretation in the Appendix.)*

***Figure 12.** Middle Memekay Bridge, Branch C1000, site #320. Grader berms at this location concentrate road surface drainage onto the bridge where it flows directly into the Middle Memekay River.*

***Figure 13.** Cooper Main. On some inactive roads, relief ditches capture small streams, directing concentrated storm flows onto otherwise dry hillslopes. These have the potential to form streams with chronic sediment problems.*

5 MEMEKAY WATERSHED STATUS – SUMMARY

5.1 WATERSHED STATUS & RECOMMENDATIONS

- **Riparian** – Riparian and stream channel condition impaired due to legacy effects of old harvesting; measures promoting riparian recovery recommended.
- **Fish Passage** – Open-bottom structures are ensuring fish passage on all stream classes and some crossings on 1st or 2nd order modeled fish streams with closed-bottom culverts maybe barriers.
- **Sediment Delivery** – Most road-related survey sites had a very low or low risk of affecting water quality.

The results of the Memekay River WSEP show that fish passage and sediment production at stream crossings were meeting benchmarks set as indicators (Pickard et al. 2014) of satisfactory fish passage and road condition. Riparian surveys of functioning aquatic habitat condition however, showed the Memekay watershed to be impaired (Table 5 & 6). Analysis of causal factors related to riparian surveys (Table A2) showed that impacts were largely apportioned equally between: old (pre 1995) harvesting (32%); unknown upstream factors (31%); and natural conditions (27%; e.g. see Figure 15). Current harvesting (post 1995) and roads account for a minor proportion of impacts (5% each). While the outcomes of riparian surveys indicated impairment, the relatively low incidence (Pickard et al. 2014) of impacts attributable to post 1995 harvesting at any of the riparian sample sites assessed suggests that stream channels were not being adversely affected by current forest harvesting activities. Therefore, analysis of post 1995 causal factors related to riparian impacts, along with the results of both the fish passage and water quality surveys, suggests current practices were consistent with the watershed's FSW status. This conclusion does not take into account causal attribution associated with known upstream mass wasting sites, or other unknown upstream factors, above a number of key riparian sample reaches. Impacts associated with old harvesting and unknown factors (Table A2), along with high potential-risk factors identified in Tier I, indicate the need for careful assessment of ongoing activities to ensure they do not compound existing impacts (i.e. result in cumulative hydrological effects) and allow for the recovery of natural watershed processes. The future condition of the watershed will benefit from continued attention to operational (and restoration) activities associated with: unstable terrain; road location, construction and maintenance practices (Figure 14); and the rate and location of harvesting. Special emphasis on accelerating the long-term recovery of riparian function of all streams is recommended, including retaining riparian buffers on class S4, S5, and S6 streams and conducting riparian restoration activities along suitable riparian areas (Tschaplinski 2010; Tschaplinski and Tripp 2017).

***Management Opportunities** – Opportunities exist to improve future outcomes through co-ordinated and careful attention to activities associated with: unstable terrain; road building and maintenance; rate of harvest; with special emphasis on extending riparian buffers to small streams, and accelerating the long-term recovery of riparian function on all streams.*

***Figure 14.** Big Tree Main south of the Jordon Junction in the Memekay watershed. This sign depicts a good example of a road-surface sediment management practice. Along this road section, a grader berm is maintained to allow sediment-laden water to flow past a stream before being directed without harm onto the forest floor.*

RIPARIAN SURVEY RESULTS – WATERSHED SCORE		
	Y/N (%)	**Outcome***
Non-fish Habitat (n=10)		
are < 10% of sites NPF?	N (10%)	
are < 25% of sites PFC-I or NPF?	N (30%)	✗
are > 80% of sites PFC or PFC-L	N (70%)	
Fish Habitat 1st & 2nd order (n=18)		
are < 5% of sites NPF?	N (22%)	
are < 20% of sites PFC-I or NPF?	N (39%)	✗
are > 85% of sites PFC or PFC-L	N (61%)	
Fish Habitat > 3rd order (n=19)		
are 0 % sites NPF?	N (5%)	
are < 15% of sites PFC-I or NPF?	N (31%)	✗
are > 90% of sites PFC or PFC-L	N (68%)	

Fish Passage Survey results	***Confirmed Fish Habitat 1st & 2nd Order (n2)***	***Confirmed Fish Habitat ≥3rd Order (n10)***
Barrier/potential	0%	0%
No barrier	100%	100%
Watershed Score	✓	✓

Table 5 & 6. *Survey results by habitat category. A green score indicates the condition of a sub-component is within the range of acceptable variability, and a red score indicates that the highest threshold has been exceeded (Pickard et al. 2014).*

***Figure 15.** Riparian site M024 – Not Properly Functioning condition (NPF). This naturally occurring slide affected all channel bed and bank attributes, including a portion of the riparian area on this Middle Memekay tributary. While not directly attributed to human activities, this site is indicative of the inherent terrain instability (i.e. sensitivity) in many parts of the Memekay watershed and underlines the need for special management of sensitive characteristics within the fisheries sensitive watershed.*

6 REFERENCES AND DATA SOURCES

6.1 REFERENCES

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6.2 TIER I AND TIER II DATA SOURCES

	Indicators	Data Sources: (a)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Derived GIS layers									
Tier I	Road density			✓	✓				
Tier I	Road density < 100 m from a stream			✓	✓		✓		
Tier I	Stream crossing density			✓	✓		✓		
Tier I	Road density on unstable slopes			✓	✓	✓			
Tier I	Forest Harvest (Figure 3)	✓	✓						
Field Data									
Tier II	Riparian Condition								✓
Tier II	Sediment Delivery								✓
Tier II	Fish passage							✓	✓

Data Sources: (a) 2006 LandSat: (5) Consolidated cut blocks (cut within last 100yrs); (6) DRA roads; (7) FTEN roads; (8) DEM; (9) FWA stream network; (10) MOE fish habitat model Version 2.0; (11) MemekayFieldData_v1_March 28_2014.xls (available from L. Reese Hansen, FLNRO). For detailed information on data sources used for Tier 1 indicators please refer to the WSEP Tier 1 protocol document (Porter etal. 2013).

