Module 4

Riparian Area Classification and Detailed Cross Sections

4.1 Purpose

The purpose of this SHIM module is to photointerpret, classify and validate riparian land cover along the watercourse or stream corridor. This module presents the SHIM procedures, skills, equipment and background data sources required to classify riparian areas. Land cover is classified using ortho-rectified photograph interpretation and verified during field review for land cover classification and class boundaries. These procedures outline project planning; compilation of existing data, creation of a photo pre-typing and field reconnaissance, secondary photo-typing, field review, final photo-typing, and final map creation (Fig. 4.1). The SHIM riparian classification and method use is based on the land cover standards adopted by British Columbia Terrain Ecosystem Mapping. The following information outlines the major steps required to develop a land cover map, from the project planning to the creation of the final maps.
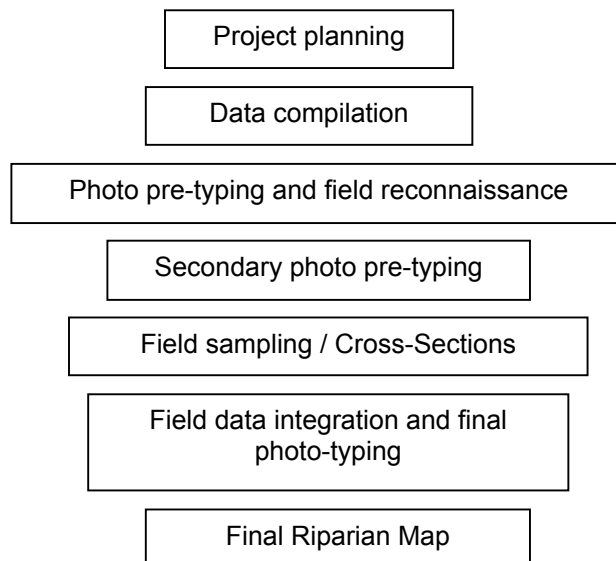
Project planning

Data compilation

Photo pre-typing and field reconnaissance

Secondary photo pre-typing

Field sampling / Cross-Sections

Field data integration and final photo-typing

Final Riparian Map

Figure 4.1 SHIM protocol to create a riparian land cover and map from photointerpretation and field verification.

4.2 Introduction

The riparian area encompasses the natural vegetated corridor along a stream bank and the land uses within a restricted elevation or distance from the floodplain. The riparian buffer zone is not of uniform width and varies with functional properties, local conditions and elevation. Typical features include the entire floodplain, wetlands, and adjacent areas with steep slopes. The boundaries of the riparian area can often extend a considerable distance from the watercourse. In B.C., a 50m riparian management zone has been adopted to protect habitat features, functions, and processes on fish bearing streams (Miller et al., 1997). SHIM mapped riparian areas include the 50m corridor starting from the floodplain of both sides of a stream. This corridor includes both sides of the stream channel from bankfull channel width, and increases in size when contemporary floodplains, ravines, escarpments, or steeply sloped areas are present along the cross-section of a stream or watercourse. The extent, composition, and location of riparian areas are required for designating Fisheries Reserve Zones (FRZ) and delineating riparian segment classes.

The riparian zone is an important transition zone between aquatic and terrestrial ecosystems, and serves as a link or buffer between upland and lowland ecosystems (Franklin 1992, Gregory et. al. 1991, Swanson et. al 1992). Vegetation, in particular forests, play an important functional role in maintaining healthy riparian ecosystems. Intact vegetated riparian areas in B.C. provide a number of valuable ecological functions and processes including:

- *recruitment of large organic debris (LOD), such as fallen logs and snags, and log jams in stream channels;*
- *nutrient and organic matter input into channels, including leaf litter, nutrient runoff and insects;*
- *stabilisation of stream banks and substrate;*
- *modification of microclimates including light, temperature, and humidity; and*
- *control and buffering of water flow, sediments, and nutrients.*

The ability of a riparian corridor to function in a healthy state is dependent on the match between function, process and condition. For example, mitigation of temperature extremes during summer low flow conditions does not require a large in width of vegetated corridor, but rather a dense canopy for cover. The ability of the riparian corridor to filter or buffer sediments or water runoff requires large riparian width and lower slope of the corridor.

The extent of a riparian corridor is indicated by the presence of hydric soils and hydrophilic (water loving) plant communities (Franklin 1992). In coastal BC, mature riparian areas are characterised by heterogeneous deciduous and coniferous forests dominated by western red cedar (Tsuga heterophylla), Douglas-fir (Pseudotsuga menziesii), red alder (Alnus rubra), big-leaf maple (Acer macrophyllum), and black cottonwood (Populus balsamifera spp. Trichocarpa). Common understroy shrub species include salmonberry (Rubra spectabilis), vine maple (Acer circinatum), Indian plum (Oemleria cerasiformis), Pacific ninebark (Physocarpus capitatus), devil's club (Oplopanax horridus), and several fern species (Miller et al).

A number of indicators can define the buffering ability, capacity and integrity of riparian corridors. Three important categories of indicators of riparian integrity include:

Land cover and vegetation (in order of increasing complexity)

- *Amount and general type of land cover. How much of the riparian area is covered with paved areas, compacted soils, grass, shrubs, and forests;*
- *Amount and type of vegetation. Within the land cover that is vegetated, what is the specific vegetation type and its level of maturity;*
- *Vertical and horizontal diversity within forests;*
- *Continuity of the vegetated areas; and*
- *Connectivity to wetlands, upland areas, and terrestrial corridors.*

Physical Conditions

- *Eelvation of watershed / corridor slope;*
- *Type of surficial materials and geology;*
- *Soil composition and organic matter; and*
- *Position of water table across the riparian corridor.*

Local disturbance factors

- *Presence /density of road crossings, utility (power / pipeline) corridors, and other infrastructure;*
- *Presence /density of moderate-impact activities, such as trails, recreational facilities; and*
- *Drainage, stormwater runoff patterns.*

There is no simple method to combine these indicators into a single measure of riparian zone integrity. The amount and type of vegetation in the riparian corridor is a primary indicator of the general health and state. However, whether or not the riparian buffer will provide the many functions needed to maintain ecological integrity will depend strongly on the physical conditions and disturbance factors listed above.

The inventory and mapping of spatially accurate land cover in riparian corridors is as critical as stream location and extent in to assisting to development information to make informed decisions about land use planning. Photointerpretation combined with the spatial modelling and database properties of Geographic Information Systems (GIS) are the principal tools used to map the characteristics of land cover and other features of a watershed (Greene and Cruise 1995, Brown et. al 1996). The rapid technological advance of GIS and GPS (Global Positioning Software) software and equipment require only a basic understanding of mapping principles to collect and compose spatial accurate data land cover data.

4.3 Required Skills

Required training and skills for riparian corridor inventory and mapping include:

- Photointerpretation - experience interpreting vegetation and/or land cover from air photographs or ortho-rectified photographs;
- Geographic information systems (GIS) experience;
- Global positioning systems (GPS) and chain / compass survey techniques;
- Experience in native and exotic vegetation, forest structural stage identification; and
- Knowledge of the ecological processes that maintain riparian ecosystems.

4.4 Equipment

The equipment required for riparian corridor inventory and mapping include:

- Pairs of hard copy recent (< 5 years) colour air photographs, or digital ortho-rectified photos, of the study area;
- Stereoscopic viewers;
- Compatible GIS software;
- GPS unit, tight chain, compass, tape and/or range finder;
- Record keeping; and
- Native vegetation field guides.

4.5 Project Planning

Quality, accuracy and reliability of the final maps and associated databases on riparian corridors are extremely important. The following section describes procedures that should be following to produce high quality and reliable mapping products.

Project planning is the most important step in a mapping and inventory project. It sets the standard for the whole mapping project, including determining what map and interpretative products are needed, deciding how those will best be produced, and ensuring the participation and compliance of all project participants.

The following guidelines will help the mapping team develop a work plan for the mapping project and are similar to those specified in SHIM modules 1 and 2:

- Plot the watershed boundaries on an overview map.
- Determine the scale and survey intensity level to use.
- Determine project personnel, budgets, and scheduling of fieldwork and project completion.
- Ensure that all project participants have an understanding of their role in the project and that everyone involved is working towards the same goal.
- Determine GIS digital requirements.

- *Follow the SHIM standards of data collection, classification, and mapping.*

4.6 Compiling Existing Data

4.6.1 Scale

The ratio of the image on a map to the real world is called scale; it relates a unit on the map to a similar unit on the ground. Maps of 1:5,000-1:20,000 are typically referred to as large-scale maps because one unit on the map is relatively large compared to other maps. In this way maps with scales of 1:20,000-1:125,000 are termed medium scaled maps, and maps with scales exceeding 1:125,000 are called small scale maps. The smaller the scale the more abstract the map must be in relation to what is being mapped. When maps are created a scale must be selected for the map that will portray a level of detail specific to the application. SHIM recommend mapping riparian land cover at large-scales (<1:20,000, 1:5,000 preferred) to provide more detailed mapped information. The interpretation of riparian land cover should be delineated at least a scale of 1:5,000. The largest scale reference data, described below, should also be used, as this will provide the most detailed information about the watershed. Small-scale maps do not provide necessary details and should not be used for defining the riparian corridors.

4.6.2 Vector Data

Before starting to delineate land cover polygons, some digital mapping information should be collected as a reference for photointerpretation. Compiling this data is often the most time-consuming step in the photointerpretation process. Government agencies should be contacted to help locate the appropriate maps in hardcopy or in digital form. Appropriate time should be allocated to the collection of existing data, to ensure efficiency in the delivery of the project.

The vector (line) data required for riparian land cover mapping includes: watercourses, roads, property boundaries and contour lines within the watershed. Local municipalities / regional districts should be contacted first to partner and borrow these data. The planning department of local municipalities / regional districts may have other mapping information that would assist in land cover delineation including maps of wetlands, ecologically sensitive areas, stormwater runoff, and/or information on riparian fish habitat. The Ministry of Water, Land and Air Protection (MWLAP) can be contacted to assist in data collection. Terrain Resources Information Management (TRIM) topographic maps should also be obtained. TRIM maps are mid-scale maps (1:20,000) and were compiled between 1980-1988, and may not present recent stream channels or roads. Agricultural land use information should also be compiled.

Other data sources that should be included if they are available are Forest Cover Maps (1:20,000) and Biogeoclimatic Ecosystem Classification (BEC) maps (1:20,000). These are available from the Ministry of Forests. Surficial geology maps, and community watershed maps may also be available from local municipalities and are helpful references in photointerpreting land cover. See SHIm Modules 1 and 2 for further details about data sources.

The assembly of good background and reference information about the watershed and riparian corridor will greatly assist with photointerpretation tasks. that can be obtained about the watershed and riparian corridor being inventoried and mapped, the easier it will be for the photointerpreter to delineate land cover polygons. Digital data sources should be obtained and compiled into GIS. If digital data sources are not available, hard copy maps or air photos can be scanned, and the required vector data can be digitised.

4.6.3 Photographs and Photointerpretation Tools

Colour aerial photographs are a preferable data source for land cover mapping (Miller et al., 2000). However, the interpretation of aerial photos requires the use of stereoscopic viewers, which often need training and experience to use efficiently. If the required skill level can be met, aerial photographs should be used as the data source for the photointerpretation. Air photos can be obtained from a number of retail outlets throughout the province including Data BC, see SHIM Module 2 for additional details.

Another tool used for interpreting aerial photographs is the dia-positive viewer. It involves using specific software and depth-enhancing glasses to interpret scanned aerial photographs. The dia-positive viewer is only compatible with Microstation© (GIS). Though it is a fairly new mapping tool, the dia-positive viewer is relatively inexpensive. It also requires less skill and experience to successfully operate than stereoscopic viewers.

In most cases, digital colour ortho-rectified photographs are the most appropriate data source for riparian land cover delineation to minimize costs and provide high resolution. An overall planimetric accuracy of ±1m can be achieved in ortho-rectified photographs, appropriate for large scale photointerpretation (Miller et al., 2000).

It is recommended that only the highest quality and the largest scale photographs be used in SHIM riparian land cover mapping. The quality of the mapping is highly dependent on the quality of the photographs. Good contrast in colours, optimal date for photography, and the time lapse between interpretation and photography dates are factors that influence the quality of the photointerpretation (Cousins and Ihse, 1998, Kadman and Harari-Kremer 1999). Photographs should be equal to, or larger than, the scale at which the final map will be presented. The optimal scale of the photographs, determined by the flying height of the plane, should be between 1:10,000 and 1:15,000, however many aerial photographs are derived at scales of 1:25,000 or 1:30,000.

4.7 Photo Pre-typing And Preliminary Field Reconnaissance

4.7.1 Photo Pre-typing

Land cover polygons are delineated based on the SHIM Land Cover Classification System (Table 4.1). Photo pre-typing involves all members of the photointerpretation team taking part in the delineation of the first few land use and land cover polygons (Fig 4.2). All land cover polygons should be drawn at a scale of 1:5000.

The SHIM Land Cover Signature Key should be used as a reference for photo pre-typing (Riparian Land Cover Key - Appendix B). The key provides examples from the orthophotographs and the ground view for each land cover class. Use of the SHIM Land Cover Signature key ensures consistent interpretation of land cover classes, both within and between projects (Lund 1997). Land cover pre-typing should be completed before field reconnaissance.

