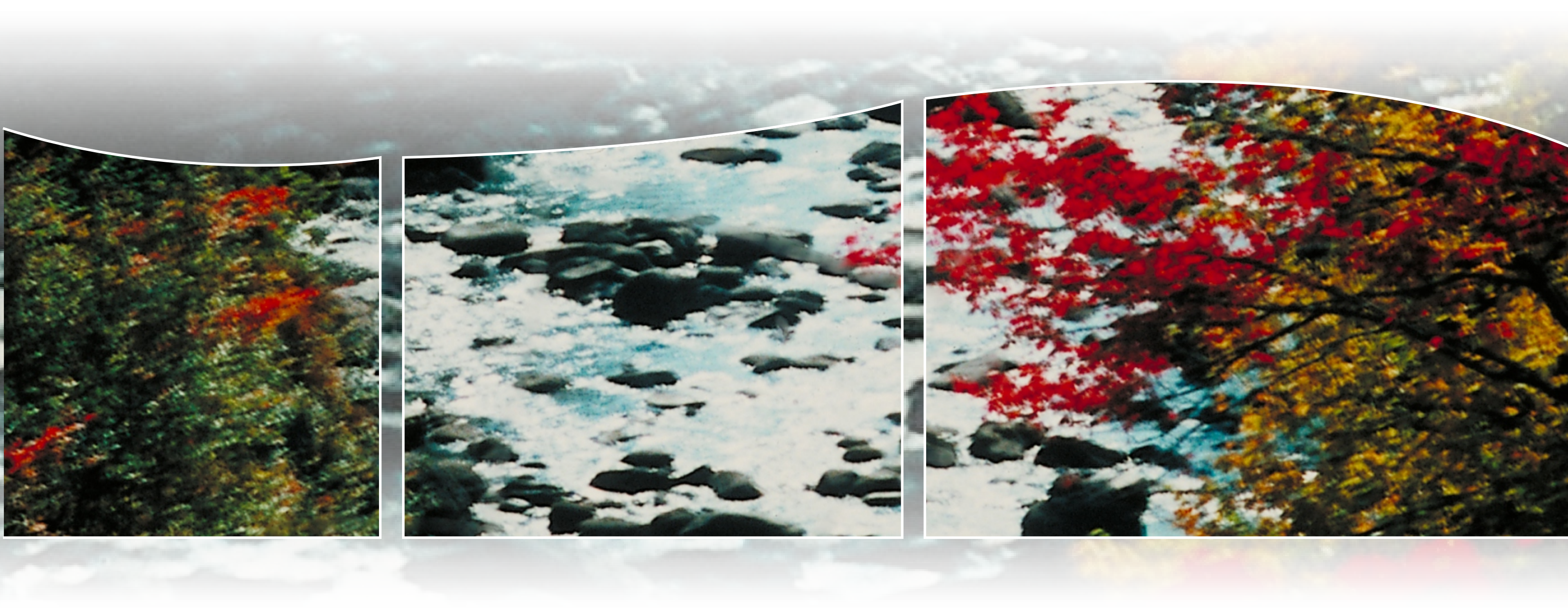
Environment Canada Environnement Canada

CANADIAN AQUATIC BIOMONITORING NETWORK

Field Manual

Wadeable streams

2012



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Introduction

The Canadian Aquatic Biomonitoring Network (CABIN) is the national biomonitoring program developed by Environment Canada that provides a standardized sampling protocol and a recommended assessment approach, called the Reference Condition Approach (RCA), for assessing aquatic ecosystem condition. CABIN provides the tools necessary to conduct consistent, comparable, and scientifically credible biological assessments of streams.

This manual describes the nationally standardized CABIN field protocol for the collection of benthic macroinvertebrate samples and associated stream information in wadeable streams and littoral zones of large rivers.

This manual provides information on:

- when to sample
- the importance of safety first
- how to collect required non-field data before sampling
- how to collect a CABIN benthic macroinvertebrate sample and related water quality and habitat data in the field
- what equipment is required to sample macroinvertebrates and water quality and collect habitat data

Biological monitoring – Why Sample Benthic Macroinvertebrates?

Traditionally, water quality monitoring has focused primarily on the collection of chemical and physical measures and resulting water quality assessments are made by comparing measured results to previously determined water quality guidelines. Such guidelines are established based on the use-related level of protection required and include the widely used Canadian Water Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment, http://ceqg-rcqe.ccme.ca/). Monitoring using these measures provides a 'snap-shot' of the status of water quality.

Recent approaches to river health assessment recognize the importance of examining physical, chemical and biological interactions. The addition of a biological component to a suite of monitoring activities can complement the traditional approach by providing the effect measurement to the assessment (that is, the effect of a stressor on the biota). The measurement of biological effect may detect impacts on the aquatic ecosystem that cannot be measured with traditional physical-chemical monitoring such as changes in water quantity, presence of invasive species, and habitat degradation. Aquatic biomonitoring can indicate preceding river conditions for weeks or months prior to collection. For example, an episodic pollution event, such as a chemical spill, may go undetected by periodic water sampling regimes but damage to aquatic biota can be detected long after the cause of the impact has passed.

Benthic macroinvertebrates are used in aquatic biomonitoring for several reasons. They are common inhabitants of lakes and streams and are important in moving energy through food webs. The term "benthic" means "bottom-living", organisms that usually inhabit bottom substrates for at least part of their life cycle. The CABIN wadeable stream protocol only collects benthic macroinvertebrates. The term 'macro' refers to the size of the organism, in this instance organisms retained by mesh sizes of 200 – 500 µm, while 'invertebrates' are organisms with no backbone.

Aquatic insects are the most diverse group of freshwater benthic macroinvertebrates; they account for almost 70% of known species of major groups of aquatic macroinvertebrates in North

America. The remaining 30% are non-insects such as worms, nematodes, and mites. More than 4,000 species of aquatic insects and water mites have been reported in Canada alone. The diversity of benthic macroinvertebrates makes them excellent candidates for studies of changes in biodiversity.

Benthic macroinvertebrates are the most commonly used biological indicators for freshwater resources because they are:

- Sedentary = stay in one place and therefore integrate site-specific impacts
- Ubiquitous and generally abundant = can be easily collected everywhere
- Long-lived (1-3 years) = reflect cumulative impacts
- Diverse = respond to a wide range of stressors
- Key part of the food web = ecologically important

When are samples collected?

To ensure data comparability, samples must be collected in the same season. Typically, CABIN sampling is done in the late summer or fall. The late summer and fall sampling season is chosen for several reasons:

1. Most taxa in the benthic community are in an aquatic life stage at that time of year.
2. Many taxa are at a stage in their life cycle that is advanced enough to be identified to levels of taxonomic resolution that are required by CABIN.
3. Flow conditions are usually low during this time therefore sampling is safest.
4. The low water levels mean that the substrate below the wetted stream channel is stable habitat and not the result of a peak flow rates that create ephemeral aquatic habitats in areas that become stream banks during low flow periods.

***NOTE**: The optimal sampling season may vary depending on location and the hydrograph of the watershed. Contact the regional CABIN lead for the appropriate sampling time for the basin of interest.*

Overview of Sampling Procedures

This section outlines the type of measurements and samples that are collected at a CABIN site as part of the standard national protocol.

- **Primary Site Data:** this data is determined before field sampling begins, usually during the site selection process. The basin name, estimate of site location coordinates, ecoregion, and stream order are all recorded.
- **Site Description:** this is a broad characterization of the site. It includes a site drawing and written description, site coordinates, and surrounding land use classification.
- **Reach Characteristics:** this is a description of the aquatic habitat types, canopy coverage, macrophyte coverage, streamside vegetation, and periphyton coverage in a defined sampling reach (site).
- **Water Chemistry:** this includes measurements of certain physical-chemical water quality parameters which are required by CABIN for assessment purposes. Most can be collected with on-site water quality probes. Water samples may also be collected for laboratory analyses.
- **Benthic Macroinvertebrate Sample:** this is obtained using the standardized CABIN benthic macroinvertebrate collection method. A three minute travelling kick technique, with a kick net, is used to collect the sample.
- **Substrate Characteristics:** this includes measurements of the stream substrate, which is the habitat of benthic macroinvertebrates. A 100 pebble count is used to characterize substrate. Embeddedness of substrate and the size of surrounding material are also determined.
- **Channel Measurements:** this is a characterization of the stream channel at present flow conditions and includes an estimate of peak flow conditions. This includes measurements of channel width (bankfull and wetted), depth, velocity, and slope.

It is critical that all measurements be completed.

Incomplete information may result in the site being discarded because the CABIN models cannot accommodate missing data.

ALWAYS check field sheets before leaving a site. Ensure that all measurements have been taken and all samples collected.

There are times when a field cannot be filled on the field sheets (for example, due to equipment malfunction). In order to eliminate future confusion, be sure to make a clear note on the field sheet describing why that field was not completed.

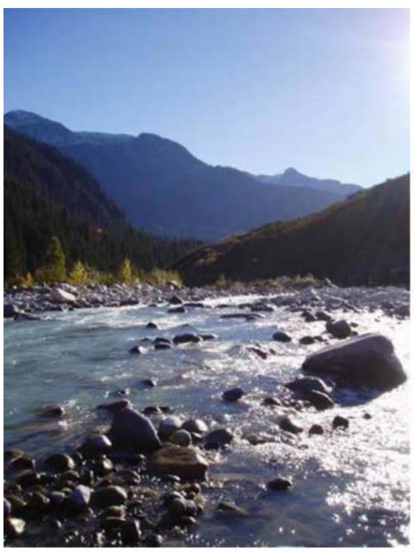
Preparing for Sampling

Some preparation is necessary prior to sampling. The project manager must select potential sampling locations that conform to study design principles and meet the study objectives. The following section briefly describes site selection. All field staff should be aware of this information in case it is necessary to relocate a site in the field. Site code guidelines are presented in this section along with an outline of safety procedures and considerations for water quality measurements to address prior to sampling.

Selecting reference and test sites

Once a study design has been developed and the objective has been defined, sites are selected to meet the study objective. Considerations for selecting a sampling location may differ depending on the type of site visited; reference or test site. The actual sample reach is not determined until the site is visited. However, a general location should be determined before going into the field.

Module 4 of the CABIN online course "Study design and the statistics of model building" provides more information on designing a study and selecting reference sites.



Reference sites

Reference sites are used to build the CABIN reference models and are chosen within areas that are minimally affected by human activities. It may not be possible to find reference areas that represent pristine (or pre-European settlement) conditions, but areas in which impacts are lowest or disturbance is minimal should be preferentially selected (Simon 1991, Omernik 1995). For example, minimally impacted reference areas in the prairies may lack point source effluents or logging activities but, unavoidably, have a high degree of agricultural activity.

Reference sites must share natural habitat features with test sites. References sites must also be sampled in a way to capture the environmental variability of the study region such as biogeographic and hydrological variability in order to apply the Reference Condition Approach.

Test sites

Test sites are in unknown condition and suspected of impairment. They are selected according to the objectives of a study. For example, if the objective of the study is to study point source pollution, test sites will be located downstream of the point source pollution source.

Creating Sitecodes

Sitecodes are important identifiers that act to uniquely or individually identify the site from other sites. They are essential for data management. Each site must have a unique code. To avoid duplication, only the project manager should assign codes. Site nomenclature should be established prior to field sampling.

CABIN recommended site coding system

A conventional site nomenclature could include:

- 3 letters for a basin/sub-basin code
- 2 numbers for a site number code, and
- 2 numbers or letters for another level of sampling within a site (e.g. replication).

For example, GLD07 would be the site code for site no. 7 on the Gold River. If replicate samples are collected on the same date, another identifier is appended to the site code. For example, the first sample is designated with A (GLD07A), second sample with a B (GLD07B) and the third sample with C (GLD07C).

The CABIN database allows for multiple site visits (ie, visitng the same site in different years) to be entered under the same site code assuming the location is the same. As a result, there is no need to include the year in the site code.

