



**CENTRAL
OKANAGAN LAKE
FORESHORE INVENTORY
AND MAPPING**

PART III

TECHNICAL ADDENDUM

REPORT PREPARED BY Regional District of Central Okanagan Planning Services Department
Brent G. Magnan, Environmental Technologist
Todd W. Cashin, Environmental Coordinator

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The project methodology was compiled from several recognized and standardized sources including Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards (Resources Inventory Committee, 1999a) and SHIM (Mason and Knight, 2001). Development of the methodology was guided by a need to inventory a large study area with limited resources.

Sources

Maps and orthophotos of the study area were acquired for photo interpretation and general background information. These were Terrain Resource Information Management (TRIM) map sheets and orthophotos 082E.072, 082E.073, 082E.082, 082E.083, 082E.093, 082L.003, 082L.013, and 082L.023. TRIM maps at 1:5,000 scale were prepared to provide an overview of the Okanagan Lake foreshore and to delineate preliminary segment breaks. Segments are defined as linear sections of lake shoreline that have similar characteristics including: shore type, substrate, riparian vegetation, land use, modifications, and density of development. TRIM maps included regional zoning, cadastral, and stream (SHIM and TRIM 2) information that would be used during the field component.

Pre-field Assessment

Differential GPS data were collected using a Trimble GeoXT handheld GPS receiver. The GPS receiver was configured according to standard SHIM methodology. Both position and attribute data were captured simultaneously via the data dictionary, which provides a structure for the data. The data dictionary has been designed based on SHIM methodology and refined through previous foreshore mapping projects. Field cards were designed to facilitate data collection by several individuals at once during the field component (Appendix D). This increased the amount of data that could be collected, minimized collection time, and enhanced quality assurance within the database.

Field Assessment Foreshore Data Collection

Four field technicians collected the data. Their duties included operating the GPS and completing the data dictionary, completing pre-determined site cards (would later be input into the database), collecting information describing foreshore modifications within each segment, and collecting digital video data. As the boat followed the shoreline, the team divided the foreshore into segments based on the boundaries of contiguous shoreline morphology and land use characteristics.

For each segment, detailed information was recorded describing existing shore type, land use, riparian condition, shoreline substrate composition, littoral zone, modifications, and disturbance level. A minimum segment length of 100 m was set to ensure classification did not interfere with project efficiency. Optimal boat speed was 4 knots, as determined by time and video quality constraints, as well as study area size. Optimal boat distance from shore was 60 metres; however, boat distance varied because of undulation of the shoreline, water depth, littoral zone width (the distance from the watermark on shore to the end of the shelf in the lake), and presence of log booms, docks, and aquatic vegetation.

Video and Photographic Data Collection

A Cannon GL-1 video camera was used to take digital video of the entire foreshore simultaneously with the foreshore data collection described above. The video technician captured images in Digital Video (DV) format (frame size 720 x 486). GPS positional data (latitude and longitude), time (GMT), date, heading (degrees), and speed (knots) were projected from a Magellan handheld GPS onto the video image using a Seaviewer Sea-Trak GPS overlay device. The resulting analogue image was recorded using a Sony TRV-900 video camera providing the basis for subsequent video management.

The video was recorded to achieve approximately one mature tree height within the view. Segment breaks were recorded on the video based on time (PST) and field identifiers such as major changes in shore type, land use, and modifications. These breaks correspond to segments identified within the database. Representative digital photographs were taken for each segment using a Kodak DC5000 digital camera. Representative photograph numbers can be found within the Arcview shapefile 'lake_shore.shp' under the field heading 'Rep_photo'. Photo descriptions can be found under the field heading 'Photo_log' in the same database (Appendix D).

Logistics, Weather and Other Considerations

Conditions were calm and clear during the survey, with the exception of light northerly winds in the afternoons. Wave heights were minimal; however, some segments had marginally poor wind and wave conditions. Two GPS problems were encountered during the survey. On June 22, 2004, a recurring error in the NMEA output caused random letters and numbers to be momentarily output in the time, date, and coordinate locations of the video stamp.

The coordinates, time, and date were verified during the incident using the GeoXT handheld GPS unit and were found to be correct at all other times during the day. The problem was corrected by projecting GPS information from a Magellan handheld GPS unit. On June 24, a system failure occurred with the handheld GeoXT GPS unit used to collect the foreshore information. A replacement unit was used to complete the project.

Data Management Trimble GPS Data Processing

Differential correction of the raw GPS files (.ssf) was performed upon completion of the field component. GPS files were managed using Trimble Pathfinder Office software according to standard SHIM protocol (Mason and Knight, 2001). The GPS data were post processed using source data from SOPAC (Scripps Orbit and Permanent Array Center), Dominion Radio Astrophysical Observatory in Penticton, BC. The rover files were exported to shapefile format (.shp) useable in the ESRI GIS platform.

Data management was performed using ArcView 3.2 via the SHIM ArcView extension. Individual segments were extrapolated from the GPS data (boat centreline) and transferred onto the existing TRIM 2 shoreline location with the aid of local cadastral maps and orthophotos. The database was then populated with additional information collected on site cards during the field survey. Select information was added to the database subsequent to the field phase of the project. This information includes:

- land use, which was referred to from local zoning bylaw maps to determine percent composition per segment;
- littoral width, which was obtained using orthophotos; and
- docks and groynes per kilometre, which were calculated from the database.

Raw digital videotapes were transferred to computer in .AVI format and encoded into MPEG2 format (frame size 640 x 480). The video was broken into 165 files corresponding with the foreshore segments, and it was then compiled on nine DVDs that can be found in Appendix C.

Foreshore parameters were collected and input into a data dictionary, which is the medium for entering data into the foreshore database via the GPS unit. The results were then compiled in an Arcview accessible database (Appendix D – Lakeshore.shp).

The existing data dictionary and database have been under revision since projects on Osoyoos, Christina, and Kootenay lakes, which began in 2002. Deliberation with DFO and partnering agencies has guided this process in determining the scope of information to be collected and its applicability to successful lakeshore management. Sections of the database that describe land use have been adopted based on regional Official Community Plans from partnering agencies. A detailed description of the database, including column headings and descriptions can be found in Appendix A.

The objectives of quality assurance are:

- to ensure the database is consistent, attributes are classified correctly, and percent compositions are comparable within the database; and
- to ensure the database entries are repeatable based on the methodology provided.

The accuracy of the database was maintained through the following:

- Key technical staff were consistent throughout the field component of the project to ensure data capture methods were comparable.
- New technical staff were briefed on specific duties as part of the field component.
- Data management and reporting were performed by key staff from the field component of the project.

Arcview Data Processing

Video Processing

Database Development
and Refinement

Quality Assurance

Quality Control

Quality control was performed by key technical staff responsible for the field and data management portions of the project. All video segments were reviewed in detail and compared to the information presented in the database. Where discrepancies were found, the database was amended appropriately. All video segments were also reviewed to ensure they matched delineated segment breaks in the Arcview Lake_shore.shp shapefile. In addition, the report was edited for content by partnering agencies.



Methodologies

We recommend that a formal set of lake shoreline inventory mapping methodologies be developed under consultation with the Community Mapping Network (CMN). These methodologies would provide a standardized procedure for collecting detailed information in support of local planning, stewardship, and environmental protection of lake shorelines in British Columbia. The methodologies would be based on the current SHIM and Coastal Shoreline Inventory Methodology (CSIM) available through the CMN.

We propose that the lake shoreline methodologies are refined to include the following information:

- Littoral depth – This is especially useful when determining quality of kokanee spawning habitat in proximity to escape cover.
- Subsurface substrate composition – Beach grooming activities have altered the substrate composition of the foreshore, making it difficult to determine status of subsurface spawning materials used by a variety of fish species. Detailed substrate composition would also help in identifying areas sensitive to siltation or areas prone to excessive siltation.
- Retaining wall percentage – This is the percentage of the total segment that is fronted by retaining wall above and below the high water mark.

Digital Video

The following recommendations are intended to improve the quality of video that is collected during a survey:

- Replace analogue video stamp, which is known to degrade picture quality. GPS coordinate information should be collected on a separate medium (i.e., additional video track) to ensure highest quality video.
- Synchronize clock on camera with GPS clock for ease of managing video data.
- Capture field information on audio track for ease of delineating segment breaks.
- Use maximum boat speed of 4 knots along straight shorelines and of <4 knots where the shoreline is undulating. This reduces camera swing.
- Keep the sun opposite the camera shooting direction to ensure consistent video quality. Video quality is often best when taken in the morning or evening.
- Use an additional viewing monitor on board the boat to allow real-time viewing of the video.
- Take video after full leaf-out in the spring or before senescence in the fall to ensure deciduous vegetation is easily identifiable on the video.
- Assess and plan around lake conditions during the field component because wind and wave action affect video quality.



Summary descriptions and disturbance level (DL) of each segment can be found below. Segment locations can be found in map format in Appendix E. See Part I for descriptions of DL.

Segment 1 – DL Low

Shore type in this segment is primarily cliff/bluff (70%) mixed with low rocky shore (20%) and gravel beaches (10%). The undulating rocky topography encloses small gravel coves with deciduous riparian vegetation. The segment remains undisturbed by humans; however, it was burned substantially in 2003. Most of the conifers remain healthy. The gap between segments 1 and 2 is represented by Crown provincial land and was not surveyed.

Segment 2 – DL Low

Although this segment is largely unaltered (80% natural), limited disturbance has occurred throughout, including modifications to upland areas (few modifications exist along the foreshore). Development has mostly occurred away from the foreshore, on top of small bluffs or on steeper rocky slopes. Shore type is primarily cliff/bluff (70%) with small amounts of low rocky shore and gravel beach. As in segment 1, small riparian ecosystems are found in gravel coves and on alluvial fans of streams such as Wild Horse Creek. Upland vegetation includes coniferous forest broken by large patches of native grassland. This segment was also burned in 2003.