4.7.2 Field Reconnaissance

Field reconnaissance involves verifying pre-typed land cover polygons. Field reconnaissance allows the photointerpreter to verfiy accuracy of polygons and true land cover classes. This step is essential to calibrate photointerpretation and true land cover. Field reconnaissance should also provide insight for access and logistics for field sampling.
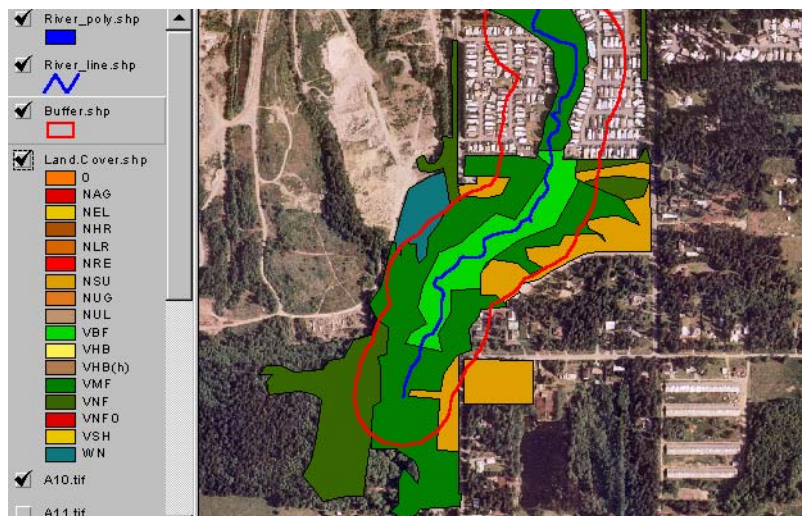

Figure 4.2 Photo pre-typing of the Little Campbell River riparian corridor, Langley, B.C.. The watercourse is shown in blue, the project area and 100m riparian corridor in presented in red.

4.8 Secondary Photo Pre-typing

4.8.1 Delineating the Watercourse and Project Area

This portion of the SHIM method protocol should be used to compile all existing information into a compatible GIS project. At this point the known watercourse should be delineated on a map (Fig 4.3); the resolution of the watercourse on photos and maps will be dependent on the scale and resolution of the compiled data and on the density of riparian cover over the stream.

The project or study area can then be defined by creating 100m delineated buffers around the mapped watercourse. The "Convert to Buffer" feature in GIS (ESRI ArcView) can be used. If the stream is composed of both line and polygon themes, 100m buffers should be applied to both of these themes (Fig 4.3). The "Merge Features" function can then be used to merge the two buffer themes together and create a single buffer theme for the project area. The 100m buffer theme should be modified so that only the outline is viewed along with the stream watercourse line.

4.8.2 Delineating Land Cover Polygons

A specific land cover theme should be created for delineated polygons. Land cover should be delineated within the 100m watercourse buffer, although it can extend beyond this buffer to include the furthest boundary of polygons found in the 100m area (Fig 4.3). The minimum mapped unit should be approximately 20m × 20m (400m²), however a minimum polygon size of 5m × 20m (100m²) can be used to identify small linear strips of riparian vegetation and hedgerows. The land cover signature key (Appendix B) can be used to help guide the process of delineating land cover polygons. A land cover polygon should be classified, based on the SHIM classes (Table 4.1), and the class code and class name should be entered into the land cover theme attribute table in GIS. This coding or name can be used to view the different classes of the riparian land cover.

Two additional fields (or columns) should be added to the land cover theme attribute table and titled "Degree of Confidence" and "Area". The "Degree of Confidence" is ranked code applied by the photointerpreter to each delineated polygon. This code is intended to describe the level of confidence, or reliability assigned to classified land cover polygon. We propose that the ranking system be based on a numeric scale of 1-5; with 5 being the highest estimate of confidence, and 1 being the lowest estimate of confidence. The coding is intended as an estimate of the difficulty of making the interpretation due to polygon complexity and in turn which polygons should have field reconnaissance. The area of each polygon should be calculated using the "Calculate" GIS feature. It is recommended that when approximately one half of the project riparian area has been classified, field sampling should begin to validate classified polygons.
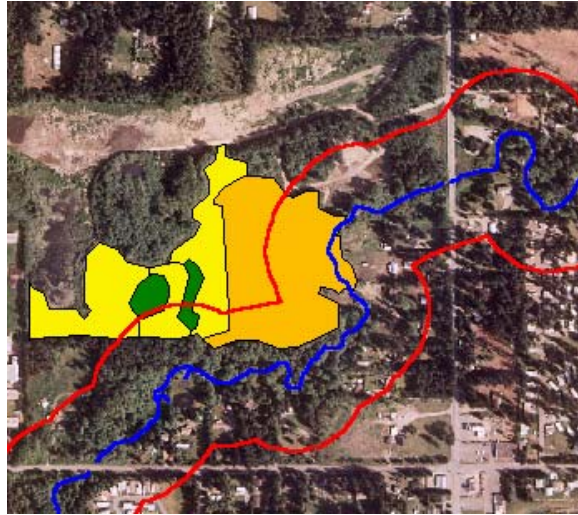
Figure 4.3 Land cover polygons should delineated to their furthest for each land cover class; even beyond the 100m riparian corridor. The stream location is shown in blue, the 100m corridor around the stream is presented in red..

4.9 Field Sampling

Sampling and reconnaissance is required to: (a) confirm polygon class designations and boundaries, (b) collect more detailed data than can be delineated from the photointerpretation, and (c) develop or refine the classification of units. Below are outlined SHIM required steps needed to design a field sampling plan, and choose one of three riparian sampling methods.

4.9.1 Designing a Sampling Plan

A sampling plan is essential for focussing fieldwork to confirm and refine pre-typed riparian polygons. When preparing a sampling plan the project team should consider the following:

- *Budget;*
- *Access and topography;*
- *Goals of the study. Additional data collection for sampling, including polygon attributes, and wildlife presence, wildlife habitat, or coarse woody debris;*
- *Size (area) of the riparian area;*
- *Field knowledge and skill level (Land cover classification, sampling techniques, vegetation identification) of the field crews.*

A sampling plan including the location and number of riparian transects applied should be assigned to based on the above project / area

considerations. An overview field map of the watershed area should be created to reflect the location and number of riparian transects.

<u>*Note:*</u> *Land owner permission (public or private) should be granted prior to sampling riparian areas in the field.*

4.9.2 Sampling Methods

The intensity of field sampling is a main consideration effecting the reliability of the photointerpretation. Often increased reliability of land cover polygon delineation and classification is best achieved through greater experience and validation through field sampling. Three field sampling methods for riparian corridors have been identified. Choose one method which best reflect your project goals and budget.

Method 1: *Record riparian land cover classes while traversing upland cross-sections during SHIM stream survey (also see Cross-section 4.11). The transect starting point should be located at the end of the floodplain and continue for at least 50m. Your GPS unit, compass on set a specific bearing and traversing tight chain should be used to determine the location and extent of each transect and land cover class. A change in riparian land cover should be recorded by distance and bearing or GPS co-ordinate. The minimum land cover class collected should be 5m. The initiation of a new land cover class the class type, code, qualifier and structural stage should be recorded. Field notes and records should enable the project team to determine the approximate UTM co-ordinate for each change and extent of land cover class. This is the least intense and costly sampling method.*

Method 2: *Use your assigned land cover class confidence ranking values to determine the areas needing field sampling. Transect locations should be selected prior to initiating field sampling. Transects selection should be based on: (a) 10-20% polygons with high to moderate degree of confidence, (b) at least 80% polyogns with low degree of confidence. At least 5% of the entire study should be field sampled. Field photos should be assigned transects without polygon / land cover class assignments. A greater number of transects should be planned to allow field crews to drop inaccessible transects.*

Transect location should be determined using UTM co-ordinates from your map and GPS unit. Use northings and eastings (x and y) co-rodinates to locate the stream centre line. Local land marks or knowledge can be used to locate stream centres. From this point, determine the downstream compass bearing. Perpendicular transects (+ 90º) can be located for left and right banks. This sampling method provides a moderate field sampling intensity including time and cost.

Method 3: *Apply random sampling across all land cover classes to determine the approximate accuracy of interpreting each class. Point samples for each polygon should be used to collect this information. Prior to field sampling, the co-ordinate location of point samples can be generated from GIS base maps. This information should be transferred from the GIS to the field photographs to be used for reference for your GPS unit in the field. Greater than 5% of the study area is sampled with*

this method. This method is the most intensive and requires the greatest amount of time and budget.

All three field sampling methods should include: (a) observed class for each area and transect based Table 4.1 (SHIM Land Cover Classes), (b) Land cover class qualifiers and (c) descriptions of cover structural stage. The visible dominant and sub-dominant plant species should also be recorded. Observations made in the field should focus on homogenous land cover within polygons and avoid transition zones between land cover classes.

Depending on the specific goals of each inventory, additional information should be collected in the field to describe land cover. This information can include:

- *detailed inventory of all vegetation;*
- *counts of coarse woody debris;*
- *wildlife species found within the plot;*
- *diameter at breast height (dbh), height of significant trees;*
- *description of the site's soil (e.g. soil pit sampling).*

4.10 Field Data Integration And Final Photo-typing

4.10.1 Adding Field Data to the GIS

Following field sampling, collected data should be added to the compiled GIS project information. If a GPS unit was used to collect field data points, the x and y co-ordinates and associated notes for each point should be downloaded and added to the GIS project (each day). Hardcopy field notes and data should be entered electronically (MS Excel to dbf format for ESRI ArcView) to incorporate into the GIS project. Field notes (bearings, distances) should be used to estimate X and y co-ordinates from the original x/y starting point. Additional field notes should be added as comments to attribute tables. Tables can be imported into ArcView GIS using the "Add Event Theme" function. This theme should now illustrate all the sample data points collected in the field.

4.10.2 Final Photo-typing

Field sample data should be compared with pre-typed photo polygons for riparian land cover. This review should compare and contrast the field and map based data by:

- *identifying whether land cover or land use classes are under/over represented in pre-typing polygons;*
- *building experience in classifying polygons from photos based on calibration from field observations;*
- *understanding the degree of variation in observed characteristics between and within land cover classes.*

During the final photo typing, corrections should be made to the pre-typed data based (attributes and boundaries for each polygon) on field sampling experience. When the polygon delineation and attribute coding is completed, a thorough edit of the database and map against the original air or ortho-rectified photos is required. Final riparian land cover should be carefully reviewed to ensure the classes are correct, GIS polygons are closed areas, structural stages and class qualifiers are applied (Fig 4.4).

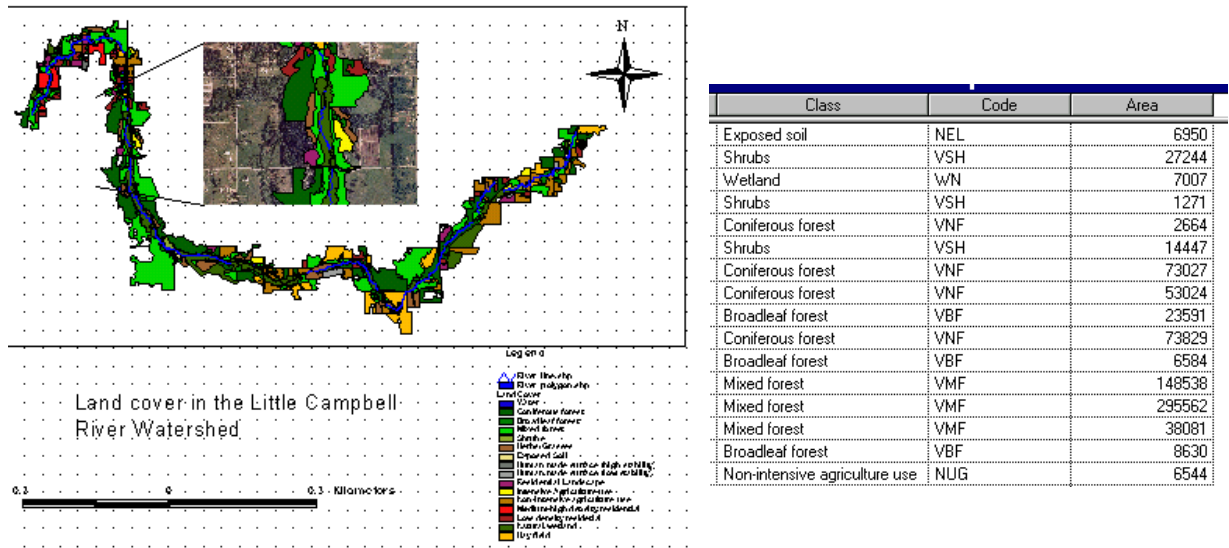| Class	Code	Area
Exposed soil	NEL	6950
Shrubs	VSH	27244
Wetland	WN	7007
Shrubs	VSH	1271
Coniferous forest	VNF	2664
Shrubs	VSH	14447
Coniferous forest	VNF	73027
Coniferous forest	VNF	53024
Broadleaf forest	VBF	23591
Coniferous forest	VNF	73829
Broadleaf forest	VBF	6584
Mixed forest	VMF	148538
Mixed forest	VMF	295562
Mixed forest	VMF	38081
Broadleaf forest	VBF	8630
Non-intensive agriculture use	NUG	6544

Figure 4.4 Final riparian land cover map and attribute table for the Little Campbell River. Note land cover polygons extend beyond 100m riparian corridor.

4.10.3 Interpretive Mapping

The polygon attribute files for land use and land cover should contain a complete set of core attributes for each polygon (class names, class codes, and area), as well as any information collected during field sampling. GIS projects and software are capable of producing colour themed maps and summary statistics. Maps can be displayed in many forms and can include other important SHIM or watershed based themes including: fish habitat, sensitive areas, impervious surfaces, wildlife habitat, stormwater runoff, cadastral, topography.

4.11 Detailed Stream Channel Cross-sections

A standard SHIM survey involves collection of stream channel wetted, bankfull and floodplain widths and depths as a general sample of stream conditions along the

channel. When channel complexity increases, more detailed SHIM corss section survey procedures and tools are needed to sample and describe these channel areas. More precise measurement of channel shape in conjunction with descriptions of upland slope and condition can aid in development of hydraulic models used for regional flood planning. This information is becoming of ever-greater importance as urban development of headwater areas in British Columbia continues to increase. Outlined below are the specific field procedures and measurement points for undertaking detailed channel cross-sections, as well as description of the accompanying ArcView Cross-Sectional tool designed to graphically display the collected data.

