MINOCQUA-KAWAGUESAGA LAKES WATERSHED MANAGEMENT PLAN

Prepared For:

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GLOSSARY

Best Management Practice (BMP): A practice or combination of practices that are determined to be most effective and practical (including technological, economic, and institutional considerations) means of controlling point and nonpoint pollutant levels compatible with environmental quality goals.

Drainage Basin: A geographic and hydrologic subunit of a watershed.

Dry Detention Ponds: A structural BMP or retrofit that consists of a large open depression that stores incoming storm water runoff while percolation occurs through the bottom and sides.

EPA: United States Environmental Protection Agency.

Groundwater: Subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the water table.

Heavy Metals: Metallic elements with high atomic weights (e.g. mercury, cadmium, etc.). They can damage living organisms at low concentrations and tend to accumulate in the food chain.

Impervious Surface: Hard surface that prevents and retards the entry of water into the soil mantle as natural conditions prior to development and/or a hard surface area that causes water to runoff the surface in greater quantities or at increased flow rates from the flow present under conditions prior to development. Common impervious surfaces include, but are not limited to rooftops, walkways, patios, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam, or other surfaces that similarly impede the natural infiltration of urban runoff.

Infiltration: The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Land Conversion: A change in land use, function or purpose.

Local Government: Any County, City, or Town having its own incorporated government for local affairs.

Nonpoint Source Pollution: Pollution whose sources cannot be traced to a single point such as a municipal or industrial wastewater treatment plant discharge pipe.

Pollution Prevention: A management measure to prevent and reduce nonpoint source loadings generated from a variety or everyday activities within urban areas. These can include turf management, public education, ordinances, planning and zoning, pet waste control, and proper disposal of oil.

Post-Development Peak Runoff: Maximum instantaneous rate of flow during a storm, after development is complete.

Pre-Development Peak Runoff: Maximum instantaneous rate of flow during a storm prior to development activities.

Removal Efficiency: The capacity of a pollutant (sediment) control device to remove pollutants from wastewater or runoff.

Retrofit: The modification of an urban runoff management system in a previously developed area. This may include wet ponds, infiltration systems, wetland plantings, streambank stabilization, and other BMP techniques for improving water quality and creating aquatic habitat. A retrofit can consist of new BMP construction in a developing area, enhancing and older runoff management structure, or combining improvements and new construction.

Runoff: That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. Runoff can carry pollutants into receiving waters.

Sedimentation Basins: Sediment storage areas that may consist of wet detention basins or dry detention basins. Excavated areas with storage depression below the natural ground surface; creek, stream, channel or drainageway bottoms properly engineered and designed to trap and store sediment for future removal.

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

Wet Detention Ponds: A structural BMP or retrofit that consists of a single permanent pool of water that stores and treats incoming storm water. Wet detention ponds usually have three to seven feet of standing water, allowing pollutants to settle, with a defined siltation/sedimentation pond and outlet structure.

CHAPTER 1: INTRODUCTION

The Minocqua and Kawaguesaga Lakes are a series of interconnected navigable lakes and are invaluable water resources in the community of Oneida County. These Lakes are very unique – the aesthetic, recreational and environmental qualities of the lakes have withstood the pressures of modern life and have retained much of their historic qualities. Despite the current (2005) remarkable condition, maintaining, protecting and enhancing the quality of these Lakes are key in sustaining the natural beauty, water quality, and availability for recreational use.

The long-term management of these Lakes is a concern for the local community and the local county and state governments. The Towns of Minocqua and Woodruff encompass the lake surface area. Oneida County assists in protection of the Lakes through County land and zoning regulations. They also have regulation of resources through the County Zoning Code and Lake Classification System. The Wisconsin DNR provides oversight through provision and regulation of State Administrative Codes. The DNR also provides funding opportunities to protect and enhance the State's natural resources. This project is supported in part through grants provided by the Wisconsin DNR and the U.S. Geological Survey.

Minocqua and Kawaguesaga Lakes have been subject to substantial lake water quality monitoring and protection efforts. The Lakes were part of a DNR sponsored Priority Watershed program in the early 1990s. The program lapsed as lake water quality was considered by many to be of too high a quality to require management. However, recent studies have shown increasing water quality fertility, increased sedimentation, and the presence of aquatic invasive species. The Minocqua-Kawaguesaga Lakes Protection Association was formed and this influential group has established themselves as a local force committed to protecting and improving the Lakes' water quality.

The need for a Lake Protection Association became obvious as increasing development on the lakeshore presented obvious signs of water quality degradation. High density housing and tourist opportunities, uncontrolled sediment erosion, and a recognized increase in aquatic plants (macrophytes), all developed an increased concern to protect water quality. The MKLPA (Minocqua-Kawaguesaga Lakes Protection Association) mission is to find ways and means to improve lake water quality.

Cedar Corporation, a Menomonie, WI, based engineering/environmental consulting firm, was hired by MKLPA in 2004 to assist in promoting water quality in the area. Cedar chose a holistic watershed approach as opposed to a simple lake/flowage approach to assess current and future conditions. This report documents the various information gained through multiple studies and assessments as well as continuing previous work. The intent is to provide a dynamic document that can be altered in the future as more information becomes available. Recommendations to implement water quality protection and improvement projects are presented in Chapter 9.

This work could not have been completed without the efforts and support of:

- the Board and members of the MKLPA
- the Board and Chair of the Town of Minocqua
- the Board and Chair of the Town of Woodruff
- the Wisconsin DNR
- the United States Geological Survey
- concerned citizens and local organizations

1.1. What is a "Watershed?"

Meriam-Webster's Dictionary defines a watershed as "a region or area bounded peripherally by a divide and draining ultimately to a particular water course or body of water." In fact, large watersheds are a combination of smaller or sub-watersheds. Delineation of watersheds can be completed by the use of topographic maps. Finding the high point or ridgeline between low draining areas defines the periphery of the sub-watershed.

With the watershed defined, one can evaluate land use within the watershed and begin developing an assessment of the impacts of land use on the water quality within the watershed. The advent of high speed computers and complex mathematical algorithms accents this understanding by allowing the complex inter-relationship of water runoff and infiltration and pollutant loading to be calculated.

Understanding that man's imprint on the surface of the watershed affects the water quality draining from the watershed is a necessity in understanding the affects of water quality degradation in the water courses and basins receiving this water – our lakes, rivers and impoundments.

1.2. What is Runoff?

Rainfall and snow melt are generally termed "runoff" and either runs off the land or infiltrates into the subsurface. Urban storm water runoff is considered to be that precipitation or snowmelt water that is unable to infiltrate the Earth's surface, and enters urban storm water control systems. In the hydrologic cycle (Figure 1-1), runoff water is termed "overland flow." As land is developed, less land area is available for infiltration of storm water, thus runoff increases.

Runoff water drainage systems are incorporated in developed areas as a preventive action to minimize localized flooding. These drainage systems may discharge through an individual or local outfall to a surface water body or swale, or may runoff the land as overland flow. Runoff water quality, however, has not been much of a concern until the last 15 years. The U.S. Environmental Protection Agency (EPA) has defined contaminated surface runoff water as one of the greatest threats to our ecology.

1.3. Runoff Water Regulation Driven by Water Quality

Runoff water has been targeted by the U.S. EPA as the major contributor to the degradation of surface water quality in our environment. In Wisconsin, the Department of Natural Resources (WDNR) regulates runoff water through Wisconsin Administrative Code (WAC) NR 151 and NR 216. Current regulations for the discharge of urban storm water are already in place for larger municipal separate storm sewer systems (or MS4s). These regulations have also been introduced in smaller "urban areas," which have been defined by EPA and WDNR as "an area with a population density of 1,000 or more per square mile, or an area of industrial or commercial uses, or an area that is surrounded by an area described in this definition" (WAC NR 155.12 (31)). The Towns of Minocqua and Woodruff are not identified by the WDNR as a community that will be required to enact storm water management. However, in the interests of protecting and improving water quality in the Lakes, the Minocqua-Kawaguesaga Lakes Protection Association is pursuing the evaluation of watershed water quality and its affects on the lake water quality. The results of this effort will be shared with the Towns and communities in the Watershed to develop the basis for local guidelines and ordinances in an effort to maintain and improve lake water quality.

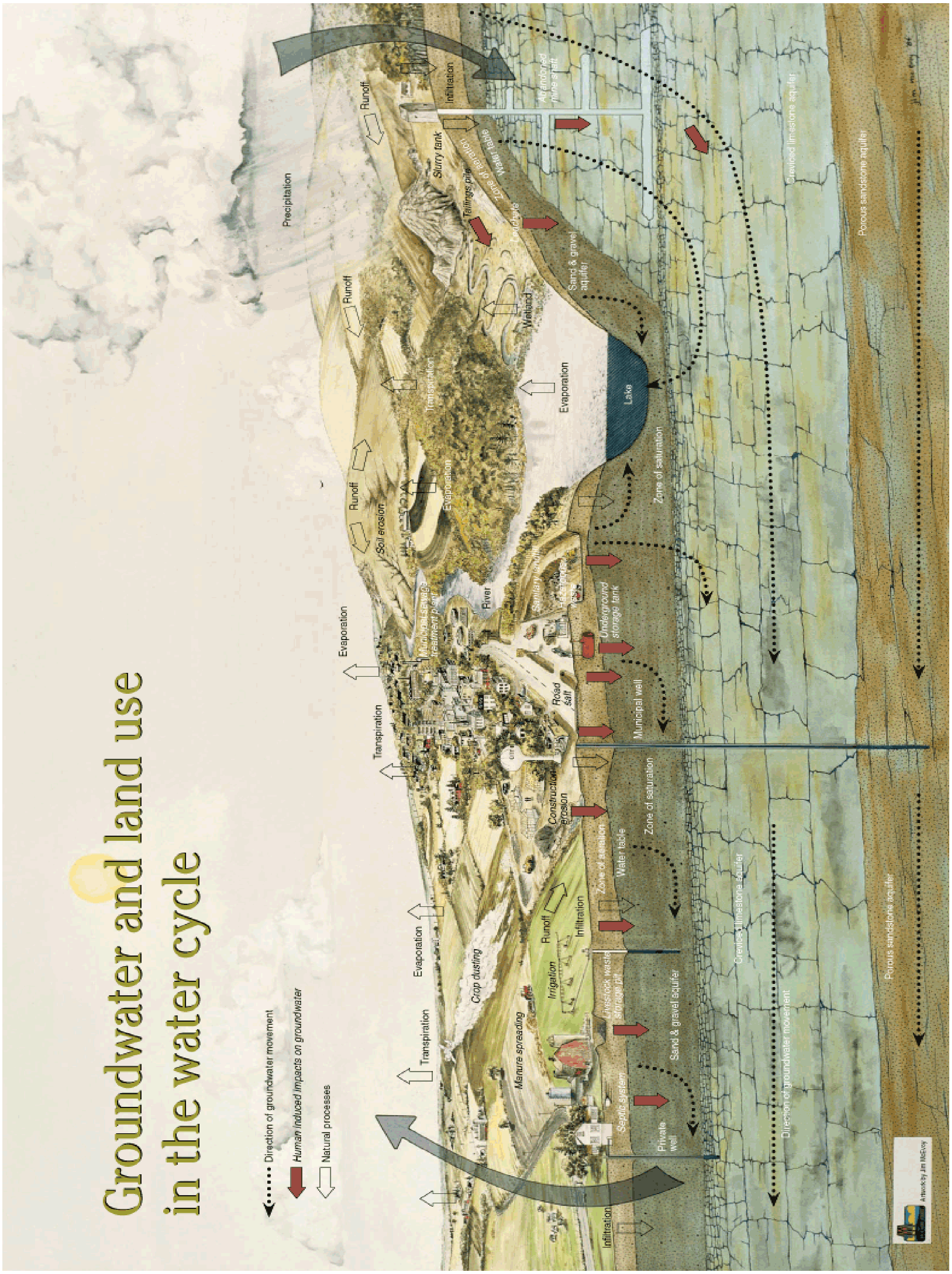
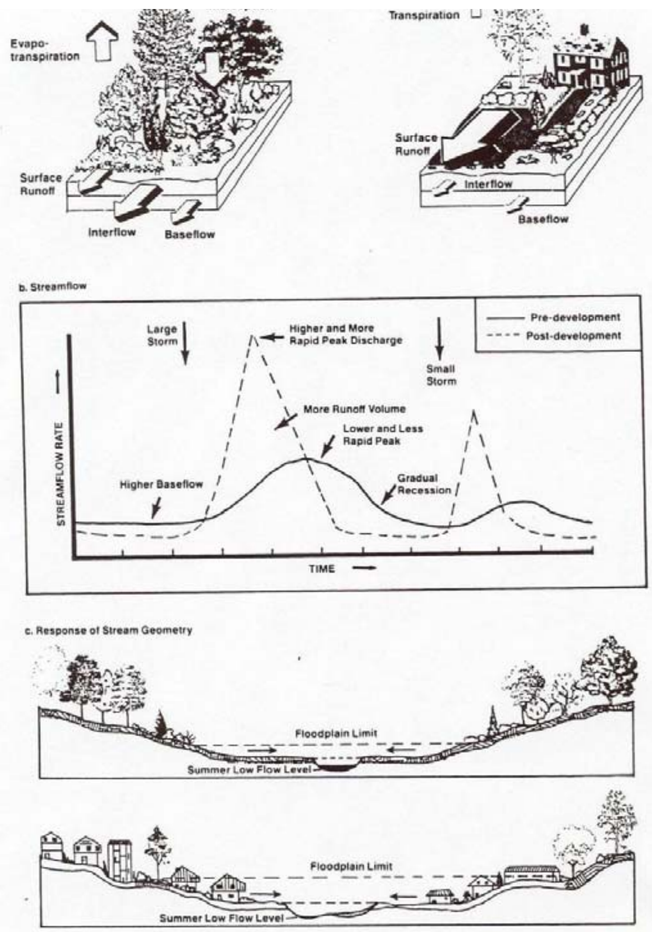