Health and Field Safety - First Priority

Personal safety and the safety of the field team must be addressed before field sampling. Field safety equipment must be available and all field personnel must be adequately trained and follow health and safety procedures. No sample is worth risking the health or lives of team members. This section describes safety considerations for both field sampling and the proper handling of chemicals.

Field safety training, procedures, and equipment

The following safety recommendations apply to anyone who is conducting field work:

- Do not sample if conditions are unsafe (e.g. higher or swifter water than usual, weather conditions, dangerous wildlife in the area, construction).
- Never sample alone. A field crew should consist of at least two people; three or four person field crews are beneficial.
- Always inform someone of the sampling route and sampling location along with the expected return time.
- Establish a call-in procedure with colleagues in the office or a call-in service.
- Wear a lifejacket when working near or in water, no matter how safe the conditions appear to be. Consider a swift water helmet on slippery surfaces.

Environment Canada is not responsible for safety training of CABIN participants, however, the mandatory safety training, procedures and equipment for Environment Canada employees are listed here as an example. CABIN participants should follow the occupational health and safety requirements of their individual organizations.

Environment Canada Health and Safety Procedures for CABIN Sampling

Safety Training

- Swiftwater Rescue (Rescue Canada)
- First Aid Level One (St. John's Ambulance)

Safety Procedures

- Read and sign a Task Hazard Analysis (THA) for "Streamflow Measurement: Wading"
- Read and sign a Safe Work Procedures (SWP) for "Streamflow Measurement: Wading"
- Fill out a Site Inspection Sheet for each site upon arrival (in Appendix 2)
- Provide a field sampling itinerary to your supervisor prior to departure
- Establish a 'Call-in' procedure for the end of the day

Safety equipment

- Life jackets, throw ropes, waders and a first aid kit present at all field sites.
- Swift water helmets if necessary.

Safe handling of chemicals and sample preservatives

Benthic macroinvertebrate samples are best preserved in the field using 10% buffered Formalin at a ratio of 1:3. Field preservation is necessary to prevent degradation; if samples cannot be fixed in the field, samples must be immediately preserved in the laboratory. Samples that contain large amounts of organic debris need to be separated into multiple sample jars; this will ensure the correct ratio of Formalin to sample.

Formalin can be harmful and should be handled with care. Use of Formalin, like all chemicals, requires knowledge and understanding of the Workplace Hazardous Materials Information System (WHMIS) and the Material Safety Data Sheet (MSDS). Use proper personal protective safety gear when handling all chemicals.

Pre-sampling water chemistry considerations

CABIN recommends that certain physical-chemical water quality parameters be collected for each site. Additional physical-chemical water quality parameters may be sampled and analyzed by an analytical laboratory or on-site depending upon the parameters necessary to meet the study objective as well as the study budget.

Recommended parameters for CABIN may aid in interpretation of test site assessments. In order for water chemistry parameters for to be useful, the parameters must be collected at both reference and test sites. These factors must be considered in designing the study.

It is also important to arrange analyses with the chosen lab prior to sampling. The lab may provide the bottle sets needed and sampling requirements such as preservatives or short handling times. For more information on water quality measurements, see the Water Quality section below.

Pre-departure hydrologic considerations:

Check the weather forecast as well as previous recent water level information prior to CABIN sampling (Water Survey of Canada - http://www.wateroffice.ec.gc.ca). CABIN recommends sampling during low flow conditions. The influence of rain events on streams must be taken into consideration when planning CABIN sampling. A significant period of time should pass in order to allow the hydrologic conditions to return to normal and stabilize before sampling.

Large or unusually heavy rain events cause higher than normal water levels which can affect all aspects of CABIN sampling such as:

- Water chemistry (for example, suspended solids, contaminant spikes from runoff, pesticides)
- Benthic macroinvertebrate communities due to drift or scour
- Benthic habitat and substrate characteristics
- Safety considerations
- Channel measurements (widths, velocity, discharge)
- Substrate characteristics

Pre-departure equipment checklist

Prior to field sampling ensure that all the necessary equipment is functioning properly before it is packed for sampling. Water quality probes must be calibrated and batteries of electronic devices charged. Use a checklist to ensure that all equipment necessary to carry out the CABIN protocol is prepared and available (table below, also see the Equipment Checklist in Appendix 1).

Field equipment checklist for CABIN sampling

General Equipment
Field sheets and clipboard
Pencils and markers
Waterproof labels
Labelling tape
Ziploc bags
Tool kit and duct tape

Location and Reach data
GPS
Camera
Densiometer (optional)

Channel and Substrate characteristics
Velocity metre OR Meter stick
Measuring Tape
15 or 30cm ruler
Hand Level OR Survey equipment
Calculator
Tent pegs

Water chemistry sampling
Water quality metres
(temp, pH, DO, conductivity, turbidity)
Cooler with sample bottles and ice packs
Extra batteries

Benthic Sampling
Kicknet
Stopwatch
Squeeze Bottle
Spoon/tweezers
Bucket
Sieve
White tray
Sample jars
Formalin and formalex
Tightly sealed container for sample jars & Formalin

Safety equipment
Lifejackets
First aid kits (field and vehicle)
Cell phone or Satellite phone
Swift water helmet
Throw bags
Waders, boots, raingear
Gloves (rubber, neoprene)
Safety goggles
MSDS sheets for chemicals
Sunscreen, hat, bug spray

Primary site data

There are a number of site attributes that can be determined prior to field sampling, using topographic maps and online resources. These are simple to acquire and useful in initial characterization of sites.

PRIMARY SITE DATA

CABIN Study Name: ________________ Local Basin Name: _________________

River/Stream Name: ________________ Stream Order: (map scale 1:50,000) __________

Select one: ☐ Test Site ☐ Potential Reference Site

Primary site data includes the basin and stream name, the ecoregion, and stream order. Whether the site is a test site or potential reference site is also indicated on the field sheet. Refer to the section above for more information on the difference between reference sites and test sites.

Local basin and stream name

The local basin name is based on a large or well known river in the study area. This information is used as a reference to the region where the site is located. The local basin name is a scale at which it is meaningful to the project manager. Once location information is entered into the CABIN database, a large scale watershed will be automatically assigned from the Know Your Watershed website (http://map.ns.ec.gc.ca/kyw/). It is this watershed scale that will be consistent from study to study within the CABIN database.

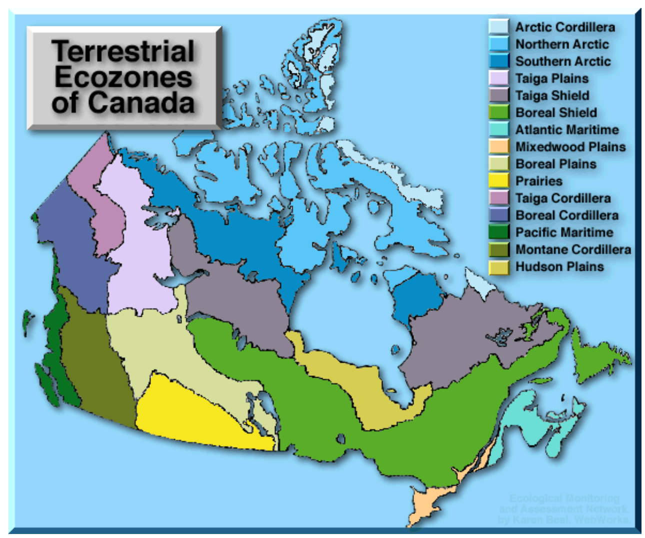
The stream name is the official name of the watercourse. The information is used to locate the site; this information should be reliable. Obtain the stream name from a map, signage in the area, or knowledgeable local expert.

Method:

1. Enter the CABIN study name, local basin name and the river/stream name on the field sheet.
2. Indicate if the site is a test or reference site, check the appropriate box. Indicate how this was determined.

Ecoregions

An ecoregion is a unit of space that is defined by unique landscape characteristics. The characteristics that were used to define the ecological framework in Canada include geology, soil, vegetation, climate, wildlife, water and human factors (Ecological Stratification Working Group 1995).



Ecoregion provides general information about the broad differences between regions. As ecoregions change, so do the dominant landscape characteristics. The ecoregion summarizes the major environmental gradients in the study area.

When designing a study, ecoregions may be used to stratify your site selection. Ecoregion information can be obtained from the following website, and can be entered onto the field sheet (http://ecozones.ca)

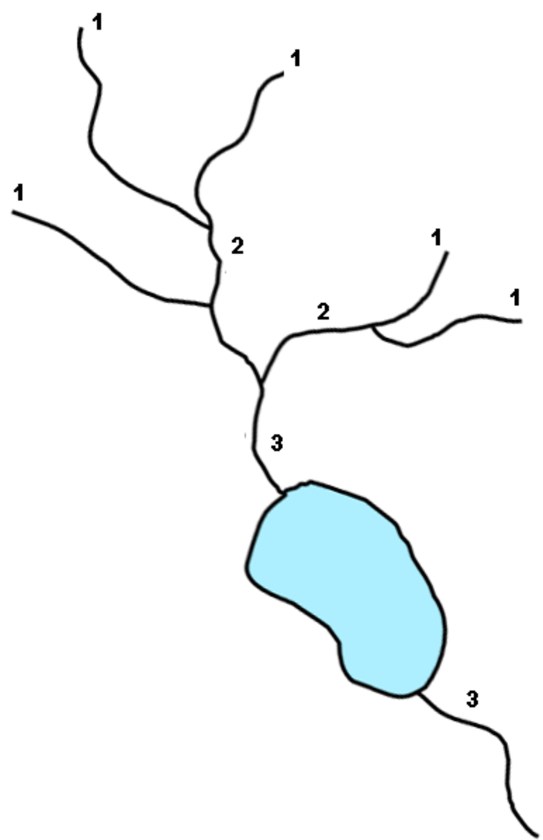
Method: Ecoregion is calculated automatically by the CABIN database when the accurate GPS coordinates for the site have been entered.

Stream order

Stream order is the hierarchical ordering of streams based on the degree of branching (Strahler, 1957). It is a simple quantitative method to categorize stream segments based on their relative position within the drainage basin. Stream order provides a general indication of stream size, stream function and energy sources. Stream order characterizations of all streams within a project must be done on the same scale map. The national standard for CABIN is to use maps at the 1:50,000 scale.

Method: Stream order is determined as follows:

1. The entire basin for the river in question is mapped out using a 1:50,000 scale map
2. First order streams are defined as those segments that do not have tributaries. First order streams are assigned a value of 1.
3. Subsequent stream orders are assigned values according to the method established by Strahler (1957, p914)
4. Where stream segments of the same order come together, the resulting segment is assigned the next highest order. For examples, where first order streams join, the resulting stream segment is elevated to the second order (2).
5. Where segments of differing orders come together, the resulting segment retains the order of the highest contributing tributary.
6. Where a stream enters a lake, the lake is treated as part of the stream. If more than one stream enters a lake, the outflow of the lake retains the order of the highest contributing tributary segment (Figure 1). If two streams of the same order run into a lake, the outflow increases to the next stream order.



Strahler method of stream order determination

Initial procedures

Initial procedures are completed upon arrival to the sampling location and include a safety inspection, determination of the sample reach, and documentation of the site code, sampling crew, and date.

Do not enter the stream!

Safety inspection

Upon arrival to the sampling location, inspect the area for safety hazards. All members of the field crew should be aware of potential dangers and knowledgeable of safety precautions. A thorough inspection is important for preventing accidents.

Examples of safety considerations are:

- Potential hazards such as parking on the highway shoulder, bear activity in area, hunting season, cars, unstable banks
- Special driving directions
- Weather conditions such as heavy rain, wind hazards, excessive heat, extreme cold, lightning

Environment Canada uses a standard site inspection sheet for all visits (Appendix 2). Safety hazards are identified on this sheet along with emergency contact information and other safety procedures.

