Module 2

Watershed Overview

2.1 Purpose

The purpose of this SHIM module is to develop an interim base map on which existing information can be presented, prior to initiating field mapping. This base map should be used as a key component to planning fieldwork. A field copy should be used initially to assist in ground truthing the watercourse network, delineate watershed boundaries and provide a base to geo-reference habitat features as they are surveyed. The updated base map is considered a project deliverable. The objectives of this module are to:

- Prepare a preliminary map of the boundaries of the watershed and its watercourse network.
- Identify and code all known waterbodies (streams, wetlands and lakes), divide the stream network into the preliminary reaches that will be used in organising the instream inventory procedures described in Module 4 (Riparian Area Classification and Cross Sections), and characterize the stream reaches.
- Identify preliminary reach breaks, and map reach breaks, habitat features and other existing information (e.g., fish distribution) that was collected using SHIM Module 1 (Existing Information Review).

Streams and watersheds are often too small to be represented on 1:50,000 NTS (National Topographic Survey) maps available from Energy, Mines and Resources Canada or on the 1:20,000 Terrain Resource Information Maps (TRIM) provided by the Province of BC. Smaller watercourses often have variable resolution on existing maps. Often the extent and spatial position of streams with watershed

areas less than 1 or 2 km^2 (100 to 200 hectares), or first and some second order streams are not correct on the variety of the existing maps (e.g. Figure 2.1).

We recommend the development and use of a base map with a scale of 1:5,000. This scale is required for municipal planning purposes and is needed to represent stream network, habitat features, and other information derived through field surveys. Consequently, the key task of this module is to develop this base map both in hardcopy and electronically. The development of this base map should be undertaken with local fisheries and municipal and/or regional planning agencies.

Small urban streams are often not adequately represented on the 1:5,000 base maps and field mapping is the only accurate method to determine their position. An interim base map with preliminary reach characteristics is needed to develop a project plan for fieldwork. This interim base map will help to organize watercourse reconnaissance, verify and adjust reach breaks and plan fieldwork.

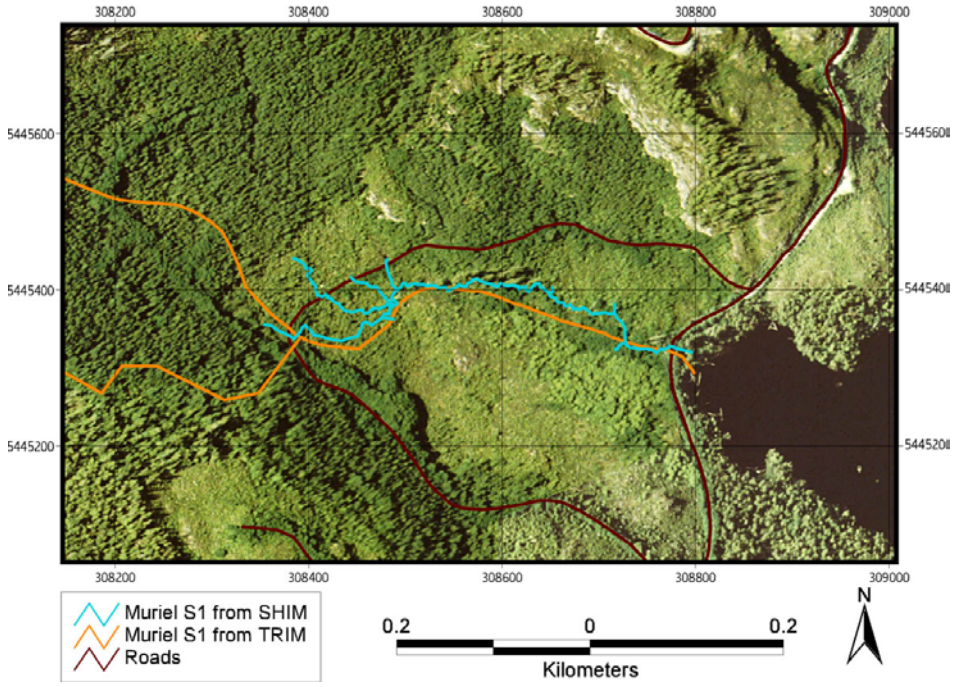

Figure 2.1 Muriel S1 Creek, Kennedy Watershed, west coast Vancouver Island, British Columbia, 1:5000 aerial photographic with TRIM and SHIM stream centrelines, showing the large difference in the position and detail of mapped stream networks.