AREA 1

RDCO South Slopes Segments 1 - 3

The South slopes area remains largely unaltered, with limited disturbance associated with rural development as seen in segment 2.

Photo: T. Cashin

Segment 3 – DL Low

This segment coincides with the alluvial fan of Deeper Creek. Shore type is entirely gravel beach. Although a small buffer exists along the foreshore, the majority of the riparian vegetation has been cleared for agriculture. Larger, natural patches of mature cottonwoods still remain, especially at the western end of the fan. Shore type is entirely gravel beach interspersed with modified boulder sections.

Segment 4 – DL Low

Segment 4 remains entirely natural, although it was affected extensively by the 2003 fire. Foreshore type is primarily cliff/bluff (75%) with smaller amounts of low rocky shore and gravel beach interspersed. Upland vegetation includes open grasslands as well as partially burned coniferous stands. Small shrubs and pockets of riparian vegetation remain along the foreshore where substrates are not dominated by bedrock.

Segment 5 – DL Moderate

Shore type in this segment is characterized by cliff/bluff (50%) with smaller amounts of low rocky shore (30%) and small coves with gravel beach (20%). Land use is primarily rural (70%), with some areas occurring within the agricultural land reserve. The segment remains primarily natural (60%) with isolated modifications occurring throughout. Where development has occurred near the shoreline, the foreshore is altered significantly by both retaining walls and docks (12 docks/km).

Segment 6 – DL Moderate

This segment coincides with Bertram Creek Regional Park. It consists of steep shorelines with cliff/bluff (50%), gravel beach (20%), sand beach (20%) and low rocky shore types (10%). Gravel and sand beach areas have been groomed and are used for recreation activities. Importing sand is common. Upland vegetation was altered by the 2003 fire and by the removal of hazard and danger trees within the park. Few modifications exist in this segment with the exception of a single dock and viewing platform.

Segment 7 – DL Moderate

In this rural segment, the foreshore has been altered extensively around developed areas. Shore type is primarily cliff/bluff (60%), gravel beach (30%), and low rocky shore (10%). Larger lots provide riparian buffering between residences near both ends of the segment, while alterations around smaller lots have affected the foreshore in the remainder of the segment.

Retaining walls and docks (11 docks/km) are found in association with such development. Portions of the segment have been heavily modified with riprap along the shoreline, such as near the east end. Areas of native riparian vegetation do exist, although they are isolated.

Segment 8 – DL Moderate

This rural segment exhibits heavily disturbed, large residential lots buffered by sections of natural, undisturbed foreshore. Where modifications do exist, they occur in association with residences and include docks (15 docks/km) and retaining walls. Natural sections are mixed forest (coniferous and broadleaf) with shore type that is dominated by gravel beach (45%) and low rocky shore (35%). This segment contains the southern half of the Lebanon Creek alluvial fan.

Segment 9 – DL High

This rural segment is highly disturbed (95%) by small residential developments. Riparian vegetation has been removed and replaced with groomed grasses and shrubs. Foreshore alterations are extensive as docks are found in association with most lots (32 docks/km). Shore type is predominantly sand beach, although retaining walls (concrete and rock) have reduced the amount of natural shore type remaining.

Segment 10 – DL High

This segment is entirely park and has been heavily disturbed (80%). The majority of overstorey riparian vegetation has been removed, although isolated pockets of broadleaf species remain, especially in the eastern end of the segment. Shore type is dominated by gravel beach (70%), but several small isolated sections of vegetated shoreline remain. Primary modifications include concrete steps which extend into the water. Although disturbance is found throughout this segment, there is potential for rehabilitation as there are few permanent structures along the foreshore. Domestic animals frequent this section of shoreline, as it is one of the City of Kelowna dog parks.

Segment 11 – DL High

This segment is characterized by continuous residences and is highly disturbed. Natural riparian vegetation has been removed. Shore type is predominantly gravel beach (60%), with more sand beach (40%) being found at the eastern end of the segment where beach grooming is common. Modifications are found throughout including a large number of docks (30 docks/km) and retaining walls.

Segment 12 – DL High

Segment 12 is primarily disturbed (70%), although many intact sections of foreshore and riparian vegetation remain. Residential development has occurred on top of the steep hillside adjacent to this segment. Foreshore modifications are limited to isolated beach access sites that include staircases, boathouses and docks (24 docks/km) and retaining walls (many below the high water mark). Shore type is a mix of low rocky shore (35%), vegetated shore (35%), gravel beach (20%), and sand beach (10%). Beaches consisting of fine substrate materials are likely a function of long-term beach grooming activities.

Segment 13 – DL Moderate

This rural segment remains mostly natural (70%); large tracts of riparian vegetation are unaltered throughout much of the area. Shore type is primarily vegetated shore (90%) with small amounts of gravel beach (10%). Foreshore modifications include few docks (8 docks/km) and retaining walls that are found in association with riparian disturbance. An eroding bank was observed and identified as a potential sediment source. Rembler Creek is tributary to Okanagan Lake mid-segment. Although riparian disturbance is limited to isolated sites, disturbance is high within these sites.



Sediment source observed
in Segment 13.

Photo: T. Cashin

Segment 14 – DL High

This segment is characterized by highly developed urban residential land use. The south end of the segment is more natural with residences set back from the foreshore. Impacts to riparian vegetation become more apparent in the northern sections of the segment. Shore type is primarily sand beach (90%) with small amounts of vegetated shore (10%). This segment is influenced by the Bellevue Creek alluvial fan, which is located at the northern end of the segment. Modifications are extensive with a high number of docks (20/km) and retaining walls throughout.

Segment 15 – DL High

This segment begins at the mouth of Bellevue Creek. The foreshore of this segment is highly disturbed (100%) with residential development occurring immediately adjacent to the foreshore. Modifications are found extensively throughout; most residences exhibit large continuous retaining walls, many of which extend below the high water mark. Beach grooming is common, riparian vegetation has been completely removed, and large marinas and docks (19 docks/km) are found adjacent to one another.

Segment 16 – DL High

This segment has been highly affected through residential development (95% disturbed). The majority of riparian vegetation has been removed, although three small patches of natural shoreline still exist. Shoreline modifications are extensive with many retaining walls (extending below the high watermark) and docks (23 docks/km). Shore type is primarily gravel beach (90%), with some areas being exclusively sand where beach grooming has occurred. The littoral zone is shallow, averaging 150 m.

Segment 17 – DL High

This segment is influenced primarily by the Mission Creek alluvial fan. The shore type is entirely sand beach, which has been highly disturbed (90%). Residential development has occurred immediately adjacent to the foreshore, and most riparian vegetation has been removed, although some mature conifers remain. Modifications are extensive including docks (20/km) and retaining walls. The northern end of this segment is delineated by the mouth of Mission Creek. The littoral width of this segment averages 250 m, but varies greatly (the southern half of the segment exhibit littoral widths of >400 m, while the northern half exhibits widths of approximately 100 m).

Representative foreshore type—Sandy beach. Often associated with alluvial fans or other shoreline deposition areas as seen in Segment 17.

Photo: T. Cashin



Segment 18 – DL High

The foreshore in this segment has been entirely disturbed. High-density commercial development occurs immediately adjacent to the foreshore. Riparian vegetation has been completely removed, while modifications include several marinas, a public boat launch, docks (14/km), retaining walls and imported beach material. Foreshore materials have been altered throughout. Shore type is classified as sand beach; this segment contains a substantial sand bar at the confluence of Mission Creek. The littoral width in this segment averages 150 m.

Foreshore material being moved on site during development in Segment 18.

Photo: T. Cashin



Segment 19 – DL High

The foreshore of Rotary Park has been heavily disturbed (100%). Most of the riparian vegetation has been removed; understory vegetation is dominated by groomed grasses. There are no modifications and only one permanent structure (public restrooms) in this segment. The littoral zone on this sand beach shore type is shallow (>200 m).

Segment 20 – DL High

Residential development occurs immediately adjacent to the foreshore on this sand beach shore type. Most riparian vegetation has been removed; however, some mature deciduous trees remain. Modifications include a large number of retaining walls and docks (over 32 docks/km), which is one of the highest densities in the study area. The littoral zone in this segment is shallow (>200 m).

Segment 21 – DL High

Riparian vegetation on the foreshore of Gyro beach has been completely removed for recreational purposes. The sand beach shore type has been groomed extensively and extends approximately 25 m upland. Some remnant riparian vegetation remains set back from the foreshore amongst groomed grasses and pathways.

Segment 22 – DL High

A high-density condominium development occurs adjacent to the foreshore of this segment. Modifications include a continuous retaining wall and complete removal of riparian vegetation. The littoral zone is extremely shallow and extends 600 m into the lake.

Segment 23 – DL High

This urban residential, sand beach segment is almost entirely disturbed (95%). Modifications include many docks (20/km) and retaining walls. The littoral zone is shallow and extends 400 m into the lake.

Segment 24 – DL High

This segment is characterized by a high-density condominium development adjacent to the foreshore. A continuous retaining wall separates the development from the beach. Some mature deciduous trees remain along the beach, although understory vegetation has been removed.

Segment 25 – DL High

This segment has been entirely disturbed by residential development, although riparian vegetation still remains adjacent to some areas of the foreshore. Modifications include docks (32/km) and continuous retaining walls. Shore type is sand beach. The littoral zone is shallow and extends into the lake approximately 250 m.

Segment 26 – DL High

This segment corresponds with Strathcona Park, which has been modified extensively. A continuous retaining wall spans the entire segment below the high water mark, and most of the riparian vegetation has been removed. Some remnant mature deciduous trees do remain upland. Shore type is classified as sand beach despite the presence of the retaining wall.

