FTSW #59

Shoreline Naturalization Monitoring Protocol
Background Report

By

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Abstract:

The purpose of this report is to provide background information and recommendations for a volunteer-based monitoring program. The emphasis of these recommendations are on the Kawartha Lakes Region since the parameters upon which the protocols are based were identified through research of shoreline conditions for this area. It is anticipated that further research will allow these recommendations to be applied to the whole of the Trent-Severn Waterway. The findings of the Kawartha Lakes shoreline conditions research are available in report format. This report deals specifically with protocols for monitoring physical stream and lake conditions. A second background report of the same genre, although with a biological and habitat emphasis is also available.

INTRODUCTION

The FTSW's Shoreline Naturalization project coordinators have identified the need to monitor the success of their project sites. This would provide evidence of any changes in the ecosystem that may be attributed to shoreline naturalization. Monitoring results would be useful to educate riparian land owners of their impacts on the nearby waterway and to encourage their involvement in the project.
It was also decided that the monitoring program should enlist the aid of volunteers from the community.

The purpose of this report is to provide background information and recommendations for a volunteer-based monitoring program. The emphasis of these recommendations are on the Kawartha Lakes Region since the parameters upon which the protocols are based were identified through research of shoreline conditions for this area. It is anticipated that further research will allow these recommendations to be applied to the whole of the Trent-Severn Waterway. The findings of the Kawartha Lakes shoreline conditions research are available in report format (St-Onge 1999; Warren 1999). This report deals specifically with protocols for monitoring physical stream and lake conditions. A second background report of the same genre, although with a biological and habitat emphasis is also available (Warren 2000).

The parameters that will be addressed by this report include: erosion, suspended solids (water clarity) and sedimentation. Different protocols for each parameter are discussed in detail in regards to their importance, capabilities and limitations. Moreover, an outline of their equipment needs, sampling design and data analysis is provided. A step by step explanation of each protocol is also given. The protocols mentioned in this report are widely used in volunteer monitoring and have the ability to isolate the impacts of naturalization projects. In order to reduce the list of possible protocols a list of criteria was created. This reduced the time required in the research phase of this study. The criteria are listed below. The protocols are described later in this report.

<u>Criteria for Choosing/Dismissing Monitoring Techniques:</u>

-Ease of access to equipment
-Low operator variance in equipment
-Adaptable to a range of physical conditions
-Pleasant for volunteers to keep interest
-Sampling locations are accessible
-Technical skill required should be limited to training offered
-Further technical skill provided by a coordinator or contracted out
-Availability of bench marks
-Reliable and literature about the method's limitations
-Adaptable to volunteer-based monitoring program
-Allows site and regional sampling/monitoring/comparison

-Ability to reflect impacts of naturalization activities
-Not too labour and time intensive (exact time commitments of volunteers ?)
-Small monitoring groups (2 - 4 people)
-Liability
-Ecologically sensitive monitoring (i.e. No animals killed)

PROTOCOL DESIGN

Throughout the research conducted for this report several general factors were identified that are important to the success of a long-term, volunteer monitoring program. Before a monitoring program is put in place the program designers must understand the program's objective(s), the level of quality required of the data, the location of monitoring sites, and the level of commitment that can be expected of volunteers. Moreover, a monitoring program requires a reliable coordinator and institution to house the monitoring data and organize activities (Chakela 1992). Facilities for rapid data processing and analysis are also required (Chakela 1992).

Quality Assurance/Quality Control

Since the data obtained will be used by the FTSW and dispersed to riparian land owners for educational purposes the quality of the data need not be extremely high. Nevertheless, measures should be taken to assure that the data is accurate, precise, complete, representative and in most cases comparable to other stream or lake shore locations. Accuracy is achieved by assuring that equipment is working well and that the procedure used reflects the use of the data (EPA 1999c). Precision takes into consideration the reproducibility of the data at a particular site, regardless of accuracy. In order to establish precision human and equipment error need to be minimized. The key to consistent results is to train volunteers to follow standard sampling procedures and, if possible, have the same individual take the reading at the same site throughout the season (EPA 1999c). Site location is important to assure that the data is representative of the site's conditions as well. Data is complete if the number of samples outlined in the sampling design for that protocol is met. This can be represented as a percentage (EPA 1999c). Monitoring at the same time of year, day and at regular intervals ensures comparability over time. It is often useful to relate site data to a regional scale. Therefore, sites should be comparable regardless of their location. This is achieved by monitoring every site using the same protocols for each parameter.

There are several different ways to show that the data collected is accurate and precise. These techniques include: field blanks, negative and positive plates, field duplicates, laboratory replicates, spike blanks, calibration blank and standard blank. These techniques are described in Appendix A. Although some of these techniques are touched upon in this report further consideration for their implication in this project is warranted.

Quality assurance is also important at the level of sampling design for the purposes of data analysis. A study by Block and Gregor at Environment Canada (1985) showed that changes in trends can be attributed to a change in analytical methods, variable timing and frequency of the sampling (monitoring) program (Block and Gregor 1985). In order to reduce the amount of work required during data analysis (to determine if changes in program design are to blame for changes) it is advisable to choose protocols carefully. Expensive or laborious protocols may not survive if funding problems arise and volunteers could lose interest if their tasks are monotonous. Changing laboratories could also affect data analysis. Block and Gregor (1985) advise that before changing laboratories or any part of the monitoring protocol, a period of overlap should be allowed so that the effect of each change can be measured directly.

A quality assurance/quality control project plan should be developed that addresses the above factors. The plan would govern how volunteers are trained, samples are collected and analyzed and how information is stored and disseminated (EPA 1999e). Often there is skepticism over how a volunteer-based program will ensure that the data collected is consistent over time and within projects, and that group members collected and analyzed data using standardized and acceptable techniques comparable to data collected in other assessments using the same methods (EPA 1999e). A written document of quality assurance techniques is very useful to reduce skepticism over the quality of data collected and the legitimacy of the monitoring results. Therefore, it is suggested that a quality assurance plan should be incorporated into the development of the FTSW's Shoreline Naturalization Monitoring Program.

Many organizations offer information on how to prepare a quality assurance project plan. These sources are listed in the reference page (identifiable by a *) and should be consulted when preparing the final monitoring protocol.

Site locations

Most monitoring sites will be located on private and public properties that have been naturalized by the FTSW's Shoreline Naturalization Project. These sites will be limited to those in which there is permission by the property owner and easy, safe access by boat or land. The EPA (1999c) suggests that the following questions be asked when choosing a monitoring site:

- Are other groups (local, state, federal agencies; other volunteer groups; schools or colleges) already monitoring this site?
- Can you identify the site on a map and on the ground?
- Is the site representative of the (naturalized shoreline)?
- Does the site have water in it during the times of year that monitoring will take place?
- Is there safe, convenient access to the site (including adequate parking) and a way to safely sample a flowing section of the stream? Is there access all year long?
- Can you acquire landowner permission?
- Can you perform all the monitoring activities and tests that are planned at this site?

- Is the site far enough downstream of drains or tributaries? Is the site near tributary inflows, dams, bridges, or other structures that may affect the results?

- Have you selected enough sites for the study you want to do?

For some monitoring protocols it will suffice to monitor on the naturalized site itself, however, in some cases one or several samples will be required offshore in the water. To determine whether the naturalized site is a source of various contaminants or pollutants it may be useful to monitor at offshore locations upstream and downstream of the naturalized shoreline.

For most protocols, however, the purpose is to monitor how well the naturalization activity is working to meet its objectives. Therefore, bench mark sites that have very similar physical and biological characteristics but that are not naturalized should also be monitored. These bench mark sites should be both natural and undisturbed as well as natural but disturbed. This would offer a variety of comparison possibilities. A paired-comparison approach can be taken by comparing a naturalized site to a non-naturalized site. The required number of bench marks and the level of variability between paired sites requires more research. Moreover, there is debate over the use of bench marks in monitoring therefore, further research regarding their capabilities, limitations and requirements should be conducted.

Volunteer Commitment and Training

A detailed study regarding the level of commitment that can be expected of volunteers in long-term monitoring projects was beyond the scope of this report. The undergraduate thesis by Haigh (1995) was consulted and provides some indication of volunteer commitment in the Peterborough area. However, the study is very much group-based. Further resources for individual and land owner participation in environmental improvement activities should be consulted to ensure that the protocols used for this monitoring program will keep the interest of volunteers. If volunteers are not interested in their part of the program or do not see the point of a particular protocol; thus quitting their duty or not being consistent, it would be difficult to assure precision and completeness of the data.

Since the people who will benefit from shoreline naturalization are the property owners along the Kawartha Lakes an effort should be made to involve these individuals in the monitoring process. The participation of users of the waterway is essential to gain the necessary knowledge to ensure that the projects address their needs, and will attain the intended objectives in the most efficient way (Wates and Knevitt 1987 in Kendle and Forbes 1997). Moreover, as Kendle and Forbes (1997) state very clearly "Involvement leads to understanding, which in turn leads to the ability to act, both individually and collectively". Therefore, by involving riparian land owners they would be more likely to keep in mind the lessons learned from monitoring the shoreline and even apply their knowledge once the monitoring program is completed.

Kendle and Forbes (1997) suggest the following to ensure effective participation from volunteers:

- Provide well-focused, relevant and low level initiatives rather than formal and high-profile initiatives which attract unbalanced responses. Foster a down to earth local image with which local people can identify.
- The 'problem' must be worth the time and effort in the eyes of all concerned. Participation takes time and energies. If the task is trivial, or foreclosed, and everyone realizes it, participative methods will boomerang. Issues that do not affect the individuals concerned will not, on the whole engage interest.
- There must be attractive benefits to the community from the project and particularly to individual members of the community.
- Ideally, the individuals concerned must have the skills and the information to enable them to participate effectively. It may be necessary to develop these skills further. However, one must be careful not to erect an 'educational barrier' to involvement
- The manager, must want participation and not indulge in it because of a sense of obligation. The manager must be prepared to give up some responsibility and give advice and guidance without dominating.
- Opportunities for involvement should be easy to identify and without unnecessary barriers or bias.
- Opportunities for social benefits should be maximized, for example having fun.

When volunteers are performing tasks they are unaccustomed to they need to be instructed and directed. This also improves their sense of not wasting time. If volunteers are well trained they can accomplish the duty much more quickly and allow for some fun while working (Kendle and Forbes 1997). Therefore, this monitoring program should have a training component for the volunteers that will perform the protocols. The training program should be well designed and effective at teaching volunteers their duties in a minimal amount of time. The EPA (1999f) provides some key elements to consider when developing a training program for volunteers (Appendix B).

Land Use Surveys

A visual assessment, as outlined by the EPA (Appendix C) would be useful in establishing whether factors other than site specific naturalization or problems may be causing changes in trends. Volunteers could boat around the lake or stream and observed land uses and activities on the shoreline that may be useful for data analysis. Further research should be conducted to determine the value of this additional monitoring.

DESCRIPTIONS OF PROTOCOLS

Shoreline Erosion Protocols

Shoreline erosion is an important issue in riparian zones. The lost soil from shorelines enters waterways and negatively affects water quality and consequently affects aquatic wildlife. Fine particles of sediment can remain suspended in the water column. This process reduces water clarity that in turn reduces the ability of aquatic plants to survive on lake and stream beds. Consequently, aquatic animals must move elsewhere for sustenance. The suspended particles can also irritate the gills of fish. Large and small particles from eroded banks eventually settle-out of the water column and accumulate upon stream and lake beds. Accumulations of fine particles (especially sediments) on gravel beds are responsible for the loss of many spawning areas for fish and other aquatic animals.

Although many environmental and ecological impacts occur form shoreline erosion, humans are also negatively affected. Shoreline erosion often creates hazardous areas on riparian properties. Therefore, owners of such properties lose access to those portions of their yards. Moreover, costly rehabilitation efforts are sometimes used to correct the problem. As a result property owners are usually concerned over erosion and should be receptive to learning about activities that reduce soil losses from their yards. Erosion should therefore be monitored at naturalized sites since the results could favor wider acceptance and use of re-vegetation and naturalization activities instead of hardening shorelines to reduce site erosion.

