Population Size And Distribution

The 1985 population in the Cedar Creek Watershed was estimated to be 26,930 persons. An estimated 11,610 persons, or 43 percent of the watershed population, live in incorporated urban areas. The remaining 15,320 persons (57 percent of the watershed population) reside outside the incorporated areas of the watershed, either in subdivisions, isolated small enclaves of residential development, or on farmsteads.

Regional and watershed specific trends suggest that the watershed population will increase by 12.5 percent, to 30,330 persons by the year 2010. This increase in population, combined with a trend towards smaller household size, is anticipated to add significant amounts of urban land use to the watershed.

Land Uses

Table 2-2 summarizes existing land use in the watershed. Rural land uses comprise about 110 square miles, or 87 percent of the drainage area. Agricultural lands and wetlands are the dominant rural land uses, making up 64 percent and 16 percent of the watershed land use respectively. Urban land uses cover about 16 square miles or 13 percent of the watershed. Residential and transportation land uses are most prevalent, making up 9 percent and 6 percent of the watershed land use respectively. Commercial, industrial, institutional and higher density residential land uses are centered in and around the village of Jackson, the village of Grafton and the city of Cedarburg. However, low density residential developments are scattered throughout the watershed in both Ozaukee and Washington counties. These scattered developments include lakeshore developments around Big Cedar and Little Cedar Lake. It is important to note that land uses within the city of Mequon's and the village of Germantown's portions of the watershed are primarily rural.

Although rural land uses will continue to dominate the overall land use pattern in the watershed through the end of the decade, important increases in urban land uses are projected to occur. The urban land uses are expected to increase by about 500 acres in the vicinity of the village of Jackson. This represents a doubling of urban land use for that area. Urban land uses in the vicinity of Cedarburg and Grafton are projected to increase by about 1,100 acres. This represents an increase of about 33 percent in urban land use for this area. On a watershed basis, urban land uses will increase about 45 percent.

Table 2-2. Land use in the Cedar Creek Watershed: 1985

Land Use Types	WASHINGTON COUNTY Area (sq. mi.)	WASHINGTON COUNTY Percent	OZAUKEE COUNTY Area (sq. mi.)	OZAUKEE COUNTY Percent	TOTAL Area (sq. mi.)	TOTAL Percent
Urban Land Use						
Residential	4.09	11.7	4.7	5.2	8.8	6.9
Commercial	0.10	0.3	0.14	0.2	0.24	0.2
Industrial	0.12	0.3	0.17	0.2	0.29	0.2
Transportation/ Utilities	1.89	5.4	4.3	4.7	6.19	4.9
Government/ Institutional	0.29	0.8	0.20	0.2	0.49	0.4
Other	0.23	0.6	0.23	0.3	0.46	0.4
Urban Subtotal	**6.72**	**19.1**	**9.74**	**10.8**	**16.46**	**13.0**
Rural Land Uses						
Agriculture, Open	18.48	52.7	61.72	67.7	80.2	63.7
Wetland	7.41	21.1	12.25	13.5	19.66	15.6
Woodland	1.66	4.7	5.08	5.6	6.74	5.3
Surface Water	0.84	2.4	2.17	2.4	3.01	2.4
Rural Subtotal	**28.39**	**80.9**	**81.22**	**89.2**	**109.61**	**87**
All Land Uses	**35.11**	**100**	**90.96**	**100**	**126.1**	**100**

Source: Southeastern Wisconsin Regional Planning Commission

Municipal And Industrial Point Sources Of Water Pollution

All municipal and industrial discharges are regulated by the Department of Natural Resources under the Wisconsin Pollutant Discharge Elimination System permit program. Currently, there are 11 facilities that have WPDES permits to discharge process and non-process wastewater to surface and groundwater in the watershed.

Two public sewage treatment plants discharge effluent to Cedar Creek. The village of Jackson operates an advanced wastewater treatment plant that discharges effluent to Cedar Creek. Jackson is engaged in facilities planning to correct occasional violations of its effluent standards and to upgrade its disinfection system. Bioassay tests conducted on effluent indicated that there is no effluent toxicity. However, a toxics screening analysis is also being conducted to determine if permit requirements should be expanded to include metals. The city of Cedarburg discharges effluent to Cedar Creek from its facility that also provides advanced wastewater treatment. This facility consistently meets its effluent standards since being upgraded in 1988. A toxics screening analysis is being conducted to determine if permit requirements should be expanded to include additional substances including metals and some organic toxic materials.

Nine industries discharge effluent to surface and groundwater in the watershed. All discharges except one are currently meeting their permit requirements. This non-conforming industry, which discharges to Cedar Creek at Cedarburg, will be evaluated as part of its permit re-issuance process.