Segment 27 – DL High

Segment 27 is a small sand beach located between a natural and a heavily modified segment. Although this segment is heavily disturbed, vegetation is found throughout the shoreline including below the high water mark. Residential development, retaining walls, and docks (10 docks/km) are all found within this segment.

Segment 28 – DL Low

This segment coincides with Maude Roxby bird sanctuary, which is characterized by its vegetated shore type with abundant cover and healthy riparian vegetation. This segment is classified as natural (95%), although many of the riparian species are non-native. Boardwalks adjacent to the foreshore allow public access throughout. A substantial backwater area is located within the segment. The littoral zone is shallow in this segment, averaging 160 m. Erosion was noted amongst the vegetation.

Segment 29 – DL High

This segment is characterized by a combination of high-density condominiums and residential units. The foreshore on this sand beach shore type has been modified extensively. Continuous retaining walls and removal of riparian vegetation are found throughout. Lake infilling has occurred along the condominium development; the only over-water structure in the segment is a marina associated with the condominium. Disturbance to this segment is high (100%).

Segment 30 – DL High

This segment coincides with Kinsman Park. Shore type is sand beach (100%); most of the riparian vegetation has been removed. Several remnant deciduous trees remain and modifications are minimal. No permanent structures are located along the foreshore. The littoral zone is shallow, averaging 175 m.

Segment 31 – DL High

This residential segment has been heavily disturbed (100%). Riparian vegetation removal and foreshore modifications such as retaining walls and docks (17 docks/km) occur throughout. Few remnant coniferous and deciduous trees remain. Several public beach access points are found in this segment. The littoral zone is shallow, averaging 150 m. The northern end of this segment is delineated by the confluence of Mill Creek.

Segment 32 – DL High

This recreational segment coincides with City Park and includes the fill slope associated with the Okanagan Lake floating bridge. Most riparian vegetation has been removed on this sand beach shore type, although some remnant deciduous trees remain along the foreshore. Modifications are limited to beach grooming activities. There are few permanent structures located along the foreshore.

Segment 33 – DL High

Also coinciding with City Park, this segment has been heavily disturbed and modified. All riparian vegetation has been removed and replaced with groomed grass. Although this segment is classified as sand beach, a continuous retaining wall with public boardwalk spans the entire segment, which is located below the high water mark.

Segment 34 – DL High

Segment 34 coincides with the Kelowna Yacht Club marina. Land use is primarily institutional (70%) with modifications including a continuous retaining wall and boardwalk. Shore type is considered sand beach, although it is not apparent as the retaining wall exists below the high water mark. A significant log breakwater borders the marina.

Segment 35 – DL High

Segment 35 is dominated by park and has been heavily disturbed (100%). Modifications include a boat launch, a continuous riprap retaining wall associated with lake infilling, and a public board walk. Historically, the shore type in this segment would have been sand beach, but this is not visible due to the modifications mentioned.

Segment 36 – DL High

This segment is dominated by sand beach and used primarily for recreation. Significant high-density development has occurred beyond the foreshore. Modifications include beach grooming (and infilling), complete riparian vegetation removal, and a continuous retaining wall set well above the high-water mark. There are no permanent structures found immediately adjacent to the foreshore.

Segment 37 – DL High

This segment is considered park and has been heavily modified by the construction of the Rotary Trail marsh complex. Significant lake infilling has occurred in creating this marsh system, which includes a substantial backwater and trail system at the mouth of Brandt's Creek. Shore type is classified as sand beach, although significant modifications have occurred including riprap armouring of the entire shoreline. Riparian planting has occurred adjacent to the shoreline, but most of the shrubs and trees are immature.

Segment 38 – DL High

The shore type in this segment is primarily sand beach (90%) with a small amount of wetland (10%) found immediately south of Manhattan Point. Residential development occurs throughout this segment with modifications including docks (14/km) and retaining walls. A significant amount of lake infilling has occurred at the end of Manhattan Point, which has been retained by a concrete wall. Native riparian vegetation has been removed, although a few large deciduous trees remain, most of which are non-native. The littoral zone is shallow in this segment (approximately 200 m) and aquatic vegetation is abundant throughout.

Segment 39 – DL High

This segment has been substantially affected by Tolko Industries Ltd. mill site. Land use is considered industrial; the entire segment has been heavily disturbed (100%) and a retaining wall is found along the entire foreshore. Shore type is considered sand beach because subsurface substrate materials are primarily fines. A large log boom exists along this segment. Aquatic vegetation is found throughout, mostly in shallow areas adjacent to the foreshore.

Segment 40 – DL High

Sutherland Bay is a small park that is sheltered from prevailing winds from the south (due to the log boom at Riverside Mill) and from the north by Poplar Point. As such, it is a popular area for mooring boats. Shore type consists of sand beach (30%) to the south and vegetated shore (70%) to the north. Evidence of erosion is found throughout, especially in the northern sections where most riparian vegetation has been removed, but several isolated patches of immature riparian vegetation remain. A continuous retaining wall exists on the most northerly end, although it is deteriorating. Lake infilling has facilitated the location of Poplar Point Drive adjacent to the lakeshore.

Segment 41 – DL High

The southern boundary of this segment is defined by Poplar Point. It is characterized by residential land use and a large number of modifications such as docks (22/km), retaining walls and extensive riparian vegetation removal, although a few remnant pine trees remain. Shore type is exclusively gravel beach with limited coarse material, which is related to infilling or the presence of various types of retaining walls. Residences occur adjacent to the foreshore with very little setback distance.

Segment 42 – DL Moderate

The shore type in this residential segment is primarily cliff/bluff (80%); beach access from adjacent properties is limited by staircases to small gravel beach (20%) coves found between rock bluffs. Most of this segment remains natural because most development has been set back from the foreshore. Modifications include a large number of docks (22/km) and a few retaining walls.

Segment 43 – DL High

This segment has been highly affected by the water intake facility adjacent to the foreshore. Shore type is classified as cliff/bluff based on what would have occurred before a substantial amount of lake infilling was done to facilitate site development (cliff/bluff was observed adjacent to the site). Riparian vegetation has been removed and replanted with a few immature trees. A riprap retaining wall is found along the entire segment.

Segment 44 – DL Low

The southern part (60%) of this segment corresponds with Knox Mountain Park, while the northern section (40%) is rural. A combination of cliff/bluff (70%), gravel beach (15%), and low rocky shore (15%), this segment remains entirely natural. Riparian vegetation is primarily small pockets of deciduous vegetation along the lakeshore and mature coniferous trees on top of the small cliffs and hillsides.

Segment 45 – DL Moderate

The residences in this rural segment are set back from the foreshore leaving access to the water via small walking trails only. This segment represents a prime example of minimizing foreshore disturbance while not limiting access to residences. Riparian vegetation is abundant and has been retained throughout. Modifications include docks (15/km), boardwalks, retaining walls, and boathouses situated between rocky bluffs and cliffs.

Segment 46 – DL Low

The shore type in this undisturbed segment is dominated by cliff/bluff (70%). Large rock bluffs line the foreshore with isolated gravel beaches and riparian vegetation in between. Land use is rural. Modifications are limited to one small discontinuous retaining wall in this segment. Kokanee actively spawn throughout this segment.

Segment 47 – DL Low

Segment 47 is dominated by gravel beach (60%) with isolated patches of vegetated shore (35%) and cliff/bluff (5%). Steep hillsides are found throughout with disturbance limited to the northern end of the segment where trees have been cleared from the adjacent hill slope. Deciduous vegetation lines the foreshore where gravel substrates are present.

Segment 48 – DL Low

This rural segment is primarily natural (90%). Cliff/bluff dominates the shore, so riparian vegetation is limited. A small amount of disturbance has occurred in association with a single residence. At this site, substantial infilling of the foreshore has occurred to provide a flat site for recreation adjacent to the lakeshore.

Segment 49 – DL Low

The shore type in this natural segment is primarily vegetated shore (70%) with small amounts of gravel beach (20%) and cliff/bluff (10%). Riparian vegetation is abundant along the shoreline with little disturbance. The only modification is remnant dock pilings located at the northern end of the segment.

Segment 50 – DL High

The shore type in this large segment is primarily low rocky shore (45%) with smaller amounts of gravel beach (35%) and cliff/bluff (20%). Although land use is rural, the segment has been substantially disturbed (80%) by residential development. Access to the lakeshore is limited by steep, rocky hill slopes, although recreational development along the foreshore is found throughout. Modifications are intensive including docks (23/km), groynes, and riparian vegetation removal. Most large substrate materials have been removed and used for retaining walls and groynes. This has generally been associated with lake infilling behind the retaining walls. Boat and beach houses are common, some of which are built below the high water mark. Several sediment sources were observed in association with recent residential development.



Sediment source in Segment 50.

Photo: T. Cashin

Segment 51 – DL Low

This rural segment remains mostly natural with only 20% of the foreshore being disturbed. Shore type varies substantially and includes cliff/bluff (40%), gravel beach (20%), vegetated shore (20%), and low rocky shore (20%). Riparian vegetation is sparse, except in isolated areas between rock bluffs. Residences are well set back from the foreshore; lake access from residences is limited to small pathways. Modifications include docks (6/km) and beach grooming activities. Recent residential development has resulted in a small amount of lake infilling near the north end of the segment.

Segment 52 – DL Low

This segment remains mostly natural (70%); historical disturbance is evident where an old road runs parallel to the foreshore. Shore type is dominated by vegetated shore (50%), gravel beach (45%) and cliff/bluff (5%). Riparian vegetation is abundant, except where removed on the road location, although active re-vegetation is occurring here. No other modifications exist in this segment.

