MassWWP The Massachusetts Water Watch Partnership

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Watershed Survey Manual
for
Lakes and Rivers

March 2000

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Introduction

This manual describes a method that any individual can use to conduct a visual watershed survey. A watershed survey is a simple yet very effective tool for individuals to use for understanding a lake or river system. It requires no specialized training and very little equipment, yet it can provide a great deal of information about a water body. The watershed survey is usually the starting point for a larger monitoring effort, or it may be useful in its own right.

The **watershed survey** is a visual survey of the land surrounding the stream or lake of interest to you. To maximize the information gained and minimize the time needed to complete the survey, we identified three levels of watershed surveys. From the speediest to the most complex, the three levels are: the **indoor survey** (looking at your watershed on maps and aerial photographs), the **windshield survey** (checking "hot spots" by car), and the **intensive survey** (walking along waterways). When done along a lake, the intensive survey is called a **shoreline survey**. Along a river, the intensive survey is a **stream corridor survey**. Lake groups may wish to do a stream corridor survey of their lake's inlets. Information for all surveys is recorded using standard formats on survey forms and maps. This information is assembled by the lake or river group with assistance from the Massachusetts Water Watch Partnership (MassWWP) to develop a detailed picture of activities in the watershed that potentially affect water quality and uses. Members of the citizen organization review the results, follow up on problems requiring immediate attention, and devise strategies to protect or restore the water body.

Anyone can "adopt" a lake or a stream and begin surveying. It doesn't take much time, it is a good excuse to get out and enjoy the water, and it is easy enough for youth groups and students to do. But, because the survey itself is just a start, all persons interested in doing watershed surveys are encouraged to work with a local citizen group or to form a new group that will use the watershed survey results to actively protect fresh waters. MassWWP partners such as Riverways, the Congress of Lakes and Ponds (COLAP) and the Watershed Coalition are also excellent sources of information.

Section I of this manual describes how to plan a watershed survey to provide the information you need most to protect the water body.

Sections II and III outline the steps in conducting the survey - what to look for and how to record and report findings. These instructions are mainly to provide a standard, comprehensive format so that all surveys can be easily reviewed and compared. Making a survey is very simple, and actually a lot more fun than work. It is not much different from what observant fishermen and canoeists naturally do when out enjoying a favorite pond or stretch of river. The important difference is that the information is collected and stored in one place where it can be used to document water quality conditions and serve as a basis for management.

Section IV provides background information on common sources of pollution, interpreting findings and diagnosing water quality problems.

Section V suggests ways the survey findings can be used by local groups to manage fresh waters.

If you are interested in starting a watershed survey as the first step in protecting a favorite water body, but aren't sure if there is already an active group in your area, call MassWWP at (413) 545-5531. We will be pleased to supply you with information about our training programs for watershed surveys and water quality monitoring or refer you to other members of the Partnership. Other general information on water resource topics is also available.

SECTION I

Purpose

Although the watershed survey is a simple first step, it has many functions in an ongoing monitoring effort. The first survey is the most important because it is the volunteers' first comprehensive examination of all the factors in the watershed that have actual and potential impacts on water quality and water use. In addition, it establishes a baseline against which future change can be compared. For these reasons, the watershed survey provides initial guidance in developing a water quality monitoring plan and establishing priorities.

1. Set Goals

Prior to planning a watershed survey, individuals should have a vision of their water body -- what it is like currently (its uses and misuses) and what it could be. Meet with other interested volunteers to develop a common vision of the area. Be idealistic but keep in mind the realities of your water body. Develop an initial set of goals and priorities for the volunteer effort. These will serve as an effective starting point but will be modified as you learn more about the watershed. For lakes and rivers, these might include protecting selected undeveloped areas for recreation or maintenance of scenic shoreline. In areas with some development, goals might focus on maintaining water quality suitable for fishing and swimming while managing development to maintain existing scenic qualities. Goals for urban waterways might include improving public access and awareness of the water body while working to improve water conditions and make the shoreline more aesthetically pleasing. These goals will help to define the nature of the overall monitoring effort. Be ambitious in setting your goals. Prioritize the goals, keeping in mind that some goals may be easily achieved with a modest level of effort and others may take more intensive or long-term effort. The success of your overall project will be helped if goals are structured so that all volunteers can see that some goals are accomplished quickly while for others reasonable progress is being made. Be careful that your goals are not so complex that success on at least a few cannot be claimed without many years of intensive effort.

The watershed survey can serve one or more of three primary functions:
1) to collect information on present or "baseline" conditions;
2) to identify potential sources of pollution; and
3) to track changes in water quality and land uses over time for the detection of long-term trends.

2. Collect baseline data

Baseline surveys are very useful as they document existing conditions in a standardized format. Ideally, areas influenced by shoreline development or changing land use in the watershed should be surveyed at least annually. But even one survey is valuable. For example, the information from one survey can be used to identify unique scenic qualities and to note shoreline land use, including developed segments where water quality or recreational use may be threatened. One survey is also useful in locating blowdowns, other obstructions that block canoeing access, and concentrations of litter and trash.

The survey results can then be used to correct problems requiring immediate attention and to undertake management of more complex problems arising from land use conflicts. Over the long-term, the information collected might be used to set priorities for protection of scenic recreation areas through acquisition of land or conservation easements, to help prepare local watershed management plans, and to interpret monitored water quality data.

An example of use of a baseline survey: in the Green River watershed, the Conservation Commission asked the watershed association for potential sites on the Green River that could use habitat improvement work to be funded through the Conservation Commission.

3. Identify sources of pollution

Watershed surveys are often undertaken with the intent of documenting and remedying pollution problems. Visual surveys can detect signs of gross water quality degradation, but for the most part, visual evidence of water quality impairment tends to be inconclusive. However, the visual survey provides the clues and supporting information to help interpret physical, chemical, and biological monitoring results. Pollution sources are categorized into two types:

<u>Direct discharges</u> to surface waters or groundwater will be covered by the permit program of the Massachusetts Department of Environmental Protection (DEP), but unpermitted discharges may still be found.

Most sources of nutrients, sediment, and other pollutants are numerous and diffuse, often without a well-defined point of discharge. These so-called <u>non-point sources of pollution</u> typically include highway storm drainage discharges, seepage of effluent from septic systems, lawn fertilizers, agricultural chemicals, animal wastes and runoff from developed land.

Interpretation of cause and effect is more complicated when several sources are present and where natural factors, such as a long residence time of water in a lake, are involved. For this reason, visual surveys are most useful in documenting non-point sources that have the potential to affect water quality due to their location within a shoreline area. For example, homes clustered on small lots near the shore of a pond or river have the potential to contribute nutrients to the water body via underground flow even if signs of septic system failure are not apparent. Likewise, farm fields and fertilized lawns extending to the water's edge, without natural vegetated buffers, are probably contributing nutrients to the water body even if evidence of nutrient enrichment is not present.

Development throughout the watershed can also contribute pollutants to a site far downstream via tributaries and groundwater flow. Knowledge of the land use and potential pollution sources throughout the watershed draining to your lake or river is therefore most important with this type of survey. Surveys of the tributaries flowing to your area of interest will also be important if you have reason to believe watershed land uses are contributing nutrients or other contaminants.

4. Establish long-term trends

Over a period of years, repeated surveys provide a record of seasonal and annual changes in water quality conditions and land use. This long-term information is the most useful. It can be used to determine if visual water quality conditions and, consequently, the aesthetic experience of resource use, are staying the same, declining or improving, and to correlate land use changes with changes in monitored water quality.

When to Survey

Even one survey is valuable but because water conditions change seasonally and land use can change rapidly, repeated surveys provide the most useful information.

It is recommended that surveys be repeated at least annually and, ideally, 3 times each year. This provides baseline information on a water body throughout the seasons, under a range of conditions.

The best times to survey are:

- Early spring (March through early May), before trees and shrubs are in full leaf, water tables are high, and shoreland visibility is good.

- Late summer (late July to early September), when water levels are low and aquatic vegetation has reached maximum growth; and

- Fall (October through November), when leaves are down, providing good visibility and water tables are high again.

Keep in mind that these are guidelines, not a rigid schedule. The idea is to become acquainted with your site, to learn to recognize natural seasonal patterns, and to distinguish these from unusual or extreme changes. Once a schedule is selected for visual surveys, subsequent surveys should be conducted at the same time each year.

If your site is very large, after the first survey you may wish to concentrate on developed shoreline segments or inlets where developed tributaries flow into your area. If you suspect land use activities, storm drains, or direct discharges are adversely affecting water quality, more frequent spot checks are desirable. If, for example, your site has a concentration of older homes on small lots adjacent to the shore, you may want to check for obvious signs of septic system failure in the early spring when water tables are high. Or, look for signs of sedimentation or turbidity at storm drainage pipes and channels during or just after a heavy, prolonged rain; inspect discharges from industrial and municipal wastewater treatment facilities to determine if aesthetic standards are being met downstream.

What to look for

The type of information you collect is up to you and the organization you are working with. You may decide the basic information called for in this manual is fine for your purposes. Feel free to expand the list or to concentrate on a few characteristics, depending on your special interests;

MassWWP can help in designing standard formats for expanded survey work. For example, naturalists or bird watchers may enjoy documenting the species of plants, birds or other wildlife observed, especially in scenic areas where preservation of undisturbed habitat is a priority. Where the goal is to protect or restore a cold water fishery, the survey could be expanded to include specific information for streams on the length of riffles and depth of pools, the pool/riffle ratio, percent stream shading, and more specific information on bottom characteristics or, for lakes, bottom dissolved oxygen and temperature and other habitat characteristics. Where efforts are being made to revitalize an urban waterway, it may be especially important to document existing recreational use of the area and sites where visual or physical access to the water body could be enhanced.

Logistics and Safety

In selecting the area to survey yourself, be careful not to try to cover too large an area. Keep the section to a manageable size that you can review thoroughly without feeling overwhelmed or losing your sense of enjoyment. Uniform segments with little development can be surveyed quickly in comparison to highly diverse environments or those with numerous potential sources of pollution.

The watershed survey is constructed in three stages: The first is an **indoor survey** of your watershed; you outline the watershed boundaries on a topographic map and mark the areas to be spot-checked and those that are unlikely to need closer inspection. The indoor survey is designed to develop a broad scale but rudimentary description of the entire watershed. It helps reduce your workload down to a manageable level, by eliminating field work or parts of watershed that aren't in danger, and lets you focus your resources on the priority areas. Get a small group of people together for this stage; pick participants who are very knowledgeable about the terrain and land use in your watershed.

The second stage is a **windshield survey**. It may be conducted by car, bicycle or other means of transportation appropriate to covering quite a few miles. You will physically travel to areas of special interest identified in the indoor survey, such as active construction areas, agricultural areas bordering tributaries, etc. Take your time, take a partner and hone your observational skills. Note areas that deserve a still more detailed survey.