Erosion Pins (manual measurement)

Soil erosion rates are easily calculated using erosion pins. The erosion types that can be detected by erosion pins include creep, rill and sheet (USGERIO 2000). Erosion pins provide very site- specific data; however with the proper sampling design it is possible to create a regional outlook of soil erosion. Changes in the exposure height of the pins indicate net erosion or deposition at the pin (Bradbury et. al. 1995).

This technique has been used to detect the extent of soil erosion from agricultural land, various slope types and from shorelines and banks of lakes and streams. Erosion pins are used by a wide range of professionals such as university research professors, the United States Geological Survey (USGS) and geomorphologists. Nevertheless, erosion pin installation and data collection is simple enough to be conducted by nonprofessionals if adequately trained.

The equipment required consists of:

-several metal rods or spikes (roughly 155 mm in length)

-measuring tape

-wooden stakes

-light fencing

-data sheet

Any metal rods of 155 mm in length and of a small diameter could be used. Therefore, prices will vary.

Protocol:

<u>Installation</u>

The erosion pin method consists of setting up permanent plots (quadrats) along the bank of a shoreline. The pins are placed within this plot along transect lines perpendicular to the shore. Ultimately, the location of erosion plots within the Kawartha Lakes region will be limited to those locations that are legally and physically accessible and possess surface characteristics that favour the use of erosion pins. Erosion pins will not be effective if placed in fine textured soils that would erode due to the pins. Nor should erosion pins be placed in extremely hard soil types due to the difficulty of inserting the pins without creating significant fractures in the surface material.

This type of monitoring is a long-term project. Therefore, the pins must remain in their initial positions in order for data to be useful. When deciding plot and pin locations consideration should be given to the level of disturbance to which these pins may be subjected. Any disturbance, other than erosion, that will cause the pins to be displaced will be harmful to the monitoring activity. These plots should be placed in locations that are not physically used by property owners. The pins should be placed within the plantings; however, they must be easily accessible to take height measurements. Light fencing should be placed around the plot to reduce access by people and other animals that may inadvertently disturb the pins. The plots and erosion pins should be set up before or shortly after planting has occurred (same season) in order to collect adequate baseline data.

Each plot should have fixed dimensions of width and length along the shoreline. Wooden stakes are used for permanent delineation of the plot. These dimensions should be recorded permanently on the site's field data sheet. It is suggested that the plot not exceed 15 meters in width (Ponce 1998). Figure 1 illustrates the positioning of the plot on the shoreline. The transect lines within the plot are randomly chosen using computer-generated, random number sheets. As many pins as possible should be placed within each plot (Ponce 1998). Once the pins are installed, each pin should be marked with a code to ensure that they are easily distinguished from one another. The height of the pin above the ground surface should be recorded for each pin. This data will serve as the baseline data for that location.

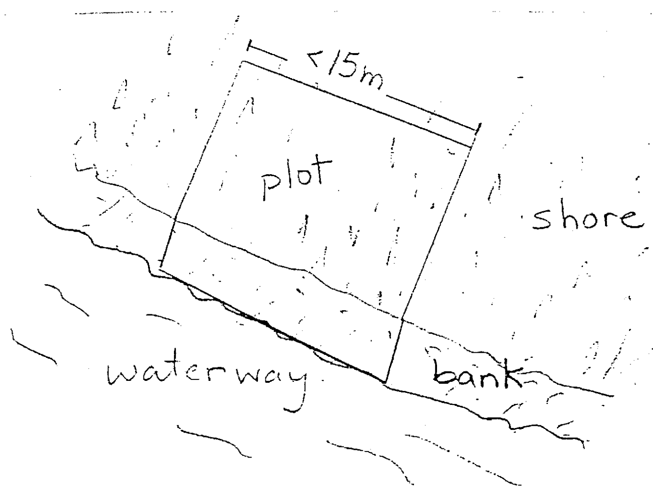

Figure 1: Location of erosion pin plot on shoreline

Source: Adapted from Ponce (1998)

Successive Monitoring

The height measurement is the only information necessary for this type of monitoring. Therefore, the protocol consists of measuring the height of each nail with the measuring tape and recording this height on the field data sheet. Figure 2 illustrates how the measurements should be taken.

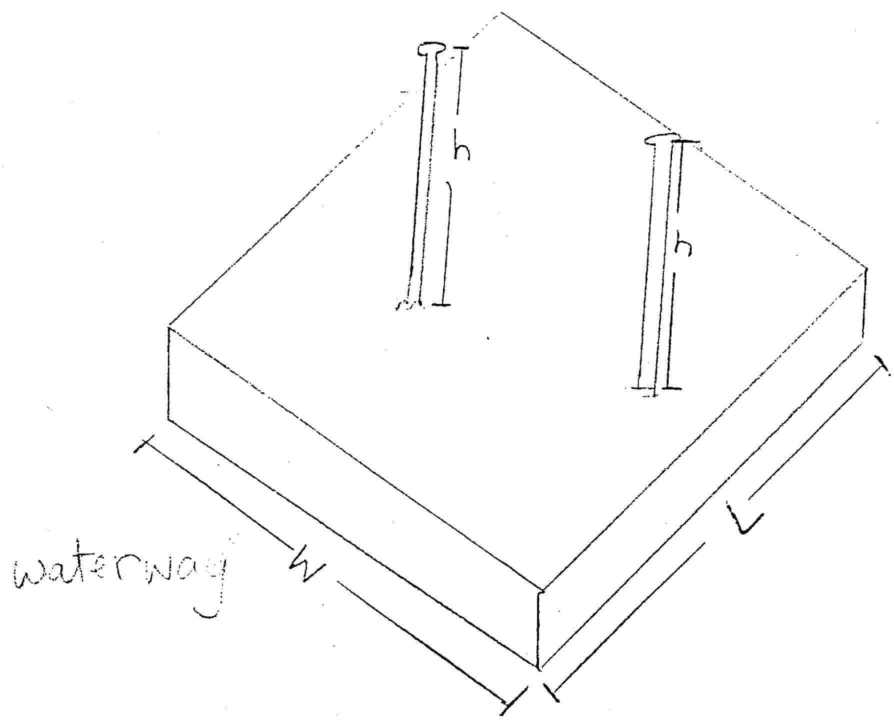

Figure 2: Measurement of erosion pin heights and dimensions of the erosion plot.

Source: Adapted from Ponce (1998).

Sampling design:

Experimental plots are placed on naturalized sites and bench marks that are set up along the same water body. Choosing representative bench mark (BM) sites that correspond to the naturalized properties is the most important step of sampling design. No set criteria have been found that outlines the conditions required for accurate representation of erosion in an area. Therefore it may be necessary to enlist the help of a professional who is knowledgeable about erosion processes and familiar with the physiography of the Kawartha Lakes region. This person could find possible plot locations at the outset of monitoring.

Bench marks would be used to compare the ability of the re-vegetated site to reduce erosion in relation to the ability of an undisturbed natural site or a disturbed site to perform this same function. Since the factors that affect erosion rates are soil type (erodibility), rainfall intensity (erosiveness), slope steepness and length, land use and wave action intensity these land characteristics should be similar for both the bench mark site and re-vegetated site. Vegetation types and abundance should be the only variables so that the comparison is based on whether the pattern and type of re-vegetation effort measures up to the natural site in terms of reducing erosion. It may be possible to locate both bench mark and experimental sites on the same property if undisturbed, natural shoreline vegetation exists.

Monitoring could occur as infrequently as every six months. Monitoring is not possible when there is snow cover however. It is possible to time the monitoring to various major seasonal events. For instance, monitoring could occur during peak times for water sports, tourist cruises, drawdown, spring water release and many other significant events along and within the waterway (Bradbury et. al. 1995). The intervals should remain constant from year to year however to reduce variability in results. Extra monitoring should occur after rainfall events, if possible. One individual could easily conduct the field measurements in under ten minutes, although if a boat is used to access the site two volunteers are recommended for safety. Bench mark sites should be monitored on the same day as the corresponding naturalized site. Depending on the distance between these related sites, the same volunteers could monitor both sites or each site could be monitored by different volunteers. To maintain quality control it is suggested that the same persons be assigned to particular sites through time.

Data analysis:

Average heights are calculated by using all pin heights in the same plot (Bradbury et. al. 1995). These data along with the dimensions of the plot are used to calculate the volume cost (equation 1) for a particular year.

$$(1)\ \text{volume cost} = [L*W(\text{avg.}h1-\text{avg.}h0)]$$

Where L is length of the plot, W is width of the plot, avg. h0 in the average initial height (from the previous visit) and avg. h1 is the average final height (from the current visit). This value provides an estimate of the volume of soil lost over the period between time 0 and time 1. Volume cost is the amount of soil lost that has an economic value to the land owner.

In terms of analyzing the data collected, statistical tests are useful in determining trends. Statistical analyses of soil loss data for rainfall events can provide important information regarding the ability of plantings to reduce soil loss during heavy runoff and rainsplash. The level of variability between the naturalized and BM sites should be determined by statistical analysis. The coordinator should be in charge of this stage. When considering variation and the accuracy of the data it should be noted that on sandy banks the upper bank pins give the best overall indicator of erosion because the middle and bottom pins may be distorted by (often temporary) deposition of sand that has been eroded from higher up on the bank (Bradbury et. al. 1995).

Discussion:

Erosion pin data provide a meaningful output to riparian property owners. The owners are given a value that estimates the amount of soil lost which can be translated into monetary loss. This technique also meets all of the set criteria with the exception that it may not be applicable in some areas due to soil physiography and lack of accessibility. Nevertheless, it is believed that not all sites require erosion monitoring. Therefore, only those sites with proper legal and physical access as well as a proper bench mark could be monitored with adequate results for the monitoring project. Due to the irregular distribution of erosion over time and space this method can only generalize shoreline erosion on the basis of a small sub-section (USGERIO 2000). As a result, determining representative plots on naturalized sites and bench mark sites is important when monitoring shoreline soil erosion. If adequate time and knowledge is applied to this step of the erosion pin method the success of erosion monitoring should be satisfactory.

References for manual erosion pin method:

U.S. Global Exchange Research Information Office. Soil and sediment erosion. [Internet]. **Www.gcrio.org/geo/soil.html.** Last updated April 3, 2000.

Bradbury, J., P. Cullen, G. Dixon and M. Pemberton. 1995. Monitoring and Management of Streambank Erosion and Natural Revegetation on the Lower Gordon River, Tasmanian Wilderness World Heritage Area, Australia. Environmental Management, 19 (2): 259-272.

Ponce, R. 1998. [lecture notes] Soil Conservation and Management.

Photo-Electronic Erosion Pins (PEEP)

Photo-electronic erosion pin technology was developed in the UK by D.M. Lawler (1991). This method is very similar to the erosion pin technique mentioned above, however it is possible to collect continuous data. The PEEP sensors (erosion pins) are attached to a data logger that reads from each pin a photo-electronic reading. This reading is then matched to a range of soil loss units. Early testing of this equipment on bank erosion has established that the results obtained are more accurate than manual measurements (Lawler 1991). Since its development many shoreline erosion studies have utilized PEEP (Lawler and Leeks 1992; Lawler et al. 1997; Stott 1999; also see appendix). PEEP systems have been used in the UK, the USA and Australia. Manufacturers claim that PEEPs can be used to monitor river banks, drainage and irrigation channels, soil erosion plots, hillslopes, beaches, creeks and many other locations (Hydro Scientific Ltd. 2000).