Sanitary Sewer Service

Sanitary sewer service is available to 16,840 persons or 60 percent of the watershed population. These people are served by treatment plants located in the village of Jackson, the city of Cedarburg and the village of Grafton. The remaining 10,090 persons, or 40 percent of the watershed population, are serviced by private, on-site waste disposal systems.

Water Supply Service

Water supplies used in the Cedar Creek Watershed are obtained from both municipal and non-municipal groundwater sources. Supply wells tap one of three aquifers: 1) the shallow sand and gravel aquifer, 2) the shallow dolomite aquifer, and 3) the deeper sandstone, dolomite and shale aquifer. Large municipal wells serve Cedarburg and Jackson. The remaining areas are served by private wells.

Natural Resource Features

Climate

The frequency, duration and amount of precipitation influences surface and groundwater quality and quantity, soil moisture content, runoff characteristics and the physical condition of surface waters. Precipitation events throughout the watershed are most frequently moderate in duration and quantity. An event is defined as a distinct period when precipitation is equal to or greater than 0.1 inch. Approximately 50 events per year occur in this area.

The drainage area's annual precipitation averages 31 inches. The driest months are December, January and February, with an average of 1.54 inches, 1.31 inches and 0.95 inches of precipitation, respectively. These are also the months of greatest snow accumulation, when more than 30 inches or 68 percent of the average annual snowfall occurs. The wettest months are June, July, August and September when more than 14 inches, or 47 percent of the average annual rainfall takes place. Most runoff occurs in March, April and May when soil is either frozen or saturated.

Soils and Topography

Soils in this watershed are numerous in type and diverse in characteristics. Soil textures range from loams, sandy loams and silt loams in the uplands and creek valleys to the organic soils that are formed in basins and depressions such as the Cedarburg Bog, the Jackson Marsh, and along Kressin Creek. These soils vary widely in drainage, from well drained to very poorly drained. This wide diversity in soils is a product of glaciation, resulting in soils formed in loess and glacial till. These soils formed in a variety of settings including old lake beds, upland areas, outwash terraces and moraines.

Topographic features vary widely in the watershed. The steepest topography occurs in the drainage areas to Big and Little Cedar lakes. Topography is gently rolling in the remainder of the watershed except for the Cedarburg Bog area where it is flat. The low topographic relief and poorly drained soils has resulted in low gradient streams, particularly in the southern half of the watershed.

Table 2-3. Named perennial streams of the Cedar Creek Watershed

Stream Name	Stream Miles
Cedar Creek	31.5
Little Cedar Creek	8.2
North Branch Cedar Creek	8.1
Cedarburg Creek	6.1
Frieden's Creek	5.5
Evergreen Creek	5.2
Kressin Creek	4.7
Mud Lake Outlet	3.5
Lehner Creek	2.3
Polk Springs Creek	0.8
All Streams	75.9

Source: Wisconsin Department of Natural Resources.

Surface Water Resources

Streams

Table 2-3 lists the named perennial streams in the watershed. Approximately 72 miles of these named streams are truly perennial, maintaining at least a small continuous flow throughout most of the year. The longest perennial stream is Cedar Creek, which flows 31 miles from its headwaters in Big Cedar Lake to its confluence with the Milwaukee River near Cedarburg. Its principal tributaries, which range in length from 2.3 to 8.2 miles, include: Lehner Creek, Little Cedar Creek, Frieden's Creek, Evergreen Creek, North Branch Cedar Creek and Cedarburg Creek.

These perennial streams generally have low to moderate gradients and have the potential to support warm water sport fish communities. About 26 miles or 37 percent of these streams have been channelized or impounded with the greatest concentration of channelization occurring on Cedarburg Creek, Little Cedar Creek and its tributaries, Evergreen Creek and Frieden's Creek. Nearly all of these perennial streams are characterized as being moderately degraded by nonpoint source pollution and only partly able to support their potential

biological and recreational uses. Lehner Creek is the most notable exception. This stream has the potential to support a cold water aquatic community yet is unable to even partially support this potential biological use over much of its length due in large part to nonpoint pollution impacts. Cedar Creek, Lehner Creek, North Branch Cedar Creek and the Mud Lake Outlet have all been designated high priority for streambank easement acquisition through the Wisconsin Stewardship Program. This will help provide permanent vegetative buffers along these streams to help preserve and extend good riparian habitat.

Intermittent streams, which have a combined total length of 76 miles, flow only during and immediately after wet periods of rainfall and snowmelt. These streams, which form the headwaters of the perennial stream system, have experienced more intensive channelization. Approximately 49 miles or 63 percent have been so modified. The small size of these streams makes them particularly susceptible to nonpoint source pollution. Their dynamic nature does allow rapid improvement, however, if pollution sources are reduced.