4.11.1 Cross-sectional measurement points

Channel measurements are taken using a folding ruler and a flexible tape measure stretched perpendicular to the direction of stream flow. A handheld clinometer and a flexible tape measure are used for determinations of upland slope. Required cross-sectional measurements of stream channel widths, depths and elevations as well as upland riparian features are based on the following survey points defined in Figure 1 below:
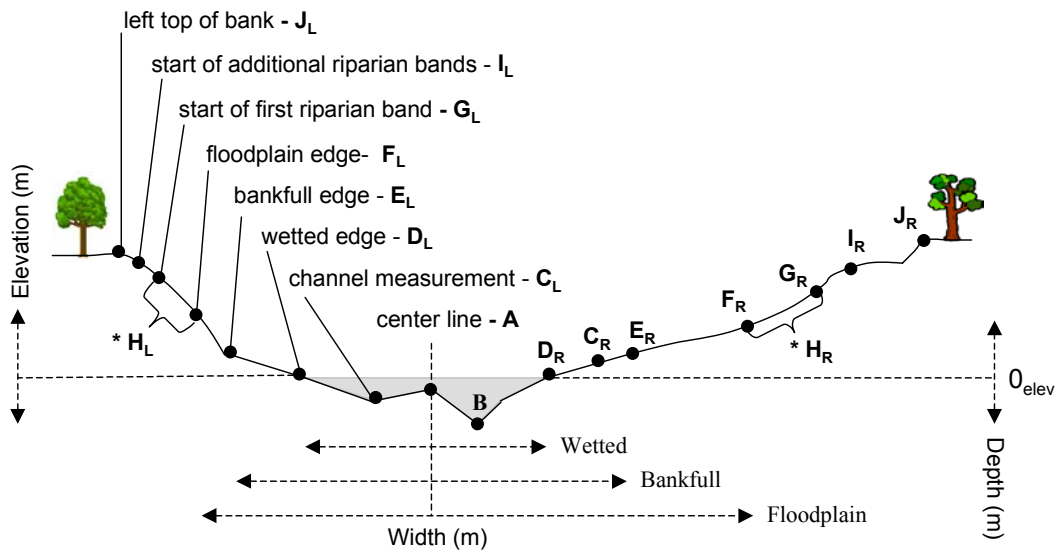

Figure 4.5 Cross section measurement points.

A – channel center line (midpoint of bankfull width)

B – thalweg (deepest channel measurement, may be left or right of center line)

C$_L$ – left channel measurements (CL1 to CL3) – may be taken below or above water line

C$_R$ – right channel measurements (CR1 to CR3) – may be taken below or above water line

D$_L$ – left wetted channel edge

D$_R$ – right wetted channel edge

E$_L$ – left bankfull edge

E$_R$ – right bankfull edge

F$_L$ – left floodplain edge

F$_R$ – right floodplain edge

G$_L$ – beginning of first left bank riparian band

G$_R$ – beginning of first right bank riparian band

*H$_L$ and/or *H*$_R$: measured when a strip of vegetation is too narrow to include as a distinct riparian band, yet is considered to represent a significant change in bank slope.

I$_L$ - beginning of additional riparian band(s) for left bank

I$_R$ – beginning of additional riparian band(s) for right bank

J$_L$ – top of bank location for left bank

J$_R$ – top of bank location for right bank

<u>*Note:*</u> *Left and right banks are determined facing downstream.*

4.11.2 General Field Protocol for Detailed Cross-sectional Measurements

1. Stretch out tape measure between two partners and measure/record bankfull width

2. Go to defined stream center line (midpoint of bankfull width)

3. Measure/record stream center line depth/elevation

4. One partner (who will be the operator of the GPS unit) stays at stream center line for the duration of the channel measurements and holds the spool of the tape measure. The second partner (who will actively take channel measurements) then moves towards the right bank stretching out the end of the tape measure and using the folding vertical ruler to take multiple measurements of right channel widths and depths/elevations and wetted right channel width. After each channel measurement this partner calls out the associated values to the GPS operator, who will repeat the numbers (to ensure that the measurement has been heard correctly in potentially noisy conditions) and record them in the GPS unit. Upon reaching right bankfull edge, measure/record right bankfull elevation.

5. Measure/record right floodplain width and elevation.

6. Return to stream center line point and move towards left bank repeating procedural steps 4 to 6 for all left channel points.

7. Upon completion of channel measurements the GPS operator joins their partner at the edge of the left floodplain. Begin measurements of any extra bands (if needed) or left riparian bands from this point.

8. The GPS operator again holds the spool of the tape measure while their partner stretches out the tape to the end of the extra band or to the beginning of the next riparian band. This partner calls out the associated width to the GPS operator who records the measurement.

9. The GPS operator then uses a clinometer to measure the slope of the left band (in conjunction with their partner providing an adjustment for ground-to-eye height as described in the following methods section) and also takes a compass bearing of the transect direction. Both these measurements are recorded in the GPS data logger.

10. Both partners advance up the left slope taking measurements of widths and slopes (and associated vegetation information) for each of the left riparian bands defined. Continue up left bank until all measured riparian band widths total 50 meters, or (in steeply sloped areas) extend the riparian measurements to 10m beyond the "top of bank", if not included in the 50m measurement.

11. Upon encountering "top of bank", end the current riparian band at this point and record a "Yes" in the appropriate data field in the GPS unit.

12. Both partners then walk across the stream channel to the right floodplain edge and repeat procedural steps 7 to 12 for the right bank upland measurements from this point.

Note: as an alternative or supplement to tape measurements, "top of bank" and riparian band breaks may be collected directly as GPS point features .

Note: *a) in the standard SHIM procedures wetted, bankfull and floodplain heights were measured as depths (+) relative to the stream bottom at channel center line, whereas; b) in the detailed SHIM cross-sectional procedures channel, wetted, bankfull and floodplain heights are measured as depths (-) or elevations (+) relative to the stream water surface level or deepest point in stream channel (if dry).*

4.11.3 Measurement Methods

All measurements of cross-sectional channel widths are determined relative to the stream center line, while measurements of depth (-) and elevation (+) are determined relative to zero elevation at the level of the water surface or, if the stream channel is completely dry, at the level of the deepest point in the stream channel.

Depths: *measured by an individual holding a folding ruler vertically upright from the wetted stream bottom. Markings from the ruler are read off at the water surface for associated depth measurements taken at multiple points within the wetted stream channel (CLs and/or CRs). (Figure 2). All depth measurements (below the water surface) are recorded as negative values (-).*

Elevations: *measured by an individual holding a folding ruler vertically upright from the edge of the water surface (D) while simultaneously holding one end of a tape measure. For stream channels that are dry the ruler is held vertically upright from the bottom substrate. A partner stretches the other end of the tape measure to the appropriate channel measurement point (i.e., CL, CR, E or F). The first individual then holds their end of the tape measure horizontal to the folding ruler and reads off from the ruler the associated elevation measurement for the surveyed point (Figure 2). Elevation measurements are recorded as positive values (+). For sections of the stream channel that are dry, channel measurements (including CLs, CRs or center line) are measured as elevations (+) relative to the surface level of the existing water flow. If the entire stream channel is dry (no flowing water), then measurements for all channel features are recorded as elevations (+) relative to the deepest point of the channel (B).*
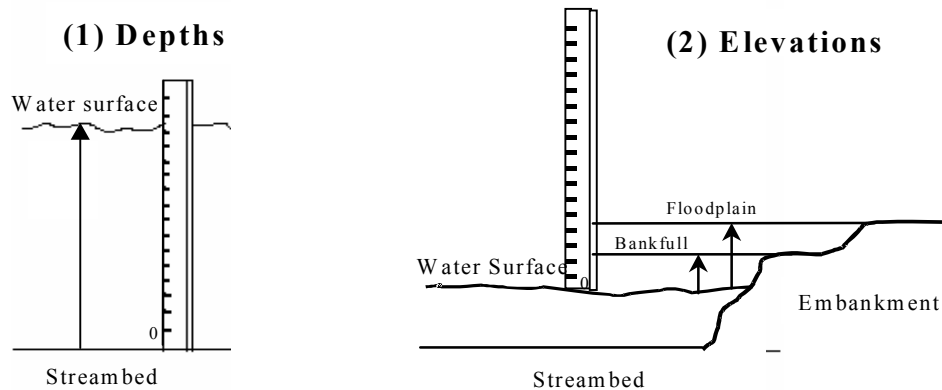
(1) Depths

Water surface

0

Streambed

(2) Elevations

Floodplain

Bankfull

Water Surface

0

Embankment

Streambed

Figure 4.6 Depth and elevation measurements used in the detailed channel methods.

> **Widths:** *determined by anchoring one end of a flexible tape measure (either by one partner holding a tape end or else securing it with a rock or stick) while stretching the other end across to a desired survey point. The measured distance is then read off from the markings indicated on the tape.*
>
> **Slope:** *determined in degrees with a clinometer, a sighting device used to measure the angle of a line of sight above or below horizontal. To use a clinometer, you look through the eyepiece with one eye to see the angle measuring scale and a horizontal line. With the other eye, you sight on the point of land you want to measure. When the horizontal line is aligned with your survey point, you simply read the scale to find the gradient (Figure 3).*
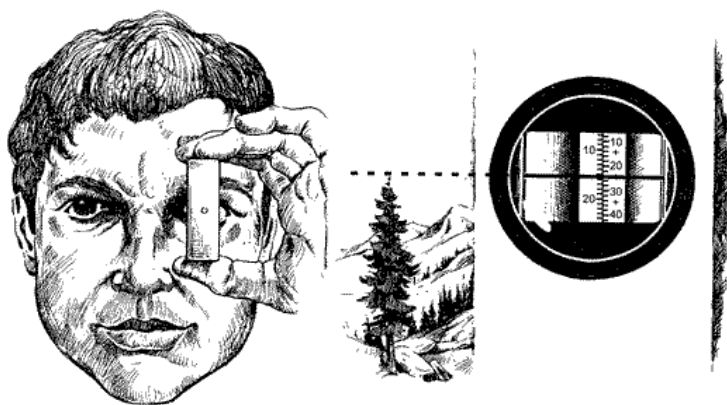
Figure 4.7 Slope measurements with a handheld clinometer.

> *Gradient is a measure of how quickly the land falls (or rises) over a measured horizontal distance. The higher the gradient, the steeper the slope. Steep, high gradient slopes lose height quickly over short distances, whereas gentle, low gradient slopes lose very little height over comparable distances. To use the clinometer in the field, first determine*

the height from the ground to the eyes of the person holding the instrument. This height can be flagged on a pole or stick as an adjustable siting marker, which will be held vertical from the base of the survey point by a second team member. All clinometer readings should then be taken in line with this marker to adjust for individual variations in observer height (Figure 4). Before commencing measurements of the slope, determine the aspect (direction that the slope is facing) with a magnetic compass (correctly adjusted for declination).
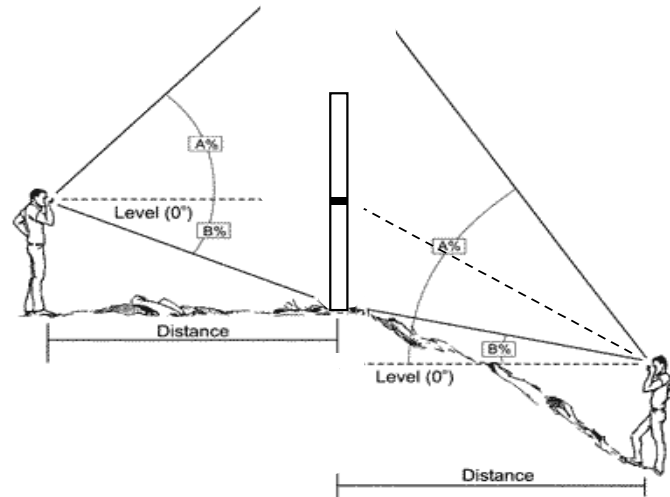
Figure 4.8 Adjusting for ground to eye height when taking clinometer measurements.

4.11.4 Channel Measurements

Center line: no width is taken here (only depth or elevation), as the channel center line (A) provides the zero reference point for all cross-sectional width measurements. Accurate spatial co-ordinates for this point are captured with a Trimble Pathfinder GPS unit.

Left channel widths (CL1, CL2 and CL3): measured for each by stretching a tape measure from the stream center line (A) and determining incremental widths across the channel (Figure 5). One to three channel widths may be taken in conjunction with depths or elevations to provide a good representation of the channel bottom. A separate left channel width (D_L) is taken at the wetted edge of the stream.

Right channel widths (CR1, CR2 and CR3) measured by stretching a tape measure from the channel center line (A) and determining incremental widths across the channel (Figure 5). One to three channel widths may be taken in conjunction with depths or elevations to provide a good representation of the channel bottom. A separate right channel width (D_R) is taken at the wetted edge of the stream.

Wetted Width

Center line (A)

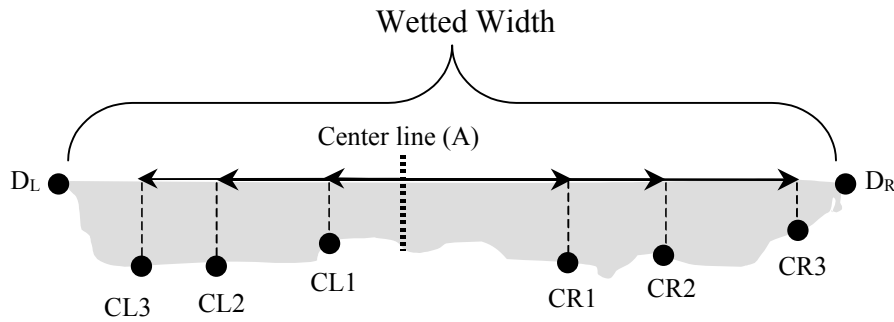D_L CL3 CL2 CL1 CR1 CR2 CR3 D_R

Figure 4.9 Incremental channel width measurements taken from the channel center line.