2.2 Final Products

A completed watercourse and watershed overview should generate the following products:

- A 1:5,000 base map showing the boundaries of the watershed and its major sub-watersheds, preliminary watercourses and reach breaks, and existing information on habitat features (obstructions or barriers) and known fish distribution and habitat information (Module 1);
- Long or elevation profiles (if known) of the main stream and its tributaries that show preliminary reach breaks and existing information on obstructions and other features; and
- A basin and reach classification table summarising the watercourse (streams, lakes wetlands) location(s), physical characteristics of the reaches, as interpreted from the base maps, TRIM map or aerial photographs, or gathered from review of other existing information sources, and Interim Locational Point (ILP) data sheets.

Note: Interim base maps should illustrate, if possible, watershed boundaries, reach breaks, features, and the existing fish and fish habitat information gathered in Module 1 (Existing Information Review). Hand-drawn symbols are to be annotated on a paper map copy using *Provincial Mapping Standards* (RIC 1997) when preparing the Interim Map.

2.3 Introduction

The Watershed Overview Module should be office-based relying on information review completed in SHIM Module 1. The tasks in SHIM Module 2 involve interpretation of stream courses and watershed boundaries from larger-scale (<1:20,000) aerial photographs and maps.

This requires that a member of the SHIM project team be trained and/or experienced in map and air photograph interpretation. There are numerous recognized training courses through universities or colleges, Forestry Continuing Network and other institutions.

A completed watercourse network and map will be based on air photograph interpretation that is verified during field mapping. In many rural areas of the Georgia Basin some photointerpretation has already been conducted. Please contact local MWLAP or FOC agency staff for support. In areas that have no interpretation, it is useful that a team member completes this work to provide needed familiarity with the watershed. Note that riparian vegetation can be

expected to obscure many stream channels preventing reliable interpretation of some habitat and channel features from aerial photographs (see SHIM Module 4). Stream channels can be accurately mapped using global positioning survey (GPS) techniques described in SHIM Module 5 (GPS Surveying Procedures).

Note: The project manager or a team member will be required to set the tasks involved in preparing the projects' base map and organize and potentially contract component tasks.

2.4 Obtain A Base Map

Fish and fish habitat inventory data must be surveyed and displayed at a 1:5,000 map scale. The preferred product is an orthophotographic based map (e.g. Figure 2.1), produced from recent air photographs, and tied to the Universal Transverse Mercator (UTM) coordinate system (NAD83). This mapping projection can be used to electronically project both the mapped information from TRIM and scanned and rectified orthophotographs (adjustments for altitude and attitude on photograph) through a Geographic Information System (GIS). The digital files may be enlarged to produce maps at various scales. Image and map resolution will often deteriorate at scales larger than 1:5,000. Topography, shown as elevation contours at some fixed interval, may also be used in conjunction with aerial photographs for mapping watercourses. The topography and specific contours are often generated from models within GIS using TRIM elevation data or aerial photographs.

Note: If elevation is derived from TRIM digital files, the elevation coordinates will be based on 1:20,000 TRIM map data and will not meet the standards for 1:5,000 maps that are specified for British Columbia Geographic System of Mapping (BCGS). The resulting topography will be a hybrid of moderate-quality TRIM data suitable for 1:20,000 scale, and rectified planimetry. Care should be used when interpreting vertical elevation data. Although the longitudinal elevation profile of watercourses are important, SHIM methods focus on horizontal position of watercourse. Detailed elevation surveys to create longitudinal profiles often involve other survey techniques see 2.9.1.

Watercourses which have been interpreted as a portion of the base map, can also be displayed as an independent layer overlain on the orthophoto. Watercourses which have not been clearly mapped or interpreted, may be visible on the base map and orthophoto. Often a watercourses' approximate channel position can identified based on other clues including the riparian vegetation corridor even when the stream channel is not clear in the photograph.