The equipment consists of:

-auger

-several PEEP sensor rods (50 cm or 66 cm long)

-Wireman's tape (cablesnake)

-cable tubing

-housing unit

-light fencing

-data logger

-data sheet

PEEP sensors are "...narrow transparent acrylic tube[s] containing an array of photo-sensitive cells"(Hydro Scientific Ltd. 2000). These sensors output a millivolt signal proportional to the length of the PEEP tube that is exposed to daylight. Erosion therefore increases voltage outputs, while deposition creates a decrease in outputs (Hydro Scientific Ltd. 2000). Equipment lists can be found at the Hydro Scientific Ltd. website. Quotes could be sent by email to HydroSci@aol.com. By connecting PEEPs to a data logger (e.g. 15-min scans) very clear measures of magnitude, timing and frequency of erosional and depositional events are determined (Hydro Scientific Ltd. 2000). Data loggers cost around $149.00 U.S. each. Although the PEEP sensors require sunlight to function, nocturnal events are usually detected just a few hours after the event (Hydro Scientific Ltd. 2000).

Protocol:

Installation and Sampling design

The installation of the system of PEEP is illustrated in Figures 3 and 4. Detailed installation instructions are provided with the purchase of a PEEP system. The sensors are installed and reset in the sediment much like conventional erosion pins (Hydro Scientific Ltd. 2000). Sampling design could follow the same principles as the above manual erosion pin protocol. However, the frequency of monitoring could be increased (once a week, once a month, et cetera). The same factors should be considered to obtain representative results. The only exception would be the installation of the data logger. The data logger should be housed in a stilted box or other container to be safely guarded from the weather and theft (Figure 3).

Successive monitoring

Once the pins and data logger are installed, it is simply a matter of occasionally downloading the data.

Data Analysis:

The analysis of this information will require much time due to the abundance of data that continuous monitoring produces. The coordinator should conduct analyses regularly and program the data logger to take readings at an interval that reduces the data set to a manageable size. Unlike the manual erosion pin method PEEP does not require calculations of soil loss. Instead the output is quickly matched to a predetermined range of soil losses. Statistical analyses would be conducted to determine the impacts of naturalization activities (as discussed for the manual erosion pin method).

Discussion:

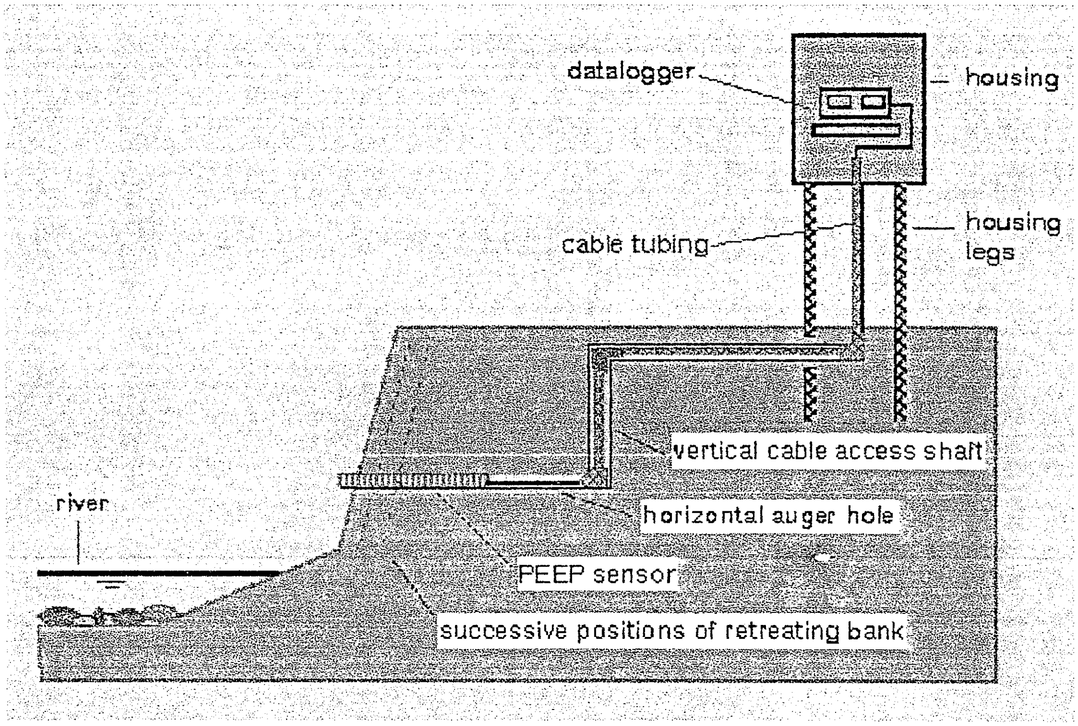

Figure 3: **Schematic installation of a PEEP sensor and datalogger at a river/gully bank site.**
Source : Hydro Scientific Ltd.(2000)

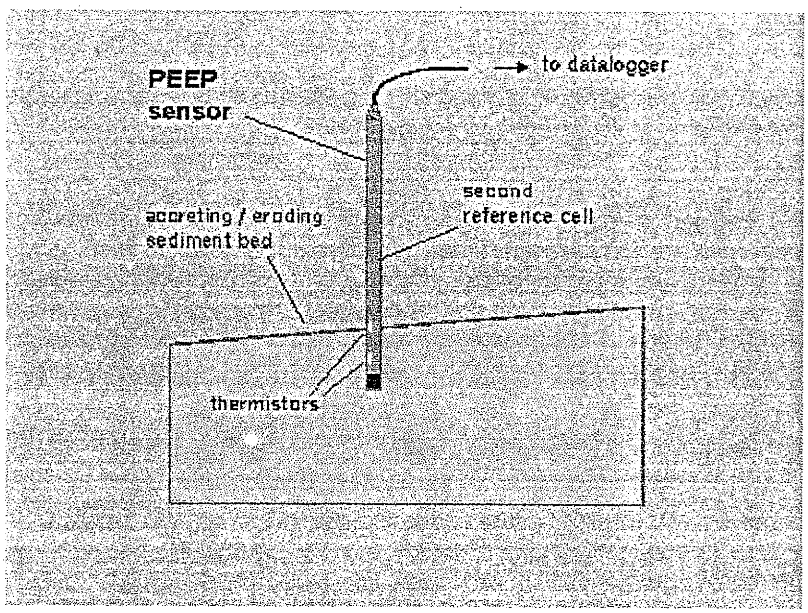

Figure 4: **Alternative PEEP installation for beaches, mudflats, etc.**
Source : Hydro Scientific Ltd. (2000)

The PEEP system is regarded as an accurate tool for monitoring soil erosion. Much literature (Appendix) exists stating the capabilities and limitations of this equipment. Moreover, it reduces the number of visits required to each site by volunteers. This is an advantage to property owners as well since some may not want to participate in the monitoring program due to the undesirability of frequent visits to their properties. The collection of data is very simple and less time consuming than manual erosion pins. Moreover, the PEEP method reduces the chance of trampling the plants. Drawbacks of this method however are cost and possible theft of the electronic pins and data loggers. Many pins and one data logger are required for each site. Depending on the number of sites being monitored it may be too expensive to implement this protocol.

PEEP references:

Hydro Scientific Inc. 2000. PEEP accessories. [Internet] members.aol.com / HydroSci/ pages/ peep15.htm

Lawler, D.M. 1991. A new technique for the automatic monitoring of erosion and deposition rates, Water Resources Research, 27, 2125-2128.

Lawler, D.M., Harris, N. and Leeks, G.J.L. 1997. Automated monitoring of bank erosion dynamics: applications of the novel Photo-Electronic Erosion Pin (PEEP) system in upland and lowland river basins, In Wang, S.Y., Langendoen, E.J. and Shields, F.D., Jr. (Eds), Management of Landscapes Disturbed by Channel Incision, The University of Mississippi, Oxford, Mississippi,

249-255.

Lawler, D.M. and Leeks, G.J.L. 1992. River bank erosion events on the Upper Severn detected by the Photo-Electronic Erosion Pin (PEEP) system, in: Bogen, J., Walling, D.E. and Day, T.J. (Eds) Erosion and Sediment Transport Monitoring Programmes in River Basins, Proc. Oslo Symposium, International Association of Hydrological Scientists Publication, No. 210, 95-105.

Stott, T. 1999. Stream bank and forest ditch erosion: preliminary responses to timber harvesting in mid-Wales, in: Brown, A.G. & Quine, T.A. (Eds) Fluvial Processes and Environmental Change, John Wiley, Chichester, pp. 47-70.

Bank Profile Method

This technique is also known as the repeated profile method or the multiple cross-section method. Bank profiles are utilized when site properties do not allow the proper use of erosion pins. These sites may be on colluvium. In this case the erosion pins would promote erosion around the pin thus rendering the data unrepresentative of other processes acting upon the stream bank. The bank profile method involves measuring the width and depth of a channel along transect lines. This is completed at predetermined time intervals in order to calculate a rough measure of changes in volume for that channel.

Many monitoring and erosion research organizations have suggested this method, which implies that it is widely accepted and reliable. This method has been specifically applied to streams and rivers since it is aimed at measuring the volume of a channel cross-section. However, it is possible to modify the sampling design so that a profile of one bank can produce soil loss data related to naturalized sites (Ponce 2000). Instead of measuring from a point on each bank, measurements are made from a point on the naturalized bank, along the bank, and the final point of measurement would be at a certain distance offshore in the water (Ponce 2000).

The equipment required for this protocol would include:

-tape measure

-line level

-graduated line with plumb bob on end

-boat with anchor or hip or chest waders

-data sheet

Protocol: (suggested)

1) Set up transect line perpendicular to the shore:

One person stays on the shoreline holding one end of the measuring tape and checks that the tape is held level. A second person holds the other end of the tape at the offshore location.

2) Decide the interval of measurements along the transect.

Note: At least ten point measurements should be made to create a good profile.

3) Record the location of the transect line and the measurement points along the transect on the site map.

4) A third person starts onshore and measures the distance between the measuring tape and the bed of the lake or channel with the graduated plumb bob line.

5) Record height on data sheet.

6) Repeat steps 4 and 5 for each point along the transect line.

7) Repeat steps 1 to 6 for the other transect lines.

Note: Record the distances between each transect lined and calculate the total width of the shoreline that is being monitored.

Sampling Design:

Further research is required in order to determine the best time of year for this type of monitoring and how often it should occur over a year. Although, it may be possible to monitor once a year to receive adequate data. The sampling interval need not be short since this type of erosion monitoring only shows changes that have occurred over long period of time. Individual events cannot be observed with this method. No more than three volunteers would be necessary to undertake this protocol. A site could be monitored in under 2 hours with proper training. Coordination of leveling the tape and keeping the transect line steady is required and techniques to achieve this should be a part of the training session. The measuring tape should be held at an elevation from the ground that is easily reproducible. Therefore, an object of permanent and unchanging height on the shoreline should be used to ensure that the tape height is constant each time measurements are taken. Moreover, measurements should be taken at the same interval along the transect at each new measurement interval.

Data Analysis:

Analysis of these data is only possible after the second visit to the site. Using the length of the transect line and the heights measured it is possible to calculate the volume of soil lost during the time between the first and second measurements. Figure 5 illustrates how this is achieved. The volume of the area sampled is calculated at each visit. Volume is calculated by multiplying the cross-sectional area (length of transect line x average depths) by the total width of the monitored shore. The change in volume is calculated by subtracting the volume for one visit by the volume calculated for the previous visit. Soil loss has occurred if the difference is positive. If the difference is negative, sedimentation occurred and if the difference is zero then no soil was lost or deposited. This value also indicates the actual volume of soil that was lost over that period of time. Many analyses could be undertaken with these volume data. For instance, measurement of soil loss over different temporal scales is possible. A time series graph of these volumes would also help indicate trends.