Segment 53 – DL Low

The foreshore in this rural segment remains natural (90%), except for several residential developments located at the south end of the segment. Modifications in these areas include a single retaining wall and dock. Other foreshore alterations include a boat slip blasted into the adjacent bedrock. Shore type is varied between vegetated shore (40%), cliff/bluff (30%) and low rocky shore (30%).

Segment 54 – DL High

This segment has been heavily disturbed (80%) by residential development. Only one isolated section of intact foreshore remains near the southern end of the segment. Shore type is primarily gravel beach, although heavy modifications to the foreshore have altered most of the shoreline. Modifications include docks (22/km), retaining walls (many below high water mark and associated with lake infilling) and boathouses. Riparian vegetation has been largely removed and replaced with non-native species and groomed grass. Older developments, such as those at the north end of the segment, have had substantially less impact on the integrity of the foreshore than the newer developments to the south.

Segment 55 – DL Low

This rural segment remains primarily natural (85%) with several small developed areas at the northern end. Shore type is primarily cliff/bluff with small amounts of gravel beach (20%) and low rocky shore (20%). Riparian vegetation is sparse as bedrock dominates the shoreline substrate. Grassland and sparsely vegetated coniferous forest are found on top of the rock bluffs. Modifications are minimal and limited to several docks.

Segment 56 – DL High

Development in this segment is mainly limited to walk-in cabins accessed from upland areas. Shore type is a combination of gravel beach (60%) and cliff/bluff (40%). Many residential developments are found along the foreshore, especially in areas where rock bluffs are not prominent. Riparian vegetation has been removed in isolated areas, although patches of natural vegetation remain, mostly associated with gravel beaches. Modifications include retaining walls and docks (24 docks/km). Recent development has allowed access to the foreshore in several areas and has significantly changed the upland areas.

Segment 57 – DL Low

This segment remains almost completely unaltered with the exception of the Hiram Walker pump house located in the southern portion of the segment. Shore type is primarily cliff/bluff (70%) with lesser amounts of gravel beach (15%) and low rocky shore (15%). Riparian vegetation is naturally limited by the coarse foreshore materials. Modifications are limited to one dock.

Segment 58 – DL High

This segment has been highly affected by rural development. Shore type is primarily vegetated shore (80%) and low rocky shore (20%), which was determined from several small natural sections that remain. Large concrete retaining walls are found in several areas, which have been backfilled to create private residential lawns with little or no riparian vegetation. Other modifications include docks (12/km).

Segment 59 – DL High

This segment has been heavily disturbed by agricultural practices. It is located on an alluvial fan, so shore type is gravel beach. Most of the riparian vegetation has been removed from the foreshore, although remnant trees remain. A significant amount of erosion has occurred in the northern portion of the segment where all riparian vegetation has been removed. No permanent structures or modifications exist on this segment, which make it a potential candidate for a foreshore restoration project.

Segment 60 – DL Low

The foreshore in this natural segment is considered Crown land as it is located in a road right-of-way. As such, limited impacts have occurred in this segment. Shore type is primarily vegetated shore (60%) and gravel beach (40%). Riparian vegetation remains intact throughout, although much of it is not mature. Modifications include several small buildings (sheds) and docks (6/km). Beach grooming has occurred in areas where access grants recreation opportunities.

Segment 61 – DL High

This segment coincides with Safe Harbour Regional Park. A significant moorage facility and boat launch exists in this segment. The moorage area is protected by a vertical log breakwater. Shore type is gravel beach, and the riparian vegetation has been completely removed.

Segment 62 – DL Low

This natural segment is considered Crown land, as it is located in a road right-of-way. As such, limited impacts have occurred in this segment. Shore type is primarily gravel beach (60%) and vegetated shore (40%). Riparian vegetation remains intact throughout, although most deciduous vegetation is immature. Modifications are limited to a few docks (4/km). Riparian clearing and beach grooming have occurred in association with areas frequented for recreation (picnic tables, fire pits, etc.).

Segment 63 – DL High

This small segment has been highly disturbed by residential development. Riparian vegetation has been completely removed and replaced with manicured lawns and non-native species. One small natural patch of foreshore remains at the northern end of the segment. Shore type is gravel beach. Modifications include docks (26/km) as well as a single boat launch.

Segment 64 – DL Low

This natural segment is considered Crown land as it is located in a road right-of-way. Shore type is primarily gravel beach (60%) and vegetated shore (40%). Riparian vegetation remains intact throughout, although most deciduous vegetation is immature. Modifications are limited to a few docks (7/km). Riparian clearing and beach grooming have occurred in association with areas frequented for recreational purposes (picnic tables, fire pits, etc.).

Segment 65 – DL High

This small segment has been highly disturbed by residential development. Riparian vegetation has been removed and replaced with non-native tree species associated with large homes built adjacent to the foreshore. One mature cottonwood stand remains mid-segment. Several rock and concrete retaining walls were observed, and docks are common (20/km). Shore type is predominantly gravel beach.

Segment 66 – DL Low

Shore type in this natural section is vegetated shore with no disturbance occurring from the adjacent agricultural activities. A riparian buffer of approximately 50 m remains, making this one of the few pristine shoreline areas in the District of Lake Country. Riparian vegetation is healthy and intact with a variety of age classes represented within the stand.

Segment 67 – DL high

This segment has been moderately disturbed (60%) by residential development. Riparian vegetation has been removed in association with residences and replaced with non-native species and groomed grass. Patches of natural riparian vegetation remain isolated between larger residential lots. Shore type is gravel beach. Modifications are limited to several large retaining walls and a few well-spaced docks.

Segment 68 – DL Moderate

Shore type in this rural segment is primarily vegetated shore (7%) and gravel beach (30%), although disturbance has altered this shore type throughout. Many residences in this segment are set back with natural riparian buffers, while others have removed all vegetation. Generally, large patches of riparian vegetation remain as most of the segment is left undisturbed (70%). Modifications are limited to a few dock structures and retaining walls and beach grooming activities.

Segment 69 – DL High

This segment has been heavily disturbed by residential development. Many residences are close to the foreshore. Riparian vegetation has been removed or replaced with non-native species and groomed grass. Docks (21/km) are abundant throughout, and retaining walls are found throughout the segment.

Segment 70 – DL Moderate

The shore type in this segment is dominated by cliff/bluff (90%) interspersed with gravel beach (10%) naturally occurring in small coves. Most of the residential development occurs on top of the many cliffs and has little direct effect on the integrity of the foreshore, which remains approximately 70% natural. However, alterations have substantially affected the foreshore, including docks (16/km) and small boat or beach houses located immediately adjacent to the shoreline.

Segment 71 – DL High

This segment is characterized by low-lying gravel beach, which extends into a steep hillside. Development has been set back from the foreshore, occurring on top of the hillside. Riparian vegetation varies with level of disturbance. In many areas, riparian vegetation has been removed and replaced with grass and non-native trees. Where natural vegetation remains, it occurs in isolated pockets. Modifications include docks (25/km) and retaining walls throughout.

Segment 72 – DL Low

This segment remains primarily natural (70%), with steep hillsides or cliff/bluff (70%) and gravel beach (30%) occurring on the foreshore. Riparian vegetation is found in small patches between cliff areas and has had limited disturbance. Modifications are minimal and limited to several docks, storage sheds, and stairway access points. Beach grooming has occurred in association with beach access points.

Segment 73 – DL Moderate

Shore type in this segment is primarily vegetated shore (80%) with a small amount of gravel beach (20%). Riparian vegetation has been moderately disturbed (60%), although larger patches of natural riparian vegetation still remain. This vegetation acts as a buffer from agricultural practices that occur adjacent to the segment. Foreshore integrity is high with no permanent modifications (other than vegetation removal).

Segment 74 – DL Moderate

This primarily rural segment has been heavily disturbed (70%), especially in the northern end of the segment where property size decreases and development occurs closer to the foreshore. Riparian vegetation has been altered throughout, although large patches of vegetation remain, especially in the southern half of the segment. Shore type is primarily gravel beach (60%) with vegetated shore (40%). Modifications include docks (18/km), retaining walls, marine railways, and boat launches.

Segment 75 – DL Moderate

The gravel beach foreshore in this segment is primarily natural (60%). Riparian vegetation remains unaltered in the southern sections, although removal has occurred at the northern end of the segment in conjunction with recreational use of the Girl Guide camp. No structural modifications to the foreshore have occurred.

Segment 76 – DL Moderate

This small rural segment corresponds with several developed lots along the foreshore. Disturbance is moderate (40%); substantial riparian vegetation remains between residences. Modifications include docks (17/km) and discontinuous retaining walls.

Segment 77 – DL Low

Shore type in this segment is primarily vegetated shoreline (40%), although smaller amounts of gravel beach (30%) and cliff/bluff (30%) occur (cliff/bluff occurs in the southern end of the segment only). This segment remains largely undisturbed (90%) with the exception of recent development in the southern end, which includes riparian removal and blasting of rock bluffs to provide road access to the foreshore. Riparian vegetation remains intact in the undeveloped areas.

Segment 78 – DL Moderate

This segment roughly coincides with Kopje Regional Park. The foreshore remains primarily natural (60%), although riparian removal and beach grooming have occurred in association with recreational activities throughout. Shore type is primarily gravel beach (60%) with smaller amounts of vegetated shore (40%). No modifications are found along this segment.

Segment 79 – DL Moderate

This small segment is characterized by a disturbed riparian buffer located adjacent to agricultural land. Shore type is primarily vegetated shore (60%), except in areas where significant riparian clearing has occurred, leaving gravel beach (40%). The littoral zone is wide and shallow (as compared to surrounding areas). This segment is adjacent to Whiskey Island, which is a large ring-billed gull colony and protected as an ecological reserve.



Island adjacent to Segment 79.
Photo: T. Cashin

Segment 80 – DL High

This segment has been heavily disturbed (90%) by residential development. Shore type is exclusively gravel beach. Riparian vegetation has been altered extensively, having been removed and replaced with non-native species. Many residences are located immediately adjacent to the foreshore. Docks (27/km) and retaining walls are common throughout.