At the office project stage, the interim base map can be either hardcopy or electronic; although transforming paper records to a digital information base map as Geographic Information System (GIS) layers is an important task. The project will need the appropriate computer hardware and software to maintain data standards and distribute final information products from the project.

The main criterion used to obtain a suitable base map is scale and the accurate representation of the stream network. These attributes are needed to interpret UTM coordinates, stream reach breaks and other watercourse features. Topography (elevation) is also helpful when deriving the longitudinal elevation profile of the watercourse between reaches and the watershed boundary.

Base maps at 1:5,000 scale are not universally available for urban areas in British Columbia. One source is using enlarged digital orthophotos. Recent digital orthophotos (less than five years old) are available for eastern Vancouver Island (black and white), Clayoquot Sound (colour), Capital Regional District and the Fraser Valley (colour). Topography is not included with the digital orthophotos, although TRIM elevation data can be overlain and used for topography. Interpreted stream channel locations are available for many watercourses in the Greater Vancouver Regional District, Fraser Valley and east Vancouver Island and can be overlain on orthophotos (Sensitive Habitat Atlas series 1995 to 2000).

The map base available from TRIM maps or the Sensitive Habitat Atlas series do not usually extend beyond municipal boundaries. Watersheds that extend into crown land or private forest lands, on eastern Vancouver Island, may be only partly covered by these maps. TRIM maps are acceptable for mapping boundaries and defining the stream networks in the upper portions of these watersheds. TRIM maps are also acceptable for initially defining watershed boundaries, longitudinal elevation profiles, and a preliminary identification of the stream network, where watersheds are greater than 10 km^2 (1,000 hectares) in area.

In the western part of the lower Fraser Valley, most municipalities and cities will be able to provide a suitable base map and they may also have available additional study or interpretive information, such as stormwater management plans or drainage maps that also display the stream network of the watershed. In other areas of the Province, little or no information may be available from these sources.

Various other 1:5,000 map products are also available. British Columbia Geographic System of Mapping (BCGS) 1:5,000 maps may be available from the local municipality or regional district. They can be used as base maps although use of this information should be cautioned given the level interpretation of hydrographic map features. The *BC Specifications and Guidelines for Geomatics: Volume 4* (Surveys and Resource Mapping Branch, 1990) describes these

interpretative standards. Some municipalities may provide 1:5,000 cadastral maps (property boundaries, sub-division lines). For streams within a larger watershed, 1:20,000 TRIM maps may be acceptable as base maps at the Pre-field stage, until a larger scale map can be obtained.

Note: Cadastal maps should be used with caution. These maps and plans have been principally derived from legal land surveys for very specific sites, are often older and seldom illustrate small stream channels and their positions. In many municipalities and regional districts, cadastral maps are not projected in UTM's and will need revision for projection in this coordinate system.

2.5 Develop a Base Map

The procedures needed to develop a base map are outlined below. If an appropriate base map is not available for a given watercourse, it will be necessary to follow these procedures. Field surveys can be used in conjunction with less expensive photographic interpretation methods. These procedures include:

- Select and review appropriate air photograph(s). It may become apparent that the stream is too small or overgrown by riparian vegetation to be visible and therefore easily mapped. Stream channels not visible or easily identified from photograph interpretation need to be field inspected. Air photographs should be used in the field to mark stream channel positions.
- Identify and map selected features along the watercourse using the air photos. For example the following features are commonly identified from photographs and used on 1:5,000 base maps:
    - Right and left channel boundaries and water lines;
    - The boundaries of vegetation within the channel (islands covered by reasonably mature vegetation), as well as those parts of islands or bars covered by successional vegetation (usually shrubs), and the boundaries of attached bars;
    - The position of bedrock outcrops and organic debris (mapped either as individual pieces or jams); and
    - The features near the watercourse such as roads, trails, bridges, houses or other structures, overhead cables, and tributary junctions.