Thalweg *(B): the deepest point captured in the stream cross-sectional depth/elevation measurements. Thalweg may be left or right of the channel center line.*

Wetted channel width: *the total distance from D_L to D_R. Left and right wetted channel widths are measured separately from the channel center line. No depth is taken at the wetted edges, as the water surface represents the zero reference point for measured depths and elevations.*

Bankfull width: *measured by stretching a tape measure from left bankfull edge (E_L) to right bankfull edge (E_R). Alternatively, this can be measured as the combined separate distances of center line to left bankfull edge (E_L) and center line to right bankfull edge (E_R).*

Left floodplain width: *measured by stretching a tape measure from left bankfull edge (E_L) to left floodplain edge (F_L).*

Right floodplain width: *measured by stretching a tape measure from right bankfull edge (E_R) to right floodplain edge (F_R).*

Right and left extra bands *(H_L and H_R): measured by stretching a tape measure from edge of floodplain (F_L or F_R) to end of first extra band. Only the slope and width of these bands are recorded. As many as two strips may be measured for each bank.*

4.11.5 Riparian Measurements

Left riparian bands: *measured by stretching a tape measure from start of first riparian band (G_L) to beginning of next riparian band (I_L). Repeated in a continuing sequence for each distinct riparian band identified (e.g., I_L to J_L etc. for a possible total of 1 to 4 left riparian bands). Gradient of each riparian band is also determined from G_L to I_L, I_L to J_L, etc. using a handheld clinometer. Widths are determined along the slope of the embankment, providing a measure of slope-distance for each of the left bank riparian bands. A compass bearing for the left slope is taken at the commencement of the first riparian band.*

Right riparian bands*: measured by stretching a tape measure from start of first riparian band (G_R) to beginning of next riparian band (I_R). Repeated in a continuing sequence for each distinct riparian band identified (e.g., I_R to J_R, etc. for a possible total of 1 to 4 right riparian bands). Gradient of each riparian band is also determined from G_R to I_R, I_R to J_R, etc. using a handheld clinometer. Widths are determined along the slope of the embankment, providing a measure of slope-distance for each of the right bank riparian bands. A compass bearing for the right slope is taken at the commencement of the first riparian band.*

Left top of bank (J_L)*: no additional measurement for this point is required in the field. Simply enter a coding of (Yes) in the SHIM field data logger if the end of an identified riparian band represents the left top of bank. An algorithm calculating the distance from the stream center line to the designated left top of bank point will be activated automatically in the SHIM cross sectional tool extension.*

Right top of bank (J_R)*: no additional measurement for this point is required in the field. Simply enter a coding of (Yes) in the SHIM field data logger if the end of an identified riparian band represents the right top of bank. An algorithm calculating the distance from the stream center line to the designated right top of bank point will be activated automatically in the SHIM cross sectional tool extension.*

4.11.6 Definition of Terms

Active floodplain: *a level area adjacent to a stream channel, having its lower elevational extent defined by the bankfull discharge level, that is occupied by standing or flowing water on average once in five years[1]. The active floodplain can be identified by:*

- *flood channels free of terrestrial vegetation*
- *rafted debris or fluvial sediments newly deposited on the surface of the forest floor or suspended on trees or vegetation*
- *recent scarring of trees by material moved by flood waters.*

Bankfull width: *the width of the wetted stream channel at the normal high water level attained during mean annual flow events. A number of criteria can be used to determine bankfull edge in the field. The following should be considered:*

- *a change in vegetation (>2 years old) from bare ground, with no trees, to vegetated ground with trees, from no moss to moss covered ground, or from bare ground to grass-covered ground, particularly in range lands (i.e., where rooted, terrestrial vegetation begins);*
- *the highest elevation below which no fine woody debris (needles, leaves, cones or seeds) occurs; and*
- *a change in texture of deposited sediment (e.g., from clay to sand, or sand to pebbles, or boulders to pebbles).*

Riparian bands: *distinct associations of hydrophilic vegetation (plants adapted to continuous high moisture content) occurring next to the banks of surveyed streams, lakes, and wetlands, as well as adjoining*

upland vegetation influenced by the adjacent stream or ponded water. Each riparian band represents uniform slope and vegetation, and a change in either of these requires delineation of a new band.

Slope-distance: *measurement of distance (width) along a gradient (as opposed to horizontal distance)*

Thalweg: *the lowest point along the length of a measured stream or river bed.*

Top of Bank: *the point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break; and, for a floodplain area not contained within a ravine, the edge of the active floodplain of a stream where the slope of the land beyond the edge is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the edge[1]. Top of bank is a necessary prerequisite for establishing the boundaries of Fisheries Sensitive Zones (FSZ). FSZs are an important planning component in determining minimum setbacks required for development adjacent to a stream.*

[1] *Millar, J.N., N.Page, M. Farrell, B. Chilibeck, and M. Child. 1997. Establishing Fisheries Management and Reserve Zones in Settlement Areas of Coastal British Columbia. Canadian Manuscript Report of Fisheries and Aquatic Sciences N0. 2351.*

[2] *Taken from the Streamside Protection Regulations pursuant to Section 12 of the BC Fish Protection Act (2001).*

4.12 Arcview Cross-sectional Diagram Tool Extension

The Cross-Sectional Diagram Tool extension was developed to generate diagrams of spatially accurate stream cross-sectional profiles based on GPS collected point data for stream widths and depths. This information can be used in hydraulic analyses that help determine stream water-surface elevations at periods of high flood and can assist planners in defining floodway limits. This guide will provide step-by-step instructions in the application of the Cross-Sectional Diagram Tool and is designed for the basic ArcView user. Although the extension has been developed to allow display of channel cross-sections using ArcView, the generated datasets are easily transferable for cross-sectional analyses in other software packages such as Microstation and ArcInfo. The Cross-Sectional tool will create profiles of stream cross-sections using information collected with either the standard SHIM cross-sectional procedures (i.e., simple measurements of wetted, bankfull and floodplain widths/depths) or the more detailed SHIM cross-sectional procedures (i.e., measurements of channel, wetted, bankfull and floodplain widths and depths/elevations).

4.12.1 Loading the Extension in ArcView:

Copy the shimxsv1_5.avx file provided into the Ext32 subfolder on your computer hard drive (C:\Esri\Av_gis30\Arcview\Ext32)

Open ArcView with a new project and in the project file menu go to File > Extensions, select the SHIM XS Diagram Tool extension and click OK.
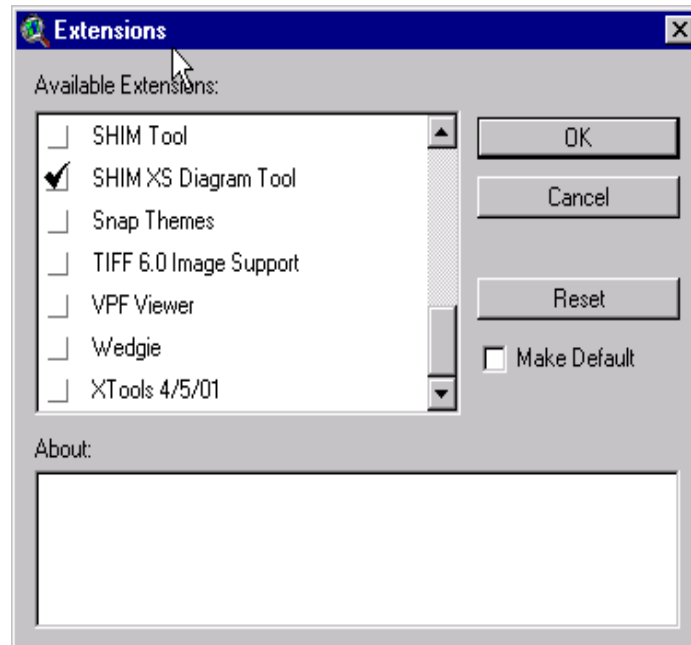

*Loading the extension will add the XS Diagram Tool icon* t◡ *view window.*

4.12.2 Displaying Stream Cross-sections

- *In the Edit View window's button menu click on the Add Theme tool and add a SHIM Cross-Section points theme to the view.*
- *Next click on the XS Diagram Tool icon ◡ and then click on any selected cross-sectional point within the Cross-Section theme.*
- *A diagram of the stream channel's cross-sectional profile at this location will be generated automatically based on the entered stream data points and internal algorithms for trigonometry coded within the extension. Three different levels of cross-sectional complexity are possible given the extent of point data collected in regard to channel widths/depths and whether information on riparian bands and top of bank has been recorded:*

I) A cross-sectional diagram of a simplified stream channel profile will be created when collected information is limited to point data on wetted, bankfull and floodplain widths and depths (i.e., standard SHIM stream survey protocol)
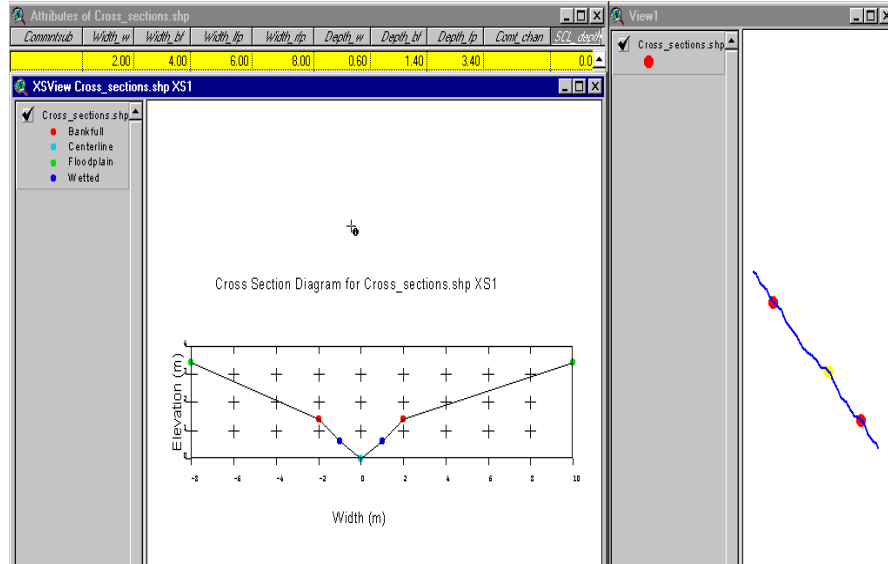

II) A more complete representation of the stream channel profile will be generated automatically if collected data includes detailed information on wetted channel bottom heterogeneity (i.e., multiple channel depth/elevation and width measurements), in addition to measurements of bankfull and floodplain widths/depths.
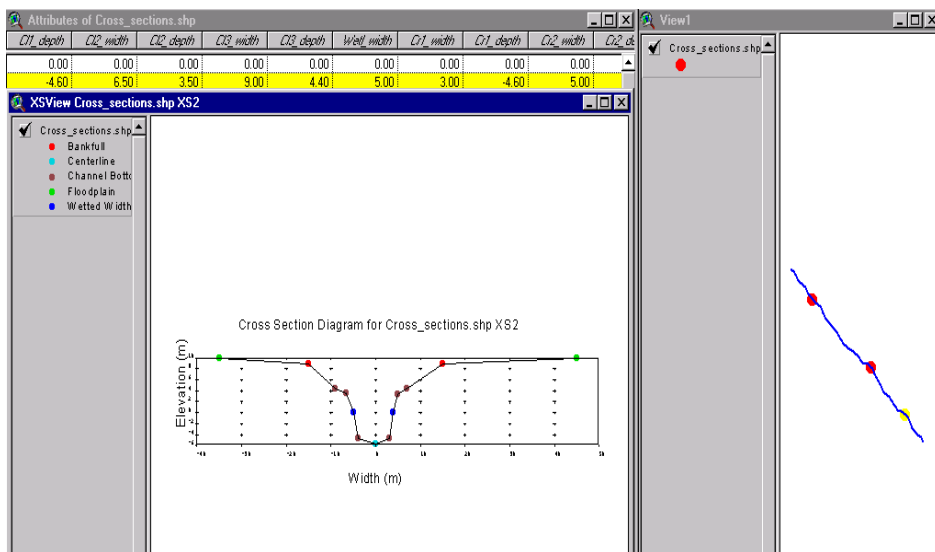
III) *The most complex cross-sectional profile illustrating details of both channel structure and the adjacent upland slope will be generated automatically if data collected includes information outlined for (ii) and additional accompanying information on riparian bands (i.e., widths and slopes) and top of bank location (i.e., detailed SHIM cross-sectional protocol).*
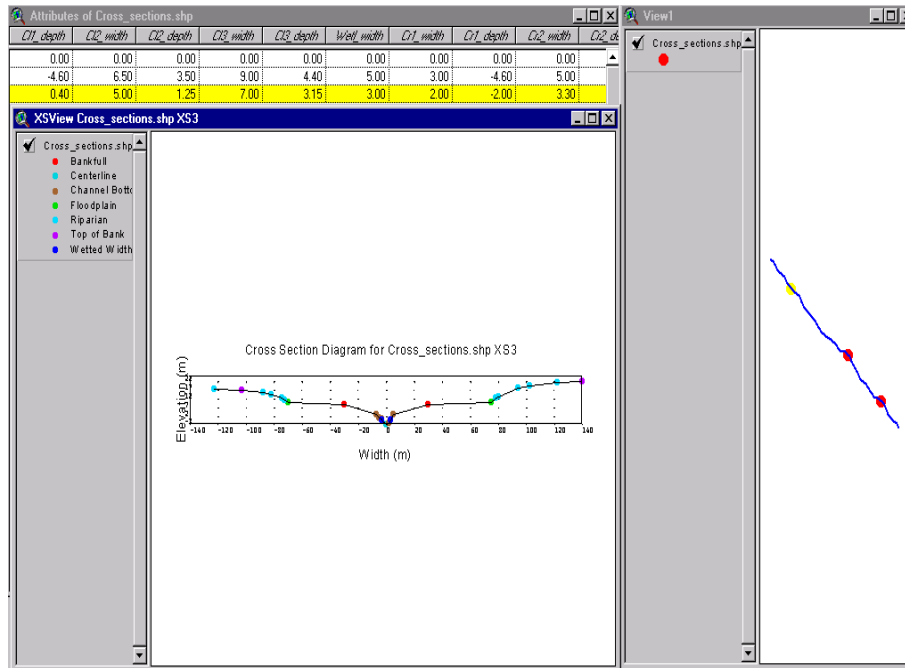