Segment 81– DL Low

Shore type in this rural segment is primarily low rocky shore (60%) and vegetated shore (40%). Disturbance is minimal as over 90% of the shoreline remains natural. A small group of vegetated rock islands are located adjacent to this segment and a small backwater channel exists behind the islands. Riparian vegetation is mostly unaltered with the exception of one development site at the northern end of the segment. Modifications are limited to several docks within the segment.



Small vegetated island adjacent
to Segment 81.
Photo: T. Cashin

Segment 82 – DL Low

This rural segment remains primarily natural (95%). Shore type is classified as cliff/bluff (80%) with small amounts of gravel beach (20%). Riparian vegetation is limited to small gravel areas; coniferous vegetation dominates the remainder of the segment. A prominent rocky point is found midway along this segment.

Segment 83 – DL High

Land use in this segment varies among urban residential, commercial, rural and park. Extensive disturbance (90%) is found throughout this gravel beach shore type. Riparian vegetation has been removed and replaced with non-native trees and groomed grass. Modifications are found throughout including docks (15/km), retaining walls, marine railways, and boat launches. Residences are located immediately adjacent to the foreshore.

Segment 84 – DL High

The southern end of this residential segment is delineated by the Toby Road access point. Disturbance is found throughout with a small amount of natural shoreline (30%) remaining. Shore type is primarily gravel beach (80%) with vegetated shoreline (20%). Disturbance level varies depending on proximity of houses to the foreshore. Modifications include a large number of retaining walls (28), docks (22/km), marine railways, boat launches, and beach grooming activities.

Segment 85 – DL Moderate

This rural segment is primarily gravel beach (70%) with cliff/bluff (30%) interspersed. Development is varied but has mostly occurred adjacent to the foreshore below steep hillsides or on top of cliffs. Riparian vegetation has been removed in areas of immediate development but has been left largely unaltered between residential properties. Modifications such as retaining walls occur where development is immediately adjacent to the foreshore. Docks (17/km) and marine railways are also common.

Segment 86 – DL Low

This rural segment remains almost completely natural (95%) with the exception of one developed site. Shore type is primarily cliff/bluff (85%) with small sections of low rocky shore (10%) and vegetated shore (5%). Riparian vegetation remains unaltered although deciduous cover is isolated on small rocky benches at the foot of steep cliffs. Modifications are limited to a residential development near the southern end of the segment where substantial blasting of the surrounding cliffs and infilling of the lake have occurred.

Segment 87 – DL Low

This natural (90%) segment coincides with the Evely Forest Service Recreation Site (park). Limited impact recreational activities are found throughout. Shore type is vegetated shoreline, which remains largely intact. Small trails and access points to the shoreline are found throughout. Riparian vegetation is limited and is mixed with coniferous species. It appears that overstorey riparian vegetation has been removed, but substantial regeneration is occurring throughout. Modifications are limited to one boat launch.

Segment 88 – DL High

This rural segment has been affected by residential development; approximately 80% of the foreshore has been disturbed, although the disturbance is not intense. Riparian vegetation has been largely removed, but many overstorey coniferous trees remain, including on developed sites. Understorey vegetation has been cleared in association with residences. Substantially less disturbance has occurred in the southern half of the segment where lot sizes are much larger. Shore type is primarily gravel beach (90%) with small amounts of vegetated shore (10%) where disturbance is nil. Modifications include docks (13/km), retaining walls, and lake infilling. Beach grooming has occurred in areas of coarse substrates, promoting the construction of groynes adjacent to residential properties.



Recent retaining wall and lake infilling in Segment 88.

Photo: T. Cashin

Segment 89 – DL High

This rural segment has been affected substantially by development of residences along the foreshore. Approximately 90% of the foreshore has been disturbed, although isolated patches of natural vegetation remain between some residences (undeveloped lots). Shore type is primarily gravel beach. Modifications are abundant with many retaining walls, docks (22/km), and large groynes. Recent infilling of the lakeshore has occurred as well as cut slopes to provide road access to the lakeshore (See photo previous page, Segment 88).

Segment 90 – DL Moderate

The land use in this segment is considered park, which has been highly disturbed (90%) due to a road paralleling the foreshore. Rock fill has been placed along the foreshore to accommodate this road. Riparian vegetation has been largely removed with several remnant trees remaining. Regeneration is occurring, although it appears to be limited by coarse road fill material. Modifications include many beach access points, rock groynes, retaining walls, and a single dock.

Segment 91 – DL Moderate

This segment has been disturbed throughout (75%), although many isolated natural areas remain. Development is largely smaller cabins and summer homes with limited building footprints. Most residences are set back from the foreshore. Shore type is primarily gravel beach (90%) with remnant vegetated shore areas (10%). Riparian vegetation has been disturbed, although many mature deciduous trees remain. Understorey vegetation is removed in association with residential development and replaced with groomed grass. Modifications include many docks (26/km), retaining walls, marine railways, boat launches (8), and beach grooming activities.

Segment 92 – DL High

This rural segment is extremely variable. Many residences are found well set back from the foreshore with minimal disturbance, while other larger homes are clustered along the foreshore. Significant patches of natural foreshore remain isolated between clusters of development. Approximately 50% of the foreshore has been disturbed. Shore type is primarily gravel beach (80%) with a small amount of vegetated shoreline (20%). Modifications are extensive including docks (27/km), retaining walls, groynes, marine railways, boat launches, and beach grooming activities.

Segment 93 – DL Low

This rural segment is 80% natural. Shore type is a combination of vegetated shore (90%) with a small amount of gravel beach (10%). Riparian vegetation is mostly intact and is represented by a variety of age classes. It appears that historical disturbance to the riparian vegetation has removed some of the larger specimens from the disturbed portion of this segment. No modifications exist in this segment.

Segment 94 – DL Moderate

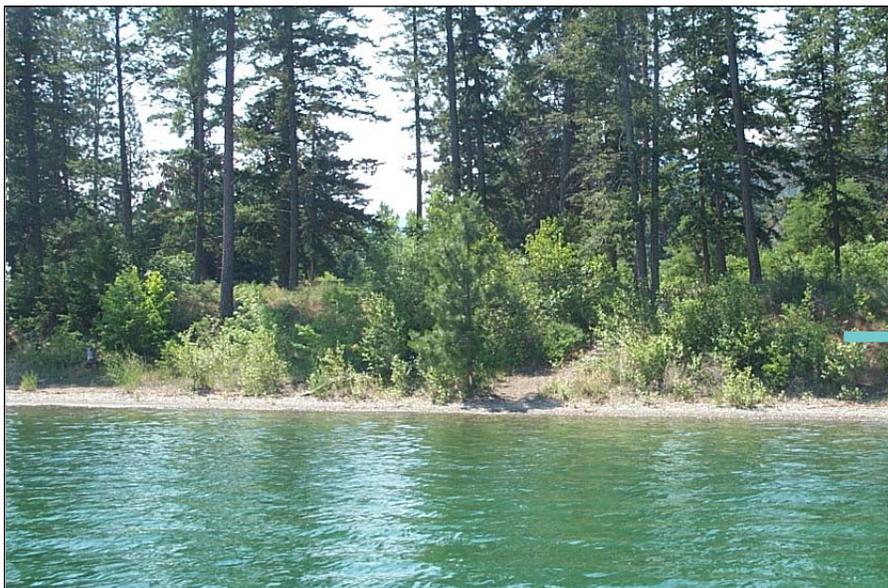
This rural segment is moderately disturbed (60%) with patches of natural shoreline located at the northern end. The southern part of the segment is more disturbed and is located on a small alluvial fan. Shore type is gravel beach (90%) with a small amount of vegetated shore (10%). Modifications include docks (16/km), retaining walls, and groynes.

Segment 95 – DL Low

This rural segment remains almost entirely natural (85%). Disturbance is limited to one primitive road access site onto the foreshore, as well as logging activities that have removed patches of upland vegetation. Shore type is mixed with vegetated shore (40%), low rocky shore (30%), and cliff/bluff (30%). Riparian vegetation is abundant as shrubs and immature trees line the foreshore. Upland vegetation in the southern half of this segment has been affected by fire.

Segment 96 – DL Low

This segment represents the northern half of the Shorts Creek alluvial fan also known as Fintry Provincial Park. Land use is entirely park with limited disturbance (10%) to the foreshore. This disturbance is associated with recreational activities, which are found throughout the northern section of the segment. Large undisturbed gravel beaches are found to the south. Riparian vegetation is healthy and undisturbed. Historical disturbance is associated with a tobacco barn that is found near the tip of the alluvial fan. Many of the mature cottonwood trees have been removed from this area.



Representative foreshore type— Gravel beach. Often associated with low gradient foreshore or coves with pockets of riparian vegetation among steeper hillsides. Sometimes associated with alluvial fans. Photo taken in Segment 96, Fintry Provincial Park. Photo: T. Cashin

Segment 97 – DL High

Beginning near the mouth of Shorts Creek, this segment represents the southern half of the Shorts Creek alluvial fan. It has been heavily disturbed (99%) by residential development. Shore type is considered gravel beach, but intensive modifications have left the foreshore extremely altered. Continuous retaining walls are found throughout, most of which are located below the high water mark. Other modifications include docks (24/km), marine railways, private boat launches (11), and boat houses.

Segment 98 – DL Low

This rural segment remains almost entirely natural (80%), although it shows signs of historical disturbance. Shore type is primarily vegetated shore (80%) with small amounts of low rocky shore (20%). Riparian vegetation is healthy but has been removed in several locations where historical disturbance has occurred. Modifications include a large number of groynes (9) isolated to the southern end of the segment. Several springs are found along the foreshore at the boundary between this segment and Segment 99.