Method: Complete the site inspection as required, fill in the necessary site inspection information on the field sheet.

Sample reach

It is important to select a sampling reach that is representative of the area in terms of aquatic habitat and streamside vegetation. The sampling reach is defined as six times the bankfull width (annual flood level, channel defining width). Six times bankfull width represents a complete pool:riffle sequence (Newbury and Gaboury, 1993) and thus should contain the desired aquatic habitat for sample collection and habitat measurements.

A number of criteria can be used to determine bankfull edge in the field. The following should be considered (DFO, 2001):

- 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 grassy 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
- A change in texture of deposited sediment (e.g., from clay to sand, or sand to pebbles, or boulders to pebbles)

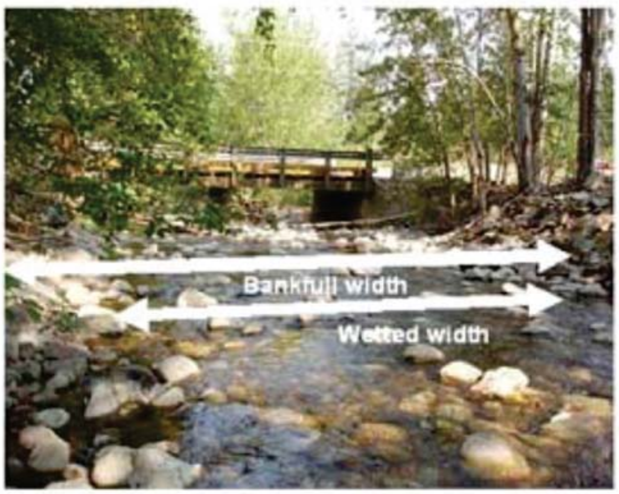
The sampling reach will generally contain a pool (depositional zone) and a riffle/run/rapid (erosionsal zone). In the erosional zone the water travels faster and carries materials such as sediment and small rocks. The size of particle the river can carry will depend on the velocity of the water. The erosional zone will be a run, riffle or rapid and this will depend on factors such as substrate, slope, velocity and depth. In a riffle feature, the water will break the surface, and in a rapid you will see standing waves. A pool or depositional feature is usually found on a bend or meander in the river and will be deeper and slower than the erosional zone. The particles carried by the erosional zone are generally deposited in these areas because of the abrupt change in water velocity.

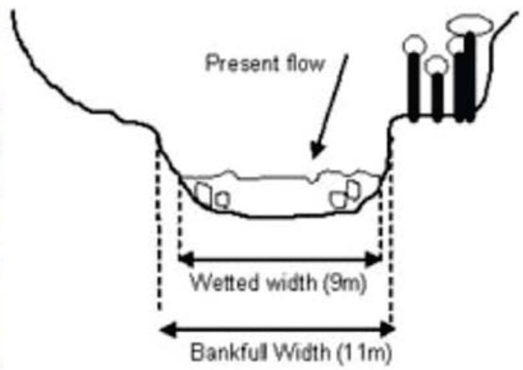
The reach defines where samples will be collected and determines the upstream and downstream limits from which reach characteristics are evaluated (discussed in later sections). The benthic sample, substrate, channel measurements and water samples will be collected within the erosional zone of the reach. Other observations such as macrophyte coverage, streamside vegetation, and slope are evaluated within the entire reach.

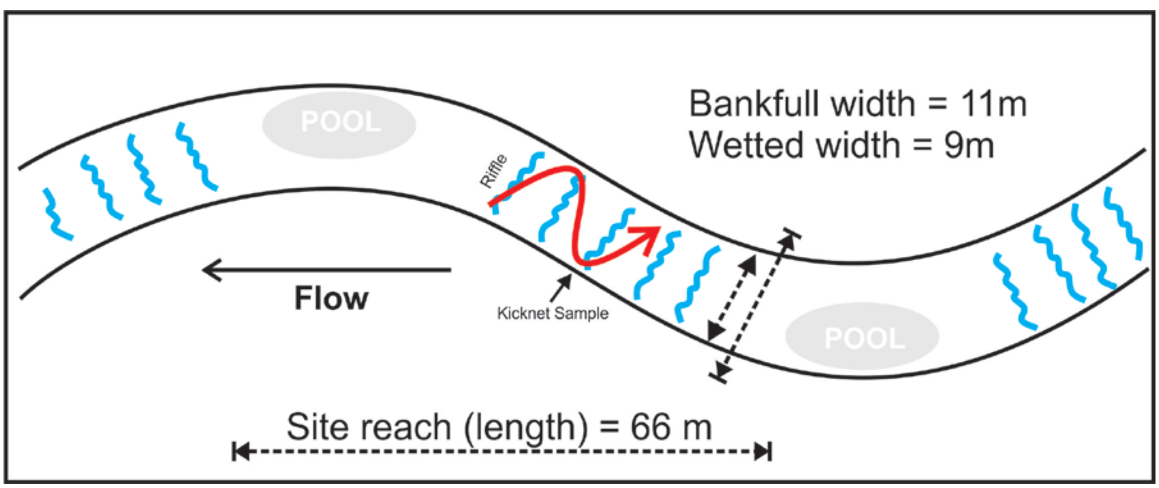
Method:

1. Estimate bankfull width visually or with a range finder. Do not enter the stream before the benthic sample is collected.
2. Multiply bankfull width by six to calculate the size of the sample reach.
3. Ensure that all crew members are aware of the reach area.

In the example below, bankfull width is 11m, thus the sample reach is (6 x 11m) 66 meters. This is usually done by visual estimation. You would not go and physically measure 66 meters.







Approximation of bankfull and wetted width (top). Diagram of pool-riffle sequence and determination of site length and sampling location (bottom).

Selecting a sampling reach

When selecting the sampling reach, follow the guidelines below (modified from Davies 1994). All guidelines apply in the selection of the sampling reach for reference sites. In the case of test sites, some of the guidelines may not be applicable.

Criteria for selecting an appropriate sampling reach	
The site must	‣ Be deemed representative of the major characteristics of the overall reach such as substrate, discharge, streamside vegetation, stream type and habitats ‣ Be subject to minimal human related disturbance ‣ Be accessible and safe during sampling
The site must not	‣ Lie within a specified distance upstream or downstream of an obstruction (e.g. bridge, culvert, dam, weir or waterfall), unless a test site is established to assess the affect of that obstruction; ‣ Reference sites must not lie within a specified distance upstream or downstream of livestock watering area; significant confluence or discharge; significant diversion of flow; areas subject to channelization, dredging or weed removal ‣ Reference sites must not be subject to significant adverse flow regulation (large abstractions or releases that severely modify water quality, temperature or discharge) ‣ Reference sites must not be downstream of identifiable source(s) of pollution Or must be sufficiently far downstream for recovery in the biological community composition to take place. (for example > 10km for small streams and > 20km for larger rivers)

Site code, sampling crew, and date

The site code, sampling crew names and the date are recorded at the top of every field sheet. This information ensures that the data on the sheet can always be attributed to the proper sampling location and time, and that the field crew can be consulted if questions arise about the field data. This information is recorded on the top of every field sheet page to eliminate mixups should the pages become separated.

Field Crew____ Site Code:____________________

Sampling Date (DD/MM/YY) __________________________________

Method: Record the site code, date, and field crew names on the top of each field sheet. Be sure to record this information at the top of every page.

Site Description

Description of the site includes notes and directions for getting to the site, characterization of surrounding land use, geographic coordinates, map and photographs of the site. These observations describe the general characteristics of the site.

Important Note

Benthic macroinvertebrate and water chemistry samples for the CABIN protocol **MUST** be collected from an undisturbed area. Always be aware not to disturb the sampling site.

If you **MUST** enter the stream to complete the site description and reach sections of the field sheet before invertebrate and water quality samples have beencollected - make sure to do it cautiously downstream of the benthic and chemistry sampling locations.

Geographical description and notes

The geographical description and notes includes directions to the site (roads, trails, landmarks) and notable features of the sampling location. This information, along with the Site Map (see below) is used to return to the sampling location. Notes may help in data interpretation.

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: _____________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ________

Dominant Surrounding Land Use: (check one) Information Source: _____________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ________

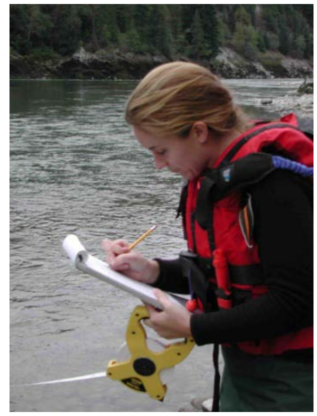
Surrounding land use

Surrounding land use includes a general description of land uses that are upstream of the sampling site and may be affecting the benthic macroinvertebrate community at the site. Land use may assist in data interpretation.

Method:

1. Check the appropriate box for all land use types that are upstream from the sampling site under the “Surrounding Land Use” category.
2. Check the dominant land use type in “Dominant Surrounding Land Use”
3. Indicate the information source, whether observed at the site, gathered from a map, aerial photos, local experts, or another source.

Location data



Location data includes latitude and longitude coordinates for the sampling site and the elevation. CABIN uses latitude and longitude coordinates in decimal degrees (DD) or degrees, minutes, seconds (DMS). UTM coordinates must be converted before entry into CABIN. Often the site coordinates are approximated using GIS or a topographic map prior to field sampling to aid in locating the site, and true coordinates are measured at the site using a handheld geographic positioning system (GPS) unit.

Method:

1. Measure latitude, longitude, and altitude with a handheld GPS unit.
2. Indicate whether the coordinates are reported in DD or DMS
3. Indicate the GPS datum. The same datum should be used for all measurements.

Location Data

Latitude: ______________N Longitude: -__________W (DMS *or* DD)

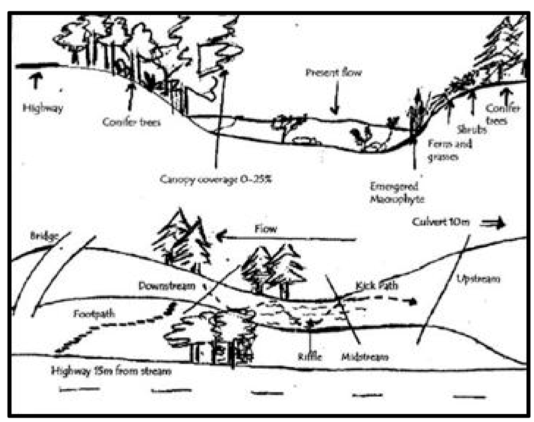
Elevation: ________(fasl *or* masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: _________

Site drawings

A hand-drawn map illustrates major stream and landscape features, entry to the site, landmarks and the sampling area. This map is used as a guide for site revisits, indicating how to get to the site and the sampling location and for interpretation based on habitat features.

Method:

1. Draw a map (aerial view) of your sample reach on the field sheet in the appropriate space.
2. If the channel is irregular, sketch a profile of the channel in addition to the aerial view.
3. Indicate the benthic sample location by sketching the kick path taken during the invertebrate collection.
4. Include channel shape, stream habitats (e.g., riffles, runs and pools); broad landscape features (e.g., cliffs, hills, vegetation), access point, roads and trails to the site, landmarks, and orientation.
5. Note any potential sources of disturbance.



Example of completed site location map from "Site Location Map Drawing" section on CABIN field sheet.

NOTE: *Limit the amount of time spent on the drawing. It is intended to be a simple sketch for future reference.*

Site photographs

Photos
☐ Field Sheet ☐ Upstream ☐ Downstream ☐ Across Site ☐ Aerial View
☐ Substrate (exposed) ☐ Substrate (aquatic) ☐ Other ____________

Site photographs capture broad features of the sample reach. Because returning to the site is often impractical, photos will serve as an important reference. They can assist in resolving questions that arise during data entry or analysis. Photographs also illustrate how a site has changed if it is revisited. The first photo taken is always that of the top of the completed field sheet (with site code, field crew and sampling date filled in). This way you know what site the following photos pertain to.