Figure 1-1: Hydrologic Cycle

1.4. Water Runoff Management

Traditionally, the objective of runoff water management has been water quantity control, that is, to transport runoff as quickly as possible through the drainage system to prevent flooding and protect lives and property. Although public health and safety are still the most important goals, other objectives, such as the preservation of water quality, groundwater, and natural habitat, must now be met. Existing flood and water quantity control methods are not always readily adaptable to meet these new requirements, because the historic methods contribute to increased downstream water quantity, generate water quality problems, and do not provide for habitat protection. Likewise, some recommended water quality and habitat solutions, such as naturally vegetated drainage ways, can contribute to upstream flooding problems by reducing the carrying capacity of the drainage conveyance. Figure 1-2 shows the impacts of urbanization throughout a watershed and the increase in water runoff reflects the change in waterways that flow through an urbanized area.

Figure 1-2: Water Balance, Stream Flow, and Stream Geometry; Source: Schueler, 1987



It is necessary to achieve a balance for both water quantity and water quality objectives. This balance is achievable through regional solutions, including effective land use planning to minimize impervious areas and preserve natural vegetation, and the protection of riparian areas along streams and lakes. Local ordinances and codes can be implemented to reduce impervious areas and increase vegetation by limiting the extent to which a site can be developed. Quantity and quality goals can also be met at the local level through proper site planning and appropriate design that carefully considers the various impacts of development and application of Best Management Practices (BMPs) to minimize problems. BMPs are recognized engineering devices that minimize the impacts of polluted runoff on receiving waters. BMPs have been developed for many common problematic situations and are readily incorporated into today's construction design plans. Examples include siltation fences, water velocity checks such as hay bales in swales, etc.

1.4.1. Water Quantity

The quantity or volume of water runoff generated by varying land uses depends on three factors: (1) the intensity of a given runoff event; (2) the duration of the event; and most importantly (3) the amount of impervious area present. Impervious surfaces include asphalt and concrete, building rooftops, compacted soils, etc. Urbanization increases the quantity of runoff, and therefore runoff has a serious impact on receiving waters. As shown in Figure 1-2, the natural water balance is disrupted when an area is developed. Paved surfaces and buildings replace vegetation that once intercepted runoff, allowed it to soak into the ground, and returned water to the atmosphere through evapo-transpiration. Heavily compacted surfaces, such as well-used pastures and compacted lawns, act much the same as pavement in preventing water from seeping into the ground. Snowmelt, especially when accelerated by rain, also increases the chance of flooding. As the volume and flow rate (velocity) of the runoff increases, water reaches streams and lakes more quickly. Less obvious is the reduced quantity of groundwater to contribute base flow to streams, sustain lake levels, and maintain ground water elevation (essential for well supplies). The higher runoff volumes and rates lead to overland erosion, scouring or undercutting of stream banks, flooding, and loss of habitat.

1.4.2. Water Quality

Urbanization adversely affects the quality of runoff water by increasing runoff volume which carries increased erosion and results in more rapid transfer of pollutants to receiving water. This has a serious impact on receiving waters. Runoff collects and transports pollutants, including:

- *nutrients* such as phosphorus and nitrogen, which hasten the lake aging process; this process naturally results in increased algae and plant growth
- *sediment* such as silt (fine particulates), sand, and gravel, which has the capacity to carry other pollutants and can smother fish eggs, also results in shallower lake water
- *bacteria and viruses* from humans and animals
- *organic chemicals*, such as pesticides and hydrocarbons (dissolved in water or adsorbed to the sediment)
- *heavy metals* such as lead, copper, zinc and cadmium, among others, that are usually adsorbed on the grains of sediment are redistributed in ponds and lakes after high runoff events

Sources of runoff water pollutants from developed areas include, but are not limited to:

- automobiles and related surfaces – roads, parking lots, service areas
- construction and new development activities
- atmospheric fallout from vehicle and industrial emissions
- dust from construction/logging/agricultural activities
- overuse and improper disposal of toxic chemicals, pesticides, herbicides, and fertilizers
- illegal discharges to storm sewer systems
- decaying plants and animal wastes from natural and agricultural sources
- disturbed or exposed soils

1.5. Objectives of Watershed Management Planning

This Plan presents general *technical guidelines*. Specific conditions may require site-specific modifications of the practices described or an alternative practice that is approved by a local permitting authority.

The Minocqua-Kawaguesaga Lakes Watershed Management Plan provides a discussion and plans for runoff water and lake water quality protection and improvements. The Plan is intended for water quality and quantity professionals as the community continues to develop within and beyond the local Watershed. We say beyond because this Plan considers only the local Watershed for the Minocqua-Kawaguesaga Lakes. Also affecting water quality in these Lakes are Watershed activities in the Minocqua Chain of Lakes, including those lakes and watersheds draining into the Minocqua and Tomahawk Thoroughfares. These areas, although less developed now, will become the future areas of development. The need for planning water quality improvements is now, such that future developments can be designed to allow improved runoff water quality to protect and preserve the character of these surface waters.

1.6. Components of Watershed Planning (from *The Wisconsin Storm Water Manual*)

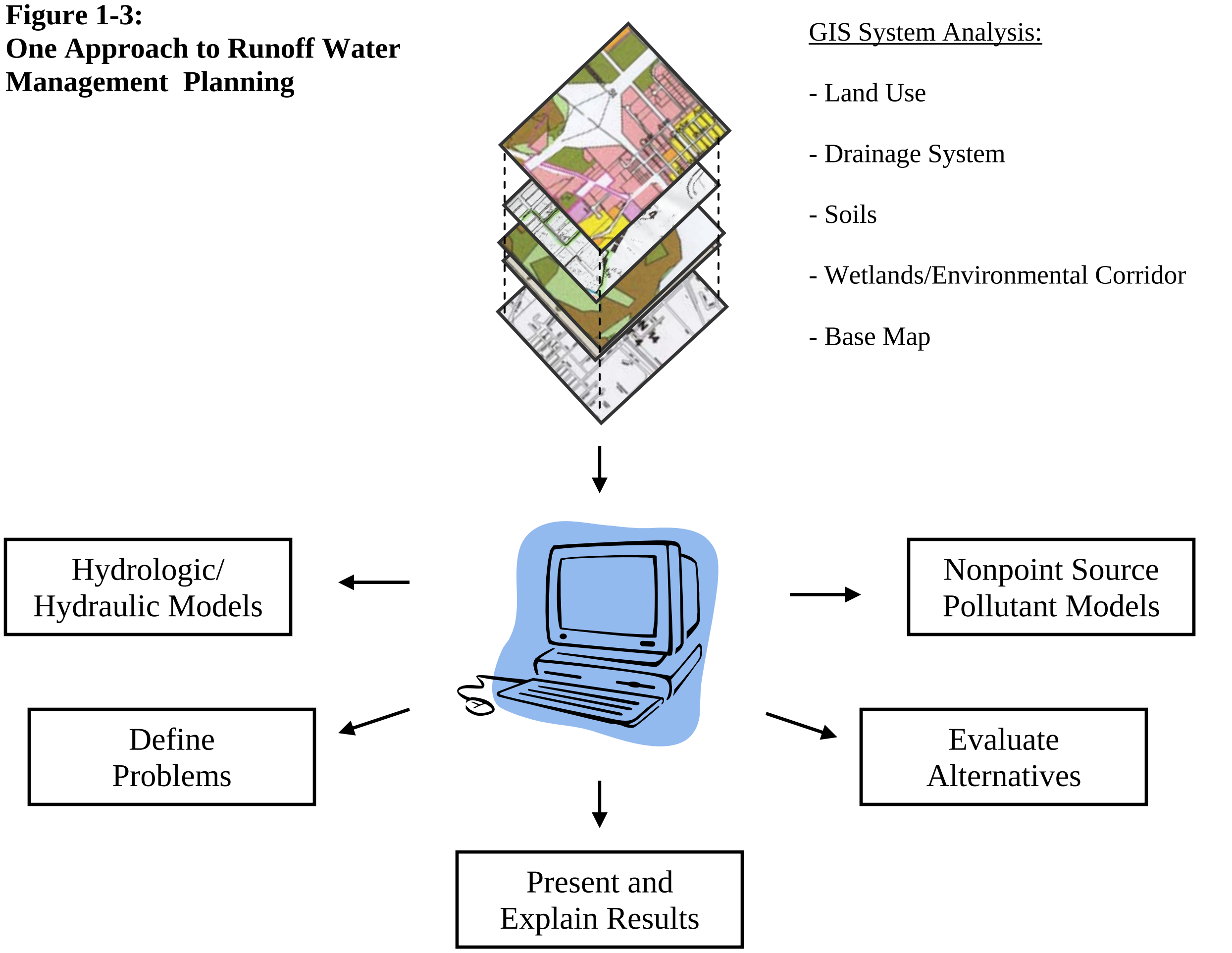
Minocqua-Kawaguesaga Lakes Protection Association is recommending the adoption of runoff water planning and controls with the presentation of this Plan to the local Townships. The adoption of this Plan will require:

- Land Use Planning
- Performance or Design Criteria for Runoff Water Best Management Practices (BMPs)
- Financing Mechanisms
- Storm Water Ordinance

Before completing any component of the Plan, the Protection Association recommends the Townships develop an outline for a Runoff Water Management Plan. There are four fundamental elements to consider when protecting human and environmental concerns:

- Flood Control
- Urban Water Resource Protection
- Generic Urban Nonpoint Source Pollutant Control
- Specific Urban Nonpoint Source Pollutant Control

Figure 1-3:
One Approach to Runoff Water Management Planning



1.7. Updates to the Plan

The practice of lake watershed water quality management is quickly evolving and this Plan must be updated as new information is available. Design information for various BMPs is expected to change as more people apply the practices and learn from their experience. New BMPs will be developed for specific situations that will improve runoff water quality. The Plan should be considered dynamic and regular updates incorporated.