Lakes

There are 19 named lakes and ponds in the watershed with a combined surface area of 1,600 acres. Five of these lakes (Big Cedar Lake, Little Cedar Lake, Mud Lake, Gilbert Lake, Long Lake) are over 30 acres and make up 94 percent of the watershed's total lake area.

Big Cedar Lake (932 acres), located at the headwaters of Cedar Creek, is the largest lake in the watershed. This lake is considered to be only partially meeting its full recreational use potential. The lake is mesotrophic due to moderate over-fertilization and has shown evidence of bacterial contamination. Although water quality is generally good, the lake is showing signs of increasing eutrophication.

Little Cedar Lake (246 acres) is also moderately fertile, also experiencing the effects of bacterial contamination and over-fertilization. This lake is also considered to be only partially meeting its full recreational use potential.

Gilbert Lake (40 acres), located adjacent to Big Cedar Lake, is a spring-fed lake with excellent fish and wildlife habitat. The lake quality is threatened, however, from nutrient and sediment loads.

Mud Lake (245 acres) and Long Lake (34 acres) are located in the Cedarburg Bog Wildlife Refuge. Both lakes have high value for fish and wildlife, and are well buffered from the impacts of nonpoint source pollution. These lakes are considered to be fully meeting their biological use potential.

The remaining 14 lakes, scattered throughout the watershed, range in size from 1-15 acres. Many are naturally formed in the glacial topography of this area, and some are formed by small dams. Most are in rural settings, although Hasmer Lake (15 acres) and Tilly Lake (13

acres) are located in the Village of Jackson Sewer Service Area and have residential development adjacent or near to the shoreline.

In addition to these lakes there are 15 impoundments on Cedar Creek and its tributaries.

Wetlands

Wetlands are some of the most valuable natural resource features in the watershed. Their values include wildlife habitat, fish spawning and rearing, recreation, attenuation of runoff and flood flows and removal of pollutants. They comprise 19.7 square miles, or nearly 16 percent of the watershed. The largest contiguous wetland complexes include the Cedarburg Bog and the Jackson Marsh. Wetlands are located adjacent to a significant portion of Cedar Creek and its tributaries. An extensive system of drainage ditches and stream channelization has greatly reduced the effectiveness of these wetlands as buffering systems, however. There are an estimated 94 miles of drainage ditches in the watershed.

Groundwater Resources

Groundwater is contained in one of four aquifers underlying the watershed--sand and gravel, eastern dolomite (limestone), sandstone and dolomite, and crystalline bedrock. An aquifer is an underground rock or soil formation that stores and transmits water to lakes, streams and wells. Aquifers in the Milwaukee River South Watershed are discussed in order of occurrence beneath the surface.

Sand and Gravel Aquifer

The sand and gravel aquifer is comprised of surface material deposited from glacial ice that covered the watershed approximately 10,000 years ago. These deposits, which are generally 100 to 200 feet deep, are unconsolidated soil material with physical and chemical characteristics different from agricultural soils.

Groundwater in these deposits moves in the void spaces among the grains of sand and gravel. It is locally important as a source of groundwater for both public and private use where there are relatively thick saturated unconsolidated deposits. The potential for contamination is high because of the shallow depth to groundwater and permeability of the bedrock.

Eastern Dolomite Aquifer

The eastern dolomite aquifer occurs beneath the sand and gravel formation. It was deposited approximately 400 million years ago and is 300 to 400 feet thick. It consists of both the Niagara dolomite formation and an underlying shale layer (Maquoketa shale). Dolomite is a brittle rock similar to limestone which contains groundwater in interconnected cracks. The Maquoketa shale formed from impermeable clays prevents water from moving between the

Niagara dolomite and the deeper aquifers. Most potable water used in the watershed comes from this formation. The potential for contamination is moderate.

Sandstone and Dolomite Aquifer

The sandstone and dolomite aquifer occurs beneath the eastern dolomite formation in deposits between 425 and 600 million years old. It consists of sandstone and dolomite bedrock between 400 and 600 feet thick characterized by materials with variable water yielding properties. In eastern Wisconsin, most users of substantial quantities of water tap this deep aquifer to ensure adequate supplies are available. In areas where the Maquoketa shale underlies the dolomite aquifer, which is the case for most of the South Branch, the potential for contamination is low.

Crystalline Bedrock Aquifer

The crystalline bedrock aquifer is located beneath the sandstone and dolomite aquifer in formations more than 600 million years old. This aquifer is not a primary source of water in the watershed. Most of the deposits are very dense crystalline rock that normally yield small amounts of water. Fractures in the crystalline structured rocks store water, but the quality and reliability of this water source and the extreme depth restrict its use.

Environmental Corridors

Areas within southeastern Wisconsin having the highest concentrations of natural, recreational, historic, aesthetic and scenic resources are called environmental corridors. These areas normally include selected elements of the natural resource base (lakes, rivers, streams, wetlands, woodlands, prairies, wildlife habitat areas, wet and poorly drained soils, rugged terrain and areas of high-relief) as well as existing outdoor recreation sites, historic and archaeological sites, and natural and scientific areas.

The DNR and the SEWRPC have identified environmental corridors and isolated natural areas (SEWRPC, 1979). These areas contain primarily wetlands, woodlands and surface water and comprise roughly 30 square miles, or nearly 25 percent of the watershed. Preserving these areas is important for improving water quality in this watershed and the basin as a whole.

Natural Area Sites

Natural areas were identified statewide by the Wisconsin Scientific Areas Preservation Council and the DNR's Bureau of Endangered Resources. These areas are contained exclusively in environmental corridors and isolated natural areas. They are tracts of land or water exhibiting pristine pre-settlement conditions or containing unique plants and animals.

Natural areas are classified in one of three categories: statewide or greater significance, county-wide or greater significance, and local significance. There are 11 natural area sites designated in this watershed, most associated with lowland forests or bogs. Three sites are associated with the Jackson Marsh and seven sites are associated with, or located near, the Cedarburg Bog.

Endangered Species

The DNR has documented the occurrence in the watershed of seven fish species, two reptile species, one insect specie and eight plant species that are classified as endangered, threatened or rare in Wisconsin. These species are protected by the Wisconsin Environmental Policy Act. These species usually indicate the presence of high quality habitat and low impact from human development.

Water resources in the watershed that harbor these important species are noted below.

Tilly Lake, Hasmer Lake, Mayfield Pond, Cedarburg Pond, Big Cedar Lake

These water bodies contain fish species of special concern.

Cedar Creek

Cedar Creek contains fish species at several locations throughout its length that are designated as being endangered, proposed threatened and of special concern. The segment of Cedar Creek between Big and Little Cedar Lakes contains a specie of special concern. The middle portion of Cedar Creek in the Mayfield Subwatershed contains a proposed threatened specie. Segments of Cedar Creek in and below the city of Cedarburg contain fish species of special concern and an endangered fish specie.

North Branch Cedar Creek

This stream contains fish species of special concern in its middle portion and near its mouth.

Cedarburg Bog

This large wetland harbors a threatened reptile specie, a threatened insect specie, four threatened plant species and four plant species of special concern.

Kinnamon Swamp

This wetland, located near the Cedarburg Bog, contains a threatened plant specie.

CHAPTER THREE
Watershed Planning Methods

This chapter describes the steps and procedures used to prepare this plan. This includes:

- Evaluating water quality and aquatic habitat.
- Assessing pollution sources.
- Establishing water resources objectives.
- Establishing pollution reduction goals.
- Developing a nonpoint source control strategy.
- Involving the public and local units of government.

Evaluating Water Quality and Aquatic Habitat

The Department of Natural Resources (DNR) is responsible for: designating the biological and recreational uses that surface waters can support under proper management; prescribing the water quality required to sustain these designated uses; and indicating the methods to implement, achieve and maintain those conditions.

The DNR's Southeast District Water Resources Management staff conducted investigations of the existing quality and natural resource conditions for lakes and streams during 1985-86. Through these investigations water quality problems were evaluated and a basis for setting water resource management objectives was established. Most perennial and intermittent streams and all of the major lakes were evaluated.

Detailed assessment results are documented in water resources appraisal reports prepared for the Milwaukee River South Watershed (Wakeman, 1989).

Data Collection

The following is a summary of the five elements comprising the water quality and aquatic habitat investigation.

Subwatershed Delineation and Stream Segmentation

Prior to collecting field data, the watershed was divided into 16 hydrologic subwatersheds. This was accomplished using 1985 1"=400' scale aerial photographs and 1"=2,000'(7.5 minute) U.S. Geological Survey quadrangle maps. These maps were also used to divide the perennial and intermittent stream network into segments. Stream segments were used to separate portions of waterways where either natural conditions or human-induced changes resulted in pronounced differences in stream character or water quality.

Stream Habitat Evaluation

Information characterizing stream habitat was collected using techniques developed by the DNR. The information included flow rate and depth, substrate quality, channel configuration, streambank stability and water temperature. The data was evaluated using the DNR's Stream Classification Guidelines (Ball, 1982).

Water Quality Assessment

Water quality was assessed using a combination of historical water chemistry data and an evaluation of bottom dwelling animals (macroinvertebrates) using the Hilsenhoff Biotic Index (Hilsenhoff, 1982). Extensive bacteria (fecal coliform) surveys assessed the suitability of surface waters for recreational use.

Fisheries Resource Assessment

Fish communities were assessed qualitatively using a combination of historical data (Fago, 1984) and information collected during this investigation. Resident fish populations in the streams, lakes and impoundments were sampled using seines and electrical shocking equipment.

Navigability and Recreational Use Determinations

The extent and degree of stream navigability were determined based on: evidence of canoeing or boating; field data including evidence of stream alteration or use; and information provided by landowners or other local experts. Recreational uses were determined through field observations, file data and information from local users. Information from local users was collected, in part, through a survey of urban residents conducted during 1989.

Data Interpretation

This information identified the existing and potential biological and recreational uses for surface waters. The existing uses reflect present biological and recreational conditions.

Potential uses reflect biological and recreational conditions that could be achieved under prescribed types and levels of management. Even where existing and potential uses of a surface water are the same, management programs can result in significant and perceptible changes in the quality of the aquatic environment.

Generic use classifications and supporting water quality standards are discussed below.

Biological Stream Use Classification

Biological stream use classes describe the fish species or other aquatic organisms supported by a stream system. Designation is based on the ability of a stream to provide suitable habitat and water quality conditions for fish and other forms of aquatic life. The following biological stream use classification system was used in preparing this watershed plan. After this plan and its associated maps were prepared, the stream classification system for the state of Wisconsin was slightly modified. The new stream classification designations are contained in NR 102(04)(3).

- Fish and Aquatic Life (FAL) A Cold Water Communities. These streams are capable of supporting a community of cold water fish (trout, sculpin) and other aquatic life, or serve as spawning areas for cold water fish species.

- FAL B Warm Water Sport Fish Communities. These streams are capable of supporting a community of warm water sport fish (bass, walleye, pike) or serve as spawning areas for warm water sport fish.

- FAL C Warm Water Forage Fish Communities. These streams are capable of supporting an abundant, diverse community of forage fish (shiners, minnows) and other aquatic life (insects, clams, crayfish).

- Limited Forage Fish Communities (Intermediate Surface Waters). These streams are capable of supporting small populations of forage fish tolerant of pollution, or fish and aquatic invertebrates tolerant of pollution. Small physical stream size and reduced stream flow usually limit the aquatic community.

- Limited Aquatic Life (Marginal Surface Waters). At best, these streams are capable of supporting a limited community of aquatic life. These streams are usually small, such as intermittent streams and ditches, or have been extensively modified through channel straightening or concrete lining.

Recreational Stream Use Classification

Recreational stream use classifications are described based on the level of human body contact determined to be safe and reasonable. The system applies to all surface waters including those categorized as intermediate or marginal under the above referenced biological

use classification system. Three designations are used under the recreational stream classification system. These designations are: full-body contact; partial-body contact; and noncontact.

- Full-body Contact. These waters are used for human recreation where immersion of the head is expected and occurs often. Recreation activities classified as full-body contact include swimming, waterskiing, sailboarding and other similar activities.

- Partial-body Contact. These waters are used for human recreation where immersion of the head is not frequent and contact is most often incidental or accidental. Recreational activities classified as partial-body contact include boating, canoeing, fishing and wading.

- Noncontact. These waters should not be used for human recreation. This category is used infrequently when extenuating circumstances, such as high concentrations of in-place pollutants, an uncontrollable pollution source or other conditions, dictate that contact with the water would be an unnecessary health risk.

Water Quality Standards and Criteria: Surface water quality standards and criteria are expressions of the conditions considered necessary to support biological and recreational uses. Water quality standards for these uses are contained in NR 102, NR 103, NR 104 and NR 105 Wisconsin Administrative Code. Additional information to assess the suitability of surface waters for biological uses includes recommended maximum nutrient levels, suspended solids concentrations and the extent to which streambeds are clogged with sediment.

In addition to these standards, other criteria were used to assess the suitability of surface waters for recreational uses. Stream size and accessibility data helped determine the suitability and types of recreation which a stream could support. Users at public access points provided information on current recreational use of surface waters, and discussions with local officials provided information to assess suitability of surface waters for recreation.

Assessing Pollution Sources

The pollution source assessment identified the rural and urban sources and quantities of pollutants affecting surface waters. Rural and urban pollutant sources assessed for this watershed are discussed below.

Rural Nonpoint Sources

Excessive quantities of sediment, nutrients, oxygen-demanding substances, pesticides and bacteria are pollutants carried in runoff draining from agricultural areas. These pollutants degrade surface water quality thereby restricting recreational and biological uses. The principal rural nonpoint sources evaluated in preparing this plan include:

- Barnyards and livestock feeding, pasturing and loafing areas.
- Eroding uplands which deliver sediment to surface waters.
- Eroding, slumping or trampled streambanks.
- Areas contributing runoff of winterspread livestock manure.

The Ozaukee County and Washington County Land Conservation Departments' staff conducted inventories during 1986 and 1987. Inventory procedures are documented in a manual that the DNR developed for the Milwaukee River Basin (DNR, 1985). The DNR completed data analyses in cooperation with the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), the Ozaukee and Washington County Land Conservation Departments and the USDA-Soil Conservation Service. Inventory and evaluation procedures are summarized below.

Barnyard and Livestock Area Runoff

County land conservation departments mapped locations of 136 barnyards in the watershed on 1985 1"=400' scale aerial photographs. A field survey of each barnyard was conducted to collect information needed to determine its pollution potential.

The barnyard data was used in the "Barny Model" (Baun, 1987), a modification of the animal lot runoff model developed by the U.S. Department of Agriculture, Agricultural Research Service (Young, 1982). Information on event mass loading of total phosphorus was used to assess the relative pollution potential of each barnyard. Each livestock operation was then ranked according to its potential to impact surface water and/or groundwater quality.

Upland Erosion and Sediment Delivery

County land conservation department staff members conducted the inventory on 100.5 square miles of land using existing data and field investigations.

Cropland, pastures, grasslands, woodlands and other open (non-urban) land uses were investigated. Existing data sources included site-specific farm conservation plans, 1985 1"=400' scale aerial photographs, and U.S. Geological Survey 1"=2,000' scale quadrangle maps. The information obtained for each parcel included size, soil type and erodibility,

slope percent and length, land cover, crop rotation, present management, overland flow distance and destination, channel type and receiving water.

Upland erosion and sediment delivery was determined using the Wisconsin Nonpoint Source (WIN) Model (Baun & Snowden, 1987). The WIN model calculates the average annual quantity of eroded soil reaching surface waters from each farm field. The determination is based on a "typical" year of precipitation. Estimated sediment delivery assessed the relative pollution potential of each farm field in the watershed.

Streambank Erosion

County land conservation department staff members conducted field surveys on all perennial and major intermittent streams. The survey method used is a modification of Phase II of the Land Inventory Monitoring (LIM) process used by the U.S. Department of Agriculture, Soil Conservation Service. At locations where erosion was occurring, the following site-specific information was recorded: length of trampled or eroding bank; vertical height; estimated annual rate of recession; adjacent land uses; and potential management measures.

The amount of sediment lost annually was calculated for each erosion site. In addition, areas adjacent to streams that are affected by livestock were also noted.

Runoff from Areas Winterspread with Livestock Waste

This analysis estimated the pollution potential in the watershed associated with winterspreading livestock waste. This evaluation included the information collected for the barnyard and upland erosion surveys.

This analysis was completed using a three-step process. First, the number of acres needed by each livestock operation to landspread manure was calculated for a six-month period approximating when manure cannot be incorporated into the ground because of frozen or saturated conditions. The amount of manure that each operation generated was based on the number and type of livestock. The area required for spreading was based on an application rate of 25 tons per acre per year.

Second, the land available to each livestock operation for winterspreading was characterized according to its environmental sensitivity. Lands having slopes equal to or greater than 6 percent or located within the floodplain were considered to have a high potential to deliver landspread manure to lakes and streams during periods of spring thaw.

Third, the number of sensitive acres winterspread with manure was estimated for each livestock operation. This estimation was based on the number of acres needed for winterspreading and the proportion of environmentally sensitive lands available to the livestock operation. This number was used to indicate the relative pollution potential of each livestock operation due to runoff of winterspread manure.

Urban Nonpoint Sources

Nationwide investigations confirm that urban runoff can have a significant adverse impact on receiving waters. The result is that urban areas and activities can affect several important components of a stream including stream flow, habitat, water quality, bottom sediment quality and stream biology (Pitt, 1987).

Pollutants in urban stormwater runoff include some of the same pollutants associated with rural nonpoint source runoff. Examples of these pollutants are: sediment, nutrients, oxygen demanding organic materials, bacteria and pesticides. Other pollutants, many of which are potentially toxic, are transmitted to surface water and groundwater primarily by urban runoff. These include heavy metals (lead, zinc, chromium, copper, cadmium and arsenic) and a wide range of hazardous organic compounds. Urbanization also causes devastating hydrologic changes in streams by reducing groundwater recharge and increasing the volume and peak of streamflow during storms. This results in flashy streams that destroy stable habitat for aquatic life. Natural streams may subsequently be modified through channelizing and armoring to reduce flood damage in urban areas.

Principal urban nonpoint sources evaluated in preparing this plan include:

- Existing urban land uses.
- New urban development, including the potential for construction site erosion as well as increased pollutant loading from the newly established urban surfaces.

Stormwater pollutant concentrations, runoff volumes and pollutant yields vary with urban land use (residential, commercial, industrial) and development characteristics (intensity of the development, stormwater conveyance system). The inventory of existing and planned urban areas was designed to quantify the urban land use and development characteristics for existing and planned urban development. This information estimated the existing and potential future urban pollutant loads.

Existing Urban Areas

Two study areas were delineated in the watershed. The Jackson Study Area is 6 square miles in area and includes the village of Jackson and surrounding lands within the urban service area where future development is anticipated to occur. The second study area is 14 square miles in area and includes the city of Cedarburg, the village of Grafton and surrounding lands within the established urban service areas for these communities.

Existing land use categories were delineated on 1"=400' scale aerial photos, digitized, quantified and mapped by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). Land use definitions are presented in Appendix A.

A qualitative survey was made of the residential lakeshore development on Big and Little Cedar Lake to evaluate the potential for urban stormwater problems in those areas. This survey was augmented by a videotape of a snowmelt event in the drainage area to Big Cedar and Gilbert Lakes, filmed by the Big Cedar Lake Protection and Rehabilitation District in the spring of 1989.

New Urban Development

The SEWRPC delineated areas of planned development for each study area. The delineations represent long-range (up to 50 years) projections for urban development. The information was plotted on 1"=1,000' scale maps. This information was based on existing land use configuration, SEWRPC sanitary sewer service area plans, other available land use plans and meetings with local officials to discuss information on committed or planned development projects. It was assumed that environmental corridors and isolated natural areas would not be urbanized. The commission estimated the portion of the planned urban area expected to undergo conversion by the year 2000. This information was used in turn to determine potential increases in urban pollutant loading.

The DNR used information on existing and planned urban development in its Source Loading and Management Model (Pitt and Voorhees, 1989) to estimate urban nonpoint source loads for three pollutants. These pollutants include sediment, phosphorus and lead. Information on existing pollutant loads identified the magnitude and distribution of the current urban nonpoint source loadings and identified high priority land uses responsible for most of these loads. Information on planned urban development was used to estimate the future pollution potential associated with uncontrolled development. The effectiveness of applying urban management practices to existing and planned urban areas was also evaluated to determine the level of management needed in reducing urban pollutant loads to acceptable levels by the year 2000.

The potential for *construction site* impacts was based on the number of acres planned for development by the year 2000. The adequacy of existing local construction erosion control programs was evaluated through a survey developed by University of Wisconsin Cooperative Extension Service and the DNR.

Other Pollution Sources

Sources of surface water pollution, beyond those discussed in this plan, are degrading water quality in the watershed. These pollution sources may overshadow water quality improvements that might otherwise occur as a result of the priority watershed program.

The DNR conducted an inventory and evaluation of these other pollution sources. Inventory results and recommendations for alleviating the water quality impacts of these other pollution sources are documented in the integrated resources management plan for the Cedar Creek

Watershed (DNR, 1990). In addition the DATCP, the DNR and the University of Wisconsin Extension Service are cooperatively working through a technical committee to define pesticide guidelines to minimize threats to surface and groundwater quality. The results will be applicable statewide and will be incorporated into this watershed project when available.

Establishing Water Resources Objectives

Recreational and biological water resources objectives were established for each of the major lakes and streams in the watershed. These objectives identify how the project is anticipated to change the quality of the aquatic environment for recreational and biological uses. Factors considered in setting water resources objectives include: existing water quality and aquatic habitat; factors or pollutants that may be keeping the surface water from its full potential to support biological and recreational uses; and the practicality of reducing pollutants.

Establishing Pollution Reduction Goals

Nonpoint pollution reduction goals are estimates of the level of nonpoint source control needed to meet the water quality and recreational use objectives identified in this plan. Pollution reduction goals and water resources objectives are set together since they are integrally related.

Nonpoint source pollution reduction goals contained in this plan are a refinement of recommendations contained in water quality management plans prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC, 1971, 1979, 1987). The nonpoint source pollution reduction goals in this plan specifically target the control of sediment and nutrients in rural areas, and the control of sediment, toxic materials and streamflows in urban areas. Pollution reduction goals for sediment are based on the change in substrate embeddedness needed to restore aquatic habitat. Pollution reduction goals for urban toxic materials are based on changes needed to meet chronic toxicity standards in the Milwaukee River and acute toxicity standards in the stormwater effluents discharged to the river. Importantly, reducing the quantity of these substances reaching surface water will also decrease the amount of other substances such as pesticides and bacteria, which also degrade water quality.

Water resources objectives presented in this plan recognize that pollution control and resource management efforts beyond the scope of the Nonpoint Source Control Program are needed to achieve the identified objectives. These additional management needs are set forth in other planning documents prepared by the SEWRPC and DNR. These studies include the areawide water quality management plan for southeastern Wisconsin water resources

management plan for the Milwaukee Harbor Estuary, the integrated resource management plan for the Milwaukee River Basin, and the remedial action plan for the Milwaukee River area of concern (SEWRPC, 1979; SEWRPC, 1987; DNR, 1990; DNR, 1991).

Developing a Nonpoint Source Control Strategy

The final step in the planning process involves developing a strategy to achieve the nonpoint source pollution reduction goals identified in this plan. The strategy includes identifying nonpoint source control needs, and the specifics of local implementation programs that will be needed to carry out plan recommendations.

The identification of nonpoint source control needs includes eligibility of specific sources for cost-share and technical assistance. The eligibility is based on the overall reduction in pollutant loads needed to meet water quality goals and the relative contribution of each source to the pollutant loading. This evaluation is completed on a subwatershed and watershed basis for the rural and urban nonpoint sources.

Important components of the local implementation programs include: critical nonpoint sources and best management practices; project responsibilities and local staffing needs; budget requirements to support practice and staffing costs; state funding guidelines; information and education needs; and project evaluation needs.

Involving the Public and Local Units of Government

The DNR convened an advisory committee and a technical workgroup to assist in preparing this watershed plan. The advisory committee contains representatives from cities, counties, villages and towns in the watershed. This committee provided review and comment of proposed management strategies and draft plan documents. The technical workgroup was convened to help with developing technical aspects of the plan. The group was involved in reviewing land and water resources assessment information, developing water resources objectives and pollution reduction goals, developing the pollution control strategy and in preparing the detailed programs for implementation.

CHAPTER FOUR
Water Resources Conditions, Nonpoint Sources and Water Resource Objectives

Water Resource Conditions

This chapter documents the urban and rural nonpoint pollution sources known to exist in the Cedar Creek Watershed and identifies the observed impacts on surface waters caused, at least in part, by these pollution sources. This chapter also sets forth the water resources objectives for this watershed project along with the pollutant reduction goals that must be achieved to make water resources improvements a reality. Specific nonpoint source control actions that must be taken in order to adequately reduce nonpoint source pollutant loads are presented in Chapter 5.

Surface Water Conditions

Stream Potential

Cedar Creek and its principle tributaries have been classified by the Department of Natural Resources according to their potentials for supporting recreational, fish and aquatic life uses (Wakeman, 1989). These classifications reflect the potential of surface waters to support these uses assuming that cultural limitations such as point and nonpoint source pollution impacts are reduced or eliminated.

Potential biological uses for surface waters in the Cedar Creek Watershed are shown in Map 4. Potential recreational uses are not shown on this map, but are included in the summary which follows:

- **Cedar Creek**: The entire main stem is capable of supporting a warm water sport fish community. The entire stream, with the exception of those portions flowing through the Mayfield and Horn's Corners subwatersheds, is large enough to support full-body contact recreation.

- **Lehner Creek**: This tributary has substantial groundwater input and is capable of supporting a cold water aquatic community. Brown trout inhabit some portions of the stream. The stream is not large enough to support full-body contact recreation but will support partial-body contact recreational uses.

- **Little Cedar Creek, Kressin Creek, Frieden's Creek, lower Evergreen Creek, Cedarburg Creek and the North Branch Cedar Creek**: These six tributaries are capable of supporting warm water sport fish communities throughout their lengths, either year round or during the seasonal spawning period. Only the lower section of Little Cedar Creek is large enough to support full-body contact recreation; the other tributaries can only support partial-body contact recreational uses.

- **Upper Evergreen Creek, Jackson Tributary, un-named tributary to Cedar Creek (Mayfield), un-named tributary to North Branch (Trenton)**: Limited by size, these three tributaries are capable of supporting warm water forage fish communities and partial-body contact recreation.

Existing Status of Streams

Map 5 illustrates the extent to which these surface waters are currently meeting their potential biological uses. Cedar Creek and most of its tributaries are only partially meeting their biological use potential. Degradation of these streams is low to moderate, and proper management could result in a better quality of the biological community that currently exists. Three tributaries are more severely affected. Lehner Creek, lower Evergreen Creek and the Jackson Tributary are not currently meeting their potential biological uses. These streams are severely impacted to the extent that proper management could result in a marked shift to different aquatic communities. The range of cold water aquatic life, including trout, could be extended to lower sections of Lehner Creek, warm water sport fish communities could be extended to lower reaches of Evergreen Creek, and balanced warm water forage fish communities could be re-established in the Jackson Tributary.

There are many cultural factors keeping these surface waters from fully meeting their recreational and biological potential. These are documented in the *Milwaukee River Basin Integrated Management Plan: 2000, Volume 6, Cedar Creek Integrated Resource Management Plan* (WDNR, 1990). Common factors include nonpoint source pollution, wetland drainage, stream channelization and the creation of many impounding dams. Less common factors include sediment contamination with PCBs (lower Cedarburg Subwatershed), suspected municipal sewage treatment problems with sewer leaks and by-passes (Jackson Tributary) and carp activity (Jackson Tributary).

Table 4-1 summarizes the water quality problems caused, at least in part, by nonpoint source pollution and the type of nonpoint source pollutant or activity responsible.