Method:

1. A minimum of five photos are taken at each site and should always be taken in the same order. Check the appropriate boxes once the photos are taken.
2. The photographs are as follows:
    - Photograph 1 - The field sheet with visible site code and sampling date
    - Photograph 2 - Upstream of the sample location.
    - Photograph 3 - Downstream of the sample location.
    - Photograph 4 - Across the stream from the sampling location.
    - Photograph 5 – Stream bottom that is representative of substrate in the kicknet area. A scale (eg. ruler) should be included in this photo. An exposed bar of substrate is preferred as it is most easily photographed. Photos taken through the water are difficult.
3. If additional photos are taken, check the appropriate box and note each additional photo on the field sheet.

NOTE: *Photos can be taken underwater with a waterproof camera bearing in mind the distance required to capture an accurate representation of the substrate. Underwater photos are difficult in shallow streams.*

Examples of site photographs. First row: field sheet, upstream, downstream. Second row: across, substrate, aerial view.

Reach Characteristics

Reach characteristics are either estimated over an area of 6x bankfull width or only in the erosional zone. Measurements include habitat types, canopy coverage, macrophyte coverage, periphyton coverage and description of streamside vegetation. Together, these measurements provide a broad characterization of the stream environment that affects the benthic macroinvertebrate communities.

Habitat types

1. Habitat types present in reach *(check those present):*
☐ riffle ☐ rapids ☐ straight run ☐ pool/back eddy

Habitat type is a categorical description of the types of aquatic environments within the entire sampling reach: riffle, rapids, straight run, pool/back eddy. The types of habitats provide an indication of what type of organisms may be expected.

Habitat types found in streams. Clockwise from top left: pool, straight run, riffle, rapids.

The habitat type where invertebrate samples are collected in CABIN is the erosional zone (riffle, straight run or rapid). A reach that does not have a well established riffle or straight run should not be used for CABIN sampling.

Other habitat types may be more common in a particular region and may be the focus of the regional reference database. Questions regarding habitat type can discussed with the regional Environment Canada CABIN team member.

Method: Check the habitats present in the sample reach on the field sheet. Look for obvious features. If you have to look hard to find it – it is not recorded.

Canopy coverage

2. Canopy Coverage *(stand in middle of stream and look up, check one)* ☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

Canopy coverage is a visual estimate of the percentage of the stream within the sampling reach (erosional and depositional zones) shaded by the tree canopy. Imagine the river/stream width at bankfull to to this. A densiometer may be used to estimate canopy coverage. The degree of canopy coverage is important to benthic macroinvertebrate communities for two reasons:

1. Canopy cover provides shade preventing the stream from overheating in the summer. It can affect water temperature and the concentration of dissolved oxygen of a stream.
2. The canopy is an important source of organic material entering the stream and affects the stream benthic habitat and nutrient availability for organisms living in the stream.

Examples of stream canopy coverage

Method:

1. Stand in the middle of the stream, look up and estimate the percent shading of the stream channel provided by overhanging vegetation for the entire sampling reach (imagine trees with leaves on them).
2. Have all the individuals present at the site estimate the coverage and then take the average value of all estimates. Record the average value on the CABIN field sheet. It will fit into one of the broad categories (0%, 1-25%, 26-50%, 51-75% and 76-100%).
3. If this is difficult to estimate the first few times, a densitometer can be used to determine the broad categories by averaging the value observed at 3 locations in the stream (bottom, middle and top of the reach) by looking in 4 directions at each location in the stream (upstream, right bank, downstream, left bank).

Macrophyte coverage

3. Macrophyte Coverage *(not algae or moss, check one):*
☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

Macrophyte coverage refers to the quantity of rooted aquatic plants or vegetation that are present within the sampling reach (erosional and depositional zones). There are three types of macrophytes:

1. submergent, (e.g. oxygen weed),
2. emergent (e.g. water cress, bulrushes, reeds)
3. floating (e.g. water lilies, duck weed).

Examples of stream macrophytes

Macrophyte coverage provides a broad characterization of a benthic macroinvertebrate microhabitat. Many organisms are adapted to specifically living among macrophytes; these macroinvertebrates are often associated with slower flow conditions and higher nutrient levels.

NOTE: *Macrophytes refer only to rooted aquatic plants; algal cover and moss are not included in estimates of macrophyte coverage.*

Method: Select the appropriate category that represents the percentage of the stream bed within the sampling reach that is covered by macrophytes.

Streamside vegetation

4. Streamside Vegetation (*check those present):*

☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

5. Dominant Streamside Vegetation *(check one)*:

☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

Streamside vegetation is an area of transition between aquatic and terrestrial ecosystems. Vegetation bordering a stream protects the water from disturbance, acts as a buffer between the stream and general activities in the watershed, and protects the banks from erosion.

Examples of streamside vegetation types

Streamside vegetation includes all terrestrial vegetation that influence the stream either by providing nutrients in the form of leaves or needles or by drawing water from the channel for growth. The description of streamside vegetation provides a general understanding of quality of nutrients from material that enters the stream from the terrestrial environment.

Method:

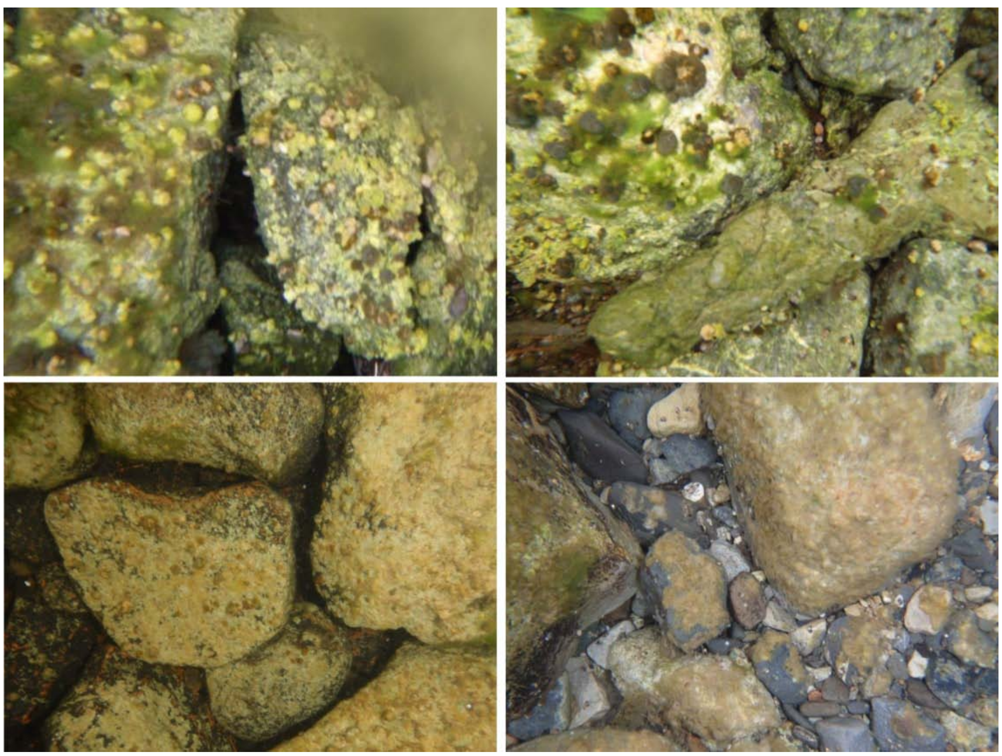
1. Select the vegetation types which are present within the sample reach (erosional and depositional zones). Be sure to look around. The presence of a single conifer in a 60 m reach may not provide significant influence and should not be checked. Check the appropriate box(es) under the Streamside Vegetation category.
2. Select the prevalent type of streamside vegetation (in terms of biomass) in the Dominant Streamside Vegetation category. Check the appropriate box.

Periphyton Coverage

6. Periphyton Coverage on Substrate *(benthic algae, not moss, check one*)

☐ **1 -** Rocks not slippery, no obvious colour (thin layer < 0.5 mm thick)
☐ **2** - Rocks slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
☐ **3 -** Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
☐ **4 -** Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
☐ **5 -** Rocks mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. It is composed of primary producers and acts as an important food source for other aquatic organisms, including benthic macroinvertebrates and fish. Periphyton stabilizes substrata and serves as habitat for many other organisms including some benthic macorinvertebrate taxa. Five descriptive categories are used to describe periphyton coverage, modified from Stevenson, J. and L.L. Bahls. (2007).



Examples of different types of periphyton

Method:

1. Pick up a rock from the erosional zone within your sampling reach and scrape with a metal ruler to determine the thickness of the periphyton.
2. Select the appropriate category on the field sheet and check the appropriate box.

NOTE*: Periphyton is best estimated at the same time as the 100 pebble count (see Substrate Characteristics section).*

Water Chemistry

WATER CHEMISTRY DATA **Time:**__________ (24 hr clock) **Time zone**: ____________

Air Temp: _____________(ºC) Water Temp: _____________(ºC) pH: __________________
Specific Conductance: ___________(µs/cm) DO: _______(mg/L) Turbidity: ________(NTU)

Check if water samples were collected for the following analyses:

☐ TSS (Total Suspended Solids)
☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
☐ Phosphorus (Total, Ortho, and/or Dissolved)
☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other_______

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

Chemical and physical water quality measurements include temperature, pH, conductivity, alkalinity, nutrients, metals and ions. Some of these parameters and others are recommended depending on local issues and management goals. Water quality probes are available to take some measurements on site while some parameters must be measured by an analytical laboratory.

Measurement of several key water quality variables that either directly or indirectly affect the benthic macroinvertebrate community can provide a great amount of information about the types of pollutants and their impact on a stream.

On-site water quality measurements

Basic water quality parameters are easily incorporated into any water quality monitoring program using individual field sensors or a multi-parameter field probe *in-situ*, including temperature, pH, conductivity, dissolved oxygen and turbidity. The table below describes each of these commonly used parameters, their effect on the benthic macroinvertebrate community, and the natural and anthropogenic factors that may modify the parameters' quantity.

VARIABLE	**DESCRIPTION**
Temperature (^{o}C)	Temperature is a key physical variable measured in degrees Celsius that directly affects many of the physical, biological and chemical factors influencing aquatic organisms. If temperatures are outside the range of tolerance for organisms for extended periods of time they can become stressed and die, resulting in a change in the types of organisms inhabiting the stream. Temperature can be modified by various factors including weather, removal of riparian vegetation, turbidity and dams.
pH	The relative acidity of water is ranked on a pH scale in a range of 0 –14. A pH of 0 is strongly acidic while 14 is strongly basic (alkaline). Pure water has a pH of 7 (neutral). The pH scale is logarithmic thus for every change in 1 unit there is a 10 fold change in acidity. A stream with a pH of 6 is 100 times more acidic than one with a pH of 8. Water with pH 6.5 to 9 is suitable for the greatest diversity of aquatic organisms. Young fish and aquatic insects are especially sensitive to extreme pH values outside the optimum range. Stream pH is usually determined by the surrounding geological makeup, but acid rain, wastewater discharges and drainage from coniferous forests (acidic) can contribute to a low stream pH. pH can also influence the forms (e.g. percent dissolved) of metals and therefore the toxicity to different aquatic species.