CHAPTER 2: PHYSICAL ENVIRONMENT

The understanding of Lake Watershed Management requires the understanding of existing conditions and resources within the select watershed boundaries. Thus, understanding the physical environment and the history of the Minocqua-Kawaguesaga Lakes Watershed is critical in determining the policies and standards that best protect this Watershed's resources while meeting the member communities' needs.

2.1. Physical Environment

Time and geologic processes (plate tectonics, glaciations, and erosion) have defined the physical environment of the Minocqua-Kawaguesaga Lakes Watershed over the course of millions of years. The distribution of bedrock, unconsolidated (loose) sediments, landforms, and structural features in the watershed are the geologic backbone on which the biological and human environments exist. The characteristics of the physical environment ultimately determine the availability of natural resources, the susceptibility of resources to pollution, and success of organisms living in the watershed.

2.2. Geomorphology and Surficial Geology

Geomorphology is the study of the shape of the Earth's surface and the processes that sculpt it. The relief (variation in height and slope) of the landscape establishes watershed drainage patterns and drives the hydrologic (water) cycle. Topographic maps completed by the USGS and others define these surfaces. Surficial geology is the description of the distribution and physical properties of earth materials that are exposed at the surface. In the Minocqua-Kawaguesaga Lakes Watershed, this is the partially unconsolidated (loosely arranged or uncemented) sediments such as sand and loamy sands existing above the sub-surface bedrock interface. In some areas these unconsolidated sediments are quite thin (10 feet or less), yet in other areas, they are quite thick. The State of Wisconsin maps the overburden in this Watershed at thicknesses of 100 to 300 feet (Figure 2-1).

Throughout time, the forces of wind, water, and ice have modified the landscape of the Minocqua-Kawaguesaga Lakes Watershed. The most recent influential process to shape the topography of the watershed was the movement of continental ice sheets. During the Pleistocene Epoch (between 2 million and 10,000 years before present), glaciers repeatedly covered most of northern Wisconsin. Glaciers shaped the landscape through erosion and deposition of material.

Generally, only the effects of most recent glacial advance and retreat are evident in the land's surface topography as this advance erases the signatures of previous events. About 10,000 years ago, a general warming trend occurred that was periodically interrupted by relatively short, cool periods. This warming trend resulted in the slow melting of the continental ice sheet. As the ice front receded, the sediments carried by the ice sheet were deposited and redistributed by glacial melt water. The Minocqua area is characterized by the Wildcat and Nashville members of the Copper Falls Formation. These members were deposited by the advance and retreat of the Wisconsin Valley and Langlade Lakes during the Wisconsin Glaciation period. These sediments are considered to have been deposited by braided streams on the plains at the foot of retreating glaciers. These sediments are typically well sorted, poorly stratified to well stratified sands and gravels.

2.3. Bedrock Geology

Underlying the unconsolidated surficial sediment is bedrock. The bedrock in the Towns of Woodruff and Minocqua consists of the Early Proterozoic Age (1630-1880 million years ago) materials. Specifically, two Early Proterozoic Age formations are found in the Minocqua-Kawaguesaga Lakes Watershed. The older sequence, Metavolcanic Rocks, is found in the central and western parts of the Watershed. Gneiss is found in the eastern parts of the Watershed. As stated earlier, bedrock is 100 to 300 feet below surface in this Watershed.

2.4. Hydrogeology

Ground water in Minocqua and Woodruff is directly influenced by the lakes and rivers and the tributaries that traverse the region. The primary regional hydrogeologic (ground water) divide in this region is the Tomahawk River. The Tomahawk flows north to southwest of the Lakes and ground water in the project area is interpreted to be flowing southwesterly towards this river.

Municipal Wells #3 and #4 are located on Minocqua Island. Well #5 is located northeast of Woodruff. Wells #3 and #4 are screened in glacial sands and gravel, and are cased to less than 100 feet below surface. Well #5, proposed in 2004, is to be cased some 250 feet below surface and will draw water from the lowermost sand and gravel aquifer just above the almost permeable bedrock surface.

The Well Head Protection Plan and ordinance (Appendix E) provides for a radius of 1,200 feet within which certain land uses, including storm water infiltration basins, are considered prohibited uses.

The sensitivity of the ground water to surficial contamination is a function of the permeability of the surficial soils and underlying sediments and bedrock. The region is mapped as moderately to highly sensitive to ground water contamination. The presence of near surface sandy soils provides a surface readily capable of conducting surface water and dissolved contaminants to the ground water. However, the sandy soils will act as an excellent filter to remove inorganic and organic particulate matter (suspended solids) from the infiltrating surface waters. In addition, there is a less permeable silty layer found at depth in this region. This formation acts as a ground water quality protective barrier for the underlying sand aquifer.

2.5. Soils

When bedrock and sediments are exposed on the Earth's surface, the rocks and minerals erode and decompose (weather). The most important product of this weathering process is soil, or veneer. The formation of soil and the soil type is dependent on five factors:

- **Parent Material –** Refers to the bedrock and/or the surficial geology from which the soil is developed. The differing chemical and physical properties of parent materials results in varying types of soils.

- **Time –** Refers to length of exposure on the earth's surface a parent material has experienced. Soils mature or age (develop horizons, increase in depth, and change chemically). Since glaciers remove older soils and deposit new parent materials, the majority of soils in the Minocqua/Woodruff area are considered to be as old as the last ice age, which occurred approximately 20,000 to 10,000 years before present.

- **Climate –** Refers to the established temperature and moisture conditions at and near the earth's surface. Climate is one of the most important factors affecting mechanical (i.e. freeze-thaw) and chemical weathering (i.e. leaching) of parent materials. It is important to note that climate may change on the time scale over which soils are formed. Oneida County is characterized by a temperate, continental climate. Seasonal changes include long and snowy winters with several very cold days, warm summers with short periods of heat and humidity; and spring and fall transitions which are often short and with increased precipitation.

- **Vegetation –** Refers to the plant community that is established in a soil. Plants mechanically (through root growth) and chemically (by enrichment in organics and removal of nutrients) alter the soil and aide its formation. The dominant vegetation in an area varies and changes with the climate. As humans dramatically alter the vegetative cover faster than soils can adjust, pre-settlement vegetation should be considered when interpreting the soils of the Minocqua-Kawaguesaga Lakes Watershed. The majority of the current land uses are single family residential, recreation, and forest management. Although the downtown cores of the communities are essentially 90% commercial.

- **Topography –** The shape of the land surface. The most important factor of topography for soil formation is slope. The slope of a surface will determine if erosion or deposition is likely to occur. Thus, soil types vary from hilltop to hillside to valley or depression.

Over time, soils develop horizons (a vertical differentiation based on observable physical and chemical properties). The O Horizon is an accumulation of organic material on the soil surface characterized by decomposing plant material with little mineral content. The A Horizon (or top soil) is an accumulation of organic material, with a loose or open texture, and is leached of dissolved chemicals and fine particles. The E Horizon is a light-colored layer characterized by leaching of iron and aluminum with a lower organic content. The B Horizon is the horizon where the material leached from the A and E Horizons tends to accumulate. The C Horizon is made up of slightly weathered parent material that has not undergone leaching or accumulation.

Depending on the soil forming factors acting on a surface, some of the horizons may be poorly developed or missing; and removing, compacting, and/or mixing soil horizons dramatically alters the soil's ability to sustain vegetation.

Soil descriptions are based on their physical and chemical properties. Soil classification systems are used to group soils of similar properties and to provide a systematic means of mapping. For the purposes of this Management Plan, the soils of the watershed are classified by their hydrologic soil group (HSG). This classification system is based on infiltration (water movement into soil) and transmission (water movement through soil) rates. The HSG classification of a soil describes the potential of that soil type to produce runoff. The four hydrologic soil groups as defined by USDA (1955) are:

- **Group A:** Well to excessively drained soils. High infiltration rate even when thoroughly wetted. Transmission >0.30 inches per hour.

- **Group B**: Moderately well to well-drained soils. Moderate infiltration rates when thoroughly wetted. Transmission between 0.15 and 0.30 inches per hour.

- **Group C**: Soils with an impeding layer to downward movement. Low infiltration rates when thoroughly wetted. Transmission between 0.05 and 0.15 inches per hour.

- **Group D**: Soils that are almost impervious at or near the surface. Very low infiltration rates when thoroughly wetted. Transmission between 0 and 0.05 inches per hour.

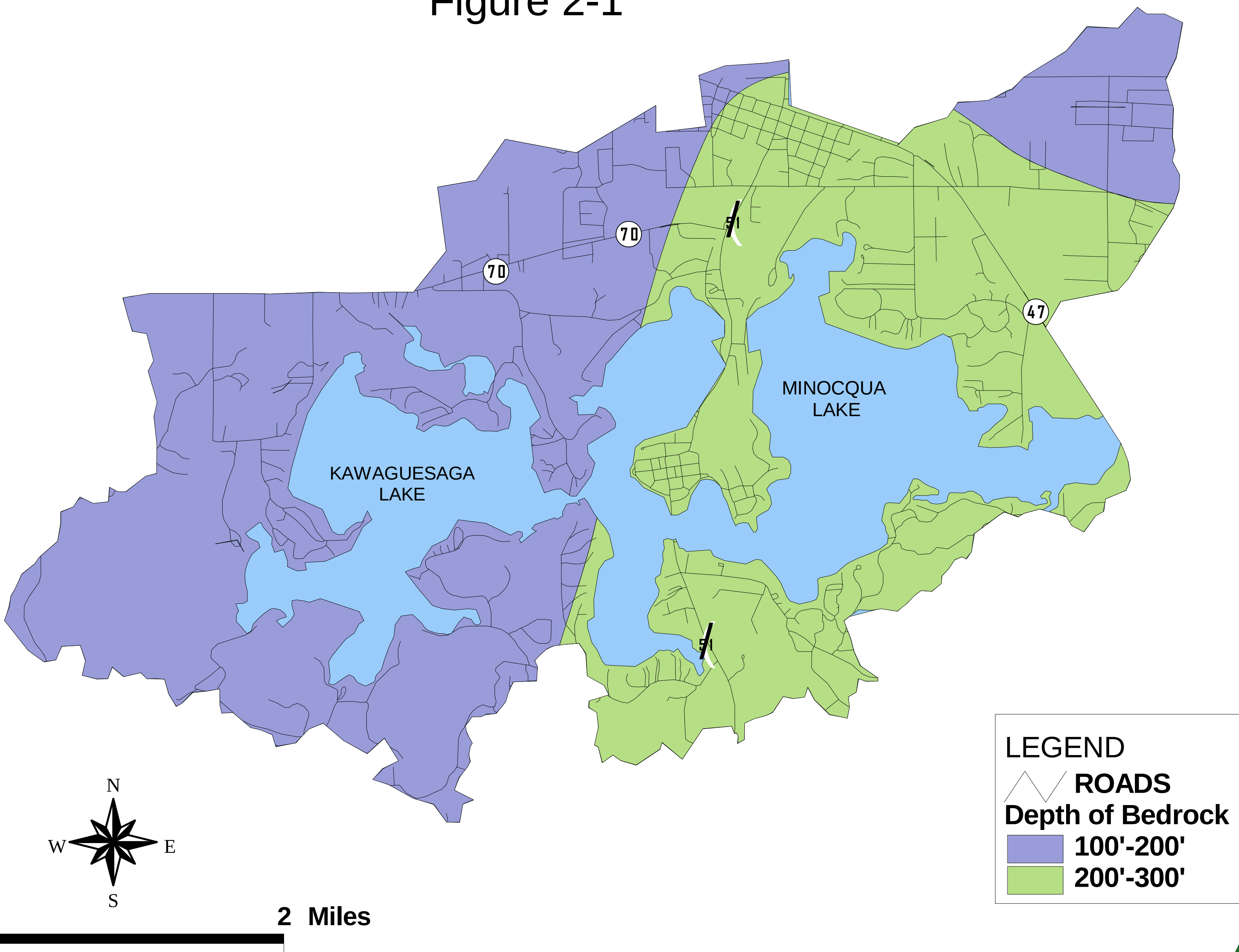
- **Note**: Soils that do not meet the criteria of Group A, B, C, or D may be saturated and do not have an established rate of infiltration.