Segment 99 – DL High

This segment has been heavily disturbed (90%). Shore type is considered low rocky shore (75%) with a small amount of naturally vegetated shore (10%) and gravel beach (15%). Natural springs are found in association with the vegetated shore. Vegetation has been removed over most of the segment in association with proposed development of this commercial site. Modifications include a substantial amount of lake infilling, rock retaining walls, a large portable marina, and a pump house.



Representative foreshore type— Low, Rocky Shore. Cobble, boulder or bedrock substrate, prevalent along the base of steeper shorelines as evident in Segment 99.

Photo: T. Cashin

Segment 100 – DL Low

This segment corresponds with Shorts–Chaparron Provincial Park and remains entirely natural. Shore type is mixed between vegetated shore (50%), cliff/bluff (30%), and low rocky shore (20%). Riparian vegetation is limited to low gradient sections of beach and creek mouths.

Segment 101 – DL High

This segment is characterized by eight small parcels surrounded by Shorts–Chapperon Provincial Park. Most of the segment has been disturbed by residences that line the foreshore. Shore type is primarily gravel beach (80%) and a small amount of vegetated shore. Riparian vegetation has been cleared and replaced with groomed grasses and small shrubs. Small patches of natural vegetation remain between some residences.

Segment 102 – DL Low

This segment corresponds with Shorts–Chapperon Provincial Park and remains entirely natural. Shore type is mixed vegetated shore (85%), low rocky shore (10%), and gravel beach (5%). Riparian vegetation is abundant and undisturbed. Several wet seepage areas are apparent along the foreshore.



Representative foreshore type–
Vegetated shore. Characteristic of
undisturbed foreshore with narrow
littoral width. Vegetation is common-
ly shrubs, small trees and overhanging
vegetation as seen in Segment 102.
Photo: T. Cashin

Segment 103 – DL Low

Also part of Shorts–Chapperon Provincial Park, this entirely natural segment is characterized by cliff/bluff (85%), low rocky shore (10%), and gravel beach (10%). Riparian vegetation is isolated on small gravel coves between bedrock cliffs and rocky outcrops.

Segment 104 DL – Low

This natural segment parallels Westside Road. It is primarily vegetated shore (80%) with a small amount of low rocky shore (20%). One small development occurs on a small alluvial fan at the southern end of this segment. Other than riparian vegetation removal, minimal disturbance is associated with this development.

Segment 105 DL – Moderate

This small rural segment is associated with the road fill slope of Westside Road. Although the entire segment is disturbed by the fill slope, vegetation remains throughout. Shore type is primarily low rocky shore.

Segment 106 DL – Low

The shore type in this primarily natural segment is dominated by cliff/bluff (60%) and low rocky shore (40%). Riparian vegetation is moderately abundant but limited to areas where coarse substrate materials are at a minimum. Disturbance is isolated to one site characterized by extensive foreshore modifications including cliff blasting and lake infilling for road access to the foreshore. A large, rock retaining wall is found along the entire disturbance area, and one dock was also noted.



Representative foreshore type—Cliff/Bluff. Areas adjacent to steeper slopes, usually indicating a steep-sided lake basin or sudden drop off as found in Segment 106.

Photo: T. Cashin

Segment 107 DL – Moderate

This segment remains primarily natural (60%) but can be characterized by several types of disturbance. At the northern end of the segment, highway fill slope extends into the foreshore zone from Westside Road. Disturbance at the southern end is associated with several small residential developments adjacent to the foreshore. In these cases, riparian vegetation has been partially removed, although much still remains. Modifications include several retaining walls and a single dock. Shore type varies but is primarily low rocky shore (35%) to the north, gravel beach (45 %), and vegetated shore to the south (20%).

Segment 108 DL – Low

This rural segment remains natural (98%). Shore type varies between vegetated shore (85%) and low rocky shore (15%). Riparian vegetation is moderate throughout, with dense patches likely associated with localized springs. Disturbance is limited to one site, where riparian and upland vegetation has been cleared, and a primitive access road has been built to the foreshore.

Segment 109 DL – Moderate

This segment has been largely disturbed (80%) by the removal of upland and riparian vegetation, which varies from abundant to nil. Shore type is classified as vegetated shore (100%). A mature buffer of riparian vegetation remains at the north and south ends of the property, as well as an isolated patch in the centre. Shoreline stability has been compromised as indicated by a moderate-sized slump near the southern end of the segment.



Moderate-sized slump in Segment 109.
Photo: T. Cashin

Segment 110 DL – Low

This segment corresponds with a low rocky point that extends into Okanagan Lake. Shore type is primarily vegetated shore (60%) with small amounts of gravel beach (20%) and low rocky shore (20%). Most of the segment remains natural (90%). Riparian vegetation is intact, although riparian clearing or thinning has occurred at isolated sites. Modifications are minimal and include one boat launch.

Segment 111 DL – Low

The shore type in this natural segment is primarily cliff/bluff (70%) with small amounts of low rocky shore (20%) and vegetated shore (10%). Riparian vegetation is sparsely scattered amongst rock bluffs and proliferates in less coarse bed materials. Upland vegetation is largely undisturbed with the exception of a single primitive road access to the foreshore. No modifications are found in this segment. Disturbance is limited to an isolated road fill site that extends into the foreshore.



Example of road fill extending into foreshore as in Segment 111.

Photo: T. Cashin

Segment 112 DL – Moderate

This segment remains mostly natural (60%); shore type is primarily cliff/bluff (90%) and gravel beach (10%). Disturbance is associated with residential development located on top of steep rock bluffs. Foreshore access is via steep staircases leading down to the water. Modifications include docks (of varying footprint) that extend perpendicular to the shoreline or form large pads adjacent to rock walls. Retaining walls and small cabins are sometimes associated with docks. Many residences are withdrawing water directly from Okanagan Lake. Blasting and lake infilling have occurred at the far northern end of the segment.

Segment 113 DL – Moderate

This segment is characterized by various shore types including cliff/bluff (60%), vegetated shore (15%), low rocky shore (15%), and gravel beach (10%). Riparian vegetation is limited to small gravel coves and areas with fine substrates. The segment remains primarily natural (70%), although disturbance is found in isolated residential areas, which are generally located on top of steep hillsides or rock bluffs. Associated with such development are several primitive road access sites, lake infilling and retaining walls. Docks (7/km) are also found throughout the segment.

Segment 114 DL – High

This primarily rural segment has been heavily disturbed (80%) by residential development. Anthropogenic activities have substantially modified the foreshore and upland areas. Riparian vegetation has been removed and replaced with a few non-native species, leaving grasses and shrubs. Primitive roads have been built to provide access to the foreshore in areas without houses. Modifications include lake infilling, importation of fines, retaining walls, and docks (16 docks/km).

Segment 115 DL – Moderate

Shore type in this segment is primarily vegetated shore (60%), cliff/bluff (30%), and gravel beach (10%). Most of the segment has been disturbed (70%) by residential development, which is spaced evenly throughout. Riparian vegetation remains, although isolated patches have been removed. Modifications to the foreshore are found throughout including substantial infilling associated with residences. Retaining walls and docks (7 docks/km) are also common, although also well spaced. A small alluvial fan in the southern half of the segment is used for recreational activities.

Segment 116 DL – Low

This natural segment is primarily park land (60%); however, the southern portion of the segment is considered commercial (40%) and coincides with Okanagan Lake Resort. Shore type varies between low rocky shore (50%), cliff/bluff (30%), and vegetated shore (20%). Riparian vegetation is abundant where suitable bed material exists. Modifications are limited to an isolated pump house adjacent to the foreshore.

Segment 117 DL – High

This segment coincides with Okanagan Lake Resort. The foreshore has been disturbed throughout. Shore type is primarily low rocky shore (70%) and sand beach (30%). A rock retaining wall is found in conjunction with lake infilling along the northern half of the segment. Riparian vegetation has been replaced with groomed grass, especially in the southern portions of the segment. Sand beach portions of the foreshore have resulted from importing fine material. Modifications include one continuous retaining wall, an extensive marina, and a marine gas station.

Segment 118 DL – Moderate

This segment is primarily natural (60%), although the southern portion is heavily disturbed (40%) by residential development. Shore type is primarily low rocky shore (50%) and intact sections of vegetated shore (30%) and gravel beach (20%). Riparian vegetation has been removed in the disturbed sections and replaced with grass and shrub species. Some mature conifers remain between residences. Modifications to disturbed areas include large groynes, a single dock, and a continuous retaining wall, as well as numerous road access points.

Segment 119 DL – Low

This rural segment remains entirely natural. Shore type is primarily cliff/bluff (80%) with a small amount of low rocky shore (20%). Riparian vegetation is limited to a few small patches between coarse rock material. No modifications are found in this segment.

Segment 120 DL – High

This segment corresponds to the Wilson Creek alluvial fan. Approximately 80% of the fan has been disturbed by development. Land use is institutional; this segment corresponds with Camp Owaissi. Shore type is predominately gravel beach (60%) with small amounts of sand beach (20%) and vegetated shoreline (20%). Most riparian vegetation has been removed, but mature conifers remain throughout the foreshore.

Segment 121 DL – Low

Shore type in this natural segment is entirely vegetated shore. Riparian vegetation is abundant and intact throughout. No modifications are found within this segment.

Segment 122 DL – High

Land use on this small alluvial fan is primarily urban residential (55%) and rural (45%). Most of the segment has been disturbed (90%) due to residential development. Riparian vegetation has been removed and replaced with grasses and shrubs, although some mature conifers remain, especially between residences. Shore type is primarily gravel beach (60%) and sand beach (40%). Modifications include retaining walls (11), docks (31/km), and swim rafts. Beach grooming is common throughout.