Conductivity (µS/cm)	Conductivity is the ability of a solution to conduct an electrical current. This is dependant on the total concentration of ionized substances dissolved in the water and is measured in micro Siemens / centimetre (µS/cm). Pure water has a conductivity of 0µS/cm. Conductivity is affected by temperature and many probes now provide the option of recording Specific Conductance, which standardizes the measured conductivity to a temperature of 25°C. Standardization to 25°C allows for comparison of measurements that were taken from water with different temperatures. Conductivity is a useful tracer of point source discharges and sudden increases along a stream can indicate a pollution source. ***NOTE:*** *Conductivity varies greatly across Canada, and the ranges of conductivity meters differ. Be sure to choose the appropriate meter for the study area.*
Dissolved Oxygen - DO (mg/L)	Dissolved oxygen is the concentration of oxygen dissolved in the water and is measured in milligrams per liter (mg/L). The amount of oxygen dissolved in water is dependent on temperature, barometric pressure, and to a lesser degree, salinity. The amount of dissolved oxygen in water affects which kinds of organisms are likely to be present. Water with a higher concentration of oxygen is generally considered to be of higher quality and better able to support many types of animals. Areas with low oxygen concentrations (hypoxia) can occur naturally within aquatic ecosystems. Animals that evolved to these conditions in natural environments (e.g., bottom waters of productive lakes) are typically tolerant to anthropogenic pollutants. Low oxygen concentrations can create unfavourable conditions for many organisms and can change population structure. When dissolved oxygen concentrations decrease, organisms that require high oxygen levels (e.g. mayflies, stoneflies) will emigrate or die leaving other organisms that can tolerate low oxygen (e.g midges, worms). Low dissolved oxygen in streams can be caused by several factors. Temperature is the major influence as cold water can hold more oxygen. Streams with low flow in the summer, when air temperatures are high, are subject to reduced oxygen levels. Slow moving water has less natural aeration. Organic wastes such as agricultural runoff and sewage discharges reduce oxygen because of bacterial decomposition of organic matter. Aquatic plants and algae replenish oxygen during daylight but consume oxygen during the night.
Turbidity (NTU)	Turbidity refers to the clarity of water due to the presence of suspended solids such as sediment, living organisms and organic matter. It is the measure of the extent to which light penetration in water is reduced from suspended materials. The more turbid the water, the murkier it is. Turbid waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall (warm water holds less oxygen than cold water). Photosynthesis decreases with less light, resulting in even lower oxygen levels. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Settled particles smother eggs of fish and aquatic insects. Higher turbidity levels are also often associated with higher levels of disease-causing micro-organisms such as viruses, parasites and some bacteria.

Method: Methods for measuring the above parameters in the field vary depending on the instrument being used. Most field probes need to be calibrated before use. When using any instrument follow the manufacturer's instructions for care, calibration, and use.

Field team member collecting water quality parameters using water quality probe

General tips for collecting water quality data with in-situ probes:

- Be sure to place the probe in an area where water is flowing (in the erosional zone of your sampling reach), usually close to the centre of the stream or in the main flow. Dissolved oxygen (DO) may vary significantly along the length of a river. In riffle areas where reaeration occurs, DO will be higher than in slow moving areas and pools.
- Always allow time for the reading to stabilize, especially for DO, turbidity and temperature (this may take 10 to 15 minutes).
- For conductivity and pH only, a reading can be taken in water collected in a clean container from the main flow.
- Record DO results in concentration (mg/L).
- Field probes (although they are available) are not typically used to measure turbidity, rather, they are sent to the laboratory for analysis
- Take care not to disturb the area upstream where you are placing your instruments.
- Take water quality measurements upstream of areas that have been disturbed by sampling crew or downstream of where the invertebrate sample and other measurements will be taken before disturbance begins.

Water quality samples for laboratory analysis

In addition to water quality parameters that are measured in the field, some parameters require that water samples be collected and sent to an analytical laboratory. These parameters are used to aid in interpretation. The following samples may be analysed by a laboratory:

- Conductivity, pH and turbidity (if *in situ* field probes are not available)
- Nutrients including phosphorus (measured as total unfiltered phosphorus) and nitrogen
- Alkalinity
- Major ions (e.g. Ca, Mg, Na, K)
- Metals (optional)
- Total Suspended Solids (TSS)

Be aware of specific restrictions related to the parameters that are sampled. Handling procedures for water quality samples vary depending on the analytical laboratory. Consult the lab for proper handling procedures before collecting samples. The lab will indicate whether preservatives must be added to the nutrient bottle while in the field. Depending on the lab, some bottles may come with preservative already in the bottle, in which case, sampling should be done carefully and with gloves.

NOTE: *The sampling method may require adjustment in fast flowing or deep streams.*

Method: At each site a sample will be taken for alkalinity, major ions and nutrients.

1. Collect samples from flowing water in the middle of the stream (erosional zone of sampling reach). Do not touch the mouth of the bottles or the inside of the caps or lids.
2. Submerge the bottle, mouth down and then flip below the surface to fill it to avoid getting surface particles in the bottle. Do not fill the bottle completely, leaving a slight air space at the top. Secure the lid on the bottle once filled.
3. Label each bottle with proper, legible labels, with the appropriate site code and date using a water- and solvent-proof marker.
4. Keep samples in a cool (ideally 4 °C), dark place to prevent growth of bacteria and other organisms. A cooler with ice packs is sufficient until samples can be refrigerated.
5. Submit samples to the analytical laboratory as soon as possible. Most samples have a 72 hour maximum holding time and must be received by the laboratory within 24 hours.

Benthic Macroinvertebrates

What is a traveling kick net method?

The CABIN protocol uses a traveling kick net sampling method standardized by sampling effort (i.e. time). The kick net is a triangular metal frame holding a bag with mesh size of 400 microns (μm) (recommended mesh size for general sampling). A collection cup (detachable) can be connected to the end of the net to facilitate removal of the sample. At the open end of the net, a rake handle is connected to one end of the metal frame. The part of the bag that attaches to the frame is made of canvas or ripstop-plastic tarpaulin to withstand abrasion.

Various invertebrate sampling pictures: kicknet showing detachable cup; person collecting benthic sample using kicknet; kicknet pattern in river

Sample collection

CABIN samples are collected with a kick net over a period of exactly three minutes to standardize the level of effort. Use of a zigzag sampling pattern across the stream integrates benthic macroinvertebrates from various stream microhabitats within the erosional zone (for example, areas around large boulders, riffle, runs, bank overhang) in proportion to their occurrence in a sample reach. Sampling must also include stream habitats directly adjacent to the stream bank as this region may have aquatic macrophytes that support a unique fauna.

The standard level of effort and integrated samples are important for comparison among sites, where benthic macroinvertebrate samples are collected from a variety of stream sizes.

Method:

1. Define the kick area and path in the erosional zone of the sampling reach before entering the stream. Inform field team members so that this area is not disturbed.
2. At the downstream end of the kick area, place the kick net downstream of the sampler, flat side of the triangle resting on the substrate of the stream.
3. Walk backward in an upstream zigzag direction, dragging the net along the bottom of the stream while walking.
4. Kick the substrate to disturb it to a depth of ~5-10 cm if possible. For large cobble, turn over and rub your foot over the surface to dislodge macroinvertebrates clinging to the interstitial spaces. Brush the surface of large boulders with your hand or foot.
5. The net should always be held close to the area that is being disturbed to ensure that most of the disturbed substrate and organisms are swept into the net by the current.
6. Continuously zigzag over the stream bottom from bank to bank in an upstream direction for a period of 3 minutes.
7. If the sampler needs to stop to get around an obstruction, take a rest, or remove large cobbles from net, the timer pauses the stopwatch while the sampler lifts the mouth of the net from the water. The stopwatch is then restart when the sampler is ready to continue sampling by placing the net back in the stream.
8. The timers spots the sampler and alerts them of any upcoming obstructions while the sampler is traveling backwards and can't always see where they are going.

Sample transfer

Images showing transfer of CABIN benthic sample to jars.

Method:

1. Splash the side of the net in the river to transfer all material to the collection cup at the end of the net (ensure that the mouth of the net is out of the water).
2. Remove the collection cup attached to the end of the net and empty the contents directly into a widemouth plastic sample jar, pail or sieve. Always work over a pail or tray in case of an accidental spill.
3. Wash any material remaining in the cup/net into the sample jar/pail/sieve using a squeeze bottle and forceps to remove any clinging animals.
4. Carefully rinse and discard any stones and large green leaves that have freshly fallen into river and are not invertebrate habitat.
5. Transfer sample from pail/sieve (if using) to sample jar. Check pail/sieve to ensure that no orgamisms remain.
6. Leave room in the sample jars for Formalin. Use extra jars if needed.
7. Double check the net/cup/pail/sieve for remaining macroinvertebrates.
8. Label the inside, outside and top of jar. The inside label should be written on waterproof paper marked by soft pencil. The outside of the jar should be in waterproof pen. All labels should have the following information: site code, date, and sample jar number (eg. 1 of 2, 2 of 2).
9. If the amount of sand and gravel in your net is extensive and will likely require the use of many sample jars, elutration using a bucket swirling method may be applied to reduce this material (see bucket swirling section below).

NOTE: *Seams and folds should be checked carefully for hidden organisms.*

The sample collected may require more than one jar, in which case it is critical to number and label the jars accordingly.

Sample preservation

The sample is preserved with 10% buffered Formalin to fix the tissues of the organisms quickly, allowing the body to remain firm for identification and preventing decomposition. Be sure to refer to the MSDS for Formalin before handling the chemical.

Method:

1. Wear protective gloves and goggles
2. Add Formalin into jar at a 1:3 ratio (1 part Formalin to three parts sample)
3. Optional: Wrap top of jar with parafilm and seal with the lid. Parafilm helps to prevent leaks and reduces Formalin fumes.
4. Cap jar, gently swirl the sample to distribute the Formalin. DO NOT shake the jar as large gravel and rocks in the sample will damage the organisms.

Samples are transferred to Ethanol after a minimum of 72 hrs in Formalin or upon arrival at the taxonomy laboratory, see CABIN Laboratory Methods manual for more information. (available from CABIN website)

Data Recording

Once the benthic macroinvertebrate sampling is complete, several types of information are recorded regarding the kick net sample.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☐ riffle ☐ rapids ☐ straight run

400 µm mesh Kick Net	
Person sampling	
Sampling time (i.e. 3 min.)	
No. of sample jars	
Typical depth in kick area (cm)	

Preservative used: ________________

Sampled sieved on site using “Bucket Swirling Method”:
☐ YES ☐ NO
If YES, debris collected for QAQC ☐

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.

Method:

1. Record the kick sampler, kick net sampling time (the time is 3 minutes unless the protocol is modified for research purposes or extenuating circumstances), the number of jars and estimate the depth of the kick area.
2. Indicate the type of preservative that was used if not formalin (i.e. 95% Ethanol).
3. Indicate if bucket swirling method was used.
4. Indicate if debris from the bucket swirling method was saved.
5. Remember to record the sample location on the Site Location Map.

Bucket Swirling and Sieving to remove excess debris (only used in special situations)

Bucket swirling or elutriation, is a common method used by to remove large amounts of inorganic material (sand/gravel) from a sample. During elutriation the sample is agitated or swirled in a bucket with water to create a vortex. Swirling causes lighter organic material and macroinvertebrates to float in the water column while the heavier inorganic sand and gravel remains at the bottom fo the bucket. Elutriation of the organic material in the water column has been shown to reduce sorting time by as much as 50% (Rosillon 1987, Ciborowski 1991). The elutriation process also minimizes the damage that large volumes of sand and gravel can have on the macroinvertebrates.

CABIN protocol recommends that bucket swirling only be used in certain situations. Examples are when there is an excess of sample jars that can be a hindrance to the field process or when the substrate size and density is thought to be damaging to the sample.

