Wasa Lake and Cameron Pond
Sensitive Habitat Inventory and Mapping

Prepared for:

East Kootenay Integrated Lakes Management Partnership

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Cover photos clockwise from top (Holmes, July 2009): Segment 6, Segment 2 (Robert's Bay) at the south end of lake, and Segment 7.

Disclaimer

The results contained in this report include some data collected by parties other than Interior Reforestation Co. Ltd. (Interior Reforestation), including a fish and wildlife survey and orthophoto delineation. Interior Reforestation and the authors assume that data collected by the other parties are accurate and reliable. Use or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Interior Reforestation, nor the authors of this report are liable for accidental mistakes, omissions or errors made in its preparation because best attempts were made to verify the accuracy and completeness of data collected and presented.

Executive Summary

Wasa Lake and neigbouring Cameron Pond are located in the Southern Interior of British Columbia, north of Cranbrook. The East Kootenay Integrated Lake Management Partnership (EKILMP) commissioned Interior Reforestation to complete the following work for these water bodies: 1) Foreshore Inventory and Mapping (FIM), 2) a Fish and Wildlife (F&W) Assessment, and 3) Shoreline Management Guidelines for Fish and Wildlife Habitats. These three components together comprise this Sensitive Habitat and Inventory Mapping report.

The purpose of the FIM project was to provide baseline information on foreshore condition and environmental values. This was achieved by following FIM Standards which included the collection of field data and a literature review of known environmental values. Field reviews were initially completed on Wasa Lake in June 2008 by EKILMP partners, who collected data on foreshore morphology, land use, riparian condition and anthropogenic alterations for the lake. This information was supplemented by Interior Reforestation field reviews in December 2008 during low water levels and May 2010 to also include the neigbouring Cameron Pond.

The shoreline of **Wasa Lake** was determined to be 7,553 m, which was delineated into 10 segments, based on contiguous characteristics. The most prevalent shore types were Sand/Gravel Beach (38%), Vegetated Shore (33%) and Sand Beach (26%). Wetland (3%) and Stream Mouth (<1%) contributed to lesser extents. The foreshore was disturbed along 64% of its length. These disturbances were mainly related to residential land use activities (52%), while some were associated with park recreational uses (8%) as well as other Crown Land usage (4%). In the littoral zone (waters edge to where sunlight could penetrate) and the shoreline zone (water's edge), the most prevalent modifications were dock placement and beach grooming (conversion to sand beach through sand placement and/or removal of shoreline vegetation). Beach grooming appeared to have particularly large impacts on the foreshore diversity by reducing vegetation (both terrestrial and aquatic) and gravel substrate features. Higher up the foreshore, disturbances to the riparian and upland vegetation areas included conversion to lawns and other landscaping. The natural shoreline sections were mainly in Wasa Lake Provincial Park (23% of total shoreline) and at the south end of the lake (Segment W2) in undeveloped private lands.

The shoreline of **Cameron Pond** (2,483 m) was delineated into 3 segments consisting of Vegetated Shore Type (54%), Wetland Shore (42%) and Stream Mouth (5%). A high proportion of Cameron Pond remained natural (90%). 54% of the shoreline is owned by The Nature Trust with retention of natural values as the key objective.

EKILMP conducted fish and wildlife field assessments July 14, 2009 on Wasa Lake proper. Interior Reforestation completed a wildlife assessment on Cameron Pond on May 20, 2010 and a sensitive plant study on June 8, 2010. These data as well as literature review information on species and habitats were used to document the ecological status of the shoreline. **The foreshores of Wasa Lake and Cameron Pond were found to be biologically diverse and important to numerous plant, fish and wildlife species.** Several sensitive species have been reported to inhabit or potentially inhabit the area, including: one fish species, two ecological plant communities, seven plant species, two invertebrate species, ten bird species, two amphibians and one mammal. As well, there are potentially three sensitive grassland and open forest ecosystems in the area. Maintaining functioning habitats for these species is considered important.

An Aquatic Habitat Index (AHI) analysis was used to score and rank each shoreline segment in terms of its biological value. The AHI used numerical data from four categories of parameters: 1) biophysical, 2) Zones of Sensitivity, 3) riparian and 4) modifications. Parameter values were based on their positive or negative contributions to environmental health. Zones of Sensitivity for the project area were determined to be: 1) native fish spawning area, 2) biologically productive area (e.g., rearing habitat for native fish), 3) sensitive plant species, and 4) bird staging area.

Existing Ecological Shore Rankings from the AHI for **Wasa Lake** were: Very High - 7% (515 m) of shoreline, High – 21% (1572 m), Moderate – 15% (1128 m), Low – 26% (1998 m), Very Low - 31% (2340 m). With restoration (modifications removed), the AHI also determined that six segments would improve by one ranking.

Existing Ecological Shore Rankings from the AHI for **Cameron Pond** were: Very High - 46% (1150 m) of shoreline, High – 26% (657 m), and Moderate – 27% (676 m). There were no Low or Very Low ranked areas for Cameron Pond. Analysis suggested restoration would not increase Cameron Pond shoreline rankings.

The Shoreline Management Guidelines were prepared using templates from other lake studies completed in the region, (e.g.,Windermere and Moyie Lake). Segments were colour coded and mapped using the AHI rankings. Appropriate activities for each colour zone were identified. Segments ranked as Very High are coloured Red. These areas are designated for conservation use. Guidelines recommend no development occurs within Very High segments other than very low impact activities. Segments ranked as High are coloured Orange, indicating that they are sensitive to development. An environmental assessment would be required for most activities. Moderately ranked segments are yellow and Low and Very Low are coded as grey shoreline. **Although a greater number of activities are permissible in areas with lower ecological value, proper planning is still required to protect environmental values.**

The information collected will aid government and organizations overseeing foreshore and upland developments. It serves as a benchmark by documenting land use and riparian habitat changes, necessary for the development of regulations, standards, policies and education materials. Several recommended actions are proposed, including: conducting additional species and habitats inventories, addressing modifications, protecting environmentally sensitive areas, conducting monitoring and further educating the community.

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1 Introduction

Wasa Lake (historically known as Hanson Lake) and the adjacent Lewis Slough (locally known as Cameron Pond) are the focus of this study. The water bodies are situated along Highway 93-95, within a half hour drive of Cranbrook and Kimberley (Appendix A). Wasa Lake is a cottage community comprised of summer residences, permanent homes, small businesses, a provincial park and campgrounds. Its sandy beaches, scenic mountain setting, and warm, shallow waters make it an attractive recreation and retirement area. People from nearby communities as well as tourists from the United States and Alberta utilize the lake.

Overall, as with many lakes across the province, Wasa Lake's growing recreational popularity has resulted in an increase in foreshore disturbances. Historically at Wasa Lake, many of the foreshore dwellings were cabins with a relatively small footprint (MacLeod pers. comm.); however, with escalating property values many of these cabins have been sold and the new owners have often converted them into 'dream recreational getaways'. The dwellings that have replaced the cabins tend to cover a larger area of the land, include more or larger shoreline structures (such as docks and groynes) and shoreline alterations (beach grooming, dredging and riparian disturbance). These alterations and their potential negative impacts on the foreshore environment have become a concern with local citizens and regulatory agencies. Table 1 shows that at Wasa Lake, 84% of lakefront properties are owned by seasonal residents, while 16% are occupied year round. At Cameron Pond, 54% of lakefront properties are owned by seasonal residents, while 46% are occupied year round (WLLID 2010).

Table 1. Wasa Lake and Cameron Pond Property Ownership Statistics (WLLID 2010).

	Wasa Lake	Cameron Pond
Total number of Properties (n)	115	13
Alberta Seasonal	58%	38%
BC Seasonal	26%	8%
Year Round	16%	46%
Out of Country	<1%	8%

The WLLID provides representation for Wasa Lake citizens. The WLLID's objective is to identify management issues, provide development direction and education, and initiate necessary planning activities required for the improvement of the Wasa Lake area. The WLLID is a member of the East Kootenay Integrated Lake Management Partnership (EKILMP). The EKILMP formed in 2006 in response to concerns over the very fast pace of foreshore development in the East Kootenay (EKILMP 2006). The partnership aims to protect lakes in the East Kootenay by encouraging integrated and coordinated approaches and providing guidance on best practices and restrictions of use where necessary (EKILMP 2009). The partnership is comprised of the following government, First Nations, environmental and other non government organizations:

- BC Integrated Land Management Bureau;
- BC Ministry of Environment (Water Stewardship, Environmental Protection & Environmental Stewardship divisions) (BC MoE);
- Canadian Columbia River Inter-Tribal Fisheries Commission (CCRIFIC) representing A'kisq'nuq First Nation (AFN), Shuswap Indian Band and Ktunaxa Land and Resource Council;
- District of Invermere;
- Fisheries and Oceans Canada (DFO);
- Interior Health Authority;
- Regional District of East Kootenay (RDEK);
- Transport Canada;

- Village of Canal Flats;
- Wasa Lake Land Improvement District;
- Wildsight;
- Moyie Lake Community Association;
- Jimsmith Lake Community Association;
- Rosen Lake Ratepayers Association; and,
- Tie Lake Community Association.

This study is the result of a community driven initiative under the stewardship and funding of the WLLID. In-kind help and funding has also been provided from Columbia Basin Trust (CBT) Environmental Initiatives Program, BC MoE, DFO, RDEK, EKILMP and Wildsight. The WLLID worked with EKILMP to have Wasa Lake included as one of the lakes to be assessed and mapped in order to achieve improved foreshore protection and management. This document is considered to be a "living document" and it is inherent that the WLLID and Wasa Lake community will be actively involved in the protection and advocacy for their lake (Ashmore pers. comm.).

In order to help provide foreshore management direction and educate the public, Interior Reforestation Co. Ltd. (Interior Reforestation) has been commissioned to undertake this report which includes: 1) Foreshore Inventory and Mapping (FIM), 2) Fish and Wildlife (F&W) Assessment, and 3) Shoreline Management Guidelines (or Guidelines). The Guidelines will be used in decision-making by all levels of government, developers, planners and other interests. This report will follow accepted standards established in similar studies completed in the region, including Columbia Lake (McPherson *et al.* 2010), Moyie and Monroe Lake (Schleppe 2009), and Windermere Lake (McPherson and Hlushak 2008, and EKILMP and Interior Reforestation 2009). The 2009 FIM completed for Wasa Lake (McPherson *et. al.* 2009) has been superseded by this report because this document has incorporated and expanded on the earlier presented FIM findings. A major change to the 2009 FIM has been the inclusion of Cameron Pond into the study area. This area was added because of its connectivity to the lake and local significance.

A future goal of the WLLID is to develop a Lake Management Plan (LMP) for Wasa Lake and Cameron Pond (Ashmore pers. comm.). This report contains three important environmental components that would contribute to the development of the LMP (Figure 1). Water quality and quantity objectives, and social and economic values are additional components used in the development of the LMP, not included here.

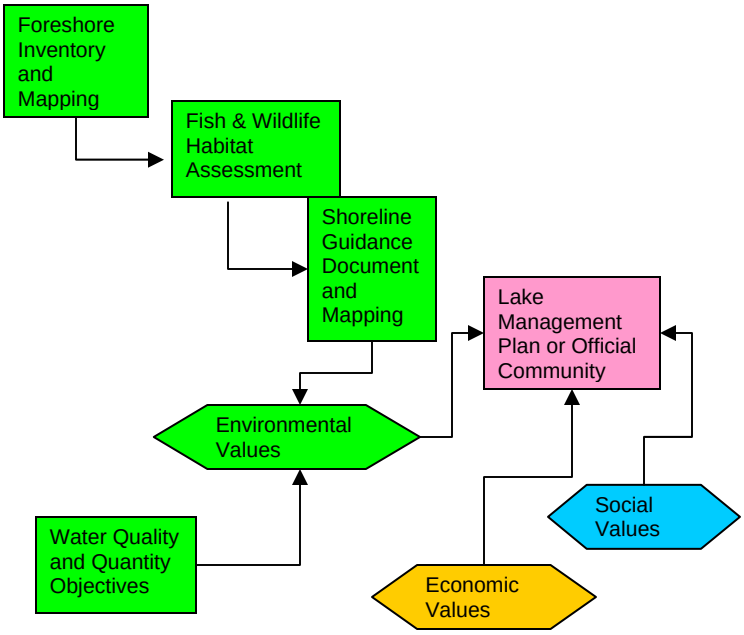


Figure 1. Lakeshore Inventory and Management Planning Process (Holmes pers. comm.)

1.1 Foreshore Significance and Sensitivity

In BC, the lake foreshore is defined as the land between the high and low water mark. This area, including the permanently wetted lake area is considered 'Aquatic Crown Land' and falls under the limits of provincial jurisdiction. Land adjacent to foreshore may be privately owned, but in common law the public retains the privilege or "bare licence" to access the foreshore. Individuals cannot build on or develop Aquatic Crown Land, including Crown foreshore, without the province's authorization, even if they own adjacent property or "upland" (BC Ministry of Agriculture and Lands 2009).

The foreshore is an important link between the aquatic and terrestrial environments, and has important biological, ecological and social significance and is extremely sensitive to disturbance (Regional District of Central Okanagan [RDCO] 2005). The foreshore has four components: the littoral zone, the shoreline, the riparian area and the upland zone (Figure 2).

Littoral Zone

From the water's edge to where sunlight no longer penetrates the lake bottom.

Up to 90% of the species in the lake either pass through or live in this zone. This area is important for primary production (production of plants). Stones, twigs and plants are important components, serving as substrates for food production and providing a variety of habitats for animals. This is a typical area for ducks to forage on plants and invertebrates; as well as for fish to spawn, and then to forage and seek cover as juveniles. Plants in this area are important in converting sunlight into food and releasing oxygen.

Shoreline

Where the land and the water meet.

This is an important barricade against erosion. Naturally, it is a profusion of stones, plants, shrubs, fallen limbs and tree trunks. It is also a busy intersection for animals, insects and birds travelling back and forth between the lake and the upland areas. Overhanging vegetation here shades and cools the water and provides important food sources for fish.

Riparian and Upland Zones

The riparian area is the land closest to the foreshore and the upland is the higher, drier ground.

Vegetation in the riparian and upland zones provides a barrier for contaminants entering the lake as runoff (including septic seepage, fertilizers and pesticides). Deep roots of trees stabilize the slopes and the forest canopy cools the area. This is an important refuge for wildlife, for example, tall grasses are used by water birds for nesting, and in the winter it provides shelter to many animal species.

Figure 2. Definition of the foreshore components – littoral zone, shoreline, riparian and upland zones (Fisheries and Oceans Canada 2008)

Foreshore vegetation, habitat structure and species use is commonly altered by anthropogenic disturbances. Holmes (pers. comm.) provided the following description of common foreshore disturbances:

> *Types of disturbance include direct habitat loss, loss of native plant communities, avoidance, alteration of predator prey relationships and direct mortality. For instance, road and house construction result in direct habitat loss and alterations of natural drainage patterns. Conversion of natural vegetation to ornamentals results in removal of native nesting and foraging habitats. Human presence reduces species use of desired attributes through avoidance and through alteration of structure such as kids playing in a sand or clay bank and destroying nesting sites of bank swallows. Most predator species tend to avoid areas with high human densities resulting in prey species congregating in other areas and abnormal population levels. Furthermore, many species considered a nuisance, such as bats, are killed by property owners, and domestic animals prey on birds and other small vertebrates.*
>
> *Few studies have been undertaken to assess the impacts on wildlife resulting from increased development around lakes. One study, however, showed increased foreshore development does have a significant influence on the presence of some breeding bird species (Lindsay et. al. 2002). The study found that the most dramatic effects from development on lakeshores were changes in nesting guilds. Developed lakes had more seed-eaters and fewer species dependent on insects and shrub nesting birds. The reduction in shrub nesters was explained by the removal of shrubs in yards and by increased success of predators.*

Woodford and Meyer (2003) found that human caused riparian and littoral zone alterations also impacted amphibians. Their study revealed that green frog densities were reduced where coarse woody debris and wetland plants were removed.

Habitat complexity in the littoral zone is also important to fish productivity. Coarse woody debris, aquatic macrophytes and substrate compositions are habitats important to fish that often become compromised as a result of foreshore development. Developments can impact these habitats through direct removal of vegetation, construction of structures (such as piers, docks and marinas), and alteration of the shoreline with riprap or concrete (e.g., retaining walls and groynes). Radomski and Goeman (2001) found that developed shorelines had substantially less emergent and floating leaf vegetation than undeveloped shorelines; and that the abundance of three fish species in Minnesota Lakes was positively correlated with emergent and floating plants. At lakes with greater development density, Jennings *et al.* (2003) also found that the quantity of woody debris, emergent vegetation and floating vegetation decreased and that littoral sediment contained more fine particles increasing substrate embeddedness. Embeddedness occurs when finer materials (silts/sands) fill in the interstitial spaces between courser substrates, and can be a concern because it reduces flow/permeability, surface area for phytoplankton and invertebrates and can smother eggs (Bisset pers. comm.).

1.2 Current Foreshore Management and Issues

Currently, land use activities at Wasa Lake adhere to the Wasa - Ta Ta Creek – Skookumchuck - Sheep Creek Land Use Bylaw (RDEK 2007), administered through the RDEK. The Environmental Policies (Section 3.07) in the bylaw are generally aimed at higher level planning. Policies that are most relevant to foreshore protection are as follows:

- Item 10 - New development near watercourses and water bodies will only be approved in accordance with floodplain management provisions provided by BC MoE;
- Item 20 - The feasibility of establishing boating restriction on Wasa Lake will be investigated;
- Item 21 - Further alienation of the foreshore for private use will not be supported;
- Item 22 - All alterations to the foreshore, including adding or removing fill require a permit from the Water Management Branch of BC MoE;
- Item 23 - Excavation below 766.72 m GSC is not supported;
- Item 24 - An application will not be supported for a private commercial marina on Wasa Lake. However, the concept of owners presently having individual docks, wishing to consolidate those docks into one facility will be supported, in the interest of improving safety and public access to the foreshore;
- Item 25 - Removal of all unlicensed water intakes on the lake is supported. Further, licensing water intakes on Wasa Lake for private irrigation purposes is not supported;
- Item 27 - Habitat and riparian improvement initiatives on private lands will be supported, subject to regulatory approvals; and
- Item 29 - In order to protect water quality, further subdivision around Wasa Lake will be restricted through minimal parcel size, floodplain management considerations and sewage disposal regulations.

Although this land use bylaw determines what can occur on an individual parcel of land and references some federal and provincial regulatory requirements, it is limited in providing specifics relating to environmental protection or implementing a community vision; this increased level of detail could be achieved through Development Permit Areas for the protection of Environmentally Sensitive Areas. The Official Community Plan (OCP) for Windermere Lake, for example has such areas outlined for wildlife habitat and corridors (RDEK 2008).

At Wasa Lake, the RDEK has typically only received referrals for projects requiring a License of Occupation under the Land Act (such as docks or sale/other alienation of Crown Land), and not very many referrals have come forth (MacLeod pers. comm.). There are numerous examples of other possible uses that would require an application to the Crown; these will be outlined in the Guidance Document portion of this study. Management issues at Wasa Lake have arisen when

land owners have ignored or 'creatively interpreted' statutory requirements relating to the protection of habitat. Violations of the province's *Water Act* at Wasa Lake have been reported when sand was spread on the beach causing damage to the foreshore (West Coast Environmental Law 2007). Government agencies have not been able to effectively address many of the problems; however, this process is intended to help with planning and education to minimize shoreline disturbance in sensitive areas.

1.3 Objectives

The objectives of this study are to provide an overview of foreshore habitat condition (FIM component), rank contiguous shoreline segments based on their fish and wildlife habitat values (F&W component); and prepare shoreline management guidelines for the ranked segments, specifying development risks of various activities. These objectives will be achieved through completion of the following activities:

1. Foreshore Inventory and Mapping

- Delineate the shoreline into segments, based on contiguous physical features using field findings and geographic data;
- Inventory foreshore morphology, land use, riparian condition and anthropogenic alterations within each of the segments; and
- Update the 2009 FIM report to include Cameron Pond.

2. Fish and Wildlife Assessment

- Report on fish habitat values using field and literature findings;
- Report on wildlife habitat values using field and literature findings;
- Prepare an index that ranks habitats along the foreshore based on biophysical attributes; and,
- Develop a GIS database on the ecological integrity of the lake's foreshore.

3. Guidance Document

- Colour code segments, based on their habitat index values; and
- Identify risk for development activities in each colour zone.

2 Methods

Field inventory and mapping of the Wasa Lake foreshore was conducted according to *Standard Methods for Completion of Foreshore Inventory and Mapping Projects* (Schleppe and Mason 2009; herein FIM Standards), which were developed from Sensitive Habitat Inventory Mapping (SHIM) procedures (Mason and Knight 2001). Additions or omissions to the FIM Standards have been outlined below. The F&W Assessment and the Shoreline Management Guidelines generally adhered to methods used at Moyie Lake (Schleppe 2009), which are the result of refinements from other earlier studies, namely shoreline F&W assessments at Okanagan Lake (Schleppe and Arsenault 2006) and Windermere Lake (McPherson and Hlushak 2008).

2.1 Field Review

Field reviews and office analysis were used to prepare this report which includes updates to the initial FIM document prepared in 2009 (McPherson *et al.* 2009), as well as F&W assessment and Shoreline Management Guidelines. The following field assessments were conducted:

- The initial FIM field assessment was conducted on June 5, 2008 from a boat by Peter Holmes (BC MoE) and BC Conservation Corps staff (Erica Heel, Brendan Guy and Erica Jenkins).

- With funding from DFO and BC MoE, Terrasaurus Ltd. flew Wasa Lake in July 2008 and created orthophotos and used these to classify and delineate vegetation.
- Interior Reforestation staff (Darcy Hlushak and Sherri McPherson) revisited the shoreline during low water conditions on December 7th and 10th, 2008.
- EKILMP members conducted the field-sampling component for the F&W study of Wasa Lake on July 14, 2009, which included sampling fish and aquatic invertebrates and documenting wildlife observations. Individuals involved in data collection included Peter Holmes (BC MoE), Bruce MacDonald (DFO) and Heather Leschied and Kalista Pruden (Wildsight).
- Interior Reforestation (Sherri McPherson, Ian Adams and Darcy Hlushak) conducted a FIM and wildlife assessment on Cameron Pond on May 20, 2010 following a request by the WLLID to also have it also incorporated into the study area.
- Interior Reforestation (Mary Louise Polzin and Aden Stewart) conducted a vegetation assessment of the project area on June 8, 2010.

2.2 Foreshore Inventory and Mapping

FIM report development involved:

1) summarizing available information on environmental values;
2) preparing detailed descriptions for each segment,
3) analyzing and summarizing biological and physical data for the lake using the FIM database; and,
4) using GIS to map segment locations, emergent vegetation polygons, and other pertinent segment data.

During the field assessment, the shoreline was delineated in contiguous segments based on biophysical features. Standard FIM data for each segment was collected to provide an understanding of features and condition. This data was summarized in a database and includes parameters such as: segment length, land use, shore type, substrates, riparian cover, aquatic vegetation, shoreline modifications and flora and fauna details. Interior Reforestation updated the June 2008 database provided by EKILMP using the December 2008 and May 2010 field review data and orthophoto analysis. Description of the alterations made to the original field data provided by EKILMP and lake specific parameter definitions not outlined in the FIM Standards are as follows.

2.2.1 Updates to the Original Foreshore Database

The following updates were made to the original Wasa Lake foreshore database following an office exercise using orthophotos and field review findings:

1. Segment W2 data was updated using a winter field assessment and orthophoto delineation results to include Robert's Bay, located at the southern end of the lake.
2. Segment W5 initially extended along the western shore from the midway point to the northern tip. This area was mainly represented by private dwellings; although, near the mid point, a substantially sized, natural, vegetated park area exists. Interior Reforestation identified this park area as its own segment and appropriately updated the database.
3. Substrate sizes are defined in the FIM Standards (Schleppe and Mason 2009). At Wasa Lake/Cameron Pond, substrates were one of silts/organics, sands (0.06 to 2 mm), gravels (2 to 64 mm), or cobble (64 – 25 mm). The substrates were predominantly classified to be 'fines or sands' during the high water field assessment (June 2008). During inspection under lower water conditions (December 2008) and the F&W assessment (July 2009), it was apparent that the substrates at the mid-low water levels included gravel substrates along much of the shoreline (Figure 3). These areas generally typified natural conditions, where sand placement (beach grooming) had not occurred. Also, in many areas gravels were constrained to the upper

margins of the beach. The database was updated to include these Sand/Gravel Shore Types and to provide the composition (percentage) of substrates for each foreshore segment.

Figure 3. Example of Sand / Gravel Shore Type. Photo: McPherson Dec. 2008.

4. The database was updated to include the 'Stream Mouth' Shore Type, which are areas important to fisheries values and overall biodiversity.
5. Transition Associations are ecosystems that have structural similarities to wetlands (although they are not classified as wetlands based on soils or vegetation criteria) and frequently occur adjacent to wetlands in a zone transitional to upland ecosystems (MacKenzie and Moran 2004). Transition vegetation is an important component of the shoreline since it contributes to biodiversity (e.g., by providing habitat diversity, foraging areas, high prey densities, and rarity in the landscape) (Mackenzie and Moran 2004). It also helps stabilize the shoreline, and acts as water purifier/filter between the upland and the lake. During the December 2008 field review, transition vegetation was identified near the high water mark and was subsequently mapped using the 2008 orthophotos and field surveys. The mapped results were used to identify the percentage of shoreline extent (m) with transition vegetation.
6. Vegetation classification and delineation along the Wasa Lake shoreline was completed by Terrasaurus using orthophotos. Delineation occurred to a distance of approximately 100 m upland from the low water mark and included eight vegetative features ranging from coniferous through to wetlands as well as roads, trails and man-made structures. Interior Reforestation conducted a spatial analysis and summarized the orthophoto results by segment.
7. GIS and orthophotos were used to determine the following riparian values, necessary for the F&W Aquatic Habitat Index: Band 1 Riparian Bandwidth (Band 1 and 2), Riparian Bandwidth Score (Band 1 and 2), Vegetation Quality Band Score (Band 1 and 2), and overhanging vegetation.
8. The 2008 orthophotos were used to update the number of docks present in each segment. The number of docks attached to the shoreline were discerned separately from those floating further off from the shore. This is because the attached docks tend to have a larger footprint and potentially disturb the shoreline to a greater extent (i.e. impact vegetation).
9. Cameron Pond, located approximately 300 m south of Wasa Lake and is connected during flood periods to Wasa, was included in the FIM following field review on May 20, 2010 (Appendix A).
10. The Wasa Lake and Cameron Pond segments were made distinguishable from one another using either the W-prefix (for Wasa) or the C-prefix (for Cameron Pond). Thereby, W1 is Wasa Lake's segment 1 and C1 is Cameron Pond's segment 1.

2.2.2 GIS Products

The shoreline of Wasa Lake was defined by digitizing the boundary using the July 2008 orthophotos. The shoreline of Cameron Pond was delineated using orthophotos from the BC Web Mapping Service (Geo BC, 2010); the date of these orthophotos was not specified and can be any time between 1995 and 2004. Delineation using orthophotos provides a higher level of accuracy (+/- 5 m) than delineation using TRIM base (+/- 20 m). Segment breaks were interpolated by overlying GPS locations and field markers onto the base map. Necessary updates were made to the 2009 FIM biophysical results (e.g., segment lengths, extent disturbed) using the revised orthophoto based boundaries.

The legal boundaries of properties (parcel fabric) around the lake were provided by the RDEK. The RDEK parcel fabric metadata states horizontal accuracy of approximately +/- 10 m. The RDEK makes no warranties or representations concerning the validity or accuracy of the data. Any errors evident in the parcel data (legal lines) may either stem from the RDEK base data or the orthophoto rectification completed by Terrasaurus.

The Sensitive Habitat Inventory and Mapping Methods (Mason and Knight 2001) and the Foreshore Inventory and Mapping Standards (Schleppe and Mason 2009) provide additional technical procedures including GPS, data management, database development and quality control.

2.2.3 Integration of the FIM into the Community Mapping Network's Digital Atlas

The Community Mapping Network (CMN) provides online natural resource information and maps and makes it accessible to the public through a user friendly mapping system. The database, mapped results and video footage from this study will be provided to the CMN database manager so that it may be incorporated into the digital atlas, located at www.cmnbc.ca.

2.3 Fish and Wildlife Assessments

2.3.1 Vegetation Survey

A floristic survey of the shoreline of Wasa Lake and Cameron Pond was completed on June 8, 2010 to determine if there were any sensitive vascular plant species or ecological communities in the study area. The survey involved looking for potentially sensitive lacustrine (associated with lakes) and palustrine (associated with wetlands) species in the Ponderosa Pine Kootenay dry hot Biogeoclimatic subzone variant (PPdh2), listed by the BC Conservation Data Centre (BC CDC 2010). A review for other species and communities not previously listed was also included. The survey also identified dominant vegetation along the shoreline such as emergent vegetation, grasslands, and shrubs.

The floristic survey used a systematic survey search pattern, as outlined by the Native Plant Society of Saskatchewan (1998). This involved a two person crew walking a series of roughly parallel transects in a search unit to maximize coverage of the area. Spacing of the search transects depended on the density of the vegetation cover, visibility through it, and the size of the plants in it. For the grasslands, the width of the transect lines were ten metres apart. Surveys extended 50 m up from high water mark. The survey was constrained to a one day period; therefore, segments that had the highest availability of native vegetation or the least impacted by anthropogenic alterations were reviewed as a priority. The survey reviewed Segments W1, W2, W4, W6, W8, W10, C1, C2 and C3. The floristic survey only represents plants present at the time of sampling and does not represent a complete survey which is typically undertaken up to six times during the growing season.

2.3.2 Fish Sampling and Analysis

Fish assessments were completed at 7 sites in Wasa Lake (representing 7 out of the 10 segments on the lake) on July 14, 2009. Snorkel and seine sampling techniques were utilized to obtain information on species presence and relative abundance. The following details were recorded for each site sampled: a description of substrate type, general aquatic vegetation details, air temperatures, water temperatures, numbers of each fish species, life stage for fish, as well as site observations. Any fish captured were released in the area where they were found once sampling data was recorded.

To provide a general understanding of fish use at each sample site, relative abundance was calculated for each species. Data from all sampling techniques was pooled in the relative abundance calculations. Where raw data provided numbers that were not absolute (e.g., >200 or 100+), only the whole number (e.g., 200 or 100) was considered for mathematical and graphical purposes.

Using the 2009 field data and historical accounts, a fish summary was prepared that discussed Wasa Lake specific data and identified important habitats and interactions, particularly for sensitive or regionally significant species. Known critical habitat for native fish species along the shoreline was included in the AHI as an area of biological significance or Zone of Sensitivity (ZOS). For this analysis, native fish values were considered sensitive because of the high incidence of non native species. This approach differs from other lakes (e.g., Columbia or Windermere Lakes), where only habitat for sensitive species (as identified by the BC CDC) or regionally significant species (as identified by BC MoE or DFO) were included in the AHI.

No fish assessment was conducted for Cameron Pond, although it is recommended. The fish assessment was not undertaken because Cameron Pond was added to the project area after the EKILMP completed their field work. Given budget limitations and the fact that background data suggested that fish values were not high, it was decided that efforts should be focused on reviewing other biodiversity values (i.e., wildlife and vegetation). Historical fish information, current understandings from BC MoE fisheries staff, and evaluation of similar shorelines from other studies were used conservatively to evaluate Cameron Pond segments and identify ZOS.

2.3.3 Aquatic Invertebrate Sampling and Analysis

Aquatic invertebrates were sampled at four sites around Wasa Lake, representing three shore types on July 14, 2009. A standard sized D-net was placed into the water and the substrate was disturbed by kicking and vigorous hand rubbing of larger substrates (i.e., large cobble and small boulders) to dislodge invertebrates. For each site, the total area disturbed was approximately 2 m x 2 m, and the duration of the disturbance was 1.5 to 2 minutes. The contents were transferred from the D-net to a white tray and invertebrates were identified by order. Following identification, all of the invertebrates were returned back to the water.