2.6 Delineating the Watershed and its Stream Network

Watershed features should be delineated using 1:50,000 NTS maps, 1:20,000 TRIM maps and recent and historic air photographs (SHIM Module 4). Historic air photographs can used to interpret changes in watercourses and channels over time. Historic photographs can be purchased or viewed at Maps-BC, Victoria.

2.6.1 Preliminary Identification of the Stream Network on the Base Map

To create a 1:5,000 base map, first review local Stormwater Management Maps (municipal) or other information maps or plans to identify stream channel and tributary positions. Use any existing mapped channels to draw the approximate centre line of the stream channel on a transparent overlay of a 1:5,000 base map (or a layer in a GIS or a drafting program), as a line along the approximate centre of the stream channel. Where both stream banks can be identified (>5-10m channel widths on 1:5,000 scale photos), each bank should be clearly drawn.

Some streams may be clearly visible on the base map and their course can be marked with confidence. In other instances, the position of the stream can be roughly interpreted from:

- patterns of contours (up-hill pointing V-shapes indicate the position of a stream course in a gully or small valley);
- the presence of gullies or narrow valleys that can be identified on the base map or air photographs;
- strips of riparian vegetation that mark the approximate stream course;
- drainage ditches;
- wetlands, open water areas, riparian edges;
- ponds or other hydrographic features; or
- culverts and bridges.

Watercourse presence, location, tributaries and other features are intended to be ground truthed through a field inspection following base mapping and air photographic interpretation. Stream positions should be corrected, and new tributaries sketched on your base map. In most urban areas, locating and inspecting stream crossings at road intersections may be sufficient to identify streams whose channels are not found on

existing maps or air photographs. Where roads and crossing are few, a helicopter over-flight can be used as an initial watercourse survey. An over-flight survey can also be to assess hillslope/bank sediment sources or other features in upper watersheds which impact location and function of downstream stream channels. Typically, over-flight survey should be combined with video recording or low-level air photographs. Details of video survey procedures can be found in *Aerial Photography and Videography Standards: Applications for Stream Inventory and Assessment* (RIC, 1995).

2.6.2 Assessing Field Mapping Requirements

The next stage needed is the assessment of field mapping requirements based on the preliminary comparisons between base maps and the actual stream channel and watercourse network. This comparison is based on a **"minimal accuracy standard"** for representing the position of stream courses on 1:5,000 maps.

This minimum standard is that: *(A) ninety percent (90%) of all well-defined features will be within* ***2.5m*** *(0.5mm at map scale) of their true position.* It is expected that relatively few field inspected stream courses will meet this minimal standard. Stream channels should also be classified relative to two additional levels of accuracy including: (B) *accurate within* ***2.5 to 10m*** *(0.5 to 2mm at map scale)*, or (C) *less accurate than* ***>10m*** *(>2mm at map scale).*

Watercourses and channels should be marked on your existing base map to display this level of accuracy based on the above standards. Stream channels and other watercourses which are interpreted based on riparian vegetation position or other indicators will likely be the least accurate (> 10m). These stream channels and watercourses will be priority sites for field mapping (SHIM Modules 3 & 5). Stream channels and watercourses which are identified with moderate levels of position and accuracy (2.5 to 10m) should also be prioritised for mapping.

2.6.3 Watershed Boundaries

The overall watershed boundary from height of land to the watercourse/ stream mouth should be included on your base map. This boundary should be based on elevation contours to enclose the entire area of the stream/watercourse drainage basin. For additional details consult

Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Manual (RIC, 1997), BC Forest Practices Code Guidebooks on (a) Fish-Stream Identification, (b) Coastal Watershed Assessment Procedures, and (c) Channel Assessment Procedures. In low-elevation or low-relief areas, it may be difficult to accurately define the watershed boundary from map based contours. Three additional approaches can be used including: stereo-viewing of current air photographs, field reviews (as above), and review of existing local plans or management maps (i.e. Stormwater).

The final task is the measurement of watershed and sub-basin area (km^2 or hectares). Hand drawn maps can be measured using a planimeter and digital maps can be measured using available GIS tools. All information should be tabulated on a ***Basin Classification Sheet*** including stream order to the mouth, tributary names, Interim Locational Point (ILP), map number and ILP number (see Section 2.8 below).