Method:

1. Use a bucket that is 30-40 cm in height, 20-30 cm diameter, circular, with a handle and has a spout to pour off the sample. It should be light weight, compact and light coloured as it needs to be transported to the field. Light colouring will allow the invertebrates to be easily seen.
2. Place the entire sample in the bucket. Add stream water to a depth of less than half the depth of the container.
3. Wash and scrape large stones and pebbles over the bucket to remove the macroinvertebrates then discard.
4. Swirl the water in the bucket to achieve a vortex. The organisms and fine particulate matter are lighter than the substrate and will float up.
5. Pour off the water that contains the organisms and fine particulate matter into a sieve while it is still moving, before it resettles. The sieve must be no greater than the mesh size of the net but can be smaller.
6. Repeat this process of adding water and swirling until there is no organic matter rinsing out of the sand/gravel. Gently swirling the sand/gravel by hand may also help to suspend organic matter and organisms into the water column.
7. The remaining inorganic material should be examined for organisms, particularly caddisflies in heavy stone cases. Use forceps to pick out any remaining organisms and put them in the sample jar. If organism are still present in the elutriate, continue the bucket swirling process until all organisms have been added to the sample jar.
8. A general rule of thumb is to continue bucket swirling until the water runs clear.
9. Transfer the material in the sieve to the sample jar(s). Label and preserve appropriately.
10. Finally, it is recommended that if this is a field protocol utilized for a study, a subset (1 in 10 samples) of the gravel be retained in a separate jar and preserved and labeled appropriately for QAQC purposes.

If there is an excessive amount of inorganic material, this process can be performed in batches. Although a small amount of sand may end up in the sieve, try to swirl so that the sand and gravel remain in the bucket and ultimately minimize the amount added to the sample jars for preservation.

The retained residual component will be examined under a microscope in the laboratory. Indicate on the field sheet if this method was used at the site and if the remaining debris was kept for QA/QC purposes.

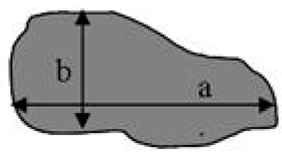
Summary of the Benthic Macroinvertebrate Sampling Procedure

- Define the kicking area within the erosional zone of the sample reach and communicate to the field team so it is clear what area of the stream not to disturb until the invertebrate sample has been taken.
- Start the kicknet sampling at the downstream end of the defined area.
- Firmly place the net on the substrate.
- Begin sampling by kicking, twisting or shuffling feet vigorously through the substrate, turning over rocks and stones, keeping the net close at all times. As the substrate is disturbed, the loosened organisms and debris are carried into the net by the current. Care should be taken not to let disturbed material flow past the net. Use a moderate pace in slow streams, to ensure that all disturbed material is caught in the net. Kicking styles can differ; shuffling and toe kicking are common styles. Either method is acceptable as long as the substrate is sufficiently disturbed.
- It is important to maintain consistent vigorous effort throughout the entire 3 minute sampling period. It is acceptable to pause to take a breath or to move around obstructions, but do so as not to disturb the sampling transect. Make sure the timer pauses the stopwatch during these times and that the net is removed from the water.
- Rub large or deeply embedded rocks using hands to loosen organisms.The net should always be in contact with the substrate and should always be directly downstream of the person kicking.
- Traverse the kick area in a zigzag pattern, moving from bank to bank and always working in an upstream direction. Bank to bank sampling may not be possible in large rivers or very fast flowing streams; follow the same procedure as wadeable streams, zigzagging only through the accessible area defined for sampling.
- Lift the net quickly from the current at the end of three minutes. Examine the net for large rocks and sticks. Remove and rinse carefully over the net, checking for and removing clinging organisms.
- Wash the sample into a container using a squeeze bottle. Check the net carefully, removing organisms with forceps. The net may need to be rinsed several times with the squeeze bottle. Seams and folds should be checked carefully for hidden organisms.
- Add 10% buffered Formalin to the sample in a 1:3 ratio (Formalin:sample).
- Label containers inside and outside. Indicate the site code, sampling date and the number of jars (i.e. 1 of 3, 2 of 3, etc).
- Record sample information on the field sheets: the person kicking, the typical depth of the kicked area, the sampling time, as well as the number of sample jars required to contain the sample.

Substrate Characteristics

The composition of the stream bed material is important in identifying hydrological characteristics of the river and the type of habitat available to aquatic organisms. CABIN uses the 100 pebble count to characterize the substrate. A number of calculated values are derived such as the dominant and subdominant substrate size class, the proportional composition of substrate size classes and mean substrate diameter. Embeddedness of the stream bed and surrounding material are also measured to characterize substrate.

Substrate Size Class	Category
Organic cover	0
< 0.1 cm (fine sand,silt or clay)	1
0.1 – 0.2 cm (coarse sand)	2
0.2 – 1.6 cm (gravel)	3
1.6 – 3.2 cm (small pebble)	4
3.2 – 6.4 cm (large pebble)	5
6.4 – 12.8 cm (small cobble)	6
12.8 – 25.6 cm (large cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9



The intermediate axis of a substrate (b).

100 pebble count

The 100 pebble count is the measurement of the intermediate axis of 100 randomly selected pebbles in the erosional zone. The intermediate axis is the axis on which the pebble will roll down the stream. Insects such as benthic macroinvertebrates attach themselves to the substrate or live within the bed materials surrounding the substrate. The larger the number of attachment places and living spaces typically equates with a greater variety and number of organisms. Optimally, a stream bed of riffle habitat will be dominated by cobbles, gravel and boulders. As the percentage of sand and silt increases, the suitability and availability of living space for macroinvertebrates decreases.

Method:

1. Zigzag through the erosional zone of your reach stopping approximately every two steps.
2. Lean down and touch the substrate material that is nearest to your toe without looking.
3. Pull out the material that the tip of your finger is touching. Be careful not to bias the substrate to the largest pebble nearest to your finger rather than the one touching your finger. Also do not bias the selection by avoiding larger boulders on the stream bed when choosing your zigzag path.
4. Measure its intermediate axis (axis b. in the figure above) in centimeters (cm). This is the diameter perpendicular to the longest axis (a). If the rock can't be pulled out then measure it in the water.
5. Record the diameter to the nearest 10th of a cm in the pebble count table (i.e. 3.4cm rather than 3cm).
6. For the case of bedrock, sand (particles <0.2cm), or organic material indicate B for bedrock, S for sand/silt/clay or O for organic material in the pebble count table.

***NOTE:** The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.*

Embeddedness

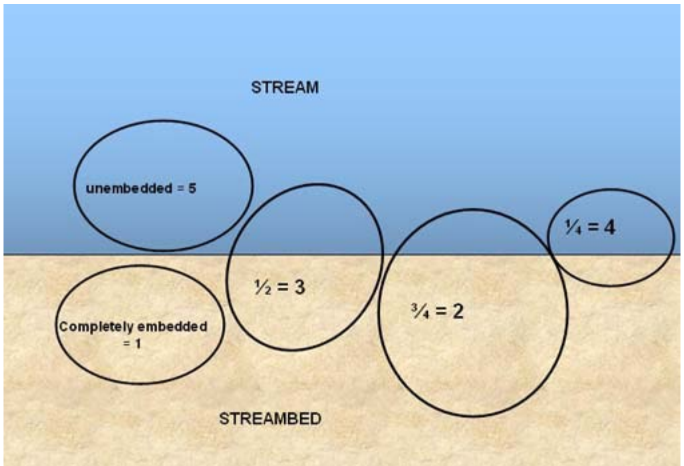
Embeddedness refers to how deeply the dominant substrate is buried in the finer particles of the surrounding material.

The more embedded the substrate, the fewer interstitial spaces there are for macroinvertebrates to live. In undisturbed streams, fine sediments (< 2mm) do not accumulate in large quantities on gravel and cobble in riffles. In areas modified by agriculture or other stream side activity, increased erosion results in accumulation of fine material in the interstitial spaces, the areas that are utilized by clinging organisms. Embedded substrates provide less desirable habitat for macroinvertebrates and reduce productivity.

Embeddedness Categories	Data entered into CABIN	Data stored in CABIN
Completely embedded	1	1
75% embedded	¾	2
50% embedded	½	3
25% embedded	¼	4
unembedded	0	5

Method:

1. Assess embeddedness during the 100 pebble count. For every 10th rock selected for the pebble count, estimate the percentage depth the rock was buried in the fine material. A stain line on the rock may indicate the level of burial and aid in the estimation.
2. On the field sheet, record the average degree of embeddedness as 1 (100% embedded), ¾ (75% embedded), ½ (50% embedded), ¼ (25% embedded), or 0 (0% embedded).



How embeddedness is visualized

NOTE: *Bedrock would be recorded as unembedded. Sandy substrate is recorded as completely embedded because it is embedded within itself.*

Surrounding material

Surrounding material are the fine particles that surrounds the substrate that forms the stream bed. It is normally composed of small silt and sand sized particles but the size will vary depending on the stream type and surrounding land and land uses.

Surrounding material, like the substrate size and embeddedness, is an indicator of the type of habitats that are available. The size of the surrounding material will determine the types of organisms found.


Images showing examples of surrounding material

SUBSTRATE DATA

Surrounding/Interstitial Material
Circle the substrate size category for the surrounding material.

Wentworth Size Class	CABIN Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

Method:

1. Reach between the larger rocks that form the streambed and pick up a handfull of the material that surrounds these rocks from several places within the erosional zone. Note that the current may take smaller particles from your hand if it is not closed tightly.
2. Estimate the size class of the surrounding material that is typical within the erosional zone. Use a ruler if necessary; be sure not to bias the estimate to larger rocks that may seem more abundant due to their size.
3. Circle the appropriate size class in the substrate data table on the field sheet.

Channel Measurements

Characteristics of the stream channel in a sample reach often determine the abundance and distribution of benthic macroinvertebrates. Dimensions and shape of the channel, flow characteristics and substrate characteristics are a result of the geology of the area and peak flows.

Bankfull or channel forming discharges tend to occur every 1 to 2 years (Gordon et al. 2004). They are related to flash floods caused by snow melt or summer rain storms. Erodible materials are carried through the stream reach and shape the dimensions of the channel (width, depth). They leave behind substrate material that the stream does not have enough energy to transport. The substrate material is crucial to the development of benthic macroinvertebrate communities. It is possible to relate benthic macroinvertebrate distributions with a particular suite of hydrological variables by measuring channel characteristics (e.g. Cobb et al. 1992).

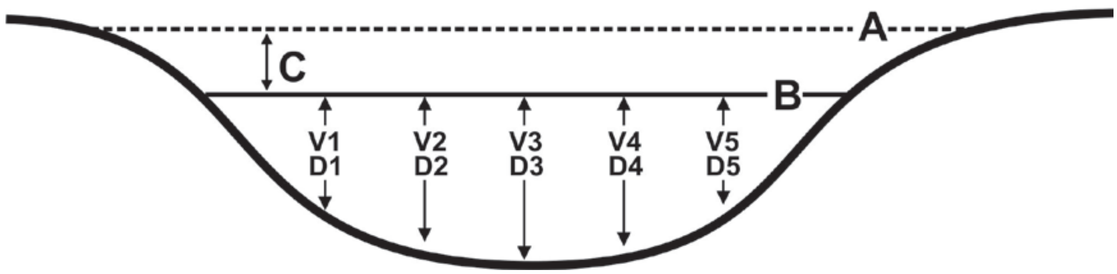
Bankfull Width, Wetted Width, and Bankfull-Wetted Depth

Widths and Depth

Location at site: ________________________________(Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: _________(m) B - Wetted Stream Width: ___________(m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): _________________________(cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations

Bankfull width is a measurement of high flow conditions while wetted width is a measurement of flow conditions at the time of sampling, usually low flow. Bankfull-wetted depth is the difference in height of the water level between the bankfull width and the wetted width.

