Chapter 2 - Designing your Water Study

Identifying Your Watershed

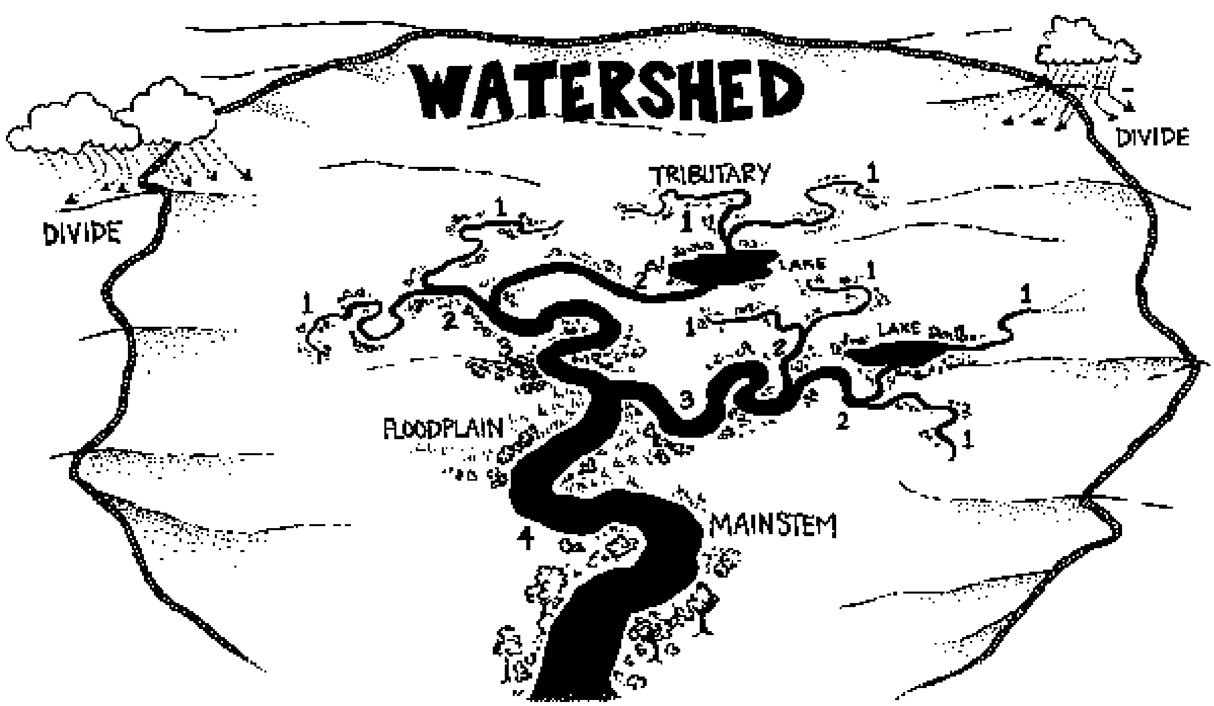
The first step in developing a water study design is identifying your watershed. The watershed is the total area of land that drains into a particular waterbody (wetland, stream, river, lake, or sea).

Land uses and runoff in a watershed determine the quality of surface water in smaller streams and waterways and can then influence the water quality of larger streams.

The ability of a stream to support beneficial uses such as fishing, boating and swimming is influenced by the major land uses in the watershed, the nature of the stream channel, the diversity of instream habitats, and the character of the riparian area.

Approximately one percent of a watershed is stream channels. The smallest channels in a watershed have no tributaries and are called first-order streams. When two first-order streams join, they form a second-order stream. When two second-order streams join, a third order stream is formed, and so on. First and second-order channels are often small, steep or intermittent. Stream orders that are six or greater constitute large rivers.

The stream channel is formed by runoff from the watershed as it flows across the surface of the ground following the path of least resistance. The shape of the channel and velocity of flow are determined by the terrain, unless changes have been made by man. When the terrain is steep, the swiftly moving water may cut a deep stream channel and keep the streambed free of sediments. In flatter areas, the stream may be shallow and meandering, with a substrate comprised largely of fine sediments.



What is Water Pollution and Where Does it Come

One reason many volunteers choose to monitor is concern about pollution impairiming water bodies. Volunteers can monitor for current pollution and develop a baseline to gauge future pollution.

Water pollution can typically be placed in one of two categories, point or nonpoint source pollution. Point source pollution is easy to identify because it is discharged from the end of a pipe. It accounts for about 25% of all water pollution. Point sources are regulated by permits issued from the Ohio Environmental Protection Agency (for more information http://www.epa.state.oh.us/).

Nonpoint source pollution originates primarily from runoff and is more difficult to identify. It can be defined as polluted run-off from land and makes up about 75% of water pollution. Different types of pollution are described below and shown in the figure below.

Point sources are indicated by a "P"; nonpoint sources are "NP."

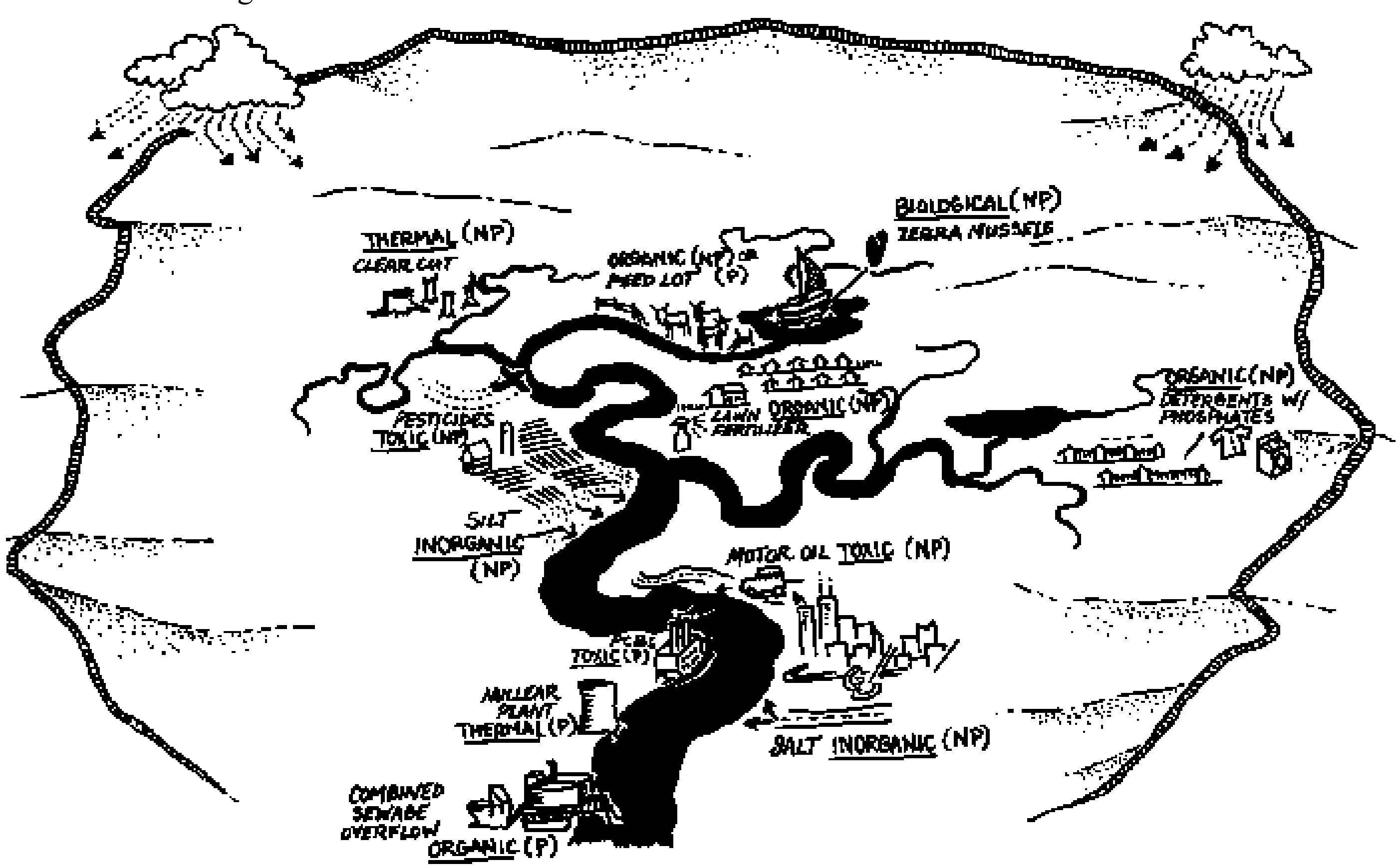
1. **Organic Pollution** - decomposition of once-living plant and animal materials

2. **Inorganic Pollution** - suspended and dissolved solids (e.g. silt, salt, minerals)

3. **Toxic Pollution** - heavy metals and lethal organic compounds (e.g. iron, mercury, lead, PCB's) - some of these are transferred via the atmosphere and air deposition

4. **Thermal Pollution** - heated water from runoff (e.g. streets, parking lots) or point source discharges (e.g. industries, nuclear or other power plant discharges)

5. **Biological Pollution** - introduction of non-native species (e.g. zebra mussels, purple loosestrife, Eurasian Water Milfoil).



What is Your Watershed Address?

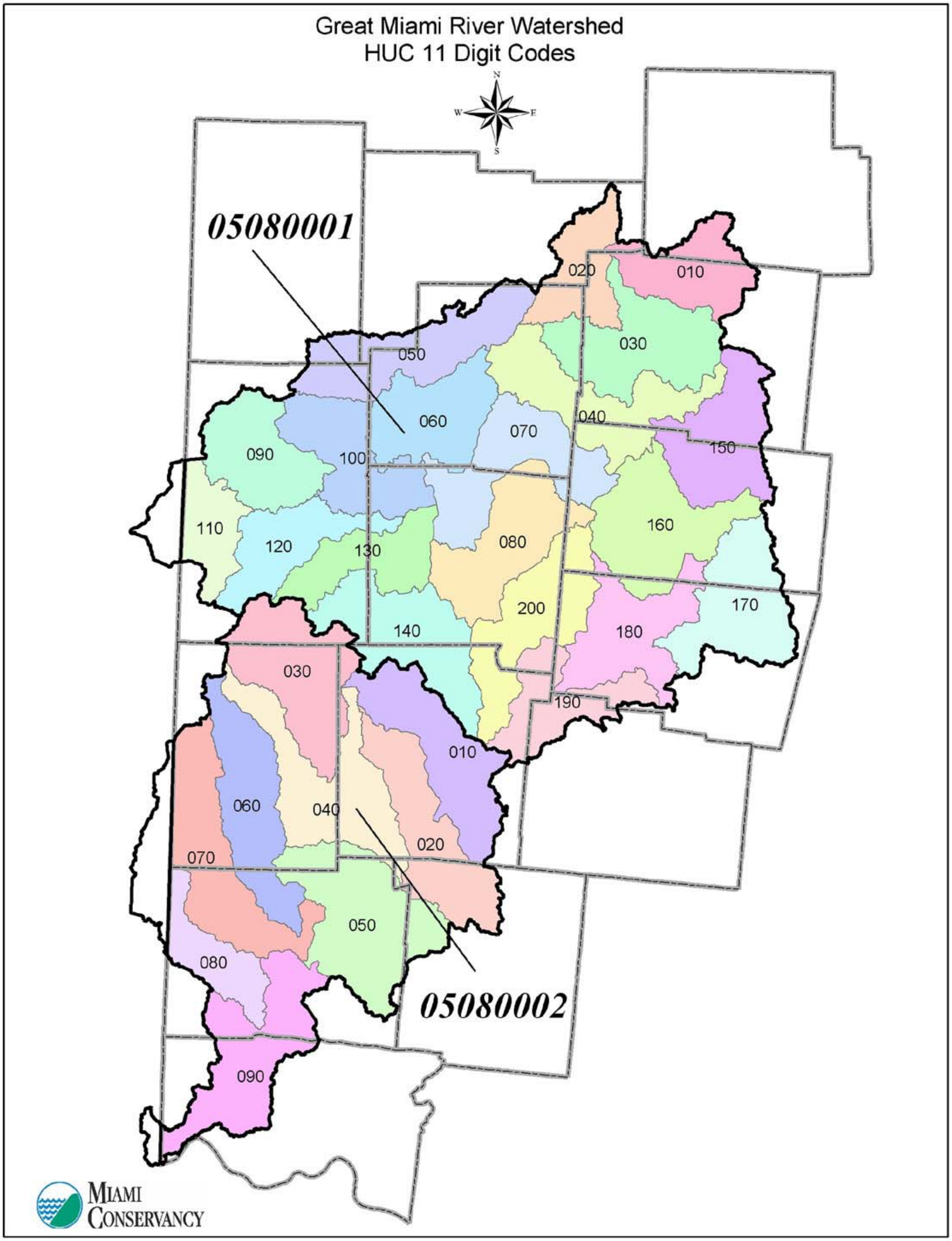
The Miami Valley Stream Team organizes data from volunteer stream monitors by watershed location using the 11- Digit Hydrologic Unit Code Areas delineated by the U.S. Geological Survey. Hydrologic unit codes (HUCs) represent the geographic boundaries of water as it flows across the landscape. The Ohio Environmental Protection Agency also uses this watershed scale to organize official data from Ohio's surface water quality studies.

As you can see from the map on the following page each watershed name also has an associated 11-digit number. This number is representative of the size of the watershed. The two largest watersheds - the Upper Great Miami and the Lower Great Miami are represented by 8-digit numbers.
Knowing your "watershed address" is important to understanding the influences on the water quality in your stream or river.

Both your watershed name <u>and</u> 11-digit # are <u>required</u> on all Stream Team data sheets.

Check the map on the following page and write your watershed address here:

Watershed Name: ____
Watershed # __ __ __ __ __ __ __ __


Great Miami River Watershed
HUC 11 Digit Codes
N
W
E
S
05080001
020
010
030
050
060
070
040
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090
100
160
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120
130
080
170
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180
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190
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070
050
080
05080002
090
MIAMI CONSERVANCY

Great Miami River Watershed

The Great Miami River Watershed is located in the southwest portion of Ohio. Major tributaries of the Great Miami River include the Stillwater River (676 mi^2) and the Mad River (657 mi^2), both of which join the Great Miami River at Dayton, Ohio. The total drainage area of the Great Miami River watershed in Ohio is 4,124 square miles. The Great Miami River Watershed includes all or part of 15 counties with its headwaters in Hardin and Auglaize counties and the mouth in Hamilton County where it drains to the Ohio River.

Dayton, with a population of 190,000, is the largest city within the watershed. Other major cities within the watershed exceeding 50,000 population include Springfield, Hamilton, and Middletown. Cities with more than 20,000 people include Piqua, Troy, and Fairfield. Each of these major population centers is located directly adjacent to one of the streams or rivers in the watershed.

Approximately 79 percent of the total land area is used for agricultural activities, primarily row-crop production of corn, soybeans, and alfalfa. Residential, commercial, and industrial land uses comprise 13 percent of the area whereas the remaining area consists of forests (7 percent) and water bodies or wetlands (1 percent). Major industries, which are concentrated along the Dayton- Cincinnati corridor, produce automobile parts, business and computer equipment, chemicals, household goods, paper products, and processed foods and beverages.

Surface Water

There are 2,360 miles of rivers and streams in the Great Miami River Watershed. Major tributaries include the Great Miami River, Mad River, Loramie Creek, Twin Creek, and the Stillwater River, which is designated as a State Scenic River.

Water quality in the rivers and streams has shown strong improvement since the passing of the Clean Water Act in 1972. The following table shows the number of stream miles that meet water quality standards of the stream miles that have been monitored by the Ohio EPA:

Fully attain standards	427.3
Partially attain standards	309.5
Non-Attaining of standards	285.3
Threatened	40.3
Total Miles Monitored	**1063.0**

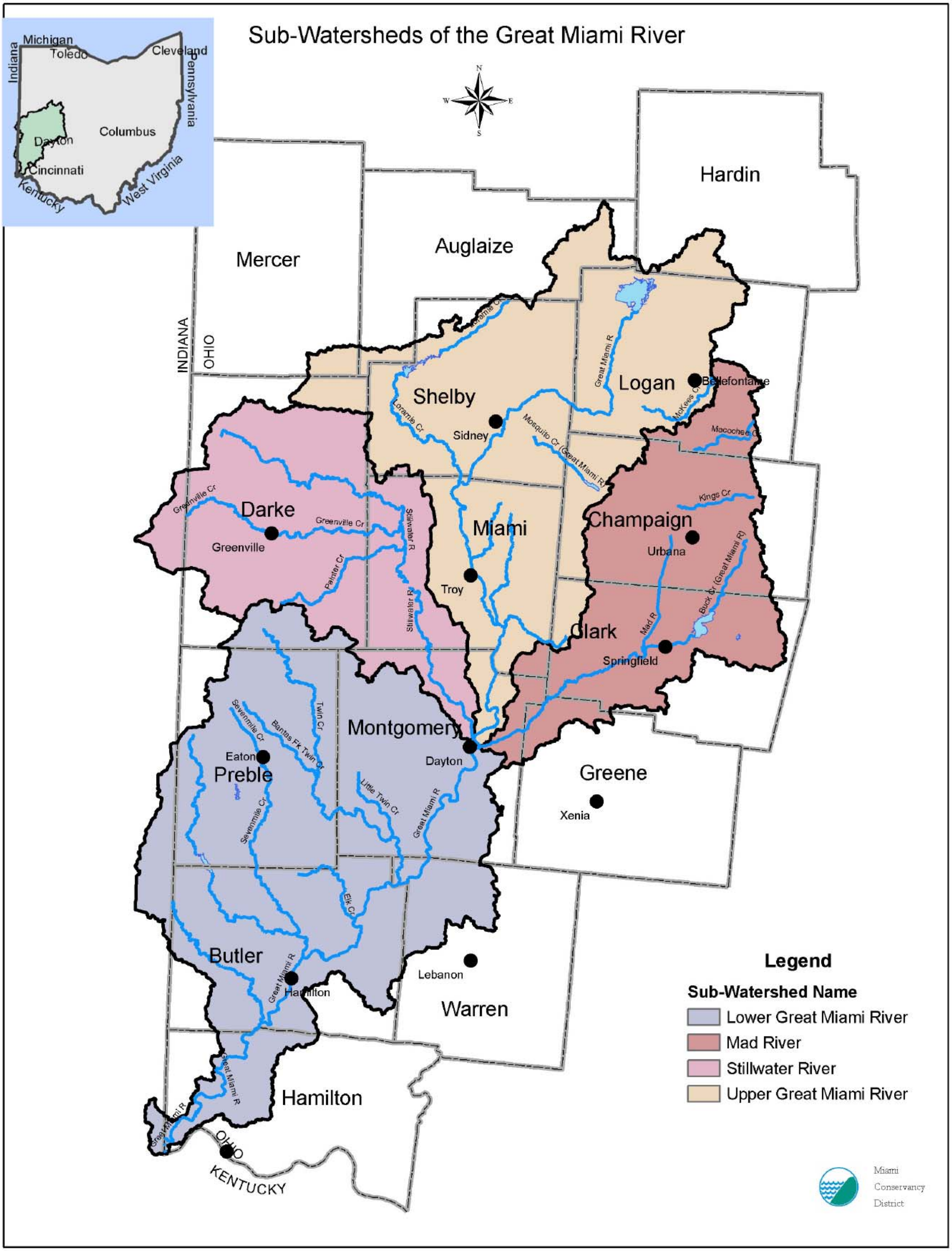
The improved quality of the surface waters in addition to the existence of several major lakes provides many opportunities for water-based recreation. Boating, swimming, and fishing are a few of the many activities enjoyed on Acton Lake, Indian Lake and Lake Loramie. The cold water habitat of the Mad River is one of the few trout fishing streams in Ohio.

Groundwater

The Miami Valley is fortunate to have one of the largest and most productive aquifer systems in the country. The Great Miami buried valley aquifer consists of ancient river valleys filled with permeable deposits of sand and gravel capable of storing vast amounts of groundwater. The buried valley aquifer has sustainable yields of 500 to 3,000 gallons per minute. This aquifer system was designated by US EPA as a Sole Source Aquifer in 1988. An estimated 97% of the population in the watershed relies on groundwater for their drinking water supply.

Geology and Soils

The geology of the watershed consists of bedrock underlying unconsolidated, surficial sediments containing Ordovician-age interbedded limestone and shale and Silurian-age shale, limestone and dolomite. The dominant soils in this watershed are Miamian, Crosby, Russell, Kokomo, Blount, Pewamo and Glynwood.


Sub-Watersheds of the Great Miami River
Michigan
Toledo
Cleveland
Indiana
Pennsylvania
Columbus
Dayton
Cincinnati
West Virginia
Kentucky
Hardin
Auglaize
Mercer
INDIANA
OHIO
Shelby
Logan
Bellefontaine
Sidney
Darke
Greenville
Miami
Troy
Champaign
Urbana
Clark
Springfield
Montgomery
Dayton
Preble
Eaton
Greene
Xenia
Butler
Hamilton
Lebanon
Warren
Hamilton
OHIO
KENTUCKY
Legend
Sub-Watershed Name
Lower Great Miami River
Mad River
Stillwater River
Upper Great Miami River
Miami Conservancy District

Setting Goals

The next step in developing a water study design is creating a list of goals. These will differ for each group depending upon individual interests. While developed for use in schools, the following types of goals apply to all Miami Valley Stream Team volunteers *(modified from the GREEN Standard Water Monitoring Kit Manual):*

Data Collection or Scientific Goals

Volunteers will:
- plan, implement and analyze a scientific investigation;
- develop field skills necessary for water quality testing;
- strengthen observational, analytical and problem-solving skills;
- compile and compare water quality data;
- use and integrate several disciplines (chemistry, biology, geography, math, etc.).

Community Goals

Volunteers will:
- become actively involved in a community-supported water quality monitoring program;
- develop an awareness and responsibility to their watershed as an individual and as a community;
- communicate findings and the results of their actions to the community.

Environmental Eductional Goals

Volunteers will:
- become familiar with the river ecosystem;
- learn to recognize water quality problems and their sources;
- understand relationships between land use and water quality;
- make a responsible, action-oriented contribution toward protecting the river and watershed.

Planning a Water Study

The final step in developing a water study design is actually planning the stream study. This involves choosing your sampling site(s) and setting a sampling schedule. **Each sampling site is a 200-foot stream segment.** You should use local landmarks (bridges, trees) or survey tape to define the boundaries of your sampling site. You must also ensure safety by considering accessibility, water depth, and private property rights. See the Chapter 1 for these and other important safety considerations.

Site Selection

Your sampling sites should reflect your individual goals and interests. If you are interested in the affects of agriculture on water quality, you may want to sample a stream with a primarily agricultural watershed. If you want to determine the affects of industrial discharge on stream water quality, you may choose to monitor at two points, one upstream of and one downstream from the industry in question. It is up to you to choose where you would like to monitor. If you need help choosing a spot, your local watershed group or county Soil and Water Conservation District may have some suggestions (see Appendix B for a list of contacts).

Sampling Schedule

Finally, make a sampling schedule. Consider how many people will be monitoring, how many sites you, or your group plan to sample and whether sampling is feasible year-round (due to drought, ice cover, etc.). Think about the types of tests that you will perform, the time requirements, and the goals you have set. A schedule will help you organize yourself and/or your group and make these goals more attainable.

Quality Assurance and Quality Control

Many volunteers strive to obtain the best data possible. We think this is important, as YOU are one of the primary users of the data. The following are some suggestions on how you can improve the quality of your water monitoring data.

A quality assurance and quality control (QA/QC) plan can help ensure that test results are as accurate and precise as possible. Accuracy refers to how close a measurement is to the true value. Precision means the ability to obtain consistent results. Reliability in both accuracy and precision is achieved by:

- Collecting the water sample as directed

- Rinsing bottles/tubes with sample water *before* collecting the sample and with distilled water *after* completing the test

- Performing tests immediately after collecting the water sample

- Careful calibration, use, and maintenance of testing equipment (check by using blanks and standards)

- Running splits to test for operator error

- Following the specific directions of a testing protocol exactly as described

- Repeating measurements to check for accuracy and to understand any sources of error

- Minimizing contamination of stock chemicals and testing equipment

- Storing kits away from heat and sunlight

- Checking expiration dates on chemicals and replacing them *before* they expire

- Checking to be sure the numbers submitted to the Stream Team database are the same as those recorded on the data sheets.

Standards, Blanks and Splits

A standard is a sample of known concentration. Standards can be purchased from Hach or other chemical companies. A blank is a sample run using distilled water. By testing standards and blanks, volunteers can check for bad reagents and equipment contamination. A split is one sample tested twice (for example, two nitrate tests preformed out of the same bucket of water taken from a stream). Splits test for operator error, as both tests should yield the same result.

Calibration

Calibration is a procedure to check the accuracy of testing equipment and to "reset" the equipment to a correct, known value. For example, to ensure that a pH pen is functioning properly, a solution of known value (a standard) is tested. Some calibration procedures may be done in the classroom or at home just before taking the equipment into the field. However, in some cases, it may be necessary to check the calibration again in the field. For most Stream Team volunteers, the pH pen is the only equipment requiring regular calibration. However, if you use other high-tech electrical equipment, calibration is likely required.

Repeated Measurements

By repeating measurements, volunteers collect better data for two reasons. First, streams and rivers are variable. The water that flows past a point in the stream is constantly changing. **Taking three measurements and averaging the values captures some of the natural variation within the stream and provides a better, more representative value.** Second, taking more than one measurement reduces the chance of reporting incorrect data. By running the same test three times, obvious incorrect values can be excluded. If more than one person and/or set of equipment are used, replicates provide an opportunity to test for both operator error and bad reagents/chemicals. If one person obtains a value that is considerably different, have them repeat the test. If only one test is run, it is much more difficult to recognize errors.

Student Groups

Measurements can be taken by groups of 2-3 students. Tasks within a group include collecting samples, processing samples, and recording data. It is very useful to have multiple groups testing for each parameter (for example, two groups measure dissolved oxygen). This allows more students to get involved in quality control. Groups of students conducting the same test should compare results to determine if the data are similar. If there are different results for the same sample, students should check the procedures and redo the test to determine what caused the difference. **Quality control should be an important part of data collection and the learning experience.**

Quality Assurance Levels

So that volunteers can strive for higher levels of data quality, we have developed a three star quality rating guide. This will give volunteers an idea of where their data ranks in terms of quality assurance. The more stars you get the better. It is important to note that ALL volunteer data is useful, whether it's used for education or to promote erosion control practices within a community. We do not ask you to report your quality level; this information is provided to help you develop your monitoring plan.

3 Star Quality Assurance Guide

Habitat Assessment

★ Drawing a stream map and taking just a few physical measurements.

★★ Completing the CQHEI Habitat Evaluation.

★★★ Completing the QHEI Habitat Evaluation.

Chemical Assessment

★ Using a less accurate testing method - such as presence/absence indicators.

★★ Use of the GREEN LaMotte chemical testing kit; and/or running only one sample of each test

★★★ Use of the Hach chemical testing kit; and running each test at least three times and averaging the values (excluding obvious outlying values)

Biological Assessment

★ Noting the presence of groups of organisms but not counting the individuals; and/or spending less than 45 minutes on the total biological sampling at your stream site

★★ Reporting the actual number of macroinvertebrates collected (34 mayflies, 8 dragonflies, etc.); and spending more than 45 minutes on biological sampling and identification

★★★ Reporting the actual numbers of organisms collected; and spending more than 45 minutes on sampling and identification; and completing the diversity index calculation.