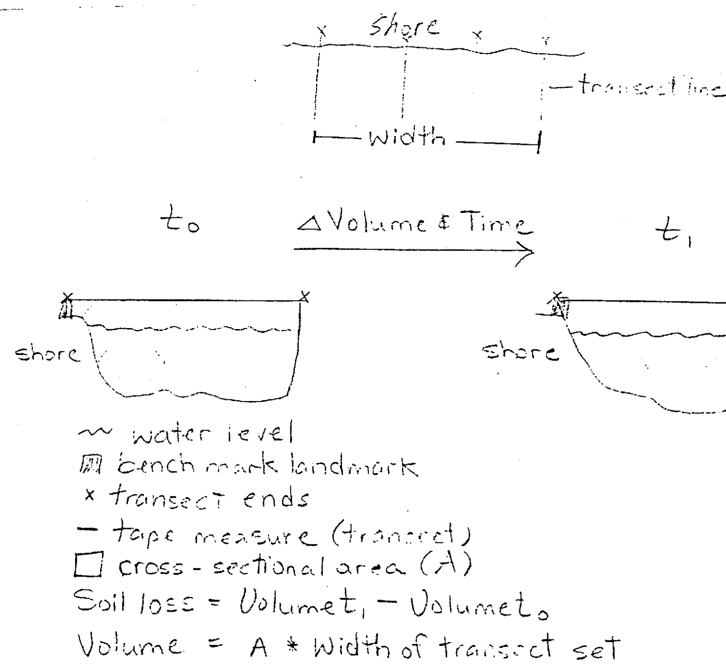

Figure 5: Visual representation of the Bank Profile method.
Source: Adapted from Ponce (1998; 2000).

Discussion:

Much research is still required to perfect this protocol for shorelines. This should not be too difficult to undertake since bank profiles are widely used. This technique is recommended as an alternative tool for monitoring sites where erosion pins cannot. It should be noted that the above mentioned protocol is only an interpretation of Ponce's (1998) diagrams. Further research should be conducted to establish if a more reliable means of conducting this protocol exist.

Water Clarity/Transparency/Turbidity Protocols:

Water clarity is related to the amount of suspended particles (turbidity) as well as phytoplankton and zooplankton (WRI 1999) present within the water column. Suspended particles or suspended solids include; sediments, algae, microbes and other substances. The transparency of water within a lake, river or stream is important to the ability of that water body to support aquatic plants and other organisms.

Naturalization of the shoreline is expected to reduce inputs of sediment and nutrients to the waterway as well as offer shading to reduce water temperatures. Therefore, water clarity is expected to improve by reducing turbidity and extreme algal growth. Monitoring the changes in water clarity of a particular water body could show whether naturalization activities along this water body's shore have contributed to improving general water conditions. Moreover, water clarity is intuitively used by the public to judge water quality and usually has a value to the public (Lee, Jones-Lee and Rast 1995). Therefore, the findings of this protocol would be easily understood and appreciated by residents who use the water body.

<u>Secchi Disk Method with Florel-Ule colour scale</u>

The Secchi disk method is also found under the names Secchi depth, Secchi reading and Secchi transparency. The Secchi disk method looks at the depth of lake water clarity to determine its trophic status and whether there exists a problem with turbidity. Water clarity is described as the amount of light that suspended solids allow to pass through water (EPA 1999b). Clear water at great depths indicates that turbidity is low, and waters that are clear at only marginal depths are considered turbid. This type of protocol is mainly used to assess the overall condition of a particular lake or of a deep, slow-moving water channel. However, it does apply to determining the turbidity of nearshore waters as well.

Secchi disks are simple enough to be used by school children. Other users of the Secchi disk include volunteer groups (CoastNet), Lake or stream associations (Michigan Lake and Stream Associations Inc., Minnesota Lakes Association), research institutes (Robert B. Annis Water Resources Institute) and government (U.S. Environmental Protection Agency, British Columbia Ministry of Forests, British Columbia Ministry of Environment, Lands and Parks).

Florel-Ule water colour scales are used to determine the type of material contributing to turbid conditions in the water body. There are several variables that can affect how one perceives water colour. These variables include the perception of the observer, sky conditions, time of day, surface conditions, direction from which the water is viewed and suspended particles (WRI 1999). The Florel-Ule colour scale attempts to standardize observer perception (WRI 1999). Other techniques are also used to reduce variability (see discussion of Quality Control/Quality assurance).

Florel-Ule colour scales have been used by the WRI research vessel (WRI 1999). The Ministry of Forests (BCMF 1998) (appendix) and Ministry of Environment, Lands and Parks (2000) in British Columbia have also used colour codes as indicators of the types of particles found in water bodies. Volunteer programs such as the Alberta Provincial Stream Survey (1999) and the Falmouth Pond Watchers Program (1999) in Massachusetts also use water colour codes and colour comparison sheets as part of their water quality monitoring protocols. Although this report emphasizes the use of the Florel-Ule colour scale further research should be conducted to assess the accuracy of these other techniques.

Equipment:

The equipment required for this technique are as follows:

-Secchi disk with graduated rope

-Florel-Ule colour scale

-white cardboard

-boat with anchor

-data sheet

The Secchi disk consists of a disk attached to a long, non-elastic cord or rope. The rope should have markings at an interval of one (1) meter in order to determine the depth at which the disk disappears and reappears from view. The disk is flat and round and is generally painted so that two quarters of the disk are white and the other two are black (Figure 6). Secchi disks cost around $32.50 U.S.. Some users of the Secchi disk method have noticed that the cord can often stretch or even shorten over time (EPA 1997). For this reason it is suggested that minimal stretch nylon cord be used. A price on this cord could not be found at the time this report was written.

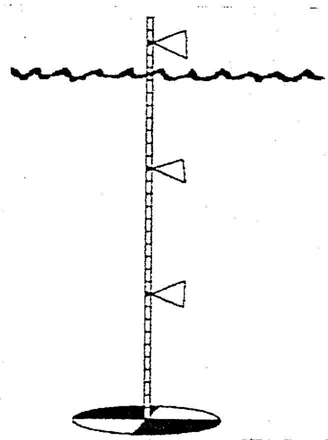

Figure 6: Secchi disk with graduated line.
Source: EPA (1999c)

The Florel-Ule colour scale consists of twenty-two glass vials of coloured water (Figure 7) that have been obtained by using standardized chemical procedures for producing coloured water (WRI 1999). The vials are arranged on a scale from pale blue (#1) to brown (#22) within metal frames to keep them from breaking (WRI 1999). Nevertheless, care is required not to break these vials. A price for this instrument was not found at the time this report was written.

Quality Control/Quality Assurance:

The following steps or procedures should be taken in order to reduce variability and error within the data and thus improve confidence in the data:

-To reduce observer variability when determining water colour one should view the water from directly overhead so that the colour will be dependent upon the nature of the material creating the turbidity (WRI 1999).

-The same person should be taking all readings since sharpness of vision varies from person to person (MLSA 1997).

-The reading should be taken on the same day of the week, or at least not more than one day before or after the same day of the week (MLSA 1997).

-It is preferable that the measurement be taken between 10:00 am and 4:00 pm so that the light rays from the sky are at a similar angle each time the reading is taken (MLSA 1997).

-Avoid taking the measurement when the lake is choppy or rough (MLSA 1997).

-Take the reading on the shady side of the boat (MLSA 1997).

-The reading should be taken at the same location at each monitoring interval (MLSA 1997).

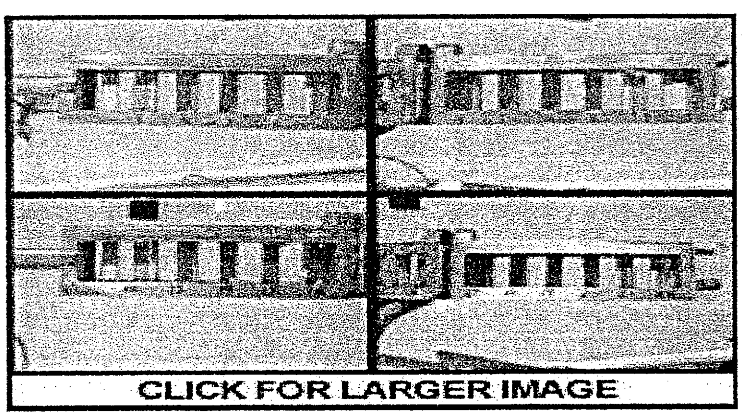

Figure 7: Florel-Ule colour scales.
Source: (WRI 1999).

Protocol:

1) Move offshore from the naturalized site to a location where the water is deep enough for disk to be used.

2) Record water surface conditions according to the criteria in table 1 (below)

3) Remove sunglasses: Record cloud cover in the circle as either 1/2,1/4,3/4, full or blank

4) Lower Secchi disk into water on shady side of the boat to one meter depth

5) Compare the colour of the water against the white portion of the Secchi disk to the vials of the Florel-Ule coloured water, record on data sheet the scale number

Note: place a piece of white cardboard behind the Florel-Ule vials and keep the scales securely around your wrist so as to not lose them

6) Lower Secchi disk into water on shady side of the boat, record depth at which disk disappears from view as it is lowered

Note: Depth is either measured from the marks on the line or, in shallow water, by holding a finger at the endpoint and measuring the line with a meter stick

7) Raise slowly and record the depth at which the disk reappears as it is raised

8) Add the depth that the disk disappears and reappears and divide by two (2) to get the Secchi disk reading for the lake

9) If the disk is still seen when it hits the bottom, record this depth as the Secchi disk reading for the lake

10) Repeat steps 5 to 7 another two times and average the final Secchi disk readings (from step 7 or 8) by adding these numbers together and dividing by three (3)

Note: Record the depth to the nearest 0.1 meter and round averages to the nearest 0.1 meter (Adapted from the Watershed Report Card - Silver Level (1999),CoastNet (1997) and WRI (1999).)

Table 1: Surface water conditions

Conditions	Description of Water
calm	complete absence of wind, glasslike appearance of water
rippled	lightly ruffled, not more than 2 cm rise in waves
ruffled	wavy, not more than 5 cm in waves
rough	waves more than 5 cm in height

Source: Watershed Report Card, Development Committee. 1999. Watershed Report Card - Silver Level. [draft].

Sampling Design:

For a complete seasonal analysis readings should be taken every 2 weeks starting from ice-out until fall turnover (Watershed Report Card Development Committee 1999). With the bi-weekly data one could calculate an average for the season(s). According to CoastNet (1997) Secchi measurements should not take more than 10 minutes to accomplish at each site. It is suggested that readings be taken sometime within the period of two (2) hours after dawn to two (2) hours before dusk (BCMF 1998). Two volunteers are necessary for this protocol. One person should handle the Secchi disk and Florel-Ule vials while the other records onto the data sheet and keeps the boat steady.

Data Analysis:

Analysis of the Secchi disk data would be in terms of changes over time. It is *not* advised to compare Secchi disk data between different water bodies (MLSA 1998). The program co-ordinator may choose to create monthly and yearly time series graphical representations of changes in Secchi disk depths. This would allow for easy analysis of trends over time within the sample site. An effort should also be made to associate changing anthropogenic and natural activities along the shoreline to changes in Secchi depth.

The MLSA (1998) have suggested causes of certain trends. If the reports for any one season show an increased water transparency depth after the first week of spring it may be due to 1) reduced nutrient input from the watershed, 2) increased grazing of algae by zooplankton, 3) reduced soil erosion into the water body, or 4) seasonal algae succession. Should Secchi depths get shallower during the summer season, it may be due to 1) increased abundance of free floating algae (especially if water colour is distinctly green, brown or red), 2) re-circulation of bottom sediment from motorboat activity, 3) erosion of the shoreline or from site development near the water body, 4) discolouration of the water from wetland runoff and/or plant decomposition, 5) increased turbidity, or 6) reduced zooplankton populations. Water colour data would therefore be helpful in such an analysis.

The mean Secchi depths for each year could also be used to determine the trophic status of the lake for that year. The MLSA (2000) use ranges of Total phosphorus, Chlorophyll-a and Secchi depth to establish trophic status. This type of analysis would allow for the generalization of annual water quality conditions. The trophic categories relate the level of production, biomass, green and/or blue algae fractions and hypolimnetic oxygen content for the lake or river. The 1982 document for the OECD suggests that trophic categories should be determined from all of the parameters (i.e. Total phosphorus, Chlorophyll-a and Secchi depth) (SWCA 2000). Ranges for these parameters and the associated trophic category are listed in the appendices.