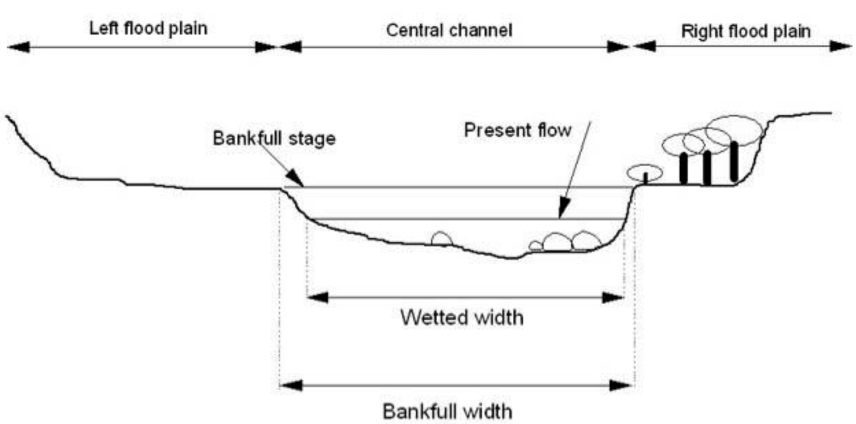


Image showing where to measure widths in a typical stream

Bankfull width, wetted width, and bankfull-wetted depth are used to characterize the hydrology of a stream. Wetted width is used to calculate current (non-flood) discharge, while bankfull width and bankfull-wetted depth are used to estimate stream discharge in high flow conditions.

Method:

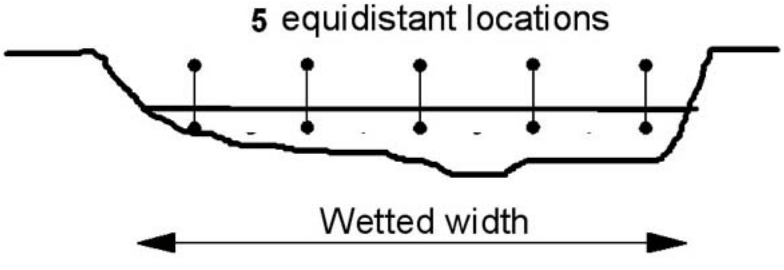
1. Establish a transect perpendicular to the flow; in or near the benthic macroinvertebrate sampling area.
2. Measure the bankfull width of the channel with a measuring tape. You can picture this as the channel defining width. To find the bankfull width observe the points of vegetation change on the stream banks, where algae or marl have been scoured from boulders, where sediment texture changes abruptly or where tree roots have been exposed.
3. Measure bankfull-wetted depth. This is the distance from the water surface to the height of the measuring tape at bankfull width. The bankfull measurement (e.g. the tape) must be level to the water surface. Ensure that the measuring tape is taut and level, so that bankfull-wetted depth remains the same across the stream. A tent peg may be used to secure the end of the measuring tape to the stream bank.
4. Measure the wetted width (the current water level width) of the channel.
5. Record measurements on the field sheet and indicate whether the measurements were taken upstream or downstream of the kicknet sampling area.

Velocity and Depth

Velocity is the speed at which the water is moving and depth is the height of the water level from the stream bed. The velocity and depth cross section measurements should be taken at or near the kicknet sampling location and where the wetted and bankfull width channel measurements were taken. The cross section should be representative of the area where the macroinvertebrates were collected.

Field crew taking velocity measurements.

CABIN is most interested in the velocity of the water at the time of sampling although the discharge is important. For this reason, CABIN measures only 3-6 points across the channel. In smaller streams (5 m or less wetted width) this should be done at approximately ¼, ½ and ¾ of the way across the stream. In larger streams (> 5m), measure five or 6 equidistant measurement points across the stream. If obstructions, such as large boulders, make it difficult to achieve exact equidistant points, move the instrument as needed to avoid these obstacles and adjust distance measurements accordingly.



An example of velocity and depth cross-sectional profile

	1	2	3	4	5	6	AVG
Distance from Shore (m)							
Depth (**D**) (cm)							
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D=D_2-D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)							

Velocity Meter (direct or rotary): Velocity can be measured directly or indirectly with a variety of velocity meters therefore the CABIN field sheet provides options for entering data depending on the instrument used. Refer to your user manual for instructions. Indirect meters (rotary) will give you the number of revolutions of a propeller in a specified amount of time (use a minimum time 40 sec) and direct meters will calculate the velocity for you. Water flows slower on the bottom of a stream and faster on the surface making 40% from the bottom the best location to hold your velocity meter for an indication of average velocity.

Method:

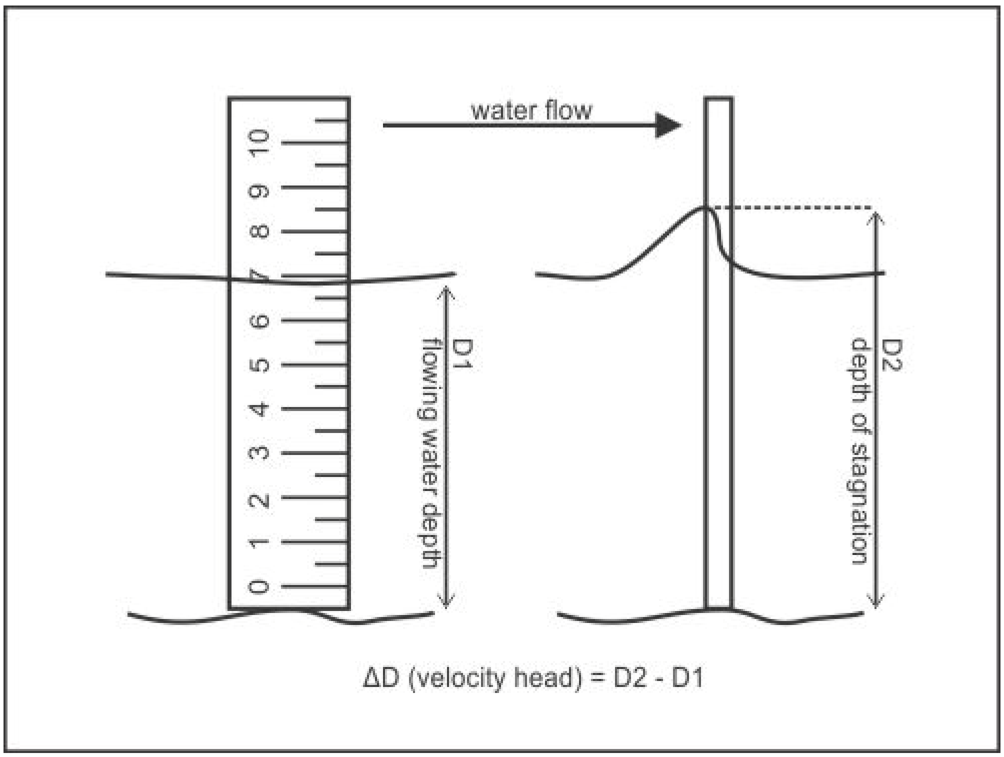
1. Indicate which velocity method was used.
2. Record the appropriate velocity observations as well as distance from shore and depth of water.
3. Repeat step 2 at three to six equidistant locations across the stream.

Velocity Head Rod: Velocity meters can be expensive and are usually limited by the depth at which they can measure velocity. A meter stick can be used to measure velocity relatively accurately in small streams or shallow, turbulent streams or when other instruments will not work. Velocity can be measured with a meter stick, following the method below. The meter stick must be strong enough not to bend against the current.

CABIN field team member taking velocity head rod measurements.

Method:

1. Place a metal ruler or meter stick vertically in the stream with the narrow edge in line with the oncoming flow of water (parallel to the flow of water). Measure the water level (the depth of flowing water). When the narrow edge of the ruler is facing the flow there is little effect on the flow. The water level will fluctuate slightly so the depth will have to be averaged by the observer.
2. Record the flowing water depth on the field sheet.
3. Turn the ruler so the wide surface is against the flow (perpendicular to the flow of water). ***NOTE:*** *when the ruler is turned, it* ***MUST*** *remain at the same depth on the stream bed (it can't slip off a rock, or press into the substrate) because the velocity calculation uses the change in depth at the water surface*. The water will be super-elevated (piles up) on the upstream side of the ruler causing the water depth to increase at the point of zero velocity (stagnation zone). This superelevated water mass is called the "velocity head".
4. Record the height at which the water "piles up" on the flat surface of the ruler facing the flow (e.g. the depth of stagnation zone). Again, the water level will fluctuate slightly so the depth will have to be averaged by the observer.
5. Record distance from shore.
6. Repeat steps 1 through 5 at three to six equidistant locations across the stream.



Velocity head rod measurements

The difference between the flowing water depth and the depth of stagnation is the velocity head (ΔD). Calculate this difference for all velocity measurements in the stream cross section. Record these calculations on the field sheet. Stream velocity is determined using these calculations and the formula provided on the field sheet.

Calculate velocity with the following equation:
Velocity (m/s) = $\sqrt{(2(\Delta D/100)*g)}$

Where
ΔD is the difference between the flowing water depth, and depth of the stagnation zone (measured in centimetres)
g is acceleration due to gravity, or 9.81 m/s^2

Slope

Slope represents the stream gradient and influences sediment transport and discharge characteristics. Slope is the difference in elevation at the upstream and downstream ends of a stream segment, divided by the length of that segment (slope= rise/run). We are measuring the slope of the surface of the water, not the bottom of the stream. When measuring slope in the field, depending on visibility, it is recommended to start from the top or bottom of a riffle and extend to the top or bottom of the next riffle (i.e. the entire sampling reach). Slope is entered into the CABIN database as a ratio of the height in metres over the distance in metres.

We suggest two methods for acquiring slope for CABIN sites.

Method A: Topographic map

Although slope can be estimated from a map it will almost always be over a much larger area than your reach unless you have a very fine scale map. It is recommended that whenever possible proper field equipment be used to measure slope in the field to ensure that slopes are comparable from site to site and study to study in the CABIN database.

Slope can be determined using a topographic map using the following steps
(Modified from: http://geology.isu.edu/geostac/Field_Exercise/topomaps/slope_calc.htm):

1. Find your sampling site on a topographic map and measure the length of the path of the river between the contours on either side of the site. For the best accuracy, start and end the line on the contour lines on the map rather than between them. Follow the path of the river, do not make a straight line between contours.
2. Convert the length of the path of the river to the map units using the scale of the map. You can use a piece of string if necessary.
3. Determine the total elevation change along the path of the river by subtracting the elevation of the lowest contour from the elevation of the highest contour used. Do not make any unit conversions on this measurement.
4. To calculate the slope, simply divide the elevation change by the length of the path of the river that you converted to map units (difference in contour lines / length of path).

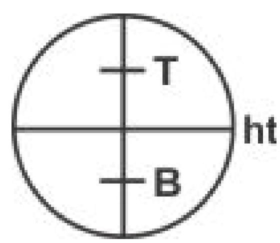
Method B: Field equipment

Typically in the field, surveyor’s equipment such as a transit, tripod and level, total station or hand level is used to measure slope. For high gradient streams (steep slopes), slope can be easily measured with a clinometer and expressed as a percentage. It is only accurate to 1% or 0.01 m/m so it is not recommended for typical low gradient streams.

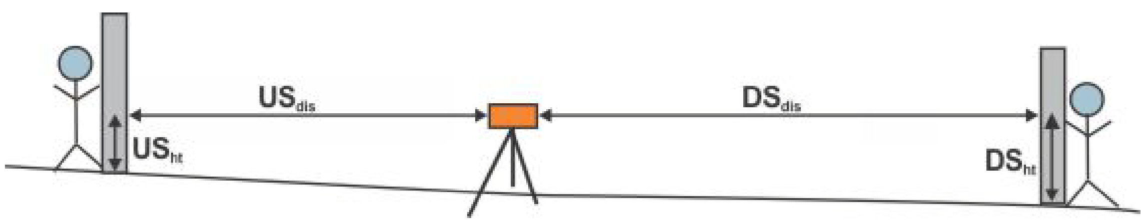
Field crew using survey equipment to calculate slope

Slope measurement using survey equipment

1. Setup the survey equipment at a stable location on the stream bank or at the water's edge. This is where all the measurements will be taken from. Do not move the survey equipment between measurements.
2. Have a person walk upstream with a graduated rod that is at least 2 m high. The person should place the rod at the water's edge so that it is not beneath the water surface. The rod should be held level (straight up and down).
3. Measure the distance the person is upstream and the height from the water surface using the graduated rod and the survey equipment. Record these values on the field sheet (USht, USdis).
4. Have that person walk to a downstream location. The person should again place the rod at water's edge.
5. Measure the distance the person is downstream from you and the height from the water surface using the graduated rod and the survey equipment.Record these values on the field sheet (DSht, DSdis).
6. Calculate the total horizontal distance (dis). The sum of the distance upstream (USdis) and downstream (DSdis) from the survey equipment is the total horizontal distance (USdis + DSdis). Record this value on the field sheet.
7. Calculate the total change in height. The difference between the height of the rod downstream and the height of the rod upstream is the total change in height (DSht - USht). Record this value on the field sheet (Δht).
8. Calculate the slope. The change in height over the total distance is the slope (Δht / dis). Record this value on the field sheet.