Segment 123 DL – Moderate

This segment falls within the highway right-of-way for Westside Road. Shore type is primarily low rocky shore (70%) and vegetated shore (30%). Approximately 50% of this segment has been disturbed. Several residences are found mid-segment and have had considerable impact on the foreshore. Modifications include riparian vegetation removal and a single retaining wall. Riparian vegetation has been largely disturbed along the entire length of the segment. Additional disturbance at the north end is evident where fill slope material extends into the lake.

Segment 124 DL – High

This segment is characterized by higher density residential development. Approximately 80% of the segment has been disturbed. Shore type is primarily gravel beach (80%) with a small amount of cliff/bluff (20%). Riparian vegetation has been removed and replaced with grasses and non-native trees and shrubs. Remnant patches of mature riparian vegetation remain between several of the residences. Modifications are extensive, including retaining walls (11), docks (23/km), groynes (2), boat launches (and associated boat houses), marine railways, and beach grooming activities. Many small cabins have been built immediately adjacent to the foreshore.

Segment 125 DL – Low

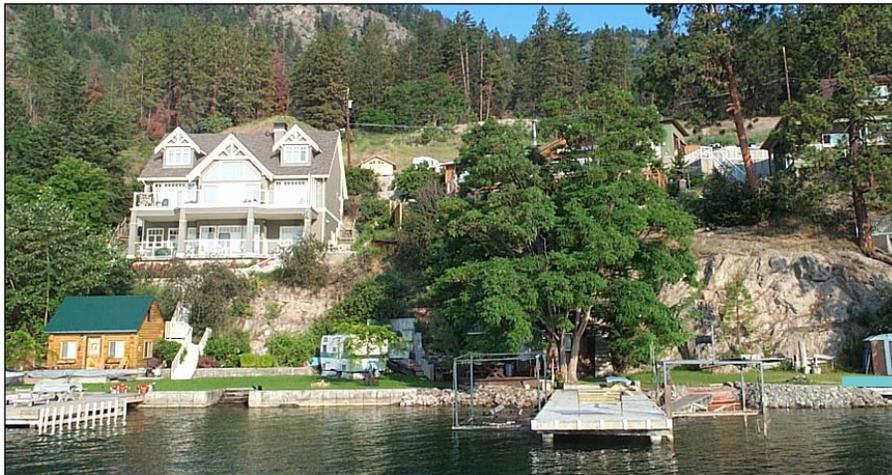
Segment 125 remains primarily natural (80%), although limited disturbance does exist mid-segment. Shore type is primarily cliff/bluff (70%) and vegetated shore (30%). Riparian vegetation is mixed with conifers dominating the rocky outcrops and deciduous vegetation found in association with small coves. Modifications are limited, but include one dock, one groyne, a marine railway, a temporary boathouse, and a small private pump house.

Segment 126 DL – Low

This segment remains primarily natural (80%) with disturbance limited to isolated patches of riparian clearing. Shore type is entirely vegetated shore, as this segment is located on the small alluvial fan of an unnamed creek. Riparian vegetation is healthy and consists of mature riparian forest. Modifications are limited to one dock.

Segment 127 DL – High

This segment has been heavily disturbed (90%) by residential development. Residences are located immediately adjacent to the foreshore where most riparian vegetation has been cleared. Modifications include a large number of retaining walls and one of the highest densities of docks in the study area (40/km). Several groynes, a marine railway, and a boat launch are also found. Beach grooming activities are commonly associated with these properties.



Continuous retaining walls and lake infilling as seen in Segment 127.
Photo: T. Cashin

Segment 128 DL – Low

This rural segment remains 100% natural. Riparian vegetation is healthy, although evidence of historical riparian disturbance is found throughout. Shore type is primarily vegetated shore (60%), gravel beach (20%), and sand beach (20%). The only modification is a derelict cabin adjacent to the foreshore.

Segment 129 DL – Low

The shore type in this natural segment is dominated by cliff/bluff (80%) with isolated patches of vegetated shore (20%). Riparian vegetation is sparse; herbs, grasses, and young conifers dominate the rocky benches found along the foreshore. There are no modifications in this segment.

Segment 130 DL – Moderate

This small segment has been moderately affected by rural development. Approximately 60% of the segment remains natural. Shore type consists of vegetated shore (60%) and gravel beach (40%). Vegetated shore areas are mainly associated with a small alluvial fan at the northern end of the segment. Riparian vegetation has been partially cleared on this fan in association with a single private residence. Modifications include several docks and groynes.

Segment 131 DL – Low

Land use in this segment is primarily rural (85%) with a small amount of urban residential (15%) at its southern end. Shore type is dominated by cliff/bluff (80%), vegetated shore (10%), and low rocky shore (10%). Most of the segment remains natural, but a small amount of disturbance is found in association with residential properties located on top of rock bluffs. Modifications include a retaining wall and a small marina, which provides moorage for several of the properties. Minor disturbance has also occurred at three locations where highway fill material (from Westside Road) has affected the foreshore.

Segment 132 DL – Moderate

This small cove has been moderately disturbed (70%) by residential development adjacent to the foreshore. Shore type is entirely gravel beach; mature riparian vegetation has been removed throughout, although mature coniferous trees remain between residences. Modifications include a single retaining wall, several docks (10/km), and a boat launch.

Segment 133 DL – Moderate

Land use in Segment 133 is industrial as it corresponds with one of Tolko Industries Ltd. log boom sites. The foreshore remains mostly natural (70%), but it has been altered in association with log storage and booming activities, especially at the southern end of the segment. Shore type is primarily cliff/bluff (70%) and vegetated shore (most of which has been disturbed). Riparian vegetation is marginal due to the coarse foreshore material. Modifications are related to booming activities and include lake infilling from adjacent roads and an A-frame log dump site.

Segment 134 DL – Low

Land use in this segment is divided between industrial (Riverside Forest Products' log boom site) and Traders Cove Regional Park. The segment remains primarily natural (95%) with the exception of two small beach access sites. A small rock peninsula extends mid-segment, creating a narrow bay. Shore type is primarily cliff/bluff (80%), vegetated shore (10%), and sand beach (10%). Riparian vegetation is limited to areas where substrates are less coarse, although most of these areas have been disturbed in association with beach access points.

Segment 135 DL – High

This residential segment corresponds to the Traders Cove subdivision and has been primarily disturbed (70%). Many residences are found set back from the foreshore on top of rock bluffs, while others are immediately adjacent to the foreshore. Shore type is primarily cliff/bluff (50%), gravel beach (30%) and low rocky shore (20%). Foreshore modifications are extensive including road access sites, docks (22/km), discontinuous retaining walls (6), groynes, and small beach houses. Riparian vegetation is restricted to small gravel coves.

Segment 136 DL – Low

This industrial segment coincides with Tolko Industries Ltd. log booming area. The foreshore remains entirely natural. Shore type is vegetated shore (50%), cliff/bluff (30%), and gravel beach (20%). Riparian vegetation is abundant in the southern half of the segment.

Segment 137 DL – Moderate

This segment corresponds with the northern half of the Bear Creek alluvial fan. Land use is split between industrial (30%) (one of Riverside Forest Products' log boom sites) to the north and Bear Creek Provincial Park (70%) to the south. Shore type is primarily sand beach (50%), vegetated shore (30%), and gravel beach (20%). The foreshore remains largely unaltered in the industrial sections; however, recreational activities have affected the foreshore at Bear Creek Park. Isolated sections of riparian vegetation have been removed adjacent to the foreshore, although much of the mature stand still remains. Modifications include a single dock, a boat launch, and beach grooming activities.

Segment 138 DL – Low

This segment represents the southern half of the Bear Creek alluvial fan. Land use is primarily park (90%) but has a small section of industrial (10%) at the southern end. The segment remains natural (95%) with healthy and largely unaltered riparian vegetation, although there is some evidence of historical modification. Shore type is primarily vegetated shore (80%) and gravel beach (20%). No modifications are found in this segment.

Segments 145-147 and Segment 159 occur on Tsinstikeptum Indian Reserve No. 9 and 10. These segments were numbered for continuity but were not compiled as part of the final results.

Segment 139 DL – High

The segment break between segment 138 and 139 is at the southern boundary of the Bear Creek alluvial fan. Shore type is primarily low rocky shore (60%) to the south and vegetated shore (40%) to the north. Land use in this segment is primarily industrial (60%) as it coincides with Tolko Industries Ltd. Bear Creek log boom site. Most of the foreshore has been disturbed (90%) as it parallels Westside Road and falls within the road right-of-way. A substantial amount of blasting and lake infilling has occurred to accommodate the current road location. A continuous riprap retaining wall remains adjacent to the southern sections of Westside Road.



Fill slope from Westside Road as seen in Segment 139.

Photo: T. Cashin

Segment 140 – DL Moderate

This rural segment can be summarized as mostly natural (80%). The shore type is vegetated shore (60%), low rocky shore (30%), and cliff/bluff (10%). Most of the riparian vegetation can be characterized as natural mixed forest with tall shrubs providing abundant shoreline cover. Modifications are limited to the northern end of the segment where residential development occurs immediately adjacent to the foreshore. Modifications include docks (4/km), retaining walls, and beach grooming activities.

Segment 141 – DL Moderate

Segment 141 lies entirely within Raymer Bay Regional Park. The northern portions of the segment have been disturbed (60%) in association with recreational activities, while the southern sections remain natural (40%). Shore type consists of gravel beach (disturbed areas) and vegetated shore (natural areas).

Segment 142 – DL High

This segment is highly affected by urban development (100% disturbed). Shore type is gravel beach (100%); riparian vegetation is sparse as it has been removed and replaced with non-native grasses and shrubs. Foreshore impacts include beach grooming activities, discontinuous retaining walls, groynes and numerous docks (38 docks/km).

Segment 143 – DL Moderate

This segment is primarily cliff/bluff (60%) and vegetated shore (20%). It has been moderately affected by urban development (60% disturbed). Most homes have large setbacks due to steep slopes and lake access via large stairways. Significant impacts to the foreshore have occurred with riparian vegetation removal, retaining walls, docks (15 docks/km), lake infilling, beach houses, and pump houses. Recent development has caused fill material to extend into Okanagan Lake at several locations.



Recent fill slope disturbance identified in Segment 143.

Photo: T. Cashin

Segment 144 - DL Low

Segment 144 consists of an agricultural parcel of land (mostly orchard) and a nearly intact foreshore area (80% natural). The shore type is naturally vegetated with young broadleaf species providing abundant shore cover. Some moderate riparian disturbances were observed along the residences. Modifications include a single retaining wall and dock.

Segment 145, 146, 147

These three segments occur on Tsinstikeptum Indian Reserve No. 10. The data for these segments were not summarized, but video documentation is included in Appendix C.

Segment 148 – DL Low

Although deciduous trees were removed from this segment historically, it remains 100% natural. The riparian buffer throughout this agricultural segment has been maintained with minimal impacts to the foreshore. Shore type was wetland and is the second largest and one of the few remaining natural wetlands in the study area. The abundant shoreline cover is provided by tall shrubs and aquatic vegetation. The littoral zone is shallow with 100% fines.

Segment 149 – DL High

This segment has been heavily disturbed (90%) by residential development. The shore type is a mix between vegetated (30%), gravel beach (40%), sand beach (20%) and wetland (10%). Riparian vegetation has been removed and replaced with herbs and grasses. A small amount of native shoreline remains on undeveloped lots. Beach grooming, retaining walls, and docks (26 docks/km) were identified as the primary modifications.

Segment 150 – DL Moderate

Segment 150 consists of an agricultural parcel of land that has a moderately affected foreshore area (60% disturbed). The foreshore is mainly wetland (40%), vegetated shore (35%), and sand beach (25%) where vegetation has been removed. The broadleaf riparian and aquatic vegetation provides moderate cover along the shoreline. Disturbance and modifications are restricted to the middle of the segment where residential development has occurred. Modifications include lake infilling, docks (3/km), groynes, retaining walls, and significant beach grooming.

Segment 151 – DL High

Segment 151 has been disturbed (100%) by residential development. Riparian vegetation has been completely removed from the foreshore; residences are immediately adjacent to the lakeshore with minimum set back. Land use is primarily residential (60%), but commercial (30%) and park (10%) uses are also found. Shore type is predominantly sand beach. Most of the residences exhibit retaining walls below the high water mark and docks (22/km). Other modifications include groynes, boat launches, and beach grooming activities.

Segment 152 – DL Low

This segment corresponds with Kalamo Regional Park, which remains predominantly undisturbed (98%). Shore type is vegetated shore (90%) with small amounts of cliff/bluff (5%) and sand beach (5%). Riparian vegetation is intact and dominated by broadleaf species of varying age classes. Disturbance is limited to several small beach access sites and one larger beach access with a swimming area and an adjacent parking lot.

Segment 153 – DL High

This residential segment has been heavily disturbed (99%) by residential development. Many of the houses are well set back from the foreshore on top of a steep hillside; however, groomed yards and gardens extend to the lakeshore. Riparian vegetation has been removed in association with residences, although several isolated patches of native vegetation remain. Shore type is gravel beach (90%) and vegetated shore (10%), but historically, the entire segment would have been vegetated. Modifications include continuous retaining walls, docks (10/km), groynes (11/km), a private boat launch, and beach grooming activities.

Segment 154 – DL High

This segment coincides with Green Bay. Although riparian overstorey vegetation was removed historically from this segment, the upland–lake interface remains largely undisturbed. Isolated patches of understorey vegetation such as grasses and shrubs remain in this primarily agricultural segment. Wetland vegetation dominates the shore type (70%) with smaller amounts of vegetated shore (30%). The littoral zone is considered shallow (>50m). This is the largest remaining wetland in the study area. Modifications include several large retaining walls and a single dock, all of which are associated with the residence at the northern end of the segment.

Agricultural activities adjacent to Segment 154. Note wetland vegetation dominating shore zone.

Photo: T. Cashin



Segment 155 – DL High

Coinciding with the Green Bay subdivision, this residential segment includes a shallow inlet with fine substrates surrounded by dense residential lots. It exhibits a high number of retaining walls, docks (23/km) and groynes. Aquatic vegetation is heavy in this segment, which is at the northern end of the McDougall Creek alluvial fan.

Segment 156 – DL High

Also included in the McDougall Creek alluvial fan, this sand and gravel beach (50%/50%) segment has urban residential (20%), commercial (45%), park (25%), and agricultural (10%) uses. The foreshore has been completely disturbed (100%) with riparian vegetation being groomed and removed for recreation and other purposes. Docks (11/km), retaining walls, groynes, and beach grooming occur throughout this segment.

Segment 157 – DL High

This segment has been heavily disturbed (100%) by residential development. Land use is primarily residential (90%) and park (10%). Riparian vegetation has been removed, groomed, or replaced with non-native species. Shore type is gravel beach. Large numbers of retaining walls and docks (24 docks/km) have altered the foreshore on this section of the McDougall Creek alluvial fan.

Segment 158 – DL High

Part of the McDougall Creek alluvial fan, this segment has a variety of land uses, which are mostly disturbed (90%). Shore type is primarily gravel (60%) and sand beach (35%) with a very small amount of vegetated shore. Overstorey riparian vegetation is partially removed, while understorey vegetation has been completely cleared adjacent to residential lots. A small amount of vegetated shoreline remains. Modifications are heavy throughout this segment including discontinuous retaining walls, docks (7/km) and groynes.

Segment 159

This segment occurs on Tsinstikeptum Indian Reserve No. 9. It has not been compiled as part of the results.

Segment 160 – DL High

This segment coincides with the Gellatly Bay Regional Park. Shore type is a mixture of gravel (80%), sand beach (18%), and a small amount of vegetated shore (2%). Modifications are heavy throughout this segment as Gellatly Road parallels the foreshore, most of which has been reinforced with riprap and concrete retaining walls (within the high water mark). Riparian vegetation has been mostly removed, leaving groomed, irrigated grasses along the foreshore. Smith Creek, which is considered a kokanee spawning tributary, flows into Okanagan Lake at this segment.

Segment 161 – DL High

This segment is characteristic of the Powers Creek alluvial fan and includes the mouth of Powers Creek and the land immediately to the south. It is primarily marina, which has been enclosed by a wooden post-break wall. Riparian vegetation has been completely removed along its length, including at the beach access and small regional park at the south end. Shore type is 100% sand beach. Powers Creek is an important kokanee spawning tributary to Okanagan Lake.

Segment 162 – DL High

Also part of the Powers Creek alluvial fan, this segment has been modified heavily by urban development (100% disturbed). It exhibits a large number of continuous retaining walls and an exceptionally high number of docks (30/km) throughout its length. Riparian vegetation has been removed and replaced with residential landscaping. Shore type is split between gravel beach (60%) and sand beach (40%).

Segment 163 – DL High

This segment represents the southern-most half of the Powers Creek alluvial fan. Its foreshore has been developed extensively as its land use is primarily urban/residential (70%) with some commercial and park lands within. Shore type is mostly gravel beach (99%), which is almost entirely disturbed (95%). Most riparian vegetation has been removed with the exception of a small cottonwood stand located within the foreshore of the Gellatly nut farm. Residential development has promoted clearing and replanting with non-native species and grasses. Modifications occur throughout and include docks and retaining walls, many of which are within the high water mark.

Segment 164 – DL Low

This segment exhibits small gravel coves (20%) amongst cliff/bluff (68%) with trace areas of low rocky shore. It remains primarily natural; native grasses and sage brush cover the benches above the cliffs and are interspersed with ponderosa pine. Land use is primarily rural (95%) with one small private development in this segment. Foreshore impacts are minimal. This segment has historical significance, as pictographs are known to exist throughout its length. It is a known kokanee spawning location.

Segment 165 – DL High

This segment coincides with Shelter Cove Resort. Land use is primarily commercial with small recreational cottages along the foreshore. Shore type is primarily sand beach (70%) that has been heavily disturbed (95%). Modifications to the foreshore include riparian clearing and retaining walls.



- Mason, B. and R. Knight, 2001. *Sensitive Habitat Inventory and Mapping*. Community Mapping Network. Vancouver, BC. 315pp + viii. M. Johannes, Editor.
- Resources Inventory Committee, 1999a. *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Lake Survey Form Field Guide; Errata #3* (March, 2004).



CENTRAL OKANAGAN LAKE FORESHORE INVENTORY AND MAPPING

APPENDIX A

KEY TO FORESHORE DATABASE



**CENTRAL
OKANAGAN LAKE
FORESHORE INVENTORY
AND MAPPING**

APPENDIX C

**VIDEO DOCUMENTATION
(DVD)**



CENTRAL OKANAGAN LAKE FORESHORE INVENTORY AND MAPPING

APPENDIX D

PHOTO DOCUMENTATION,
ARCVIEW SHAPEFILES AND
FIELD SURVEY FORMS (CD)



CENTRAL OKANAGAN LAKE FORESHORE INVENTORY AND MAPPING

APPENDIX E

SUMMARY MAPS 1-4 OF
STUDY AREA



CENTRAL OKANAGAN LAKE FORESHORE INVENTORY AND MAPPING

APPENDIX F

SUMMARY MAP OF KOKANEE
SPAWNING LOCATIONS



**CENTRAL
OKANAGAN LAKE
FORESHORE INVENTORY
AND MAPPING**

APPENDIX G

**DATA TABLES
CORRESPONDING TO
FIGURES 2-28 IN PARTS I & II**