The third stage, or **intensive survey** is a detailed survey of a specific area, usually a stream or a lakeshore. It is also called a stream corridor survey or a shoreline survey. This last stage is designed to develop a detailed description of the area immediately surrounding your water body or potential sampling sites. Share the task of covering the watershed with others in your group. Bear in mind the accessibility of the site, steepness of the banks, water depth and flow rate. Deep or fast-flowing waters are difficult and possibly dangerous to investigate. Walking in shallow water is the best way to survey - it forces you to go slowly and take note of water conditions up close. Sometimes submerged pipes are discovered this way. If your study area is deep, swiftly flowing or has steep banks, walk on the shore or use a boat. If in doubt about whether to walk or boat, ask someone, perhaps a fisherman, who is familiar with the segment. Take what you think is the safer alternative and always go with a partner.

If you plan to walk along a shoreline or otherwise cross private land at any portion of the site, contact the landowners for permission. The landowners may well be interested in your project and eager to share information or join the effort. Carry a few MassWWP brochures and those of your own organization with you to help in explaining your effort and to reassure the landowner that you are part of a state-wide, scientifically-based project.

SECTION II

Stage 1: The Indoor Survey

Planning and Preparing for the Indoor Survey

Obtain reports on other surveys that may have been done in your watershed and data from other sources such as the DEP discharge permit data. MassWWP may be able to help in identifying and obtaining these reports. You can use aerial photographs and specialized maps such as land use GIS (Geographic Information System) maps to help your investigation, as well as the results of the Acid Rain Monitoring Project, stocking and management records from the Division of Fisheries & Wildlife, soils maps from the Natural Resources Conservation Survey, and reports of your local Conservation Commission. Your knowledge and that of landowners, river recreation enthusiasts, and longtime residents will be helpful.

<u>Gather the right maps</u> before calling the indoor survey meeting to make for a more efficient and pleasant review. You will need the following:

1. Base map to record watershed characteristics and pollution sources. This is the map you will use to locate natural features and problems. Any large scale map can be used as a base, but it will be easier to locate watershed features if this map depicts the outline of lakes and streams, roads and utility right-of-ways as reference points. Plat maps, which are available from the local tax assessor's or Town Clerk's offices are usually suitable. USGS 7.5 or 7.5X15 minute quadrangle topographic maps are a usually a good choice for a base map. These topo maps can be bought for about $4 at sporting good stores, bookstores, or from the Earth Sciences Information Office (ESIO) at UMass (413)545-0354 or http://www.umass.edu/tei/esio. These topos or other small scale map can be enlarged on a photocopy machine for bigger resolution. Topo maps are also available on CD from the ESIO ($49 for either the eastern or the western half of the state).

2. A list of permitted discharges to surface and groundwater, such as industrial discharges permitted by DEP. You can obtain those from your DEP Regional Center; in western Mass., call (413)784-1100 ext. 214; in central Mass. the number is (508) 792-7683; in northeastern Mass. it’s (781)935-2160 ext. 112, and in southeastern Mass. call (508)946-2714.

3. Optional: aerial photographs of your watershed. These are good to show the recent or historical land use patterns. Photos are available from about 1938 to 1997 for

Massachusetts and cost $14 and up a piece; inquire at the UMass ESIO (see above) or USGS EROS Data Center Customer Services, Sioux Falls, SD 57198. You can purchase black and white or color infrared photos in various scales. 1:12,000 or larger is preferable to see enough detail. Ask for 'leaf-off' photos.

4. Optional: MassGIS land use maps of your watershed. MassGIS also has maps of aquifers, and many other features. Call (617)727-5227 in Boston.

5. Optional: If you have access to ArcView GIS software, topographic maps are available as Digital Raster Graphic CDs (available for about $35 from the ESIO or USGS, see above).

Conducting the Indoor Survey

The first step is to delineate (outline) the natural physical boundaries of your watershed on your base map. If your watershed is large, this work may have already been done by MassGIS. In case of lakes, the watershed may have been outlined by the Acid Rain Monitoring Project. Check with MassWWP if you are in doubt. If your watershed has not been delineated before, you should undertake that step yourself, preferably with the help of a knowledgeable map reader. Ask MassWWP for how-to directions that will help you.

The second step in the indoor survey is to divide the watershed into logical units. Use your topographic map and aerial photos, and mark down suspected natural or man-made borders: where a stream passes from the forest to open fields, where residential units begin to border the stream, where rip-rap banks have been installed, etc. Use the evidence of the maps or photos, as well as your own knowledge of the current and historical use of the area. Mark the location of the permitted discharges on the base map. It may be helpful to recruit the assistance of landowners, recreation enthusiasts, and longtime residents for this process. Make sure the sections are of reasonable size for one crew to visit in one outing.

The third step is to identify areas which do not need a field check: these would be large tracts of undisturbed land such as forests, where there is no activity liable to cause pollution or problems to your lake or stream. Similarly, outline the sections of watershed you want to spot check in the windshield survey. Go back to the breakdown of sections done in step two. Assign teams to each of the sections identified for field checks. Using the base map, cut and paste to get individual maps for each section. Use a copy machine that has enlarging capabilities to produce maps with a scale of about 1 inch = 300 feet (you may have to enlarge your base map several times to reach this scale).

Stage 2:The Windshield Survey

Planning and Preparing for the Windshield Survey

In the windshield survey, crews of two to four people will travel the watershed with maps and forms and write down their observations. You will need the following:

1. A reference map is useful in locating the survey area and pinpointing your position along the survey site, especially if you are not familiar with the area. A USGS map and/or road map is most useful.
2. Individual maps for each section identified in the Indoor Survey.
3. Data sheets and a set of codes to record your findings. The following are found farther in this manual:
   - Survey map codes,
   - Site Specific Information Sheets
4. Other basic equipment:
   - clipboard
   - pencils
   - tape measure or ruler
   - camera to document existing conditions and problems
   - insect repellant
   - compass for helping to pinpoint location
   - Global Positioning System Unit (GPS) (optional)

Field work

The sections you've chosen will then be "field tested". In order to cover your area in a reasonable amount of time, you will probably need to use autos (airplanes are great if you can get one) to conduct the survey. Use the base map to make notes on both general and specific characteristics of the landscape in your section. Drive along river or lake tributaries wherever roads allow. At dips in the road and the bottom of hills look for stream crossings and drainage swales and pipes. If possible, get out of the car and take a look at water conditions at these and other accessible points. If you discover a feature that is markedly different from the upstream character of the river (for instance, the water is now muddy, or there is no streamside vegetation), try to find the exact point where the change occurred - by walking up or down the stream if necessary - and mark it down on the map. Mark codes on the map (number each occurrence, such as Cl1, Cl2) and record them in the narrative section of the survey form as well, such as Cl1= cleared land next to Burr Rd. Cl2= cleared land extends from trail to stream bank.

In areas with considerable human activity, you may need to do some closer inspection, on foot or by canoe, to make sure you don't miss significant phenomena such as dumps, drainage pipes, etc. You can of course do an entire section by canoe or walking if you so desire.

Observe natural landforms - the lay of the land - and its relationship to streams, ponds, wetlands and other surface waters. Look for the highest elevation points that form the watershed boundary. These slopes often consist of glacial till soils which contribute runoff to lower-lying areas. Upland areas consisting of permeable sand and gravel soils known as glacial outwash tend to promote infiltration of rainwater and serve as groundwater recharge areas. The deepest outwash deposits are normally found in broad valleys with flat or gently rolling topography. Depending on the depth and extent of outwash, these areas can be important groundwater reservoirs or aquifers, and possible sources of flow to streams and ponds.

Observe differences in water conditions from headwater tributaries to your area of interest. Uppermost tributaries usually originate as wetland seeps or intermittent streams that flow during the wettest time of the year and become dry in summer. Further downstream these become small perennial streams which are typically shallow, fast-flowing with steep gradients and sand or gravel bottoms. In summer dry periods, flow is provided primarily by groundwater discharge and is called base flow. As the stream increases in size, flow increases and topography flattens, streams become deeper and slower moving. Slower water allows silt and other fine sediment to settle out, resulting in silt bottoms, often supporting aquatic vegetation.

Notice where the natural drainage patterns have been altered. Look for drainage ditches and swales as well as catch basins and drains that carry stormwater from developed land and roads. Find the point of discharge to a surface water body and look for signs of scouring or sedimentation to see if these discharges could be contributing sediment or other pollutants to your area. Also look for unusual vegetation, odors or color. Storm drains serving residential areas sometimes intercept wastewater effluent via underground water flow or direct tie-ins. In commercial and industrial areas, runoff may carry high concentrations of hydrocarbons and toxic metals from parking areas as well as toxic materials that may be (or have been) stored on-site.

With a list of permitted discharges from DEP, check the location of these discharges as you investigate the watershed. If the discharge site is accessible, check for obvious differences in water quality above and below the discharge.

Be aware of land use throughout the watershed. Forested lands protect water quality by allowing rainwater to infiltrate, slowly releasing it to surface waters while retaining sediments and nutrients. Uncultivated fields also function in the same manner. Active farmland, moderately dense or poorly managed residential development, highways and commercial and industrial lands all have the potential to affect water quality by dramatically increasing the amount of surface runoff and total amount of pollutants carried directly to surface waters. Factors that encourage pollutants to reach surface water include: absence of naturally vegetated buffers; construction in poor sites which may have a high water table, steeply sloping land or filled land; and new construction or active farming without proper management practices to retain sediment on-site and minimize pollutant movement.

Section borders may have to be adjusted in the field. The map may show a forest ending at a road crossing, for instance, but on visual inspection, the forest is determined to end 150 yards upstream. Note these border changes and make sure both teams (yours and the team covering the adjacent section) are aware of the new boundaries.   You may find that a section is more complex than originally thought, and you may have to subdivide further. You may also find that there are sections that are too inaccessible to be accurately estimated with the windshield survey. Indicate such areas on the map. In the narrative section, indicate how high a priority you think these areas should be for an intensive survey.

If it appears that there are too many pipes, nonpoint sources, etc. to record easily, then proceed as follows:
1) Record the general characteristics.
2) Mark that section for later inclusion in an intensive survey,
3) Record as many or as few of the specific problem sites as you feel you can feasiblely include.
4) Go on to the next section.

In other words, don't spend too much time making fine distinctions between different choices.

Stage 3: The Intensive Survey

In stage 3, you will do a detailed survey of stretches identified as too complex for the windshield survey. If you have an ambitious group of people with enough time on their hands, you may want to do an intensive survey of all the tributaries to your lake or stream. However, the intensive survey is generally used to provide detailed information about particular localized sources of pollution that may affect your lake or river. The intensive survey differs from the windshield survey in the greater level of detail required since it would not be practical to provide extensive detail on the entire watershed.