In the office, Interior Reforestation transcribed data to a spreadsheet, and data was updated to identify all samples to Order. Simpson's Index of Diversity was utilized to account for the richness and evenness of the samples collected at each site. This biodiversity index measures the probability that two individuals randomly selected from a sample will belong to different species. The value of this index ranges between 0 and 1; 0 represents no diversity and 1 represents infinite diversity.

Equation 1: Simpson's Index of Diversity $\mathbf{1 - [\sum n(n-1) \div N(N-1)]}$

Where:

n = the total number of organisms of a particular taxon
N = the total number of organisms of all taxa

2.3.4 Wildlife / Sensitive Species Observations and Analysis

The wildlife assessment for Wasa Lake proper was completed during the July, 2009 field program. The assessment involved walking along the upland side of the foreshore area (approximately 200 m length and 50 m or more in width) at each site where a fisheries assessment was completed. Species presence (particularly bird) and other wildlife attributes were recorded. Bird presence was reported using both visual and audio accounts. Wildlife assessment for Cameron Pond was completed in May, 2010 by Ian Adams. This work was conducted from a canoe paddled slowly around the shoreline of the pond with all wildlife attributes recorded. All birds were identified by sight or sound.

A review of the BC CDC records was conducted to identify sensitive vegetation and wildlife species potentially in the area. Where background information was available, a short summary on each sensitive species was provided. Additional accounts for wildlife species closely associated with foreshore ecosystems are also provided. Any confirmed habitat for sensitive species along the shoreline was included in the AHI as an area of biological significance or ZOS.

2.3.5 Aquatic Habitat Index

The Aquatic Habitat Index (AHI) estimates the environmental sensitivity or biological value of the shoreline. The index incorporates physical and biological data into a model which analyses and ranks each segment. For consistency and comparison between lake systems, the AHI methods closely followed those used in the recently completed Moyie F&W study (Schleppe 2009) and those used at Windermere Lake (McPherson and Hlushak 2008). Lake specific modifications to the analysis were incorporated to account for attributes of local significance. Schleppe and Arsenault (2006) deserve special recognition for initially developing this complex matrix for Okanagan Lake.

The AHI uses physical (FIM data) and biological (F&W data) variables to mathematically score each segment. The scores allow segments to be compared to one another, to determine their importance to fish or wildlife habitat. The index incorporates both positive habitat features such as natural areas that add to the habitat value of a segment, and negative habitat features such as marinas which decrease the habitat value. Parameter values were based upon their positive or negative contribution to aquatic habitat.

The index includes four categories of parameters: 1) Biophysical, 2) Zones of Sensitivity, 3) Riparian and 4) Modifications. Table 2 summarizes the categories and parameters that were incorporated into the index and provides a summary of calculations and associated parameter values. The following section briefly describes the parameters in terms of how they contribute or detract from the habitat value of a shore segment.

Table 2. Aquatic Habitat Index Parameters, Calculation Method and Values for Wasa Lake

Category	Criteria	Maximum Point	*Percent of the Category*	*Percent of the Total*	Calculation	Value Categories
Biophysical	Shore Type	20	*33.9*	*17.5*	% of Segment x Shore Type Value	Stream Mouth = Wetland (20) > Gravel Beach = Rocky Shore = Vegetated Shore (15) > Sand Beach = Cliff /Bluff (10) > Other (5)
	Substrate	10	*16.9*	*8.7*	% Substrate x Substrate Value	Cobble (10) > Gravel (8) > Boulder = Silt = Mud = Marl (6) Sands (4) > Bedrock (2)
	Percentage Natural	15	*25.4*	*13.1*	% Natural x Natural Score (15)	
	Emergent / Transition Vegetation	8	*13.6*	*7.0*	% Transition Vegetation x Transition Vegetation Score (8)	
	Overhanging Vegetation	6	*10.2*	*5.2*	% Overhanging Vegetation x Overhanging Vegetation Score (6)	
Zones of Sensitivity	Sensitive Plant Species	5	*25.0*	*4.4*	*See Value Categories*	Sensitive Community (5), Sensitive Species (3)
	Native fish spawning	5	*25.0*	*4.4*	*See Value Categories*	Present (5), Absent (0)
	Biologically Productive Area	5	*25.0*	*4.4*	*See Value Categories*	High (5), Moderate (3)
	Bird Staging Area	5	*25.0*	*4.4*	*See Value Categories*	Present (5), Absent (0)
Riparian	Band 1 (Riparian)	10	*62.5*	*8.7*	Vegetation Bandwidth Value x Vegetation Quality Value x Band 1 Score (10)	**Vegetation Bandwidth Value** 0 to 4.9 m (0.2) < 5 to 9.9 m (0.4) < 10 to 14.9 m (0.6) < 15 to 19.9 m (0.8) < 20 m (1)
	Band 2 (Upland)	6	*37.5*	*5.2*	Vegetation Bandwidth Value x Vegetation Quality Value x Band 2 Score (6)	**Vegetation Quality Value** Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)
Modifications	Retaining Wall	-3.5	*20.0*	*-3.1*	% Retaining Wall x (-5)	
	Docks	-3	*17.1*	*-2.6*	# Docks x (-0.1)	
	Groynes	-3	*17.1*	*-2.6*	# Groynes x (-0.5 per groyne)	
	Boat Launch	-3	*17.1*	*-2.6*	# Launches x (-3 per launch)	
	Beach Grooming	-5	*28.6*	*-4.4*	*See Value Categories*	<10% of Segment(0), 11-50% of Segment (-3), >50% of Segment (-5)

2.3.5.1 Biophysical Parameters

The determination of extent of each of the biophysical parameters is described in full in the FIM Standards.

Shore Type

Shore Type breaks the shore zone into distinct segments that correspond to the physical features of the land/water juncture. This parameter assumes that all shore types have similar physical features in their natural state and that habitat utilization by the different species is similar in identical shore types (e.g., the use of one sand beach by fish is similar to the use of a different sand beach in another area) (Schleppe and Arsenault 2006).

The Shore Type values were established in the earlier lake studies through detailed habitat specificity analyses using local data and literature reviews. The Okanagan Lake Shore Type scored each Shore Type according to fish usage (RDCO 2005). In the Windermere Lake analysis, although Shore Type scores were still based on fish values, the value of wetland habitat for values other than direct fish usage (e.g., primary productivity, wildlife and aquatic health) was identified as a unique parameter (McPherson and Hlushak 2008). The Moyie Lake study refined this step by incorporating the full spectrum of wetland values into the Shore Type score (Schleppe 2009). Although the Shore Type Scoring has gone through an iterative development process from lake to lake, the importance of each Shore Type has remained relatively constant. Stream mouths and wetlands were rated as having the highest values for fish and wildlife, followed by gravel beach, rocky shore and vegetated shore. Sand beach and cliff/bluff habitats were valued the lowest.

Substrate Type

Lakebed substrates relate directly to lake productivity (Schleppe 2009). Many fish species depend on coarse substrate compositions for egg deposition (spawning) and for seeking cover from predators (rearing). Substrates also provide rooting areas for aquatic vegetation, foraging opportunities for benthic macro-invertebrate, and three-dimensional structure (Randall *et al.* 1996). Schleppe and Arsenault (2006) ranked substrate types based on life history requirements for different fish species. Their attributed substrate values have subsequently been accepted as standards for this and other lake assessments (e.g., Windermere (McPherson and Hlushak 2008), and Moyie Lakes (Schleppe 2009)). Substrates were determined from FIM and F&W assessment data.

Percentage Natural

Natural shorelines typically have a high fisheries, wildlife and ecological value because they have few anthropogenic disturbances (e.g., docks, transport infrastructure) that can degrade habitat integrity. This parameter recognizes that natural areas typically function better and are more similar to historical ecosystems than highly disturbed shorelines. This parameter's value follows the standard established at Moyie Lake, which was based on the Windermere and Okanagan Lake studies.

Emergent Aquatic Vegetation and Transition Vegetation

All vegetation below the high water level is considered productive (Schleppe 2009). Aquatic plants provide fish and wildlife with food, spawning or nesting habitat, foraging substrates, and cover from sun and predators (Engel 1990). In this study, transition vegetation was also considered important for biodiversity and shoreline stability, particularly given the high incidence of sandy, unvegetated beaches (either natural or man-made through beach grooming). As described in Section 2.2.1, transition ecosystems have structural similarities to wetlands and frequently occur adjacent to wetlands in a zone transitional to upland ecosystems (MacKenzie and Moran 2004). The linear extent (m) of emergent aquatic vegetation and transition vegetation along the shoreline was mapped for each segment and used in the AHI.

Overhanging Vegetation

Overhanging vegetation is a valuable component of the shoreline. Leaf litter, fallen branches/trees and associated insect drop provide food and habitat for aquatic organisms (Holmes pers. comm.). Linear extent of overhanging vegetation was calculated using the orthophotos and GIS applications.

2.3.5.2 Zones of Sensitivity

Zones of sensitivity (ZOS) are areas of biological importance specific to Wasa Lake. ZOS are typically defined as being confirmed habitats for sensitive species or regionally significant species (as identified by BC MoE or DFO) (McPherson *et al.* 2010). For this analysis, important habitats for native fish species (even if not defined as provincially or regionally sensitive) were also considered in the AHI because of the high incidence of non native species and associated pressures. This approach followed that used at Tie and Rosen Lakes, two other small lakes with a high incidence of non-native species (AMEC Earth and Environmental 2010), as well as at Moyie Lake (Schleppe 2009). At these lakes juvenile fish rearing habitat was included in the AHI as a ZOS.

ZOS were confirmed through this study's F&W field investigations, literature review, or by other reputable sources. Supporting information for each of the ZOS is provided in the Results Section of this document and information has also been summarized in the Segment Database (Appendix D) for each segment. ZOS for the Wasa lake project area are as follows:

- **Native Fish Spawning Area:** Largescale sucker spawning site identified in the bay along Segment W8.
- **Biologically Productive Areas:** Areas with wide littoral areas (> 50m) associated with stream mouths/ outlets, aquatic vegetation and/or wetlands. These areas provide important refuge and foraging habitat for: 1) native fish species (Section 3.4); and, 2) other wildlife including invertebrates, birds and mammals, through their diverse riparian communities, not readily found in throughout the project area.
- **Sensitive Plant Species:** Sensitive plant species and communities identified during the vegetation survey (Section 3.3) were mapped and identified as ZOS.
- **Bird Staging Area:** Segment W2 (Robert's Bay) and its associated mud flats are an important staging area for migratory birds, in the Wasa Lake area.

2.3.5.3 Riparian Parameters

Band 1 (riparian) and Band 2 (upland)

Vegetation adjacent to lakes is important for fish and wildlife habitat as described above for the Overhanging Vegetation parameter. It is also important for terrestrial wildlife species since it can incorporate important habitats such as grasslands and migration corridors. Vegetated shorelines help to reduce erosion through soil stabilization and by reducing the erosional energy of rainfall and wave action (Holmes pers. comm.). Riparian vegetation is distinct from upland habitats due to the presence of water and is thus considered more productive than drier or wetter habitats (Holmes pers. comm.).

Riparian band lengths, scores and vegetation quality were determined for each segment using GIS. The index considered the extent, score and quality of Riparian Band 1 and the Riparian Band 2 individually for each segment. Following the Moyie Lake index (Schleppe 2009), Band 1 vegetation,

situated directly adjacent to the lake (and theoretically contributing more to the lake productivity) was weighted higher than Band 2 vegetation.

2.3.5.4 Habitat Modification Parameters

Structural habitat modifications that are known to impact fish and other organisms were counted to determine their potential influence. Schleppe and Arsenault (2006) provided detailed descriptions of the influences of habitat modifications on the shoreline habitats and have been directly quoted here (as shown in italics). Much of the additional background in plain text was carried over from the Windermere Lake study (McPherson and Hlushak 2008). There are other anthropogenic influences that were either not evaluated here, such as boat fuelling, or that were factored into the AHI through evaluation of natural features (e.g., vegetation removal, above).

Retaining Walls

Retaining walls are considered to be negative habitat features for a variety of reasons. These structures are generally constructed to armour or protect shorelines from erosion. Kahler et al. (2000) summarized the effects of piers, docks, and bulkheads (retaining walls) and suggested that these structures may reduce the diversity and abundance of nearshore fish assemblages because they eliminate complex habitat features that function as critical prey refuge areas. Carrasquero (2001) indicated in his review of overwater structures that retaining walls might also reduce the diversity of benthic macroinvertebrate communities more than other structures such as riprap shoreline armouring because they reduce the habitat complexity.

Erosion along a shoreline can be the result of removal of riparian or lakeside vegetation. In some cases, retaining walls have been constructed to hold up soil material, possibly reclaiming land, so that lawns can be planted or for other landscaping purposes. The construction of structures by residents, may lead to neighbours imitating their neighbours. Also, construction of one retaining wall may lead to energy transfer via waves resulting in erosion somewhere else.

Docks

There are some positive affects of docks, including that they provide shaded areas that can attract fish and provide prey refuge, and pilings can provide good structure for periphyton growth (Carrasquero 2001). However, there are numerous negative influences of docks on fish communities, including that they provide hiding areas for ambush predators (such as largemouth bass), reduce large woody debris inputs, and are often associated with other anthropogenic disturbances such as retaining walls (Kahler *et al.* 2000; Carrasquero 2001). *Docks have been documented to increase fish density due to fish's general congregation around structure, but decrease fish diversity in these same areas (Lange 1999). Chinook salmon have been documented to avoid areas with increased overwater structures (e.g., docks) and riprap shorelines, and therefore, construction of these structures may affect juvenile migrating salmonids (Piaskowski and Tabor, 2001).*

Docks modify predator/prey interactions by creating islands or bottlenecks in lake habitats, which can cause fundamental shifts in the trophic structure of an ecosystem (Bisset pers. comm.). Largemouth bass (*Micropterus salmonides*) is an introduced species in Wasa Lake, which is known to negatively impact native fishes and their population growth (McPhail 2007). At Windermere Lake, largemouth bass were often found utilizing modified structures such as boats, docks and retaining walls, where they were guarding a territory (Porto pers. comm.). Because maintaining native fish populations in Wasa Lake is considered important, dock density was included in the index. Docks were treated as a negative parameter, with increasing dock density considered as having more negative effects than lower dock densities.

Groynes

*Groynes are structures that are constructed to reduce or confine sediment drift along a shoreline. These structures are typically constructed using large boulders, concrete, or some other hard, long lasting material. G*roynes are known to have significant impacts as docks on shoreline processes and fish. They concentrate fish, disrupt shoreline migration, and force juveniles into deeper waters away from refuge where they are easily predated upon (MacDonald pers. comm.). *Groynes also reduce the natural movement of substrates along the shoreline, which can increase the embeddedness of gravels. These structures are often considered a Harmful Alteration and Disruption of Fish Habitat (HADD) as defined under the federal Fisheries Act.*

Boat Launches

Boat launches were considered to be a negative parameter within the index. Boat launches are typically constructed of concrete that extends below the high water level. The imperviousness of this material results in a permanent loss of habitat, which ultimately reduces habitat quality and quantity for fish. Concrete does not allow growth of aquatic macrophytes, and reduces foraging and/or refuge areas for small fish and macroinvertebrates. The extent of the potential effects of boat launches relates to their size. Thus, multiple lane boat launches tend to have a large effect on fish habitat than smaller launches with fewer lanes.

Beach Grooming

Beach grooming is the conversion of shoreline to sand beach through sand placement and/or removal of shoreline vegetation. Beach grooming impacts the shoreline diversity through a reduction of vegetation (aquatic, transition and upland) and gravel substrates in the littoral zone. DFO assessments completed on Kootenay Lake compared fish use over various substrates (fines, cobbles, boulder and large woody debris/macrophyte) and provided additional insight to effects of altering the substrate habitat (MacDonald pers. comm.). The fish species observed during the DFO study were kokanee, rainbow trout, whitefish and non salmonids (sculpins, suckers and redside shiners). The results revealed that abundance and diversity of fish was low at the altered site compared to sites with natural complex habitats. Non-salmonids showed the greatest diversity in species, lifestage and habitat use over the cobble substrate.

An estimate of linear shoreline extent (percent) with beach grooming evident was calculated from orthophotos. Beach groomed areas were distinguished from natural sand beach areas through a comparison with neighbouring natural properties.

Marinas

No marinas exist at Wasa Lake and as the Land Use Bylaw for the area outlines, an application for a private commercial marina will not be supported (RDEK 2007). Should a consolidation of docks into one facility be considered, the general impacts associated with a marina discussed in other projects (such as Windermere Lake [McPherson and Hlushak 2008]) should be reviewed.

2.3.5.5 Index Ranking

Once the biophysical, ZOS, riparian and modification scores were assigned for all parameters, the values were summated for each segment. The index results were run through several iterations comparing the outcomes to perceived habitat value. Minor adjustments were made to the parameter scores to ensure that items were not overly weighted. Once the segments were scored, the range in lake values were divided into five equal AHI Ranks - Very Low, Low, Moderate, High, and Very High. These categories are considered the **Current Ecological Value** of a shore Segment.

To investigate the potential for restoration, negative instream parameters were removed from the index and the index was re-run to determine the **Ecological Potential** of each segment. Segments

that increased in value were considered to be areas where shoreline improvements would result in increased habitat value.

2.4 Shoreline Management Guidelines

Shoreline Management Guidelines (henceforth 'the Guidelines') are intended to conserve fish and wildlife habitat and are a tool to assist landowners and developers who want to propose shoreline development. Guidelines were prepared for Windermere Lake by EKILMP and Interior Reforestation in 2009. During the preparation of the Moyie Lake Guidelines (Schleppe 2009), the Windermere Lake template was modified slightly to account for the fact that ZOS had been built into the AHI. The methods employed here at Wasa Lake, followed these accepted templates.

Guideline development involved attributing a colour scheme to the Current Ecological Rankings determined through the AHI. The colours represent a segment's level of vulnerability to development and are as follows:

1. Red Shoreline was designated for segments with a Very High Ecological Value;
2. Orange Shoreline was designated for segments with a High Ecological Value;
3. Yellow Shoreline was designated for segments with a Moderate Ecological Value; and
4. Grey Shoreline was designated for segments with Low and Very Low Ecological Value.

The risks for specific activities in each color zone and the associated review process were outlined in a brief and user-friendly document, which is both found within this report and is also a separate stand alone document.

3 Results

3.1 Biophysical Background

This study reviews the environmental values of the shoreline of Wasa Lake, which includes the adjacent Cameron Pond. Wasa Lake is located in the southern Interior of British Columbia in the East Kootenay Trench Ecosection (Appendix A – Foreshore Summary Maps). The Wasa Lake Watershed is comprised of mainly forested (52%), private (20%) and open range or agricultural cleared lands (17%) (BC Lake Stewardship Society (BCLSS) and BC MoE 2008). Table 3 provides a summary of the physical characteristics for Wasa Lake and Cameron Pond. A bathymetric map is only available for Wasa Lake and has been provided in Appendix C.

Table 3. Wasa Lake physical characteristics

Parameter	Wasa Lake	Cameron Pond
Watershed Code	349-469900	349-469900-41100
Elevation	772 m*	770 m**
Surface Area	1.1 km^2*	0.18 km^2
Drainage	12.15 km^2 *	12.15 km^2
Maximum Depth	15.8 m*	unknown
Mean Depth	3.8 m*	unknown
Average Width	400 m	230 m
Foreshore Perimeter	7.55 km	2.48 km

Source: *BCLSS and BC MoE 2008
** BC MoE 2010

Wasa Lake is a kettle lake that formed through glacial fluvial processes (BCLSS and BC MoE 2008). A kettle lake results when ice breaks off a receding glacier and becomes buried by glacial outwash and then melts leaving a kettle hole (Wikipedia 2008). Wasa Lake does not have continuous inlet or outlet streams (BCLSS and BC MoE 2008). The lake is situated below the water table and the lake levels are thus largely governed by the levels of the neighbouring Kootenay River (Baker 1987 and McArthur 2005). Lake levels fluctuate annually as a result of this hydrogeology. Water level averages for the period of 1996-2006 (WLLID 2008) indicate that lake levels alter by approximately 2 m between the winter low period and the summer high period in July.

Although limited, there are ephemeral streams flowing both into and out of Wasa Lake. Hanson Creek, located on the west shore, is historically known to carry flow both into the lake from the Kootenay River (during river flood conditions) and to change direction and carry lake flows out to the river with receding river levels (McArthur 2005). However, from the current orthophotos, the Hanson Creek channel appears undefined once it crosses under the highway and nears the Kootenay River. Terrain Resources Inventory Mapping (TRIM) reveals that there are also two unnamed creeks situated on the east shores. The flow through these creeks is uncertain since the drainage has been disturbed; however, they appear to likely provide some ephemeral flow from the mountain side during run-off periods as evident by their riparian vegetation.

Cameron Pond is situated to the south of Wasa Lake. Cameron Pond is separated from Wasa Lake by approximately 300 m of land designated as Park and Open Land (RDEK 2007) and Wasa Lake Park Drive. The 2008 orthophotos reveal tributary outlet features into Wasa Lake at Segment W2, indicating that flow enters the lake from Cameron Pond. Ashmore (pers. comm.) confirmed that overland flow connects the two water bodies during high flow periods. Private landowners have installed various features to control and direct flows between the water bodies including culverts and baffling devices (Figure 4). Lewis Creek, total length 17.38 km, flows into Cameron Pond at its north eastern shore (Segment C2) (Figure 5).

Figure 4. Swale and culverts beneath private roadway to direct high flows between Cameron Pond and Wasa Lake. Photo: McPherson, May 2010.

Figure 5. Looking downstream where Lewis Creek flows into Cameron Pond at Segment C2. Photo: McPherson, May 2010.

At the south end of Cameron Pond, a trial flood mitigation system (dyke roadway with culvert) has been installed to manage flows between Cameron Pond and the southern section of the Cameron Slough Wildlife Sanctuary (See 3.1.3 Protected Areas). The system mitigates flooding which can particularly be a concern when Kootenay River reverses during flood episodes. During floods, water levels typically overtop the culvert depicted in Figure 6 (Ashmore pers. comm.).

Figure 6. Looking south towards Cameron Slough Wildlife Sanctuary (outside project area) from the trial flood mitigation system (left photo); and looking west at Segment C1 of Cameron Pond study area from flood mitigation system (right photo). Photos: McPherson, May 2010.

3.1.1 Water Quality

The following summary of water quality conditions has been obtained from BCLSS and BC MoE (2008). **Wasa Lake** is a warm lake. Monthly data in 2005 showed that water temperatures were around 15 ^{o}C in May and gradually climbed to a maximum nearing 23 ^{o}C by August. The measure of time that inflow replaces the lake water volume, also known as 'flushing rate', is unknown for Wasa Lake; however, considering that there is no permanent inflow or outflow from the lake, the flushing rate is likely low. Flushing rate is a significant factor to a lake's water quality, since a low flushing rate may result in it becoming more productive with time (eutrophic), as nutrients entering the lake do not get moved through very quickly (Figure 7).Wasa Lake was not determined to be eutrophic based on water quality sampling conducted between 2003 and 2006. According to the phosphorous levels during this period, the lake was determined to be oligotrophic, meaning that it

had low productivity, which is typical of clear water with low nutrient levels, sparse plant life and low fish production. The secchi depth and nitrogen levels, however, indicated that the lake was mesotrophic.

Lakes naturally become more eutrophic with time. Since Wasa Lake is naturally filtered by the surrounding sand/gravel deposits, it is expected that eutrophication would be a slow process (Bisset pers.com.). However, since Wasa Lake does not receive flushing flows and anthropogenic activities are concentrated around it, it could be susceptible to accelerated aging causing negative impacts (Bisset pers. com.). This could be further accelerated with global warming, further justifying a cautious approach to development. The extent of groundwater flushing could be confirmed through future studies (Bisset pers comm.).

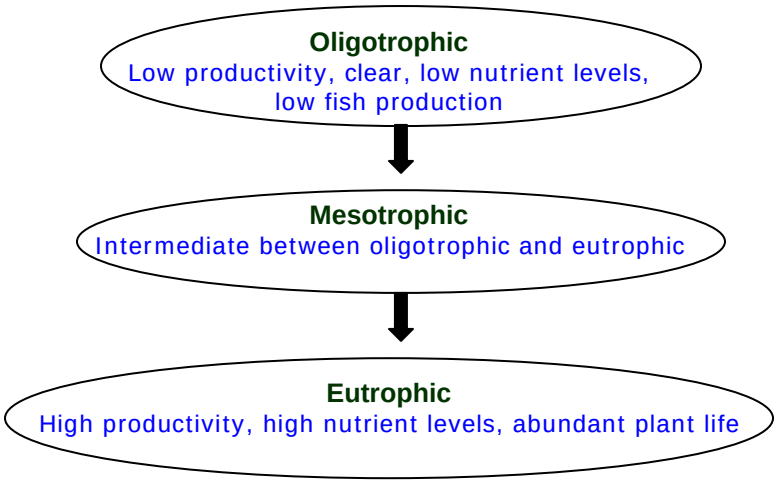


Figure 7. Lake Productivity Chart

No water quality data was available for **Cameron Pond**. Lewis Creek provides intermittent flows to the pond. The north east end of Cameron Pond was historically used by the Estella Mine as a tailings depository (Miles pers. comm.). This occurred during the approximate period of 1950-55, when ore from the mine was processed in Wasa (Miles pers. comm.). This ore was mainly zinc with some lead and silver (Wikipedia 2010). The tailings from the process remain as the unvegetated sand substrate beyond the wetland, near the outlet of Lewis Creek. A water and sediment quality review would be valuable to confirm the health of the pond for human use and aquatic life.

3.1.2 Biogeoclimatic Zone

Wasa Lake occurs in the Kootenay Dry Hot Ponderosa Pine biogeoclimatic zone variant (PPdh2) (Meidinger and Pojar 1991). The variant is characterised by ponderosa pine (*Pinus ponderosa*) trees, up to 950 m in elevation with a mix of rough fescue (*Festuca scabrella*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) with various flowering plants, including silky lupine (*Lupinus sericeus*), and round-leaved alumroot (*Heuchera cylindrical*) and other flowering plants (Grasslands Conservation Council of BC [GCC BC] 2009). Mature stands are typically open forest savannahs, although extensive in-growth has occurred (GCC BC 2009). Grasslands are found throughout the zone, though they too have been degraded through forest encroachment, overgrazing and recreational activities (GCC BC 2009). The zone is fire-maintained, with historical fire-return intervals of 20 years or less (Rocky Mountain Trench Ecosystem Restoration Steering Committee 2006). Fire suppression over the past 60-plus years has contributed to both in-growth and encroachment.

3.1.3 Protected Areas

Wasa Slough Wildlife Sanctuary

The Nature Trust of BC (TNT) purchased lands around Cameron Pond and slough areas to the south in 1975 and created Wasa Slough Wildlife Sanctuary (Figure 8; TNT 2010). The sanctuary covers 78.58 hectares and protects lake, marsh and upland complex that is of importance to migrating Tundra Swans (TNT 2010).

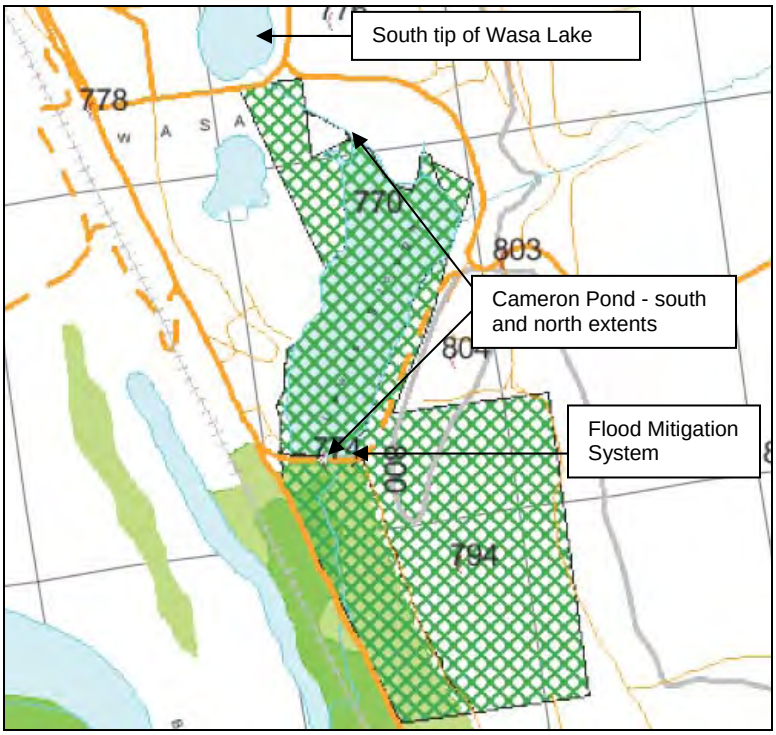


Figure 8. Wasa Slough Wildlife Sanctuary (indicated by green cross-hatching), owned by The Nature Trust of BC (Source: Biodiversity Atlas 2010).

Wasa Lake Provincial Park

Wasa Lake Provincial Park was designated primarily "to protect the remnant open forest, grassland and riparian ecosystems of the East Kootenay Trench" (BC MoE 2003). The park is situated in four separate blocks around Wasa Lake, totaling 144 ha. Although the park has areas within it designated as natural environment (71% of the park), other areas are managed for intensive recreation (29%). Key attributes protected by the park are as follows (BC MoE 2003):

- The park provides 4% of the protected area representation to the East Kootenay Trench Ecosection, which is under-represented (0.68%) province-wide;
- It protects the very poorly represented PPdh2 subzone/variant biogeoclimatic zone, which only has 0.18% protected province-wide.
- A special feature of the park is the natural sand dunes riparian habitat and the endangered grassland ecosystem (<1 % of the park).

These values and features do not necessarily stop at the park boundary. The orthophoto delineation for this project revealed that grassland habitats are found on adjacent private properties surrounding the lake (Appendix B).

The park plan further identified that non-native invasive plants (e.g., diffuse knapweed (C*entaurea diffusa*)), forest in-growth, the lack of natural fire and the expansion of recreational activities into endangered ecosystems are management issues threatening the park landscapes (BC MoE 2003).

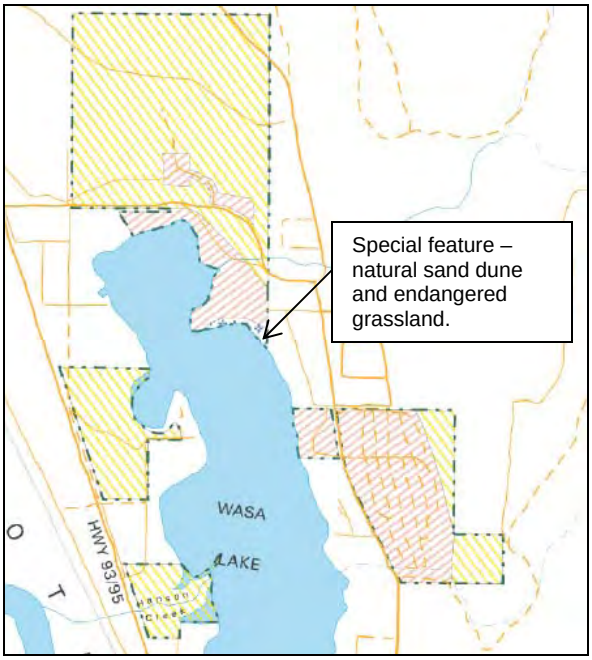


Figure 9. Wasa Lake Provincial Park, with the management strategy for the four properties indicated as yellow hashed (natural environment), pink hashed (intensive recreation) and blue star (special feature) areas (BC MoE 2003).

3.2 Biophysical FIM Summary

Wasa Lake has 7,553 m of shoreline which was divided into ten segments (W1 to W10). Cameron Pond has 2,483 m of shoreline, divided into three segments (C1 to C3). Maps showing segment locations and key segment information are provided in Appendix A, the segment database of biophysical findings is provided in Appendix D and segment/site photos are located in Appendix E.

3.2.1 Land Use and Natural versus Disturbed

Table 4 presents overall values for extent of natural versus disturbed shoreline, and land usage for Wasa Lake and Cameron Pond. Where possible, figures combine Wasa Lake and Cameron Pond information for brevity as well as comparative purposes. The statistics for the two water bodies however (e.g., percentages) were calculated independently.