Selecting multiple cross-section points simultaneously will allow you to visually examine the change in hydraulic profile along the length of the stream.
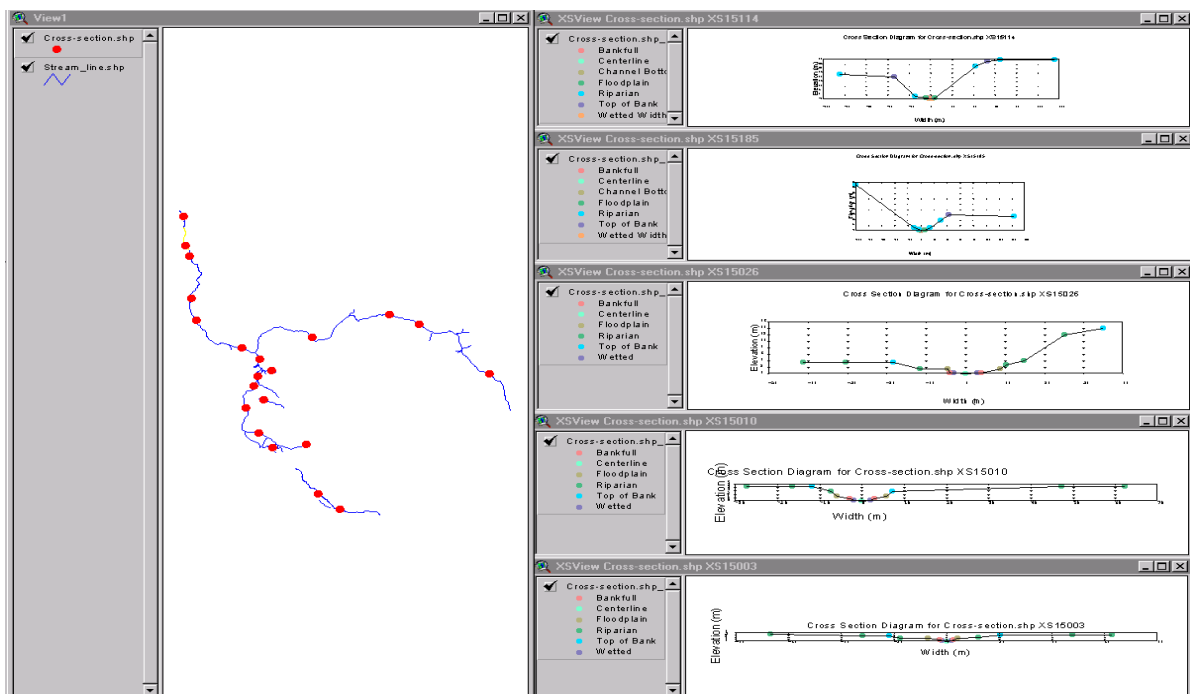
4.12.3 Displaying Cross-sectional Attribute Tables

The Cross-Sectional Tool Extension can be used to examine the stream channel attributes within a database (dbf) format. The dbf tables created can be exported to other software packages (e.g., Arc Info, Microstation, etc.) for GIS users who prefer to work outside the ArcView environment.

> 1) In the Edit View window select the "Add Event Theme" option which and bring up the associated menu box.
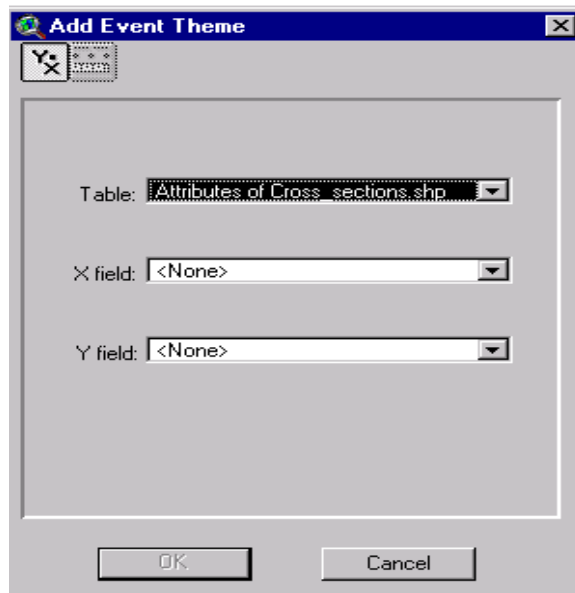
> 2) Scroll through the Table options within the menu to select a desired cross-section point. In the X and Y fields select Easting and Northing respectively; these last 2 fields will orient your cross-sectional features within a UTM coordinate system.

3) Clicking on "OK" will then bring up a shape file of the detailed cross-section attributes within the Edit View window.
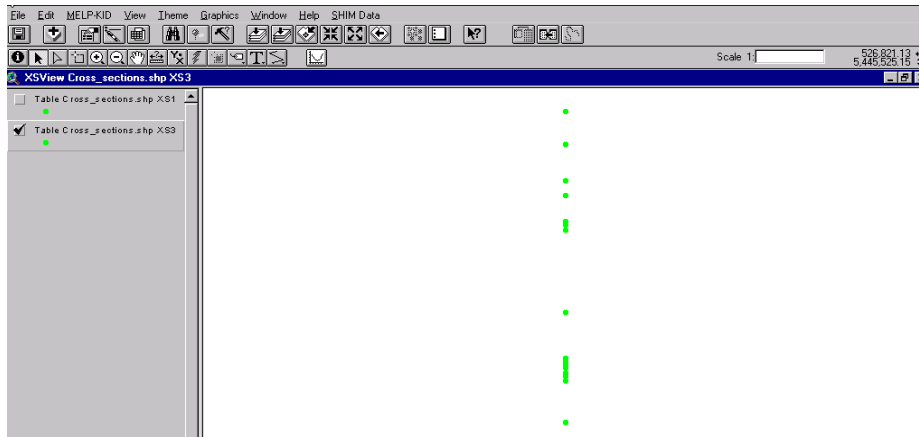
4) In the Edit View window's button menu click on the Open Theme Table tool ▦ to bring up the detailed attribute table for the selected cross section.

Shape	Station	Elevation	Label	RipClass	Easting	Northing
Point	0.00	-0.28	Centerline		585334.72	5443481.51
Point	-0.50	-0.24	Channel Bottom		585334.55	5443481.04
Point	-1.60	0.05	Channel Bottom		585334.19	5443480.00
Point	-2.30	0.10	Channel Bottom		585333.97	5443479.34
Point	-1.20	0.00	Wetted Width		585334.32	5443480.38
Point	0.50	-0.34	Channel Bottom		585334.88	5443481.99
Point	1.15	-0.24	Channel Bottom		585335.09	5443482.60
Point	2.50	0.23	Channel Bottom		585335.53	5443483.88
Point	1.93	0.00	Wetted Width		585335.34	5443483.34
Point	-2.95	0.22	Bankfull		585333.75	5443478.72
Point	2.95	0.22	Bankfull		585335.68	5443484.30
Point	-4.75	0.30	Floodplain		585333.17	5443477.02
Point	4.15	0.30	Floodplain		585336.07	5443485.44
Point	-63.26	54.86	Riparian	Mixed forest	585314.12	5443421.70
Point	-138.43	82.22	Top of Bank	Mixed forest	585289.65	5443350.62
Point	-188.37	84.84	Riparian	Mixed Forest	585273.39	5443303.41
Point	65.43	51.72	Top of Bank	Mixed forest	585356.02	5443543.38
Point	122.00	-4.85	Riparian	Mixed forest	585374.44	5443596.87

The station field within this table represents channel feature widths (m) relative to the stream center line [negative values (-) representing widths on the left streambank, whereas positive values (+) represent widths on the right bank]. The elevation field (m) represents depths (-) or elevations (+) relative to the wetted surface level or, in the case of totally dry channels, the deepest point of the streambed. Easting and Northing fields define accurate geographic locations for surveyed channel points, based on the trigonometry of field measured slope-distances relative to the original GPS captured stream center line.

4.12.4 Spatial Display of Cross-sectional Features

Cross-sectional attributes collected using the SHIM methods are spatially linked to a GPS referenced stream center line (accurate to $\pm$ 5m). Consequently, all channel cross-section points have associated UTM coordinate locations that can be used to display the points on any underlying map or orthophoto backdrop. This mapping feature greatly enhances the ability to examine the layout of the stream corridor within the spatial context of the surrounding landscape.

- In the Edit View window double click on the selected Table_Cross sections.shp file that you added earlier as an event theme. This will bring up the Legend Editor for the event theme.
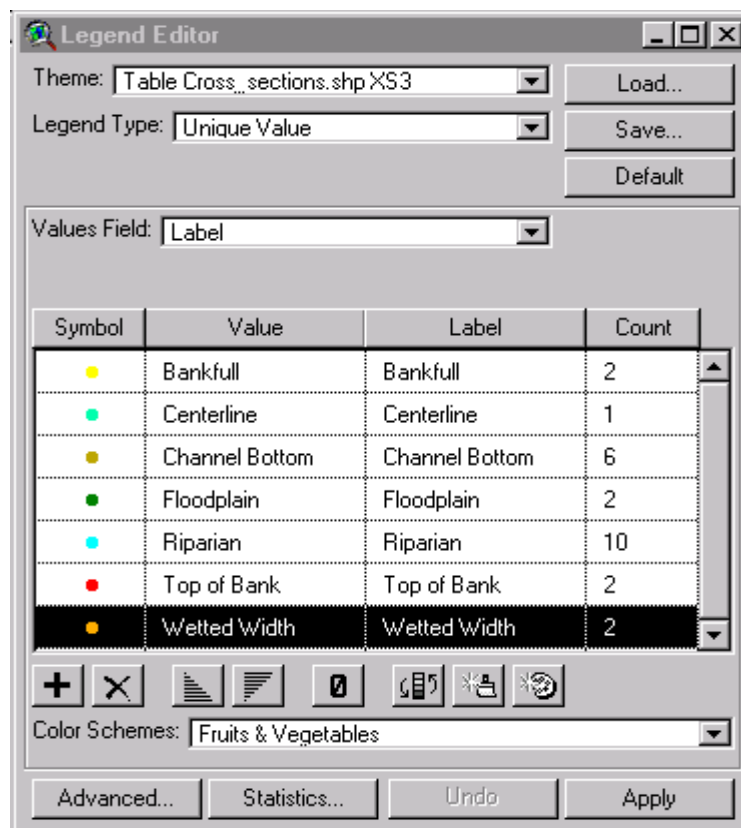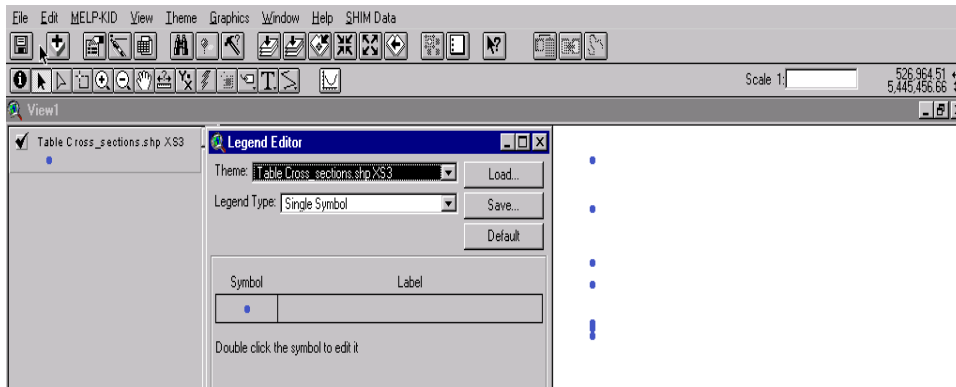
▪ *Click on Apply and unique colour identifiers will be created for each channel feature in the view.*
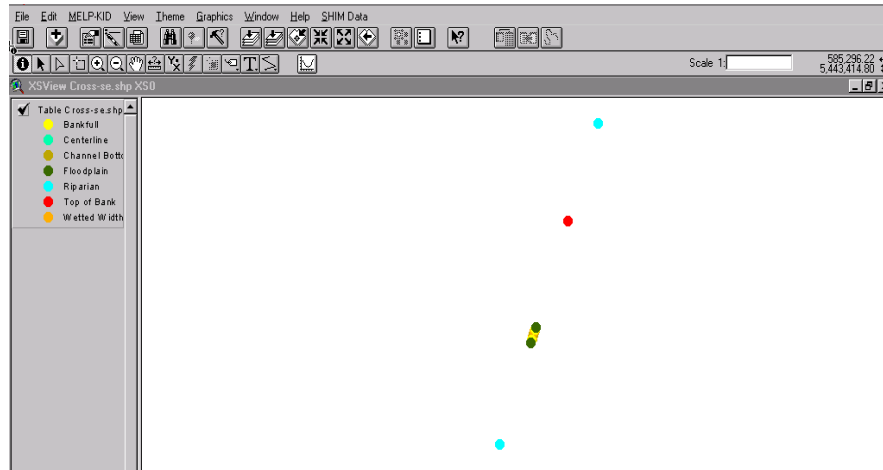
▪ *In the Edit View window click on the Add Theme tool* ⊞ *, select Image Data Source and scroll through your directories to select an appropriate orthophoto coverage to provide a visual backdrop to your surveyed stream channel.*
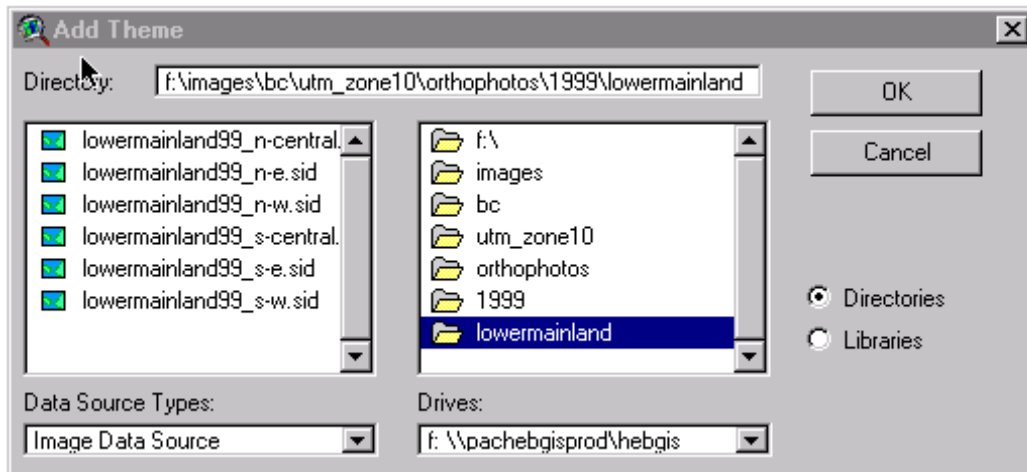
Acquiring current orthophoto coverage of the survey area is the responsibility of the proponent. As described in SHIM Module 2, orthophotos can be loaned through various regulatory agencies (e.g. FOC, GDBC, municipal governments) or purchased.