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THANK YOU

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MORE INFORMATION

For further information, contact: Lars Reese-Hansen, Habitat Management Section, B.C. Ministry of Forests, Lands, and Natural Resource Operations.
Email: Lars.ReeseHansen@gov.bc.ca.

For additional information about FREP, please refer to our website: www.for.gov.bc.ca/hfp/frep.

7 APPENDIX

7.1 ANALYSIS OF RIPARIAN & WATER QUALITY SURVEYS

Table A1. *Riparian survey data breakdown – Summary of each channel and riparian question used in the riparian reach surveys by category and the watershed as a whole. Increasing numbers indicate a higher frequency of recorded impacts related to each riparian question. Frequency is also presented as a percentage of the stratum/strata sample size (n).*

Riparian Question #	*Riparian Question (Indicator) Category*	*Non-fish Habitat (n = 10)*	*Fish Habitat 1st & 2nd order (n = 19)*	*Fish Habitat ≥ 3rd order (n = 19)*	*All Strata (n = 48)*
1	Channel bed disturbance	4 (40%)	4 (21%)	9 (47%)	17 (35%)
2	Channel bank disturbance	2 (20%)	6 (32%)	13 (68%)	21 (44%)
3	Large woody debris characteristics	5 (50%)	7 (37%)	11 (58%)	23 (48%)
4	Channel morphology	0 (0%)	1 (5%)	0 (0%)	1 (2%)
5	Aquatic connectivity	5 (50%)	13 (68%)	3 (15%)	21 (44%)
6	Fish cover diversity	0 (0%)	3 (16%)	0 (0%)	3 (6%)
7	Channel stability (moss abundance/condition)	2 (20%)	7 (37%)	10 (53%)	19 (40%)
8	Fine sediment introduction	2 (20%)	4 (21%)	2 (11%)	8 (17%)
9	Aquatic invertebrate diversity	7 (70%)	10 (53%)	4 (21%)	21 (44%)
10	Windthrow frequency	0 (0%)	0 (0%)	1 (5%)	1 (2%)
11	Riparian soil disturbance/bare ground	3 (30%)	3 (16%)	4 (21%)	10 (35%)
12	Large woody debris supply/root network	1 (10%)	4 (21%)	4 (21%)	9 (19%)
13	Shade and riparian microclimate	1 (10%)	2 (11%)	1 (5%)	4 (8%)
14	Disturbance: increased plants, noxious weeds, & invasive plants	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15	Vegetation form, vigour, and structure (buffer condition)	4 (40%)	8 (42%)	5 (26%)	17 (35%)

Table A2. *The average number of "No" answers caused by different factors on riparian assessments of sample sites in the Memekay River watershed. Numbers in brackets are the % of the total average number of "No" answers for each type of site (Tripp 2016).*

Factors Causing "No" Answers	*Unlogged Sites (n = 11)*	*Pre-Code Sites (n = 19)*	*Post-Code Sites (n = 19)*	*All Sites (n = 48)*
Old logging	0.0 (0%)	2.2 (48%)	0.9 (23%)	1.2 (32%)
Current logging	0.0 (0%)	0.0 (0%)	0.5 (13%)	0.2 (5%)
Roads	0.0 (0%)	0.4 (8%)	0.1 (1%)	0.2 (5%)
Natural events or conditions	1.7 (67%)	0.7 (15%)	1.1 (29%)	1.1 (27%)
Unknown upstream factors	0.8 (33%)	1.4 (30%)	1.2 (33%)	1.2 (31%)
All	2.5 (100%)	4.6 (100%)	3.7 (100%)	3.8 (100%)

Table A3. *Observed water quality fixes – a list of roads randomly surveyed as part of the 2012 Watershed Status Evaluation Protocol (WSEP) showing where potential treatments would result in improvements to water quality. Additional treatments may be required elsewhere in the watershed on roads not assessed as part of the WSEP.*

Site #	*Road Use*	*Fine Sediment Generated (m^3)*	*Issue*
320	Branch	5.4	Remove berms
271	Branch	2	Too close to wetland
273	Branch	2	Remove berms
324	Branch	1.8	Too close to stream
264	Branch	1.76	Remove berms
263	Branch	1.7	Remove berms
270	Branch	1.36	None
321	Branch	1.1	Too close to stream
318	Branch	1.04	Install culvert

HOW TO READ A BOX PLOT

Box plots are one of the best ways to represent data; they illustrate the center, the spread, and the shape of the data. The data are plotted and divided into quartiles (i.e., groups containing 25% of the data). The *median* represents the mid-point of the data (i.e., 50% of the values are above/below this point). 25% of the data fall below the *Lower quartile* and 25% of the data fall above the *Upper quartile*. The box thus represents the *Interquartile Range* or the middle 50% of the data. An additional benefit to box plots as they are used in this report is to show the raw data overlaid on the current thresholds. This allows the reader to imagine how the interpretation would change if the thresholds were different.