The land uses at **Wasa Lake** were mainly residential (64%) and park/protected area (31%), with some Crown Land portions (5%).The extent of natural and disturbed foreshore for each segment and the predominant land uses are depicted in Figure 10. The shoreline of Wasa Lake is approximately 19% residential land in a natural condition, 39% disturbed residential land, 31% natural park/conservation land, 6% disturbed park/conservation land and 5% disturbed Crown land.

A total of 64% of the Wasa Lake shoreline length has been disturbed. Of the disturbed shoreline, residential lands were the greatest contributor (80% of disturbed area was residential). An exception was Segment W2, located at the south end of the lake. This segment had approximately 70% of it's foreshore in a natural condition, despite being classified as residential land (typed as

both semi-rural residential and residential in the local RDEK bylaw (2007). Development may be limited by floodplain restrictions in this segment.

Wasa Lake Provincial Park is a large contributor to naturalized foreshore, with natural park land comprising 23% of the shoreline. The Provincial Park has several disjunct blocks, four of which include separate segments of Wasa Lake shoreline. Blocks are managed for either natural environment values or intensive recreational values (Figure 9). Segments W4 and W6 on the west side of the lake were 100% natural. Park Segments W8 and W10, located on the south and east side of the lake, had approximately 35% and 75% of their respective lengths disturbed.

Table 4. Wasa Lake and Cameron Pond shoreline condition (natural vs. disturbed) and land use summary.

Foreshore		Wasa Lake		Cameron Pond	
		Length (m)	% of total	Length (m)	% of total
Total Shoreline	Natural	2716	36 %	2232	90 %
	Disturbed	4837	64 %	250	10 %
Land Use Summary	Residential	4861	64 %	1001	40 %
	Park	2318	31 %	1347	54 %
	Crown	374	5 %	135	5 %
Shoreline Condition by Land Use	Natural Residential	955	13 %	955	38 %
	Disturbed Residential	3906	52 %	46	2 %
	Natural Park	1750	23 %	1347	54 %
	Disturbed Park	568	8 %	0	0 %
	Disturbed Crown	374	5 %	135	5 %
Total Foreshore Length		7553		2483	

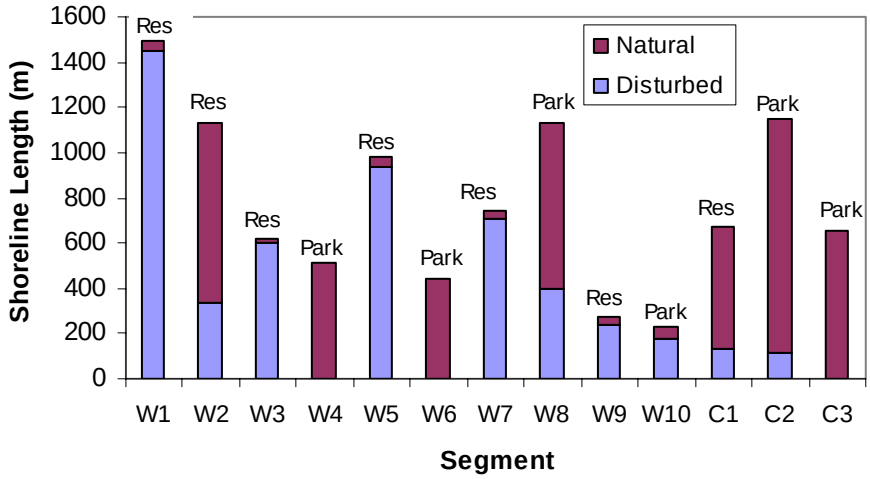


Figure 10. Extent (m) of natural and disturbed shoreline and predominant land use (Res. = Residential, Park = Provincial Park) for Wasa Lake (W1-W10) and Cameron Pond (C1-C3) segments.

The land uses along **Cameron Pond** were comprised of conservation land (54%), residential (40%) and a small section of crown land (5%). The Cameron Pond shoreline was mainly natural (90%). Even along residential areas, the shoreline generally had not been disturbed with modifications. The Nature Trust of BC lands at Cameron Pond were largely intact, although some historical disturbance was evident (e.g., along the northwest boundary of Segment C2).

3.2.2 Shore Type

The foreshore of **Wasa Lake** was diverse containing sand/gravel beach, vegetated, sand beach, wetland, and stream mouth shore types. The lengths and overall percentages of each foreshore type are provided in Figure 11. Sand/gravel beach shoreline was most prominent (2851 m). The vegetated shore type followed (2490 m), along with sand beach (1928 m). Wetland (258 m) and stream mouth (26 m) were rare.

Cameron Pond was comprised of mainly vegetated (1332 m) and wetland (1035 m) shore types. The mouth of Lewis Creek contributed 115 m to the shoreline (Figure 12). The shore types found in each segment of Wasa Lake and Cameron Pond are depicted in Figure 13.

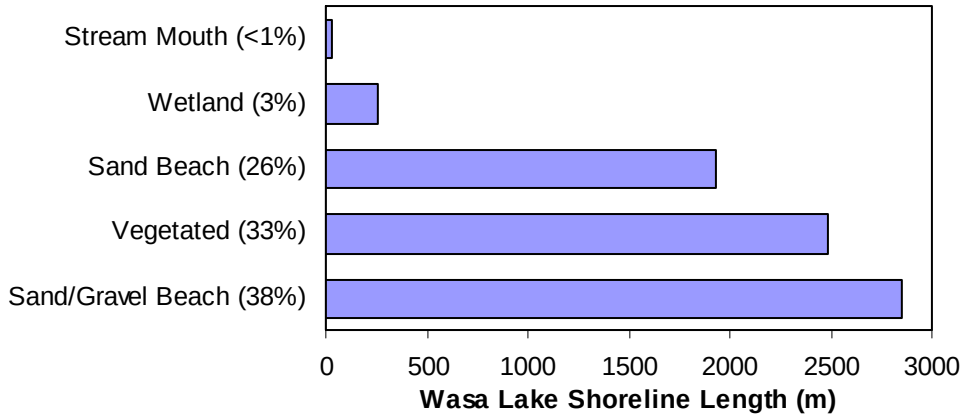


Figure 11. Total length (m) and percentage (%) of Shore Types at Wasa Lake

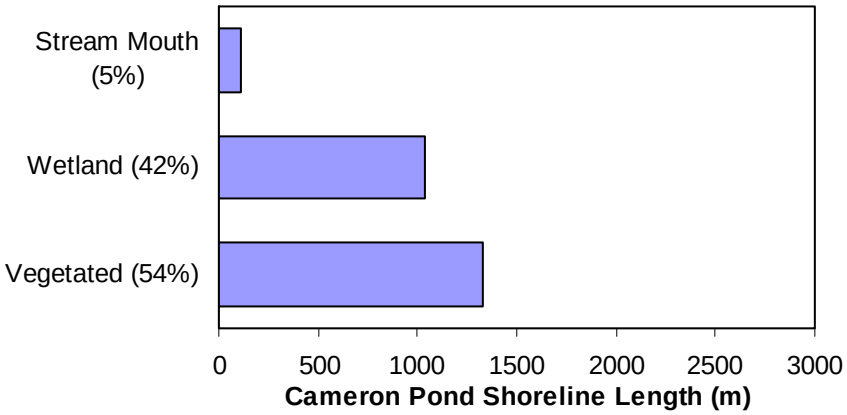


Figure 12. Total length (m) and percentage (%) of Shore Types at Cameron Pond

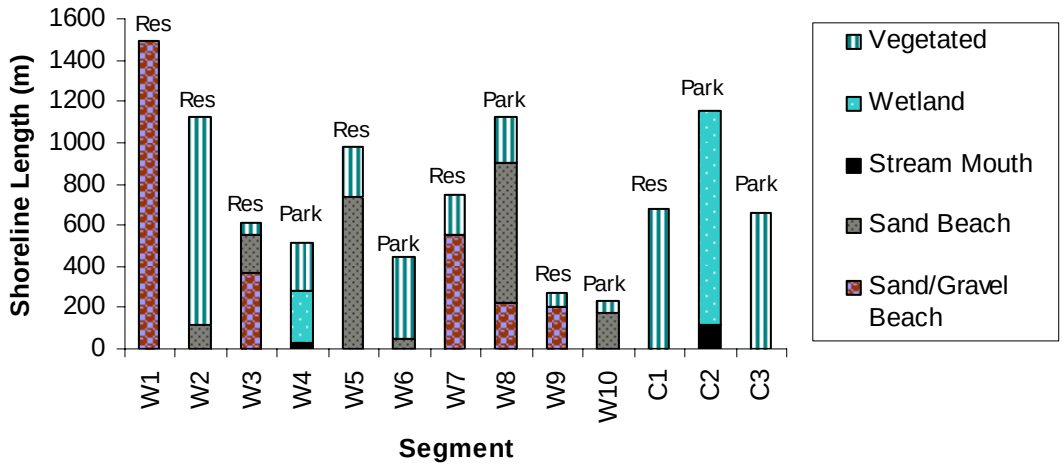


Figure 13. Shore type and extent (m) for Wasa Lake (W1-W10) and Cameron Pond (C1-C3) segments

Some additional observations relating to the shore type findings at Wasa Lake were as follows:

- The sand/gravel beach shore type was not evident during high water levels (Figure 14), but at low water levels appeared prevalent in many segments around the lake. This was considered an important shore type to distinguish, particularly because many of the purely sand beach areas were likely the result of beach grooming (sand placement and/or vegetation removal).

Figure 14. Segment W1, showing extensive sandy beach at high water, however, this area was extensively covered with gravel substrate at lower water levels. Photo: Holmes July 2008.

- Although Segment W6 was classified as a vegetated shore, substantial areas of gravel were identified at low water levels (Figure 15). In this location, there were two overlapping shore types and it was decided that the intact vegetation along the shoreline was the important feature for classification.

Figure 15. Gravel shoreline following the base of the Vegetated shore type of Segment W6. Photo: McPherson Dec. 2008.

3.2.3 Foreshore Modifications

Cameron Pond had few modifications, with seven docks and two road access points. Some beach grooming accounted for 9% of the total shoreline area (Figure 16).

Shoreline modifications were extensive at **Wasa Lake**. Modifications included retaining walls, docks, groynes, boat launches, road access points and beach grooming/sand placement. Riparian and upland vegetation removal are other anthropogenic modifications that will be discussed separately below. The greatest numbers of structures at Wasa Lake were docks (84 count). Wasa Lake also had three each of retaining walls, groynes and boat launches. Ten road access points were also identified; three of which were used as boat launches. There is also an undeveloped highway's access at Cherry Rd, not included in the count. The figure also provides the percent of each segment estimated to been beach groomed. Beach grooming was identified as extensive removal of vegetation and/or sand placement.

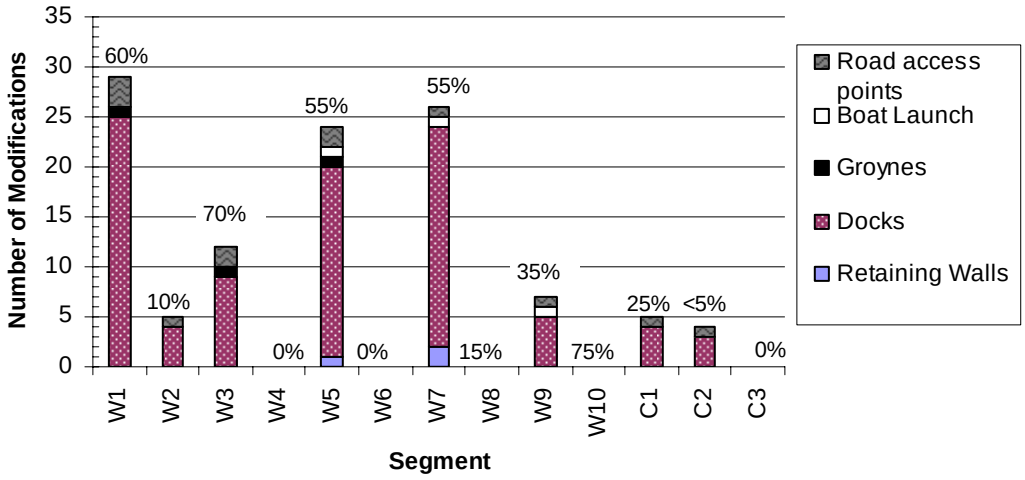


Figure 16. Segment modifications (type and number) and estimated segment length with beach grooming (indicated as % in parentheses) for Wasa Lake (W1-W10) and Cameron Pond (C1-C3) segments.

Considering all segments at **Wasa Lake**, 37% of the total foreshore length was estimated to have been beach groomed. Substantial beach grooming (>50% of segment) was evident in the residential Segments W1, W3, W5 and W7, and the park Segment W10. Figure 17 illustrates beach grooming at Segments W1 and W5. The photos clearly depict the “grooming line”, showing the

contrast of the sandy or unvegetated beaches up against the vegetative features of the neighbouring shoreline, which in the case of the left photo is a park in a natural state (Segment W4). Maintaining a natural vegetative cover of this transitional vegetation is preferable, and this has been done in some cases, while allowing for recreational use of the beach (Figure 18). In this photo, the dock was placed at the low water mark and the vegetation and substrates higher on the shoreline were left intact.

Figure 17. Examples of beach grooming: vegetation has been removed and sand has been placed along the shoreline of Segment W5 (left), and vegetation has been mowed in Segment W1 (right). Photo: McPherson Dec. 2008.

Figure 18. Example of dock attached to the shore at the low water mark where beach grooming was not evident in Segment W7. Photo: McPherson Dec. 2008.

Because docks were prevalent modifications, particularly at **Wasa Lake**, their number per kilometer of shoreline was calculated (Figure 19). Segment W7 had the highest dock density (30 docks/km). High dock densities were also seen at Segments W1, W3, W7 and W9 (ranging from 15-19 docks/km).

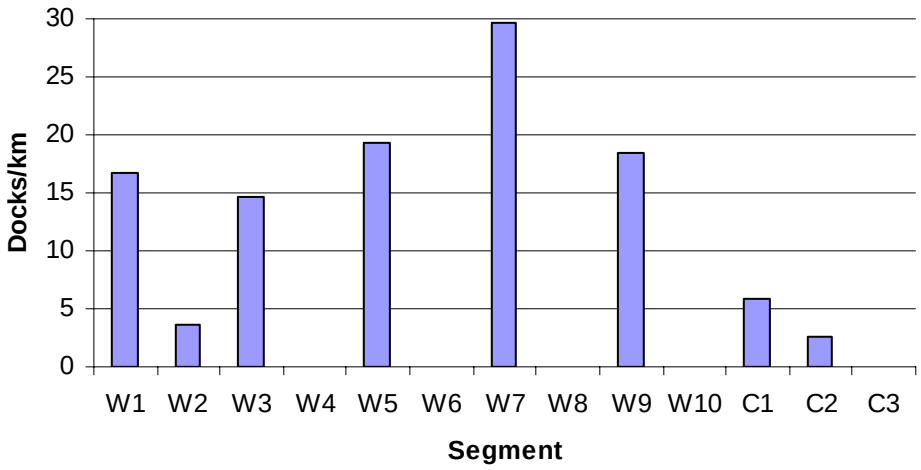


Figure 19. Number of docks per kilometer for each shoreline segment at Wasa Lake (W1-W10) and Cameron Pond (C1-C3).

Dredging was another modification observed at a few locations around Wasa Lake (Segments W1 and W3). Figure 20 depicts a location on Segment W1, which was dredged in order to allow access up from the shoreline to a dock. This dredging, consequently, appears to have occurred on Crown Land zoned as P-2 Parks and Open Space (RDEK 2002).

Figure 20. Example of area that was dredged in order to allow access to a dock in Segment W1. Photo: McPherson Dec. 2008.

3.2.4 Emergent and Transition Vegetation

The Wasa Lake orthophoto delineation data set created by Terrasaurus was updated in ArcGIS to identify emergent aquatic vegetation and transition vegetation (Appendix A and Appendix B). Emergent aquatic vegetation identified at **Wasa Lake** and **Cameron Pond** included softstem bulrush (*Scirpus lacustris*), cattail (*Typha latifolia*), canary reedgrass (*Phalaris arundinacea)* and slough sedge (*Carex obnupta)*. The transitional species (Figure 21) were predominantly tufted hairgrass (*Deschampsia cespitosa*), as well as Nuttall's alkaligrass (P*uccinellia nuttalliana*), seaside arrow-grass (*Triglochin maritimum*), green sedge (*Carex viridula*), and common horsetail (*Equisetum arvense*).

Figure 21. Transitional vegetation along Segment W2. Photo: Holmes, July 2009.

Percentage of linear shoreline with aquatic/transition vegetation is provided in Figure 22. Because modifications to the substrates (such as placement of sand and vegetation removal) have an impact on natural shoreline vegetation, the extent of substrate modified was also depicted. These data, indicate that presence of substrate modifications is inversely proportional to aquatic and/or transitional vegetation. Where substrate modifications have been low, aquatic and/or transitional vegetation were high, such as Segments W2, W4, and W9. It appears that as the degree of substrate modification increased, the aquatic/transition vegetation became less. Emergent aquatic vegetation and transition vegetation were found along approximately 51% of the shoreline of Wasa Lake and 42% of Cameron Pond. Cameron Pond's low percentage was primarily due to Segment C3 having naturally steep banks, with more riparian than aquatic vegetation.

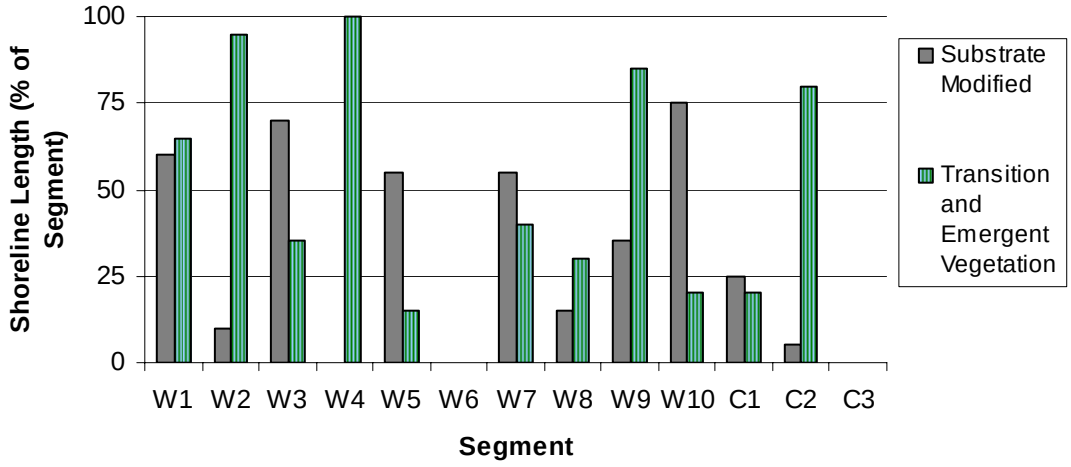


Figure 22. Percent of segment with modified substrates and transition/emergent aquatic vegetation along Wasa Lake (W1-W10) and Cameron Pond (C1-C3) Segments.

3.2.5 Riparian and Upland Vegetation

Riparian and upland areas have also experienced anthropogenic disturbances similar to that for emergent and transitional vegetation. Although the extent of vegetation disturbance has not been quantified, residential development was generally associated with native vegetation loss. For instance, Segments W1, W3, W5, W7, W8, W9 and W10 all had moderate to high levels of disturbance and riparian vegetation data reporting mainly exposed soils with some sparse coverage with herbs/grasses. Meanwhile, the less disturbed (Segment W2) and natural segments (Segments W4, W6, W11, W12, W13 and C1-C3) all had abundant riparian vegetation coverage with herbs/grasses, shrubs or wetland vegetation.

Similarly, upland vegetation appeared to be impacted by the residential land uses which often included some degree of landscaping and clearing activity. Generally the upland of the less disturbed segments had higher coverage with the mature Ponderosa Pine / grassland vegetation and less lawn. This will be further depicted in the following section.

Orthophoto delineation of **Wasa Lake** foreshore, conducted by Terrasaurus identified six natural, coarse-level plant communities around Wasa Lake: coniferous forest, deciduous forest, high shrub, low shrub, grasslands, lawn and wetlands (Appendix B). Delineation occurred to a distance of approximately 100 m upland from the low water mark and included eight vegetative features ranging from coniferous through to wetlands as well as roads, trails and man-made structures. Interior Reforestation updated the GIS data set by digitizing the extent of aquatic and transition vegetation evident at low water levels. Appendix B also contains the results of the spatial analysis of the orthophoto results, summarized by segment. Table 5 provides summary statistics for the delineated lake perimeter area.

Table 5. Summary of orthophoto delineation statistics for the Wasa Lake riparian and upland area (up to 100 m from the low water mark).

Foreshore Class	Total Area	
	m^2	%
Coniferous	134,929	18
Deciduous	1,983	<1
Aquatic Vegetation	56,909	7
Grassland	264,328	34
Lawn	36,277	5
Man-made structure	40,184	5
Mixed forest	25,421	3
Road (paved)	47,151	6
Road (unpaved)	16,689	2
Sand	61,104	8
Sand/Grass	37,483	5
Shrub (high)	17,373	2
Shrub (low)	16,230	2
Stream	2,272	<1
Trail	3,265	<1
Wetlands	7,442	1
Grand Total (m^2)	*769,042*	100

Considering foreshore, riparian and upland areas (up to 100 m from shoreline), grassland accounts for the highest vegetative coverage (34%), followed by coniferous forest (18%). The remaining parameters account for 10% or less coverage. The riparian and upland vegetation information in

the FIM database was improved (i.e., greater detail provided) using the orthophoto delineation results for each segment.

During the June 2010 vegetation survey, a few errors were identified in the computer generated orthophoto delineation. The classification colouring made it hard to distinguish between some of the vegetation types (e.g., mixed forest and sand/grass, and deciduous and coniferous). Some other errors identified were as follows: in Segment W1 some polygons were deciduous trees, not mixed forest; in Segment W2, sand/grass was actually landscaped vegetation; and in Segment W4, high bush should be deciduous, and wetland vegetation was not evident along north and south margins of segment; rather grassland.

3.2.6 Summary of Development Impacts

Although sand is a prevalent component of **Wasa Lake** geology, there is a diversity of shore types comprised of varying substrates and vegetation along the shoreline. Modifications are reducing the shoreline diversity to Sand Beach from more diverse shore types such as Vegetated and Gravel Shores. In Figure 23, the properties on the north and south ends have been landscaped, beaches groomed and have had other modifications (i.e., docks and dredging). On these properties many of the natural features are no longer visible. By comparison, the central property was setback and had limited modifications resulting in minimal shoreline impacts. As a result, the central property showed extensive area with riparian vegetation (grassland) and aquatic vegetation and gravel substrate in the littoral area. The sand placement on the beach (beach grooming) of the outlying properties appeared to result in loss of natural vegetative and structural features, which are important for biodiversity, aesthetics and water quality. In some locations, particularly at the north end of Wasa Lake (Segment W8), wind and wave action causes sand to naturally accumulate, so some features such as aquatic and transition vegetation and gravels do not exist naturally. A qualitative orthophoto review of features for neighbouring, unimpacted properties tends to identify what the natural conditions of a segment once were.

Figure 23. Overview of properties along Segment W3, showing area where the natural shoreline features were kept intact (low impact area) against adjacent properties where development has substantively altered the shoreline.

3.2.7 Level of Impact (LoI)

Level of Impact (LoI) provides a qualitative indication of the overall health of the foreshore and considers the land use, level of disturbance, and modification information presented above. Generally a High LoI refers to a segment with >40% alteration along its shoreline, a Moderate LoI is between 10 and 40% alteration, and a Low LoI segment is mainly natural with <10% alteration. Figure 24 provides a summary of the LoI ratings for Wasa Lake and Cameron Pond. Photos of segments representing each of these LoIs are provided in Figures 25 - 27.

At **Wasa Lake**, 57% of the shoreline was found to have a High LoI. This included all residential segments other than Segment W2, which had not been fully developed. The Moderate LoI at Wasa Lake accounted for 29% of the shoreline and included Segment W2 and the recreational use park Segment W8. The Low LoI Segments made up 12% of the shoreline and were only those park/conservation segments, W4 and W6, which have been set aside for biodiversity and protection of habitat.

Due to limited development, **Cameron Pond** did not have any High LoI segments. Here, Moderate LoI segment (C1) accounted for 27% of the shoreline; while the Low LoI segments (C2 and C3) accounted for 73% of the shoreline.

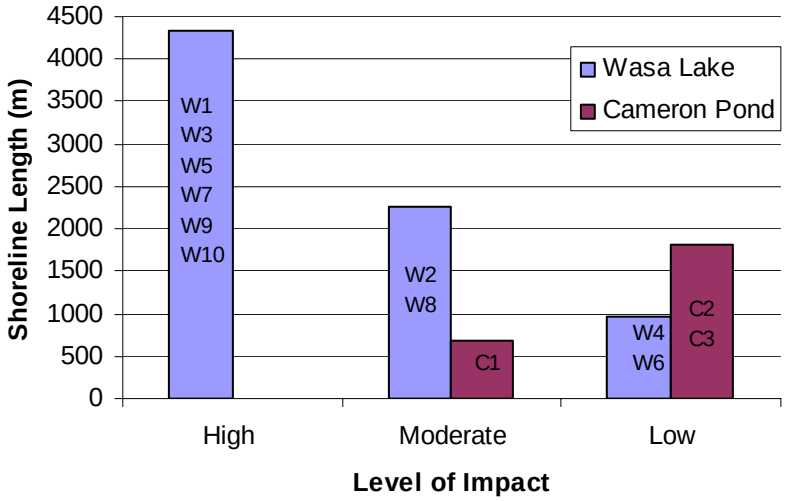


Figure 24. Level of impact (LoI) rating (High = >40%, Moderate = 10-40% and Low = <10%) for Wasa Lake (W1-W10) and Cameron Pond (C1-C3) segments and total shoreline length (m) attributed to each of the LOI ratings.

Figure 25. High Level of Impact example (Segment W1), showing how development has impacted all of the shoreline. Photo: Holmes July, 2008.

Figure 26. Moderate Level of Impact example (Segment W2), showing how development has impacted approximately 30% of the shoreline. Photos: Holmes July, 2008.

Figure 27. Low Level of Impact example (Segment W4), where the wetland shoreline features are undisturbed and protected as a Provincial Park. Photo: Holmes July, 2008.

3.3 Vegetation Survey Results

The BC CDC sensitive species listings (Table 6) indicates that the Wasa Lake area (includes Cameron Pond) potentially contains several sensitive plant species, including those that are red or blue listed and either provincially designated as critically imperiled (S1), imperiled (S2) or vulnerable (S3) (BC CDC 2010). Lacustrine (associated with lakes) and palustrine (associated with wetlands) plants have been specifically identified in this table, since these would most likely be associated with the foreshore environment. The sensitive plant survey, conducted on June 8, 2010, confirmed the presence of some of these species along the shoreline. Spangle-top (*Scolochloa festucacea)* and wild licorice (*Glycyrrhiza lepidota*), both red-listed species, were observed in the project area. **These plant occurrences have been mapped and because of their sensitive designation, have been incorporated in the AHI as a ZOS** (*See* Section 2.3.5.2). Other sensitive species may be present, although they were not apparent during this particular survey date (e.g., had not bloomed yet or produced seed heads). A complete list of plant species identified during the survey is provided in Appendix F.

Table 6. Lacustrine and palustrine associated vascular plant species at risk that may occur in the Wasa Lake area. Source: BC CDC 2010.

Common Name	Scientific Name	Global Rank[1]	Prov Rank[1]	BC CDC[2]	Survey Notes, June 2010
spangle-top	*Scolochloa festucacea*	G5	S2	Red	Found in Segment C3 in grassland under trees and between shrub and tree bands.
slender wedgegrass	*Sphenopholis intermedia*	G5	S3	Blue	Known at waters edge from Edwards Lake near Grasmere (BC CDC 2010), but not identified during survey.
obscure cryptantha	*Cryptantha ambigua*	G4	S3	Blue	Known from Butte (BC CDC 2010). Not identified during survey – may not have bloomed yet (blooms June to July)
wild licorice	*Glycyrrhiza lepidota*	G5	S2	Red	Found in Segments W2 and W10; just emerging in some places. Also known in nine patches around Wasa Lake (Segments W4, W6 and W8; [Keefer pers. comm. 2007]).
mountain sneezeweed	*Helenium autumnale* var. *grandiflorum*	G5	S2S3	Blue	Not found during survey; could possibly find later in the season. Known from Wasa, beside water (BC CDC 2010)
western St. John's-wort	*Hypericum scouleri* ssp. *nortoniae*	G5	S2S3	Blue	Not found during survey; could possibly find later in the season. Known in most CDC locations in west Kootenay (BC CDC 2010)
sweet-marsh butterweed	*Senecio hydrophiloides*	G4G5	S1	Red	Not found during survey; would have been evident if present since Rocky Mountain butterweed (*Senecio streptanthifolius*) was observed. Known from Flathead and Grand Forks (BC CDC 2010)

[1] Rank codes: **G = Global** rank; **S = Sub-national** (provincial/state) rank; 1= **Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors. **2 = Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors; **3 = Vulnerable**—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors; **4 = Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.; **5 = Secure**—Common; widespread and abundant; **NR = not ranked.** A **numeric range rank** (e.g., S3S4) is used to indicate the range of uncertainty in the status of a species. Source: NatureServe (2008)

[2] BC CDC: British Columbia Conservation Data Centre (provincial element ranking organization). **Red-listed** species and ecological communities are considered to be extirpated, endangered or threatened (at risk of becoming endangered) in British Columbia. **Blue-listed** species and ecological communities are considered "particularly sensitive to human activities or natural events". Neither listing provides any legal protection to the animals or their habitat.

Sensitive Ecological Communities

Most land at low elevations in the East Kootenay trench is private land and is often of significant conservation value (Wells *et al.* 2004). Many ecological communities found in the PPdh2 are red-listed by the BC CDC (Table 7). Two of these red-listed ecological communities were found at Wasa Lake during the vegetation survey. **These ecological communities have been mapped and because of their sensitive designation, have been incorporated in the AHI as a ZOS** (*See* Section 2.3.5.2)**.**

1. The ponderosa pine – trembling aspen / prairie rose community (*Pinus ponderosa - Populus tremuloides / Rosa woodsii*) was found near the northern boundary of Segment W4.
2. Another sensitive ecological community was found in Segment W4, along the north and south boundaries of Hanson Creek. This was the black cottonwood / red-osier dogwood – prairie rose (*Populus balsamifera* ssp. *trichocarpa* / *Cornus stolonifera - Rosa woodsii*). This presence of prairie rose rather than nootka rose in this community was discussed with Cadrin, BC MoE Vegetation Ecologist. Cadrin (pers comm) identified that it is likely a red listed plant community even though it is a different species of rose, since it is still the same community type.

Other sensitive ecological communities identified by the BC CDC were not found during the survey, as they were more likely to be found in upland areas, outside of the 50 m range of the floristic survey.

Table 7. Ecological communities at risk found in the Ponderosa Pine Kootenay dry hot biogeoclimatic subzone variant (PPdh2) that may occur at Wasa Lake (Source: BC CDC 2010).

English Name	Scientific Name	Global Rank*	Prov Rank*	BC CDC*	Field notes, June 2010 survey
rough fescue - bluebunch wheatgrass	*Festuca campestris - Pseudoroegneria spicata*	G4	S2	Red	Upland community, not found along shoreline.
ponderosa pine - trembling aspen / prairie rose	*Pinus ponderosa - Populus tremuloides / Rosa woodsii*	GNR	S1	Red	Found in Segment W4
ponderosa pine / bluebunch wheatgrass - silky lupine	*Pinus ponderosa / Pseudoroegneria spicata - Lupinus sericeus*	GNR	S2	Red	Upland community, not found along shoreline.
black cottonwood / red-osier dogwood – Nootka rose	*Populus balsamifera* ssp. *trichocarpa* / *Cornus stolonifera - Rosa nutkana*	GNR	S1S2	Red	Community exists with Prairie rose instead of Nootka rose in Segment W4.
bluebunch wheatgrass - junegrass	*Pseudoroegneria spicata - Koeleria macrantha*	G2	S2	Red	Upland community, not found along shoreline.
antelope-brush / bluebunch wheatgrass	*Purshia tridentata / Pseudoroegneria spicata*	G3	S2	Red	Upland community, not found along shoreline.

* For ranking definitions and codes, see Table 6

Grasslands

Grasslands are one of Canada's most endangered ecosystems (Fish and Wildlife Compensation Program (FWCP) 2008) and BC's grasslands are known to be home to over 30 percent of the species at risk in the province (Grasslands Conservation Council of BC 2009). Making up less than one percent of British Columbia, grasslands account for over 30% of the province's rare and endangered species (Grasslands Conservation Council of BC 2009). Remaining grasslands have been heavily altered by livestock grazing, off-road recreation, invasive exotic plants and encroachment of adjacent forests. A northern extension of Great Basin grasslands in the United States and different from the prairie grasslands east of the Rocky Mountains, the species found in BC Grasslands are largely at their northern range limit and uniquely adapted to an often harsh

environment. In the East Kootenays, there are 20 red-listed and an additional 20 blue-listed vascular plant species and six red-listed plant communities (Grasslands Conservation Council of BC 2009). However, not all of these occur at Wasa and/or they do not necessarily occur in close association with lacustrine or palustrine ecosystems.

At Wasa Lake and Cameron Pond, grassland areas and open forests with grass understory were observed in several areas, including Segments W2, W8, W9, W10 and C3 (*See* Appendix B). These areas often included an open ponderosa pine forest containing a grassy understory. Qualitative vegetation analysis revealed that the grasslands associated with high recreation use (Park Segments W8 and W10) or other areas with human disturbances such as road ways, had a high incidence of agronomic non-native species, including for example, crested wheatgrass *(Agropyron cristatum),* Kentucky bluegrass *(Poa pratensis) and* smooth brome *(Bromus inermis).* The less disturbed areas and conservation areas (Segments W2, W4, W6 and C3) had a much higher proportion of native grasses present including for example, barnyard grass (*Echinochloa crusgalli*), spreading needlegrass (*Stipa richardsonii),* and Nuttall's alkali grass (*Puccinellia nuttalliana).*

Wildlife Trees

As a veteran tree deteriorates, it can support up to 80 wildlife species, or 15% of the province's birds, mammals and amphibians (BC Wildlife Tree Committee 2009). Wildlife trees provide many kinds of critical habitats including nest cavities and platforms, nurseries, dens, roosts, hunting perches, foraging sites and display stations (Backhouse 1993). Loss of this habitat is a concern for many dependant wildlife species and the most effective wildlife management practices is to retain wildlife trees (Wildlife Stewardship Program 2008). Vertebrate species known to the Wasa Lake area that are cavity nesters and that would thus utilize wildlife trees include: Lewis' Woodpecker (*Melanerpes lewis*) and several other woodpeckers, Saw-whet owl (*Aegolius acadicus*), Northern Pygmy-owl (*Glaucidium gnoma*), chickadees (*Parus* spp.), nuthatches (*Sitta* spp.), bluebirds (*Sialia* spp.) northern flying squirrel (*Glaucomys sabrinus*), red squirrels (*Tamiasciurus hudsonicus*). Wildlife trees located along foreshore, riparian habitats, deciduous patches, gullies and ravines are known to be used the most (Backhouse 1993).

Wildlife trees were present in small numbers (<5 each) in many Segments (Appendix D and Appendix I). High value wildlife trees take a long time to generate so maintaining those present is the preferred management option. Wide diameter trees are best and these are often centuries old. Dead trees are often removed for either aesthetic or safety reasons, as well as firewood collection. The current mountain pine beetle outbreak may result in the death of mature ponderosa pine trees around Wasa Lake.

We recommend that a Wildlife Tree Assessment be completed for the foreshore. Options should be explored for maintaining as many of these trees as safely possible. It is recognized that this is a sensitive subject, given that there has historically been losses of life at Wasa Lake resulting from fallen tree(s) (Bisset pers. comm.). The Wildlife Tree Assessment should be ongoing for any trees protected, to help ensure public safety. We also recommend an education program for residents, on the value of wildlife trees.

3.4 Fish Results

A list of fish species known to Wasa Lake and to Lewis Creek which drains into Cameron Pond is provided in Table 8. Fish presence data has been obtained from the Fish Inventory Summary System (FISS - BC MoE 2010) and from surveys completed through this project in 2009 (Table 9 and Appendix G).

In Wasa Lake proper, lack of suitable habitat, in particular a connection to tributary flow with gravels substrates for spawning is likely a limiting factor for many of the historically listed native fish species such as burbot (*Lota lota)*, peamouth chub (*Mylocheilus caurinus),* bull trout *(Salvelinus confluentus*), and westslope cutthroat trout (*Oncorhynchus clarkii lewisi)*. Some of the accounts

(e.g., bull trout and burbot in the lake), in the past may be from fish accessing the lake from the Kootenay River during high flows (Bisset pers. com.). Peamouth chub records may be a misidentification with lake chub, as this often occurs in southern BC (McPhail 2007). Lake chub are found throughout North America, whereas peamouth chub are restricted to the Columbia River System (McPhail 2007).

Although bull trout, westslope cutthroat trout (a blue-listed species; BC CDC 2010) and burbot have historically been recorded in Lewis Creek, the lower part of the creek (area below Lazy Lake) is not expected to provide high value habitat for spawning and rearing of potential adfluvial forms (fish that would spawn in the streams and then move to Cameron Pond to reside as adults). This is because bull trout and cutthroat trout are a cold water species, uncommon at temperatures above 15^{o}C, 20^{o}C and 18^{o}C respectively (McPhail 2007). Habitat degradation in Lewis Creek has been extensive and included riparian vegetation removal, channelization and flow diversion (Tepper pers. com); which are activities that result in higher than normal water temperatures. Cutthroat trout are known to occupy the less impacted stream areas above Lazy Lake (Tepper pers. comm. and Jaimeson pers. comm.). Cameron Pond also likely reaches temperatures that are high for these species, because of its small size, and the ephemeral flows from Lewis Creek (typically), and thus would not likely provide good habitat for these adults. Current data on water temperatures and species presence would be required to confirm this.

Table 8. Fish species historically recorded at Wasa Lake and Hanson Creek (Source: BC MoE 2010 and 2009 fish survey data associated with this study).

Species*	Scientific Name	Most Recent Reference Date	
		Wasa Lake/Hanson Creek	Lewis Creek (potentially Cameron Pond)
Wild Indigenous			
Bull Trout	*Salvelinus confluentus*	-	1975
Burbot	*Lota lota*	1952	1975
Lake Chub	*Couesius plumbeus*	1983	-
Longnose dace	*Rhinichthys cataractae*	2009 (first record)	-
Largescale sucker	*Catostomus macrocheilus*	2010	1975
Northern pikeminnow	*Ptychocheilus oregonensis*	1983	1975
Peamouth chub	*Mylocheilus caurinus*	1960	1975
Redside shiner	*Richardsonius balteatus*	-	1975
Sculpin	*Cottus spp.*	-	1975
Westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	-	Present, but date not specified
Introduced/Naturalized			
Largemouth bass	*Micropterus salmoides*	2009	1990
Pumpkinseed	*Lepomis gibbosus*	2009 (first record)	1975
Yellow perch	*Perca flavescens*	2009	1990
Hatchery			
Eastern brook trout	*S. fontinales*	1983	1975
Rainbow trout	*O. mykiss*	1995	1990 (stocked in 1960 & 1995)
Westslope cutthroat trout	*O. clarkii lewisi*	-	1942 (Cameron Pond)

Table 9. Wasa Lake fish data collected on July 14, 2009 and relative abundance by site and species.

Species (lifestage)	Number of fish counted at each site							Total	Relative abundance (%)
	W1-1 seine 1x20m	W1-2 seine 1x15m	W2-1 seine 1x20m	W4-1 snorkel 1x100m	W6-1 seine 1x20m	W7-1 snorkel 1x150m	W10-1 seine 1x20m		
Habitat (shore / dom. substrate)	Veg. bay/ gravel	Veg. beach/ silt	Veg./silt & gravel	Hanson Ck. wetland/ silt	Veg. park/ gravel	Groom (docks)/ silt	Sandy beach/ sand		
cyprinid spp. (juvenile)	-	-	-	-	-	-	50	**50**	**5.7**
longnose dace (adult)	-	2	-	-	1	-	-	**3**	**0.3**
yellow perch (juvenile)	500	50	100	6	5	-	-	**661**	**76.0**
yellow perch (adult)	-	-	-	1	-	-	-	**1**	**0.1**
largemouth bass (juvenile)	-	-	-	-	3	100	-	**103**	**11.8**
largemouth bass (adult)	-	-	-	-	-	5	-	**5**	**0.6**
pumpkinseed (adult)	-	-	3	24	-	20	-	**47**	**5.4**
Total Count	**500**	**52**	**103**	**31**	**9**	**125**	**50**	**870**	
Relative abundance of fish (%) by site	**57.5**	**6.0**	**11.8**	**3.6**	**1.0**	**14.4**	**5.7**		

The hatchery stocked eastern brook trout and rainbow trout may reproduce in Lewis Creek, since they were diploids (BC MoE 2010). Brook trout in particular, may be present because they can tolerate higher temperatures (up to 22^{o}C) and are known in a variety of habitats including streams, beaver ponds and lakes (McPhail 2007). Lake dwelling rainbow trout usually occur in mesotrophic or oligotrophic lakes and stay below the 18^{o}C isotherm in areas where the oxygen content is above 3.0 mg/L (Raleigh *et al.* 1984). In small lakes, adult rainbows are often associated with cover (large woody debris) in the lower littoral zone (McPhail 2007).

Cyprinids (including lake chub, northern pikeminnow, longnose dace and redside shiners), sculpins and the largescale sucker, can spawn along lake margins and are suited to the habitat conditions of the project area throughout their lives (Table 10). These species form the native fish assemblage for the project area, and although they are not sport fish, their habitat is important to maintain. In addition to their inherent biodiversity values, these species provide an important food source for wildlife in the area, particularly birds. Many of these are small bodied species, which are likely experiencing pressures from the species introduced to the area. The native species only represented 6% of the fish population surveyed on July 14, 2009.

Valuable habitat areas for native fish species were thus considered a ZOS in the AHI analysis. The largescale sucker spawns in the north east bay of Segment W8, where the ephemeral stream enters the lake. The spawn is an annual spring event that draws locals, nature enthusiasts as well as various birds of prey (Stephens pers. comm.). The spawn is only known to occur in this part of the lake (Stephens pers. comm.). This species spawns in late May and peaks in June, usually as temperatures approach 15^{o}C (McPhail 2007). **In order to protect native species values, largescale sucker spawning habitat has been mapped as a ZOS** (*See* Section 2.3.5.2)**.**

Another ZOS that recognizes important habitat for native fish species are the biologically productive areas. This ZOS was defined similarly to Moyie Lake (Schleppe 2009) and Tie/Rosen Lakes (AMEC 2010) as areas with wide littoral areas (> 50m) associated with stream mouths/ outlets, aquatic vegetation and/or wetlands. All creeks flowing into the Wasa Lake and Cameron

Pond are believed to be ephemeral, flowing during only part of the year. However, these areas with their diverse riparian communities and more complex habitats, not readily available in the project area, did stand out. They were considered important for providing refuge and foraging habitat for native fish species; particularly for young of the year (YOY) and juvenile rearing. The biologically productive ZOS was also considered important for invertebrates, birds and mammals.

Table 10. Typical shoreline habitat use for fish in the Wasa Lake area (Source: McPhail 2007, unless otherwise identified).

Species	Spawning (all species are spring spawners)	Young-of-Year	Juvenile rearing and adults
Native Fish Species			
lake chub	Not selective about substrates, flowing or standing water	Within 1 m of shore, less than 1 m deep over fine substrates; prefer vegetative cover. Progress out from shore (2-3 m) over summer.	Close to bottom in littoral zone. During day, remain in shallows seeking shelter from predators amongst vegetation. Move offshore at night.
northern pikeminnow	Water velocities <0.4 m/s and a sand-free substrate of gravel and cobbles (Beamesderfer 1992)	Lake margins, shallow waters (<0.30 m) close to cover (usually weeds) and are typically mixed with other cyprinids (Miura 1962).	By fall, juvenile move offshore to deeper water. Adults often forage in the littoral area.
longnose dace	Over gravels; often associated with cobble or boulders. 1 m water on wave-washed shore in areas with larger littoral shelves (10-30 m) (Schleppe and Arsenault 2006).	Close to shore where there is cover (Brazo *et. al.* 1978).	Creek mouths or wave-washed cobble/boulder substrate areas. (Schleppe and Arsenault 2006)
redside shiner	Any shoreline having cobble, gravel or vegetation present (Schleppe and Arsenault 2006)	Shallow water, usually less than 1 m, along the margin often associated with aquatic vegetation.	Loose schools along the lake margin. Generalist in most shore types (McPherson and Hlushak 2008).
largescale sucker	Shallow water over course material (fine gravel to cobble). At Wasa Lake, known to spawn in sandy bay in Segment 8 (ZOS).	Shallow areas over rock and gravel, shifting to sand in late summer.	Shallow areas close to the shore. Associated with vegetation at sandy beach and vegetated shore (McPherson and Hlushak 2008).
Non-Native Fish Species			
pumpkinseed	Pit prepared in the sand or gravel substrates, near or in aquatic vegetation, in shallow water <1 m.	Open water to feed on plankton	Littoral area. Found in vegetated shore at Windermere Lake (McPherson and Hlushak 2008)
largemouth bass	1 m or less and typically near wood cover.	Shallow, calm, often vegetated lake margins.	Associated with soft substrates in areas with dense beds of aquatic vegetation. Often found around modified structures such as boats, docks and retaining walls; also in warm vegetated bays (Porto pers. comm.).
yellow perch	Inshore waters.	Littoral zone and usually associated with vegetation (Bryan and Scarnecchia 1992).	Juveniles - Littoral zone and usually associated with vegetation. Adults are in the littoral and offshore bottom areas.

Three non-native species have successfully established in Wasa Lake, largemouth bass, yellow perch, and pumpkinseed. Together these species made up 94% of the population sampled on July 14, 2009. Individually, yellow perch was the most abundant (76.1%) followed by largemouth bass (12.4%) and pumpkinseed (5.4%). Largemouth bass and yellow perch are most likely negatively influencing native fish populations. These species have overlapping habitat preferences with the native fish species, and are predatory on the small bodied fish. Juveniles and adults are suited to warm water conditions, with largemouth bass typically remaining in lake shallows until temperatures exceed 27^{o}C and perch until temperatures exceed 20^{o}C (McPhail 2007). Bass have been documented to impact small bodied fish like cyprinids by altering their habitat use and reducing their abundance (sometimes to the point of extirpation) (MacRae and Jackson 2001). At Windermere Lake largemouth bass were often found around modified structures such as boats, docks and retaining walls (Porto pers. comm.). This occurred at Wasa Lake as well, with the bulk of largemouth bass (juveniles and adults) associated with a dock.

Overall, BC MoE has not been stocking or managing Wasa Lake in recent years due to the presence of perch and bass (Tepper pers. comm.). It is important to recognize that these species are sought by recreational fishers throughout the year (Bisset pers. comm.). Although bass and perch are not native to the area, as a result of their recreational value, agencies could consider including them in future management planning. This would include protecting important habitats and preventing their spread to other areas through education. Duck Lake, near Creston, is one example of a lake that is managed for non-native fish species (Holmes pers. comm.). Another management option could be to remove these non-native species from the lake.

3.5 Invertebrate Results

Invertebrates are important to the lake's trophic system since they provide one of the first and key links in the food chain for many animals (Mitsch and Gosselink 2000). Benthic invertebrate field data and Simpson's Index of Diversity Analysis on the data are provided in Appendix H. The results of the diversity analysis are summarized in Table 11, which also provides associated habitat characteristics. This analysis accounts for the richness and evenness of the samples collected at each site and measures the probability that two individuals randomly selected from a sample will belong to different species. The value of this index ranges between 0 and 1, with 0 representing no diversity and 1 representing infinite diversity.

Table 11. Simpson's Index of Diversity results and substrate and aquatic/transition vegetation characteristics of the Wasa Lake sample sites.

Wasa Lake Site	1.2	2.1	6.1	10.1
Simpson's Index of Diversity (1-D)	0.57	0.72	0.04	0.60
Substrate Composition	80% silt, 15% gravel, 5% sand	60% silt, 10% sand, 30% small gravel	80% gravel, 20% sand	95% sand, 5% small gravel
Aquatic / Transition Vegetation	Yes	Yes	Yes	none
Disturbance Indicators	None	None	Park, conservation area - None	Wasa Lake recreational beach; beach groomed

The benthic invertebrate sampling results for Wasa Lake indicate that the highest diversity was at Site 2.1 (0.72). This site is in the Robert's Bay mud flats and is a testament to the areas use and identification as a ZOS for staging birds. Site 6.1 had the lowest index of diversity (0.04). This may be attributed to the disproportionately high number of copepods in the area (1000+) compared to other groups.

3.6 Wildlife Results

We searched the BC CDC (2010) online Species and Ecosystem Explorer for terrestrial species at-risk associated with lacustrine (lake) and palustrine (wetland) habitat associations (Table 12). This list was further delimited by expert knowledge of what species are known to occur in the area and removing species known not to be in the area. Relevant known information relating to habitat use is summarized for each species. Wasa Lake and the sloughs south of the lake are commonly viewed by local naturalists and reliable records exist of species that occur there, birds in particular (See Appendix I). A discussion for these listed species and others have been provided below.

Table 12 Lacustrine and palustrine associated animal species at risk that may occur in the Wasa Lake area.

Common name	Global Rank[1]	Prov Rank[1]	BC CDC[1]	COSEWIC	SARA Schedule
Pronghorn Clubtail	G5	S2S3	Blue	not assessed	na
Twelve-spotted Skimmer	G5	S3	Blue	not assessed	na
Horned Grebe	G5	S4	Yellow	Special Concern	under review
Western Grebe	G5	S1S2	Red	not assessed[2]	na
Great Blue Heron	G5	S3S4	Blue	not assessed	na
American White Pelican	G3	S1	Red	Not at risk	na
Tundra Swan	G4	S3	Blue	not assessed	na
Long-billed Curlew	G5	S3	Blue	Special Concern	Schedule 1[3]
American Avocet	G5	S2	Red	not assessed	na
Common Nighthawk	G5	S4	Yellow	Threatened	Schedule 1[3]
Lewis' Woodpecker	G4	S2	Red	Threatened	Schedule 1[3,4]
Barn Swallow	G5	S3S4	Blue	April, 2011[5]	na
Badger	G5	S1	Red	Endangered	Schedule 1[3]
Western Toad	G4	S4	Yellow	Special Concern	Schedule 1[3]
Rubber Boa	G5	S4	Yellow	Special Concern	Schedule 1[3]

Column acronyms: BC CDC: British Columbia Conservation Data Centre (provincial); COSEWIC: Committee on the Status of Endangered Wildlife in Canada (federal); SARA: Species at Risk Act (federal).

[1] For ranking definitions and codes see Table 6

[2] Western Grebe is on COSEWIC's priority 1 list for status assessment (no timeline for when it will be assessed).

[3] Schedule 1 is the "official" species at risk list approved by federal cabinet under the SARA. Note that SARA prohibitions do not apply to species ranked as Special Concern.

[4] COSEWIC recommended Lewis' Woodpecker be listed as "Threatened" in April, 2010. Prohibitions under SARA will apply if that species is formally adopted as "Threatened" by federal cabinet. A decision is expected in March, 2012 (Reiss pers. comm.). The species is currently on SARA Schedule 1 as "Special Concern" (see point 4 above).

[5] COSEWIC will assess Barn Swallow in April, 2011.

Pronghorn Clubtail, *Gomphus graslinellus*

This blue-listed dragonfly was first observed from Wasa Lake in 1998 (Cannings *et al.* 2000). Initially, red-listed, it was down-listed to blue when additional occurrences were found throughout the Okanagan. Pronghorn clubtails have also been observed at Surveyor's Lake (Kikomun Creek Provincial Park; Nicholson pers. comm.); these locations are the only known occurrences in British Columbia east of Christina Lake.

Proghorn clubtails are closely associated with foreshore habitats. The larvae burrow in sand and silt of wave-washed shores, and then metamorphose slightly back from the water's edge. Adults often bask on beaches and clearings near water. Their recorded flight dates (when adults are present) range from 3 June to 20 July (Cannings *et al.* 2000). For management considerations, Cannings *et al.* (2000) note that "Marina developments, pollution from power boats and popular swimming beaches all have potential impact on larval survival."

Twelve-spotted Skimmer, *Libellula pulchella*

Libellulid dragonflies are most common around marshy lakeshores with calcareous soils. Eggs are oviposted directly into the water, preferably around submerged vegetation. The larvae are more aquatic than the pronghorn clubtail, living on muddy lake bottoms (Cannings *et al.* 2000). The blue-listed twelve-spotted skimmer is known from Bummer's Flats and a few other ponds in the East Kootenays, but not Wasa Lake itself (Cannings *et al.* 2000).

Western Grebe, *Aechmophorus occidentalis*

Western Grebes are large waterfowl who migrate through the East Kootenays, primarily in late April and early May. They are colonial nesters, with colonies near Creston and Salmon Arm. In migration they can form very large flocks (over 100 individuals) and make regular stops at 'staging lakes' to rest and feed for several days before moving on. While staging, they feed on small fish and aquatic invertebrates, while generally avoiding areas with human activity (Burger 1997). Western Grebes are known to stage on Wasa Lake in late April to early May, staying for up to a week and may be found foraging close to shore. Western grebe diet is predominantly small fish, but also includes aquatic insects and crustaceans (Burger 1997).

Great Blue Heron, *Ardea herodias herodias*

Herons are regularly observed foraging at Wasa Lake and in sloughs and wetlands in the area. There are two Great Blue Heron nesting colonies close to Wasa Lake. One is Saugum Lake, southeast of Wasa Lake, which was last active in 2002. Another colony between Highway 93/95 and the Kootenay River, immediately west of Wasa was active, but unsuccessful in 2007 (Machmer 2008).

Herons stalk prey in shallow waters with abundant small fish (Butler 1992). Maintaining the integrity and wetland characteristics of foraging areas, such as Wasa Lake, that are close to nest colonies is especially important (Machmer and Steeger 2003). Management actions that ensure prey availability are therefore essential.

American White Pelican, *Pelecanus erythrorhynchos*

The American White Pelican is one of only four species formally listed as Endangered under the provincial *Wildlife Amendment Act*, and subject to protections under this legislation. In the East Kootenay, the pelican is an occasional migrant, staging on lakes and sloughs in late April to early May. The only known breeding colony in BC is at Stum Lake in the Fraser Plateau (BC CDC 2010). There are numerous colonies on lakes in the prairies and aspen parklands east of the Rocky Mountains. Pelicans are occasionally observed on the sloughs south of Wasa and likely use the lake on occasion too.

Water birds

Many species of water birds (loon, grebes, ducks, geese, swans, gulls, etc; *see* Appendix I) use Wasa Lake and Cameron Pond either in migration (spring and fall) or for nesting. Common Loons (*Gavia immer*) use the entire Wasa Lake for foraging and are known to nest in the northwest bay (Segment 6; Ashmore pers. comm.) They are also regularly observed on Cameron Pond. Tundra and Trumpeter Swans (*Cygnus* spp.) stage on the lakes and adjacent sloughs during migration, especially during the spring in March and April. Relatively low levels of recreational activity are important while waterfowl are staging in the spring and fall to allow them the opportunity to forage and restore energy. For species nesting in the area (e.g., loon, some ducks and grebes), having refugia away from high summer boat activity is important.

Shorebirds

Shorebirds are typically small to medium-sized birds that may occur alone (e.g. Semi-palmated Plovers, dowitchers) or in large flocks. Numerous shorebird species stage on mudflats and beaches of Wasa Lake and surrounding sloughs and wetlands during spring and fall migrations (Appendix I). Birds may spend up to a week in the area, depending on the weather. Spring migration occurs, approximately, from mid-April to mid-May, and south-bound "fall" migration occurs in mid-August to early September. Birds are found primarily on sand / mud beach and shallow water areas where

they forage for aquatic invertebrates. Roberts Bay at the south end of Wasa Lake is particularly important for shorebirds in both spring and fall migrations. This bay usually has broad mudflats that offer excellent foraging opportunities and receives much less human disturbance than other areas in the main lake. **Because of the regional importance of Roberts Bay to migrating shorebirds, Segment 2 is included as a ZOS** (*See* Section 2.3.5.2).

Common Nighthawk, *Chordeiles minor*

Nighthawks are known in the Wasa area, arriving in late May to early June (Campbell *et al*. 1990). Nests are built directly on the ground in wide array of habitats including: beaches, pasture, open forest, lakeshores, gravel roads, river banks, railways, airports and flat gravel rooftops. (COSEWIC 2007 and references therein). Incubation lasts 16 to 20 days and nestlings remain in or near the nest until late August (COSEWIC 2007 and references therein). Large flocks of nighthawks congregate post-fledging prior to southward migration in late summer. Most nighthawks have migrated south by mid-September. There is a low probability of nighthawks nesting on the Wasa Lake foreshore; however, they may nest in the area. As aerial insectivores, they feed on air-borne insects, some of which emerge from aquatic larvae. As a federally listed species (Threatened, COSEWIC 2007), they merit discussion and management concern.

Lewis' Woodpecker, *Melanerpes lewis*

Lewis' Woodpecker is a migratory bird present in the East Kootenays from late April until early September (Cooper *et al*. 1998). They excavate cavities in large dead or decaying trees in open ponderosa pine forests, open riparian woodlands and recently burned forests (Cooper *et al*. 1998). Fire appears to play a key role in the creation and maintenance of Lewis' Woodpecker nesting habitat (Cooper and Beauchesne 2000; Cooper and Gillies 2000). A reliable source of insects for food is also necessary.

Suitable nesting and foraging habitat exists for Lewis' Woodpecker immediately adjacent to Wasa Lake and they are historically documented in Wasa, TaTa Creek and Skookumchuk Prairie (Cooper *et al*. 1998). However, in 2007 the closest active nest was at Bummer's Flats and previously used (and still apparently suitable) nest sites were abandoned (Beauchesne and Cooper 2007).

Swallows

Several species of swallow are known in the Wasa Lake area (Table 13; Campbell *et al*. 1997). Only Barn Swallows are provincially blue listed (BC CDC 2010) and will soon be assessed by COSEWIC. However, most swallows have suffered major declines across North America. For example, Bank Swallows have had statistically significant annual declines of 7.5% from 1986 – 2006 in Canada, based on breeding bird survey data (McCracken 2008).

Lacustrine habitats are an important aspect to swallow ecology, as they regularly forage over lakes, hunting aerial insects which hatch from aquatic larvae. Cameron Pond in particular had very high numbers of Northern Rough-winged Swallows, Violet-green Swallows and Tree Swallows foraging over it during the wildlife assessment completed May 20, 2010 (Appendix I). Coarse woody debris emerging from the pond, especially near the Lewis Creek mouth, was widely used for perching by the swallows and other birds.

Table 13. Swallow species known or likely to occur at Wasa Lake, BC, the type of nest each constructs and characteristics of breeding colony. Source: Campbell *et al*. (1997)

Swallow species	*Nest type*	*Colonies*
Barn, *Hirundo rustica*	Open cup mud nest usually built on human structures	Loosely colonial
Cliff, *H. pyrrhonota*	Enclosed mud nest on cliff faces or human structures	Highly colonial
Bank, *Riparia riparia*	Excavates burrows in bank / cliff faces of silt, clay or sand with very specific soil stability requirements.	Highly colonial
Tree, *Tachycineta bicolor*	Cavity nester – trees, cavities, crevices, rarely on vertical faces	Primarily solitary
Violet-Green, *T. thalassina*	Primarily cavity nester, occasionally on cliffs; highly adaptable	Primarily solitary, but will form substantial colonies.
Northern Rough-winged, *Stelgidopteryx serripennis*	Burrows in banks, occasionally in cliff crevices. Rarely excavates its own burrow, relying on Bank Swallows and kingfishers.	Primarily solitary, occasionally colonial, sometimes associated with Bank Swallows

Raptors

Several raptor species occur in the Wasa Lake area, including Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*). Other possible species nesting nearby include Cooper's Hawk (*Accipiter cooperii*), Sharp-shinned Hawk (*Accipiter striatus*), Red-tailed Hawk (*Buteo jamaicensis*), Merlin (*Falco columbarius*) and American Kestrel (*Falco sparverius*). Most of these species build large, highly visible stick nests in trees or atop human-constructed poles (e.g., power lines). Golden eagles (*Aquila chrysaetos*) are regularly observed during spring and fall migration (Bisset pers. comm.). Rough-legged hawks (*Buteo lagopus*) are regularly observed over-wintering in the area, though not necessarily along the Wasa Lake foreshore.

Bald Eagle nesting begins in April, with young usually fledged by late July (Campbell *et al*. 1990). Ospreys arrive soon after the lake is ice-free, with nesting beginning in late April. Young are fledged by late July (Campbell *et al*. 1990). The other raptors listed above have similar nesting periods, but are not necessarily associated with foreshore or riparian habitats.

Bald Eagles and Osprey are known to nest in the area. A Bald Eagle pair has nested on the east shore of Cameron Pond since 2004 (Machmer 2008), and are regularly observed around Wasa Lake proper. Bald Eagles are both hunters and scavengers, often feeding on dead fish at the lake shore. Ospreys also nest nearby (though not necessarily adjacent to water) and regularly feed on live fish from Wasa Lake. Both these species are highly visible, recognizable to most residents and visitors and likely highly valued.

Raptor nests are relatively easy to locate: the nests are large, the adult birds are conspicuous and, except for incubation, they are noisy and often aggressively defended. As with most birds, raptors are protected by the *Wildlife Act* (s.34) which provides year-round protection to nests of Bald Eagle, Osprey and selected others, regardless of whether the nest is active.

Songbirds

Numerous songbirds (primarily passerines) use the riparian areas around Wasa Lake and Cameron Pond (see Appendix I – bird list and D. Cooper notes). Species include Song Sparrow (*Melospiza melodia*), Yellow Warbler (*Dendroica petechia*), American Redstart (*Setophaga ruticilla*), Red-eyed Vireo (*Vireo olivaceus*). Northern Waterthrush (*Seiurus noveboracensis*) is a warbler associated with older forests close to water. Despite historical records, the species has no recent records in the Wasa area (Appendix I- D. Cooper's notes). Maintaining well vegetated riparian areas is important for these species.

Badger, *Taxidea taxus jeffersonii*

Badgers are mid-sized fossorial carnivores. Traditionally considered an upland species, research in the East Kootenay (Newhouse and Kinley 2001) has found badgers to maintain exceptionally large home ranges (males average 70 km^2) which suggests they must regularly encounter foreshore areas. In the East Kootenay, badgers' primarily prey on Columbia ground squirrels (*Spermophilous columbianus*), but will feed on a variety of species including aquatic species, including spawning fish (e.g. suckers; Newhouse and Kinley 2001; Messick 1987).

Fine scale habitat associations include glaciofluvial, fine sandy-loam textured and well-drained soils on south-facing slopes (Apps *et al*. 2002). Numerous sightings of badgers and burrows have been documented in and around Wasa Lake, including the provincial park day-use area on the east shore near the campground (Kinley pers. comm.). Apps *et al*. (2002) rate the area at a coarse scale as 'better' and 'best' badger habitat. Figure 28 provides further support of badger habitat use and suitability in the Wasa Lake area by depicting data synthesized by the FWCP (2008) of badger sightings between 1968 and 2002, tracked movements obtained during radio telemetry studies from 1996-2005 and habitat suitability analysis results. Updated badger habitat modeling is in progress but not yet available (Kinley pers. comm.).

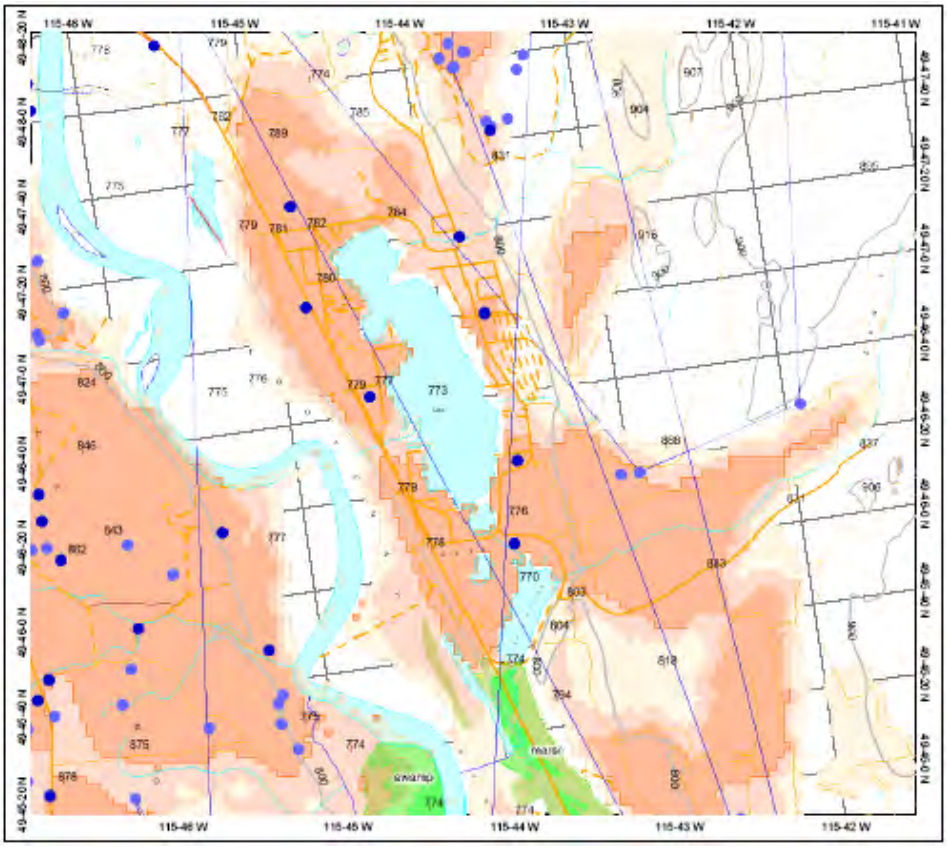


Figure 28. Wasa Lake area badger sightings (dark blue dots), radio telemetry (light blue lines and dots) and habitat suitability (shaded area; with darkest salmon colour representing high suitability, light pink is medium and yellow is low). Source: FWCP 2008.

Amphibians

At some point in their life cycle, all amphibians require a reliable water source. Most require at least a moist environment for much of their lifespan and are incapable of surviving in hot, dry environments. As such, the ponderosa pine forests and grasslands around Wasa Lake are not particularly hospitable to amphibians.

Residents report amphibians have not been abundant in the area for the past 30 years or more (Ohanjanian 2000). An amphibian survey of Wasa Lake in 2000 (Ohanjanian 2000) found the only amphibian species present to be western toad (*Bufo boreas*).
This species is federally listed as a species of "Special Concern", but not considered at risk provincially (Table 12). Only 2 individual toads were observed, a recently metamorphosed toadlet in the south bay of Wasa Lake and one adult on Wasa Lake Drive near Birch Rd. Ohanjanian (2000) suggested that the "exceedingly low" numbers of both amphibians and aquatic insects suggest "this ecosystem is not functioning well."

Other amphibian species that may be expected to be in the Wasa Lake area include: Columbia spotted frog (*Rana luteiventris*), Pacific treefrog (*Hyla regilla*) and long toed salamander (*Ambystoma macrodactylum*). Red-listed and federally endangered northern leopard frogs (*Rana pipiens*) were re-introduced to Bummer's Flats south of Wasa in 2003. There are no known historic records of them at Wasa Lake proper and the lake is not currently a priority site for future re-introductions (Adama pers. comm.).

Snakes
The only snake listed 'at-risk' that may possibly occur in the Wasa Lake area is the rubber boa (*Charina bottae*). Rubber boas inhabit a wide variety of habitats, including riparian, grassland and montane forest areas (COSEWIC 2003 and references therein). They spend up to 25% of their time underground (St. Clair 1999) and seem to require coarse woody debris or other similar structures as protective and thermoregulatory cover. While there are no known records of rubber boas from Wasa Lake, they do occur in the East Kootenay region (BC CDC 2010).

Other snake species known from the East Kootenays also have close associations with wetland and wet habitats (e.g. western terrestrial garter snake (*Thamnophis elegans*) and common (or red-sided) garter snake, *T. sirtalis*). In cold climates such as this, snakes are often limited by access to hibernacula for over-wintering. Best management practices (BMPs) for garter snakes in BC (Ovaska *et al*. 2004) recommend access to wetland foraging areas. Maintaining good herbaceous cover in the foreshore area is very important for western terrestrial garter snakes who, despite their name, are very aquatic and seldom found far from water (The Reptiles of BC 2008).

3.7 Aquatic Habitat Index Results

The Current Ecological Value and Ecological Potential, determined through the AHI are depicted on the Summary Maps (Appendix A) and the AHI calculations are provided in the AHI Tables (Appendix J).

The **Current Ecological Value** results for **Wasa Lake** reveal that the greatest extent of shoreline length was determined to be Very Low (31%), followed by Low (26%), High (21%) and Moderate (15%) (Table 14). Segments ranked as Very High, were the least available (7%). The extent of intact areas of importance for fish and wildlife is attributed to the undeveloped conservation areas (Segments W2, W4, W6). Segments with intensive development (Segments W1, W3, W5, W7 and W9) or a substantial area managed for recreational park use (Segment W10) were ranked as Low or Very Low. The moderate segments were those that had a mix of conservation and recreation in a park (Segment W8). There were ZOS (rare or significant biological) elements around the lake that contributed to many of the Segment Values.

The **Ecological Potential** analysis shows that with restoration (e.g., infrastructure removal) Wasa Lake shoreline areas impacted with retaining walls, docks, groynes, boat launches and beach grooming would see an improvement in their ranking. With restoration, six segments would increase by one rank. Low, Moderate and High rankings each increased by a factor of at least 1.3. This analysis did not consider riparian habitat improvements. Additional benefits could be realized at all disturbed segments with riparian restoration.

Table 14. Wasa Lake AHI analysis results following current ecological value analysis (with in-water structures) and ecological potential analysis (without in-water structures).

Ecological Value	Current Ecological Value			Ecological Potential		
	Segments	Total Shoreline Length (%)	(m)	Segments	Total Shoreline Length (%)	(m)
Very High	W4	7	515	W4	7	515
High	W2, W6,	21	1572	W2, W6, W8	36	2700
Moderate	W8	15	1128	W1, W9	23	1767
Low	W1, W9, W10	26	1998	W3, W5, W7, W10	34	2570
Very Low	W3, W5, W7	31	2340	-	0	0
			7553			7553

The **Current Ecological Value** results for **Cameron Pond** reveal that the shoreline is largely ranked as Very High (46%). High and Moderate values each contributed similarly (26% and 27% respectively) (Table 15). No segments were calculated to be Low or Very Low. The extent of intact areas of importance for fish and wildlife is attributed to the undeveloped conservation areas (C2 and C3). The moderate segment (C1) had low intensity development set back from the shoreline. There were ZOS (rare or significant biological) elements around the pond that contributed to the Segment Values.

The **Ecological Potential** analysis shows that current rankings at Cameron Pond would not notably increase with restoration. This is because the shoreline is largely intact.

Table 15. Cameron Pond AHI analysis results following current ecological value analysis (with in-water structures) and ecological potential analysis (without in-water structures).

Ecological Value	Current Ecological Value			Ecological Potential		
	Segments	Total Shoreline Length (%)	(m)	Segments	Total Shoreline Length (%)	(m)
Very High	C2	46	1150	C2	46	1150
High	C3	26	657	C3	26	657
Moderate	C1	27	676	C1	27	676
			2483			2483

4 State of the Foreshore

Foreshore ecosystems function upon intricate relationships, provide living space for permanent and transitory species, and support primary production and food webs (Batelle 2001).

Sensitive Species

The shorelines of Wasa Lake and Cameron Pond are biologically diverse and important to numerous plant, fish and wildlife species. Several sensitive species have been reported to inhabit or potentially inhabit the area, including: seven plant species (two were confirmed through this study), two ecological plant communities, two invertebrate species, ten bird species, two amphibians, one fish species and one mammal species. At Wasa Lake the native fish species assemblage was found to be primarily comprised of non-sport fish, including cyprinids and suckers.

These native species are also considered sensitive, since they were found in low numbers; which is likely attributed to predation and competition with non-native fish species.

Fish assemblages in Cameron Pond, although not studied, are expected to be similar to Wasa Lake. Habitat degradation of Lewis Creek which drains into the pond, has led professionals to believe that it does not likely provide good habitat to support additional salmonid species (Tepper and Robinson pers. comm.). Additional studies should examine this issue.

Maintaining functional habitats for present species is considered important both now and in the future. McArthur (2005) outlines climate change models that suggest the sloughs south of the lake, will be compromised due to reduced flow, affecting wildlife resources and increasing the importance of available habitat at Wasa Lake. He predicted that Wasa Lake may not be as greatly influenced by climate change, since it receives its water from the Kootenay River, whereas the snowmelt from Lewis Creek contributes to the water levels in Cameron Pond and the sloughs.

Biophysical Characteristics

Wasa Lake levels are dynamic (high in the spring/summer and low in the fall/winter) affecting the visible habitat along the shoreline. Wasa Lake has a high sand component as part of its natural geologic makeup. The sand beach shore type does not tend to be as valuable to fish and wildlife as other shore types which provide more diverse habitat. Thus, shoreline with established vegetation and/or other substrates (gravels/ mud flats) were identified as particularly valuable. For instance, undisturbed shorelines with wetlands were ranked highest through the AHI (Segments W4 and C2) as well as natural segments with mud flats (Segment W2) and vegetated shorelines (Segments W6 and C3). Approximately half of the shoreline had aquatic vegetation and/or transition vegetation which had not been disturbed. This vegetation is anticipated to be beneficial in many ways including providing: bank stability, a filtering agent for nutrients and potential toxins, habitat for fish and wildlife, and foraging opportunities (either directly or through related invertebrate production). Because of shallow soil component, these areas are prone to degradation.

Ephemeral creek mouths were important contributors to the segment values, because of the diversity of habitat they provide. This included the Lewis Creek mouth (Segment C2), Hanson Creek mouth (Segment W4) and Robert's Pond (Segment W2) and the two creek areas along the eastern shore (Segments W1 and W8), which were identified as ZOS.

Natural Areas

Although disturbances are vast, the natural areas (totaling 36% of Wasa Lake and 64% of Cameron Pond) provide important biological function to the area. Large portions of these natural areas are the result of Wasa Lake Provincial Park (Segments W4 and W6) and Wasa Slough Wildlife Sanctuary (Segments C2 and C3). The ecological integrity of these natural areas should remain protected from development and recreational activities in perpetuity according to their management objectives (Figure 29; BC MoE 2003, TNT 2010). Segments W8 and W10 are also in the Provincial Park and do show higher recreational development and associated modifications. Efforts should be made to minimize further disturbance in these areas and restoration opportunities could be explored.

Figure 29. Signage minimizing recreation impacts inside the bay of Segment W6.

At **Wasa Lake**, approximately 13% (or 955 m) of the undisturbed foreshore is associated with private residential areas. Segment W2 had the largest length of natural shoreline (790 m), representing 83% of undisturbed residential area. The natural area in Segment 2 (primarily Robert's Bay) is an important staging area for birds and breeding and development location for federally listed Western Toads. It is a ZOS and continuing to protect its natural features is important. New development here may be limited by floodplain construction regulations, since this is a low lying semi-wetland area.

Cameron Pond had an equivalent length (955 m, comprising 38% of the waterbody's shoreline) of natural residential land, which was the result of low impact development along the shoreline of Segment C1. There were few modifications in the immediate shoreline area (Figure 30). With a slightly wider buffer strip this could be a very good template for shoreline development.

Figure 30. Residences set back with few modifications in the immediate shoreline area. Photo: McPherson May, 2010.

Disturbed Areas

Wasa Lake will be the focus of discussion on disturbed area since Cameron Pond was largely natural along the shoreline. At Wasa Lake, 64% of the foreshore has been disturbed through anthropogenic alterations. The alterations were mainly the result of residential land use activities (52%), while some of the disturbances were associated with park areas managed for recreational uses (8%) or other disturbances on crown land (5%). The most prevalent shoreline modifications were dock placement and beach grooming. Higher up the foreshore, disturbances to the riparian and upland vegetation areas included conversion to lawns and other landscaping activities which

often resulted in only patches of natural vegetation on properties. Section 2.3.5.4 (Habitat Modification Parameters) describes several negative impacts associated with typical shoreline modifications.

In the intensively developed residential segments along Wasa Lake, dock densities ranged from 13 docks/km to 30 docks/ km. These densities are considered high. In comparison, a similar study on Windermere Lake found the highest dock density to be 12 docks/km for a highly developed segment (McPherson and Michel 2007). In addition to potential impacts on native fish species assemblages, docks also impact lakebed characteristics, can limit vegetation through shading, and can introduce pollutants from associated motors (BC MoE 2006). The Best Management Practices for Small Boat Moorage (MoE 2006) provide guidelines to ensure proposed docks protect water quality and aquatic shoreline habitat

Beach grooming at Wasa Lake was estimated along 37% of the shoreline and appeared to impact the shoreline diversity by reducing riparian, shoreline and aquatic/transition vegetation and gravel substrates in the littoral zone. DFO has developed Beach Grooming Guidelines for Kootenay Lake and other lakes deemed appropriate (DFO 2003). Examples of applicable provisions within the Beach Grooming Guidelines are:

- beach grooming could only occur in areas of fine or boulder substrates and not cobble, large woody debris or macrophyte (aquatic vegetation) substrates;
- beach grooming may be allowed on only a small proportion of the frontage (e.g. 10%) as long as habitat features are added to the remaining area; and,
- the natural substrates are to be loosely sidecast to adjacent non-groomed area and not placed over cobble, large woody debris or macrophyte substrates (DFO 2003).

Similarly to Okanagan Lake (RDCO 2005) and Windermere Lake (McPherson and Michel 2007), shoreline modifications tended to be alike at neighbouring residential properties. A few good examples may initiate a trend of leaving the foreshore more natural, and of designing modifications in a more environmentally sensitive manner. Many of the values of living on a lake depend on maintaining foreshore habitat including: fishing, bird watching, wildlife viewing and good quality water for recreation and drinking.

The level of shoreline disturbance at Wasa Lake (64%) was in the high range compared to other lakes studied in the region: Tie Lake was 31% and Rosen Lake 93% (Amec 2010); Columbia Lake was 37% (McPherson *et al.* 2010); Moyie Lake was 50% and Monroe was 22% (Schleppe 2009, Schleppe 2009b) and Windermere Lake was 62% (McPherson and Hlushak 2007). To promote long-term health of the fish and wildlife of Wasa Lake, further habitat disturbance in important areas should be curtailed. Restoration opportunities should be sought along disturbed shoreline areas. This could include, removing individual docks and cooperatively sharing such infrastructure, restoring riparian and transitional vegetation and removing sand and fill material (with the appropriate permits). As well, land owners should continue to be educated about foreshore development activities that can not occur on Crown Land without prior approval (e.g., dredging or beach grooming).

There is local concern that government has not managed disturbances as strictly at Wasa Lake as elsewhere, due in part to the fact that the native fish values are not high. Managing the lake for its sport fishery (e.g. Duck Lake near Creston; P. Holmes pers. comm.) and for biodiversity may help to maintain habitat values. The B.C. *Water Act* should be enforced more routinely in order to ensure environmental foreshore values are considered.

5 Shoreline Management Guidelines

The fish and wildlife habitats of Wasa Lake and Cameron Pond are sensitive to development. This is the result of many factors, including the small sizes and shallow depths of the water bodies, the extent of existing development (including other areas in the watershed such as Lewis Creek), lack of consistent flow from inlet and/or outlet streams and geologic characteristics. It is important to have 'conservation' be a goal for the remaining high value ecosystems that exist in the Wasa Lake area. Development, where appropriate, should be consistent with the intent of protecting and maintaining the cultural and biological diversity of the area, and where possible, restoring continuity, physical and ecological (and hence social) functions (Bisett pers. comm.).

Clearly defined principles and associated policies and strategies will help guide future decisions and promote a coordinated approach to foreshore management among regulatory agencies. The science-based methods employed at Windermere Lake (EKILMP and Interior Reforestation 2009) and subsequently at numerous other lakes including Moyie Lake (Schleppe 2009) and Columbia Lake (McPherson *et al.* 2010), included the development of Shoreline Management Guidelines for Fish and Wildlife Habitats (Guidelines). These templates were used in preparing the Guidelines for Wasa Lake and Cameron Pond. These Guidelines will help the WLLID and EKILMP meet their objectives of maintaining environmental attributes of the foreshore while facilitating human requirements.

A colour scheme has been developed which delineates the shoreline based on habitat values determined through the AHI analysis in the Fish & Wildlife Habitat Assessment report. The scheme has coloured shoreline areas as red, orange, yellow or grey zones. These zones are defined in the following Section and have been mapped in Appendix A. The risks for specific activities in each color zone (*See* Step 2) and the associated review process (*See* Step 3) have also been outlined. The coloured zones, activity risk table and the process flow chart form the basis of the Guidelines.

The How-to Guide below provides a step-wise process to help direct applicants/reviewers through the Guidelines (including the maps, risk table and flow chart):

How-to Guide for Development Planning in the Fish and Wildlife Shoreline Colour Zones

Step 1: Determine the colour zone that your application is situated in using the maps in Appendix A. Note that Red Zones are designated Conservation Areas. No development should be considered or approved in these zones.

Step 2: Determine what the risk is for your specific activity using the Activity Risk Table (Table 1). If your activity is not listed, assume high risk, and contact FrontCounter BC for advice.

Step 2a: If a species at risk has been identified in the area, the risk increases as identified in the Modifier Column of the Activity Risk Table.

Step 2b: If your activity is identified as being High risk, determine if you can move to a colour zone with less sensitive habitat (e.g., move to a yellow or grey zone) or select a lower risk activity.

Step 3: Use the Flow Chart to determine application review needs based on your given activities risk.

Step 1. Shoreline Color Zones

To determine the appropriate shoreline colour zone, the property or area that would be subject to application must be located on the maps found in Appendix A.

The AHI Values (or Current Ecological Value) as defined in the Fish and Wildlife Habitat Assessment were used to determine the color zone (red, orange, yellow and grey) of a shoreline area. The specific designation methods and guidelines for each color zone are provided below. With the methods utilized, fish and wildlife values and associated levels of sensitivity to development are highest in red and orange zones, lower in a yellow zone and lowest in a grey zone. Risks for specific activities have been identified for each colour zone and are provided in the subsequent section.

Red Shoreline

Defined by: Very High Current Ecological Values in the Aquatic Habitat Index.

Background:
These areas have been identified as essential for the long term maintenance of fish and/or wildlife values through the AHI Analysis. This zone includes the Park area associated with Hanson Creek and the north end of Cameron Pond which contains conservation lands, a wetland and the outlet of Lewis Creek. These areas are essential for fish and/or wildlife populations. EKILMP recommends that these areas be designated for conservation use, and that no development that can impact these sensitive communities occur within them. Low impact water access recreation and traditional First Nation uses are permissible in these areas, but permanent structures or alteration of existing habitats is not considered to be acceptable. Habitat restoration may be appropriate in these areas where warranted. Invasive aquatic plant removal is acceptable, provided there is an approved aquatic plant removal program including trained persons. Please contact a plant specialist if uncertain of a plant species.

Red zones account for 7% of the total shoreline length of Wasa Lake.
Red zones account for 46% of the total shoreline length of Cameron Pond

Orange Shoreline

Defined by: High Current Ecological Values in the Aquatic Habitat Index.

Background:
These shoreline segments have been identified as High Value Habitat Areas for fish and/or wildlife through the AHI Analysis. These are made up of areas that are relatively natural; possessing high value areas for fish and/or wildlife. These areas are sensitive to development, continue to provide important habitat functions, but may be at risk from adjacent development pressures. Two of the three segments included are already protected as parks. Restoration opportunities potentially exist in these areas. Proponents should consider moving high risk activities to other areas if possible, or pursuing activities that have lower associated risks.

Orange zones account for 21% of the total shoreline length of Wasa Lake.
Orange zones account for 26% of the total shoreline length of Cameron Pond.

Yellow Shoreline

Defined by: Moderate Current Ecological Values in the Aquatic Habitat Index.

Background:
These areas have experienced a moderate amount of development disturbance and pressures. At Wasa Lake, although these areas have been impacted to some degree, they still are largely intact. Some areas are identified as ZOS, including important spawning areas and general living habitats for other native fish and wildlife species. These values should be considered if any changes to land uses are proposed.

Development is more appropriate on these shorelines than on red or orange coloured areas; however, activities should incorporate protection of habitat features that remain, be well above the high water mark, and and/or be situated outside of the riparian area. Restoration may be an option in some areas that have experienced past developments. Development may precede for low risk activities provided a Best Management Practice (BMP) or Regional Operating Statement (ROS) is followed (*See* Appendix K). High risk activities without a BMP or ROS will require a report from a Qualified Professional (QP).

Yellow zones account for 15% of the total shoreline length of Wasa Lake.
Yellow zones account for 27% of the total shoreline length of Cameron Pond.

Grey Shoreline

Defined by: Low and Very Low Current Ecological Values in the Aquatic Habitat Index.

Background:
These are shorelines identified in the AHI analysis as having lower ecological value. However, they still may contain valuable habitats requiring some protection, such as ZOS associated with ephemeral stream, aquatic/or transition vegetation, or gravel substrate areas.

Human development has been concentrated in these areas and has resulted in disturbances to the natural fish and wildlife habitat. In keeping with the objective of concentrating development in areas that are already disturbed or of low value, new developments may be considered in these areas. Redevelopment will also be considered. New developments or redevelopment proposals shall incorporate fish and wildlife habitat restoration or improvement features where feasible and practicable. Obtain advice from a QP for habitat restoration techniques. For example, a retaining wall redevelopment may be moved back from the HWM and/or incorporate re-vegetation or other fish and wildlife features in the design.

Grey zones account for 57% of the total shoreline length of Wasa Lake.
Grey zones account for 0% of the total shoreline length of Cameron Pond.

Step 2. Activity Risk Analysis

Typical shoreline activities have been assigned risk ratings based on the potential level of risk that they may have on fish and wildlife habitat values (Table 16). Recognizing that the different shore zones have different habitat values and levels of sensitivity, the risk of each activity has been identified for each shoreline colour zone. In the table, each colour zone/activity combination has been rated as either: Not Acceptable (NA), High (H) or Low (L). A species at risk modifier column has also been provided, which should be used if a species at risk has been identified in the project area.

Please be aware that where several activities with differing risk factors occur on a site, then the combined risk may increase and move the activity into a higher risk category. A Qualified Professional may be required to determine if the overall risk has increased. If your activity is not listed, contact FrontCounter BC for advice. Note also, that the Activity Risk Table often distinguishes between activities above the high water mark (HWM) and below the HWM. The HWM as opposed to the 'natural lake boundary' is the standard practice used by DFO when considering impacts to fish and wildlife values.

Risk Rating Descriptors

This section provides background, description and examples for the Activity Risk Ratings. Overall, the risk ratings reflect the potential impacts on fish and wildlife, with a Not Acceptable or High activity risk rating posing the greatest potential concern and the Low Risk rating a lower level of possible concern. This process recognizes that there is a greater possibility that High Risk activities may not be approved by regulators. The process also identifies that important habitats do exist in degraded and developed areas and that at least minimal standards are required to protect fish and wildlife habitat in the grey zone areas.

Not Acceptable Activities

Several activities have been rated as not acceptable. These activities are primarily in Red and Orange zones that have very high or high ecological ratings. The activities listed are known to have significant negative impacts to fish and wildlife habitats and are extremely difficult or impossible to mitigate or compensate. Applications for these types of development in the zones identified will not be considered.

High Risk Activities

Proposals within the High Risk category are known to have significant challenges related to providing adequate mitigation or compensation to address the loss of fish and/or wildlife habitat values. Acceptable mitigation measures would likely be very costly to implement. In addition, there is a high likelihood that a request for a Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD) authorization under the *Fisheries Act* would be triggered. Applicants are thus encouraged to avoid activities with a High Risk, consider activities that are a lower risk, or relocate the activity to an area where the environmental sensitivity is less. If the applicant wishes to proceed with a High Risk activity, a qualified professional should be retained to determine if there is a HADD &/or other environmental impacts which can be mitigated through design and relocation. The application will be reviewed by the applicable agencies. As identified in the Activity Risk Table, certain activities are rated High Risk for all shore colour zones and should be avoided if at all possible.

Low Risk Activities

With appropriate design and planning, Low Risk activities could be incorporated along the foreshore with minimal impacts on fish and wildlife habitat values. These activities are to follow BMP/ROS, where available (Appendix K). Where BMP/ROS are not available, or a deviation to the BMP/ROS is proposed, a QP is to be hired to determine if there is a HADD and design the project to minimize environmental impacts. The application will be reviewed by the applicable agencies. Examples of activities which have Low risk along most/all of the shoreline are: maintenance dredging (previously approved) and erosion protection (soft-bioengineered).

Step 3. Decision Process Flow Chart

A flow chart is provided which outlines the decision-making process for the High and Low risk activities. The chart is a tool to help depict the Guideline requirements outlined in the previous sections. Note that this process provides Guidelines on only the initial planning stages of development. There are other legal requirements that are not covered through this process (such as approvals/notifications through RDEK, Transport Canada, BC *Water Act*, BC *Lands Act*), which are the responsibility of the applicant (Appendix K). If these Guidelines are followed, the intent is that the subsequent permitting process(es) should be more streamlined for the applicant. Contact

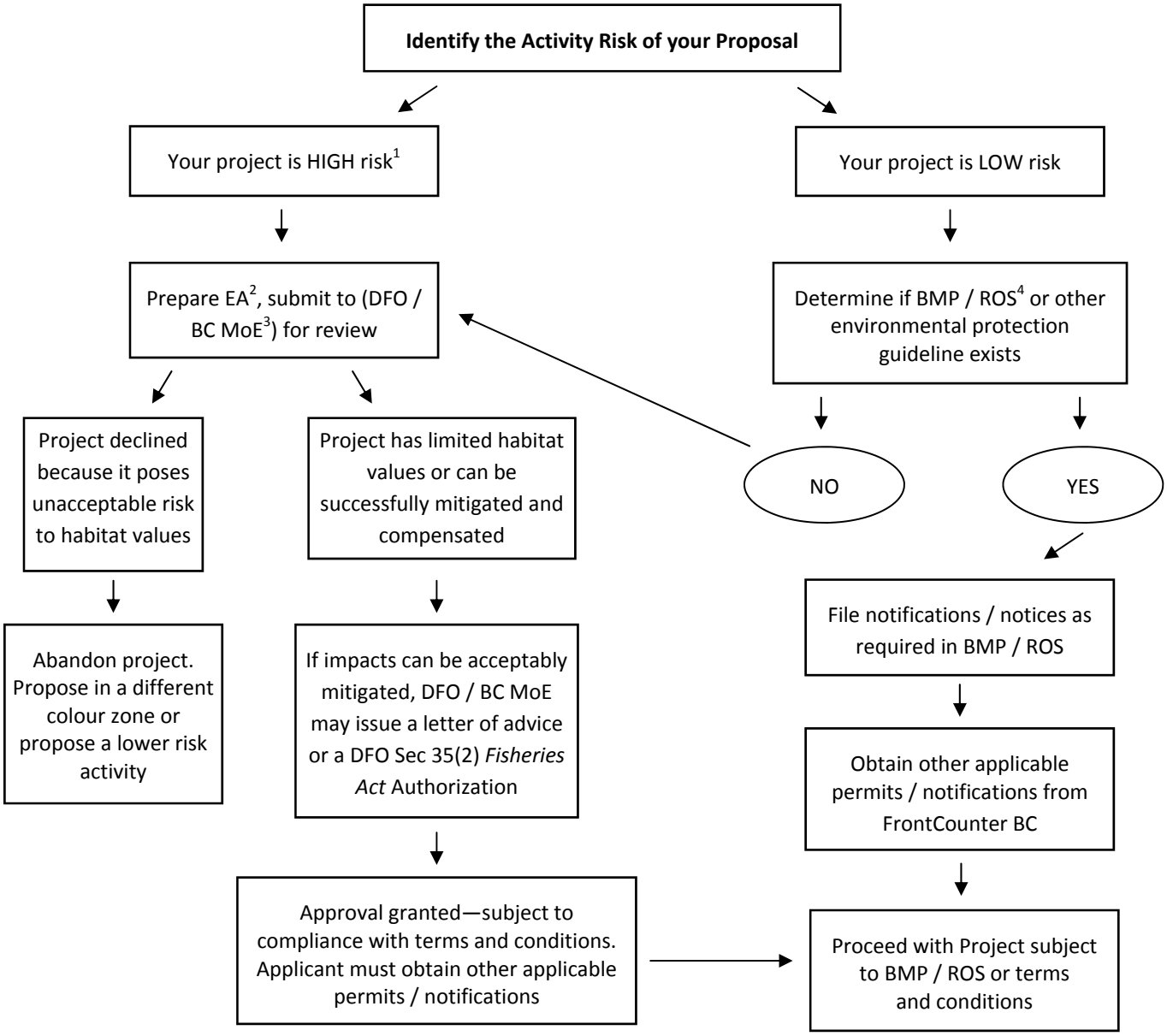
FrontCounter BC to determine which permits, approvals or authorizations you need, in addition to fish and wildlife habitat authorizations.

Table 16. Activity Risk Table (NA = Not Acceptable, High = H, Low = L).

Activity	Shore Zone Colour and Activity Risk				Modifier
	Red	Orange	Yellow	Grey	Zone has Species at Risk
Over water piled structure (i.e. building, house, etc.)	NA	NA	NA	NA	NA
Boat house (below HWM)[1]	NA	NA	NA	NA	NA
Dredging (new proposals)	NA	NA	NA	NA	NA
Beach creation above HWM	NA	NA	H	H	H
Beach creation below HWM	NA	NA	H	H	H
Aquatic vegetation removal	NA	NA	H	H	H
Upland vegetation removal	NA	NA	H	H	H
Marina[2]	NA	H	H	H	H
Breakwater	NA	H	H	H	H
Boat launch upgrade	NA	H	H	H	H
New boat launch	NA	H	H	H	H
Infill	NA	H	H	H	H
Groynes	NA	H	H	H	H
Fuel facility[3]	NA	H	H	H	H
Boat house (above HWM with vegetation removal)[1]	NA	H	H	H	H
Mooring Buoys	NA	H	H	H	H
Waterline trenched	NA	H	H	L	H
Erosion protection hard-joint planted	NA	H	H	L	H
Erosion protection vertical wall or retaining wall[4]	NA	H	H	L	H
Milfoil & invasive weed removal	H	H	H	L	H
Boat house (above HWM without vegetation removal)[1]	NA	H	L	L	H
Permanent rail launch system	NA	H	L	L	H
Removable rail launch system	NA	H	L	L	H
Dock[1]	NA	H	L	L	H
Erosion protection (soft-bioengineered)	NA	H	L	L	H
Elevated boardwalk below HWM	NA	H	L	L	H
Maintenance dredging (previously approved)	NA	H	L	L	H
Boat lift - temporary	NA	H	L	L	H
Geothermal loops - open[5]	NA	H	L	L	L
Geothermal loops - closed	NA	H	L	L	L
Habitat restoration[6]	H	H	L	L	H
Public beach maintenance	NA	L	L	L	H
Waterline drilled	NA	L	L	L	L

[1] These Guidelines are to be used in the initial development planning stage and do not cover all legislative requirements. Docks and boathouses are an example of an activity that could require additional approval process through Transportation Canada or Ministry of Agriculture and Lands.
[2] Marinas or marina expansions in orange zones may not be acceptable depending on the habitat attributes.
[3] Fuel facilities are inherently high risk, and if approved will be subject to all other regulations.
[4] Retaining wall redevelopment should be designed to restore fish and wildlife values where feasible and practical.
[5] Geothermal loops open (water) versus closed (glycol) and associated risk must also be assessed and ranked for physical habitat and water quality aspects.
[6] Habitat restoration proposals are listed as high risk in red and orange zones because individual objectives and proposals must be reviewed.

Flow Chart: Decision-making process for High and Low Risk Activities for Fish and/or Wildlife Habitat authorizations



[1] Activities within the High Risk category raise significant concerns. These activities have significant challenges related to providing adequate mitigation or compensation to address the loss of fish and/or wildlife habitat values and could be costly to implement acceptable mitigation measures. With High Risk activities, there is a high likelihood that a request for a Harmful Alteration Disruption or Destruction of fish habitat (HADD) authorization under Sec 35(2) of the *Fisheries Act* would be triggered. Proponents are encouraged to avoid activities with a High risk, revise activities to a lower risk option, or relocate the activity to a less sensitive colour zone.

[2] Environmental Assessment

[3] DFO- Fisheries and Oceans Canada; BC MoE- Ministry of Environment

[4] BMP – Best Management Practice; ROS – Fisheries and Oceans Canada Regional Operating Statement

5.1 Mitigation and Compensation Considerations

In order to assess impacts of a proposed project, it may be necessary to retain a Qualified Professional who could assess habitat values and sensitivities in the area. The Fish & Wildlife Habitat Assessment Report is a tool available to help with this task; however, further studies may be necessary, due to limitations of currently available information. The DFO principle of "no net loss" within the Policy for the Management of Fish Habitat (1986) applies to all proposals where there is the potential for a Harmful Alteration Disruption or Destruction of fish habitat (HADD) under Section 35(2) of the federal *Fisheries Act*. This involves following a sequence of mitigation alternatives. Mitigation is a process for achieving conservation through the application of a hierarchical progression of alternatives, which include: (1) avoidance of impacts; (2) minimization of unavoidable impacts; and (3) compensation for residual impacts that cannot be minimized. These alternatives are described as follows:

1. Avoidance of Impacts

The first step, avoidance, involves the prevention of impacts, either by choosing an alternate project, alternate design or alternate site for development. It is the first and best choice of mitigation alternatives. Because it involves prevention, the decision to avoid a high value area or to redesign a project so that it does not affect a high value area must be taken very early in the planning process. It may be the most efficient, cost effective way of conserving important habitats because it does not involve minimization, compensation or monitoring costs. Avoidance may include a decision of not to proceed with the project.

2. Minimization of Unavoidable Impacts

Minimization should only be considered once the decision has been made that a project must proceed, that there are no reasonable alternatives to the project, and that there are no reasonable alternatives to locating the project within high value habitats. Minimization involves the reduction of adverse effects of development on the functions and values of the habitat at all project stages (including planning, design, implementation and monitoring), to the smallest practicable degree. Considering any planning efforts, DFO must deem a HADD to be acceptable before work can commence.

3. Compensation

Compensation is the last resort in the mitigation process, an indication of failure in the two earlier steps. It should only be considered for residual effects that were impossible to minimize. Compensation refers to a variety of alternatives that attempt to replace the loss of, or damage to habitat functions and values. Habitat compensation may be an option for achieving "no-net-loss" when residual impacts of projects on habitat productive capacity are deemed harmful after relocation, redesign, or mitigation options have been implemented. After reviewing the project proposal and the potential impacts to fish habitat, DFO may determine that the impacts are not acceptable if the habitat to be affected is critical habitat or compensation is not feasible. In addition, compensation for deposit of a deleterious substance into water frequented by fish is not acceptable. Habitat compensation involves replacing the loss of fish habitat with newly created habitat or improving the productive capacity of some other natural habitat. Depending on the nature and scope of the compensatory works, habitat compensation may require, but not be limited to, several years of post-construction monitoring and remediation or redevelopment of the compensation works in the event the habitat is not meeting the compensation objectives. There is no guarantee that projects in high value fish habitats that result in HADD will be authorized under Section 35(2) if application is submitted.

5.2 Restoration

A variety of techniques have been developed to restore productive habitat (aquatic and terrestrial) and maintain/enhance productivity and biodiversity. There are a variety of groups' currently leading/undertaking restoration activities within the East Kootenay, using proven restoration

techniques and concepts. For information contact local environmental groups, local government, or provincial government offices.

6 Recommended Actions

As a result of similar needs between lakes (administrative jurisdictions, information requirements and planning requirements), the recommendations developed for the Moyie Lake FIM (Schleppe 2009) were largely utilized for this project (indicated with italicized text). The following are recommendations that could be incorporated into foreshore protection policies:

General

1. ***Environmentally Sensitive Areas should be identified and protected as they are extremely important****. It is recommended that areas that have been determined as environmentally sensitive be added to the Development Permit Areas within any policy documents applicable (e.g., OCP, Bylaws, etc.). The City of Kelowna has just recently completed a review of environmental development permit areas (EDP's) and has added over 400 properties to an EDP list for a variety of reasons. Keeping these EDP's up to date is important. EDP's are most accurately determined by appropriate inventory work such as the FIM, Sensitive Ecosystem Inventory (SEI, see below) and SHIM. It is important that the addition of new inventory data be simple and easy to implement because the budgetary constraints for inventory often result in projects being completed over a series of years as data is collected*. Other specific requirements in *Environmentally sensitive areas:*
   - Where the habitat is sensitive, boat launches should remain closed during critical periods (e.g., during bird breeding/nesting and rearing/fledgling periods).
   - Restrict high horsepower boats/jet skis in sensitive areas (e.g., wetlands), particularly during critical periods. Determine the most appropriate setback distance based on other examples and types of sensitivities (e.g., 100 m).
   - Provide technical guidance to agencies and the public regarding alternatives to traditional foreshore modifications. This could include advice on nodal development where docks are shared so that the density/length of shoreline disturbance is minimized; as well continue to create applicable Best Management Practices and Regional Operating Statements.

2. ***Environmentally sensitive areas should be included in Official Community Plans, Bylaws, and policy documents within the different agencies.*** *The AHI provides a basis for identification of shoreline environmentally sensitive areas. It is possible to incorporate the AHI into OCP documents in a variety of ways. The Guidance Document provided outlines how referrals and development proposals should proceed. The following provides additional recommendations for how Very High and High Habitats should be considered:*

   Very High and High Value Areas – These areas are considered to be the most valuable areas of the shoreline. Intensive development along these areas is strongly discouraged because it is likely very difficult to mitigate for potential impacts and not likely possible to compensate for habitat losses. Explicit terms of reference (mentioned below) for proposed significant changes in land use (i.e., large subdivisions) should be developed collectively for all projects or on a case by case basis (dependant upon resources available). If possible, an interagency approach and terms of reference could be used to streamline the referral and review process.

3. ***Standard terms of reference for professional reports should be developed for environmental assessments of development applications.*** *This document will ensure consistency in environmental reporting across agencies and jurisdictions. The Regional District of Central Okanagan (RDCO), City of Kelowna, and other Okanagan Valley municipalities have*

well developed terms of reference that could be used as templates. The Terms of Reference would outline professional requirements for assessments in the region and provide a list of considerations that environmental professionals must address as part of a development application. Site specific assessments are a critical component of a development permit process because every proposal is unique. The inventories and data within this document should be provided as part of the terms of reference (i.e., the GIS data, orthophotos, and other biological information contained in this report).

4. ***Habitat restoration opportunities should be achieved wherever possible by identifying them during the development review processes.*** In highly urbanized areas, examples include removal of retaining walls, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, recontouring dredged areas, and removing/vegetating sand placement, etc. *It may be useful to identify the potential for restoration opportunities in the standard terms of reference discussed above. There is opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lake.*

5. ***Core habitat areas are extremely important to maintain and should be identified as early as possible in the development process.*** *Detailed assessments and identification of core habitat areas for conservation should be done as early in the development process as possible. Numerous different possibilities exist for areas identified as sensitive, including Section 219 No Build / No Disturb Covenants, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), or by other mechanisms (donation to trust, etc.).*

6. ***A Land Act Section 16 Map Reserve should be established on all areas identified as having very high value (Red Zones) wherever possible.*** Red shoreline zones should be designated for conservation use, where no development can occur that has the potential to impact their sensitive communities. These areas could also be protected with property purchase by conservation groups or restrictive covenants. Low impact water access recreation and traditional First Nation uses would be permissible, but permanent structures or alteration of existing habitats would not be acceptable. Habitat restoration may be appropriate in these areas where warranted, such as invasive aquatic plant removal, provided there is an approved program and trained persons conducting the work.

7. **In addition to environmental development permit areas, restrictive covenants can be used as a tool in development approvals to protect environmentally sensitive habitats**. For example, to enact buffer leave strips to protect riparian vegetation (e.g., riparian areas regulations or as per Shoreland Management Policy (Cariboo Regional District 2004)).

8. ***An Environmental Advisory Commission or other suitable body should be created and be included in the development review process to involve local residents.*** *Similar commission has been established by the RDCO to allow local residents the opportunity to contribute to the stewardship of their natural resources. In the Columbia-Shuswap Regional District (CSRD), the Shuswap Lake Integrated Planning Process (SLIPP) process has incorporated both political and resident representatives. At Wasa Lake, this may provide an avenue to address the environmental concerns of residents and act as an advising committee to relevant stakeholders and governmental agencies.*

9. ***Establish a Wasa Lake Stewardship Committee.*** *This committee could help be a liaison for local people to express their concerns to governmental agencies.*

10. ***Development and use of best practices for construction of bioengineered retaining walls is required.*** *Bioengineering has many different meanings. Concise guidelines and BMPs should be developed that are consistent with standard practices of bioengineering.*

11. **Develop and implement a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts (e.g., beach grooming, dredging).**

12. **A communication and outreach strategy should be developed to inform stakeholders and the public of the findings of this study and improve stewardship & compliance**. Notice of the availability of this report and associated products should be made available (e.g., on the Community Mapping Network or RDEK website). The outreach strategy could include an educational program for developers and existing lakeshore owners and users. This would assist stakeholders to: 1) understand the value of retaining natural foreshore features; 2) ensure existing sewage systems are properly operated and maintained; 3) develop lots in a way that minimizes impact on the environment and includes alternatives to traditional foreshore modifications; and, 4) understand the economic value inherent in protecting the ecological integrity of the lake. Another part of the outreach strategy, could include education panels being established at all boat launches.

13. ***Lakeshore erosion hazard mapping should be conducted for private lands to identify areas at risk, which will stream line the review process and reverse the trend of unnecessary hard armoring and construction of retaining walls along the shoreline of the lakes.*** *Also, this methodology would be helpful to identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some adaptation of it should be used (Guthrie and Law, 2005). This mapping should be integrated with the FIM data, and be completed for each segment. Flooding and terrain stability should also be considered for developing areas along the lakeshore. Until lakeshore erosion hazard mapping is completed, it is advisable to only consider shoreline protection works on sites with demonstrated shoreline erosion. To accomplish this, an engineer or biologist report should accompany any proposals for shoreline armoring to ensure that works are required, minimize impacts and use bioengineering techniques.*

14. ***Storm water management plans should be included in all development applications that alter the natural drainage patterns.*** *It appears that development along the lakeshore has been occurring without the benefit of a comprehensive storm water management plan. Poor storm water management can alter small streams by diversion, changes in water quality, and/or changes in discharge locations to the lake. This can result in erosion of foreshores and impacts to shore spawning areas. It is recommended that storm water management plans be required as part of development processes.*

15. ***Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources, if feasible. Developments that have "significant" adverse effects to any biophysical resource (e.g., spawning areas) should not be approved on the basis that compensatory habitat works may offset such effects.***

16. ***Compensatory works resulting from projects or portions of projects that could not be avoided must follow the DFO Decision Framework for the Determination and Authorization of a HADD of Fish Habitat and be consistent with the 'No Net Loss" guiding principle for the Management of Fish Habitat.***

17. ***Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation is proposed. Habitat enhancement should only be considered when effective mitigation efforts are feasible (e.g., avoidance) and a strong business case proving mitigation feasibility has been prepared.***

18. ***Habitat mitigation and compensatory efforts of biophysical resources should occur prior to, or as a condition of any approval of shoreline-altering projects.*** *To ensure that works are completed, estimates to complete the works and bonding amounts should be collected.*

These bonds will ensure performance objectives for the proposed works are met and that efforts are constructed to an acceptable standard.

19. ***Development of land use alteration proposals should only be accepted if the compromises or trade-offs will result in substantial, long-term net positive production benefits for biophysical resources.***

20. ***Low impact recreational pursuits (biking, non motorized boating, etc.), pedestrian traffic and interpretive opportunities should be encouraged****. These activities should be directed to less sensitive areas, and risks to biophysical resources should be considered. Only activities that will not diminish the productive capacity of biophysical resources should be considered.*

21. **Plan a restoration workshop for foreshore property owners.** The workshop would provide information to educate private land owners (particularly in yellow and grey colour zone areas) on proactive steps to improve their shoreline areas.

Future Data Management

22. ***Environmental information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.*** *Environmental information, including GIS information and air photos are an important part of the environmental review process. This information should be available to the public, including orthophotos, GIS files, and other electronic documents. One agency should take the lead role in data management and any significant studies that add to this data set should be incorporated and updated accordingly. Future works should be integrated into this master dataset wherever possible.*

23. *The following are recommendations for future use of the FIM dataset:*
    - ***A summary column(s) should be added to FIM GIS dataset that flags new GIS datasets as they become available.*** *Examples of this include new location maps for rare species, fish, wildlife data, etc. Where feasible, these new data sets should reference the shore segment number (see below).*
    - ***The Segment Number is the unique identifier. Any new shoreline information that is provided should reference and be linked to the shore segment number.***

Future Inventory and Data Collection

24. **Conduct additional wildlife inventories to determine occurrences of sensitive species and habitats.** This would include inventories of reptile, amphibians, birds and mammals. Assess habitat conditions that would allow for re-introduction of extirpated species (e.g., northern leopard frogs and painted turtles).

25. **Conduct additional vegetation surveys.** Complete additional floristic studies (during different times of the growing season) for sensitive plant species and ecosystems in undisturbed foreshore areas.

26. **Complete a Wildlife Tree Assessment** for the foreshore and have all wildlife trees be protected during development, where safely possible. Initiate an education program for local residents about the importance of wildlife trees.

27. ***The Sensitive Habitat Inventory and Mapping (SHIM) is a GIS based stream mapping protocol that provides substantial information regarding streams and watercourses and should be conducted on all watercourses around the lake****. Mapping should focus on salmonid rivers and streams first, and then on smaller tributaries containing resident fish*

habitat, followed by non fish bearing waters. This mapping protocol provides useful information for fisheries and wildlife managers, municipal engineering departments (e.g., engineering staff responsible for drainage), and others. This information is also extremely useful for Source Water Protection initiatives because it identifies potential contaminant sources in an inventory. At Wasa Lake and Cameron Pond, fish inventories should be completed to identify spawning, migration and rearing areas.

28. ***Wetlands are extremely productive and important components of our ecosystems and these features should be inventoried****. Detailed Wetland Inventory and Mapping (WIM) of these features are recommended. Detailed mapping of terrestrial wetlands is also important to ensure that linkages between foreshore and upland areas are achieved.*

29. ***Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM) are useful terrestrial mapping tools and these inventories should be completed****. These assessments help land managers identify sensitive terrestrial zones which can be integrated into the FIM, SHIM, and WIM GIS datasets.*

30. ***An inventory of high value habitat islands in urbanized areas should be conducted.*** *Small sections of higher habitat quality were observed in segments ranked Moderate to Low. These areas were typically areas that had well-established native vegetation or relatively natural shorelines. Development applications proposed in these "islands" of higher habitat quality should avoid disturbance to these "islands" as much as possible. A survey of these small "islands" would clarify which segments contain "islands" and would help aid planning objectives. This could form part of a riparian mapping exercise.*

31. ***A carrying capacity analysis of the lake should be completed.*** *Biological systems are extremely difficult to predict and manage. Currently, these fish and wildlife ecosystems are experiencing rapid changes due to a variety of factors including but not limited to land development (e.g., water consumption may be exceeding the capacity of some streams, etc.) and climate change. Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is very difficult and therefore a conservative approach is required. The Carrying Capacity of a lake is defined as the point where a lakes ability to accommodate recreational use (e.g., boating) and residential occupation without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors. Determining carrying capacities on lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values of residents.*

32. **Develop a Lake Management Plan.** Upon final completion of the Lake Windermere Lake Management Plan, determine if a similar process and planning document would be beneficial and feasible for Wasa Lake. Many of the above mentioned items would be applicable to include in a Lake Management Plan. Additional items that this plan could include are:
    - An outline of joint community/agency objectives, established through open houses and surveys;
    - Environmental protection regulations and guidelines (e.g., riparian area regulations and environmental development permit areas) for new development, re-development and management of existing developments;
    - Links between foreshore and upland activities; and
    - A memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities.

33. ***A survey, on a home by home basis, should be conducted to help educate home owners.*** *A home owner report card could be prepared that would provide land owners with a review of the current condition of their properties. The assessment should provide them with sufficient information to help land owners work towards improving habitats on their property. This assessment is not intended to single out individual owners, but rather to help owners*

understand the important habitat values present on their properties. A similar activity was completed at Christina Lake (Mason pers. com.).

34. **Continue the water quality monitoring program and include Cameron Pond**, with the cooperation of area citizens and BC MoE.

35. **Determine Wasa Lake's flushing rate** in order to understand the lake's susceptibility to water quality issues (i.e., eutrophication). Understanding the groundwater influence would be particularly valuable since there are no year-round inlets or outlets.

36. **Continue the water level monitoring program**.

37. **Develop and maintain a habitat monitoring program, which is reported on every few years**. Compare results from the monitoring program to the original inventory data to determine compliance with best management practices and effectiveness of Guidelines.
    - When new developments are proposed, re-run the AHI analysis to determine what the changes to the Ecological Values for the shoreline segment would be with the alteration. Similarly, run the AHI analysis if restoration is planned.

7 Conclusions

Overall, conservation of the intact ecosystems in Wasa Lake and Cameron Pond is critical in maintaining the environmental, social, and economic values that have drawn people to the East Kootenay Region. The simplest way to keep the shoreline environment healthy and functioning for fish and wildlife is to leave it as natural as possible. Shoreline Management Guidelines provided here along with Best Management Practices and Regional Operating Statements will help ensure proposed structures and activities protect the valuable shoreline habitat along Columbia Lake. Federal and provincial legislation and local policies also protect the environment from irresponsible and illegal activities.

Regulatory agencies should aim to keep assessment information and planning documents updated, to ensure that individual lot-by-lot impacts (or cumulative effects) that may seem insignificant on their own do not collectively interact in complex ways to alter fish and wildlife growth and production rates (Jennings *et al.* 2003 and Radomski and Goeman 2001); thereby keeping the existing highly valuable habitats around the lake intact.

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Personal Communications

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Appendix A. Foreshore Summary Maps

590,000

595,000

5,515,000

Wasa Lake Park

WASA LAKE

Ta-Ta Creek

KOOTENAY RIVER

Wasa Lake Park

Wasa Lake Park

Hanson Creek

LEWIS CREEK

Wasa

Cameron Pond

HWY 95A

HWY 93 & 95

To Cranbrook (30 km)

WASA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Overview Map

Features

- Community
- Highway
- Major Road
- Local road
- Stream Network (20k)
- Conservation Property
- Park/Protected Area

1:25,000

0 250 500 750 1,000 *Meters*

Data Sources

Stream Network (1:20,000) provided by Freshwater Atlas, GeoBC.
Main/Overview Base Map provided by Bing Maps licence.

Map Information

Map Projection: UTM 11
Map Datum: NAD 1983
Scale: 1:100,000
Issue Date: June 29, 2010

Cartographic Information

Created By: D.Hlushak
Reviewed By: S.McPherson
Map Document: 10WASA6A\MXD_Data\AppA_Overview

GIS Standard Map Disclaimer:

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Created for:

EAST KOOTENAY INTEGRATED LAKE MANAGEMENT PARTNERSHIP

Created by:

INTERIOR REFORESTATION CO. LTD.

Overview Map

WASA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Wasa Lake North

Segment Number W-8
Ecological Value: Moderate
Colour Zone: Yellow
Shore Type: Sand Beach
Land Use: Park
Level of Impact: Moderate (10-40%)

Segment Number W-9
Ecological Value: Low
Colour Zone: Gray
Shore Type: Sand/Gravel Beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number W-10
Ecological Value: Low
Colour Zone: Gray
Shore Type: Sand Beach
Land Use: Park
Level of Impact: High (>40%)

Segment Number W-1
Ecological Value: Low
Colour Zone: Gray
Shore Type: Sand/Gravel Beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number W-7
Ecological Value: Very Low
Colour Zone: Gray
Shore Type: Sand/Gravel Beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number W-6
Ecological Value: High
Colour Zone: Orange
Shore Type: Vegetated
Land Use: Park
Level of Impact: Low (<10%)

Segment Number W-5
Ecological Value: Very Low
Colour Zone: Gray
Shore Type: Sand Beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number W-4
Ecological Value: Very High
Colour Zone: Red
Shore Type: Wetland
Land Use: Park
Level of Impact: Low (<10%)

Features
- Sample Site
- Park/Protected Area
- Legal Boundaries
- Emergent Vegetation
- Transition Vegetation

Shoreline Colour Zone
- Red
- Orange
- Yellow
- Gray

Zones of Sensitivity
- Biologically Productive
- Bird Staging
- Sensitive Plant Community
- Sensitive Plant Species
- Spawning

1:5,000

0 50 100 150 200 *Meters*

Data Sources
- Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 meters)
- Parks/Protected Areas: GeoBC, Province of BC
- Shoreline Segments: Modified from Terrasaurus Ortho Delineation
- Base Map Orthophoto provided via Bing Map Licence

Map Information
Map Projection: UTM 11
Map Datum: NAD 1983
Scale: 1:10,000
Issue Date: Oct 7, 2010

Cartographic Information
Created By: D.Hlushak
Reviewed By: S.McPherson
Map Document: 10WASA6A\MXD_Data\AppA_FIM_N.mxd

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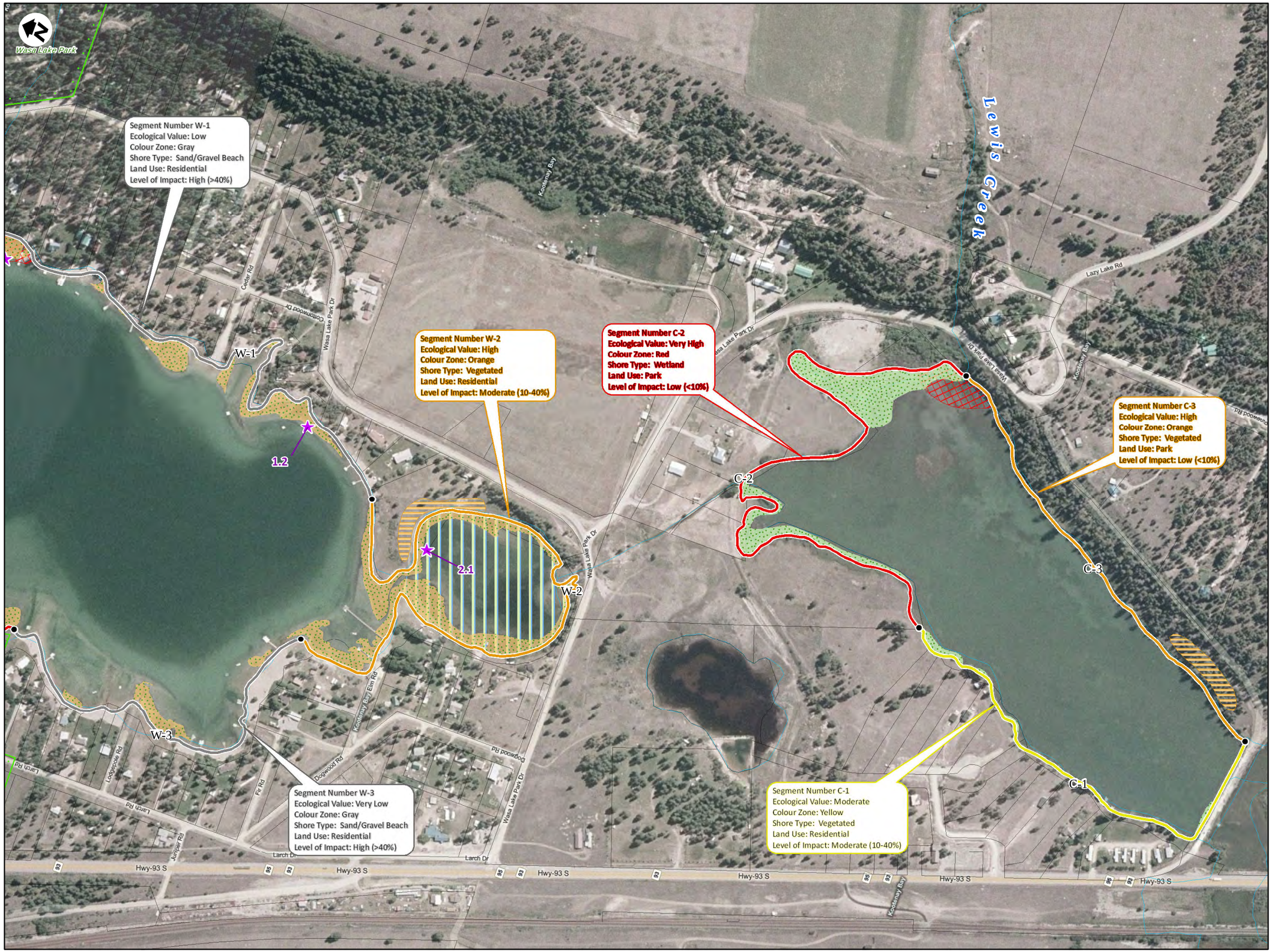
Overview Map

WASA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Wasa Lake South



Features

- Sample Site
- Park/Protected Area
- Legal Boundaries
- Emergent Vegetation
- Transition Vegetation

Shoreline Colour Zone

- Red
- Orange
- Yellow
- Gray

Zones of Sensitivity

- Biologically Productive
- Bird Staging
- Sensitive Plant Community
- Sensitive Plant Species
- Spawning

1:5,000

0 50 100 150 200 *Meters*

Data Sources
- Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 meters)
- Parks/Protected Areas: GeoBC, Province of BC
- Shoreline Segments: Modified from Terrasaurus Ortho Delineation
- Base Map Orthophoto provided via Bing Map Licence

Map Information
Map Projection: UTM 11
Map Datum: NAD 1983
Scale: 1:5,000
Issue Date: Oct 7, 2010

Cartographic Information
Created By: D.Hlushak
Reviewed By: S.McPherson
Map Document: 10WASA6A\MXD_Data\AppA_FIM_S.mxd

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Created for:
EAST KOOTENAY INTEGRATED LAKE MANAGEMENT PARTNERSHIP

Created by:
INTERIOR REFORESTATION CO. LTD.

Overview Map

Appendix B. Orthophoto Delineation Map and Statistics

WASA LAKE FORESHORE INVENTORY AND MAPPING

Appendix C: Orthophoto Delineation Map
Wasa Lake - South

Map 2 of 2
Date: 2009.01.08
Scale: 1:4,000

0 50 100 150 Meters

Fisheries and Oceans Canada
- Pacific Region

Legend

- Contour (Index)
- Contour (Intermediate)
- Legal Boundaries
- Segment Break

Shoreline Classification

- Emergent Vegetation
- Man-made Structure
- Coniferous
- Deciduous
- Grassland
- Shrub (low)
- Shrub (high)
- Lake
- Stream
- Lawn
- Mixed Forest
- Road (paved)
- Road (unpaved)
- Trail
- Sand
- Sand/Grass
- Wetlands

Data Sources

Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 m)
Transportation, Stream, Lake: TRIM
Shoreline Classification: Terrasaurus
Aquatic Vegetation Digitization: Interior Reforestation Co Ltd

Map Information

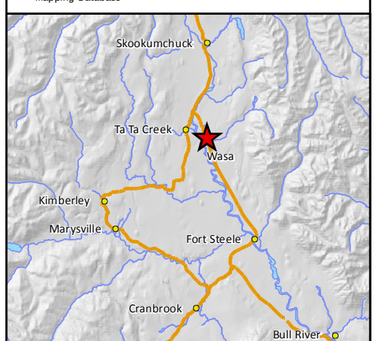
Map Projection: UTM 11
Map Datum: NAD 1983
Contour Interval: 20 m
Issue Date: 01.09.2008

Cartographic Information

Created By: D.Hlushak
Reviewed By: S.McPherson
IR File: 08WASA6A\WasaLake_ShoreClass_S.mxd

Note:

This map is used for illustrative purposes only and should be used in conjunction with the Wasa Lake Foreshore Inventory and Mapping Database



Digital Mapping By:

INTERIOR REFORESTATION CO. LTD.
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WASA LAKE FORESHORE INVENTORY AND MAPPING

Appendix C: Orthophoto Delineation Map
Wasa Lake - North

Map 1 of 2
Date: 2009.01.08
Scale: 1:4,000

0 50 100 150 Meters

Fisheries and Oceans Canada
- Pacific Region

Legend

- Contour (Index)
- Contour (Intermediate)
- Legal Boundaries
- Segment Break

Shoreline Classification

- Emergent Vegetation
- Man-made Structure
- Coniferous
- Deciduous
- Grassland
- Shrub (low)
- Shrub (high)
- Lake
- Stream
- Lawn
- Mixed Forest
- Road (paved)
- Road (unpaved)
- Trail
- Sand
- Sand/Grass
- Wetlands

Data Sources

Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 m)
Transportation, Stream, Lake: TRIM
Shoreline Classification: Terrasaurus
Aquatic Vegetation Digitization: Interior Reforestation Co Ltd

Map Information

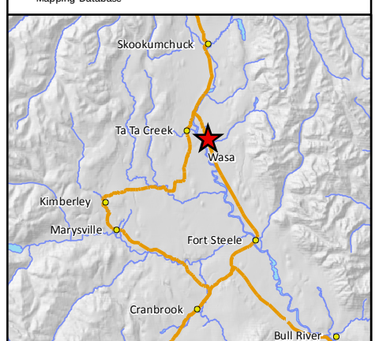
Map Projection: UTM 11
Map Datum: NAD 1983
Contour Interval: 20 m
Issue Date: 01.09.2008

Cartographic Information

Created By: D.Hlushak
Reviewed By: S.McPherson
IR File: 08WASA6A\WasaLake_ShoreClass_N.mxd

Note:

This map is used for illustrative purposes only and should be used in conjunction with the Wasa Lake Foreshore Inventory and Mapping Database



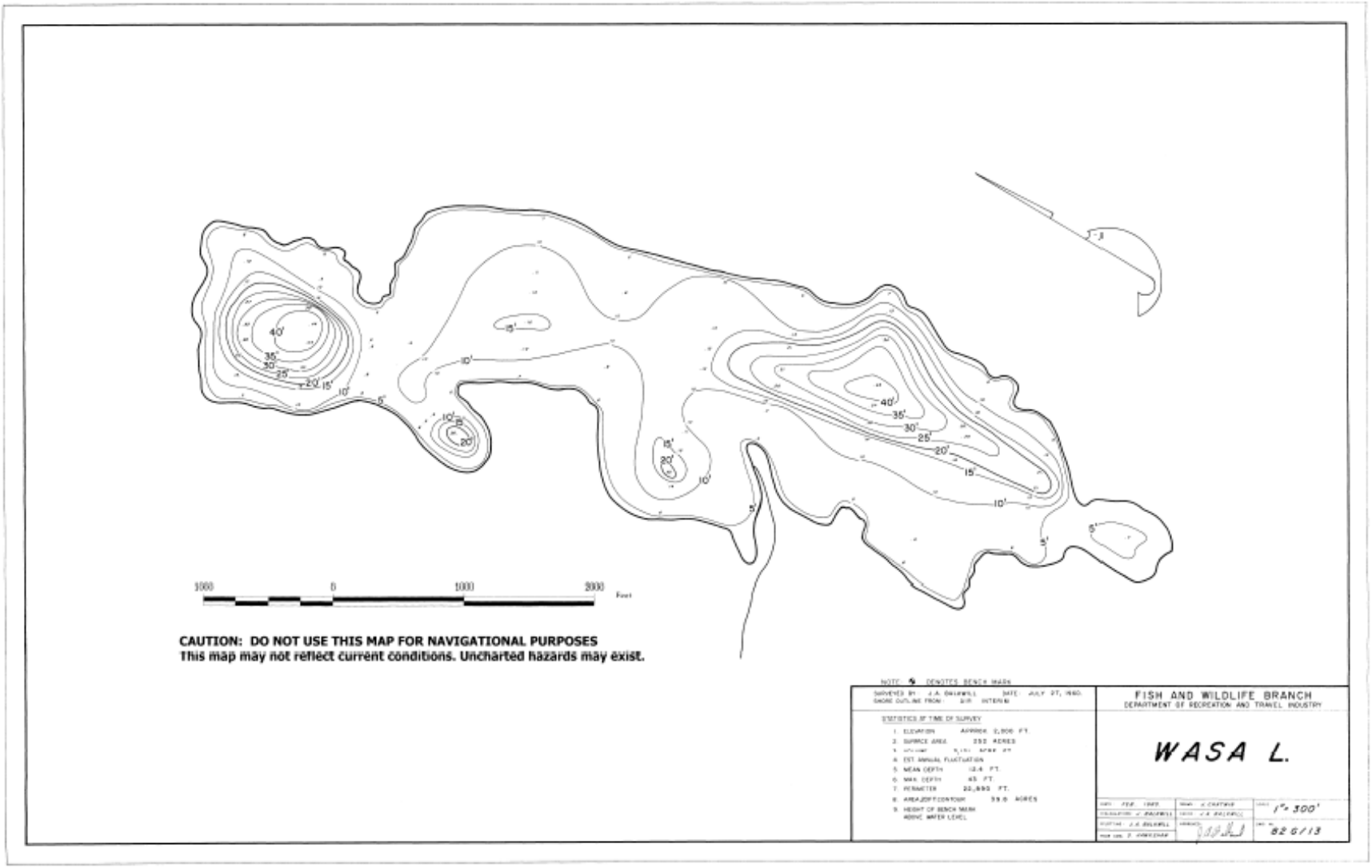
Digital Mapping By:

INTERIOR REFORESTATION CO. LTD.
Leadership in Natural Resource Management

Orthophoto Delineation Statistics of Wasa Lake (does not include Cameron Pond)

Foreshore Class	Segment W1		Segment W2		Segment W3		Segment W4		Segment W5		Segment W6		Segment W7		Segment W8		Segment W9		Segment W10		Total Area	
	m	%	m	%	m	%	m	%	m	%	m	%	m	%	m	%	m	%	m	%	m	%
Coniferous	22,801	14	9,939	9	11,836	18	1,590	4	15,916	18	24,480	58	14,702	18	21,641	20	6,065	16	5,960	21	134,929	18
Deciduous	371	0	124	0	77	0	50	0	598	1		0	119	0	219	0	349	1	74	0	1,983	0
Aquatic Vegetation	16,448	10	16,999	15	3,319	5	8,131	19	1,260	1		0	3,561	4	3,063	3	3,078	8	1,052	4	56,909	7
Grassland	52,288	33	49,715	44	22,732	35	4,016	10	26,486	29	15,206	36	31,844	39	38,171	35	8,070	21	15,800	55	264,328	34
Lawn	9,071	6	4,819	4	5,422	8		0	9,516	11	10	0	2,459	3	16	0	4,965	13		0	36,277	5
Man-made structure	11,394	7	3,288	3	4,761	7		0	8,180	9	5	0	8,923	11	124	0	3,469	9	41	0	40,184	5
Mixed forest	9,781	6	486	0		0		0	5,443	6	804	2	1,754	2	5,877	5	1,277	3		0	25,421	3
Road (paved)	10,096	6	8,587	8	4,230	7		0	8,640	10		0	2,614	3	8,250	8	2,470	6	2,263	8	47,151	6
Road (unpaved)	4,848	3	1,882	2	1,239	2		0	1,364	2	84	0	5,520	7		0	1,753	5		0	16,689	2
Sand	13,460	8	5,204	5	5,839	9	2	0	3,901	4	137	0	6,111	8	19,099	18	4,576	12	2,774	10	61,104	8
Sand/Grass	5,813	4	8,657	8	3,161	5	192	0	8,166	9	1,325	3	2,938	4	4,786	4	2,026	5	420	1	37,483	5
Shrub (high)	2,012	1	92	0	123	0	10,541	25	268	0		0	164	0	4,040	4	134	0		0	17,373	2
Shrub (low)	434	0	2,963	3	644	1	8,829	21	435	0	394	1	116	0	2,364	2		0	51	0	16,230	2
Stream		0		0		0	2,272	5		0		0		0		0		0		0	2,272	0
Trail	630	0	1,091	1		0		0		0		0		0	1,259	1	34	0	250	1	3,265	0
Wetlands	449	0		0	684	1	6,309	15		0		0		0		0		0		0	7,442	1
Grand Total (m^2)	*159,897*	100	*113,847*	100	*64,066*	*100*	*41,932*	100	*90,171*	*100*	*42,445*	100	*80,824*	*100*	*108,909*	100	*38,266*	100	*28,685*	100	*769,042*	100

Appendix C. Bathymetric Map of Wasa Lake



Appendix D. Segment Database

Segment Number (Wasa Lk: W-1 to W-10; Cameron Pond: C-1 to C-3)														SHORE TYPE (%)									
	Segment Length (m)	Photo Number	Video Time	Dominant Shore Type	Shore Type Code	Slope	Dominant Land Use	LU Code	Disturbed (%)	Natural (%)	Level of Impact	LOI Code	Livestock Access	Cliff/Bluff	Gravel Beach	Low Rocky Shore	Sand/Gravel Beach (low water)	Sand Beach (year round)	Stream Mouth	Wetland	Vegetated	Residential	Commercial	Rural
W-1	1497.4	img 0814, 0815.jpg	21:52:15	Sand/Gravel Beach (low)	SB/CB	Bench	Residential	Res	97	3	High (>40%)	H	No	0	0	0	100	0	0	0	0	75	0	0
W-2	1127.9	img 0816, 0817.jpg	21:58:55	Vegetated Shore	VS	Bench	Residential	Res	30	70	Moderate (10-40%)	M	No	0	0	0	0	10	0	0	90	100	0	0
W-3	615.2	img 0818, 0819.jpg	21:59:	Sand/gravel beach	SB/CB	Bench	Residential	Res	97	3	High (>40%)	H	No	0	0	0	60	30	0	0	10	100	0	0
W-4	515.1	img 0820, 0821.jpg	22:01:01	Wetland	W	Bench	Park	P	0	100	Low	L	No	0	0	0	0	0	5	50	45	0	0	0
W-5	982.3	img 0822, 0823.jpg	22:	Sand Beach	SB	Bench	Residential	Res	95	5	High (>40%)	H	No	0	0	0	0	75	0	0	25	100	0	0
W-6	444.0			Vegetated Shore	VS	Bench	Park	P	0	100	Low	L	No	0	0	0	0	10	0	0	90	0	0	0
W-7	742.2	img 0822, 0823.jpg	22:	Sand/Gravel Beach (low)	SB/CB	Bench	Residential	Res	95	5	High (>40%)	H	No	0	0	0	75	0	0	0	25	100	0	0
W-8	1128.5	img 0824, 0825.jpg	22:12:30	Sand Beach	SB	Bench	Park	P	35	65	Moderate (10-40%)	M	No	0	0	0	20	60	0	0	20	0	0	0
W-9	270.0	img 0826, 0827.jpg	22:17:53	Sand/Gravel Beach (low)	SB/CB	Bench	Residential	Res	90	10	High (>40%)	H	No	0	0	0	75	0	0	0	25	100	0	0
W-10	230.5	img 0828, 0829.jpg		Sand Beach	SB	Bench	Park	P	75	25	High (>40%)	M	No	0	0	0	0	75	0	0	25	0	0	0
C-1	675.6			Vegetated	GB	Bench	Residential	Res	20	80	Moderate (10-40%)	M	No	0	0	0	0	0	0	0	100	80	0	0
C-2	1150.4			Wetland	W	Low (< 5%)	Park	W	10	90	Low	L	No	0	0	0	0	0	10	90	0	40	0	0
C-3	656.7			Vegetated	VS	Steep (20-60%)	Park	P	0	100	Low	L	No	0	0	0	0	0	0	0	100	0	0	0

Segment Number (Wasa Lk: W-1 to W-10; Cameron Pond: C-1 to C-3)	LAND USE (%)				SUBSTRATES - LOW WATER LEVEL (%)								LITTORAL HABITAT			RIPARIAN VEGETATION							
	Agriculture	Park	Crown	Industrial	Silt	Sand	Gravel	Cobble	Boulder	Bedrock	Dominant substrate	Transition / Emergent Vegetation (%)	Littoral Zone Width	Littoral Zone Code	LWD	Riparian Class	Riparian Stage (height dominant veg)	Riparian Cover (%)	Riparian Bandwidth (m)	Riparian Overhang (m)	Riparian Overhang (GIS)	Riparian Veteran	Riparian Snag	Riparian Comment
W-1	0	0	25	0	10	15	75	0	0	0	Gravel	65	Moderate (10-50m)	M	No	Exposed soil and some herbs/grass	grass/herb	Sparse (<10%)	5	0	25	<5	<5	Sandy beach on shoreline, grasses in some areas
W-2	0	0	0	0	30	60	10	0	0	0	Fines	95	Moderate (10-50m)	M	No	Herbs/grasses	grass/herb	Abundant (>50%)	5	0	20	No	<5	
W-3	0	0	0	0	0	50	50	0	0	0	Gravel	35	Moderate (10-50m)	M	No	Exposed soil with some herb/grass	Sparse	Sparse (<10%)	5	0	10	No	<5	Sandy beach on shoreline
W-4	0	100	0	0	50	50	0	0	0	0	Fines	100	Moderate (10-50m)	M	No	Natural wetland	tall shrubs 2-10m	Abundant (>50%)	50	0	10	No	No	natural area
W-5	0	0	0	0	0	75	25	0	0	0	Fines	15	Wide (>50m)	W	<5	Exposed soil with some herb/grass	Sparse	Sparse (<10%)	5	0	40	No	<5	sandy/grass beach
W-6	0	100	0	0	0	50	50	0	0	0	Gravel	0	Moderate (10-50m)	M	No	Herbs/grasses	grass/herb	Abundant (>50%)	5	0	90	Unknown	Unknown	
W-7	0	0	0	0	0	25	75	0	0	0	Gravel	40	Wide (>50m)	W	<5	Exposed soil with some herb/grass	Sparse	Sparse (<10%)	5	0	30	No	<5	
W-8	0	100	0	0	10	60	30	0	0	0	Fines	30	Wide (>50m)	W	No	Exposed soil with some herb/grass	grass/herb	Sparse (<10%)	5	0	35	No	<5	park - beginning section more groomed; small patch of deciduous before point; some evidence of landscaping
W-9	0	0	0	0	0	10	90	0	0	0	Gravel	85	Wide (>50m)	W	No	Exposed soil with some sand/grass	grass/herb	Sparse (<10%)	5	0	30	No	No	
W-10	0	100	0	0	0	100	0	0	0	0	Fines	20	Wide (>50m)	W	No	Exposed soil	Sparse	None	5	0	60	No	<5	sandy beach
C-1	0	0	20	0	25	0	70	5	0	0	Gravel	20	Wide (>50m)	W	No	Shrubs	Low Shrubs	Abundant (>50%)	3		15	Yes	5	mostly natural other than along flood mitigation system (berm)
C-2	0	60	0	0	95	0	5	0	0	0	Fines	80	Wide (>50m)	W	Yes	Shrubs	Low Shrubs	Abundant (>50%)	20		25	No	No	
C-3	0	100			95	0	2	3	0	0	Fines	0	Wide (>50m)	W	Yes	Shrubs	Tall Shrubs	Abundant (>50%)	5		40	Yes	<5	

Segment Number (Wasa Lk: W-1 to W-10; Cameron Pond: C-1 to C-3)	RIPARIAN VEGETATION - ORTHOPHOTO INTERPRETATION								UPLAND VEGETATION					SHORELINE MODIFICATIONS									
	Vegetation Bandwidth Band 1 (m) (GIS)	Vegetation Bandwidth Band 1 Score	Vegetation Quality Band 1 (GIS)	Vegetation Quality Band 1 Score	Vegetation Bandwidth Band 2 (m) (GIS)	Vegetation Quality Band 2 Score	Vegetation Quality Band 2 (GIS)	Vegetation Quality Band 2 Score	Upland Vegetation Class	Upland Veg. Stage (dominant veg)	Upland Veg. Cover (%)	Upland Bandwidth (m)	Upland Comment	Retaining Walls	Percent Retaining Wall	Retaining Wall Material	Retaining Wall Type	Attached Docks	Floating Docks	Total Docks	Docks/km	Groynes	Boat Launch	Railway
W-1	5	0.4	Herbs/grasses	0.6	15	0.8	Coniferous	0.8	Mixed-landscaped, grassland & coniferous forest	grass/herb	Moderate (10-50%)	45	Ponderosa pine, grass, landscaping around houses; scattered deciduous (aspen, cottonwood, poplar)	0	0			19	6	25	17	1	0	0
W-2	15	0.8	Herbs/grasses	0.6	15	0.8	Coniferous	0.8	Mixed-mostly grassland with some coniferous forest	grass/herb	Moderate (10-50%)	45	Ponderosa pine, cottonwoods, shrubs, poplar and grass/herb	0	0			4	0	4	4	0	0	0
W-3	1	0.2	Herbs/grasses	0.6	15	0.8	Lawn	0.3	Landscaped- w/ some grassland and coniferous	grass/herb	Moderate (10-50%)	45	mixed upland with ponderosa pine, poplar and willow	0	0			9	0	9	15	1	0	0
W-4	20	1.0	Natural Wetland	1.0	15	0.8	Shrubs	1.0	N/A			0	Tall shrubs and grasses	0	0			0	0	0	0	0	0	0
W-5	5	0.4	Herbs/grasses	0.6	10	0.6	Coniferous	0.8	Landscaped- w/ some grassland and coniferous	grass/herb	Moderate (10-50%)	45	Ponderosa pine around houses	1	5	Stonework	Discontinuous	15	4	19	19	1	1	0
W-6	10	0.6	Herbs/grasses	0.6	20	1.0	Coniferous	0.8	Coniferous forest	mature forest	High (>50%)	45		0	0			0	0	0	0	0	0	0
W-7	3	0.2	Herbs/grasses	0.6	15	0.8	Coniferous	0.8	Landscaped- w/ some grassland and coniferous	mature forest	Moderate (10-50%)	45		2	5	Stonework	Discontinuous	15	7	22	30	0	1	0
W-8	3	0.2	Herbs/grasses	0.6	20	1.0	Coniferous	0.8	Coniferous and herbs/grass	mature forest and grass/herb	Moderate (10-50%)	45	Ponderosa pine and grass	0	0			0	0	0	0	0	0	0
W-9	10	0.6	Herbs/grasses	0.6	15	0.8	Coniferous	0.8	Landscaped w/ some grassland and coniferous	mature forest and grass/herb	Moderate (10-50%)	45	Ponderosa pine	0	0			3	2	5	19	0	1	0
W-10	3	0.2	Herbs/grasses	0.6	20	1.0	Coniferous	0.8	Grassland and coniferous	mature forest and grass/herb	Moderate (10-50%)	45	Ponderosa pine	0	0			0	0	0	0	0	0	0
C-1	3	0.2	Shrubs	1.0	20	1.0	Lawn	0.3	Lawn	Grass/Herb	High (>50%)	48	Lawn/ Ponderosa Pine	0	0	0	0	0	4	4	6	0	0	0
C-2	15	0.8	Shrubs	1.0	20	1.0	Herbs/grasses	0.6	Grass/Herb	Grass/Herb	High (>50%)	48	Lawn and Grass	0	0	0	0	1	2	3	3	0	0	0
C-3	10	0.6	Shrubs	1.0	20	1.0	Coniferous	0.8	Coniferous Forest	Mature Forest	High (50%)	45	Ponderosa Pine and Douglas Fir	0	0	0	0	0	0	0	0	0	0	0

Segment Number (Wasa Lk: W-1 to W-10; Cameron Pond: C-1 to C-3)	Road	Marine Railway	Marinas	Substrate Modified	Percent Substrate Modified	Modifications Comment	General Comments	Confirmed Sensitive Species / Zone of Sensitivity			
								Sensitive Plant Species	Fish Spawning	Biologically Productive Area (e.g., juvenile rearing)	Bird Staging Habitat
W-1	3 access points	0	0	Yes	60	beach grooming	Wide littoral shelf with gravels at low water levels and sand above; cabins beside boat launch.			Moderate - Creek Mouth (ephemeral). This ZOS is defined as an area with wide littoral areas (> 50m) associated with stream mouths/ outlets, aquatic vegetation and/or wetlands. These areas provide important refuge and foraging habitat for: 1) native fish species - particularly juvenile fish rearing, as well as for adult cyprinids; and, 2) other wildlife including invertebrates, birds and mammals, through their diverse riparian communities, not readily found in throughout the project area.	
W-2	1 access point and road running along length of southern bay	0	0	Yes	10	beach grooming	Low vegetated shore, few cabins. Deer tracks in Dec.	Wild licorice (Glycyrrhiza lepidota), a red listed species was found in this segment in June 2010.			Roberts Bay is an area of regional importance for shorebirds in both spring and fall migrations. This bay usually has broad mudflats that offer excellent foraging opportunities and receives much less human disturbance than other areas in the main lake.
W-3	2 access points	0	0	Yes	70	beach grooming; groyne and dredging at northern-most property	cabins above sandy beach; gravels predominant at low water levels. Deer tracks in Dec.				
W-4	0	0	0	No	0		Wetland at lake outlet. Elk tracks, clay beach and dry stream in Dec.	Ponderosa pine - trembling aspen / prairie rose (P*inus ponderosa - Populus tremuloides / Rosa woodsii)* a red listed ecological community was found in this segment.Wild licorice (*Glycyrrhiza lepidota*), a red listed species was also found in this segment (Keefer pers. comm. 2007)		Moderate - Creek Mouth (ephemeral); *See* description under Segment W-1.	
W-5	2 access points, 1 is a boat launch	0	0	Yes	55	beach grooming	Cabins above sand, some veg in sand				
W-6	0	0	0	No	0			Wild licorice, a red listed species was found in this segment (Keefer pers. comm. 2007)			
W-7	1 access point	0	0	Yes	55	beach grooming	cabins above sand, some veg in sand				
W-8	No	0	0	Yes	15	beach grooming		Wild licorice, a red listed species was found in this segment (Keefer pers. comm. 2007)	The bay located mid way along this segment where the ephemeral creek enters, is known to be an important spawning area for largescale suckers (*Catostomus macrocheilus*), a native fish species in Wasa Lake.	Moderate - Creek Mouth (ephemeral); *See* description under Segment W-1.	
W-9	1 access point	0	0	Yes	35	beach grooming					
W-10	No	0	0	Yes	75	beach grooming		Wild licorice, a red listed species was found in this segment in June 2010.			
C-1	Yes	0	0	Yes	25	20% from flood mitigation system					
C-2	Yes	0	0	Yes	5	One property has added gravels for dock				Moderate- Lewis Creek. *See* description under Segment W-1.	
C-3	No	0	0	No	0			spangle-top (*Scolochloa festucacea*), a red listed plant was found in grassland under trees and between shrub and tree bands.			

Appendix E. Segment and Site Photo Documentation

Segment and Site Photo Documentation

This appendix provides a brief segment description and representative photo for each of the shoreline segments. Also provided, is a representative photo of sites surveyed during the F&W assessment. Segment and site locations are mapped in Appendix A (Foreshore Summary Maps). Further details are provided in Appendix D (Segment Database), Appendix F (Vegetation Survey Plant List), Appendix G (Fish Field Data) and Appendix I (Wildlife Data). Wasa Lake Segments are identified as W1 to W10 and Cameron Lake Segments are C1 to C3. All sites pertain to Wasa Lake as no fish and wildlife analysis was conducted at a site level at Cameron Pond.

Segment W1 (1548 m)

High Level of Impact (LoI), Sand/Gravel Shore Type

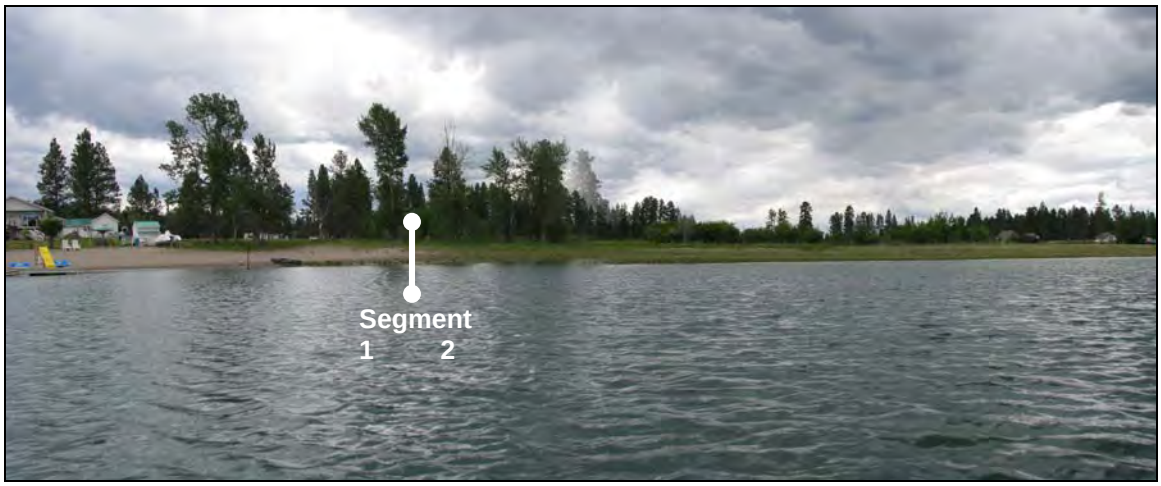
Segment W1, located on the eastern shore of Wasa Lake, has sand/gravel beach (during lower water levels than that depicted), residential development and associated modifications including beach grooming (approx. 60% of shoreline length), 25 docks, 1 groyne and 3 road access points. Photo: Holmes, June 2008.

Site 1.1: Fish survey (seine) and wildlife observation site in July, 2009. Identified as a ZOS, based on biologically productive characteristics of wide littoral area (> 50 m) associated stream mouth (ephemeral), sheltered embayment and riparian vegetation. This ZOS provides important refuge and foraging habitat for native fish species and is valuable for invertebrate production, birds and mammals. Photos: Holmes, July 2009.

Site 1.2: Fish survey (seine), invertebrate sampling and wildlife observation site in July 2009. Photos: Holmes, July 2009.

Segment W2 (1128 m)

Moderate LoI, Predominantly Vegetated Shore Type



Segment W2: The edge of the sandy beach marks the beginning of Segment 2 (vegetated area), which includes Robert's Bay at the southern tip of Wasa Lake. This segment is unique because although it is classified as a residential area (RDEK 2007), approximately 75% of the shoreline length was still in a natural condition. A rare plant species was found in this segment contributing to the AHI. Modifications included 4 docks, riparian vegetation removal, and the adjacent road. A culvert under the road carries flood flows into the lake from Cameron Pond. Photo: Holmes, June 2008.

Site 2.1: Robert's Bay, at south end of Wasa Lake, had fish survey (seine), wildlife observations and invertebrate sampling completed in July, 2009. Note transition vegetation along shoreline. This bay is a ZOS based on mud flats habitat, which are important for spring and fall bird staging. Photo: Holmes July, 2009.

Segment W3 (615 m)

High LoI, Predominantly Sand/Gravel Beach Shore

Segment W3, located on the southwestern shore of Wasa Lake; has had extensive disturbance associated with residential development including: beach grooming (70%), docks (9) and a groyne/dredging modification for boat access.

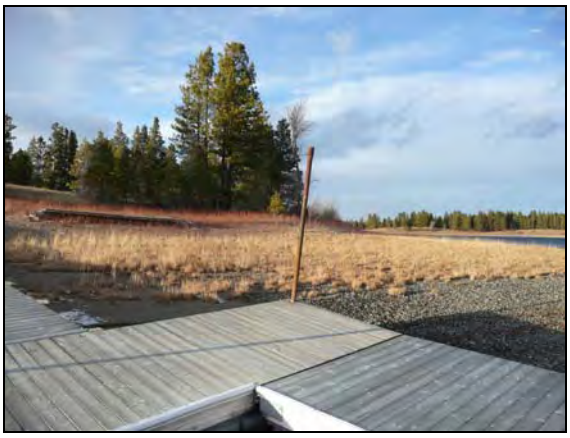
Segment W4 (1198 m)
Low LoI, Predominantly Wetland Shore Type

Segment W4, a natural parcel within Wasa Lake Provincial Park that includes Wetland, Vegetated and Stream Mouth Shore Types. There were several ZOS habitats in this segment including a rare ecological community, a rare plant species, and biologically productive habitat (e.g., for fish rearing and biodiversity). Photo: Holmes, June 2008.

Site 4.1 located at the mouth of Hanson Creek, an ephemeral channel connecting Wasa Lake to the Kootenay River floodplain. F&W surveys completed include fish survey (snorkel), and wildlife observations. Photo: Holmes July, 2009.

Segment W5 (982 m)

High LoI, Predominantly Sand Beach Shore Type

Segment W5 has been mostly disturbed by residential development. Modifications include: beach grooming (approx. 55%), 1 retaining wall, 19 docks, 1 groyne and 2 road access points (including 1 boat launch) and native vegetation removal. The small undisturbed areas remain so, because development has been set-back from the shoreline (right photo). Photos: Holmes, June 2008 (left); and McPherson, Dec 2008 (right).

Segment W6 (444 m)

Low LoI, Predominantly Vegetated Shore Type


Segment W6, located in an embayment on Wasa Lake's western shore, and is the second undisturbed parcel (managed for conservation) in Wasa Lake Provincial Park. At low water levels the substrates varied throughout the segment, with sand predominating along the northern stretch, and gravels in the southern half. Photos show gravel substrate, transition grasses, and conifers along shoreline (left); and park signage protecting habitat (right). Photos: McPherson, Dec. 2008.

Site 6.1: fish survey (seine), wildlife observations and invertebrate survey completed in July 2009. Photo: Holmes July, 2009.

Segment W7 (742 m)

High LoI, Predominantly Sand /Gravel Beach Shore Type

Segment W7, located on the northeastern shore of Wasa Lake, has been largely impacted by development. Total Shoreline modifications included: 2 retaining walls, 22 docks and 1 boat launch at the road access point. Beach grooming was estimated to along 55% of the shoreline. Photo: McPherson, Dec. 2008.

Site 7.1- Fish survey (snorkel) and wildlife observation site in July, 2009. Depicted above are contrasts between vegetated shoreline areas where coniferous and/or transition vegetation were left intact and areas where modifications (e.g., beach grooming greatly altered the natural shoreline). Photo: Holmes, July 2009.

Segment W8 (1128 m)

Moderate LoI, Predominantly Sand Beach Shore

Segment W8: recreation parcel in the Wasa Lake Provincial Park, situated at the northern end of the lake. This area has seen a moderate level of impact as a result of recreational infrastructure and associated landscaping (e.g. beach grooming and lawn establishment), which was concentrated near the northern point. ZOS identified in this segment included: biologically productive area associated with ephemeral stream / embayment, and in this same bay, a native fish spawning area (largescale sucker). Photo: Holmes, June 2008.

Segment W9 (270 m)

High LoI, Predominantly Sand/Gravel Beach Shore

Segment W9, located on the north east shore of the lake; and was highly impacted as a result of the residential land use. The houses are generally set-back on a bench located above the lake. There were some Vegetated Shore Type areas (25%), which were areas where transition grasses/riparian vegetation had been left intact (left photo). The riparian area was mainly composed of sand and as such, was sparsely vegetated. Beach grooming was estimated along 35% of the shoreline. Five docks, and a concrete boat launch and associated groyne were also observed. Photo: Holmes, June 2008.

Segment W10 (230 m)

Moderate LoI, Sand Beach Shore Type

Segment W10 and Site 10.1: Wasa Lake Provincial Park, high recreational use property, situated proximal to the campground. Beach grooming was evident along nearly all of its extent. The riparian and upland vegetation has been landscaped. July 2009 assessment included fish survey (seine), invertebrate sampling, and wildlife observations. A rare plant occurrence was identified here, which was identified as a ZOS. Photo: Holmes, July 2009.

Segment C1 (676 m)

Moderate LoI, Vegetated Shore Type

Segment C1, located in Cameron Pond and includes the flood mitigation system and residential area along the south west boundary. The immediate shoreline area along the residential properties was largely left intact with riparian vegetation present and few modifications (4 docks). The flood mitigation system is a dyke structure with a culvert, which controls flows to the southern ponds in the Cameron Slough Wildlife Sanctuary, managed by The Nature Trust. Photo: McPherson, May 2010.

Segment C2 (1230 m)

Low LoI, Predominantly Wetland Shore Type

Segment C2, located along the northern margin of Cameron Pond, is predominantly wetland, but also includes the stream mouth of Lewis Creek. Sixty percent of the segment is within the Cameron Slough Wildlife Sanctuary, with the remainder being private rural property. Modifications are limited to three docks, one road access point and a small section where the substrate was modified. The historical tailings area is located beyond the wetland proximal to Lewis Creek outlet. The Lewis Creek outlet was identified as a biologically productive ZOS. Photo: McPherson May 2010.

Segment C3 (657 m)
Low LoI, Vegetated Shore Type

Segment C3, located along the eastern shore of Cameron Pond is protected through the Cameron Slough Wildlife Sanctuary and has no modifications evident. Sensitive plant species occurrence contributed to the ZOS. Photo: McPherson May 2010.

Appendix F. Plant Species Identified During the Floristic Survey (June 8, 2010)

Common Name	Latin Name	Segment									
		W1	W2	W4	W6	W7	W8	W 10	C1	C2	C3
crested wheatgrass*	*Agropyron cristatum*	√					√		√		
bluebunch wheatgrass	*Agropyron spicatum*						√				
Saskatoon berry	*Amelanchier alnifolia*	√	√						√		√
hemp dogbane	*Apocynum cannabinum*		√					√			
kinnikinnick	*Arctostaphylos uva-ursi*								√		
water birch	*Betula occidentalis*									√	
smooth brome*	*Bromus inermis*						√			√	
pinegrass	*Calamagrostis rubescens*										
yellow sedge	*Carex flava*	√	√				√	√	√		
slough sedge	*Carex obnupta*	√					√	√	√		
beaked sedge	*Carex utriculata*	√	√	√			√	√	√		
green sedge	*Carex viridula*	√	√	√	√	√	√	√	√		
spotted knapweed*	*Centaurea maculosa*						√		√	√	
red-osier dogwood	*Cornus stolonifera*	√		√			√		√		
black hawthorn	*Crataegus douglasii*	√		√			√		√		
tufted hairgrass	*Deschampsia caespitosa*	√	√		√	√	√				
flixweed	*Descurainia Sophia*									√	
barnyard grass	*Echinochloa crusgalli*	√									
wolf-willow	*Elaeagus commutate*	√		√	√		√				
common horsetail	*Equisetum arvense*	√	√	√							
rough fescue	*Festuca campestris*	√	√				√				
wild strawberry	*Fragaria virginiana*									√	
American licorice	*Glycyrrhiza lepidota*		√					√			
creeping juniper	*Juniperus horizontalis*						√				
junegrass	*Koeleria macrantha*								√		
stiff clubmoss	*Lycopodium annotinum*	√		√							
alfalfa*	*Medicago sativa*	√							√	√	
reed canarygrass	*Phalaris arundinacea*			√			√		√		
ponderosa pine	*Pinus ponderosa*	√	√	√	√		√		√		√
Kentucky bluegrass*	*Poa pratensis*			√							
trembling Aspen	*Populus tremuloides*	√	√	√	√						
black cottonwood	*Populus trichocarpa*	√		√			√	√			
silverweed	*Potentilla anserina*	√		√							
interior Douglas-fir	*Pseudotsuga menziesii*										√
Nuttall's alkali grass	*Puccinellia nuttalliana*	√	√	√				√			
prairie rose	*Rosa woodsi*		√	√			√		√		
willow	*Salix spp*	√	√	√	√			√		√	
great bulrush	*Scirpus lacustris*	√	√	√					√		
spangle-top	*Scolochloa festucacea*										√
Rocky Mountain butterweed	*Senecio streptanthifolius*			√							
star-flowered false Solomon's-seal	*Smilacina stellata*			√							

Common Name	Latin Name	Segment									
		W1	W2	W4	W6	W7	W8	W 10	C1	C2	C3
Indian ricegrass	*Stipa hymenoides*	√					√				
spreading needlegrass	*Stipa richardsonii*		√				√				
common snowberry	*Symphoricarpos albus*	√	√	√					√	√	
seaside arrow-grass	*Triglochin maritimum*	√		√		√					
cattail	*Typha latifolia*									√	

* Introduced Plant Species
**Note: this plant list is not exhaustive, as the objective of the floristic survey was to identify sensitive plant species; thus not all common or non-native species may have been recorded

Appendix G. Fish Field Data

TABLE I: FISHERIES FIELD DATA FROM SAMPLING ALONG THE FORESHORE OF WASA LAKE IN JULY AND SEPTEMBER OF 2008

Segment	Site	Sampling Season	Sampling Date	Start Time	End Time	Predominant Shore Type	Disturbance Level	Substrate Type	Aquatic Vegetation	Air Temp. (°C)	Water Temp.(°C)
W1	1	Summer	14-Jul-09	10:30	10:50	Sand/Gravel Beach	undisturbed	silt 10,sand 20, 80 gravel	extensive sedges, arrowgrass	16.7	20
W1	2	Summer	14-Jul-09	11:25	11:40	Sand/Gravel Beach	n	silt 80, 15 gravel, 5 sand	common horsetail, seaside arrowgrass,sedges abundant, scattered willow	16.7	20.6
W1	2	Summer	14-Jul-09	11:25	11:40	Sand/Gravel Beach	n	silt 80, 15 gravel, 5 sand	common horsetail, seaside arrowgrass,sedges abundant, scattered willow	16.7	20.6
W2	1	Summer	14-Jul-09	12:30	12:50	Vegetated Shore Type	n	silt 60,sand 10, gravel 30	sedges, arrowgrass,coontail, milfoil	18.3	21.1
W2	1	Summer	14-Jul-09	12:30	12:50	Vegetated Shore Type	n	silt 60,sand 10, gravel 30	sedges, arrowgrass,coontail, milfoil	18.3	21.1
W4	1	Summer	14-Jul-09	14:10	14:26	Wetland	n	100 silt	common horsetail, seaside arrowgrass,spike bullrush, pondweed, northern milfoil	21	21.1
W4	1	Summer	14-Jul-09	14:10	14:26	Wetland	n	100 silt	common horsetail, seaside arrowgrass,spike bullrush, pondweed, northern milfoil	21	21.1
W4	1	Summer	14-Jul-09	14:10	14:26	Wetland	n	100 silt	common horsetail, seaside arrowgrass,spike bullrush, pondweed, northern milfoil	21	21.1
W6	1	Summer	14-Jul-09	13:25	13:40	Vegetated Shore Type	undisturbed	80 gravel, 20 sand	sedges, arrowgrass	21.1	21.1
W6	1	Summer	14-Jul-09	13:25	13:40	Vegetated Shore Type	undisturbed	80 gravel, 20 sand	sedges, arrowgrass	21.1	21.1
W6	1	Summer	14-Jul-09	13:25	13:40	Vegetated Shore Type	undisturbed	80 gravel, 20 sand	sedges, arrowgrass	21.1	21.1
W7	1	Summer	14-Jul-09	14:30	14:53	Sand/Gravel Beach	high	10 gravel, 10 cobble, 80 silt	none	21.1	20
W7	1	Summer	14-Jul-09	14:30	14:53	Sand/Gravel Beach	high	10 gravel, 10 cobble, 80 silt	none	21.1	20
W7	1	Summer	14-Jul-09	14:30	14:53	Sand/Gravel Beach	high	10 gravel, 10 cobble, 80 silt	none	21.1	20
W10	1	Summer	14-Jul-09	10:10	10:20	Sand Beach	n	95 sand, 5 gravel	none	15	18.3

TABLE I: FISH

Segment	Site	Photo No.	Sample Type	Channel Distance (m)	Species	Number of Fish	Life Stage	General Site Observations
W1	1	PH	seine	20	yellow perch	500+	juvenile	undisturbed vegetated bay 50 m with submerged sedge and willow fringe
W1	2	PH	seine	15	yellow perch	50+	juvenile	foreshore is sand, gravel, grasses, sedges upland
W1	2	PH	seine	15	dace	2	adult	
W2	1	PH	seine	20	pumpkinseed sunfish	3	adult	pond connected to segment 2 by narrow channel scattered willow patches along margin; lawn to high water mark
W2	1	PH	seine	20	yellow perch	100+	juvenile	
W4	1	PH	snorkel	100	pumpkinseed sunfish	24	adult	
W4	1	PH	snorkel	100	yellow perch	1	adult	
W4	1	PH	snorkel	100	yellow perch	6	juvenile	
W6	1	PH	seine	20	largemouth bass	3	juvenile	undisturbed upland, 90% park, 2 houses with good foreshore protection
W6	1	PH	seine	20	yellow perch	5	juvenile	
W6	1	PH	seine	20	dace	1	adult	
W7	1	PH	snorkel	150	pumpkinseed sunfish	20	adult	
W7	1	PH	snorkel	150	largemouth bass	5	adult	18" fish; gravel out to 1 m depth, cobble to 2.5 m; turbid water
W7	1	PH	snorkel	150	largemouth bass	100	juvenile	heavily vegetated under each dock pondweed, coontail. Last dock had bulk of fish; visibility to 2 m., obvious grooming of aquatic plants.
W10	1	PH	seine	20	cyprinids	50	juvenile	Wasa Provincial Park Beach

Appendix H. Aquatic Invertebrate Field Data and Analysis

Table I. Aquatic invertebrate sampling along the Wasa Lake shoreline, July 14, 2009

Site	Number	Order	Common Name	Comments
1.2	8	Hydrachnida	water mite	
	12	Amphipoda	scud	
	2	Diptera	true fly	
	35	Copepoda	copepod	
2.1	50	Amphipoda	scud	
	50	Hydrachnida	water mite	
	20	Copepoda	copepod	
	2	Diptera	true fly	
	3	Ephemeroptera	mayfly	
	16	Gastropoda	snail	
6.1	1000+	Copepoda	copepod	
	20	Amphipoda	scud	
	1	Gastropoda	snail	shell only
	1	Ephemeroptera	mayfly	
	1	Hydrachnida	water mite	
10.1	5	Diptera	true fly	
	3	Amphipoda	scud	
	4	Diptera	midge	casing only
	3	Hydrachnida	water mite	

Table II. Aquatic Invertebrate Summary for Simpson's Index of Diversity

	Site 1.2		Site 2.1		Site 6.1		Site 10.1	
Order	n	n(n-1)	n	n(n-1)	n	n(n-1)	n	n(n-1)
Ephemeroptera		0	3	6		0	1	0
Hydrachnida	8	56	50	2450	3	6	1	0
Amphipoda	12	132	50	2450	3	6	20	380
Diptera	2	2	2	2	9	72		0
Copepoda	35	1190	20	380		0	1000	999000
Gastropoda		0	16	240		0	1	0
Sum (N)	**57**	**1380**	**141**	**5528**	**15**	**84**	**1023**	**999380**

Table III. Simpson's Index of Diversity Calculation

Site	1.2	2.1	6.1	10.1
N	57	141	1023	15
Sum n(n-1)	1380	5528	999380	84
N(N-1)	3192	19740	1045506	210
Simpson's Index D= Sum n(n-1)/N(N-1)	0.43	0.28	0.96	0.40
Simpson's Index of Diversity (1-D)	0.57	0.72	0.04	0.60

Appendix I. Wildlife Data.

Table I. Field notes summarizing Riparian Site Characteristics and Wildlife Data collected at Wasa Lake on July 14, 2009 (Sites 1.1 – 10.1) and at Cameron Pond on May 20, 2010 (Segments 11-13).

Habitat Type	Site 1.1	Site 1.2	Site 2.1	Site 4.1	Site 6.1	Site 7.1	Site 10.1	Segment C1	Segment C2	Segment C3
Forest Canopy - Age/Canopy - Species	Mid-mature, semi-open Py, willow, aspen	Mid-mature Py, Ct	Young aspen		Mid-closed Py, Fd	Mod-Semi-open Py, Ct, aspen	Mid/semi-open Py, few Ct	narrow band of mature Py along lake shore, grass	none	mature Py, Fd, Lw ~50% closure
Wildlife Trees	2				Few	1 Py stub	1- class 1	6, class 2 to 6	none	minimum 5, class 4 to 6
CWD/LOD	1			Very little	Few				lots at Lewis Ck mouth	
Shrub Cover - Amount - Species	Willow, alder, red osier dogwood, birch, hawthorn, saskatoon	Hemp dogbane, willow, hawthorn, saskatoon, red osier dogwood	Snowberry, dogbane, willow, rose, clover, hawthorn	Abundant Willow, red osier dogwood, poplar, aspen	Abundant Red osier dogwood, rose, willow, snowberry, Oregon grape, alder, soopolallie, juniper	Sparse – moderate Red osier dogwood, willow, dogbane, chokecherry, wolf willow, juniper	Sparse Willow, juniper	hawthorn, willow, red-osier dogwood, snowberry, rose, lilac, chokecherry	hawthorn, laurel, birch, red-osier dogwood, willow, saskatoon	willow, saskatoon, red-osier dogwood, rose
Grasslands		Yes	Yes	No		Yes,	Yes, mostly introduced	non-native (lawn)	No	No
Clay Banks				No				No	No	No
Adjacent Wetlands	Yes		Yes	Yes				Across dyke	yes	No
Littoral Zone - Gradient - Piece size	Shallow, Mud, pebble	Shallow Sand, pebble	Shallow	Shallow Clay	Moderately steep	Shallow	Shallow Sand/pebble			
Emergent/ Submergent	Both	Both	Both	Both	Both	Some of both	Emergent at south end			
Wildlife	Magpie, crow, swallows, sparrow, deer pellets, silver sage, dogbane, reed canary grass, *potentilla* (silver weed)	Robin, chickadee, swallow, northern flicker, crow, sandpiper, vertebrate, *potentilla* (silver weed)	Sandpiper (abundant), heron, loon, cedar waxwing, moose pellets	Osprey, eagle, song sparrow, yellow warbler, robin, eastern phoebe, waxwing, loon	Sparrow, nuthatch, crow, osprey	Bald eagle, swallows, magpie, sparrow, pine siskin, N. flicker, dark-eyed junco, waxwing, common golden eye, sandpiper, mountain chickadee	Eagle, swallow, nuthatch, osprey, ground squirrel, crow, dark-eyed junco	red-winged blackbird, song sparrow, Brewer's blackbird, tree swallow, northern rough-winged swallow, American robin	magpie, red-winged blackbird, song sparrow, Brewer's blackbird, tree swallow, northern rough-winged swallow, violet-green swallow, western meadowlark, warbling vireo, American kestrel, western kingbird, Canada goose, mallard, sora, beaver, western painted turtle (dead)	belted kingfisher, bald eagle (on nest), song sparrow, pine siskin, cassin's vireo, yellow-rumped warbler, yellow warbler, beaver lodge
Notes	breezy				1:00 p.m. getting hot		concrete boat launch	large number of swallows over Cameron Pond. Mostly northern rough-wing, also tree and violet-green. Windy, probably many birds in adjacent forests were not singing. Loon is often on Cameron Pond, but was not observed today.		

Table II. List of 63 waterfowl and shorebird species observed at, or near, Wasa Lake. Species marked with an asterisk (*) have only been observed at the 'sloughs' south of the main lake. Sources: Nicholson (pers. comm.); Campbell *et al.* (1990; 1997); Nicholson *et al.* (2003).

Common Name	Scientific Name	Breeding Status[1]	Occurrence[2]
Common Loon	*Gavia immer*	breeds	common
Red-necked Grebe	*Podiceps grisegena*	breeds	common
Western Grebe	*Aechmophorus occidentalis*	non-breeder	uncommon
Eared Grebe	*Podiceps nigricollis*	breeds	uncommon
Horned Grebe	*Podiceps auritus*	breeds	uncommon
Pied-billed Grebe	*Podilymbus podiceps*	breeds	common
American White Pelican*	*Pelecanus erythrorhynchos*	non-breeder	occasional
American Bittern*	*Botaurus lentiginosus*	breeds	uncommon
Great Blue Heron	*Ardea Herodias*	breeds	common
Tundra Swan	*Cygnus columbianus*	non-breeder	uncommon
Trumpeter Swan	*Cygnus buccinators*	non-breeder	occasional
Snow Goose	*Chen caerulescens*	non-breeder	rare
Canada Goose	*Branta canadensis*	breeds	common
Wood Duck*	*Aix sponsa*	breeds	common
Mallard	*Anas platyrhynchos*	breeds	abundant
Northern Pintail	*Anas acuta*	breeds	common
Gadwall	*Anas strepera*	non-breeder	rare
American Wigeon	*Anas americana*	breeds	common - abundant
Eurasian Wigeon	*Anas penelope*	non-breeder	rare
Northern Shoveler	*Anas clypeata*	breeds	uncommon
Green-winged Teal	*Anas crecca*	breeds	common
Blue-winged Teal	*Anas discors*	breeds	common
Cinnamon Teal	*Anas cyanoptera*	breeds	common
Canvasback	*Aythya valisineria*	?	uncommon
Redhead Duck	*Aythya americana*	breeds	common
Ring-necked Duck	*Aythya collaris*	breeds	common
Greater Scaup	*Aythya marila*	non-breeder	uncommon
Lesser Scaup	*Aythya affinis*	non-breeder	common
Common Goldeneye	*Bucephala clangula*	breeds	common
Barrow's Goldeneye	*Bucephala islandica*	breeds	common
Bufflehead	*Bucephala albeola*	breeds	common
Ruddy Duck*	*Oxyura jamaicensis*	breeds	common
Common Merganser	*Mergus merganser*	breeds	common
Red-breasted Merganser	*Mergus serrator*	non-breeder	rare
Hooded Merganser*	*Lophodytes cucullatus*	breeds	uncommon
American Coot	*Fulica americana*	breeds	abundant
Sora*	*Porzana carolina*	breeds	uncommon
Virginia Rail*	*Rallus limicola*	probable breeder	rare
Black-bellied Plover	*Pluvialis squatarola*	non-breeder	rare
Semipalmated Plover	*Charandrius semipalmatus*	non-breeder	rare
Killdeer	*Charandrius vociferous*	breeds	common

Common Name	Scientific Name	Breeding Status[1]	Occurrence[2]
Black-necked Stilt	*Himantopus mexicanus*	non-breeder	occasional
American Avocet	*Recurvirostra americana*	non-breeder	rare
Greater Yellowlegs	*Tringa melanoleuca*	non-breeder	uncommon
Lesser Yellowlegs	*Tringa flavipes*	non-breeder	uncommon
Solitary Sandpiper	*Tringa solitaria*	breeds	uncommon
Spotted Sandpiper	*Actitis macularia*	breeds	common
Upland Sandpiper	*Bartramia longicauda*	non-breeder	occasional
Semipalmated Sandpiper	*Calidris pusilla*	non-breeder	occasional
Western Sandpiper	*Calidris mauri*	non-breeder	occasional
Least Sandpiper	*Calidris minutilla*	non-breeder	occasional
Baird's Sandpiper	*Calidris bairdii*	non-breeder	occasional
Pectoral Sandpiper*	*Calidris melanotos*	non-breeder	occasional
Long-billed Dowitcher	*Limnodromus scolopaceus*	non-breeder	occasional
Wilson's Snipe	*Gallinago gallinago*	breeds	common
Wilson's Phalarope	*Phalaropus tricolor*	breeds	rare
Red-necked Phalarope	*Phalaropus lobatus*	non-breeder	rare
Bonaparte's Gull	*Larus philadelphia*	non-breeder	uncommon
Ring-billed Gull	*Larus delawarensis*	non-breeder	uncommon
California Gull	*Larus californicus*	non-breeder	uncommon - rare
Herring Gull	*Larus argentatus*	non-breeder	uncommon
Common Tern	*Sterna hirundo*	non-breeder	occasional
Black Tern*	*Chlidonias niger*	breeds	common

[1] Breeding Status – species indicated as 'breeds' are known to breed in the East Kootenay, though not necessarily at Wasa Lake.
[2] Occurrence order: Abundant > Common > Uncommon > Rare > Occasional > Accidental

Table III. Bird utilization at each of the Wasa Lake segments and Habitat Significance, provided by Dianne Cooper, Naturalist (pers. comm.).

Segment	W1 Cedar Rd	W2 Robert's Pond	W3 SW end	W4 Hanson Cr	W5 West Bay	W6 Loon Bay	W7 N end Res	W8 Main & 2nd Beach	W9 Balsam Res	W10 3rd Beach
Waterbirds										
Common Loon	c	c	c	c	c	c	c	c	c	c
Pied-billed Grebe		i	c	c	c	i	i	i		
Horned Grebe	c	i	c	c	c	i				
Red-necked Grebe	c	i	c	c			i	c		
Eared Grebe	c	i	c	c	c	i				
Western Grebe	c	i	c	c					c	
American White Pelican			c							
Canada Goose	i	c	c	c	c	c	i	c	i	i
Trumpeter Swan	i		c	c	c					i
Tundra Swan	i	i	c	c	c					i
Wood Duck	c	c	c	c	c		i	i		
American Wigeon	c	c	c	c	c		i	i		
Mallard	c	c	c	c	c		i			
Gadwall	c	c	c	c	c					
Blue-winged Teal	c	c	c	c	c					
Cinnamon Teal	c	c	c	c	c					
Northern Shoveler	c	c	c	c	c					
Northern Pintail	c	c	c	c	c					
Green-winged Teal	c	c	c	c	c					
Canvasback	c	c	c	c	c					
Redhead	c	c	c	c	c					
Ring-necked Duck	c	c	c	c	c		i	i		
Greater Scaup	c		c	c	c					
Lesser Scaup	c	c	c	c	c					
Bufflehead	c	c	c	c	c		i	i		

Segment	W1 Cedar Rd	W2 Robert's Pond	W3 SW end	W4 Hanson Cr	W5 West Bay	W6 Loon Bay	W7 N end Res	W8 Main & 2nd Beach	W9 Balsam Res	W10 3rd Beach
Common Goldeneye	c	c	c	c	c		i	i		
Barrow's Goldeneye	c	c	c	c	c		i	i		
Hooded Merganser	c	c	c	c	c		c	c		
Common Merganser	c	c	c	c	c		c	c	c	c
Red-breasted Merganser	c		c	c	c		c	c	i	i
Ruddy Duck	c	c	c	c	c		i	i	i	i
American Coot	c	i	c	c	c		i	i	i	i
Large Raptors										
Osprey	c	i	c	c	c	i	c	i	i	i
Bald Eagle	c	i	c	c	c	i	i	i	i	i
Shorebirds										
Sora	c	c	c			i				
Killdeer	c	c	c	c	c		i	i	i	i
Black-necked Stilt	c	c	c	c	c					
American Avocet	c	c	c	c	c			c		
Long-billed Dowitcher	c	c		c	c					
Wilson's Snipe	c	c		c	c					
Greater Yellowlegs	c	c		c	c		i	i	i	i
Lesser Yellowlegs	c	c	c	c	c		i	i	i	i
Spotted Sandpiper	c	c	c	c	c	i	i	i	i	i
Solitary Sandpiper	c	c	c							
Semipalmated Sandpiper	c	c	c							
Pectoral Sandpiper	c	c	c	i	i					
Baird's Sandpiper	c	c	c							
Western Sandpiper	c	c	c							
Least Sandpiper	c	c	c							
Wilson's Phalarope	c	c	c	c	c					i

Segment	W1 Cedar Rd	W2 Robert's Pond	W3 SW end	W4 Hanson Cr	W5 West Bay	W6 Loon Bay	W7 N end Res	W8 Main & 2nd Beach	W9 Balsam Res	W10 3rd Beach
Red-necked Phalarope	c	c	c	c	c					i
Gulls and Terns										
Bonaparte's Gull	c	i	c	c	c	i	i	c	i	i
Ring-billed Gull	c	i	c	c	c	i	i	c	i	i
Herring Gull	c	i	c	c	c	i	i	c	i	i
Common Tern	c	i	c	c	c	i	i	c	i	i
Swallows										
Tree Swallow	i	i	i	i	i	i	i	i	i	i
Violet-green Swallow	i	i	i	i	i	i	i	i	i	i
N. Rough-winged Swallow	i	i	i	i	i	i	i	i	i	i
Bank Swallow	i	i	i	i	i	i	i	i	i	i
Barn Swallow	i	i	i	i	i	i	i	i	i	i
Perching Birds										
Belted Kingfisher	i	c	i	c	i		i		i	i
American Pipit	c	c								
Alder Flycatcher		i		c				i		
Willow Flycatcher		i		c				i		
Least Flycatcher		i		c				i		
Western Kingbird		i								
Eastern Kingbird	c	c	i	c	c		i	i	i	i
Cassin's Vireo	c	c		c	i					
Red-eyed Vireo	i	c	i	c	i		i			
Yellow Warbler	c	c	i	c	i		i	c	i	i
American Redstart	c	c	i	c	i		i		i	i
Northern Waterthrush										
Song Sparrow	c	c	c	c	c		i	c	c	i
Red-winged Blackbird	i	c	c	c	i		i	i	i	i

Segment	W1 Cedar Rd	W2 Robert's Pond	W3 SW end	W4 Hanson Cr	W5 West Bay	W6 Loon Bay	W7 N end Res	W8 Main & 2nd Beach	W9 Balsam Res	W10 3rd Beach
Brewer's Blackbird	i	c	c	c	i		i	i	i	i
American Goldfinch	c	c	c	c	c		c	i	c	c
Legend:										
c	critical	habitat maintenance and minimal human disturbance in these areas would ensure this species' residency and/or usage of the lake								
i	integral	part of overall habitat needed								
blank		insufficient data								
Note: -because Wasa is small, other areas (not marked 'c') are needed to ensure the health of all segments										
-usage areas change with season and water levels in different years										
-segment 6, because of its restricted site line from our usual view points, has not been adequately surveyed for birds Next page:										
See: Notes on Bird Usage by Dianne Cooper, April, 4, 2010										

Appendix J. Aquatic Habitat Index Tables

Table I. Aquatic Habitat Index Values

Biophysical						Zones of Sensitivity				Riparian		Modifications				
Segment #	Shore Type	Substrate	% Natural	Emergent Vegetation	Overhanging Vegetation	Sensitive Plant Species	Native Fish Spawning	Biologically Productive	Bird Staging	Band 1	Band 2	Retaining Walls	Docks	Groynes	Boat Launch	Beach Grooming
W-1	15	7.2	0.45	5.2	1.5	0	0	3	0	2.4	3.8	0	-2.5	-0.5	0	-5
W-2	14.5	5	10.5	7.6	1.2	3	0	0	5	4.8	3.8	0	-0.4	0	0	0
W-3	13.5	6	0.45	2.8	0.6	0	0	0	0	1.2	1.4	0	-0.9	-0.5	0	-5
W-4	17.75	5	15	8	0.6	5	0	3	0	10.0	4.8	0	0	0	0	0
W-5	11.25	5	0.75	1.2	2.4	0	0	0	0	2.4	2.9	-0.25	-1.9	-0.5	-3	-5
W-6	14.5	6	15	0	5.4	3	0	0	0	3.6	4.8	0	0	0	0	0
W-7	15	7	0.75	3.2	1.8	0	0	0	0	1.2	3.8	-0.25	-2.2	0	-3	-5
W-8	12	5.4	9.75	2.4	2.1	3	5	3	0	1.2	4.8	0	0	0	0	-3
W-9	15	7.6	1.5	6.8	1.8	0	0	0	0	3.6	3.8	0	-0.5	0	-3	-3
W-10	11.25	4	3.75	1.6	3.6	3	0	0	0	1.2	4.8	0	0	0	0	-5
C-1	15	7.6	12	1.6	0.9	0	0	0	0	2.0	1.8	0	-0.4	0	0	0
C-2	20	6.1	13.5	6.4	1.5	0	0	3	0	8.0	3.6	0	-0.3	0	0	0
C-3	15	6.16	15	0	2.4	3	0	0	0	6.0	4.8	0	0	0	0	0

Table II. AHI Summary Table

Segment #	Biophysical Total	Zones of Sensitivity Total	Riparian Total	Modifications Total	Current Value	Current AHI Rank	Potential Value	Potential AHI Rank
W-1	29.35	3	6.24	-8	30.59	Low	38.59	Moderate
W-2	38.8	8	8.64	-0.4	55.04	High	55.44	High
W-3	23.35	0	2.64	-6.4	19.59	Very Low	25.99	Low
W-4	46.35	8	14.80	0	69.15	Very High	69.15	Very High
W-5	20.6	0	5.28	-10.65	15.23	Very Low	25.88	Low
W-6	40.9	3	8.40	0	52.3	High	52.3	High
W-7	27.75	0	5.04	-10.45	22.34	Very Low	32.79	Low
W-8	31.65	11	6.00	-3	45.65	Moderate	48.65	High
W-9	32.7	0	7.44	-6.5	33.64	Low	40.14	Moderate
W-10	24.2	3	6.00	-5	28.2	Low	33.2	Low
C-1	37.1	0	3.80	-0.4	40.5	Moderate	40.9	Moderate
C-2	47.5	3	11.60	-0.3	61.8	Very High	62.1	Very High
C-3	38.56	3	10.80	0	52.36	High	52.36	High

Max	Min	Range	Class	Break(VH)	Break(H)	Break(M)	Break(L)
69.15	15.23	53.92	10.784	58	47	36	25

Appendix K. Guidance Document Appendices – 1) Legal Requirements and 2) Best Management Practices and Regional Operating Statements

1. Legal Requirements

Laws and regulations provide the regulatory 'teeth' to uphold environmental protection and management. Applicable legislative requirements must be met for a project to be in compliance with the law. Legal requirements have been presented here in the following categories: Federal, Provincial, Regional District and District of Invermere. For each of these jurisdictions, a list of pertinent legislation bylaws and/or plans; and contact information (web site links) has been provided. The reader is cautioned that other legislation (not listed) may apply to their development, and they are encouraged to consult with the appropriate agency prior to proceeding with any proposed works.

Federal Legislation

All federal legislation is administered by the parliament of Canada (federal government).

Canada Migratory Birds Convention Act

This Act implements an internationally recognized Convention between Canada and the United States to protect various species of migratory game birds, migratory insectivorous birds and migratory non-game birds including herons. The taking of nests or eggs of these birds is prohibited, except for permitted scientific or propagating purposes.

Fisheries Act

The *Fisheries Act* is administered by the federal Department of Fisheries and Oceans and is one of the most important pieces of legislation for managing aquatic resources in Canada. The fish habitat provisions of this Act enable the federal government to protect marine and freshwater habitats supporting those species that sustain fisheries, namely fish, shellfish, crustaceans and marine mammals.

Navigable Waters Protection Act

This act is administered by Transport Canada and is primarily applicable to protecting, maintaining, and developing opportunities for the public to access and use waterbodies for navigation and recreation. Any activities that may affect movement of people or goods, near or on water are affected (i.e. dock/marina construction, dredging, shoreline development).

Pesticides Act

The *Pesticides Act* is intended to 1) prevent and mitigate harmful effects to the environment and human health, and 2) rationalize and reduce the use of pesticides. The Act promotes the analysis, assessment and control of the effects of the use of pesticides through specific activities intended to widen knowledge about these products (environmental monitoring, for example).

Species at Risk Act

This act prevents Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, provides for the recovery of endangered or threatened species and encourages the management of other species to prevent them from becoming at risk.

Canadian Environmental Assessment Act (CEAA)

The CEAA requires federal departments to conduct environmental assessments (EA) for prescribed projects and activities before providing federal approval or financial support. The EA is a planning tool used to identify potential effects of projects or activities on the environment. This includes the air, water, land and living organisms, including humans.

Indian Act
The *Indian Act* provides legislation relating to Indians and Lands Reserved for Indians. The Indian Act is administered by the Minister of Indian Affairs and Northern Development.

Provincial Legislation

All provincial government legislation within BC is administered by the legislative assembly of British Columbia (provincial government).

Land Act
The *Land Act* is the main legislation governing the disposition of provincial Crown (i.e. public) land in British Columbia. Crown land is any land owned by the Province, including land that is covered by water, such as the foreshore and the beds of lakes, rivers and streams. The *Land Act* is administered by the Ministry of Sustainable Resource Management.

Wildlife Act
The provincial Ministry of Environment administers the *Wildlife Act*, which includes legislation relating to the conservation and management of wildlife populations and habitat, issuing licenses and permits for fishing, game hunting, and trapping. A provision of the Wildlife Act, which may be pertinent to shoreline development is the prohibition, to take, injure, molest, or destroy a) a bird or its egg; b) the nest of an eagle, peregrine falcon, gyrafalcon, osprey, heron, or burrowing owl; c) or the nest of any other bird species when the nest is occupied by a bird or its egg.

Water Act
The *Water Act* is the primary provincial statute regulating water resources. Under the Water Act, a stream is defined as "*a natural watercourse or source of water supply, whether usually containing water or not, and a lake, river, creek, spring, ravine, swamp and gulch*." Section 9 of the *Water Act* requires that a person may only make "changes in and about a stream" under an Approval or Notification where required; or under a Water License or Order.

Weed Control Act
The B.C. *Weed Control Act* imposes a duty on all land occupiers to control designated noxious plants. The purpose of the Act is to protect our natural resources and industry from the negative impacts of foreign weeds.

Regional District of East Kootenay

The Regional District of East Kootenay (RDEK) provides local government services to rural areas outside municipal boundaries. The RDEK functions as a partnership of the municipalities and electoral areas (unincorporated areas) within its boundaries. These local governments work together through the RDEK to provide and coordinate services in both urban and rural areas. Regional districts are governed by the *Local Government Act* and other provincial legislation.

Wasa – Ta Ta Creek – Skookumchuck – Sheep Creek Land Use Bylaw, Bylaw No. 1625
This land use bylaw directs what can occur on an individual parcel of land.

Wasa Lake Land Improvement District

The Wasa lake Land Improvement District provides local government services to the district of Wasa.

2. Best Management Practices and Regional Operating Statements

Many provincial and federal agencies have developed Best Management Practices (BMP) in order to provide consistent direction to the public on acceptable development methods. The BMPs provide information to help ensure that proposed development activities are planned and carried out in compliance with the various applicable legislation, regulations, and policies. The range of activities that associate BMPs is broad.

The province of BC has, over a period of many years, developed a series of BMPs. These have evolved into "Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia." The Develop with Care Guidelines have links to several provincial BMPs related to shoreline development activities. Examples are as follows:

- Standards and Best Management Practices for Instream Works;
- Best Management Practices for Small Boat moorage on Lakes
- Timing and Terms and Conditions for Changes In and About a Stream Specified by MOE Habitat Officers, Kootenay Region
- Small Boat Moorage
- Boat Launch Construction and Maintenance on Lakes
- Lakeshore Stabilization
- Installation and Maintenance of Water Line Intakes
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia
- Best Management Practices for Amphibians and Reptiles in Urban and rural Environments in BC

The Regional Operating Statements (ROS) developed by DFO, provide information regarding several low risk activities associated with shoreline development, including but not limited to:

- Aquatic Vegetation Removal in Lakes
- Bridge & Culvert Maintenance
- Dock and Boathouse Construction in Freshwater Systems
- Routine Maintenance Dredging for Navigation
- Public Beach Maintenance
- Clear Span Bridges
- Culvert Maintenance
- Directional Drilling
- Small Moorings
- Underwater Cables in Freshwater Systems
- Overhead Line Construction
- Maintenance of Riparian Vegetation in Existing Rights of Ways
- Dry Open Cut Stream Crossing
- Isolated Ponds

Appendix L. Digital Copy of the Report and Video Documentation