▪ *Displaying underlying orthophotos will improve the ability to resolve stream channel features in relation to the surrounding landscape.*
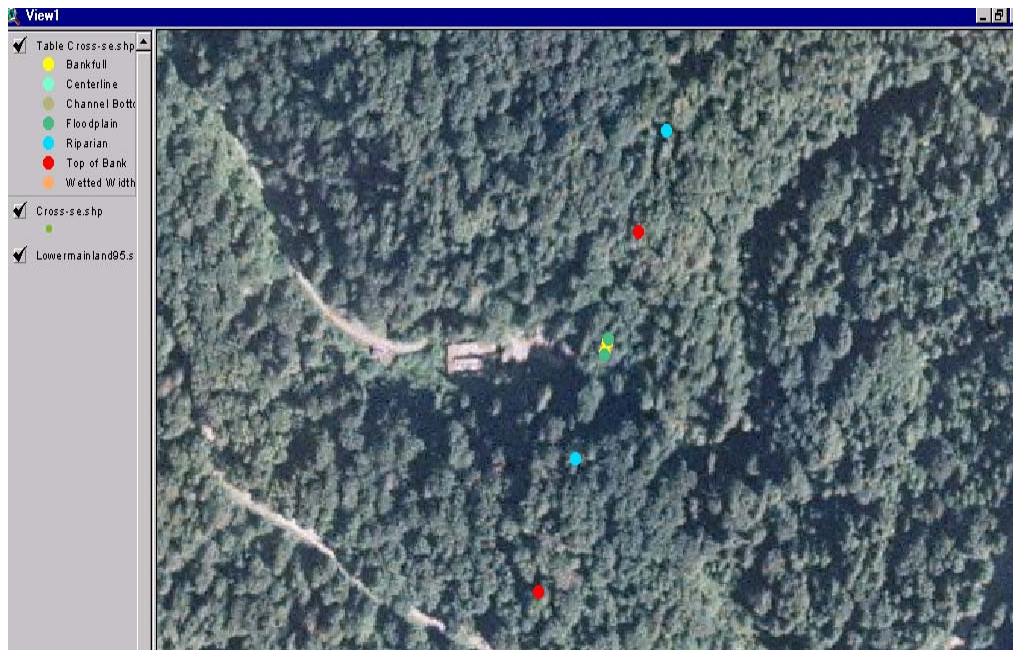
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	http://www.for.gov.bc.ca/RIC/pubs/TEVEG/PhotoStandards/index.htm

Table 4.1   SHIM land cover classification system

Land Cover Classes Used for Photointerpretation and Field Sampling

Class	Code	Description
Coniferous forest	VNF	This area has a natural tree crown cover of 20% or more of the total polygon area, and at least 80% of the trees are conifers
Broadleaf forest	VBF	This area has a natural tree crown cover of 20% or more of the total polygon area, and at least 65% of the trees are broadleaf.
Mixed forest	VMF	This area has a natural tree crown cover of 20% or more of the total polygon area, but of the total trees no more then 80% can be conifer and no more then 65% can be broadleaf.
Shrubs	VSH	The area has less than 10% tree crown cover and natural shrubs constitute 20% or more of the ground cover. Shrubs are defined as multi-stemmed woody perennial plants, both evergreen and deciduous. Qualifier: d
Herbs/grasses	VHB	The area has less than 20% tree cover, less than 20 % shrub cover, and 20% or more natural herbaceous cover. Herbs for this classification are defined as grass-like vascular plants, including ferns and forbs, without a woody stem. Some dwarf woody plants may be included in this category. A class qualifier must be assigned to this category. Qualifiers: ag, n, ur, r, d, and u
Bryophytes	VCR	The area has more then 5% vegetation cover and greater then 50% of the vegetation cover are mosses and lichens, such as in rock outcrops.
Rock	NNB	The area has less than 5% vegetation cover and the substrate is exposed rock, such as in natural rock faces, boulders, bedrock, or fragmented rock.
Exposed soil	NEL	Areas where recent disturbance, either human or natural, has exposed the soil substrate, such as in development sites or soil slides. The main characteristic is exposed soil under active erosion processes.

Human-made surfaces (high imperviousness)	NHR	Areas covered by highly impervious man-made surfaces such as pavement, concrete, and buildings with total impervious area >40%. This class can include industrial, commercial, and residential areas as well as roads and greenhouses. Qualifiers: ag, ur, r, and d
Human-made surfaces (medium imperviousness)	NMR	Areas covered by moderately impervious man-made surfaces with total impervious area between 10-40%. This class is similar to the human made surface (high imperviousness) class but more vegetation is present. Qualifiers: ag, ur, r, and d
Human-made surfaces (low imperviousness)	NLR	Areas of low impervious human made surfaces with total impervious area < 10%. Such areas may include low density suburban houses, barns, horse tracks, paddocks, or gravel or packed soil parking lots. Qualifiers: ag, n, ur, r, and d
Row Crops	NAG	Areas of agricultural crops and farmland. Agricultural areas where rows cannot be identified should be classified as Herbs/grasses with an agriculture qualifier.
Planted tree farm	NTF	Areas used as tree farms, including Christmas tree farms, ornamental tree nurseries, and fruit orchards.
Dug-out pond or reservoir	DOP	Dug-out ponds, either of natural or man made origin, which have been excavated and are maintained. They are mostly cleared of vegetation and may be under sudden human induced water fluctuations.
Natural wetland	WN	This class includes natural wetlands which are largely undisturbed by human modification and retain most of their natural characteristics.

Class Qualifiers Used for Photointerpretation and Field Sampling

Qualifier	Code	Description
Agriculture	ag	This area may be used for agricultural purposes including hay fields and grazing pastures.
Natural	n	This area is dominated by native herb/grass species and its appearance is not modified by human use.
Urban/residential	ur	This area is composed of residential lawns, and may contain clumps of shrubs and trees. Vegetation is controlled and maintained by fertilizing, weeding,

		controlled and maintained by fertilizing, weeding, mowing, and pruning.
Recreation	r	This area is used for recreational fields, with heavily controlled and highly maintained vegetation. Examples of this area include golf courses, school fields, or parks.
Disturbed	d	This area has been recently disturbed and is undergoing early successional stages. Vegetation may consist of native and non-native grasses and/or small shrubs, and small patches of exposed soil may be visible.
Unknown	u	The use of this area cannot be identified.

Land Cover Classes Used Only in Field Sampling

These classes cannot be identified from orthophotographs but should be applied, along with the above listed classes, during field sampling.

Class	Code	Description
Flood plain	VFP	Area of the flood plain subject to annual prolonged flooding. Scouring by high water flows may result in exposed soil or a cover of very flood tolerant species or annuals that germinate after flooding recedes.
Disturbed wetland	DWN	Ponds or wetlands which have been disturbed by digging or drenching but retain some natural characteristics such as well developed wetland vegetation and a fairly natural water fluctuation regime.

Qualifier	Code	Description
Veteran trees	v	The area includes young or mature forest with scattered large old trees within.
Wildlife trees	w	This qualifier will be used in combination with forest classes when snags are present and have significant potential wildlife value.

Vegetation Structural Stages Used Only in Field Sampling

Class	Stage	Code	Description
Shrubs	Low shrubs	3a	Communities dominated by shrub vegetation less than 2m tall; tree seedlings may be abundant; time since last disturbance is >20 years for normal forest succession.
Shrubs	Tall shrubs	3b	Communities dominated by shrub vegetation more than 2m tall; tree seedlings may be abundant; time since last disturbance is >40 years for normal forest succession.
Forest cover	sapling	4	Typically there is a high density of trees: the main characteristics of this stage are: trees that have overtopped shrub and herb layers where self thinning is not evident. Trees are usually younger than 40 years for normal forest succession.
Forest cover	young	5	The main characteristics of this stage is that self-thinning has become evident and the forest canopy shows three distinct layers (overstory, intermediate, and suppressed). Dominant trees are generally between 40 and 80 years of age.
Forest cover	mature	6	The main characteristic of this stage is the canopy has begun to open and the understory has become well developed. Dominant trees are generally older then 80 years.

Table 4.2 SHIM Riparian Land Cover Signature Key

Coniferous forest   VNF   *This area has a natural tree crown cover of 20 % or more of the total polygon area, and at least 80 % of the trees are conifers*

Broadleaf forest   VBF   *This area has a natural tree crown cover of 20 % or more of the total polygon area, and at least 65 % of the trees are broadleaf.*

Mixed forest   VMF   *This area has a natural tree crown cover of 20 % or more of the total polygon area, but of the total trees no more then 80 % can be conifer and no more then 65 % can be broadleaf.*

Shrubs   VSH   The area has less than 10 % tree crown cover and natural shrubs constitute 20 % or more of the ground cover. Shrubs are defined as multi-stemmed   woody perennial plants, both evergreen and deciduous.   Qualifier: d

Herbs/grasses   VHB   The area has less than 20 % tree cover, less than 20 % shrub cover, and 20 % or more natural herbaceous cover. Herbs for this classification are defined as grass-like vascular plants, including ferns and forbs, without a woody stem. Some dwarf woody plants may be included in this category.

A class qualifier must be assigned to this category.

Qualifiers: ag, n, ur, r, d, and u

Herbs/grasses   VHBag This area may be used for agricultural purposes including hay fields and -grazing pastures.

Agriculture

Natural   VHBn   This area is dominated by native herb/grass species and its appearance is not modified by human use.

Recreation   VHBr   This area is used for recreational fields, with heavily controlled and highly maintained vegetation. Examples of this area include golf courses, school fields, or parks.

Disturbed   VHBd   This area has been recently disturbed and is undergoing early successional stages. Vegetation may consist of native and non-native grasses and/or small shrubs, and small patches of exposed soil may be visible.

Urban/   VHBur   *This area is composed of residential lawns, and may contain clumps of shrubs and trees. Vegetation is controlled and maintained by fertilizing, weeding, mowing, and pruning.*

residential

Human-   NHR   *Areas covered by highly impervious man-made surfaces such as pavement, concrete, and buildlings with total impervious areas > 40%. This class can include industrial, commercial and residential areas.*

made

surfaces

(high

imperviousn

ess)

Human-made surfaces (medium imperviousness)	*NMR*	*Areas covered by moderately impervious man-made surfaces with total impervious area between 10-40 %. This class is similar to the human made surface (high imperviousness) class but more vegetation is present. Qualifiers: ag, ur, r, and d*

Human-made surfaces (low imperviousness)	*NLR*	*Areas of low impervious human made surfaces with total impervious area < 10 %. Such areas may include low density suburban houses, barns, horse tracks, paddocks, or gravel or packed soil parking lots. Qualifiers: ag, n, ur, r, and d*

Row Crops	*NAG*	*Areas of agricultural crops and farmland. Agricultural areas where rows cannot be identified should be classified as Herbs/grasses with an agriculture qualifier.*

Row Crops   *NAG*   *Areas of agricultural crops and farmland. Agricultural areas where rows cannot be identified should be classified as Herbs/grasses with an agriculture qualifier.*

Natural wetland *WN*   *This class includes natural wetlands which are largely undisturbed by human modification and retain most of their natural characteristics.*

Module 8

Photodocumentation

8.1 Purpose

The purpose of this SHIM Module is to develop a photo-document which characterizes SHIM activities and sites in the project watershed. This record is intended to augment data collected during the inventory program, and is useful in verifying field and site conditions.