Discussion:

This method does not isolate the causes of turbidity at the lake or stream site. Secchi disk monitoring may show that the water is turbid however it does not isolate which type of suspended solid is the cause (soil particles, algae, plankton, microbes or other substances). Conversely, changes from season to season or year to year are observed, however many factors could be in play to create these differences. Soil erosion, waste discharge, urban runoff, eroding stream banks, large numbers of bottom feeders (i.e. carp) and excessive algal growth are all sources of turbidity in lakes and rivers that may vary temporally (EPA 1999b). Consequently, the use of the Florel-Ule colour scale would be helpful in establishing whether any of these variables are the cause of turbidity.

Although the colour scale is rather subjective, if the appropriate techniques are maintained it is possible to obtain some very useful data (WRI 1999). Therefore, it is recommended that these two techniques be combined in order to improve the analytical merit of Secchi depth data (i.e. reduce generalization). Nevertheless, further assessment of the causes of turbidity within the water body would require specific monitoring of algae, phytoplankton, zooplankton and erosion.

Secchi disks have limited use for river monitoring because in most cases the river bottom will be visible and the disk will not reach a vanishing point (EPA 1999c). Deeper, slower moving rivers are the most appropriate places for Secchi disk measurements in channels, although the current might require that the disk be extra-weighted so it does not sway and make depth measurements difficult (EPA 1999c). Therefore, Secchi disks are better used in determining water clarity of lake sites and slow flowing river and stream sites (EPA 1999c). Consequently, another technique would be required in order to monitor the turbidity of fast moving and shallow water bodies.

References on Secchi disks and colour scales:

Alberta Agriculture, Food and Rural Development. 1999. Provincial Stream Survey. [Internet]. Www.agri.gov.ab.ca/sustain/water/wq12.html.

British Columbia Ministry of Environment, Lands and Parks. 2000. Field Data Information System. [Internet]. Www.elp.gov.ca/isb/spp/ads/datadmin/da/models/FDIS.html

British Columbia Ministry of Forests (BCMF). 1998. Reconnaissance (1:20 000): Fish and Fish Habitat Inventory: Data forms and User Notes. Resource Inventory Committee Publ.. [Internet]. www.for.gov.bc.ca/ric/pubs/aquatic/recon/dataform/data1%2D06.htm

CoastNet. 1997. Estuary Water Quality Monitoring Project. [Internet]. secchi.hmsc.orst.edu/coastnet/manual/turbidity.html

Environmental Protection Agency (EPA). 1997. Secchi line shrinkage. In: River trends [Internet]. Www.epa.gov/owowwtr1/monitoring/volunteer/fall97/pg13.html

Environmental Protection Agency (EPA), Office of Water. 1999b. Volunteer Stream Monitoring: A Methods Manual. [Internet]. www.epa.gov/OWOW/monitoring/volunteer/vms55.html

Environmental Protection Agency (EPA), Office of Water. 1999c. Volunteer Stream Monitoring: A Methods Manual. [Internet]. www.epa.gov/ OWOW/monitoring/ volunteer/ stream/ 155. html

Falmouth Pond Watchers Program (FPWP). 1999. [Internet]. www.epa.gov/owowwtr1/ coastal/cookbook/page14.html

Lee, G.F., A. Jones-Lee and W. Rast. 1995. Secchi depth as a water quality parameter. Report of G. Fred Lee and Associates, El Macero, Calif. [Internet]. Home.pacbell/gfredlee/ secchi.html

Michigan Lake and Stream Associations Inc.(MLSA). 1998. [Internet]. Www.iserv.net/mlsa/ secchi.htm

Robert B. Annis Water Resources Institute (WRI). 1999. WRI instructor's manual. [Internet]. www.coast3.net/wri/manual

Soil and Water Conservation Society of Metro Halifax (SWCS). 2000. Prediction of Lake Capacity/Lake Use/Trophic Status. [Internet]. reseau.chebucto.ns.ca/science/SWCS/ lakecapa.html.

Watershed Report Card, Development Committee. 1999. Watershed Report Card - Silver Level. [draft].

Transparency Tube

The transparency tube, a comparatively new development, is gaining acceptance in programs around the country but is not yet in wide use. Transparency tubes measure turbidity as the depth of water clarity much like Secchi disks. However water samples are taken from the water body and poured into a plastic tube instead of direct measurement in the lake or stream. This instrument was developed by the Australian Department of Conservation. However, some U.S. volunteer monitoring programs (e.g., the Tennessee Valley Authority (TVA) Clean Water Initiative and the Minnesota Pollution Control Agency (MPCA)) are testing the transparency tube in streams and rivers (EPA 1999c). MPCA uses tubes marked in centimeters, and has found tube readings to relate fairly well to lab measurements of turbidity and total suspended solids, although they do not recommend the transparency tube for applications where precise and accurate measurement is required or in highly coloured waters (EPA 1999c). Although it is being tested in streams the transparency tube could also be applied to monitoring shore waters of lakes.

The equipment required for this technique includes:

-Transparency tube

-bucket

-hip or waist waders or a boat with an anchor

-data sheet

The transparency tube is a clear, narrow, plastic graduated tube with a dark pattern painted on its base. This instrument can be purchased for $34.95 U.S.. Any bucket should suffice as long as it is cleaned using the preparation procedure outlined in Appendix D. Chest waders cost between $67.50 U.S. to $73.50 U.S. while hip-boots cost from $89.95 U.S. to $99.95 U.S..

Quality Control and Quality Assurance:

The Tennessee Valley Authority (TVA) Clean Water Initiative and the Minnesota Pollution Control Agency (MPCA) suggest the following considerations when sampling form streams and rivers and using the transparency tube:

- Avoid stagnant water.
- Avoid collecting sediment from the bottom of the stream.
- Face upstream as you fill the bucket.
- Take readings in open but shaded conditions. Avoid direct sunlight by turning your back to the sun.

Protocol:

1) Move offshore to a specified distance from the naturalized shoreline.

2) Collect water sample with the bucket using the procedure outlined in Appendix E.

3) Carefully stir or swish the water in the bucket or bottle until it is homogeneous,

Note: Take care not to produce air bubbles (these will scatter light and affect the measurement).

4) Pour the water slowly in the tube while looking down the tube (Figure 9).

Note: Stop intermittently to check when the symbol disappears.

5) Measure the depth of the water column in the tube when the symbol just disappears.

6) Record this depth on the data sheet.

(Adapted from EPA 1999c)

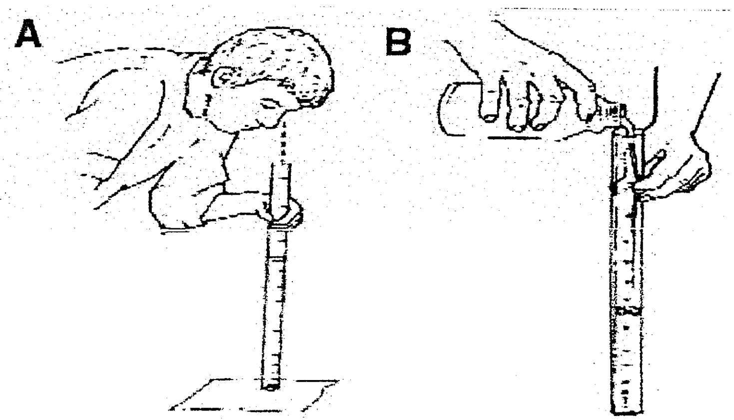

Figure 8: Using the transparency tube.

Source: EPA (1999b).

Sampling Design:

This technique is much like the Secchi disk method and could follow a similar sampling design. Two volunteers are suggested for safety concerns. Sampling should not exceed ten minutes. The time of day for sampling is not restricted like the Secchi disk method however. Samples could be taken anytime during daylight hours however subsequent sampling should occur at the same time of day. Samples should also be taken at the same interval within a year and between years. This is sufficient to reduce variability since the Kawartha Lakes and tributaries are controlled and follow rigid flow sequences from season to season. Depth measurements should be taken by the same individuals at each new sampling period.

Data Analysis:

Considering that data acquired from this technique are depths of water clarity it is suggested that similar analyses to those for Secchi disk data be applied.

Discussion:

This technique is also restricted in terms of analyzing the constituents of turbid waters. Nevertheless, it provides a useful indication of water quality that is well accepted by riparian property owners. Since the transparency tube method is a relatively new monitoring technique it should be carefully investigated before incorporation into the protocol. Nevertheless, this transparency tubes offer a solution to the problem of measuring turbidity in fast moving and shallow waters. For this reason it is recommended that this technique not be discarded without further investigation of its capabilities and limitations. The results of the TVA and MPCA's tests could be reviewed for this purpose.

References for transparency tube:

Environmental Protection Agency (EPA), Office of Water. 1999c. Volunteer Stream Monitoring: A Methods Manual. [Internet]. www.epa.gov/ OWOW/monitoring/ volunteer/ stream/ 155. html

Turbidity Meters

Turbidity meters detect light scattered by particles suspended in water which in turn generate an output voltage proportional to turbidity or suspended solids (Geneq Inc. 2000). The instrument consists of a light source that illuminates a water sample and a photoelectric cell that measures the intensity of light scattered at a 90^0 angle by the particles in the sample (EPA 1999b). It measures turbidity in nephelometric turbidity units or NTUs (EPA 1999). Turbidity meters can measure within the range of 0 to 100 NTUs. A reading of 1 NTU indicates a clear stream and a reading of over 100 NTUs indicates high turbidity (EPA 1999b).

This instrument has been used for pollution monitoring, water and wastewater quality, sediment transport, ocean profiling and river and stream monitoring (Geneq Inc. 2000). Regular turbidity monitoring has been helpful in detecting trends that may indicate increases in erosion in developing watersheds (EPA 1999b). Turbidity meters have been used in streams and lakes of the United States by EPA sanctioned monitoring programs and studies.

The equipment necessary for this type of monitoring includes:

-turbidity meter kit

-sample bottle (large)

-lint-free cloths

-hip or chest waders or a boat with an anchor

-data sheet

Turbidity meter kits can cost $950.00 U.S. for a laboratory type and $695.00 U.S. for a field type. A large, plastic sample bottle costs $7.00 U.S. for a 2500 mL glass bottle and $9.90 U.S. for a 4000 mL bottle. The bottle should be prepared using the procedure outlined in Appendix D. See the Transparency Tube method for prices of hip and chest waders.

Protocol:

1) Move offshore from the naturalized site to a specified distance.

2) Collect water sample using the procedure outlined in Appendix E.

3) Take samples to the central measuring station.

Note: This is done so that you do not need to bring the turbidity meter to the field and risk damage or loss.

4) The EPA (1999b) suggests the subsequent steps for taking turbidity measurements with a turbidity meter:

i) Prepare the turbidity meter for use according to the manufacturer's directions.

Note: Check batteries.

ii) Use the turbidity standards provided with the meter to calibrate it. Make sure it is reading accurately in the range in which you will be working.

iii) Shake the sample vigorously and wait until the bubbles have disappeared. You might want to tap the sides of the bottle or bucket gently to accelerate the process.

iv) Use a lint-free cloth to wipe the outside of the tube into which the sample will be poured. Be sure not to handle the tube below the line where the light will pass when the tube is placed in the meter.

v) Pour the sample water into the tube. Wipe off any drops on the outside of the tube.

vi) Set the meter for the appropriate turbidity range. Place the tube in the meter and read the turbidity measurement directly from the meter display.

vii) Record the result on the field or lab sheet.

viii) Repeat steps 3-7 for each sample.

ix) Once samples are measured, test the duplicate sample(s).

Sampling design:

Sampling could be performed every two weeks from ice out to fall turnover. Sampling should not take more than ten minutes. Considering that turbidity is directly related to stream flow and velocity any comparisons of turbidity over time should be made from the same point and during similar flow conditions (EPA 1999b). Therefore, samples should be taken during intervals in which these conditions recur. This should not be difficult to determine since the waterways of the Kawartha Lakes are controlled and generally follow the same seasonal patterns of velocity and flow from year to year. Therefore, it should not be necessary to undertake a preliminary study of seasonal nor annual variability for stream velocity and flow. If samples are taken at the same time each year the results should reflect a correlation with these hydrological factors. For safety reasons at least two volunteers should be present during sampling. Ideally the same person should take the turbidity readings at each interval to reduce operator variance.

Data Analysis:

The analysis would consist of converting NTU values to a qualitative description of water quality for easy dissemination of information to the public. Analysis with NTU data should be conducted to determine trends over time for each site (much like the Secchi disk method). Further research regarding the analytical value of turbidity meter data should be conducted.

Discussion:

Turbidity is simply a measure of the amount of light scattered by particles. It does not measure the amount of suspended solids or the rate of sedimentation in a water body. (EPA 1999b). Nevertheless, the information provided is useful for generalizing changing trends in water quality. Moreover, turbidity meters can be used to monitor shallow to deep waters and slow to fast waters. Therefore, this technique could be applied to all sites. A regional outlook could also be statistically estimated if sampling sites are an adequate representation of the entire water body. Moreover, an adequate sample size (number of monitored sites) would be necessary.

References for turbidity meters:

Environmental Protection Agency (EPA), Office of Water. 1999b. Volunteer Stream Monitoring: A Methods Manual. [Internet]. www.epa.gov/OWOW/monitoring/volunteer/vms55.html

Gneneq Inc. 2000. Catalogue for turbidity meters. [Internet]. **Www.geneq.com.** Last updated February 15, 2000.

Filtration Method

This technique measures the amount of suspended solids that contribute to turbidity. A water sample from a lake or stream site is filtered in a laboratory setting. The amount of suspended solids is measured a the portion of total solids that remain on a filter paper with pores of 0.002 cm in diameter. This technique is recommended by the EPA (1999a) for volunteer monitoring. Thomas (1985) has also used this technique for assessing the impacts of forestry. Site specific or regional monitoring are both possible with filtration by altering sampling design.

The equipment required is as follows:

-sample bottles or factory-sealed Whirl-pak (R) bags

-hip or chest waders or a boat with an anchor

-cooler and ice

-buoyant ball

-stop watch or wrist watch

-data sheet

Sample bottles should be prepared using the procedure in Appendix D. Whirl-pak (R) bags do not require cleaning since they are already sanitized. Bottles of 75 mL are $0.68 U.S. and 500 mL bottles are $1.40 U.S.. Whirl-pak (R) bags cost $42.80 U.S. to $116.00 U.S. for 2 oz. and 42 oz. bags respectively. These prices are for a box of 500 bags. See the Transparency Tube method for wader prices.

Protocol:

1) One person moves offshore from a location upstream of the naturalized site. The second person to a location down current from the naturalized site along the shore.

2) The person upstream lets a ball fall into the water from their location and tells the other person to start the stop watch.

3) The person downstream stops the watch when the ball reaches his/her location.

4) This time is then the interval between the first persons sample collection and the second persons sample collection.

5) Collect each sample using the procedure outlined in Appendix E.

6) Place the samples in a cooler of ice.

7) Send samples to a laboratory for filtration well before seven (7) days go by.

Note: Keep samples on ice or refrigerated until they are analysed.

(Adapted from EPA 1999a and Hilton and Thomas 1985)

Sampling Design:

Monitoring should take place from ice out to fall turnover. The sampling interval could be every two weeks like the Secchi disk method. Two to four volunteers are required since the downstream sample must be taken within a short time of the upstream sample. With proper training volunteers should be completed in under thirty minutes. Similarly to the other turbidity protocols factors such as changes in velocity, channel form and water elevation create much variability in the concentration of suspended solids. Therefore, these samples should be taken at the same time of year in order to reduce variability due to these factors and concentrate on variability due to the naturalization activity.

The U.S. department of Agriculture (1985) has stressed that if baseline data on the difference between the suspended solid concentrations between the upstream and downstream sites are not available, monitoring after the activity is underway would be a waste of money and effort (Thomas 1985). Therefore, water samples should be collected using the above protocol before or during the naturalization process. The data obtained from these samples would be the baseline data for that site.

Data Analysis:

Once amount of suspended solids is known for each site it is possible to calculate the amount of suspended solids that had its source in the naturalized site. This consists of subtracting the downstream value from the upstream value (Thomas 1985). A positive difference would indicate that the naturalized site is a source for suspended solids while a value of zero would mean it was not. Negative difference should indicate that suspended solids had settled out of the water column near the naturalized site. Since weather conditions are to be noted at each new sampling interval (general recommendations for monitoring above) it should be possible to correlate large amounts of suspended solids to rainfall events. Seasonal or yearly trends as well as a historical record of the naturalized site's yield of suspended solids to the waterway should be established with these data. For further discussion of analyzing suspended solids and especially suspended sediments see Olive and Rieger (1992).

Discussion:

This method has been used for over twenty years and provides reliable data when baseline data are available. Moreover, filtration provides a means to estimate quantitatively the level of turbidity near naturalized shorelines. The data also complement the data obtained using the Secchi disk or turbidity meter methods. Although this information is less important to riparian property owners, it is an important parameter for determining whether naturalization is reducing shoreline sources of solids to a particular waterway.

References for the filtration method:

Environmental Protection Agency (EPA), Office of Water. 1999. Volunteer Lake Monitoring: A Methods Manual. [Internet].www.epa.gov/ owow/ monitoring/ volunteer/ lake/ chapter6.html#6a

Olive, L.J. and W.A. Rieger. 1992. Stream suspended sediment transport monitoring - why, how and what is being measured? Erosion and Sediment Transport Monitoring Programmes in River Basins (Proceedings of the Oslo Symposium, August 1992). IAHS Publ. No. 210.

Thomas, R.R. 1985. Measuring Suspended Sediment in Small Mountain Streams. US Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

Sedimentation Protocols:

Sedimentation is one result of shoreline erosion. Sedimentation often leads to increased flooding. However, since the Kawartha Lakes and tributaries are controlled by locks this is not very likely. Nevertheless, accumulations of fine sediments on lake and stream beds cause major problems for aquatic wildlife. Sedimentation is the main process attributed to the loss of fish spawning areas in streams and lakes. Surface runoff washes sand and silt into the lake where it settles to the bottom and creates shallow areas that interfere with lake and stream use by wildlife and humans.

The amount of accumulated sediment on a stream or lake bed can also indicate the amount of sediment available for re-suspension by wave action or watercraft activity. Property owners may not immediately understand the importance of sedimentation, although some may know of its effects on fish. However, turbidity is an issue that property owners can understand and has a meaning. Therefore, with proper education of the interrelationship of sedimentation and turbidity sedimentation should become an important issue to riparian land owners thus warranting its monitoring.

Measuring water and unconsolidated sediment depths

The purpose of this method is to characterize the build-up of sediments and to create a historical record of sedimentation. Generally, key areas are assessed, such as mouths of tributary streams or near an eroding shoreline (EPA 1999a). This method has also been used to measure the fractional volume of fine sediment in stream channel pools (Hilton and Lisle 1993). The EPA (1999a) recommends this method in the Volunteer Lake Monitoring Manual, but is easily applied to streams.

The equipment necessary includes the following:
-one inch diameter graduated probe (dowel)
-one inch diameter graduated probe with a nine-inch plate securely attached to one end
-hip or chest waders or a boat with an anchor
-data sheet

The probes should be long enough to stick above the water's surface at the deepest point of measurement. Both probes should be calibrated in meters and tenths of meters. The dowels could be bought from any lumber store. See Transparency Tube method for prices on hip and chest waders.

Protocol:

1) Determine transect lines perpendicular to the shoreline and to a specified distance from the naturalized shoreline.

2) Create a map of the transect line locations using shoreline landmarks
Note: This is only necessary the first time this protocol is used at the site

3) Locate sample sites at the predetermined distances along the transect and record them onto the above map.
Note: Distances are initially determined using random number sheets but subsequent sampling will always occur at these same points along the transect lines.

4) Measure the depth of the water from the surface to the top of the sediments using the probe with the plate on its end. Record this depth on the data sheet.

5) Push the other probe into the sediments until first refusal (it becomes hard to push) and measure the depth. Record this depth on the data sheet.
Note: The difference between the two depths is the thickness of the unconsolidated

sediment.

6) On the map place resulting depths of sediment near the corresponding sample sites.
(Adapted from EPA 1999a)

Sampling Design:

The purpose of measuring at the same points along the same transect lines is to determine where sediments are accumulating in the area near the naturalized shoreline. Two volunteers can complete this protocol in under an hour if well trained. One person should take the measurements with the probes while the other records depths and if applicable steadies the boat. The frequency of such monitoring is uncertain since there was no mention of this in the literature consulted. Nevertheless, measurements should be taken from ice out to fall turn over. Due to the variability of sedimentation and re-suspension processes and the controlled flow of the Kawartha Lakes and tributaries, measurements should be taken at the same time of year.

Data Analysis:

Historical records of changes in sedimentation should establish whether the naturalization of the shoreline has contributed to reducing sedimentation in the nearby offshore waters. Time series graphs would be a useful visual representation of these trends. Other statistical analyses could also be performed with these data to establish trends and relationships between the naturalization of the shoreline and the rate of nearby offshore sedimentation.

Discussion:

This protocol is a simple procedure that offers important information regarding the health of a subset of riparian ecosystem. This was the only protocol found that monitors sedimentation; however, further research may produce other suitable protocols. Although no other sedimentation protocols were found and further research is required to determine the interval of monitoring this protocol is recommended as a good choice for monitoring the effects of shoreline naturalization on sedimentation.

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COMPREHENSIVE SHORELINE MONITORING PROTOCOL

The above monitoring protocols should be combined into one all encompassing monitoring protocol. Moreover, these protocols need to be combined with those for biological and habitat monitoring. This could be achieved by simply choosing the same sampling sites and bench mark sites as well as the same interval of sampling for different protocols. In the case of monitoring physical parameters it would be possible to perform the sedimentation protocol with one of the turbidity protocols. This is due to the fact that both have the same sampling interval, required number of volunteers (except the filtration method) and together they do not take up too much time. Table 2 shows the characteristics of each protocol for physical parameters. The "*" indicates protocols that could be conducted at the same time (although not all of them should be conducted at the same time because of time requirements). In some cases changes may be necessary and acceptable to allow for monitoring of different parameters to occur in the same visit. The same type of combinations could be done for biological monitoring and physical monitoring.

CONCLUSION

Although there was some difficulty finding volunteer monitoring protocols specifically for assessing the physical conditions of shorelines the above protocols provide a baseline of information on this subject. Alterations of original protocols were required and made on the basis of accepted procedures and techniques. With the exception of erosion, monitoring programs that had the objective of assessing shoreline conditions were scarce. The protocols mentioned above are generally used for monitoring in stream and lake conditions. Nevertheless, it was seen that they could be applied to shoreline monitoring. This report has provided background information for the purpose of creating a starting point for the preparation of a functional and long term monitoring protocol for the FTSW's Shoreline Naturalization Project. Further research should be conducted and not limited to simply the protocols outlined above.

Table 2: Protocol Characteristics.

Protocol	Parameter measured by protocol	Total Eqpt Cost	Number of Volunteers	Time Required	Time of Year	Time Interval	Lake or Stream Based	Regional or Site Specific
Manual Erosion Pins	soil erosion	?	1 or 2	< 10 min	no snow	6 months	both	both
PEEP	soil erosion	>$149US	1 or 2	< 10 min	no snow	6 months	both	both
Bank Profile Method	soil erosion	>$100US	3	< 2 hours	ice out to fall turn over	once a year	both	site
Secchi Disk method and		>$40US						
Florel-Ule colour scales *	turbidity	?	2	10 min	ice out to fall turn over	2 weeks	both but depends	both
Turbidity Meter *	turbidity	~ $1000US	2	< 10 min	ice out to fall turn over	2 weeks	both	site
Transparency Tube *	turbidity	~ $240US	2	< 10 min	ice out to fall turn over	2 weeks	both	both
Filtration Method *	turbidity/TSS	~ $100US	2 to 4	< 30 min	ice out to fall turn over	2 weeks	both	site
Water and Soil depths *	sedimentation	?	2	< 2 hours	ice out to fall turn over	?	both	site

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Appendices

Appendix A

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Water Quality Reporting
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QUALITY ASSURANCE, QUALITY CONTROL, and QUA MEASURES

Back to Chapter 5 - Water Quality Conditions

Quality assurance/quality control measures are those activities you undertake to c close to the real result you are) and precision (how reproducible your results are) Assurance (QA) generally refers to a broad plan for maintaining quality in all aspe should describe how you will undertake your monitoring effort: proper document training of volunteers, study design, data management and analysis, and specific q Control (QC) consists of the steps you will take to determine the validity of speci procedures. Quality assessment is your assessment of the overall precision and ac run the analyses.

Quality Control and Assessment Measures: Internal Checks

Internal checks are performed by the project field volunteers, staff, and lab.

- *Field Blanks.* A trip blank (also known as a field blank) is deionized water used to identify errors or contamination in sample collection and analysis.
- *Negative and Positive Plates (for bacteria).* A negative plate results when water used to rinse down the sides of the filter funnel during filtration) has sample. This is different from a field blank in that it contains reagents used be no bacteria growth on the filter after incubation. It is used to detect labo the sample. Positive plates result when water known to contain bacteria (su influent) is filtered the same way as a sample. There should be plenty of bac incubation. It is used to detect procedural errors or the presence of contam that might inhibit bacteria growth.
- *Field Duplicates.* A field duplicate is a duplicate river sample collected by t sampler or team at the same place, at the same time. It is used to estimate s precision.
- *Lab Replicates.* A lab replicate is a sample that is split into subsamples at tl analyzed and the results compared. They are used to test the precision of tl bacteria, they are used to obtain an optimal number of bacteria colonies on
- *Spike Samples.* A known concentration of the indicator being measured is a increase the concentration in the sample by a predictable amount. It is used method.

- *Calibration Blank.* A calibration blank is deionized water processed like an "zero" the instrument. It is the first "sample" analyzed and used to set the n from the field blank in that it is "sampled" in the lab. It is used to check the periodically for "drift" (the instrument should always read "0" when this bla compared to the field blank to pinpoint where contamination might have oc

- *Calibration Standards.* Calibration standards are used to calibrate a meter. "standard concentrations" (made up in the lab to specified concentrations) one of which is the calibration blank. Calibration standards can be used to c the test, or they can be used to convert the units read on the meter to the re absorbance to milligrams per liter).

Quality Control And Assessment Measures: External Checks

External checks are performed by nonvolunteer field staff and a lab (also known a results are compared with those obtained by the project lab.

- *External Field Duplicates.* An external field duplicate is a duplicate river sa an independent (e.g., professional) sampler or team at the same place at the samples. It is used to estimate sampling and laboratory analysis precision.

- *Split Samples.* A split sample is a sample that is divided into two subsample analyzed at the project lab and the other is analyzed at an independent lab. '

- *Outside Lab Analysis of Duplicate Samples.* Either internal or external fiel an independent lab. The results should be comparable with those obtained l

- *Knowns.* The quality control lab sends samples for selected indicators, labe the project lab for analysis prior to the first sample run. These samples are a compared with the known concentrations. Problems are reported to the qua

- *Unknowns.* The quality control lab sends samples to the project lab for anal to the first sample run. The concentrations of these samples are unknown to are analyzed and the results reported to the quality control lab. Discrepanci and a problemidentification and solving process follows.

The table below shows the applicability of common quality control measures to tl covered in this manual.

Steps To Quality Control

1. Consult with your technical committee and/or program advisor to help you assurance/quality control measures you will use to answer your questions a requirements

2. Locate a quality control lab—-an independent lab that can run external che

3. Determine which quality checks you have the resources and capabilities to

financial resources and expertise might limit the water quality indicators yo

References

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Common Quality Control Measures

.....	Dissolved Oxygen	Temperature	pH	Turbidity	Phosphorus	Nitrates	Total Solids
Internal Checks							
Field blanks				•	•	•	•
Field duplicates	•	•	•	•	•	•	•
Lab replicates	•		•	•	•	•	•
Positive plates							
Negative plates							
Spike samples		•			•	•	
Calibration blank				•	•	•	
Calibration standard	•a		•	•	•	•	
External Checks							
External field duplicates			•	•	•	•	•

Split samples			•	•	•	•	•
Outside lab analysis	•			•	•	•	•
Verification							
Knowns	•		•	•	•	•	
Unknowns	•		•	•	•	•	

a - using an oxygen-saturated sample
b - using subsamples of different sizes

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Appendix B

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Training Volunteer Monitors

Back to Section 2.2 - Designing the Stream Study

Training should be an essential component of any volunteer stream monitoring project. When volunteers are properly trained in the goals of the volunteer project and its sampling and analytical methods, they:

- Produce higher quality, more credible data.
- Better understand their role in protecting water quality.
- Are more motivated to continue monitoring.
- Save program manager time and effort by becoming better monitors who require less supervision.
- Feel more like part of a dedicated team.

Some of the key elements to consider in developing a training program for volunteers include the following:

1. *Plan ahead.* When you are in the early stages of developing your training program, decide who will do the training, when training will occur, where it will be held, what equipment and handouts volunteers will receive, and what, in they end, they will learn. Plan on at least one initial training session at the start of the sampling season and a quality control session somewhat into the season (to see if volunteers are using the right methods, and to answer questions). If volunteers will be sampling many different chemical parameters or will be conducting intensive biological monitoring, you should probably schedule two initial training sessions—one to introduce volunteers to the program, and the other to cover sampling and analytical methods in detail. You might also want to plan a postseason session that encourages volunteers to air problems, exchange information, and make suggestions for the coming year. Make sure the program planning committee agrees to the training plan.

2. *Put it in writing.* Once you've made these decisions, write them all down. Note the training specifics in the program's quality assurance project plan. It might also help to develop a "job description" for the

volunteers that lists the tasks they will perform in the field and lab, and that identifies the obligations to which they will be held and the schedule they will follow. Hand this out at the first training session. Volunteers should leave the session knowing what is expected of them. If they decide not to join after all because the tasks are too onerous, it is better for you to find out after the first session than later in the sampling year.

3. *Be prepared.* Nothing will discourage volunteers more than an illplanned, chaotic initial training session. The elements of a successful initial training session include:

   - Enthusiastic, knowledgeable trainers
   - Short presentations that encourage audience participation and don't strain attention spans
   - A low ratio of trainers to trainees
   - Presentations that include why the monitoring is needed, what the program hopes to accomplish, and what will be done with the data
   - An agenda that is followed (especially start and finish times)
   - Good acoustics, clear voices, and interesting audiovisual aids
   - Opportunities for all trainees to handle equipment, view demonstrations of sampling protocols, and practice sampling
   - Instruction on safety considerations
   - Refreshments and opportunities for trainees to meet one another, socialize, and have fun
   - Time for questions and answers.

4. *Conduct quality control checks.* After your initial training session(s), schedule opportunities to "check up" on how your volunteers are performing. The purpose of these quality control checks is to ensure that all volunteers are monitoring using proper and consistent protocols, and to emphasize the importance of quality control measures. Some time into the sampling season, observe how volunteers are sampling, analyzing their samples, identifying macroinvertebrates, and recording their results. Either observe volunteers in small groups at their monitoring sites or bring them to a central location for an organized quality control session. If your program is involved in chemical monitoring, you might want all volunteers to analyze the same water sample using their own equipment, or hold a lab exercise in which volunteers read and record results from equipment and kits that have already been set up. For a biological monitoring program, have trainers or seasoned volunteers observe sampling methods in the field and

provide preserved samples of macroinvertebrates for volunteers to identify. Reserve time to answer questions, talk about initial findings, and have some fun.

5. *Review the effectiveness of your training program.* At the end of each training session, encourage volunteers to fill out a training evaluation form. This form should help you assess the effectiveness of individual trainers and their styles, the handouts and audiovisual aids, the general atmosphere of the training session, and what the volunteers liked most and least about the session. Use the results of the evaluation to revise training protocols as needed to best meet program and volunteer needs.

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3.2 The Visual Assessment

To conduct the visual stream assessment portion of the watershed survey, volunteers regularly walk, drive, and/or canoe along a defined stretch of stream observing water and land conditions, land and water uses, and changes over time. These observations are recorded on maps and on visual assessment data sheets and passed to the volunteer coordinator, who can decide whether additional action is needed. Volunteers might themselves follow up by reporting on problems such as fish kills, sloppy construction practices, or spills they have identified during the visual assessment.

The basic steps to follow are:

Task 1 Determine the area to be assessed

The visual assessment will have most value if the same stream or segment of stream is assessed each time. In this way, you will grow familiar with baseline stream conditions and land and water uses, and will be better able to identify changes over time. You should choose the largest area you feel comfortable assessing and ensure that it has easy, safe, and legal access. The area should have recognizable boundaries that can be marked or identified on road maps or U.S. Geological Survey topographic maps. This will help future volunteers continue the visual assessment in later years and help the program coordinator easily locate any problems that have been identified.

Once you have identified the area to be assessed, define it clearly in words (for example, "Volunteer Creek from Bridge over Highway One to confluence of Happy Creek at entrance to State Park"). Then, either draw the outline and significant features of the stream and its surroundings on a blank sheet of paper or obtain a more detailed map of the area, such as a plat, road, or neighborhood map. This will serve as the base map you will use to mark stream obstructions, pollution sources, land uses, litter, spills, or other problems identified during your visual assessment.

Task 2 Determine when to survey

Because land and water uses can change rapidly and because the natural condition of the stream might change with the seasons, it is best to visually assess the stream or stream segment at least three times a year. In areas with seasonal changes, the best times to survey are:

- Early spring, before trees and shrubs are in full leaf and when water levels are generally high

- Late summer, when trees and shrubs are in full leaf and when water levels are generally low

- Late fall, when trees and shrubs have dropped their leaves but before the onset of freezing weather

In addition, you may wish to spotcheck potential problem areas more frequently. These include construction sites, combined sewer overflow discharges, animal feedlots, or bridge/highway crossings. If polluted runoff or failing septic systems are suspected, schedule a survey during or after heavy rainfall. If a stream is diverted for irrigation purposes, surveys during the summer season will identify whether water withdrawals are affecting the stream.

Again, it is important to survey the stream at approximately the same time each season to account for seasonal variations. You might find it productive to drive through the watershed once a year and to walk the stream (or the stream's problem sites) at other times (see Tasks 4 and 5).

Task 3 Gather necessary equipment

In addition to the general and safety equipment listed in Chapter 2, the following equipment should be gathered before beginning the visual assessment:

- Reference map such as road map or USGS topographic map, to locate the stream and the area to be assessed

- Base map to record land uses, land characteristics, stream obstructions, sources of pollution, and landmarks

- Field data sheet

- Additional blank paper, to draw maps or take notes if needed

- Relevant information from background investigation (e.g., location of NPDES outfalls, farms, abandoned mines, etc.)

Task 4 Drive (or walk) the watershed

The purpose of driving (or walking) the watershed is to get an overall picture of the land that is drained by your stream or stream segment. It will help you understand what problems to expect in your stream, and it will help you know where to look for those problems.

As with all other monitoring activities, you should undertake your watershed drive or walk with at least one partner. If you are driving, one of you should navigate with a road map and mark up the base map and field sheet with relevant discoveries while the other partner drives. You might want to pull over to make detailed observations, particularly near stream crossings. ***Remember never to enter private property without permission*** (see section 2.3 - Safety Considerations).

As you drive or walk the watershed, look for the following:

- *The "lay" of the land*--become aware of hills, valleys, and flat terrain. Does any of this area periodically flood?

- *Bridges, dams, and channels*--look for evidence of how the community has dealt with the stream and its flood potential over the years. Are portions of it running through concrete channels? Is it dammed, diverted, culverted, or straightened? Where the road crosses the stream, is there evidence of erosion and pollution beneath bridges? Is streamflow obstructed by debris hung up beneath bridges?