The relationship of a soil's hydrologic soil group to its landscape position is important in delineating wetlands and determining its susceptibility to erosion. Wetland, or former wetland, areas are characterized by hydric soils. Hydric soils are defined in the 1987 Army Corp of Engineers Wetland Delineation Manual (ACEWDM) as "soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation."

Areas with low infiltration rates (Group C and D) and flatter topography are more likely to form wetlands, but wetlands may also form where the water table is at or near the surface regardless of soil texture. Wetland hydrology is defined in the 1987 ACEWDM as "the sum total of wetland characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation." In order for wetland hydrology to be present, the area must be inundated or saturated to the surface for at least 5% of the growing season (consecutive days) in most years (>50%). From May 18 to September 23, the average growing season for Oneida County is 127 days (*Soil Survey of Oneida County, Wisconsin*, USDA SCS, 1993). Therefore, areas inundated or saturated for seven or more consecutive days (5% of 127 equals 6.35) during the growing season during most years meets the definition of a wetland.

The soil erosion potential is a combination of a soil's infiltration rate, texture, drainage, and slope. Areas with low infiltration rates and steep slopes have soils that are more likely to erode, but even soils with high infiltration rates are highly likely to erode on steep slopes. The reader is referred to the *Soil Survey of Oneida County, USDA SCS, 1993 (pg 83 and Table 17),* for more detailed and site specific information on soils in the Minocqua/Woodruff area.

MINOCQUA / KAWAGUESAGA LAKES
DEPTH OF BEDROCK
Figure 2-1



Source: University of Wisconsin - Extension 1973

CHAPTER 3: PROJECT DESCRIPTION

Adopted recommendations of the Minocqua-Kawaguesaga Lakes Watershed Management Master Plan will guide site specific implementation of runoff water management practices within the watershed of the Minocqua-Kawaguesaga Lakes. The Watershed Management Master Plan utilizes the best available methodology designs and management practices to encourage infiltration; reduce velocities and volume of storm water runoff, reduce pollutant loading, and minimize impacts on the Lakes, wetlands, groundwater, and other ecological and natural features.

3.1. Purpose of Watershed Planning

The purpose of this Minocqua-Kawaguesaga Lakes Watershed Management Master Plan is to minimize runoff, encourage runoff infiltration, prevent property damage and hazardous conditions, prevent erosion, reduce sediment and nutrient deposition in the storm water conveyance system and waterways, protect the quality of groundwater, protect the water supply aquifer, preserve the Minocqua-Kawaguesaga Lakes as an asset to the community, and minimize the negative impact to existing and future storm water discharges to the Lakes and the environment. By implementing this Plan, less soil erosion and the pollutants dissolved in runoff water will be discharged to the drainage ways, wetlands, environmentally sensitive areas, Lake Kawaguesaga, Minocqua Lake and the Tomahawk River.

The Minocqua-Kawaguesaga Lakes Watershed Management Master Plan will serve as a guide for local land owners and developers to foster development of a well-designed and efficient community that serves the needs of residents and businesses; and, improves and preserves the high quality of the natural environment. The guiding principle in developing this Plan is to enhance, protect, and preserve the unique environmental characteristics of the Minocqua-Kawaguesaga Lakes.

There are several reasons why technical guidance regarding storm water management is necessary:

- Location: The majority of the Minocqua and Kawaguesaga Lakes' watershed is located in the northeastern part of Minocqua and northwestern part of Woodruff. The Towns of Minocqua and and Woodruff are located in north-central/northwestern Oneida County, in north-central Wisconsin (Figure 3-1), at the intersections of State Highways 51, 70 and 47. Some parts of the lakes are dominated by densely populated areas. This represents a threat to the water quality of the Minocqua and Kawaguesaga Lakes.

- Growth: The Towns of Minocqua and Woodruff are growing fast. The population of the Towns of Minocqua and Woodruff is projected to increase by 15% (to 8,239) in the year 2020. Because of its natural beauty, the Towns of Minocqua and Woodruff have and continue to experience a rapid growth in tourist activity. In fact the population in the area nearly quadruples in the summer months. In addition to tourism, there is a steady growth of residents as well. Keeping in mind that the population is concentrated in the Minocqua and Kawaguesaga Lakes' watershed, planning for proper runoff water management is necessary to address the anticipated increase in runoff water as land use development increases.

- Rapid population growth translates to rapid land development, which is a recognized source of nonpoint source pollutions, or "polluted runoff." The Plan includes BMPs to minimize the discharge of pollutants from developing areas, both during the construction phase and for the life of the site. These BMPs can be used just as effectively to reduce polluted runoff from existing land development.

- Tourism: The beautiful Minocqua-Woodruff-Arbor Vitae area has over 3,200 lakes, streams, and ponds for everyone to enjoy. This is why the population in the area nearly quadruples during the summer months. To maintain the attractiveness of the area, one of the most important tasks is to maintain or improve the water quality in the area. The BMPs suggested in the Plan will protect the Minocqua-Kawagueasaga Lakes from degradation.

- Water Quality Concerns: Many water bodies throughout the state are not in compliance with state water quality standards. Beneficial uses such as domestic and agricultural water supply, fishing, swimming, and boating, can be impaired due to excessive pollutants from storm water runoff. The Plan provides guidance for controls through the use of BMPs to reduce "conventional" pollutants, with special consideration for total phosphorus and total suspended sediments.

3.2. Scope of Plan

Surface water management refers to the control and management of runoff water, including subsurface and surface water conveyance, flooding control, and water quality. It is also now widely recognized that runoff water management is more than a local issue; it requires the consolidation and coordination of the many independent efforts into a system that recognizes the regional nature of storm water and flood runoff water runoff, groundwater, and water quality pollutant loads.

The recommended storm water management philosophy encourages storm water systems which closely mimic the runoff process of a site in its natural state by preserving natural storage, conveyance, and filtering mechanisms. This approach should reduce drainage system construction costs by minimizing the need for expensive capital improvements to convey, store, and treat increased runoff water runoff volumes and flow rates.

An important tool in effective runoff water management is information of existing conditions, problems, and opportunities. The Lake Watershed Plan identifies local watershed and sub-watershed boundaries; and, natural and manmade drainage features, such as ditches and culverts. The Plan also identifies location of significant natural resource areas, natural storage areas, including depressions, woods, prairie grasses, and wetlands. The Plan describes the existing problems related to drainage, local flooding, sedimentation, degradation of existing natural resources, and storm water quality. Based on existing and future conditions, the Plan proposes effective requirements for existing land uses, new developments, and remediation needs, as well as opportunities for regional water quantity and quality runoff water management facilities.

Strategies that address the area's unique climate, topography, natural resources, hydrogeology, and land use patterns are necessary. By making use of regulatory, land use planning, and educational approaches whenever feasible, rather than costly structural solutions, the Minocqua-Kawaguesaga Lakes Watershed can greatly reduce the ultimate costs of implementing the Watershed Management Plan.

Management techniques are similar from one part of the Watershed to another, but are accomplished with different methodologies. In new developments or redevelopment areas, the program emphasizes land use planning approaches using site plan and subdivision review to decide specific storm water management actions. In existing rural and developed areas, the use of police powers and regulatory powers to abate, enjoin, or criminalize illicit discharges and the dumping of pollutants into the storm water system is crucial.

Public education policy and programs can reduce discharges of old motor oil, household wastes, litter, anti-freeze, deicing chemicals, yard fertilizers, agricultural herbicides, pesticides, and fertilizers. More frequent and improved inspections, operations, and maintenance are necessary to reduce illicit discharges into the storm water conveyance system.

3.3. Products of the Plan

This Plan will produce numerous products. A brief outline of the steps involved in preparation of the Minocqua-Kawaguesaga Lakes Watershed Management Master Plan includes:

1. Determine Watershed project area boundaries (watershed, sub-watershed, and sub-area delineations) for use in hydrologic, hydraulic, storm water management, and water quality analysis.

2. Gather, inventory, and map data within the project boundary, including land use planning information from WISCLAND, Zoning data, and Comprehensive Plan data, etc.

3. Review the DOT drainage conveyance system mapping. Inventory and inspect major DOT and Town outfalls and storm sewer conveyance systems.

4. Identify existing water quality, runoff water conveyance and management problems.

5. Establish the location and size of runoff water management and conveyance facilities.

6. Analyze and estimate the runoff water runoff pollutant loads and runoff water quantity under existing land use conditions.

7. Analyze and estimate the storm water runoff pollutant loads and storm water runoff quantity under proposed future 2020 land use conditions, or fully-developed conditions.

8. Analyze and estimate the storm water runoff pollutant loads and storm water runoff quantity under proposed future 2020 land use conditions, or fully-developed conditions, with the implementation of runoff water management facilities and best management practices.

9. Based on the guidance provided by the Minocqua-Kawaguesaga Lakes Protection Association, the Towns of Minocqua and Woodruff, residents, and WDNR, establish runoff water management goals and policies for the successful implementation, completion, and regular updates of this Plan.

3.4. Lake Ecosystem

Stable ecosystems have great diversity and habitat. Water quality in a lake without wetlands, marshes, near shore shallow areas, or deep open water is more unstable than a lake with this diversity. However, as the years change, season-by-season, the diversity of the ecosystem also changes. A single, short-term algae event does not necessarily single out a long-term problem. While land use changes in the watershed, the effects of these changes may not be immediately seen in the lakes. The effects may take years, decades, or more before the negative impacts are realized.

Wisconsin lake shorelines were once natural with lush vegetation. Private homes were sparse; oars and manpower controlled boats; and a crowded lake meant seeing another person on the lake. The lake of this scenery and serenity was established when we visited a resort or a friend's vacation home. The recent (last 30 years) rush to acquire that refuge has resulted in many of the concerns discussed in this Lake Watershed Management Master Plan.

Living organisms around and in lakes require a special balanced habitat that provides food, shelter, oxygen, and other specific needs. "The margin of our water is the place where all life comes together…a bridge between two worlds. It is a place essential for plants and creatures to survive. As many as 90 percent of the living things in our lakes and rivers are found along their shallow margins and shores." (Rideau Canal, Parks Canada). The littoral zone provides a nursery for fish, refuge from predators, and it intercepts nutrients.

The water lilies, fish, and other organisms on the Lakes need to be protected to maintain a healthy habitat and balanced ecosystem so desirable species thrive. If one habitat is altered beyond recovery, the entire community will change in some way.