8.2 Final Products

Completed photo-documentation of SHIM in-stream habitat, fish and riparian inventories should generate the following products:

1. *Digital photograph files of all watercourse reaches, fish habitat features, riparian land cover and representative captured fish in the project watercourse.*

2. *Photographs should be labelled with date, time, site location, watershed, and characteristics of the equipment (lens, f stop)*

3. *Completed photograph fields in the Site Card and Fish Collection Form.*

8.3 Introduction

Photodocumentation standards for B.C. are detailed in A Guide to Photodocumentation for Aquatic Inventories (RIC, 1996). The equipment required for this module includes:

1. *Camera (35mm single lens reflex (SLR) or digital) with a wide angle (28mm to 35mm lens);*

2. *Slide or print film (200, 400, 800 ASA). Type of film should be judged given the site conditions;*

3. *Scanner for digitizing photographs (or digital photos) is required. High digital resolution (>300dpi) is needed for photograph import into various maps and documents.*

8.4 Inventory Procedure

8.4.1 Site Photography

Photograph information should be documented on the Site Card or Fish Collection Form (see SHIM Module 6). The following photographs of a study area are required:

- *Riparian Inventory: One landscape (long horizontal axis) photograph of the left bank transect from the right bank bankfull margin, one landscape photograph of the right bank transect from the left bank bankfull margin, and a minimum of two discretionary landscape photographs of representative stand conditions or features (i.e., bank slumping, invasive species, etc.) must be taken.*

- *In-stream habitat inventory: One upstream-oriented and one downstream-oriented landscape (long horizontal axis) photograph must be taken at a representative location of each reach to show general stream characteristics including channel morphology, riparian vegetation, and fish habitat features. More than two photographs may be taken of a single reach at the discretion of the field staff. Photographs of reaches are recorded on the Site Card.*

- *Fish habitat features: One landscape (long horizontal axis) photograph must be taken of each fish habitat feature assigned a NID during the in-stream habitat inventory. The photograph should be taken from an angle that provides the best visual representation of the feature. More than one photograph may be taken of a single habitat feature at the discretion of the field staff. Photographs of fish habitat features are recorded on the Site Card.*

- *Fish: One landscape (long horizontal axis) representative photograph of each fish species collected must be taken and documented. Representative photographs of any fish that the crew is unable to identify, or of any diseased or parasitized fish must also be photographed. The quality of these photographs should enable verification of fish species identifications. Each photograph must include an object of scale, such as a ruler, to indicate the relative size of the fish. More than one photograph may be taken of each fish species at the discretion of the field staff. Photographs of fish are recorded on the Fish Collection Form.*

The following information must be recorded for each photograph:

- *roll number (roll #) - the film roll number corresponding to each photograph.*
- *frame number (frame #) - the negative frame number corresponding to each photograph.*
- *focal length (foc. lg.) - The focal length of the lens used to take each photograph, recorded in millimetres.*

- *date (date) - the date (day/month/year).*
- *direction (dir.) - the general direction of each photograph with respect to the site from which the photograph was taken, i.e., Up (upstream), Dn (downstream), XS (across the stream) or Bd (towards the stream bed).*
- *location - the location of the photograph must be determined using available mapping or a GPS unit, expressed as a UTM.*
- *comments - any relevant comments about the photograph should be recorded. These should be descriptive enough and concise enough to provide a caption for the photograph.*

8.5 Reporting

Agency partners should be consulted at the initiation of the project to determine if reporting requirements have changed for photodocumentation.

8.5.1 Required Inventory Data

The mandatory inventory data products for the Photodocumentation Review are:

1.   *Photograph Information including:*

- *roll number*
- *frame number*
- *focal length*
- *date*
- *direction*
- *location*
- *comments*

2.   *Digital Photograph Files*

A digital copy of all photographs is required. The CD must be referenced using the Project Code and labelled using the standards given in A Guide to Photodocumentation for Aquatic Inventories (RIC, 1996). The following requirements apply to data storage and presentation:

- *Scanning hardware requirements - at least 24bit, capable of 16 million true colours. A flatbed scanner with minimum 2400dpi and 600spi is suggested;*
- *File type – tagged information format file (TIFF) is required (ver. 6 preferred, ver. 5 acceptable; PC format). TIFF (ver. 5) will be much more portable to slightly older programs, however some improvements have been made for version 6, and can be read by most current software. See http://home.earthlink.net/~ritter/tiff/ for more information regarding TIFF file formats. (High resolution gif, jpeg files may also be suitable. Please contact agency partners for support);*

- Colour files are required;
- Resolution - Resolution requirements for slides is 1200 dpi, and for photographs (4"x6") is greater than 300 dpi.
- Scaling - Photographs must be scaled at 100%.
- Labelling - Digital images must be labelled using whiteboards (this will not work with post processing of images) or a software/graphics package to label the image before it is stored on CD (see example below)

Further information is available at http://www.infomedia.net/scan/The-Scan-FAQ.html

Yaakhsis Creek, Roll 2, Frame 11, 35mm, f3.5, 29/08/00, Up, Reach 1, Site 3, 250750E, 5485640N
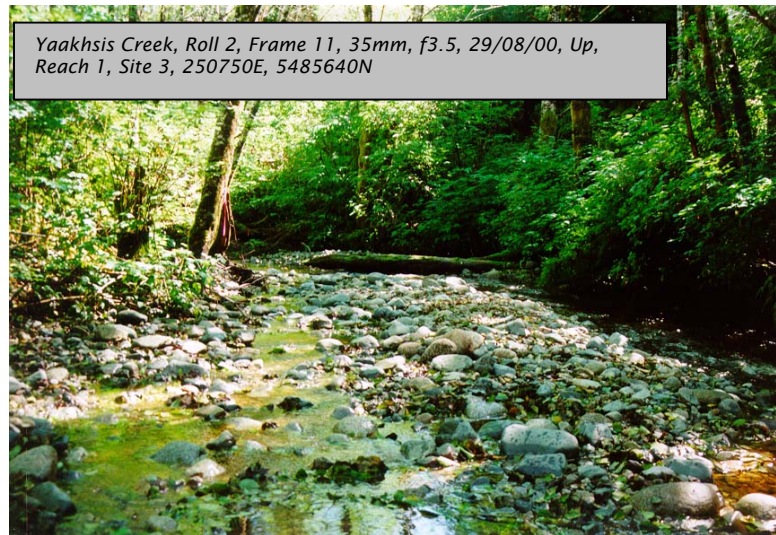
Figure 8.1: Example SHIM documented photograph. Yaakhsis Creek, Hesquiaht Harbour, Aug. 29, 2000.

8.5.2 Required Map Products

There are no mandatory map products for Photodocumentation Module.

8.6 References Cited

Tips and Techniques of Image Scanning: http://www.infomedia.net/scan/The-Scan-FAQ.html

Resources Inventory Committee. 1996. A Guide to Photodocumentation for Aquatic Inventories.

The Unofficial TIFF Homepage: http://home.earthlink.net/~ritter/tiff/

Module 9

SHIM Data Deliverables and Data Management

9.1 Data Collection and Processing

All SHIM projects must conform to current mapping standards outlined in the SHIM Mapping Procedures Guide (2001) and Resource Inventory Committee standards for GPS (2002). Stream mapping must be undertaken using resource grade GPS receiver systems that have been approved by the SHIM mapping committee. At present only a limited number of receivers have proven capable of meeting the $\pm$ 5m horizontal accuracy levels desired for SHIM mapping projects. Acceptable GPS models may change as new technology comes onto the market and a current listing of acceptable systems should be obtained from the SHIM mapping committee before initiating the project. Currently the only GPS receiver that has been fully approved for stream mapping work with an accompanying customized Shim Data Dictionary is the Trimble Patherfinder Pro XR. While the Leica GS50 GPS receiver is also considered of suitable accuracy, at present the SHIM Data Dictionary is not compatible with this receiver and would require major re-structuring. Most data collected with lower end GPS systems will lack the spatial accuracy necessary for inclusion in SHIM projects; however, this information may be useful for other planning purposes and we do not discourage its collection. Acquiring some environmental data (even if crude) is still much better than having no information at all.

The SHIM Data Dictionary (Version 24) represents the currently accepted standard for collecting map data and this file can be obtained and downloaded free (ddf format) from the SHIM mapping committee for use with the Trimble GPS units. Previous SHIM protocols involving manual data entry into Excel spreadsheets for incorporation into Access databases are no longer current, and have been superseded by more efficient applications using the GPS data dictionaries. Collected mapping data should be initially stored within GPS unit data recorders. Raw GPS data should then be downloaded on a daily basis if possible into Pathfinder Office software, differentially corrected and converted into ArcView shapefiles. Raw GPS data should be interpreted and corrected within ArcView, using the customized SHIM Data Dictionary Tool (ddtool-b4f.avx) that can be downloaded free from the SHIM website (http://www.shim.bc.ca/). Common point and polygon features must be linked to their associated stream line through a unique identifier field. Instructions and ArcView procedures for ensuring that feature points are correctly linked to unique stream identifiers are also included within the SHIM Data Dictionary Tool.

9.2 Qualifications

At least one person on each SHIM mapping team must act as a Data Manager and have completed a RIC certified GPS course in resource mapping. Acceptable training programs are offered by several agencies; contacts for which can be obtained from the SHIM mapping committee. The Data Manager is responsible for training field operators in SHIM procedures and must provide documentation of protocols implemented to quality assure (QA) data collection/interpretation and maintain overall quality control (QC) of the project.

9.3 Deliverables

SHIM data should be delivered on a CD-ROM in the following directory structure:

Stream Name Folder

- *Photo Subfolder*

- *Raw GPS Data Subfolder*

- *Corrected GPS DataSubfolder (if post-processed differential data took place)*

- *Processed GPS Data Subfolder*

- *Metadata Subfolder*

- *SHIM map subfolder*

A single winzip (zipped) file containing folder and subfolder data should be created for each stream surveyed. Be sure to select the 'Save Extra Folder Info' option for the winzip file. For older versions of Winzip (i.e., prior to version 7.0) the "Recurse Folder" option should also be selected. The required subfolders should contain the following information:

9.3.1 Photo Subfolder

1. *digitized images of all photos taken (jpg format). File naming based on photo point number (e.g., 4135.jpg)*

2. *a single summary table (Word format) listing all photos taken of the stream with identifying photo numbers, date of photo capture, description of features photographed and photo orientation*

		Photo Summary Table		
Stream Name	Photo point number	Date (d/m/y)	Feature	Direction (up/down or X stream)

*All jpg photo images must be hotlinked to the photo_point shapefile present in the process GPS data subfolder. To do this involves a series of programming steps within ArcView that are outlined in the appendum at the end of this module *

9.3.2 Raw GPS Data Subfolder

- Raw GPS data files (in Trimble's .ssf file format) for all SHIM mapped stream features (points, lines and polygons).

9.3.3 Corrected GPS Data Subfolder

- Raw GPS data files (in Trimble's .cor file format) for all SHIM mapped stream features. Submit only if GPS data were differentially corrected through post-processing and not through real time corrections.

9.3.4 Processed GPS Data Subfolder

Corrected ArcView shapefiles of all mapped stream features. This includes the associated dbf, sbn, shx, sbx and shp files for each feature with file names consistent with the feature types used in the SHIM data dictionary. The line, point and polygon files that should be included as part of a SHIM mapping project include:

- *Stream_line.shp – line feature delineating the stream center line. **Required** for all SHIM mapping projects.*
- *Wetland.shp – line feature delineating the extent of wetlands adjacent to the stream. **Recommended** but not required.*
- *Cross-section.shp*
- *Culvert.shp*
- *Discharge.shp*
- *Erosion.shp*
- *Fish_habitat.shp*
- *Fish_sample.shp*
- *Modification.shp*
- *Obstruction.shp*
- *Photo_point.shp*
- *Tree_Wildlife.shp*
- *Wildlife.shp*
- *Waterbody.shp*
- *Water_sample.shp*

point features depicting various constructions, habitats, conditions or activities at distinct locations along the stream length. **Recommended** but not required.

- *Riparian_hab.shp – polygon feature delineating the riparian habitats adjacent to the stream corridor. Recommended but not required.*

Stream files are created by merging the corrected points, lines or polygons from individual mapped stream segments into a single composite file for each feature type. Each shapefile must be associated with the parent stream using a unique identifier (denoted by the shared key_id field in the SHIM Data Dictionary)

All ArcView shape files must contain descriptive metadata fields that are simultaneously exported from Pathfinder Office with the Data Dictionary information. To ensure that relevant metadata is linked to the SHIM shapefiles the following configuration settings must be toggled on within the Export Utilities function in Pathfinder office:

Attributes Tab

- All Feature Types: PDOP, Correction Status, Receiver Type, Date Recorded, Time Recorded, Data File Name, Total Positions, Filtered Positions, Data Dictionary Name
- Point Features: Standard Deviation and Position

Position Filter Tab

- Minimum Satellites: 3D
- Maximum PDOP: 6-12 (depending on data collection circumstances. a PDOP of 12 may sometimes be necessary under extreme conditions. These occurrences must be documented).

A text file is created during the export process that lists the configuration settings used for export. This file should be included in the project deliverables as a method of QA/QC.

9.3.5 Metadata Subfolder

- All text files created during export processing from Pathfinder Office to ArcView that show configuration settings
- A summary table (Word format) describing: mapping organization, crew and qualifications, GPS and GIS systems used and target accuracies, specific location of mapping, the extent of stream mapping (i.e, mainstem and tribs), date of mapping, SHIM procedures used (i.e., field methods and data dictionary versions), protocols used for quality control/assurance

Stream Summary Table

Creek Name:
General Location:

Agency:

Data Manager:
Manager Qualifications:

Mapping Crew:
Crew Qualifications:

GPS receiver used:
GPS refererence stations:
Target accuracy:
GPS software used (Name, Version):
GIS software used (Name, Version):

Mapping start point (UTM Zone/Easting/Northing) :
Mapping end points (UTM Zone/Eastin/Northing):

Mainstem fully mapped (Y/N):
If No, why not:
All tributaries entry points mapped (Y/N):
If No, why not:
All tributaries fully mapped (Y/N):
If No, why not:
Date mapping completed:

SHIM Field Manual Version:
SHIM Data Dictionary Version:

Standard SHIM QA/QC protocols followed (Y/N):
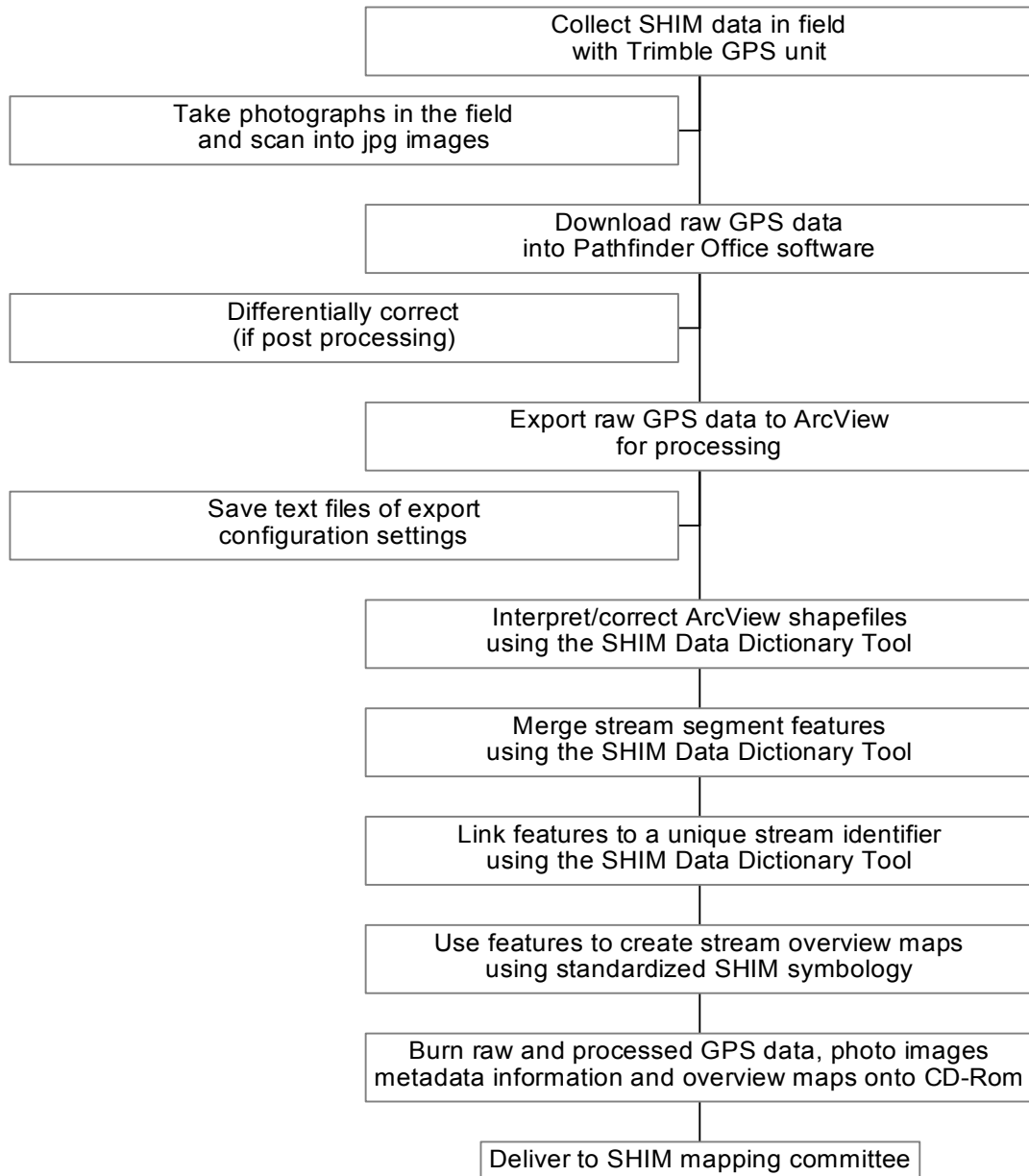**If No, describe deviations in protocol:**

Comments:

9.3.6 SHIM Map Subfolder

- *A finalized map (in either eps. or doc. format) showing all stream features labelled using standardized SHIM symbology and colour schemes.*

Map symbol templates (in ArcView avl. format) for each SHIM feature can be downloaded from the SHIM website for use in creating these maps. Stream maps should be presented at a 1:20,000 scale for general overview purposes.

9.4 Flowchart of the SHIM Data Management Process

```
                    ┌─────────────────────────────────┐
                    │     Collect SHIM data in field   │
                    │        with Trimble GPS unit      │
                    └─────────────────────────────────┘
  ┌─────────────────────────────────┐
  │     Take photographs in the field │
  │       and scan into jpg images    │
  └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │        Download raw GPS data      │
                    │      into Pathfinder Office software│
                    └─────────────────────────────────┘
  ┌─────────────────────────────────┐
  │       Differentially correct      │
  │         (if post processing)      │
  └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │     Export raw GPS data to ArcView │
                    │            for processing          │
                    └─────────────────────────────────┘
  ┌─────────────────────────────────┐
  │       Save text files of export   │
  │        configuration settings     │
  └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │    Interpret/correct ArcView shapefiles│
                    │    using the SHIM Data Dictionary Tool │
                    └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │     Merge stream segment features  │
                    │    using the SHIM Data Dictionary Tool │
                    └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │  Link features to a unique stream identifier│
                    │    using the SHIM Data Dictionary Tool │
                    └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │  Use features to create stream overview maps│
                    │     using standardized SHIM symbology │
                    └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │  Burn raw and processed GPS data, photo images│
                    │ metadata information and overview maps onto CD-Rom│
                    └─────────────────────────────────┘
                    ┌─────────────────────────────────┐
                    │   Deliver to SHIM mapping committee │
                    └─────────────────────────────────┘
```

Appendum: Hotlinking JPG Images to ArcView Shapefiles

1. *Open the photo_point theme in the View window and add a new field within its attribute table* *(name the new field photo_id).*
*This field will store the image pathway that will be accessed by the hotlink tool.*

2. *Enter for each record in this field the full pathway to locate the jpg image on the appropriate disk or drive (e.g., d:/walker_creek/photos/1230.jpg). The drive designation may have to be adjusted by varied users of this data as CD-Rom drive letters are inconsistent, and users may also choose to store the images on their hard drives.*

3. *Define the user script to allow hotlinking of the jpg images*

    ▪ *Create a new script in the Project window:*
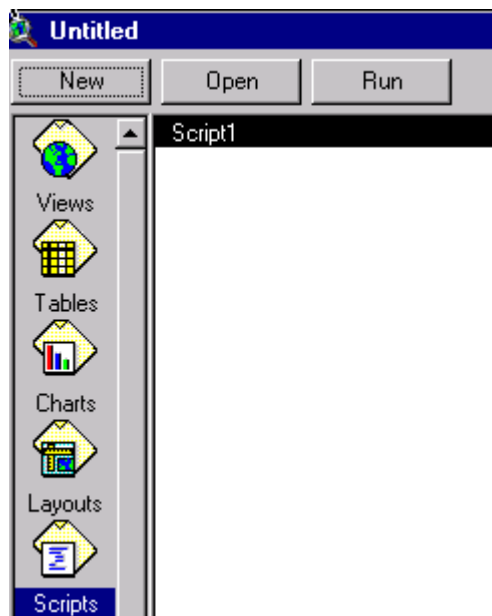
    ▪ *Select the "Load Text File" in the Script Properties dialog*
    ▪ *Navigate to the file c:\esri\av_gis30\arcview\samples\scripts\lnkmgvw.ave within the standard ArcView program*
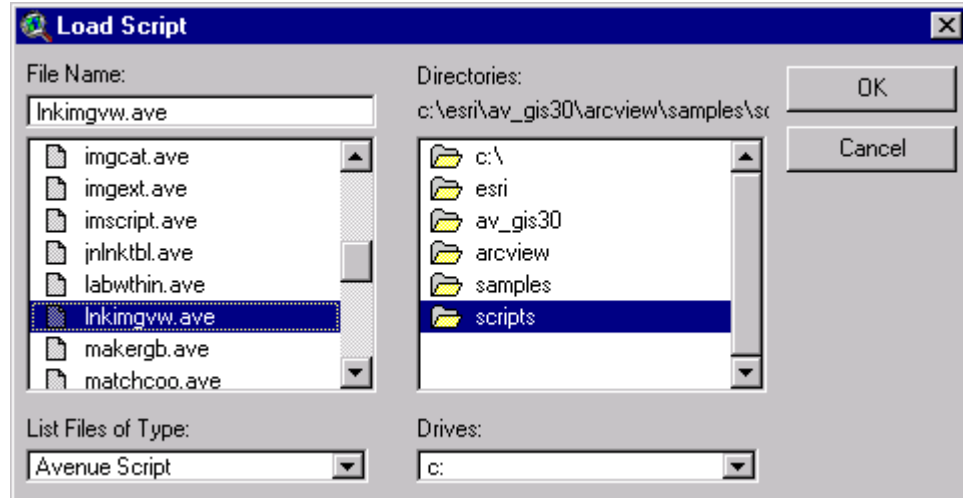
- *Download the script (shown partially below)*


```
' Name:   View.HotLinkImage
'
' Title:   Hotlinks an image to display in a View
'
' Topics:   Views, Images
'
' Description:   A hotlink script that can be used in place of Link.ImageFile
' to display an image as a theme in a View document rather than in an
' ImageWin. Some images will display faster and have better display quality
' when displayed as themes in Views.
'
```

- *Select the "Script Properties" dialog and rename the script to View.HotlinkImage*


```
' Name:   View.HotLinkImage
'
' Title:   Hotlinks an image to display in a View
'
' Topics:   Views, Images
'
' Description:   A hotlink script that can be used in place of Link.ImageFile
' to display an image as a theme in a View document rather than in an
' ImageWin. Some images will display faster and have better display quality
' when displayed as themes in Views.
'
```

- *Select the "Script Compile" option in the Script window and compile the script*

4. Define the theme's Hot Link properties

- *Open the "Theme Properties" dialog for the photo_point shapefile in the View window and scroll to the Hot Link panel*
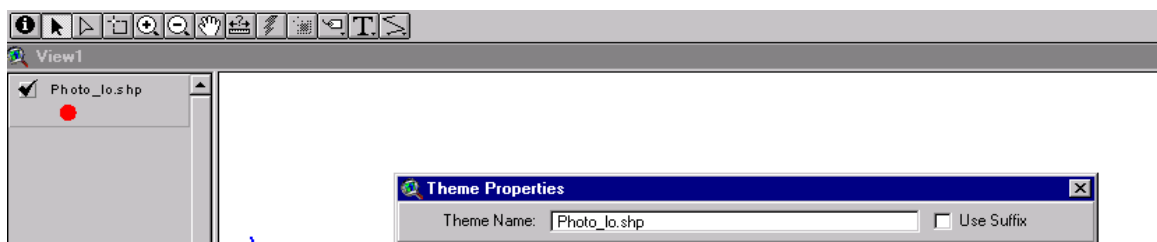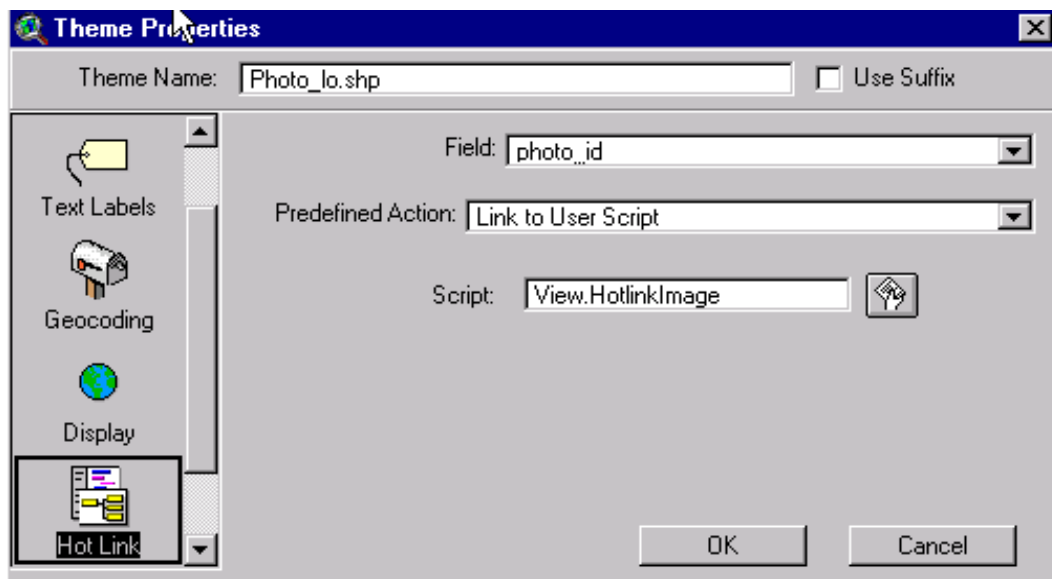
- *Within the Hot Link properties options select:*

  Field = photo_id

  Predefined Action = Link to User Script

  Script = View.HotLinkImage

5.   *Use the Hot Link tool to view and edit jpg images*

- *jpg images associated with any of the photo location points can now be viewed simply by clicking on a photo point with the Hotlink tool found in the View window. This will bring up a full sized image in its own ArcView window from which ArcView features can be applied and from which it can be printed if desired*