2.7 Watershed and Waterbody Referencing

The 1:50,000 digital Watershed Atlas provides watershed/waterbody identifiers as a means to assist in habitat management, analysis, and data sharing. The Resource Inventory Committee (RIC) requires that all lakes and streams in each inventory project be identified with the unique code used in the hierarchical system of the Watershed Atlas. Most of the watersheds and streams considered for fish and fish habitat inventory projects are often too small to be displayed in the Watershed Atlas due to scale. As a result, watershed/waterbody identifiers must be generated for individual inventory projects.

All streams on your base map must have an assigned unique identifier. Where watershed codes do not exist, interim identifiers must be used. Interim Locational Points (ILP's) need to be replaced with proper codes prior to submitting the final database. Required watershed and waterbody information (see sub sections below) includes: 2.7.1 **Map Reference**; 2.7.2 **Gazetted Name**; 2.7.3 **Alias (Local Name)**; 2.7.4 **Watershed/Waterbody Identifier**; 2.7.5 **Interim Locational Points**; 2.7.6 **Geo-referenced Co-ordinate**; 2.7.7 **Final Watershed/ Waterbody Code**.

2.7.1 Map Reference

In the British Columbia Geographic System (BCGS), maps are referred to by their NTS block number, which is divided into 100 parts for the 1:20,000 map reference number. The 1:20,000 sheets are divided into 16

parts (quartered twice) for 1:5,000 maps, so that a typical map number would be “82F.035.2.2”. The 1:5,000 map sheet covers 3 minutes of longitude and 1’30” of latitude.

2.7.2 Gazetted Name

The gazetted name is the official name of the lake, stream or wetland, as listed in the *Gazetteer of Canada for British Columbia* (Anon, 1985) or as shown on TRIM 1:20,000 maps or 1:50,000 NTS maps. Feature names since 1985 can be identified through the Geographic Names Unit of Geographic Data BC (GDBC), via their website at http://home.gdbc.gov.bc.ca, or through a CD-ROM that can be purchased from the GDBC. If the waterbody is not gazetted, it may be referred to as "unnamed."

2.7.3 Alias (Local Name)

“Alias” is an unofficial or locally used name for a lake, stream or wetland, and is often derived from local sources or experts, such as landowners, fishers, municipal or regional district offices. An alias may also be exist in MWLAP or DFO records or derived from regional agency staff.

2.7.4 Watershed/Waterbody Identifier System

The Watershed/Waterbody Identifier System is a computer-generated coding system that uniquely identifies watersheds and waterbodies for all British Columbia. It is a component of the 1:50,000 BC Watershed Atlas. The Identifier has 2 parts, a watershed code and a waterbody identifier. Depending on whether a watershed or waterbody is identified, one or both coding parts are used. For streams, only the watershed code is required for reconnaissance inventory purposes. For lakes, both watershed code and waterbody identifier are required.

- **Watershed Code** is a 45 digit, 12 set array that uniquely identifies watersheds. The watershed code is a requirement for all aquatic data collections.
- **Waterbody Identifier** is an alphanumeric, 9 character string that uniquely identifies a waterbody within a watershed. It consists of 5 digits followed by a four-letter acronym of the parent watershed group. For the purpose of fish and fish

habitat inventories, the waterbody identifier is used for lakes and wetlands only.

Further information on watershed/waterbody identifiers can be found in the *User's Guide to the British Columbia Watershed/Waterbody Identifier System, Revision 2.1* (Government of BC, 1997) or on the MELP Fisheries Inventory web site at: http://www.for.gov.bc.ca/ric/PUBS/Aquatic/watershed/index.htm.

2.7.5 Interim Locational Points (ILPs)

Where a watershed/waterbody identifier has not been assigned, an Interim Locational Point (ILP) is used in place of the watershed/waterbody identifier until one can be generated.