3.5. Movement of Water

Wisconsin is blessed with the third largest concentration of fresh water glacial lakes on the planet; only Ontario and Alaska have more. Of Wisconsin's 15,081 lakes, it is easy to see the lure of the Minocqua area lakes. About 75 percent of the precipitation that falls to our lakes and land re-enters back into the earth's atmosphere from evaporation and plant transpiration. On flat land or sandy areas, water infiltrates to the ground water and moves toward lakes and rivers. But the excess water runs off the land and enters the lakes and rivers. Lake levels fluctuate season-to-season in response to rainfall events, outside temperature, dams, etc. Such fluctuations are characteristic of normal lake systems.

The classification of lakes is dependant upon water source and types of outflow for the individual water body.

A. A lake fed by precipitation, with limited runoff and ground water, and has no stream outlet is called a <u>seepage lake</u>.

B. A lake fed by ground water, with limited precipitation and runoff, and has a stream outlet is called a <u>ground water drainage lake</u>.

C. A lake fed by precipitation, ground water, runoff, and is drained by a stream outlet is called a <u>drainage lake</u>. Minocqua and Kawaguesaga are classified as drainage lakes.

D. A manmade lake created by damming a stream, which still allows it to drain, is called an <u>impoundment</u>. The Minocqua Chain of Lakes is considered an impoundment.

3.6. Oxygen Supplies in Lakes

Aquatic plants produce oxygen gas, which is dissolved in lake water, and is absorbed by the atmosphere. In the winter, the ice on the Lakes seals off this transformation to the atmosphere and the snow cover prevents sunlight from reaching the aquatic plants. The plants may then die without oxygen, decompose, and consume oxygen. This process can cause winter kill in shallow lakes when the oxygen is depleted and is not replenished.

3.6.a. Mixing

Mixing of water in the lakes control lake oxygen supplies and the depth, size, and shape of the lake controls the ability for water to mix. In the summer, shallow lakes easily mix by wind action, if not protected, and the nutrients within the lake also mix. However, deep lakes (>20 feet) stratify, or form separate layers, and only the water closest to the surface mixes with the atmosphere.

3.6.b. Stratification

Summer stratification in deeper lakes (over 20 feet deep) usually forms three layers. The warm surface layer is called the epilimnion, and oxygen is mixed from the atmosphere in this layer. The transition zone between warm surface water and cold, deep water is called the thermocline, or metalimnion. The cold bottom water is called the hypolimnion. Deeper lakes that do not mix usually have low oxygen levels in the hypolimnion and this layer usually traps nutrients that are released form the lake bed sediments.

3.6.c. Retention Time

A lake's size, water source, and watershed size determine the average length of time water remains in a lake, or the retention time. Another way to look at this would be to see how long it would take to fill a drained lake. The USGS is preparing to complete a comprehensive study of the Lakes to identify this period.

3.7. Lake Water Quality

The USGS collected and analyzed historic and recent water quality data. This data and analyses are summarized in Appendix C.

3.7.a. Water Clarity

Two components determine water quality: materials dissolved in water and materials suspended in water (turbidity). Water quality is relatively regularly measured as clarity with a Secchi disc. It is an indicator or measure of water quality used for comparison with other lakes and is compared to other chemical and physical properties of the lake.

A Secchi disc is a round, 8-inch, weighted, flat disc with alternating black and white quadrants that can be lowered into a lake to visually measure water clarity. The depth at which the Secchi disc disappears is related to the quantity of nutrients and type of algae present in the water column: the higher the readings, the clearer the lake. Cloud cover, sun's angle, and waves, affect this reading, so it is recommended to be performed on calm, sunny days between 10:00 a.m. and 2:00 p.m. Wisconsin DNR references the water clarity index as:

Water Clarity Index	
Water Clarity	**Secchi Depth (ft)**
Excellent	32
Very good	20
Good	10
Fair	7
Poor	5
Very Poor	3

Modified from: Understanding Lake Data, Table 2, WDNR

3.7.b. Nutrients

Runoff that contains high concentrations of phosphorus and nitrogen (basic biological nutrients) can lead to increased plant growth and algae blooms in the receiving waters. River impoundments have the greatest risk of increased rates of eutrophication. In this region, phosphorus is typically the main nutrient controlling plant growth algae blooms in water systems as nitrogen is typically available.

3.7.c. Trophic Status

Section 305b of the Clean Water Act requires each state to construct "fishable" and "swimmable" goals. Federal requirements in Section 314 of the Clean Water Act require all lakes of the nation be classified using a single criteria.

Scientists have established criteria to evaluate the nutrient state of the lakes, since they are unique and at different levels of eutrophication. The first scientist to develop the trophic state concept was Einar Naumann, a Swedish limnologist from the University of Lund, Sweden. However, the terms describing this classification were adopted from C.A. Weber, who classified bog nutrient content.

<u>Eutrophication</u> is referred to as the process by which lakes are enriched with nutrients, accumulated sediments, productive aquatic plants, and algae. In Table 3-1 below, four trophic state designations for lakes are listed with corresponding TSI value/ranges and descriptions.

Table 3-1: Trophic State Index (TSI)

TSI Value	Water Quality Attributes	Fisheries, Recreation or Example Lakes
<30	**Oligotrophic:** Clear water, oxygen through the year in the hypolimnion. Water supply may be suitable unfiltered.	Salmonid fisheries dominate.
30-40	Hypolimnia of shallower lakes may become anoxic during the summer.	Salmonid fisheries in deep lakes only. Example: Lake Superior (WDNR)
40-50	**Mesotrophic:** Water moderately clear but increasing probability of anoxia in hypolimnion during summer. Possible iron, manganese, taste and odor problems may worsen in water supply. Water turbidity requires filtration.	Walleye may predominate and hypolimnetic anoxia results in loss of salmonoids.
50-60	**Eutrophic:** Lower boundary of classic eutrophy. Decreased transparency, anoxic hypolimnion during the summer, macrophyte problems evident, warm water fisheries dominant.	Bass may dominate.
60-70	Dominance of blue-green algae, algal scums probable, extensive macrophyte problems. Possible episodes of severe taste and odor from water supply. Anoxic hypolimnion, water-water fisheries.	Nuisance macrophytes, algal scums and low transparency may discourage swimming and boating.
70-80	**Hypereutrophic:** Light limited productivity, dense algal blooms and macrophyte beds.	Lake Menomonie & Tainter Lake, Menomonie, WI (WDNR).
>80	Algal scums, few macrophytes, summer fish kills.	Dominant rough fish.

There are many opinions being presented that would alter the correlation between TSI and water quality. In this text, the table above, as presented by the WDNR, is used to evaluate the Trophic State of the lake.

3.8. Carbonate System

Biological productivity, lake acid buffering capacity, and solubility of toxic chemicals are affected by a lake's carbonate system. Many natural occurring chemicals of this system constantly change with sunlight, temperature, each wave, and different biological activity.

3.8.a. Lake pH

An important aspect of the carbonate system is the acidity of pH of the lake. The pH indicates the amount of available hydrogen ions (H^+) in water. The more acid (pH less than 7) the water, the more hydrogen ions are present. Basic or alkaline water has less hydrogen ions (pH greater than 7). Neutral water has a pH of 7.

The pH in Wisconsin lakes ranges from 4.5 in reducing lakes to 8.4 in hard water lakes. Rainfall also varies in pH from 4.4 in southeast Wisconsin to 5.0 in northern Wisconsin (WDNR). These ranges are deceiving, but acid levels change 10 times for every pH unit. Therefore, a lake with a pH of 7 is 10 times more acidic than a lake with a pH of 8 because there are 10 times as many H^+ ions.

Most fish live between 5 pH to 9 pH values. Moderately low pH doesn't usually harm fish. However, with lower pH concentrations, metals (aluminum, iron, mercury and zinc) become soluble and are released from the lake bottom sediments. Lakes that contain more acidic waters usually have tainted fish due to high levels of mercury or aluminum. When eagles, loons, osprey, or humans eat tainted fish, the metals accumulate in their bodies and can threaten their health. The relative affects of lake water acidity on fish species are given below. Note the sensitivity of the walleye fishery to a pH of 6.5 or less.

Effects of Acidity on Fish Species	
Water pH	**Resulting Effect**
3.0	Toxic to all fish
3.5	Perch disappear
4.5	Perch spawning inhibited
4.7	Brown bullhead, northern pike, pumpkinseed, rock bass, sunfish and white sucker disappear
5.0	Spawning inhibited in many fish
5.2	Burbot, lake trout, & walleye disappear
5.5	Smallmouth bass disappear
5.8	Lake trout spawning inhibited
6.5	Walleye spawning inhibited

Source: Olszyk 1980

3.8.b. Alkalinity and Hardness

Alkalinity and hardness of lake water is affected by the quantities of impurities that dissolve or come in contact with lake water, soil minerals, and bedrock. Bicarbonate and carbonate are two alkaline compounds that act as acid buffers and are usually found combined with calcium (calcium carbonate: calcite or limestone) and magnesium (calcium magnesium carbonate: dolomite).

Much of northern Wisconsin contains glacial deposits that contain very little to no limestone. Therefore, these soils that have a higher sand content tend to have lower alkalinity and hardness. However, if a lake receives groundwater through limestone bedrock, the water will contain higher alkalinity and hardness. More fish and aquatic plants are produced in hard water lakes than soft water lakes.

Hardness Categorization	
Total Hardness (mg/L $CaCO_3$)	**Hardness Level**
0-60	Soft
60-120	Moderately Hard
120-180	Hardness Level
> 180	Very Hard

3.9. Minocqua and Kawaguesaga Lakes Water Quality

A discussion of the current water quality of the Minocqua and Kawaguesaga Lakes will be introduced when the USGS has completed its sampling and analytical efforts.

3.10. Elements of Watershed Management

Requirements for watershed management contained in local ordinances and subdivision regulations (Appendix B) should embody a comprehensive watershed management philosophy. The following key elements are incorporated in this approach:

1. **Provide effective soil erosion and sediment control during construction and/or urban development.** Sediment eroded from construction sites is one of the most significant pollutants. Subdivision codes and ordinances must include effective erosion and sediment control regulations and must be diligently enforced. Effective construction site controls include: avoidance of highly erosive areas, such as steep slopes; minimizing the area and time of disturbance; stabilizing disturbed areas with effective erosion control measures as soon as feasible; trapping sediment before it leaves the site; providing routine maintenance and inspection of installed practices; and providing effective enforcement when necessary. Effective soil erosion and sediment control must be in

place prior to any land disturbing activities in accordance with local ordinances and WAC Chapter NR 216 regulations. WAC Chapter NR 151 regulations will require sediment load reductions of 40% for redevelopment and 80% for new development.

2. **Minimize impervious surfaces on the development site, consistent with the needs of the project**. This objective can be accomplished by minimizing required street widths, buildings and parking lot areas, reducing house setbacks and required parking areas, and other creative techniques.

3. **Attenuate flows in natural swales, depressions, and waterways.** This objective encourages site designs which, to the extent practical, utilize the existing natural storm water conveyance and storage features to infiltrate runoff and to filter out pollutants. This is in contrast to past design practices which often filled depressions and replaced natural swales with underground storm sewers and concrete lined channels. Protection of natural drainage conveyance features can be accomplished by careful site planning and by planned unit developments (PUDs) which cluster development away from sensitive areas and preserve sensitive and environmental protection areas.

4. **Infiltrate and filter runoff from impervious surfaces.** This can be accomplished by draining rooftops, downspouts, streets, and parking lots onto adjacent pervious lawns, filter strips, swales, and prairie grasses, where feasible. This approach maximizes the use of the green areas of a development for runoff water management, infiltration, and groundwater recharge. Even though curb/gutter/storm sewer systems minimize opportunities for contact between impervious runoff and pervious landscaping prior to discharging to streams and natural resource areas, there is a need for curb/gutter/storm sewer pipe systems where natural drainage designs are not feasible and practical.

5. **Provide effective runoff water detention.** Accepted and researched runoff water detention standards have evolved significantly since the late 1980s. Recommended detention storage volumes have increased based on new information on statistical rainfall amounts and evaluations of detention performance. Detention release rates should be based on the natural carrying capacity of downstream channels and floodplains and predevelopment conditions. Release rates reduce the occurrence of downstream channel erosion. Detention should be designed to remove water pollutants through improved settling, filtering, and biological uptake methods. These functions can be achieved in detention basins designed as natural prairies, wetlands, and/or wet ponds.

6. **Construct combined storm sewer systems.** Storm sewers are necessary in many developments for effective operation and maintenance and for the purpose of prolonging pavement service life. Storm sewers should be engineered and constructed as combined storm sewer conveyance systems. Combined storm sewer conveyance systems consist of a combination of storm sewer pipe and grass swale/ditch conveyance systems constructed upland of detention basins and receiving water bodies to reduce storm water runoff volume and pollutant loading by maximizing infiltration, storage of pollutants and

temporary storage of storm water runoff. Discharging of storm sewer pipe conveyance systems directly to receiving water bodies, such as wetlands, creeks, streams, rivers, and lakes, should be discouraged.

7. **Promote cost-effective non-structural control BMPs**, such as cluster developments, street sweeping, fertilizer control, homeowner source pretreatment systems, ordinances, land use controls, catch basin sumps, agricultural land management practices, no till farming, public education, and information.

   The NR 151 Urban Performance Standards are specifically listed under Subchapter III – Non-Agricultural Performance Standards. Non-agricultural areas are required under NR 151.12 Post-Construction requirements for new or redevelopment to have:

   - **Written Comprehensive Site Storm Water Management Plan**

   - **Reduced Total Suspended Solids Pollutant Discharges**

     - 20% reduced by October 2008 and 40% reduced by October 2013
     - Activities include modeling of pollutant loads; installing and maintaining BMPs, investigating illicit discharges, creating a leaf and grass clippings program, creating an Information and Education program, etc.
     - *New development* areas are required to reduce 80% TSS [NR 151.12 (5)(a) 1.]
     - *Redevelopment* areas are required to reduce 40% TSS [NR 151.12 (5)(a) 2.]

   - **Peak Discharge 2-year, 24-hour flow control** [NR 151.12 (5)(b)]

   - **Peak Discharge control of 2-year and 10-year, 24-hour post-development storm** events at pre-development rates: 25, 50, and 100-year, 24-hour post-development storm events at 10-year, 24-hour storm event predevelopment rates, or less, if downstream capacity is not adequate is recommended as part of this Plan.

   - **Infiltration standard** [NR 151.12 (5)(c)]:

     - *Residential*: Infiltrate 90% of the average annual predevelopment infiltration volume - OR - 25% of the 2-year, 24-hour storm if soil conditions are suitable.
     - *Non-residential*: Infiltrate 60% of the average annual predevelopment infiltration volume – OR - 10% of the 2-year, 24-hour storm if soil conditions are suitable.

   - **Protective areas (buffers)** [NR 151.12 (5)(d)]

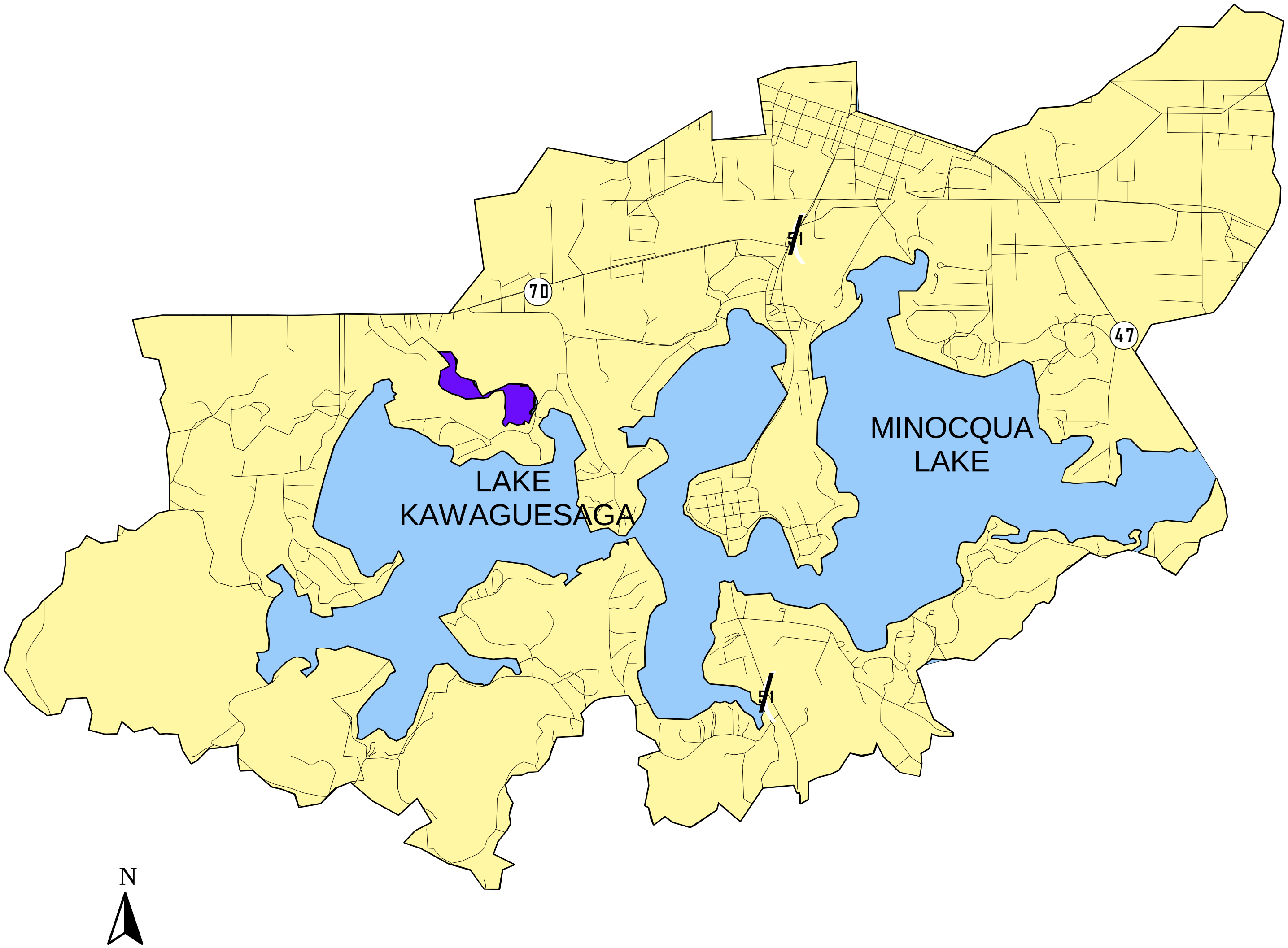
   - **Fuel and maintenance areas** (no sheen) [NR 151.12 (5)(e)]

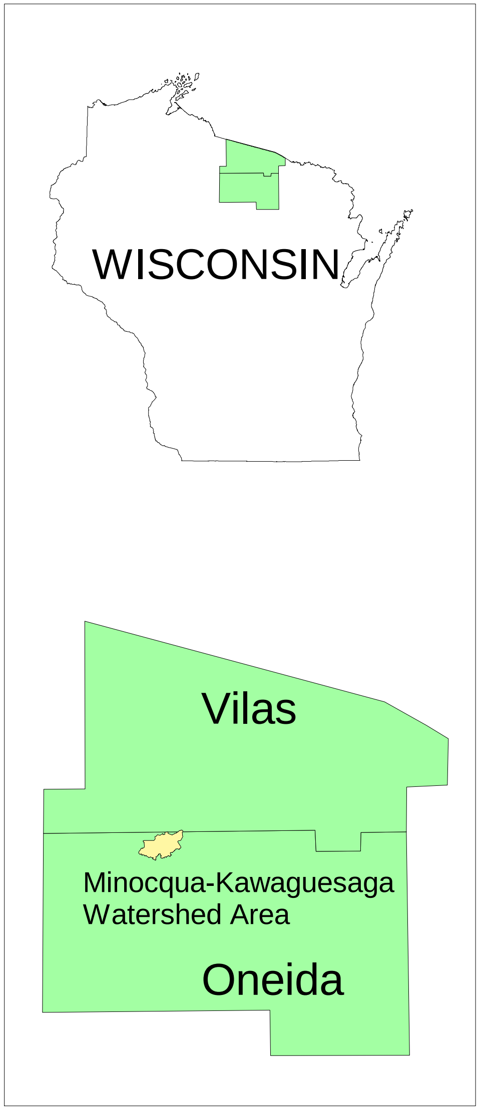
MINOCQUA/KAWAGUESAGA LAKE PROTECTION

Oneida and Vilas Counties, Wisconsin

LOCATION MAP

Figure 3-1





SOURCE: Cedar Corporation, ESRI

CHAPTER 4: GENERAL WATERSHED DESCRIPTION

4.1. General Description

A watershed is a land area in which the overland runoff can be traced to a predicted outlet; thus, the entire area of one watershed drains to one location in that watershed.

The Minocqua-Kawaguesaga Lakes Watershed can be divided into 26 large watersheds and many more sub-watersheds; most of which ultimately outlet into the Minocqua or Kawaguesaga Lakes. These watersheds consist of the commercial, industrial, recreational, rural, multiple- and single-family residential, and forest.

Each type of land use has different impacts on its portion of the watershed. Developed commercial and industrial areas have a large percentage of impervious surfaces which create a greater quantity of high velocity runoff. Similarly, residential areas have a high percentage of impervious area, but yield different sources of runoff water pollutants. Undeveloped woodland creates less runoff than the developed areas due to greater infiltration and transpiration.

The developed areas in the two towns tend to have the opposite effect on the watersheds. Storm sewer systems quickly convey runoff water to the watershed outlet with high peak quantity and high velocities. This, when combined with the minimal infiltration in these areas, creates times of high runoff quantity, which quickly impacts the Lakes with high water volumes and high concentrations of dissolved and suspended pollutants.

These currently developed areas, as well as future development, place the highest stresses on the area's sensitive watersheds. The Watershed Management Master Plan will gather existing system information, evaluate storm sewer system capacities, identify system areas that need to be upgraded or repaired, and direct development to areas that will minimize impacts on surface and ground waters. Best Management Practice recommendations will be developed for recommendations as future implementation projects.

4.2. Delineation of Watersheds, Sub-watersheds, and Sub-areas

The Minocqua and Kawaguesaga Lakes are located in the east central portion of the 187 square mile Upper Tomahawk River Basin (DNR designation UW-38) in north central Oneida County/ south central Vilas County. This basin includes the Towns of Minocqua, Woodruff and Arbor Vitae. Runoff water is conveyed through to the Tomahawk River through many sub-watershed area drainage ways. Ultimately, the Tomahawk River discharges to the Wisconsin River about 30 miles south of the Town of Minocqua. The study watershed includes the Towns of Minocqua and Woodruff. Storm water runoff is conveyed to the Lakes of Minocqua and Kawaguesaga from a number of sub-area drainage ways (Figures 4-1 to 4-27), and then drains into the

Tomahawk River from Kawaguesaga Lake. The Tomahawk River then drains to the Wisconsin River, an important riverway in the history and culture of the people of Wisconsin.

4.2.a. Environmental Corridors

Environmental corridors (water quality buffer areas) identified in this Watershed Management Master Plan form continuous systems of open space that include: environmentally sensitive lands, natural resources requiring protection from disturbance and development, and lands needed for open space and recreational use. They are based mainly on drainage ways, stream channels, floodplains, wetlands, and other resource lands and features. Environmental corridors are used to address the multiple concerns of drainage, water quality, recreation, and open space.

Protection and preservation of environmental corridors contribute to environmental protection in general and specifically to water quality through reduction of nonpoint source pollution and protection of natural drainage systems by assisting to increase filtration. In addition to protecting natural drainage systems in urban areas, environmental corridors can protect and preserve sensitive natural areas, such as wetlands, flood plains, woodlands, steep slopes, and any areas that would impair surface or groundwater quality if disturbed or developed.

4.2.b. Delineated Current Land Use (1993)

Existing land use conditions utilized in the preparation of the Minocqua and Kawaguesaga Lakes Watershed Management Master Plan water quantity and water quality modeling analyses are based on Wiscland (1993). The generated Land Use map for the watershed of the Minocqua and Kawaguesaga Lakes is presented as Figure 4-28. The major watershed delineations are shown overlain on the Current Land Use map in Figure 4-30.

4.2.c. Delineated Future Land Use (2020)

Proposed future land use conditions utilized for the preparation of the Minocqua-Kawaguesaga Lakes Watershed Management Master Plan water quantity and water quality modeling analyses were based on Town of Minocqua Land Use Plan and Zoning Map, Town of Woodruff Zoning Map and Town of Arbor Vitae Land Use Plan and Zoning Map. The Minocqua and Kawaguesaga Lakes Future Land Use map is presented as Figure 4-29. The major watershed delineations are shown overlain on the Future Land Use map in Figure 4-31.

4.2.d. Change in Curve Numbers

Table 4-1 presents the percent of change of Curve Numbers over the study period for each sub-watershed. Curve Numbers are developed for each sub-watershed in the model and are representative of the soil type and land use of each sub-watershed. A Curve Number is used in the calculations of the quantity of water runoff. As land use changes with time, then the Curve Number will also change representative of the development in the sub-water shed. By presenting the current and future data as a comparison of Change in Curve Numbers (Figures 4-33, 4-34 and 4-35), the areas that will have the greatest impact on future water quantity and quality concerns can be readily distinguished.

4.3. Statement of Problems

Runoff rates from natural landscapes such as wetlands, prairies, and woodlands are quite low due to the absorptive capacity of the soil and the evaporative uptake of lush vegetation. When surface runoff does occur, it often is temporarily stored in adjacent depressions and wetlands. During very wet periods, surface overflow leaves the landscape via small swales, ditches, and streams, eventually reaching large lakes and rivers.

Historically, many natural storage areas, swales, drainage ways, and wetlands have been completely eliminated by agricultural practices and urban development. This can increase downstream flooding by forcing more water into overburdened conveyance systems and floodplains. The effect of uncontrolled agricultural and urbanization practices is a substantial increase in the magnitude and duration of flooding and resultant flood damages. Increased runoff rates caused by agricultural practices and urbanization also promote the destabilization of downstream channels, causing stream bank erosion and increased water quality pollutant load discharges.

In addition to flooding and stream bank erosion problems, agriculture and urban runoff causes severe water quality problems in the form of nonpoint source pollution. Agricultural runoff is typically contaminated with sediment, phosphorus, bacteria, and nutrients. Urban runoff, especially from streets and parking lots, is contaminated with sediment, heavy metals, bacteria, nutrients, and petroleum byproducts. During construction, erosion from uncontrolled development sites contributes massive quantities of sediment and pollutant discharges. Urban and agricultural runoff pollutants degrade receiving rivers, lakes, streams, and creeks by killing sensitive aquatic life, encouraging the growth of non-native invasive vegetation, impairing aesthetic conditions, and making water recreation undesirable.

Daily drainage and water quality discharge problems are often highly visible and the public concerns ensure that these problems receive immediate attention. Long-term drainage and water quality discharge problems, on the other hand, often go unnoticed. The problems tend to intensify over a long period of time, and appear suddenly with a flood or recognized deterioration of water quality. At this time, only the affects of flooding and water quality degradation are addressed, rather than the causes for flooding and water quality degradation. Solving future storm water problems will require the pro-active planning, financing, design, construction, inspection, and maintenance of a watershed runoff management system.

4.4. Concerns

The best management techniques proposed in this Plan will not mitigate all flooding and water quality problems caused by runoff water from first flush (spring melt runoff and first year rain events) and severe storm events. Nor are they intended to improve lands that are inherently unsuitable for development due to poor soils, high water table, or insuffient slope. But they can help improve water quality discharge and drainage flooding conditions for many sites of average soils and gradient conditions. The techniques proposed can be helpful in dealing with pollution problems of frequently occurring rainfalls of low intensity.

There are numerous best management techniques available to help improve storm water management for many land types and developments within the watershed study area. Techniques exist that may help reduce flow impacts and pollutant loading on downstream areas, as well as improve drainage characteristics and pollutant reductions on flat lands in various conditions.

Improvement of local storm water best management techniques, guided by creative land engineering and design, should be considered by all land users. Areas of particular concern that need to be addressed are:

- Residential development has planned patterns that create the rapid flow of runoff from rooftops, yards, storm sewers, and impervious paved surfaces that may overload the downstream waterways. Residential development imposed on the land without respect to natural drainage patterns and BMPs causes flooding, erosion, sedimentation, and high pollutant loads, leading to the destruction of ecologically important areas.

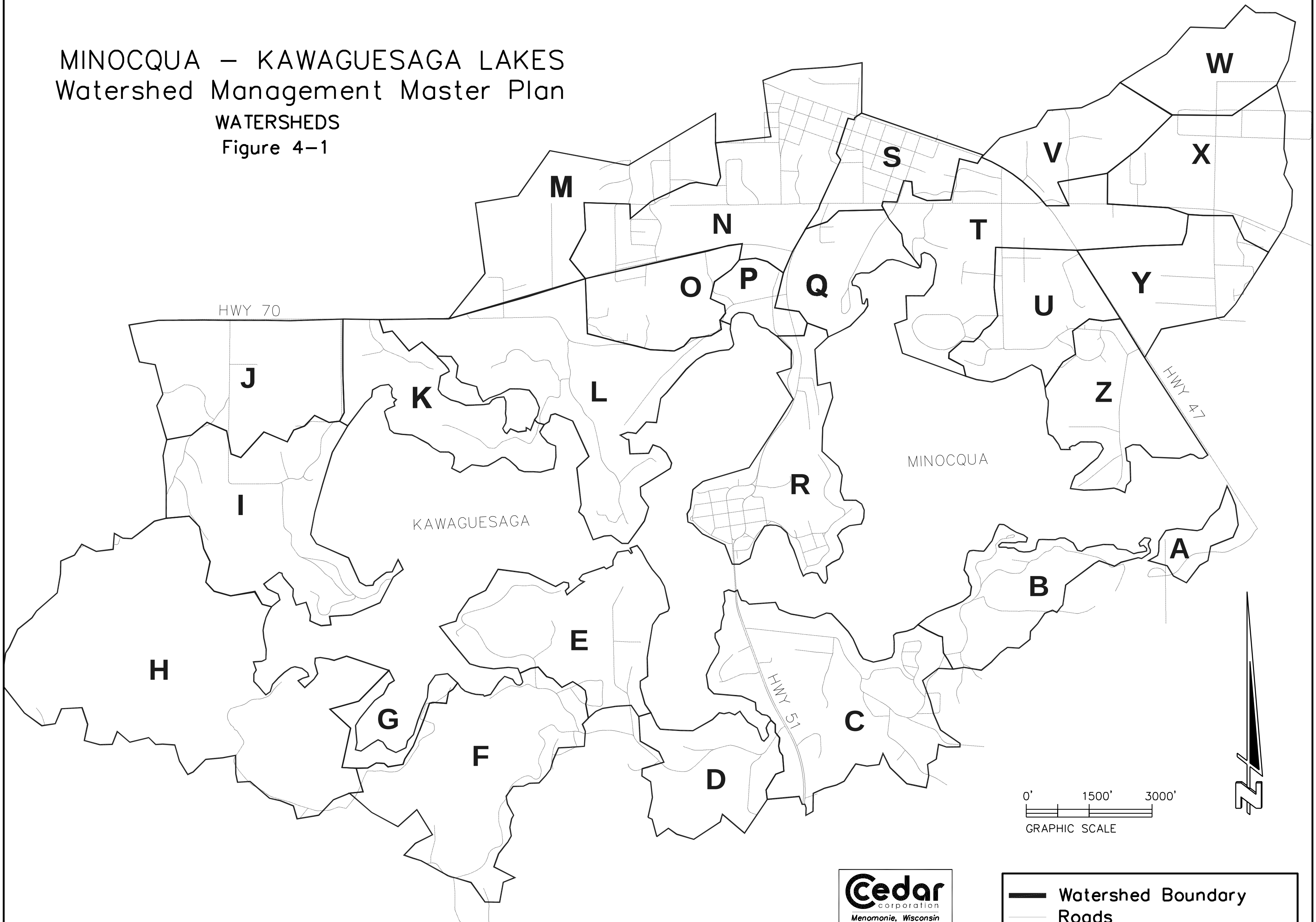
- Commercial and industrial land uses such as shopping centers, business parks, and industrial properties, contribute to an increased rate of runoff that would not exist in the natural landscape. Characterized by large impervious areas with storm sewers designated to carry water quickly and effectively away from the site, large volumes of water are transferred rapidly into public drainage ways and streams. Commercial and industrial development on the land without respect to natural drainage patterns and BMP's causes flooding, erosion, sedimentation, and high pollutant loads, leading to the destruction of ecologically important areas.

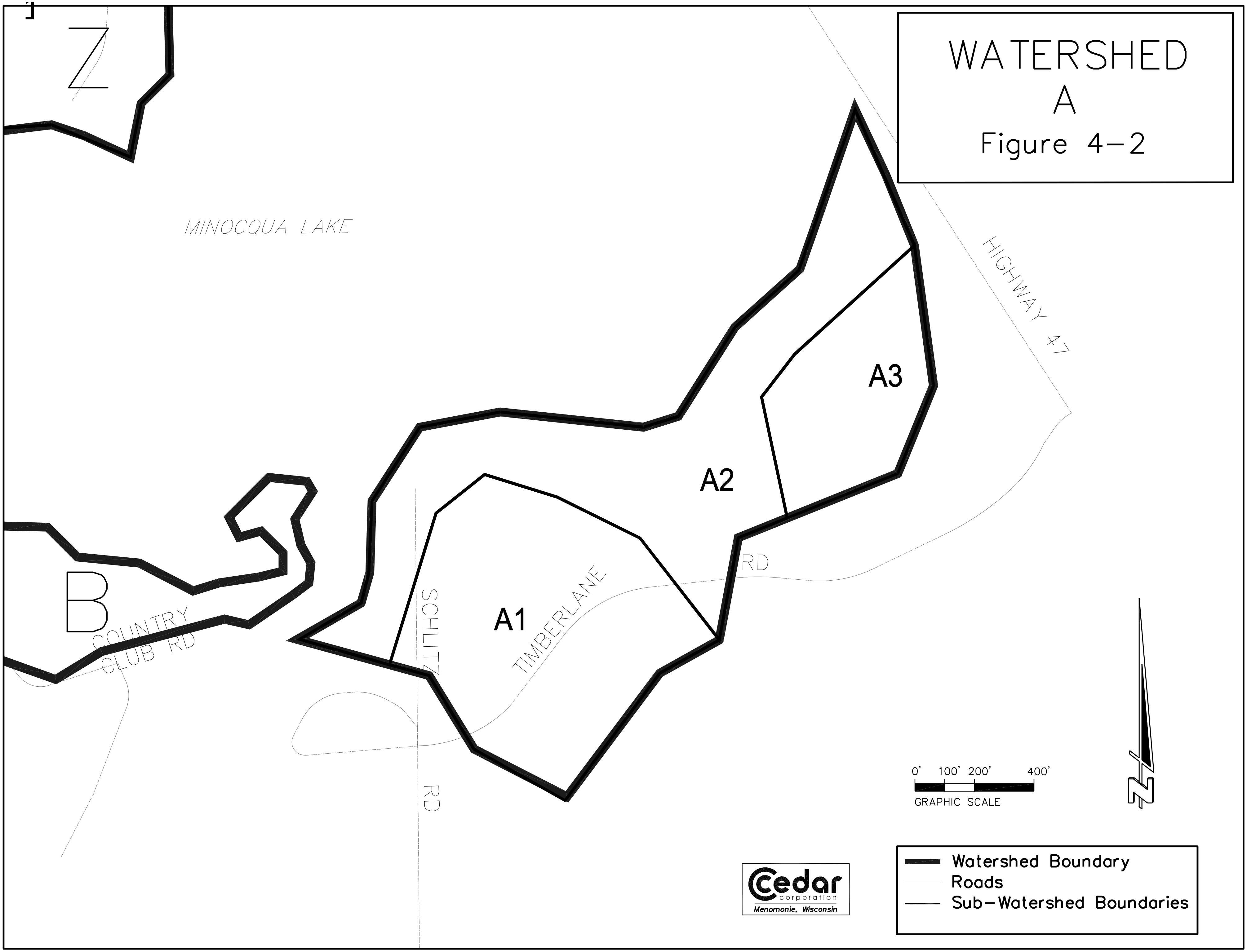
Table 4-1: Curve Numbers Current vs. Future