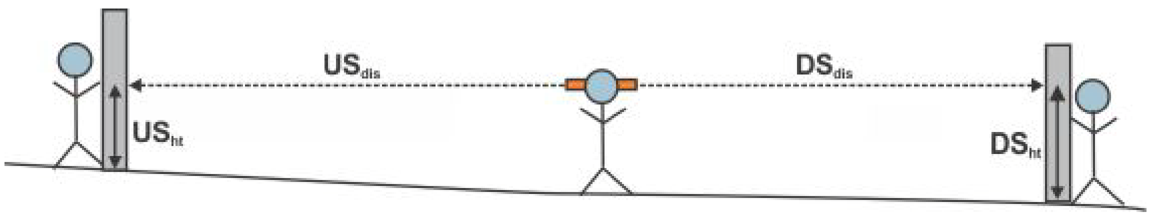
Cross hairs labeled as seen through surveysighting level



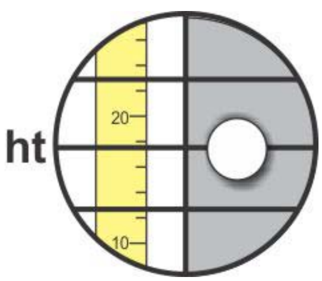
Measurements required when taking slope measurements using survey equipment

Slope measurement using a hand level

The method to measure slope using a hand level is the same as using survey equipment except that a person is now the datum (ie, the tripod) and cannot move. The distance of their eye/hand level from the surface of the water must be exactly the same when measuring upstream and downstream. The visible distance through a hand level is much shorter than through survey equipment. A measuring tape must be used to measure and record horizontal distance. The bubble in the hand level is used to record the change in vertical distance off of the survey rod.



Measurements required when taking slope measurements in a large stream using a hand level



This is the view through a hand level. The view is divided in half. The left half is for viewing the target and the right half is for leveling the spirit bubble. To read the value on the ruler the spirit bubble must be aligned with the center cross hair. The correct height value for this example would be 17.5 units.

Using a hand level to measure slope

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

Scale: ___________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) _____________ (m),
distance between contour intervals (horizontal distance) _____________ (m)
slope = vertical distance/horizontal distance =____________________

OR

☐ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

Measurements	Upstream (US)	Downstream (DS)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			

Quality Assurance and Quality Control

Quality Assurance and Control (QA/QC) is an ongoing process. Its goal is the prevention, early detection and correction of field and analytical data collection errors.

The first step to ensuring quality data is standardized training of the participants (Culp and Halliwell. 1999). Environment Canada staff provide training to participants through online modules and field workshops. Participants who complete the online modules and field training receive CABIN certification after demonstrating their knowledge and understanding of the field procedures.

In addition to adequate training, the following measures must be followed in order to ensure data quality:

- A CABIN Project Manager should be identified to ensure that field crews are trained and to coordinate the management of the data. Only trained participants will receive a username and password to enter data into the CABIN database.
- Only a Project Manager can request that a study be set up in the CABIN database for data to be entered. This ensures that at least one person understands not only the field procedures but also site selection, the reference condition approach and CABIN analyses.
- All members of the field crew must ensure that all data sheets are filled in correctly and completely before leaving the site.
- All members of the field crew must determine if the data are reasonable before they leave the field, and if not, the measurements should be repeated before leaving. This may require taking a calculator to determine if some measurements seem reasonable.
- It is best if data are entered in the CABIN database by one of the field crew members and as soon as possible after sampling in case questions arise.

Sample processing and Taxonomy

Post-field procedures on sample processing and taxonomy, including QA/QC procedures, can be found in the CABIN Laboratory Methods manual.

References and further reading

Background on Water Quality parameters http://waterontheweb.org/under/waterquality/index.html

CABIN website: http://ec.gc.ca/rcba-cabin/

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U.S. EPA 1995. Volunteer stream monitoring: a methods manual. EPA 841 D95-001 April. Office of Wetlands, Oceans and Watersheds, 4503F Washington DC 20460. (http://www.epa.gov/volunteer/stream/stream.pdf - 2.3 MB download).

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WHMIS: http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index_e.html ; http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index_f.html

WHMIS online training: http://www.yowcanada.com/

Appendices: Supporting documents

- *Field Equipment Checklist*
- *CABIN Field Sheet and Site Inspection Sheet*

Appendix 1. CABIN Field Equipment checklist

CABIN FIELD GEAR	
General Equipment	
Field sheets and clipboard	
Pencils and markers	
Gloves (rubber, neoprene)	
Waterproof labels	
Labelling tape	
Ziploc bags	
Duct tape and tool kit	
Location and Reach data	
GPS	
Camera	
Densiometer	
Channel and Substrate characteristics	
Velocity metre OR Meter stick	
Measuring Tape	
15 or 30cm ruler	
Hand Level	
Calculator	
Tent pegs	
Water chemistry sampling	
Water quality metres (Temp, pH, DO, Conductivity, turbidity)	
Cooler with sample bottles and ice pack	
Extra batteries	
Benthic Sampling	
Kicknet	
Stopwatch	
Sieve	
White tray	
Squeeze Bottle	
Spoon/tweezers	
Bucket	
Sample jars	
Formalin with MSDS, gloves and glasses	
Cooler for sample jars & Formalin	
Safety equipment	
Lifejackets	
First aid kits (field and vehicle)	
Cell phone or Satellite phone	
Swift water helmet	
Throw bags	
Waders, boots, raingear	
Sunscreen, hat, bug spray	

Field Crew: ____ Site Code: ______________

Sampling Date: (DD/MM/YYYY) ___________________________

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: ______________________________ Local Basin Name: ______________________________

River/Stream Name: ______________________________ Stream Order: (map scale 1:50,000) ________________

Select one: ☐ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: __________________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other _____________

Dominant Surrounding Land Use: (check one) Information Source: __________________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other _____________

Location Data

Latitude: ____________N Longitude: - _____________W (DMS or DD)

Elevation: ________(fasl *or* masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: _________

Site Location Map Drawing

Note: Indicate north

Field Crew: ____ Site Code: ______________

Sampling Date: (DD/MM/YYYY) __________________________

Photos

☐ Field Sheet ☐ Upstream ☐ Downstream ☐ Across Site ☐ Aerial View
☐ Substrate (exposed) ☐ Substrate (aquatic) ☐ Other ______________________

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   ☐ Riffle ☐ Rapids ☐ Straight run ☐ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   ☐ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*
   ☐ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: (*check those present)*
   ☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   ☐ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one*)

   ☐ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   ☐ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   ☐ **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   ☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   ☐ **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

   Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☐ riffle ☐ rapids ☐ straight run

400 µm mesh Kick Net	
Person sampling	
Sampling time (i.e. 3 min.)	
No. of sample jars	
Typical depth in kick area (cm)	

Preservative used: __________________

Sampled sieved on site using “Bucket Swirling Method”:
☐ YES ☐ NO
If YES, debris collected for QAQC ☐

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.

Field Crew: ____ Site Code: ______________

Sampling Date: (DD/MM/YYYY) ___________________________

WATER CHEMISTRY DATA

Time:_________ (24 hr clock) **Time zone**: ______________

Air Temp: ________________(ºC) Water Temp: __________(ºC) pH: ______________

Specific Conductance: _______(μs/cm) DO: __________(mg/L) Turbidity: _________(NTU)

Check if water samples were collected for the following analyses:

☐ TSS (Total Suspended Solids)

☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)

☐ Phosphorus (Total, Ortho, and/or Dissolved)

☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other________________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

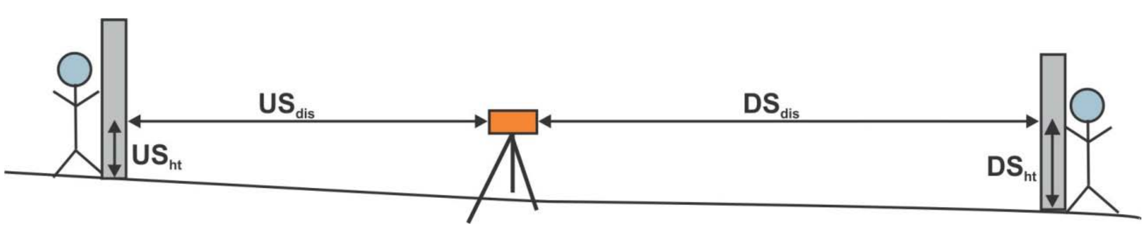
Scale: _______________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ___________ (m),
distance between contour intervals (horizontal distance) ___________ (m)
slope = vertical distance/horizontal distance =_________________

OR

☐ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	$US_{dis}+DS_{dis}=$
Change in height (Δht)			$DS_{ht}-US_{ht}=$
Slope (Δht/total dis)			



Field Crew: ____ Site Code: ______________

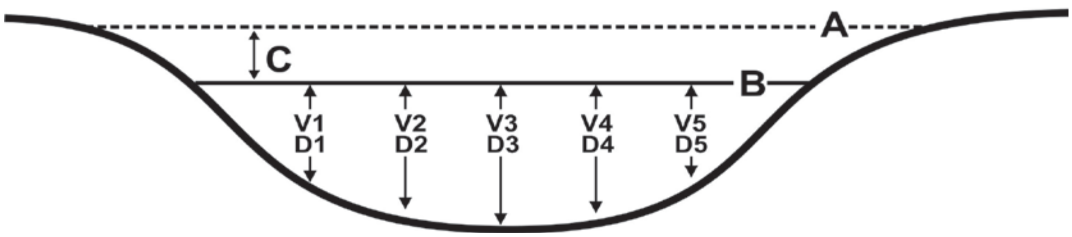
Sampling Date: (DD/MM/YYYY) ___________________________

Widths and Depth

Location at site: _____________________________*(Indicate where in sample reach, ex. d/s of kick area)*

A - Bankfull Width: __________(m) B - Wetted Stream Width: __________(m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): ______________________(cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = $\sqrt{[2(\Delta D/100) * 9.81]}$

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☐ **Direct velocity measurements**: ☐ Marsh-McBirney ☐ Sontek or ☐ Other________________

	1	2	3	4	5	6	AVG
Distance from Shore (m)							
Depth (**D**) (cm)							
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D = D_2 - D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)							

CABIN
CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: ______________________________________ Site Code: ______________

Sampling Date: (DD/MM/YYYY) __________________________

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories *(*E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1			26			51			76		
2			27			52			77		
3			28			53			78		
4			29			54			79		
5			30			55			80		
6			31			56			81		
7			32			57			82		
8			33			58			83		
9			34			59			84		
10			35			60			85		
11			36			61			86		
12			37			62			87		
13			38			63			88		
14			39			64			89		
15			40			65			90		
16			41			66			91		
17			42			67			92		
18			43			68			93		
19			44			69			94		
20			45			70			95		
21			46			71			96		
22			47			72			97		
23			48			73			98		
24			49			74			99		
25			50			75			100		

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

Field Crew: ____ Site Code: ______________

Sampling Date: (DD/MM/YYYY) ___________________________

SITE INSPECTION

Site Inspected by: ___________________________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ______________________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: ( ) ______________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes: