

# Surface and Ground Water Indicators for the Cannon River Watershed A Collaboration for Indicator Development

## Environmental Indicators Initiative and Cannon River Watershed Partnership

### The Cannon River Watershed Partnership

The mission of the Cannon River Watershed Partnership is to protect and improve the surface and groundwater resources and natural systems of the Cannon River Watershed by

- coordinating existing local and state government and citizen resources in implementation of local water plans,
- instilling a sense of watershed pride through education, information, and special events, and
- providing for cooperative management and protection of the watershed.

Decisions made at the local level (by governmental units, individuals) to promote economic development and improve the quality of life in our communities can have unintended impacts on environmental quality and natural resources. The Partnership staff and members of a Technical Advisory Committee recognized the need for a comprehensive set of environmental indicators to help them understand and convey to the residents of the watershed the causes and consequences of environmental change.

### Environmental Indicators

Environmental indicators are selected measurements of the environment and our activities that provide information for reporting on environmental conditions, assessing the performance of natural resource programs, and developing an understanding of human-environment interactions. Measuring every environmental process and relationship would require hundreds of indicators. But a set of effective environmental indicators, like the “vital signs” of medical science, can summarize and highlight the most essential information needed for sound decision making.

At the Cannon River Watershed Partnership Watershed Summit, in September of 1998, EII presented a preliminary matrix to help identify indicators and track relationships between local land use decisions and their environmental consequences (see Table 1 for an example of the information in the matrix). The matrix helps demonstrate that a relatively small number of environmental conditions can serve as “vital signs” of watershed health.

Why is this so?

A few environmental conditions affect many of the environmental benefits important to Cannon River Watershed residents. For example (see Figure 1), minimum and maximum stream flows determine when it is safe to swim and boat and influence the size and composition of fish populations and fishing success. Other examples are given in Figures 3-6.

Many environmental conditions are affected by a small set of human activities (see Figures 1-6). When the relationships between human activities and environmental conditions are recognized, changes in an environmental condition can suggest a probable cause (and remedy). For example (see Figure 2) more frequent flood flows are likely to be the result of increased stream channelization, more impervious surface in the watershed, or loss of upland vegetation that slows the movement of water into streambeds. While other causes are possible, experience in this watershed and scientific investigations elsewhere suggest examining these factors first.

Citizens, public officials, natural resource managers, and research institutions working in partnership to identify the most important relationships between human activities, environmental conditions, and benefits valued by citizens is an important first step.

Knowledge of these relationships will help improve comprehensive watershed or landscape planning and lead to effective indicator-based monitoring programs.

Based on the knowledge of the watershed captured in the matrix, EII suggested that the Partnership focus on the following indicators.

Indicators of the Benefits sought from ecosystems

- **Acres and river miles of fishable, swimmable waters**
- **Miles of trails for hiking, biking**
- **Number of boat accesses (motor and canoe)**
- **Number of swimming accesses**
- **Number of trail users**
- **Number of recreational water users**
- **Frequency of flooding**
- **Property loss due to flooding**
- **Tourism dollars**
- Adequate **quality and quantity of ground water** for economic, social and ecological benefits

Indicators of Environmental Condition

- **Percent of land area eroding at > T**
- **Sediment loads** in surface water
- **Nutrient loads** in surface water
- **Bacteria** in surface water (**percent of time over standard**)
- **Water clarity**
- **Trophic state** of lakes
- **Number of lakes/river miles achieving designated uses**
- **Flow regime** (peak and base flows)
- **Percent of stream banks with excessive erosion**
- **Length and width of vegetated corridors along water bodies**
- **Connectivity and fragmentation of natural areas**
- **Wildlife abundance**
- **Indices of community health (ICI, IBI)**
- **Spawning areas accessible**
- **Number and size of game fish**
- **Percent of wells contaminated** (by aquifer)
- **Groundwater levels**
- **Area available for recharging groundwater**

Indicators of Human Activities

- Land cover and land use
- Protected acres in permanent vegetative cover (cover type)
- Discharge from waste water treatment plants
- Livestock access to shorelands
- Percent of floodplains developed
- Per capita impervious surface area
- Number of public ditches or tiles enlarged to handle greater flow
- Acres of wetlands destroyed
- Percent of stream miles channelized
- Number of dams
- Number of abandoned and illegal dumps
- Toxic release inventory
- Water use per capita

Indicators of Management Strategies

- Percent of properties complying with shoreline or wild and scenic ordinances
- Acres enrolled in land retirement programs
- Acres of trees planted through programs
- Percent of farmland with conservation practices
- Number of communities with erosion control ordinances.
- Degree of compliance with erosion control ordinances
- Number of acres with nutrient management plans
- Effectiveness of feedlot ordinances
- Number of waste water treatment plants meeting nutrient reduction goals
- Number of farms upgraded to reduce livestock pollution
- Number of communities that restrict impervious surfaces
- Acres of wetlands created or restored
- Effectiveness of farmland protection ordinances
- Amount of lands for public access
- Miles of trails
- Number of communities with plans to maintain floodplains in natural states
- Amount of hazardous waste recycled or collected
- Number of abandoned and illegal dumps cleaned up
- Number of industries reducing hazardous materials use
- Percent of conforming septic systems
- Percent of septic systems pumped on schedule
- Water conservation by residents and industry

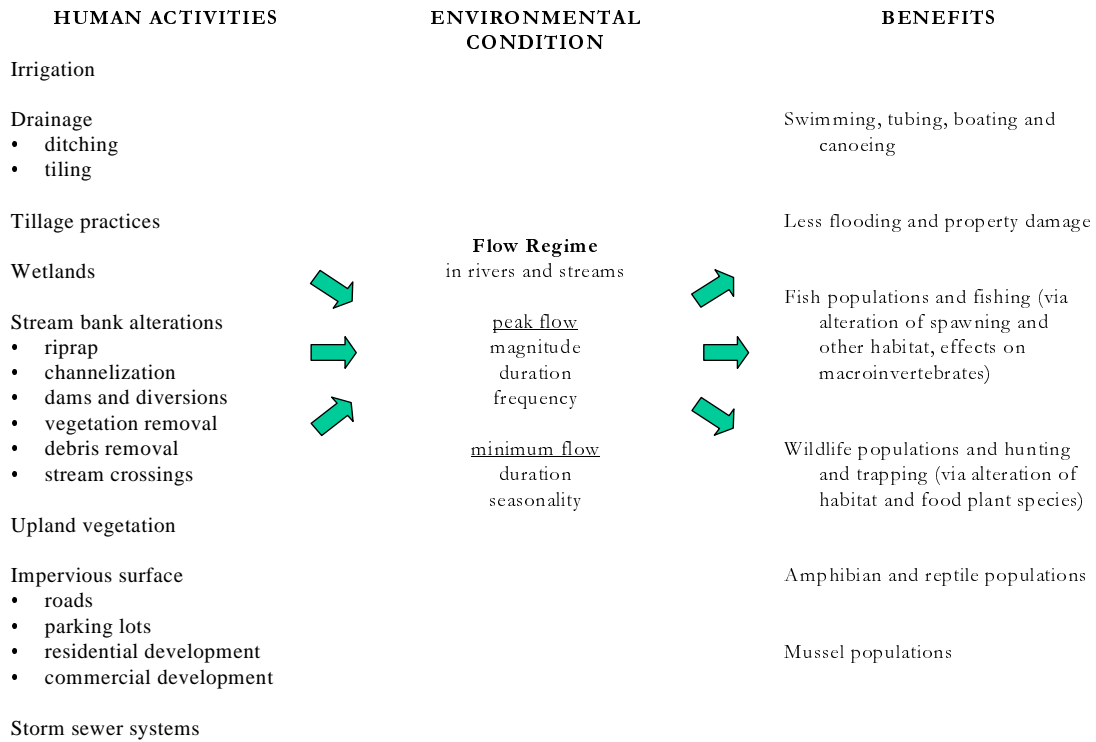
**Table 1.**

**Cannon River Watershed Partnership: Surface Waters Matrix**

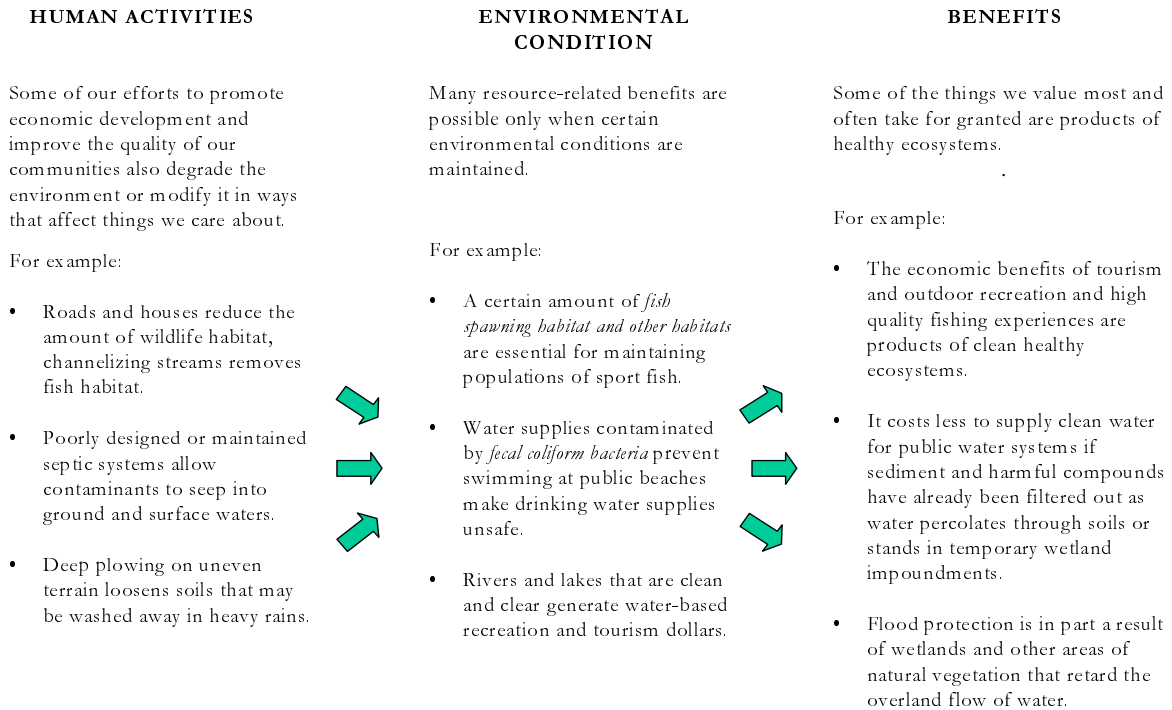
The CRWP identified relationships among benefits, environmental conditions, and human activities using a matrix similar to this. The matrix starts by listing the benefits most important to residents of the watershed. Next it identifies the environmental conditions that are necessary for these benefits to be produced (Environmental Condition 1) and the metrics by which these conditions could be monitored (Environmental Condition 2 and Environmental Condition 3). Finally, it lists the the human activities that are most likely to affect the environmental conditions. For example, the public values the aesthetic appeal of lakes and rivers, and associates clean water with water clarity and the lack of odor. Algal blooms, oxygen and nutrient levels, and sedimentation all affect water clarity and odor. Poor fertilizer management and inadequate soil conservation practices are the human activities that are most often implicated in algal blooms and increases in the sediment and nutrient content lakes and rivers. Completing the matrix requires common sense, practical knowledge of the watershed, and a dash of scientific information provided by technical experts. When completed, the matrix summarizes the relationships between benefits, environmental conditions, and human activities and suggests what indicators should be measured.

Benefits	Environmental Condition 1	Environmental Condition 2	Environmental Condition 3	Human Activities
<b>Aesthetics</b>	Clean water	Odor  Clarity	Algal blooms Oxygen levels Sediment-turbidity Nutrient levels	Fertilizer management Soil/erosion management Wetland conversions
<b>Recreation</b> Canoeing	Canoe access Lack of obstructions Stream bank integrity Wildlife	Water clarity Water levels Unsiltd stream bed Stable flows Frequency and level of algae blooms Lack of toxic materials	Water storage capacity Sediment levels Nutrient levels Oxygen levels Undisturbed natural areas Habitat diversity Vegetated corridor	Wetland conversion Amount of impervious surface Drainage and channelization Soil/erosion management
Fishing	Clean water Boat access Fish	Spawning areas Fish access to spawning areas Water clarity Unsiltd stream bed Macroinvertebrates Pool and riffle configuration Stable water table	Wetlands, backwaters Oxygen levels Nutrient levels Sediment levels Flows w/i range of natural variation Vegetative corridor Adequate groundwater recharge	Channelization and drainage Dams Wetland conversions Impervious surfaces Fertilizer management Soil/erosion management
Swimming	Swimming areas available Clean, clear water	Frequency and level of algae blooms Lack of toxic materials Bacteria levels (human and animal waste)	Nutrient levels Erosion and sedimentation rates Vegetative cover in watershed	Agricultural practices Impervious surfaces in watershed Upland soil and vegetation management Proper waste management (human and livestock)
Hunting & Wildlife viewing	Game and non-game wildlife Native species diversity	Undisturbed land areas Diversity of habitat types Lack of exotic species Vegetated corridors Clean water	Habitat area and connectivity Natural disturbance regime Adequate ground water recharge (See clean water conditions listed above)	Introductions of exotic species Habitat alterations Altered natural disturbance patterns (flooding, fires).

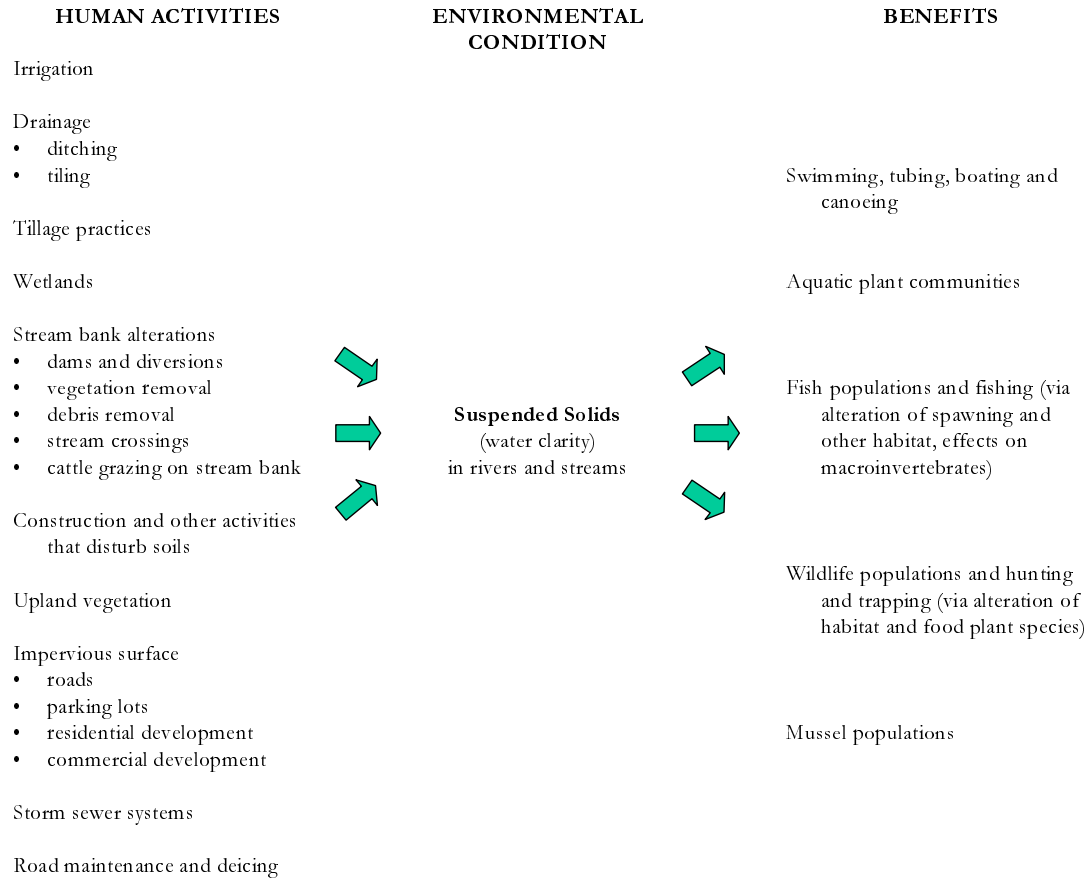
**Figure 1**



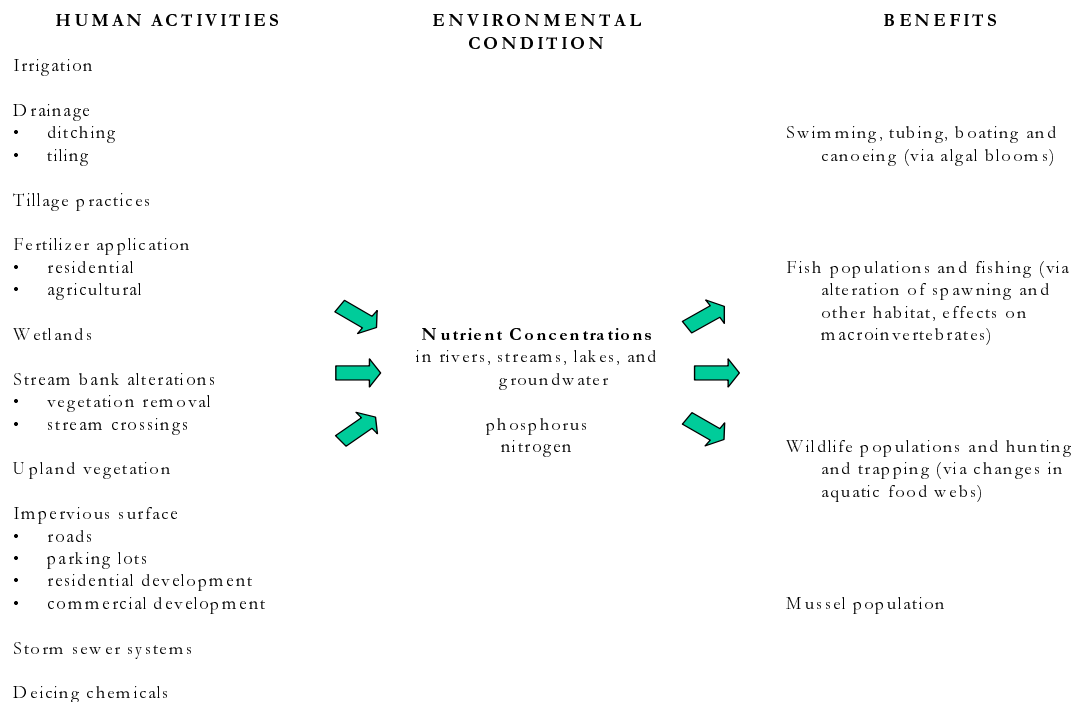
**Figure 2**



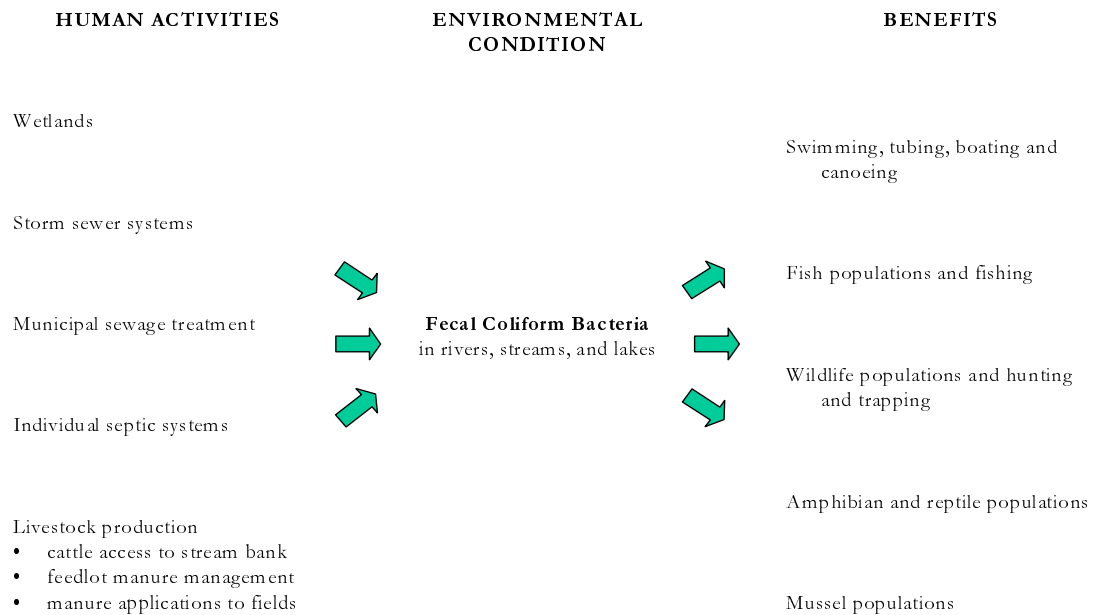
**Figure 3**



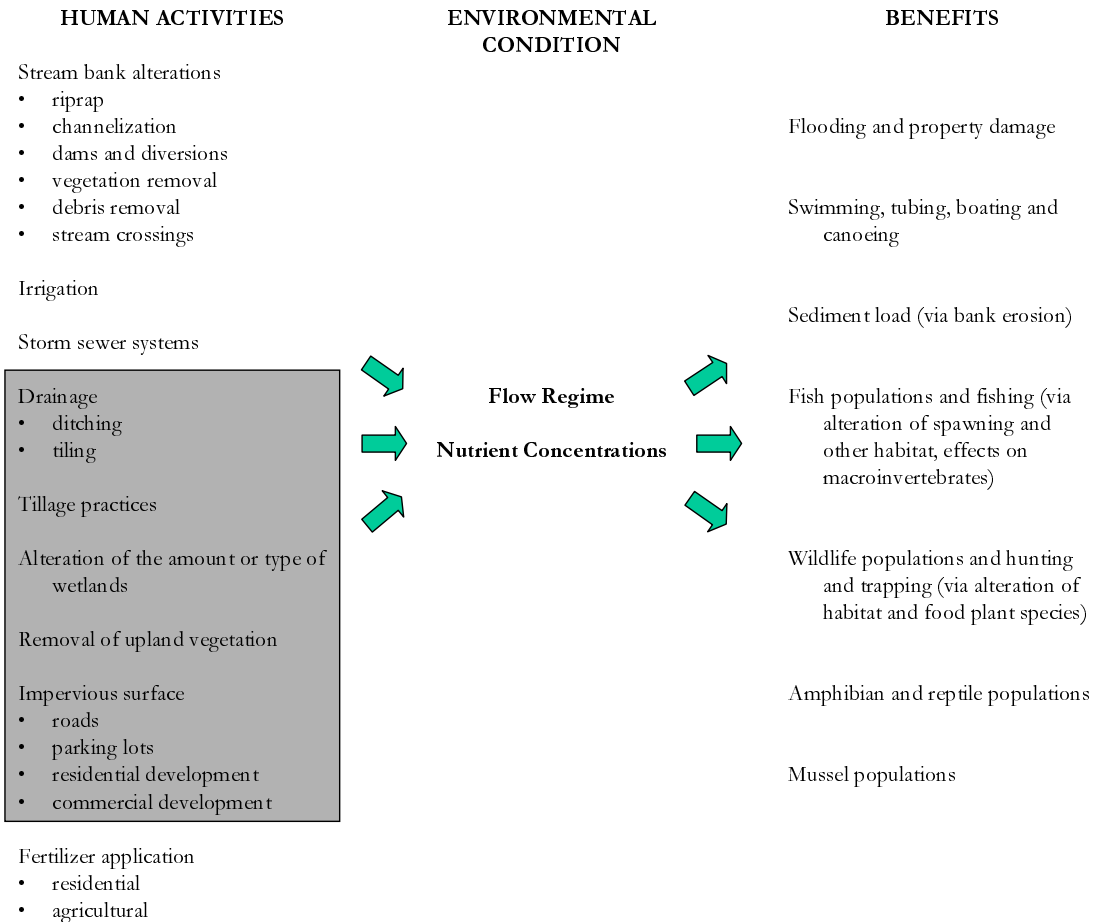
**Figure 4**



**Figure 5**



**Figure 6**

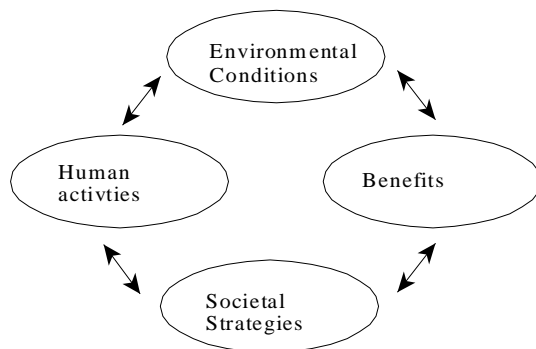


The Human Activities that are highlighted affect both flow regime and nutrient concentration. Because they have multiple effects on environmental conditions, they may be given higher priority than others.

CANNON RIVER WATERSHED PARTNERSHIP (CRWP)  
BRIEF HISTORY OF THE TECHNICAL COMMITTEE

In 1994-6 the Cannon River Watershed partnership (CRWP) developed a watershed plan. At the time, we were aware that we did not have the means to quantitatively assess the condition of the watershed or the progress being made toward the goals, but we were willing to develop those capabilities as time went on.

In 1997-9 the Minnesota Environmental Indicators Initiative (EII) was funded within the Department of Natural Resources to develop a set of measurable indicators for different parts of the state. CRWP has been cooperating with this group in developing indicators for the watershed. The EII works with a framework symbolized by the following cycle. There are measurable indicators within each area:



Many organizations and agencies have engaged in research and monitoring within the Cannon River Watershed, and the Partnership gathered many of these researches together in April 1998 to discuss their projects. This meeting resulted in the formation of a technical advisory committee and the task of applying the above framework to the watershed. That framework is presented in the form of a matrix that should help elucidate which parameters are most important to the watershed as a whole, and therefore most important to measure. It also helps track the relationships, shown as arrows in the above diagram. For example, one parameter such as natural flow regime (an environmental condition) or nutrient management education (a societal strategy) can be followed through all its relationships with other elements of the matrix.

Societal strategies must be identified, implemented and tracked by many partners operating at all levels of government and society. Part of the Cannon River Watershed Partnership’s mission is to “coordinate existing local and state government and citizen resources in implementation of local water plans.” All six of the counties in the Cannon River Watershed completed County Water Plans or the equivalent in the 90s and have updated them as of 1997. CRWP staff have assembled a list of strategies (or action steps) that are common to a number of these plans. In addition to the counties, watershed cities are engaged in activities that influence watershed resources, for example wastewater treatment plant operation, stormwater management, park planning and land development. CRWP intends to include staff of counties and cities on the Technical Advisory Committee as well.

Identifying the societal strategies, human activities, environmental conditions and desired benefits, along with measurable indicators for those that are most important, will set the stage for cooperative action and funding proposals to benefit the watershed and the jurisdictions within it.

**DRAFT  
INDICATORS  
LIST**

**INDICATOR  
EVALUATION FORM**

**MATRIX**

**MATRIX EXAMPLE**

**COUNTY WATER  
PLANS– COMMON  
ACTIONS**