You will first want to evaluate all of the results of the windshield survey segments and other available information before beginning the intensive survey. This gives you a chance to select the highest priority threats for intensive scrutiny. MassWWP can assist in this process. The intensive survey results will help to further select river sampling sites from the list of potential sites.

The Stream Corridor Survey

Let us first go over the intensive survey for streams, or stream corridor survey. Use the Stream Corridor Survey Form found a couple of pages down, with help from the instructions below. (Riverways -a program of the Massachusetts Division of Fisheries and Wildlife- offers more involved training in this procedure. Contact them at (617)727-1614, ext. 384. for more information).

Planning and Preparing for the Stream Corridor Survey

Again, you will need:

1. a general map of the watershed for the surveyors to orient themselves and find their stretch of stream
2. enlarged portions of the base map, one per segment to be surveyed
3. MassWWP codes and data sheets to record your findings.
4. Other basic equipment:
   - clipboard
   - pencils
   - tape measure or ruler
   - camera to document existing conditions and problems
   - insect repellant
   - hip boots, chest waders, or old clothes and sneakers in warm weather
   - compass for helping to pinpoint location
   - GPS unit (optional)

On the enlarged base map, divide the stream segments you want to investigate into stretches ½ to 1 mile long. More important than making the stretches equal in length, place the start and finish of the stretches at accessible and easy to find places, such as at a road crossing or at the junction with a tributary. Assign the stretches to crews of two or three people, and send them out with maps and data sheets. Don’t forget to ask for landowners’ permission to walk on their land: they even own the streambed, so walking in the stream does not relieve you of getting permission. However, navigable waters are public property, so if you float in a canoe or row boat, you may skip landowners’ approval if they are not cooperative.

Field Work

Starting at one end of your stretch, walk or slowly boat along the banks of the stream. You will probably need to cross the stream frequently, as banks become too steep or densely vegetated.
Observe the stream itself and the banks on either side, using the field sheet to write down your findings.

Many of the form questions request information about both the left and right sides of the river. **Remember that references to the left or right bank of a river are made from a viewpoint that is looking *downstream*.** In addition to describing your segment start and end, mark the segment and its code on your base map. The complete survey of your segment will consist of both the map and the survey forms.

Characterization of a stream reach will be harder for streams that run through more varied landscapes, but don't let that bother you. A 10 mile segment that is a mix of 25-50% forest, 0-10% industrial, 25-50% small residential lots, and 50-75% crops, is fine. Within a segment such as this, you will no doubt have many more notations about specific problem sites, but just remember to record them. Use your best guess as to type (i.e. meadow vs cropland) and quantities (i.e. % of area affected). Remember that these are *average* values. If you are doing a 3 mile segment, what is the average land use, stream width, or water color in that stretch?

FILLING OUT THE STREAM CORRIDOR SURVEY FORM.

Fill out all fields, unless the instructions given here indicate otherwise. Some self-explanatory fields are not mentioned below.

<u>Part 1</u>: ADJACENT LAND.

General land use: For each type of land use that is found along a segment, indicate what % of the segment it covers. Use the % categories provided: 0-10%, 10-25%, 25-50%, 50-75%, 75-90%, and 90-100%. Because the ranges allow for some overlap, and because you can have more than 1 use at a time (i.e. the land is 100% filled with 1 acre lots, but all lots are at least 50% forested), you may end up with a total for each segment that is not precisely 100%, but don't worry about that. If you think your totals might mislead a reviewer, be sure to indicate clearly on your map where the different categories exist. Remember to list both the left and right bank, unless they are the same throughout. If that is the case, write "same" in the first space available along the right column.

Width of riparian zone. The vegetation that grows on the banks themselves and that exists *immediately* adjacent to the banks is important to water quality and to wildlife which use this "riparian corridor". Use this field to indicate how far the vegetation immediately along the stream extends inland.

Streamside vegetation. This field classifies the vegetation that exists in the riparian corridor. It may or may not be different than the vegetation existing throughout the full 1/4 mile-wide areas referred to in the "General land use" question.

Stream Cover. Using your best guess, estimate how much of the stream is shaded by trees, buildings, or otherwise, during the middle part of the day, *during summer months.* This helps determine how effectively the stream can retain low water temperatures.

<u>Part 2</u>: STREAM BANK AREA.

Artificial bank protection. Make sure you note the location of this on your map.

Eroded or disturbed banks. It's important to note areas where sediment may be entering the streams. Obvious erosion from construction, vehicles, livestock, or from natural causes, should be listed. Use your judgment as to how severe it is, and if you can, list the cause(s).

<u>Part 3</u>: INSTREAM CONDITIONS.

Flow. Is the stream running higher or lower than average for this time of year?

Average stream width. If possible, stop at a site that is representative of the stream width throughout the segment, and measure the stream width. If not, estimate the average width.

Water Color. In general, is the stream clear, tea-colored, muddy, etc? Note the difference between muddy (brown - like light coffee) and milky (grayish - indicative of clay, perhaps). Sometimes, a stream changes its color dramatically, due to a tributary, an eroding bank, or some other discharge. If possible, try to find the location where water color or clarity changes, and note it on the map and in the narrative section.

Water smell. Indicate the general smell of the segment. If you notice localized odors, record them in the narrative section.

Presence of logs or woody debris in stream. Contrary to what many people believe, large woody debris, such as root systems, fallen trees, and the like, are beneficial to the aquatic life, for they provide important habitat such as pools and cover for fish, crustaceans, and other creatures. Indicate how prevalent large woody debris is in the study reach.

Part 4: RIVER RECREATION.

This section is meant to yield information about recreational *and other* resource values that might be worthy of special protection by your group or by other interests.

In Section 1, list areas that are either in current use, or which might provide good access for each of the activities mentioned. If the area is inaccessible, state the reason why.

In section 2, indicate your view of the suitability of the area for each of the listed activities. For this question, assume that you are a practitioner of each of these activities. If you see someone using the area for the activity mentioned, note this as well.

Part 5: SITE SPECIFIC INFORMATION.

Remember to record any unusual or noteworthy phenomena, whether it is a potential or current pollution source, a significant land use, or any other observation, such as a black bear chasing you. Try to note it on your map, and if possible, give directions to the site in this narrative section. Briefly describe the event or occurrence (i.e. drainage pipe with sewage flowing out of it; cattle pen running through stream, abundant bank erosion and manure input, etc.).

Finally, note on your map the beginning and ending points of any sections you think need to be covered by an intensive survey. Describe the location of these boundaries in this narrative section as well.

INTENSIVE SURVEY FORM

Stream name: ____________________________ **Segment code: __________________**

Segment Start: __________________________ **Surveyor(s) : ___________________**

Segment End : __________________________ **Date: ________________________**

When filling out this form, record *average* values for the entire survey segment:
If you observe any high-potential resource areas, pollution sources, or other phenomena, which might bear a closer look, please record them on your map and in the narrative section of the form.

ADJACENT LAND

General land use. What is the nature of the land use within 1/4 mile of either bank?
Use approximate percentages for each use encountered. List each side of stream.
Ranges: 0 - 10%, 10 - 25%, 25 - 50%, 50 - 75%, 75 - 90%, 90 - 100%

Forest (> 20' high) _______ Left _______ Right
Shrub (0-20' high) _______ Left _______ Right
Pasture _______ Left _______ Right
Open land (abandoned farm, etc) _______ Left _______ Right
Crop (cultivated) _______ Left _______ Right
Open perennial (orchards, nursery) _______ Left _______ Right
Wetland _______ Left _______ Right
Residential :
R0 - Multi-family _______ Left _______ Right
R1 - < 1/4 acre lots _______ Left _______ Right
R2 - 1/4 - ½ acre _______ Left _______ Right
R3 - ½ - 1 acre _______ Left _______ Right
R4 - Greater than 1 acre _______ Left _______ Right
Commercial _______ Left _______ Right
Industrial _______ Left _______ Right
Transportation (RRoad, airports, etc) _______ Left _______ Right
Waste disposal (landfills, sewage lagoons, etc) _______ Left _______ Right

Width of riparian zone (Is there a band of trees, shrubs, or grasses covering or extending outward from the streambank itself? If so, indicate the average width of this strip.)

Left Bank: ____ 0 - 5' ____ 5 - 20' ____ 50 - 100' ____ 100'+

Right Bank: ____ 0 - 5' ____ 5 - 20' ____ 50 - 100' ____ 100'+

Streamside vegetation. (What % of segment length is covered by the types indicated?)

Left Bank:
None or little ____% Grasses ____% Shrubs (< 20') ___% Trees greater than 20' ____%

Right Bank:
None or little ____% Grasses ____% Shrubs (< 20') ___% Trees greater than 20' ____%

Stream cover. (estimate shading between 10 A.M. and 2 P.M.)

___ 0 - 25% ___ 25-50% ___ 50- 75% ___ 75-100%

Segment code: ___________________

STREAM BANK AREA

Artificial Bank protection. (What % of segment length is covered by the types indicated?)

What is the nature of the artificial surface?
Left: ____ Rip-rap _____ Concrete/other paved surface _____ Wood
____ Junk _____ Other
Right: ____ Rip-rap _____ Concrete/other paved surface _____ Wood
____ Junk _____ Other

Eroded or disturbed banks. (What % of segment length is affected?)
Left bank:
___ 0 - 10% ____ 10 - 50% ____ 50 - 75% ____ 75-100 %

Severity: _____ Low ______ Moderate _______ Severe

Cause: ____

Right Bank:
___ 0 - 10% ____ 10 - 50% ____ 50 - 75% ____ 75-100 %

Severity: _____ Low ______ Moderate _______ Severe

Cause: ____

Any steep banks present in segment?
_____ No ______ Left bank _____ Right bank

INSTREAM CONDITIONS

Flow. _____ Low ______ Moderate ______ High.

Average stream width. (Over length of segment.) _______ Feet

Water color.
____Clear ____Green ____Tea ____Milky____Cloudy _____Muddy

If milky, cloudy, or muddy, rate:

______ Light _______ Moderate _____ Severe

Water smell.
_____ None _____ Sewage ____ Oil _____ Chlorine ______ Rotten eggs

Presence of logs or woody debris in stream.

____ None ______ Occasional _______ Common

Aquatic vegetation.
1. Do rocks on the stream bottom feel slippery or slimy: ___ Yes ___ No
2. If the following plant types are present, indicate the relative extent within the segment:
H - high M - Moderate L - low

a. _____ Submergent - plants completely underwater
b. _____ Floating - plants w/leaves floating on the surface
b. _____ Emergent - plants w/leaves rising above water surface
d. _____ Mosses - dense, cushion like mats on rocks
e. _____ Algae - green cotton ball or threadlike films, formless if brought out of the water.

Segment code: _________________

RIVER RECREATION

1) Accessibility:

	Left Bank	Right bank
By public trail	___________	___________
by private trail	___________	___________
nearby road	___________	___________
nearby parking	___________	___________
with a canoe	___________	___________
not accessible	___________	___________

Reason: ____

2) Would you come back here to:

swim ____________
wade ____________
canoe ____________
tube/kayak ____________
picnic ____________
fish ____________
camp ____________
bird watch ____________
other ____________ list: ______________________________________

Segment code: __________________

SITE - SPECIFIC INFORMATION
Please record here any obvious or potential pollution or problem sources that you find (i.e. pipes (flowing or dry), animal waste entering stream, etc), or any significant resources that you observe (i.e. waterfalls, wildlife, good swimming holes or popular fishing spots, good boating stretches, etc). Describe the occurrence and the location as clearly as you can.

Segment code:__________________

The Shoreline Survey

The shoreline survey is an intensive survey for lake shores. Those who are doing a lake survey may proceed to the shoreline survey as soon as the windshield survey is complete. However, a stream corridor survey may be very useful for lake groups to help interpret their water quality data.

Planning and Preparing for the Shoreline Survey

Review the watershed information assembled for the windshield survey and the results of the stream corridor survey, if applicable. Select a new base map of sufficient scale to permit adding detail on the lake. Divide the perimeter of the lake into segments to be surveyed on foot (or by boat). Make the segments no larger than 1 mile long, and make a new segment whenever the shoreline or land use changes. You will need:

1. Base map which includes the whole lake and roads.

2. Enlarged portions of the base map (scale of about 1 inch=300 ft), one per segment.

3. Codes and data sheets to record your findings. These include:
   Survey map codes
   Data sheet #1 for general observations (a blank one can be found on page 21)
   Data sheet #2 for specific comments (a blank one can be found on page 22)

4. A list of permitted discharges to surface and groundwater. Mark the location of these sites directly on the base map before going out.

5. Other basic equipment:
   - clipboard
   - pencils
   - tape measure or ruler
   - walking stick of known length for balance, probing and measuring if walking along the shoreline or an oar or paddle and lead line if boating.
   - boots or waders if your are walking; paddles and life jackets if boating.

6. Optional supplies
   - camera to document existing conditions and problems
   - insect repellent
   - compass for helping to pinpoint location
   - GPS unit

Field Work

You are ready to get "up close and personal" with your shoreline. For safety reasons, the shoreline survey should be conducted by more than one person. Two or three will also be faster and do a better job in describing the characteristics of a stream or lake.

As you go along the lake, record general observations about the character of the shoreline on data sheet #1. Use one data sheet per segment. If your segment markedly changes, for example, one half of the survey site is a shallow, weed-infested area and the other half is a cleared beach, use two general data sheets to describe each half. Key each data sheet to a location on your map.

Locate shoreline features and potential pollution sources on your map using the shoreline survey codes listed in Table I. These codes are described in greater detail in the next section. Codes at the end of this table refer to sediments and vegetation in the water only. Features not specifically listed in the table of codes should also be mapped. For example, individual dwellings may be drawn or the general type and density of development near the shore could be mapped. The type of vegetation and its abundance should also be noted, particularly since this will help in the selection of sites for more intensive weed mapping later.

Specific problems should be noted on the map, with a number or numbered code referencing additional comments on data sheet #2, as shown in the following sample map and data sheets. Both actual and potential pollution sources should be noted on the map and described on data sheet #2. For example, a greywater (washwater waste) hose leading from a house onto the lawn is a potential discharge if it is dry at the time of the survey. If washwater is observed flowing from the pipe, it is an actual discharge. If in doubt about any type of discharge, land clearing or suspicious plant growth or odor, mark the site on the map and describe on data sheet #2. If you witness a violation of wetland, hunting or fishing regulations, do not attempt to confront the responsible parties yourself. Note the location and time (photograph, if possible) and report the incident to the shoreline survey coordinator as soon as you return. Include your comments on data sheet #2.

In addition to the features listed on data sheet #1 and the Shoreline Survey codes in Table I, include any other descriptive characteristics of the stream or lake on the map and/or data sheet #2. For example, if you are interested, record the various plants, birds and other wildlife encountered, especially the unique or uncommon species.

See examples of a base map and filled data sheets on pages 23-25.

Note: the rest of this manual is directly borrowed from Rhode Island Water Watch's Shoreline Survey Manual for Lakes, Rivers and Streams (1990- NRS Technical Report 90-3)

Visual Survey Data Sheet #1

General Observations

Name of Lake or Pond______________County/Town______________

Watershed ___________________Date _________Time_________

Segment Surveyed ____

Surveyor(s) Name(s) ______________________________________

Today's Weather ____

Recent Weather Conditions _________________________________

Water level high_______ normal________ low__________

Water Condition

Water Odor:	Water Color:	Surface Coating:	Streambed Coating:
rotten egg___	muddy___	scum___	orange to red___
chlorine___	clear___	foam___	yellowish___
other___	tea___	oily___	black___
none___	milky___	other___	brown___
	brownish___	none___	other___
	other___		none___

Aquatic Vegetation

Algae Color:	Algae Location:	Other Aquatic Plants Location:
light green___	on streambed___	throughout section___
dark green___	surface___	in most places___
brown___	throughout section___	in spots___
other___	in most places___	none___
	in spots___	

F:\MWWP\WP\WKSHOPS\visurvey

Land Use Surrounding Lake Segment (approximate)

homes___	businesses___	factories___	construction sites___
marsh___	pastures___	cropland___	woods___
swamp___	other___		

Water Use

Recreation:	Water Withdrawal (if known):
swimming____	drinking water ____
fishing____	industrial water____
boating____	agricultural water____
other____	

Manmade Structures (Approximate number)

	0	1-10	11-50	50+
dams	____	____	____	____
docks	____	____	____	____
boat ramps	____	____	____	____
bulkheads	____	____	____	____

Litter Approximate number of litter items in 1/4 mile stream section

	0	1-10	11-50	50+
paper, small trash	____	____	____	____
cans & bottles	____	____	____	____
tires, carts, etc.	____	____	____	____

Comments:

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Sample Data Sheet #2
Additional Comments

Map Code #	Description	Discharge ACT/POT

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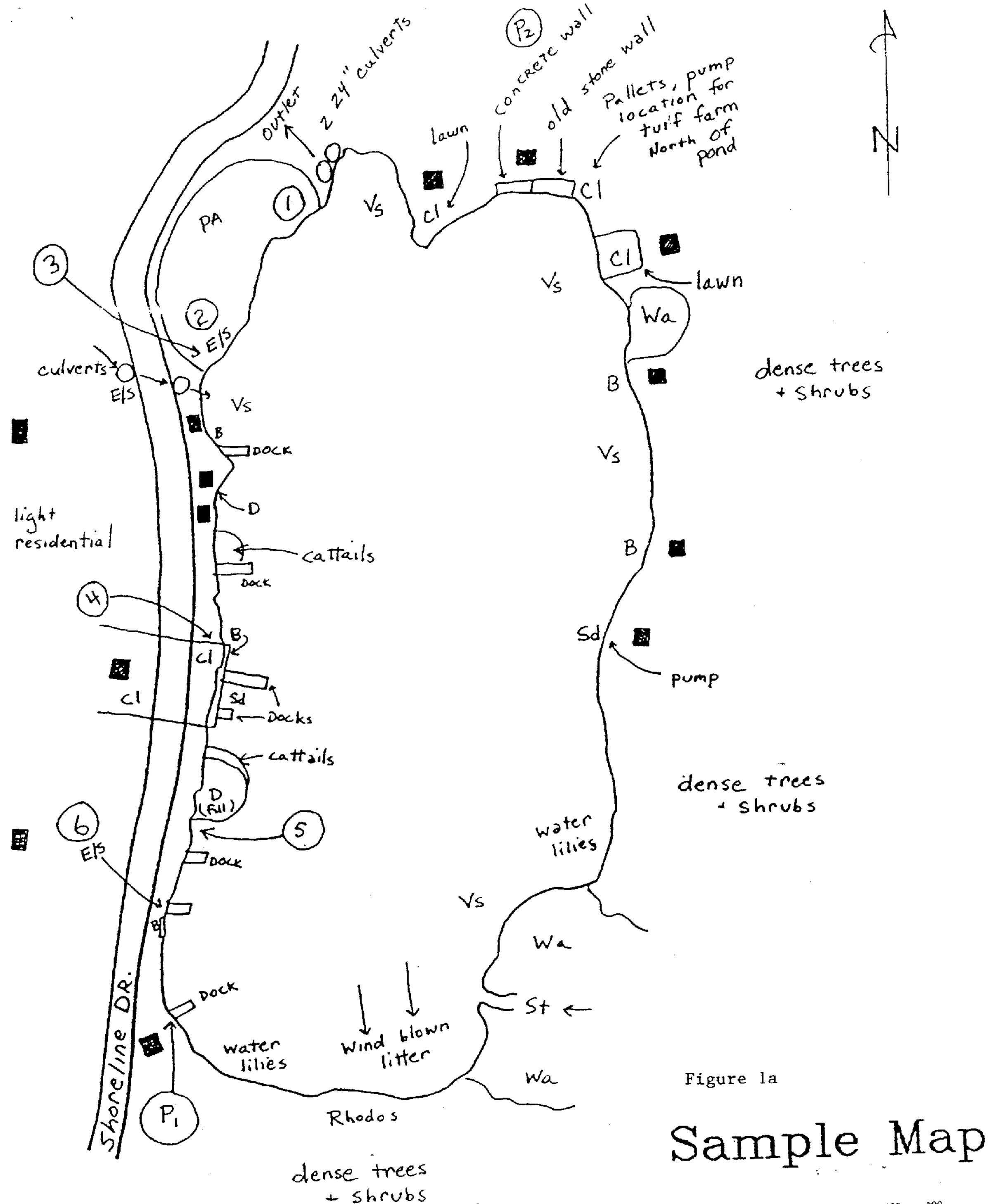

Figure la

Sample Map

SCALE IN FEET

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Data Sheet #1

VISUAL SURVEY DATA SHEET

General Observations

Name of Stream or River *SAmple PonD* County/City *Richmond*

Tributary of *PAWcatuck* Date *5/20/89* Time *10-12 am*

Section Surveyed *Perimeter of Pond*

Surveyor(s) Name(s) ____

Today's Weather *Sunny, few clouds*

Recent Weather Conditions *SAme*

Water level high ____ normal ✓ low ____

WIDTH & DEPTH Range of Stream Width (ft)___ Range of Stream depth (ft)___

WATER CONDITION

Water Odor:	Water Color:	Surface Coating:	Streambed Coating:
rotten egg___	muddy___	scum___	orange to red___
chlorine___	clear___	foam___	yellowish___
other___	tea ✓	oily___	black___
none ✓	milky___	other___	brown ✓ *light film of detritus*
	brownish ✓	none ✓	other___
	other *specks of algae*		none___

AQUATIC VEGETATION ( )

Algae Color:	Algae Location:	Other Aquatic Plants Location:
light green___	on streambed___	throughout section ✓
dark green ✓	surface___	in most places___
brown___	throughout section ✓	in spots___ *20-50' from shore*
other___	in most places___	none___
	in spots___ *bloom in water*	

LAND USE Surrounding Stream Section (approximate %)

homes *20%* businesses___ factories___ construction sites___ marsh___

pastures___ cropland___ woods *70* swamp *10* other___

WATER USE

Recreation:	Water Withdrawal (if known):
swimming ✓	drinking water___
fishing ✓	industrial water___
boating ✓	agricultural water ✓ *turf farm*
other___	

MANMADE STRUCTURES (Approximate number ( ))

	0	1-10	11-50	50+
dams	✓	___	___	___
docks	___	✓ (7)	___	___
boat ramps	___	1	___	___
bulkheads	___	✓ (6)	___	___

LITTER Approximate number of litter items in 1/4 mile stream section ( )

	0	1-10	11-50	50+
paper, small trash	___	✓	___	___
cans & bottles	___	✓	___	___
tires, carts, etc.	✓	___	___	___

Comments

Additional Comments

Map Code #	Description	Discharge ACT/POT
P1	1" diameter metal pipe under dock, no discharge.	POT
P2	3 4" diameter clay weepholes in concrete wall. No discharge	POT
1	Vegetation worn from heavy fishing/picnicking use; potential for erosion.	
2	Boat ramp eroding from over use. Needs concrete reinforcement. Call DEM Div. of F & W.	
3	Road runoff causing erosion and obvious sedimentation in water. Call highway department.	
4	Manicured lawn to waters edge.	
5	Otters seen here on occasion.	
6	Steep slope descending to dock eroding. Appears relatively stable, watch for deterioration. talk to Mr. A about planting grass or low shrubs.	

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Table 1

Watershed Watch
Shoreline Survey Mapping Codes

Symbol	Description
Al	Algal growth sufficient to (1) impede natural stream flow, (2) coat or cover substrate and submerged objects or (3) cause variation in water color. (4) form floating maps or slimy film.
B	Bulkhead - upright wall holding back soil and forming the shoreline, made of concrete, stone, wood or other material.
CB	Channel blockage caused by either natural or man-made objects preventing navigation or rerouting stream flow
C1	Cleared land with lawn or other low vegetation extending to the shoreline
D	Dump in or near water consisting of trash, organic matter such as grass clippings or fill such as sand or soil
DR	Drain, ditch or other man-made open channel designed to convey water
E/S	Eroded land adjacent to shore, cutting of shoreline or sedimentation in or near water
Fm	Farmland erosion causing sedimentation or erosion in or near water
L	Litter scattered in water or on shore
M	Made land or filled shoreline
Oil	Multicolored surface film indicating presence of petroleum products which persists when disturbed. A metallic surface sheen may appear as the result of natural metabolic processes in wetlands, but breaks up with contact
OR	Animal waste adjacent to shore or potential organic pollution from waterfowl or animals
P	Any pipe leading to or near the water's edge. On data sheet #2 specify: 1. Type - concrete, metal, plaster, clay or other material 2. Diameter

3. Presence of flow or odor
4. Erosion of shoreline or deposit of sediment in or near water
5. Excessive plant or algal growth
6. Source and purpose of pipe

PA	Public access, either officially designated with parking or other access, including foot path, with evidence of general public use
RR	Riprap foundation or wall of stones placed irregularly or loosely
St	Stream flowing into or out of sampling area
Sp	Spring or other flow of water issuing from one spot and great enough to create a stream
Sud	Suds greater than 3" high
Wa	Wetland or other wet area with water at or near the ground surface but without channeled flow

Sediments and Aquatic Vegetation

bd	boulder 10"
cb	cobble 1.5" - 10"
gr	gravel 1/8" - 1.5"
o	organic material such as leaves
sd	sand
st	silt or other mud
ve	emergent vegetation
vs	submerged vegetation

C. Description of Shoreline Survey Map Codes

The map codes listed in Table I are described in greater detail below. These descriptions provides some background information, suggest what to look for and how to report common shoreline features.

AL Algal growth sufficient to (1) impede natural stream flow, (2) coat or cover substrate and submerged objects, (3) cause variation in water color or (4) form floating mats or slimy film.

Algae are microscopic plants that are the most basic type of plant life in aquatic environments. They occur as unicellular or attached together in colonies. Some types live in the water column. When abundant, floating types can change the color of the water to green, brown or even yellow, producing an algal "bloom". Others are found attached to rocks, plants and other submerged object where they appear as mat, slime or long filaments, with colors ranging from brown to bright green. Because they respond rapidly to changes in nutrient concentrations, algae can indicate the general level of nutrient enrichment, or eutrophication, in a pond.

Algae in both streams and ponds tend to undergo natural seasonal cycles. It is therefore important to observe natural variations throughout the year in order to determine if excessive concentrations or an unusual type of algae may result from nutrient inputs or other disturbance. As a waterbody becomes eutrophic, algae become less important in the aquatic system and aquatic plants become dominant.

Note the abundance and type of algae; specify whether it is floating within the water column or attached to the bottom or on submerged objects; indicate its location within the section. If possible, estimate whether poor flushing or a source, such as nearby development, storm drain, or tributary inlet may be a factor contributing to its growth. In ponds and impoundments, indicate the duration of any bloom and describe its appearance.

B Bulkhead - upright wall holding back soil and forming the shoreline, made of concrete, stone, wood or other material

Walls and other shoreline structures indicate areas where the shoreline has been altered. These structures may alter fisheries breeding habitat by eliminating shallow sandy areas used for nest building, especially where bulkheads are used to retain fill. Removal of overhanging vegetation associated with bulkhead construction can result in loss of fish resting and feeding areas and increase water temperatures.

Be sure to note if the shoreline structure is recent or still under construction. Approval from the RI DEM is needed for new walls, bulkheads and other streambank alterations under the RI Fresh Water Wetlands Act.

CB Channel blockage caused by either natural or man-made objects preventing navigation or rerouting of the stream flow.

Note the cause of the blockage, for example, a fallen tree or other object. Indicate whether the obstruction prevents all access, is an endangerment or merely an inconvenience.

Cl Cleared land with lawn or other low vegetation extending to the shoreline.

Any type of natural vegetation separating developed land, agricultural fields and lawns from surface water helps to protect water quality by catching sediment, absorbing nutrients and maintaining cooler water temperatures. Buffers of trees and dense woody shrubs provide the greatest protection as deep roots stabilize the shore and take up nutrients. Thick, unmowed grass is next best but mowed lawns are much more desirable than bare soil.

When mapping cleared areas, include any area where natural buffers are absent and where lawns extend to the waters edge. Indicate, if known, whether lawn chemicals are used. Absence of weeds and lush, green appearance suggests fertilizers and herbicides may be used. Watering, as indicated by green lawns in mid-summer, can also promote leaching of lawn chemicals to surface waters if excessive.

The RI Fresh Water Wetlands Act requires DEM approval for all land disturbance, including removal of vegetation, within a wetland and its required buffer. Minimum buffers under the Act are: 200 feet from a river 10 feet wide or greater; 100 feet from a river less than 10 feet wide; and 50 feet from a pond, marsh or other wetland.

If you find recent clearing or other disturbance within the DEM-specified buffers, look for signs of sedimentation, cloudiness, or other adverse effects. Report the exact location and the extent of clearing; whether or not DEM approval has been granted, if known; and if protective measures, such as hay bales are in place to minimize damage to nearby wetlands and surface water.

D Dump in or near water consisting of trash, organic matter such as grass clippings or fill such as sand or soil.

Describe the type and approximate amount of material dumped. If the dumping is recent and is either an eyesore or threat to water quality, report the exact location.

Dr Drain, ditch or other man-made open channel designed to convey water.

This category includes open drainage channels designed to carry stormwater as well as natural streams and drainage ways that have been channeled or otherwise altered to convey stormwater flows. If possible, specify the type of drain, such as highway storm drain, or the type of land use draining to it. If the drainage channel carries road runoff, specify whether it serves a State or local road.

E/S Eroded land adjacent to the shore, cutting of shoreline, or sedimentation in or near the water.

This general category includes any area where disturbed or poorly vegetated land is eroding and contributing sediment in or near a waterbody. It includes open or closed drains

that empty into surface waters and carry sediment, as evidenced by a scoured channel on shore or
deposit of sand or finer sediment in or near the water. Also includes areas receiving heavy use, such as public access areas where vegetation may be worn and streambanks destabili-zed.

If the erosion is due to new construction or other major alteration of the shoreline within the buffers established by the RI Wetlands Act, note the exact location and report to the local coordinator.

Fm Farmland erosion causing any degree of sedimentation or erosion in or near the water.

Include any active farmland such as mowed pasture or cultivated fields without naturally vegetated buffers that have the potential to contribute sediment or agri-chemicals.

L Litter scattered in water or on shore

Report the approximate amount of litter on data sheet #1. Concentrations of trash and debris should be listed as a dump (D) as noted above.

M Made land or filled shoreline

Shoreline areas that jut out unnaturally from the surrounding shore may consist of filled, or made land. It is usually located on developed land and used for a purpose, such as extending the amount of usable property or to improve access to the water. A retaining wall or rip-rap is often used to keep the fill in place. Older, well established areas of made land should be noted to indicate the extent of altered shoreline. If filling in or near the shore is recent, report the exact location to the local coordinator.

Small pockets of fill that seem to be primarily for disposal, rather than creation of useable land, may be classified as dumps (D).

Oil Multicolored surface film indicating presence of petroleum products which persists when disturbed. A metallic surface sheen may appear as the result of natural meta-bolic processes in wetlands, but breaks up with contact.

Look for surface oil sheens downstream of stormdrains, roadways and commercial/ industrial land. Report any spills that appear to be significant.

OR Animal waste adjacent to shore or potential organic pollution from waterfowl or animals.

Report shoreline areas where cows and horses have free access to the water; where small animals are penned or chained next to the water; and areas where waterfowl congregate due to feeding.

P Any pipe leading to or near the waters edge. On data sheet #2 specify:

1. Type - concrete, metal, plastic, clay or other material
2. Diameter
3. Presence of flow or odor
4. Erosion of shoreline or deposit of sediment in or near water
5. Excessive plant or algal growth
6. Source and purpose of pipe

If the discharge pipe carries highway storm drainage, specify the road(s) drained and whether it is a State highway or local road.

If the discharge is permitted under the RI Pollution Discharge Elimination System (RIPDES) list the discharge and look for signs of water quality degradation. Under DEM regulations these discharges must meet aesthetic criteria and be free from pollutants that settle to form objectionable deposits, float as debris or scum, or promote the growth of nuisance species. Most RIPDES discharges are in waters having a water use classification of C. Be aware of the point where the classification changes to B further downstream. Observe water quality conditions to determine if the discharge affects visual quality within either the Class C or B areas.

Information on determining the source of discharge from other, smaller pipes that may be found along the shore is included in section V of this manual.

PA Public access, either officially designated with parking or other access, including foot path, with evidence of general public use

Specify if the access point is publicly owned and maintained. If known, describe the type of use, such as canoe access, and whether use is heavy, moderate or light.

RR Riprap foundation or wall of stones placed irregularly or loosely

Riprap walls may also be considered bulkheads (B) as noted above. If the riprap is used for another purpose, for example, to stabilize steep slopes at highway embankments or to dissipate energy from stormdrains, specify the use.

St Stream flowing into or out of sampling area

Specify the name of the tributary, if known. If streams discharging to your site flow through developed land, look for unusual odors, water colors and signs of nutrient enrichment, as evidenced by excessive growth of algae and aquatic plants.

Sp Spring or other flow of water issuing from one spot and great enough to create a stream

Springs often form along the side or at the bottom of slopes, where ground water emerges at or near the ground surface. Due to the presence of standing water or high water table, a wetland may form in these areas. In areas with abundant springs and wetlands, groundwater may be a major source of flow to a surface water body.

SUD Suds greater than 3" high

Foam occurs naturally in surface waters as a result of humic substances and other by-products of plant decomposition that reduce surface tension and act as natural surfactants. Natural foam is usually off-white or tan, has an organic odor, and occurs in rapidly flowing water, especially below water falls and at the shore of wave-filled ponds. It also dissipates quickly in calm water and is generally lower than 3 inches thick, but not always.

Suds produced by detergents are generally whiter, may have an odor of perfume, may be thicker than 3 inches, and tends to persist in calm areas.

Wa Wetland or other wet area with water at or near the ground surface but without channeled flow

Wetlands are areas where the water table is at or near the ground surface for a sufficient period to promote the growth of wetland plants. Various types of wetlands are found adjacent to rivers and ponds (which are also wetlands) including: swamps - characterized by trees (often red maple), saplings or woody shrubs; marshes - with grass-like vegetation; bogs and fens - with low shrubs and grasses and quaking substrate; and low, flat areas adjacent to rivers, ponds and streams that are subject to flooding, known as floodplains.

Sediments and Aquatic Vegetation

The following descriptions are used for sediment and vegetation in the water

bd	boulder 10"
cb	cobble 1.5" - 10"
gr	gravel 1/8" - 1.5"
o	organic material such as leaves
sd	sand
st	silt or other mud
ve	Emergent vegetation
vs	Submerged vegetation

SECTION III

Reporting Results

A. On return to shore

After the survey is completed, make sure that all data sheets and maps are both legible and understandable. You may have to redraw the map and copy data sheets.

After one or two surveys you may find it useful to "customize" your base map by drawing in permanent features such as streams, houses and other land marks using available maps or your own survey results. If you are working with an older map or one that has been enlarged from a smaller scale you may also want to correct errors in shoreline configuration or roadway locations. Make several copies of your customized map for future surveys.

B. Reporting results to a local citizen's group

Send either a copy of your map and data sheets or the originals to the local coordinator, making sure the one you send is readable. Keep a copy of the each completed data sheet and map as a reference to take with you on repeat surveys. You will also need to keep extra copies of the base map for future surveys.

If you observed discharge of pollutants or possible violation of the Freshwater Wetlands Act or other State or local regulations, call the local coordinator as soon as possible. Be sure you can provide an exact description of the location so that it can be easily found by someone unfamiliar with the area.

Each watershed association or other local group has a policy for investigating problems identified in shoreline surveys. For example, in the Wood-Pawcatuck Watershed, the local coordinator or executive director will investigate the problem site with a member of the local Conservation Commission. Upon verification that a site requires attention, the local coordinator and Conservation Commission member will contact the landowner to discuss remedial measures. Violations are not reported to regulatory agencies except where repeated attempts to resolve the problem have failed and where there is a clear threat to public health or environmental quality.

Repeat surveys

A. When and what to look for

Once you have completed the initial survey, it is important to monitor the segment periodically. Checking the site once each in spring, summer, and fall will provide a good picture of the segment under a range of environmental conditions. The best time for the survey will depend on what you are searching for. If you are concerned about failing septic systems, try to time your survey when systems are most likely to malfunction. Periods of high water table occur in late fall and early spring when rainfall is abundant. This is the best time for spotting evidence of overland flow of septic seepage. If excessive pond vegetation is a problem, the best survey time is late summer, when maximum growth of aquatic vegetation is reached.

If you are curious about pipes in your segment that appear to be dry at every survey, try checking for flow immediately after a heavy rain to determine if it is a stormwater drain. Discharge during periods of high water table or after a rainstorm when other stormdrains have stopped may indicate groundwater or perched water table drainage. Try to determine the source of a discharge using the information listed in section V before reporting the discharge to your local coordinator.

B. Reporting results

Take a copy of the original completed survey map and data sheets on the repeat survey as well as a clean base map and data sheets. Note only changes in water quality or shoreline features from the original survey on the clean data sheets and base map.

Fill out new data sheets 1 and 2 and send them, with a copy of the revised map, to the local coordinator. Or, if there is little or no change from the original survey, you may fill out a shoreline survey report post card and send it to the local coordinator instead of a revised map and data sheets.

C. Other types of surveys

The visual survey, as described in this manual, is the simplest of survey methods. This is an advantage when surveying a large river system or a number of lakes and ponds but the information collected is not quantitative. Depending on your goals you may find you have plenty of work just dealing with the problems and land use conflicts identified by the first survey(s). Or, you may want to obtain more precise information through specialized surveys. These specialized surveys include biological surveys of aquatic insects and other organisms known as macro-invertebrates, physical stream measurements, and water quality monitoring.

Using macro-invertebrate surveys, small aquatic organisms living in sediments, under rocks, or attached to sticks and other submerged object are collected and identified. The type, abundance and variety of organisms found can indicate the general health of a water body. Since macro-invertebrates such as insects, clams and worms can't escape pollution inputs they reflect something of past water quality conditions as well. The equipment and training needed for volunteers to conduct macro-invertebrate surveys is minimal.

Physical surveys are used to determine stream flow through measurement of stream width, depth and water velocity. Repeated measurements are taken to develop a relationship between stream level and discharge. This information is used to predict natural fluctuation in water levels and to estimate the relative contribution of flow to an area from various sources. Together, water quality monitoring and stream flow data are used to determine the relative contribution of nutrients to a site from various sources, known as a nutrient "budget".

The most precise water quality measurements are obtained through water quality sampling. Monitoring of physical, chemical and biological water quality parameters gives the most objective measure of water quality, but results only indicate conditions at the time of sampling. For this reason, frequent sampling is required to obtain an accurate estimate of

conditions. Simple water quality measurements can be conducted by volunteers, either independently or as part of the Watershed Watch monitoring program. The training and equipment costs are highest with
this method; however, if sampling is carried out with good quality control procedures, the resulting data is likely to be more useful to State water quality managers than visual or biological sampling alone.

Visual surveys used together with specialized surveys provide the most complete picture of the health of a stream or pond. Although not included in this manual, information on conducting biological surveys of macro-invertebrates, physical stream surveys, and water quality sampling is available from Watershed Watch.

Table 2

Sources of Information for
Watershed Inventories

Feature	Use	Source
Hydrology		
USGS Topographic quadrangle map	Determine drainage patterns and features; base map for Watershed	Sporting goods stores; RI Map Center or other map store
Watershed boundary map	same	RI DEM Office of Environmental Coordination
Physical characteristics and water quality of lakes and streams		
Bathymetric maps	By showing depth contours, provides information on physical characteristics influencing water quality	Guthrie, R.C and Stolgitis, John A. 1977. Fisheries Investigations and Management in RI Lakes and Ponds. RI DEM Div. of Fish and Wildlife.
RI Water Quality Standards and existing conditions	Determine state water quality goals for a waterbody and its present condition, if different	RI DEM, Div. of Water Resources
Water quality sampling and flow Water data	Evaluate present or past water quality condition	- Watershed Watch, - RI DEM, Div. of Resources - US Geological Survey (USGS)

Feature	Use	Source
Land Use		
Aerial photographs	Identify or update land use; locate drainage features	RI Dept. of Adm., Div. of Planning
Local plat maps and tax records	Identify patterns of land subdivision and potential for new development on existing lots; land ownership	Town or City Hall, Tax Assessors Office
Zoning maps	Determine maximum potential for new development	Same as above
Land use maps	Identify land use at time of mapping	- RI Dept. of Adm., Div. of Planning (1975 land use) - URI Dept. of Natural Res. Science (DNR) Geographic Information System (GIS) Office. (Completion of 1988 land use scheduled for 1990)
Public Utilities		
Road and urban drainage system maps	Locate areas served by stormdrains and points of discharge to surface waters	Town or City public works department
Public water and sewerage maps	Locate existing and proposed sewer and water lines in the study area	Town or city public works department
Public wells	Locate critical ground water resources	RI DEM, Div. of Groundwater & Freshwater Wetlands
Natural Features		
RI Soil Survey maps and soil descriptions	Identify soil types; limitations for development; and relative importance of ground vs. surface water flow	USDA Soil Conservation Service

Feature	Use	Source
Groundwater Aquifer recharge area maps; groundwater quality classifications	Evaluate relation between surface and groundwater resources and potential for contamination of groundwaters	RI DEM, Division of and Groundwater and Freshwater Wetlands
Freshwater Wetland maps - National Wetland Inventory maps and other local maps	Determine boundaries of freshwater wetlands	- RI DEM, Div. of Groundwater and Freshwater Wetlands - Some municipalities may have more accurate mapping
Pollution Sources		
Discharges to surface waters and groundwater including: - RIPDES and other surface water discharges - industrial waste lagoons and seepage pits - salt storage sites - solid waste landfills - hazardous waste landfills - sludge landfills - underground storage tanks	Evaluate existing and potential sources of pollution to streams and ponds	RI DEM, Div. of Water Resources or RI DEM, Div. of Groundwater and Freshwater Wetlands

Using Survey Results to Protect Water Quality

Once surveys are completed and returned to the local citizen's group the real work begins. Most groups establish policies for dealing with urgent problems, ranging from quiet negotiation with individual landowners to tiered procedures for reporting violations to local and State authorities. Unless your section is highly urban, urgent problems requiring immediate attention are likely to be the exception, not the rule. Instead, surveys will probably reveal more complex situations that will require you to devise creative protection strategies. For example, acquisition of development rights may be the only effective way to permanently protect scenic recreational shorelines. In areas where changing land use has the potential to affect both water quality and scenic character, it may be necessary to work with local governments to establish appropriate regulations for watershed land use. In urban areas the first step might be to reverse negative public perceptions about the waterbody through publicity and enhancement of its scenic and recreational characteristics.

Whether your interest is in an urban river system or a pristine lake, one of the simplest and most effective ways to protect the waterbody is to build support among those who live near or use the resource. Unless your neighbors have spied you maneuvering along the shoreline, clipboard in hand, no one may be aware of the survey or its results. Begin by collecting names and addresses of landowners in your study area. Those you don't know personally can be obtained at the local tax assessor's office. Landowner names are usually shown on plat maps, with the address cross-referenced in a separate listing.

Once you have compiled a mailing list, start a public awareness campaign. Tell landowners about the survey and about your group. Invite them to participate and to join your organization. After you have had an opportunity to review completed surveys send them a summary of results and describe your plan to protect the waterbody. Fact Sheets produced by the Department of Natural Resources Science on septic system maintenance, lawn care and other water quality management topics can be included.

Later, if there is interest, schedule a neighborhood meeting to present more information on cooperative methods landowners can take to collectively protect water quality, such as setting up a voluntary septic system maintenance program or planting vegetative buffers. Invite speakers from other watersheds that have organized successful water quality protection projects.

The same strategy can be used to help protect tributary streams. Since most tributaries will have to be investigated on foot, a list of streamside landowners will be needed to secure permission for access before conducting surveys.

The "Adopt a Stream Workbook, How to Protect Your Favorite River, Stream or Brook" by the Massachusetts Adopt-A-Stream Program (listed in Appendix B) suggests numerous activities local groups can undertake to protect water quality. This manual also has a wealth of information on setting goals, strengthening your organization, and making effective use of volunteers. There is also an extensive list of useful references.

Since water quality of a river or lake is a product of the watershed as well as the adjacent shoreline, you may eventually find it necessary to expand your efforts to include the complete watershed. Sources of information that can be used to characterize the land area draining to your site are listed in Table 3. Even if members of your group are already familiar with the land use, zoning and other characteristics of the watershed it is useful to compile the information in map form. This type of visual inventory can be used to illustrate the relationship of natural features and land use to water quality for the benefit of new members and those outside your group. If you are interested in assessing the amount of nutrients contributed from various parts of the drainage area, a land use inventory of the watershed is essential.

The local planning department may already have compiled much of this information, including a "build-out" analysis which projects the maximum development potential under existing or proposed zoning. The RI Division of Planning and the DEM Division of Water Resources may also have prepared land use or water quality management plans, respectively, for your area.

Interpreting Shoreline Survey Findings

A. Natural Characteristics of RI Lakes and Rivers

To best interpret shoreline survey observations it is important to understand the natural characteristics typical of RI lakes and rivers. Most RI lakes and ponds are small, shallow, and poorly flushed due to low topography and soil conditions. Many are man-made, having been constructed for mechanical hydropower or water supply during the industrial era. Of the state's 357 fresh water lakes, only 74 cover an area greater than 50 acres. The large majority, 240, are less than 24 acres in size.

Shallow depth, small size and slow flushing rate means these waterbodies are highly susceptible to nutrient enrichment, or eutrophication. Eutrophication is a natural "aging" process by which lakes and ponds gradually shift from deep, clear, nutrient-poor waters with little algae and aquatic plants to shallow, nutrient-rich systems with abundant aquatic plants. Oligotrophic, or nutrient-poor lakes are generally associated with pristine water quality. As nutrients are supplied to a lake from the surrounding watershed, growth of algae, small single-celled plants that occur floating throughout the water column or attached to submerged objects, become more abundant.

Proliferation of free-floating, or planktonic algae manifests itself in discoloration or darkening of the water, with hues ranging from yellowish-brown to shades of green. This mass growth of algae, known as a "bloom" may also result in floating "scum". This happens most often with blue-green algae, which float to the surface in competition for light. Early in the morning, when light intensity is low, floating algae may be visible in poorly flushed areas. As the sun becomes stronger during the day, the algae may descend below the surface, where mid-day light is sufficient for photosynthesis.

The reduced clarity and scums associated with algal blooms can be unpleasant enough. But the most detrimental effects occur when the rapidly growing algal population can no longer sustain its "wild" growth rate. This usually happens when available nutrients are depleted or other adverse environmental conditions prevail. The result is a population crash – a mass die-off of algae. The algae settle to the bottom of the lake and decompose, using oxygen in the process. In a deep, stratified lake this promotes or contributes to an oxygen deficit in the bottom waters. In shallow lakes, it can lead to fish kills if other aquatic plants are unable to photosynthesize and produce more oxygen to compensate for that used in decom-position of dead algae. In shallow lakes, the greatest oxygen stress occurs early in the morning, before light intensity is great enough for photosynthesis, and during periods of prolonged cloudiness.

Over the long term, repeated algal blooms contribute to eutrophication of a lake. The organic matter deposited at the bottom of the waterbody creates a source of nutrients that can be recycled back into the water column, thereby perpetuating the cycle of algal blooms, die-off and decay, and release of nutrients back into the water column. Physical build-up of organic matter, along with mineral sediments that may wash into the lake gradually fill the lake, reducing depth. Shallower depths reduce the basin's capability to decompose organic material without an oxygen deficit while shoreline areas become more susceptible to invasion by aquatic plants.

As eutrophication proceeds, aquatic vegetation become more abundant. Submerged vegetation normally appears first, then floating plants such as the waterlily. These forms may invade water as deep as 20 feet, especially in poorly flushed areas. Closer to the shore, at depths of less than 3 feet, emergent plants with roots in the water but leaves extending above the surface, eventually dominate. Over time the lake gradually fills with sediment and organic matter from decaying vegetation until it is filled with vegetation.

Rivers do not "age" in the same sense that lakes and ponds do but they are affected by inputs of sediment, nutrients and other pollutants. Like the state's ponds and lakes, most rivers have been dammed in numerous locations for hydropower or industrial processes. These alterations, often combined with a long history of waste discharges and relatively low flow to dilute wastes, makes RI rivers naturally susceptible to degradation. Inputs of sediment to rivers and streams further reduce depth and channel capacity, resulting in increased flooding, streambank scouring and loss of fish habitat. Nutrients promote growth of attached algae and allow floating algae and rooted plants to dominate poorly flushed areas.

Sediment deposited in a stream often carries attached nutrients, metals and organic chemicals that are toxic in small quantities. In rapidly flowing river sections, this sediment can be periodically re-suspended resulting in internal recycling of these pollutants. In sections with sluggish flow, especially behind river impoundments, organic-rich sediments can build up and consume oxygen in the overlying water as organic material in the sediment decomposes. Depletion of oxygen to the point where fish are unable to survive is primarily a problem where sediment accumulates behind dams and in the summer, when warm temperatures naturally limit the amount of oxygen that can be dissolved in water.

B. Types of Pollution

Given the natural vulnerability of RI's lakes and rives to degradation, it is important to protect these waterbodies from additional pollutant loading whenever possible. There are several types of pollutants that commonly affect water quality. These include: sediment; organic matter; nutrients, of which phosphorus is the most important and nitrogen to a lesser extent in fresh water; pathogens; organic chemicals that are toxic to aquatic organisms in small quantities; and thermal, or heat energy. Sources and effects of these pollutants are summarized in Table 2.

Table 3
Types of Pollution

Sediment

Source - sand, silt or other mineral material from disturbed land including construction sites, agricultural land, urban areas, sand and gravel pits and roads; often conveyed by stormwater runoff

- scouring of streambanks resulting from stormwater discharge to streams

Effect - increases turbidity

- clogs fish gills, smothers fish eggs and other aquatic organisms; alters habitat

- fills streams, thereby reducing storage capacity and increasing flooding; reduces depth of ponds and decreases volume of oxygenated water available to dilute waste and decompose organic matter

Organic Matter

Source - leaves, grass clippings and other plant material or animal waste from agricultural and residential land use

- some industrial wastes

Effect - consumes dissolved oxygen during decomposition, as measured by biochemical oxygen demand (BOD), required by fish and other aquatic organisms

- releases nutrients following decomposition

Nutrients - nitrogen and phosphorus

Source - on-site sewage disposal systems

- agricultural and residential fertilizers

- animal and waterfowl wastes

- soil particles carried by storm water runoff

- industrial and municipal discharges

Effect - excessive growth of algae and aquatic plants; reduced oxygen with respiration and decomposition of algae and plants

Pathogens - bacteria and viruses as indicated by total and fecal coliforms

Source - wastewater from septic systems and boats

- municipal treatment plants

- animals and waterfowl

Effect - health threat in drinking water supplies and shellfishing and swimming areas

Toxic Substances - Volatile organic compounds (VOC) such as solvents, metals, hydrocarbons or highly acidic waste

Source - industrial discharges

- spills or improper disposal from industrial and commercial land uses

- household hazardous materials, particularly septic system additives

- pesticides and herbicides

- landfills

Effect - chronic or lethal effect to aquatic organisms; bio-accumulation higher in food chain

Thermal Energy

Source - industrial cooling water discharges

- removal of streambank vegetation

- reduction in baseflow resulting from increased runoff and reduced infiltration with development

Effect - loss of habitat for cold water fish

C. Identifying the Source of Pollutants

Pollutants enter surface waters from direct discharges such as industrial and municipal wastewater treatment facilities and by so-called "non-point" sources. Non-point sources are discharges that do not have a well-defined point of origin and which often enter surface waters at numerous and diffuse locations. Typical non-point sources of pollutant include: stormwater runoff from highways and developed land; on-site sewage disposal systems; fertilizers, pesticides and herbicides used on lawns and gardens; sediment from new construction; and agricultural runoff. Industrial discharges to groundwater, underground storage tanks, landfills, and highway salt storage sites may also contaminate groundwater locally, and in turn, affect surface water.

The direct or point source discharges are major sources of pollution but they are relatively few in number. Most empty into rivers or to Narragansett Bay. At first glance the non-point sources appear to be diverse and unrelated but all result from human alteration of watershed land. All increase pollutant loading to surface waters in the same way - by increasing impervious area, increasing stormwater runoff, and by allowing water-borne pollutants to reach surface waters faster, without the benefit of filtration or uptake by soil or vegetation.

In forested environments most rainwater is absorbed or temporarily stored in the forest litter and soil. It is then slowly released to surface waters by movement through soil or groundwater. This absorption and slow release promotes retention of sediments and nutrients that might be in the water before it reaches surface waters.

With development, the natural filtering function of well-vegetated land is lost. Rainwater quickly rushes over asphalt surfaces, packed gravel driveways and crusted farm fields, carrying a load of sediment, nutrients and other pollutants to the nearest watercourse. Individually, each house lot, roadway and drainage channel may be inconsequential but too much development exceeds the limited capacity of freshwaters to attenuate these pollutants. The cumulative effect is a change in water quality.

Although land development and related stormwater runoff is one of the major causes of poor water quality in lakes and rivers, specific sources such as on-site sewage disposal systems and fertilized lawns can aggravate the problem when improperly designed or managed. Common sources of pollution that may be encountered on a shoreline survey are described below, with information to help determine whether action is needed to reduce pollutant inputs.

1. Septic systems

Location: Septic tanks are generally 5-10 ft. from the house foundation, with leaching lines or galleys extending into a generally level area 5-10 ft. from the tank. The leaching area may be slightly raised from the surrounding land, especially in high water table areas. State standards require a 50 foot buffer from the system to a pond or wetland; 100 feet to a river less than 10 feet wide and 200 feet to a river greater than 10 feet wide.

Septic system failure is evidenced by:

1) Lush, green grass due to ponding of effluent at the root zone, providing moisture and nutrients

2) Dead grass over the leach field due to extended saturation at the surface or at the root zone. In the latter case, re-growth does not usually occur immediately after the ponding subsides. In dry summers, grass directly over septic systems may turn brown before the rest of the lawn, clearly outlining the system; this may be due to backfilling with coarser material at the time of construction and is not evidence of failure.

3)Wastewater visibly ponding at the ground surface, often accompanied by odors

4) Seepage of effluent down grade from leaching area at a sideslope, streambank, roadcut or other change in grade.

2. Lawn Fertilizers

Watch for cleared land with lawns extending to the waters' edge without a buffer of natural vegetation. Heavily fertilized and watered lawns present the greatest risk of nutrient flow to nearby waterbodies.

3. Pipes and Drains

Stormwater drains - Most pipes leading to the waters edge carry storm water runoff and do not require pollutant discharge permits. These vary in design but are often concrete and commonly 12 to 24 inches in diameter. The source of the discharge may be apparent from observing the natural topography or road grade. Otherwise, maps of the drainage network, at least for more recent road improvements and urban development, may be reviewed to determine the sources. These are available at local Public Works Departments. Storm drains carry sediment and runoff pollutants. Sanitary sewers are sometimes illegally connected to storm drains, especially in areas of high water tables where septic system failure is common. For this reason, dry weather discharges from storm drains should be investigated.

Subdrains or tile drains are installed below ground to carry perched water from fields or developed land. These generally consist of 4 inch diameter perforated plastic or clay pipe. Discharge occurs during periods of high water table, which is highest in the early spring. By improving soil aeration, subdrains can promote leaching of nutrients that were formerly insoluble in the reduced state. These discharges can therefore carry elevated levels of nutrients, especially if constructed as curtain drains to lower groundwater levels adjacent to septic systems.

Industrial discharges to surface waters are regulated under the DEM RI Pollutant Discharge Elimination System (RIPDES) permit program. Characteristics of industrial discharges vary but such wastes may be discolored, have a distinct odor or raise temperature of the stream. Since industrial discharges may contain substances that are toxic in small quantities, direct contact with suspect waters should be avoided.

Other discharges from industrial or commercial development may include spills or improper disposal of oil or other wastes through floor drains. This is particularly common in automobile repair shops and old mills located adjacent to rivers. Stormwater runoff from commercial and industrial sites where oil or other hazardous materials are stored also creates the potential for direct discharge of waste to surface waters.

Miscellaneous - In residential areas, pipes leading to the waters edge could serve a variety of purposes. Although direct wastewater discharges cannot be ruled out, such flagrant violations are not common. Plastic PVC pipes, either 2 or 4 inches in diameter are most often suspect. Pipes that appear to be direct wastewater lines but never seem to flow may be abandoned sewer pipes which have been disconnected upon upgrading of the system. Likewise, pipes in industrial areas may fall into this category as well. If possible, these should be removed to avoid any possibility that they might be used again.

Small diameter, flexible tubing is commonly used to carry grey water discharges from washing machines. Often these discharges are allowed to flow over grassed areas. This is preferable to direct input to surface waters, but still a cause for concern since detergents often contain phosphorus, the primary nutrient causing eutrophication. These discharges may also indicate an attempt by the homeowner to avoid or delay hydraulic overload where the septic system is malfunctioning.

During periods of high water table or following heavy rain discharge, sump pump discharges may be apparent. These often consist of steady or pulsed flow from flexible piping. These are not a concern except that wet basements due to high water table may also be accompanied by septic system failure.

Finally, some small drain pipes or flexible tubing may be intake pipes for lawn or garden irrigation. This is almost certainly the case if the pipe end is screened. There are no regulations prohibiting water withdrawal provided fisheries habitat or other use of the waterbody is not affected. Large hoses and pumps for agricultural irrigation can lower water levels in a stream or pond to the point where fisheries habitat or nutrient flushing is affected. For this reason, water levels should be monitored during extended dry periods when agricultural water withdrawal is heavy.

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APPENDIX A:

GLOSSARY OF TERMS

Anoxia:
A condition of no oxygen in the water. Often occurs near the bottom of eutrophic, stratified lakes in summer; under ice in winter.

Algae:
Green plants that occur as microscopic forms suspended in water (phytoplankton), and as unicellular or filamentous forms attached to rocks and other substrates. About 15,00 species of freshwater algae are known.

Algal bloom:
A sudden increase in the abundance of suspended (planktonic) algae, especially at or near the water surface, producing a green scum or a "pea-soup" appearance.

Biomass:
The weight of biological matter

Brown water lakes:
Lakes which are naturally rich in humic (organic) materials derived from plants, giving the water a "tea" color; "stained" lakes.

Chlorophyll:
Green pigments found in plants which is necessary for photosynthesis; may be utilized as an indicator of algal population levels.

Cultural eutrophication:
The accelerated enrichment of waters due to the activities of man, such that they support a higher amount of plant and animal matter than they would naturally.

Ecosystem:
A community of plants and animals interacting within the physical and chemical environment.

Eutrophic:
A term used to describe very productive or enriched lakes. These lakes tend to exhibit some or all of the following characteristics: an abundance of rooted plants; turbidity due to high algal populations; loss of oxygen in bottom waters during the summer months; rapid accumulation of soft bottom sediments; and abundant fish, which may include stunted and/or rough species in the most fertile lakes.

Eutrophication:
A gradual increase in the productivity of a lake ecosystem due to enrichment with plant nutrients, leading to changes in the biological community as well as physical and chemical changes. This is a natural process, but can be greatly accelerated by man (see cultural eutrophication)

Flushing rate:
The number of times that the total volume of water in a lake is replaced in a year by inflowing streams, groundwater, precipitation, and overland runoff.

Epilimnion:
Uppermost, warmest, well mixed layer of a lake during summertime thermal stratification. The epilimnion extends from the surface to the thermocline.

Habitat:
The place where a plant or animal lives, which has all of the conditions necessary to support its life and reproduction.

Hypolimnion:
Lower cooler layer of a lake during summertime thermal stratification

Mesotrophic:
A term used to describe lakes which are moderately productive. These lakes tend to exhibit some or all of the following characteristics: moderate growth of rooted plants and algae; some loss of oxygen from bottom waters during the summer months; some sediment accumulation; relatively good fish production of cool or warm water species, such as walleye, perch, bass, pike, and panfish. Most lakes are placed in this category.

Metalimnion:
The layer of rapidly changing temperature and density which separates the hypolimnion from the epilimnion.

Nitrogen:
An element necessary for the growth of the aquatic plants; may be found in several forms including nitrates, nitrites, and ammonia.

Nutrient:
Any of a group of elements necessary for growth. Although over 15 elements have been identified as necessary for growth of aquatic plants, most are readily available in natural waters. Supplies of phosphorus or nitrogen may be depleted, however, thus limiting plant growth in surface waters.

Oligotrophic:
A term used to describe a relatively unproductive lake or one poorly supplied with plant nutrients. Because of low biological production, these lakes tend to exhibit some or all of the following characteristics: clear waters; limited growth of algae or rooted plants; bottom waters well supplied with oxygen throughout the year; low rate of sediment accumulation; low fish production, but often of desirable species, such as trout, walleye, or perch.

Plankton:
The community of micro-organisms, consisting of plants (phytoplankton) and animals (zooplankton) inhabiting open-water regions of lakes and rivers.

Phosphorus:
An element necessary for the growth of aquatic plants. It is naturally present in low concentrations, and lack of phosphorus often limits plant growth. Addition of phospho-

rus can affect water quality by increasing the production of algae and rooted plants.

Producers:
Green plants that manufacture their own food through photosynthesis.

Productivity:
The amount or mass of living things which can be supported by an ecosystem (e.g., a lake) over a specified period of time.

Photosynthesis:
Conversion of water and carbon dioxide in the presence of sunlight to carbohydrates.

Secchi disk:
A simple device widely used to measure the transparency or clarity of water, consisting of metal or plastic plate, usually 8" in diameter, painted black and white, on a calibrated line.

Secchi depth transparency:
The depth at which a Secchi disc disappears from view when lowered into the water. A measure of water clarity.

Sediment:
Solid material including both soil particles and organic matter which is suspended in the water and gradually deposited in the bottom of lake.

Standard deviation:
A statistical term used to describe the amount of variation in a set of data; 68% of all measurements are expected to fall within plus- or minus-one standard deviation from the mean (average).

Thermocline:
A horizontal plane of water across the lake through the point of greatest temperature change. It is within the metalimnion.

Trophic state:
The level of productivity in a lake, or degree of eutrophication; generally described as eutrophic (very productive).

Trophic State Index (TSI):
A numerical scale used to classify lakes according to productivity (the amount of living material supported by the lake). The TSI value (0-100) is calculated directly from Secchi depth transparency, phosphorus, concentration, or chlorophyll a concentration.

Turbid:
Cloudy, not clear.

Watershed:
A drainage area or basin; all land and water areas which drain or flow toward a central collector, such as a stream or a lake, at a lower elevation.

APPENDIX B:

Resources

Freshwater Ecology

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Rhode Island Watershed Watch Monitoring Results 1989 Report. 1989. Linda T. Green, Room 210B Woodward Hall, Department of Natural Resources Science, University of Rhode Island, Kingston, RI 02881. (401) 874-5209.

Save our Streams Stream Quality Survey and other publications on citizen monitoring. Izaak Walton League, 1701 N. Fort Myer Drive, Suite 1100, Arlington, VA 22209. (709) 528-1818.

Water Resources Protection

Adopt A Stream Workbook, How to Protect your Favorite River, Stream or Brook. Adopt-A-Stream Program, Massachusetts Department of Fisheries & Wildlife, 100 Cambridge Street, Room 1902, Boston, MA 02202. (617) 727-6278.

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