- *Activities in the watershed*--look for land use activities that might affect your stream. In particular, look for construction sites, parking lots, manicured lawns, farming, cattle crossings, mining, industrial and sewage treatment plant discharges, open dumps, and landfills. Look for the outfalls you identified in your background investigation. Also look for forested land, healthy riparian zones, undisturbed wetlands, wildlife, and the presence of recreational users of the stream such as swimmers or people fishing. (Note that heavy recreational use or large flocks of birds might adversely affect the quality of streams, ponds, lakes, and wetlands.)

Task 5 Walk the stream

Where you have safe public access or permission to enter the stream, stop driving or walking the watershed and go down to the stream. Use all of your senses to observe the general water quality condition. Does the stream smell? Is it strewn with debris or covered with an oily sheen or foam? Does it flow quickly or sluggishly? Is it clear or turbid? Are the banks eroded? Is there any vegetation along the banks? If you see evidence of water quality problems at a particular site, you might want to investigate them in more detail. Drive or walk upstream as far as you can, and try to identify where the water quality problem begins.

Use your field data sheet to record your findings. Always be as specific as possible when noting your location and the water conditions you are observing. Draw new maps or take pictures if that will help you remember what you are observing. Don't be afraid to take too many notes or draw too many pictures. You can always sort through them later.

Take note of the positive conditions and activities you see as well as the negative ones. This, too, will help you characterize the stream and its watershed. Look for such things as people swimming or fishing in the stream; stable, naturally vegetated banks; fish and waterfowl; or other signs that the stream is healthy.

For more information on what to look for in and around the stream, consult Chapter 4 and, in particular, the *Stream Habitat Walk*.

Task 6 Review your maps/field data sheets

The last step of the watershed survey's visual assessment is to review the maps, drawings, photos, and field data sheets you have assembled for your stream or stream segment. What is this information telling you about problem sites, general stream condition, potential for future degradation, and the need for additional action? In most cases you will find that you have put together an interesting picture of your stream. This picture might prompt additional monitoring or community activity, or could urge your program coordinator to bring potential problems to the attention of water quality or public health agencies in your area.

When reviewing your data, be sure maps are legible and properly identified, photos have identifiable references, and field data sheets are filled out completely and accurately. Your program coordinator might ask for your field data sheets, maps, and other material and can probably help interpret the findings of your watershed survey.

References and Further Reading

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For More Information on Your Watershed

EPA's *Surf Your Watershed* internet web site is a service designed to help citizens locate, share, and use information on their watershed or community. While you are conducting your watershed survey, you might find its features of value. Surf provides:

- Access to a large listing of protection efforts and volunteer opportunities by watershed.
- Information on water resources, drinking water sources, land use. population, wastewater dischargers, and water quality conditions.
- Capabilities to generate maps of your watershed and determine the latitude and longitude of specific sites within it.
- Opportunity to share your watershed information with other on-line groups through links with other pages and databases.

You can reach Surf Your Watershed on the web at www.epa.gov/surf/.

Watershed Survey Visual Assessment (PDF, 15.0 KB)

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http://www.epa.gov/OWOW/monitoring/volunteer/stream/vms32.html

Appendix: Various articles about PEEP applications.

Source: Hydro Scientific Ltd. 1999. PEEP systems applications: Automatic monitoring of erosion and deposition in fluvial or tidal channels. [internet] members.aol.com/ HydroSci/ pages/ peep16.htm (Last updated January 2000)

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Appendix : Standard water colour descriptions established for lake surveys in BC.

Method: Visual observation of water sample or white section of the submerged Secchi disk.
Recording Procedure: Record the closest match to the colour of the water sample from the table below.

Code	Colour	General indications
GR	Green	•due to phytoplankton blooms; likely indicative of higher productivity
BR	Brown	•staining from tannic acid; may also be zooplankton or solids
RD	Red	•could reflect high iron content and associated plankton and bacteria
BL	Blue	•indicates marl deposits on the bottom and/or water of lower productivity
PU	Purple (or pink)	•bottom samples only; the presence of purple sulphur bacteria and high hydrogen sulphide. Caution: This water is very toxic and corrosive; rinse equipment well
MP	Milky/ Pale blue	•often results from the influence of glacial meltwater; may also be a marl lake or having relatively low productivity
NC	Colourless	•no particular condition other than low productivity

from: British Columbia Ministry of Forests (BCMF). 1998. Reconnaissance (1:20 000): Fish and Fish Habitat Inventory: Data forms and User Notes. Resource Inventory Committee Publ.. [internet]. www.for.gov.bc.ca/ric/pubs/aquatic/recon/dataform/data1%2D06.htm

FIELD DATA SHEET: SECCHI DISK & WATER COLOUR

NAME OF WATERWAY: ____________________

CO-ORDINATES (SAMPLE LOCATIONS): ____________________

____

DATE: ____________________ TIME: ____________________

NAMES OF MONITORS: ____________________

WATER SURFACE CONDITIONS:

Choose one of the following by placing an "x" in the [ ]:

Conditions	Description of Water
calm [ ]	complete absence of wind, glasslike appearance of water
rippled [ ]	lightly ruffled, not more than 2cm rise in waves
ruffled [ ]	wavy, not more than 5cm in waves
rough [ ]	waves more than 5cm in height

Source: Watershed Report Card, Development Committee. 1999. Watershed Report Card - Silver Level. [draft].

CLOUD COVER:

Fill in the quadrants for observed fraction of cloud cover

WATER COLOUR:

Choose matching vial from Florel-Ule vials VIAL CODE: ________

SECCHI DEPTHS:

A) Depth disk disappears: 1)________m 2) ________m 3) ________m

B) Depth disk reappears: 1)________m 2) ________m 3) ________m

C) Final depth: (add above depths of disappearance and reappearance and divide answer by 2)

1)________m 2) ________m 3) ________m

Average Secchi depth for location: (add the three final depths in C and divide by 3)

AVERAGE DEPTH: ________m

Appendix : Parameters of trophic categories.

Table: Ranges for total phosphorus, Chlorophyll-a and Secchi depth associated to each trophic category.

Ultraoligotrophy:

mean TP </=4.0 mg/cu.m.

ean Cha </=1.0 mg/cu.m.

peak Cha </=2.5 mg/cu.m.

mean SD >/=12.0 metres

min. SD >/=6.0 metres

Oligotrophy:

mean TP </=10.0

mean Cha </=2.5

peak Cha </=8.0

mean SD >/6.0

min. SD >/=3.0

Mesotrophy:

mean TP =10-35

mean Cha =2.5-8

peak Cha =8-25

mean SD =6-3

min. SD =3-1.5

Eutrophy:

mean TP =35-100

mean Cha =8-25

peak Cha =25-75

mean SD =3-1.5

min. SD =1.5-0.7

Hypereutrophy:

mean TP >/=100 mg/cu.m.

mean Cha >/=25 mg/cu.m.

peak Cha >/=75 mg/cu.m.

mean SD </=1.5 metres

min. SD </=0.7 metres

Table: Level of production, biomass, algae and oxygen content for each trophic category.

General level of production:
Oligotrophy: low

Mesotrophy: medium

Eutrophy: high

Biomass:

Oligotrophy: low

Mesotrophy: medium

Eutrophy: high

Green and/or blue-green algae fractions:

Oligotrophy: low

Mesotrophy: variable

Eutrophy: high

Hypolimnetic oxygen content:

Oligotrophy: high

Mesotrophy: variable

Eutrophy: low

Source: OECD values found in Soil and Water Conservation Society of Metro Halifax (SWCS). 2000. Prediction of Lake Capacity/Lake Use/Trophic Status.[internet]. reseau.chebucto.ns.ca/science/SWCS/ lakecapa.html

Appendix D: General Preparation of Sampling Containers (EPA 1999d) for the turbidity meter method, transparency tube method and filtration method.

The following method should be used when preparing all sample containers and glassware for monitoring conductivity, total solids, turbidity, pH, and total alkalinity. Wear latex gloves!

1. Wash each sample bottle or piece of glassware with a brush and phosphate-free detergent.

2. Rinse three times with cold tap water.

3. Rinse three times with distilled or deionized water.

4. These steps can be ignored if Whirl-pak (R) bags are used.

Acid Wash Procedure for Preparing Sampling Containers

This method should be used when preparing all sample containers and glassware for monitoring nitrates and phosphorus. Wear latex gloves!

1. Wash each sample bottle or piece of glassware with a brush and phosphate-free detergent.

2. Rinse three times with cold tap water.

3. Rinse with 10 percent hydrochloric acid.

4. Rinse three times with deionized water.

5. These steps can be ignored if Whirl-pak (R) bags are used.

Source: Environmental Protection Agency (EPA). 1999d. Water Quality Monitoring; Chapter 5. [Internet]. www.epa.gov/owow/monitoring/volunteer/stream/vms50.html

Appendix E: Water sample collection at naturalized shoreline sites (EPA 1999d) for the transparency tube method, turbidity meter method and filtration method.

In general, sample away from the stream bank in the main current. Never sample stagnant water. The outside curve of the stream is often a good place to sample, since the main current tends to hug this bank. In shallow stretches, carefully wade into the center current to collect the sample.

A boat will be required for deep sites. Try to manieuver the boat into the centre of the main current to collect the water sample.

For Whirl-pak® Bags:

1.Label the bag with the site number, date, and time.

2.Tear off the top of the bag along the perforation above the wire tab just prior to sampling. Avoid touching the inside of the bag. If you accidentally touch the inside of the bag, use another one.

3.Wading. Try to disturb as little bottom sediment as possible. In any case, be careful not to collect water that contains bottom sediment. Stand facing upstream. Collect the water sample in front of you.

Boat. Carefully reach over the side and collect the water sample on the upstream side of the boat.

4.Hold the two white pull tabs in each hand and lower the bag into the water on your upstream side with the opening facing upstream. Open the bag midway between the surface and the bottom by pulling the white pull tabs. The bag should begin to fill with water. You may need to "scoop" water into the bag by drawing it through the water upstream and away from you. Fill the bag no more than 3/4 full!

5.Lift the bag out of the water. Pour out excess water. Pull on the wire tabs to close the bag. Continue holding the wire tabs and flip the bag over at least 4-5 times quickly to seal the bag. Don't try to squeeze the air out of the top of the bag. Fold the ends of the wire tabs together at the top of the bag, being careful not to puncture the bag. Twist them together, forming a loop.

6.Fill in the bag number and/or site number on the appropriate field data sheet. This is important! It is the only way the lab coordinator knows which bag goes with which site.

7.Follow steps 1 to 6 for a duplicate sample as a quality assurance and quality control measure.

8.If samples are to be analyzed in a lab, place the sample in the cooler with ice or cold packs. Take all samples to the lab.

For Screw-cap Bottles:

To collect water samples using screw-cap sample bottles, use the following procedures (Figs.):

1.Label the bottle with the site number, date, and time.

2.Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap. If you accidentally touch the inside of the bottle, use another one.

3.Wading. Try to disturb as little bottom sediment as possible. In any case, be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you. You may also tape your bottle to an extension pole to sample from deeper water.

Boat. Carefully reach over the side and collect the water sample on the upstream side of the boat.

4.Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream. Collect a water sample 8 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.

5.Turn the bottle underwater into the current and away from you. In slow-moving stream reaches, push the bottle underneath the surface and away from you in an upstream direction.

6.Leave a 1-inch air space (Except for DO and BOD samples). Do not fill the bottle completely (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.

7.Fill in the bottle number and/or site number on the appropriate field data sheet. This is important because it tells the lab coordinator which bottle goes with which site.

8.Follow steps 1 to 7 for a duplicate sample for use as a quality assurance and quality control measure.

9.If the samples are to be analyzed in the lab, place them in the cooler for transport to the lab.

For diagrams see www.epa.gov/owowwtr1/monitoring/volunteer/stream/vms50.html

Source: Environmental Protection Agency (EPA). 1999d. Water Quality Monitoring; Chapter 5. [Internet]. www.epa.gov/owow/monitoring/volunteer/stream/vms50.html