Requirements for generating watershed codes and waterbody identifiers from ILPs are described in the *User's Guide to the British Columbia Watershed/Waterbody Identifier System, Revision 2.1* (Government of BC, 1997). Key requirements include a 1:5,000 map linked by the attributes included on the ILP Data Sheet. The ILP Data Sheet must include the following attributes:

- **Project Code**: the inventory project code obtained from the MELP Fisheries Inventory Specialist at the start of the project.
- **ILP Map Number**: the number of the map used to assign ILP numbers.
- **ILP Number**: a user-defined number unique to any particular point on the map sheet.
- **UTM coordinate**: taken at the mouth of the subject watercourse (Northing and Easting coordinates). The *Revision of Stream Mapping Procedures for Streamkeepers in Coastal Urban Watersheds* provides a discussion of how to identify and mark the mouth of a stream.
- **Watershed Code**: the code of the subject watershed, or the next highest watershed if the subject watershed's code is not available.

2.7.6 Geo-referenced Co-ordinate

A UTM co-ordinate is used to identify the location of the lake, stream or wetland, and/or the sampling site. UTM co-ordinates are recorded as

three sets of numbers: Zone - Easting - Northing, separated by periods (e.g., 10.69751.598461). UTM co-ordinates can be obtained from a geo-referenced 1:5,000 map sheet (either interpreted from the digital database by the appropriate software, or scaled from a hard copy of the map) or from a survey of the stream course. The UTM co-ordinates should be expressed to 1m, although it is unlikely that this point is accurate relative to true co-ordinates.

For streams, the UTM co-ordinate of the upstream reach break is used for location referencing. For sampling sites in stream reaches, the UTM co-ordinate of the downstream end of the site is used. For lakes, the UTM co-ordinate of the outlet stream on the lake is used. If more than one lake outlet exists, the main outlet is used for referencing, and in cases where no outlet is present, the UTM of the geographic centre of the lake is used. For sampling sites in lakes, the UTM co-ordinate from the approximate centre of the site.

Note: that UTM refers to the 1927 North American Datum (NAD) which are found on 1:50,000 NTS maps and can be converted to the NAD 1983 datum in use on TRIM maps via the *Canadian National Transformation, Version 2*.

2.7.7 Final Watershed/Waterbody Code

Interim Locational Points (ILP's) used in place of watershed/waterbody identifiers must be replaced with watershed codes prior to providing data to the standard provincial inventory databases (i.e. FISS).

The procedure for using and replacing ILPs includes:

1. Create 2, 1:5,000 maps of the project area and stream with ILPs. One copy is kept for the project and the second is used to generate a watershed code.

2. Create 2 ILP Data Sheets for stream and lakes. Careful transcriptions between ILP data sheets and maps is required. The ILP Data Sheet is used to generate the waterbody identifier and for ongoing use in the project. **Note**: streams - UTM co-ordinates in the ILP Data Sheet (Streams) refers to outlet location (use the ILP as you would the watershed code).

3. Send the ILP Map and Data Sheet to the Ministry contact for watershed code assignment. This task should be completed during the Information Review stage of the project. Hard copy and digital files (spreadsheet)

should be attached. **Note:** that the ILP Data Sheets must be completed entirely, including UTM co-ordinates for all ILPs.

4. ILPs assigned at later stages of the inventory are recorded and a second watershed/waterbody identifier request should be completed and submitted.

2.8 Designating Preliminary Reach Breaks

The purpose of this section is to identify and describe stream reaches and their location within the watershed. This task should be completed as a planning component for field reconnaissance and fish and fish habitat sampling.

2.8.1 The Longitudinal (Long) Elevation Profile

Long profiles or changes in elevation and channel gradient should be used to help select reach breaks for the main channel and the major tributaries (stream channel one stream order less than the main channel), plus any other tributaries that have already been identified. An elevation (long) profile is often not essential for selecting reach breaks and this module step may be passed if elevation data is not available. TRIM maps can provide elevation data to help interpret reach breaks.

If topography (elevation contours) is available, the stream profile can be constructed using a 1:5,000 hardcopy basemap and/or a digital GIS query. The following steps can be helpful:

1. Mark the mouth of the stream on the base map and interpolate its elevation from the contour crossings of the larger streams that it joins or assign a geodetic elevation of zero (0m) if it flows directly into the ocean;

2. Measure the distance upstream from the mouth to the first contour crossing of the stream along the centreline of the channel with a chart measurer (opisometer). The map scale can be entered in modern chart wheels so that the distance is reported in ground distance in metres or kilometres. Otherwise, record the distance in millimetres or centimetres and adjust it to ground distance with the scale factor;

3. Record the distance to the first contour crossing and the elevation of the contour;

4. Continue to the next contour and record distance and elevation points along the main channel. Also mark distances to the outlet and inlet of culverts or bridges that are shown or can be identified;

5. Measure up the main tributaries, starting the first point as the distance along the main channel to the tributary mouth and then interpolated at the tributary mouth; and,

6. When data for the main stream and tributaries has been recorded plot separate graphs using MS Excel (Provincial Government standard).

2.8.2 Identification of Stream Reaches

Reaches are stream segments or lengths where hydrological, geological, and adjacent watershed surface conditions remain sufficiently uniform that a reasonably homogeneous channel morphology can be identified. As a reference, the characteristics of a stream channel can then be expected to change wherever its surrounding watershed conditions change, such as at major tributaries, sediment sources, elevation and changes in the stream valley.

Information that must be collected for reaches is outlined in Table 2.1.

For the purposes of the Fish and Fish Habitat Inventory Standard for Urban Watersheds, reach lengths must be at least 25 m in length (5 mm at 1:5,000 map scale). As an alternative to creating very short reaches, specific habitats can be recorded as a specific section or feature. We anticipate that most preliminary reaches will be much longer than the 25m minimum.

Recent, large-scale air photographs are an important tool needed to identify reach breaks or boundaries. The long profile constructed in the previous section of this module is particularly useful in assessing changes in gradient that are significant enough to constitute reach breaks. Historic air photographs should also be used; particularly as an aid to help identify human disturbance on watercourses.

The preliminary reach division in this module is similar to that discussed in the Forest Practices Code *Channel Assessment Procedure Guidebook* (FPC, 1996). Useful guidelines to identify reach breaks include use of:

- Tributary confluences (at least second order streams; always at entry points for major tributaries, as previously defined);

- Significant gradient changes from one reach to the next, or waterfalls or other steps in the profile, that are too short to be a reach (<25m) but affect the channel;
- Changes in stream channel confinement, such as from a wide floodplain to a confined canyon;
- Changes in the coupling of the stream channel with its valley flat or hillslopes (see Appendix 2 of the *Channel Assessment Procedure Guidebook)*;
- Entry of coarse or fine sediment from a major source, such as a construction site or high eroding bank;
- Changes in stream channel form, from straight to sinuous, or single channel to a braided channel. These changes often result from varying slope, sediment supply or changes in the valley and local geological materials.
- A lake or wetland is treated as a separate reach.
- Changes in riparian vegetation are not to be considered when setting reach breaks.

Reach breaks must be marked directly onto a copy of the base map, verified using the air photographs, and then transferred to the long profile. Review the position of reach breaks along the long profile to ensure that gradients are reasonably constant over the reach. Add additional breaks if gradients suggest a significant change from the bottom to top of a particular reach.

Table 2.1 SHIM required basin and reach classification table.

Watershed Code	Watershed Area	UTM	Map Reference	Gazetted Name	Alias	ILP Map #	ILP #	Order #

Magnitude	Reach #	NID Map #	NID	Classification	Gradient	Length	Width

2.8.3 Stream Reach Numbering

Stream reaches are numbered in upstream-ascending order, starting from Reach 1 on the main stream, nearest the mouth. Each lake or wetland is assigned a reach number in the same ordering system. Tributaries to the main stream are also assigned reach numbers.

If additional reaches are created during the field inspection, they are named by adding decimals to the existing reach numbers. For instance, if Reach 2 is sub-divided, the reaches would then be numbered, 2, 2.1, 3, etc.

2.8.4 Reach Classification

We anticipate that part of the stream or watercourse mapped with SHIM will be too small, or too overgrown by riparian vegetation to inventory in detail from air photographs. These reaches should be separated into natural and man-modified channels, those which have been channelised,

otherwise altered, or flow through culverts. These reaches should be classified as follows:

Natural (NC): Watercourses with no obvious signs of straightening, dredging, bank armouring or other man-made changes to the stream. Typically, the watercourse is irregular in width and depth, with a defined pool and riffle sequence.

Channelised (CH): Stream types that are constructed or are highly modified channels that are typically uniform in width and depth and without meanders, gravel bars or other channel features found in natural watercourses. Roadside and agricultural ditches are examples of these stream types. Channelization typically affects both banks, which are often protected by rock rip rap or other material, such as concrete.

Partially Modified (PM): These watercourses retain some of the characteristics of natural channels but have bank protection, gravel removal or other interference. Rip rap placed on one bank is an example of a partially modified watercourse.

Culverted (CU): Watercourses that are enclosed in concrete, metal or wood culverts.

As well as this classification, the reaches on the small and larger streams are described in a manner that is consistent with what can be observed on air photographs (see 'Reach Description' below).

2.8.5 Reach Description

The following reach information must be collected and entered into the Basin and Reach Classification Table for the watershed in addition to the Reach Classification described above. Where a parameter cannot be assessed, because the stream is not clearly visible, enter N/A instead.

Reach Length: The length of the reach (m) measured along the stream channel, from one end of the reach to the other.

Reach gradient: The slope of the stream, as calculated from the elevation at the upstream end of the reach, minus the elevation at the downstream end of the reach, divided by the reach length. Elevations are interpreted from the long profile. When multiplied by 100, the reach gradient is expressed as a percentage.

Channel Width: Measured as the bankfull (bank top to bank top), or vegetation boundary to vegetation boundary, width, as averaged over several cross sections along the reach. Where the channel is not visible, reach width can be estimated as less than 1 m, 1 to 5 m, 5 to 20 m, or greater than 20 m. Where the channel is not visible, it is likely that the width will be less than 5 m.

Floodplain Dimensions: On the larger streams it may be possible to interpret floodplain dimensions from the air photographs. Where these can be identified on the air photographs they should be marked and typical dimensions of the active floodplain recorded.

Channel Morphology: For the larger streams, it may be possible to classify channel morphology in a preliminary fashion, (based on the *Channel Assessment Procedure Guidebook*) from inspection of air photographs. Information on other reach characteristics, including channel pattern, channel islands, and channel confinement are collected and recorded. Module 4 (Riparian Area Classification and Cross-Sections) describes in detail, how to measure these characteristics in the field.

2.9 Reporting

This section summarises the required inventory data and map products for the final report for Module 2 (Watershed Overview). The report format is specified in the Introduction section of this report. The BC Ministry and Fisheries and Oceans representative should be consulted at the initiation of the project to determine if reporting requirements have changed.

2.9.1 Required Inventory Data

The required inventory data products for the this module are:

1. Project code, consisting of a MELP-defined code and year.

2. Basin and Reach Classification Table summarizing the basic location and characteristics of watersheds and subwatersheds. The table must include the information shown below.

- watershed code, and area
- ILP map number
- ILP number

- watershed order, and magnitude
- Reach number
- NID map number
- NID
- reach classification
- reach gradient (if suitable maps available)
- reach length, and width.

3. ILP Data sheets which are linked to the Interim Map and contain the following information:

- Project Code
- ILP Map Number
- ILP Number
- UTM co-ordinate
- Watershed Code

Any comments relevant to the project may be added. Comments should describe:

- any problems that were encountered and how they were resolved;
- special concerns and comments relating to fish populations or their habitats;
- recommendations for further work, and what the objective of further work should be; and,
- other concerns.

2.9.2 Required Map Products

The required map products for the this module are:

Interim map showing the following attributes:

- Watercourse network
- Watershed boundaries and subwatershed boundaries
- Watershed codes
- ILPs
- Reach breaks
- Reach numbers

- NIDs
- Existing fish and fish habitat information (e.g., fish presence and distribution)

Note: A paper copy of the interim map must be prepared complete with hand-drawn symbols shown in the *Standards for Fish and Fish Habitat Mapping* (RIC, 1997).

2.10 References Cited

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