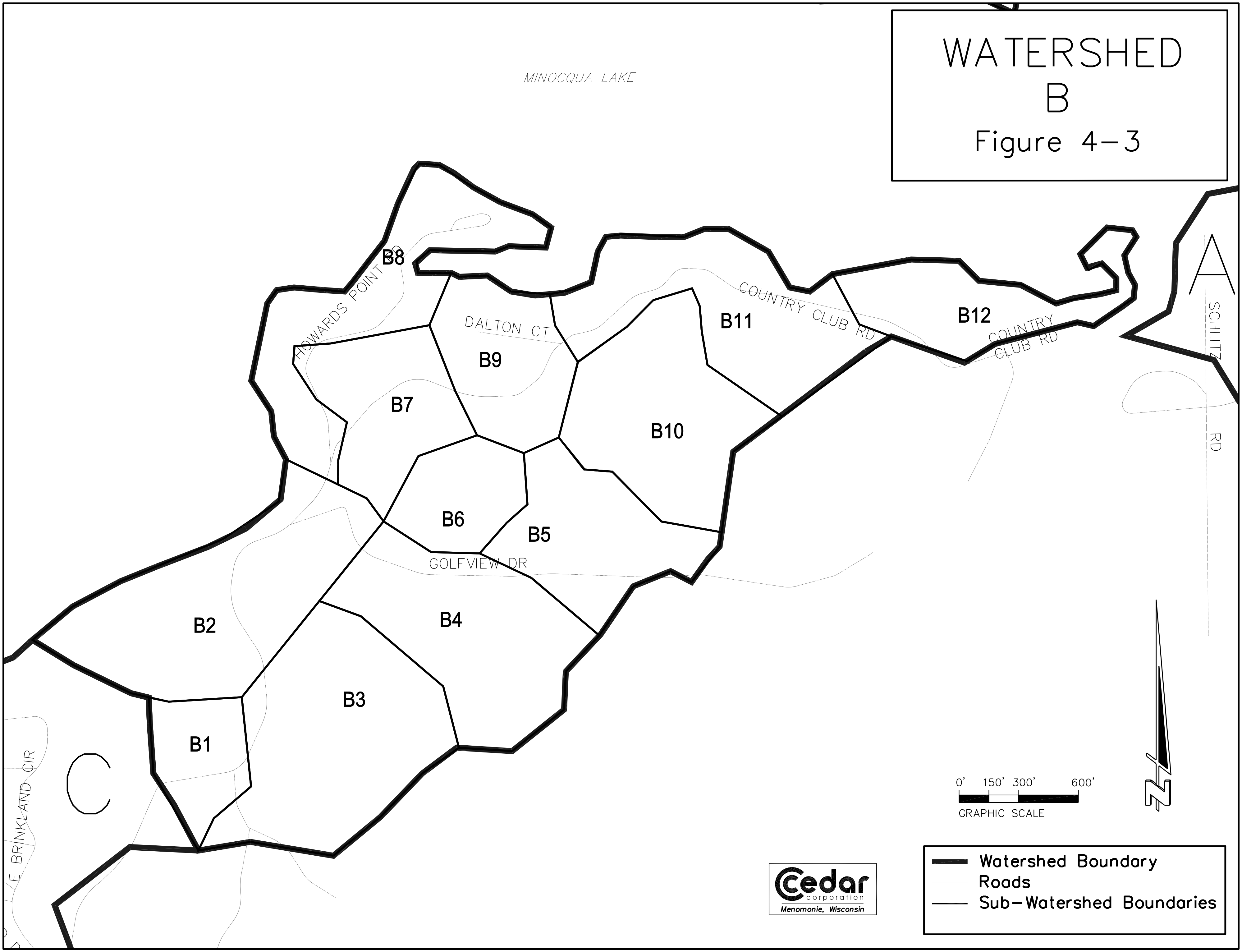
Watershed	Curve Number Current	Future	Change	Area (acres)
A	53	55	2	41.7
B	48	53	5	172.5
C	52	69	17	399.7
D	63	73	10	169.6
E	88	90	2	283.0
F	55	65	10	347.9
G	49	67	18	41.8
H	47	54	7	752.5
I	55	62	7	335.3
J	49	66	17	285.7
K	56	56	0	188.0
L	54	68	14	402.7
M	65	84	19	250.3
N1	63	87	24	44.9
N2	52	75	23	17.0
N3	61	89	28	10.9
N4	73	89	16	10.4
N5	81	91	10	31.8
N6	65	85	20	47.8
N7	65	89	24	10.6
N8	57	61	4	27.6
N9	53	73	20	22.8
N10	46	74	28	35.8
N11	65	91	26	32.9
N12	76	89	13	27.0
N13	85	89	4	37.7
O1	48	87	39	14.7
O2	53	82	29	25.9
O3	87	94	7	35.7
O4	54	89	35	20.2
O5	65	86	21	9.2
O6	54	70	16	10.4
O7	56	86	30	27.4
P1	69	82	13	15.9
P2	57	77	20	38.5
Q1	60	89	29	38.2
Q2	62	82	20	13.4
Q3	80	91	11	41.3
Q4	69	84	15	24.4
Q5	58	59	1	11.0
CONT.				

Watershed	Curve Number Current	Future	Change	Area (acres)
R1	86	90	4	21.4
R2	64	64	0	21.5
R3	88	92	4	16.8
R4	81	92	11	33.2
R5	58	77	19	9.6
R6	66	84	18	49.3
R7	57	77	20	6.7
R8	59	78	19	15.9
R9	78	89	11	9.0
R10	89	89	0	17.2
R11	83	89	6	10.8
R12	77	89	12	13.0
R13	86	89	3	17.6
S1	59	65	6	12.6
S2	57	59	2	19.7
S3	63	72	9	11.7
S4	56	77	21	21.3
S5	73	81	8	12.8
S6	75	83	8	19.3
S7	63	89	26	11.4
S8	64	88	24	17.3
T	50	70	20	263.7
T5	50	70	20	35.5
T6	51	83	32	34.4
U	51	72	21	171.5
V	54	59	5	140.1
W	47	50	3	147.8
X	65	71	6	227.6
Y	49	62	13	178.7
Z	48	53	5	200.2
TOTAL	63	77	14	6122

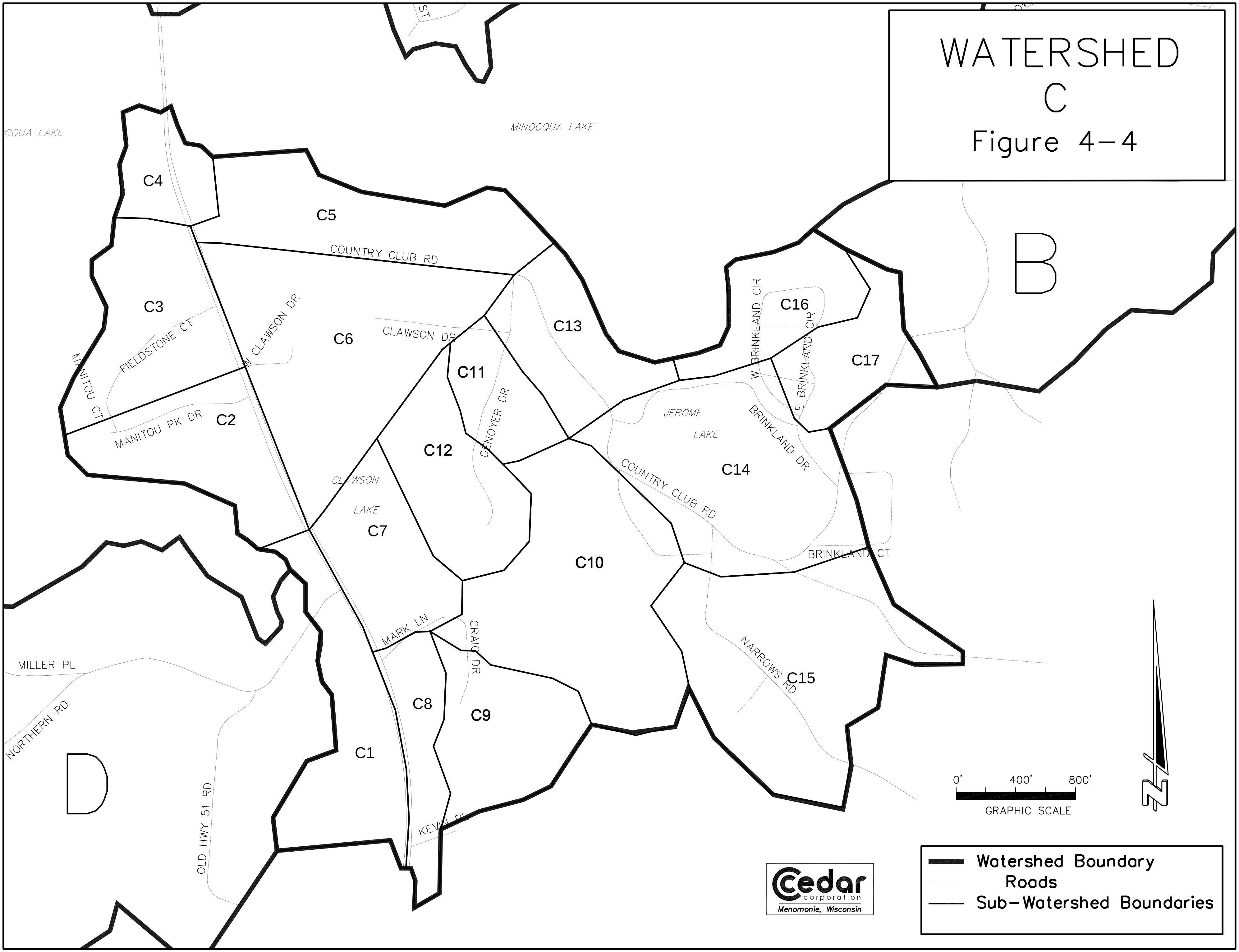
MINOCQUA – KAWAGUESAGA LAKES
Watershed Management Master Plan
WATERSHEDS
Figure 4–1

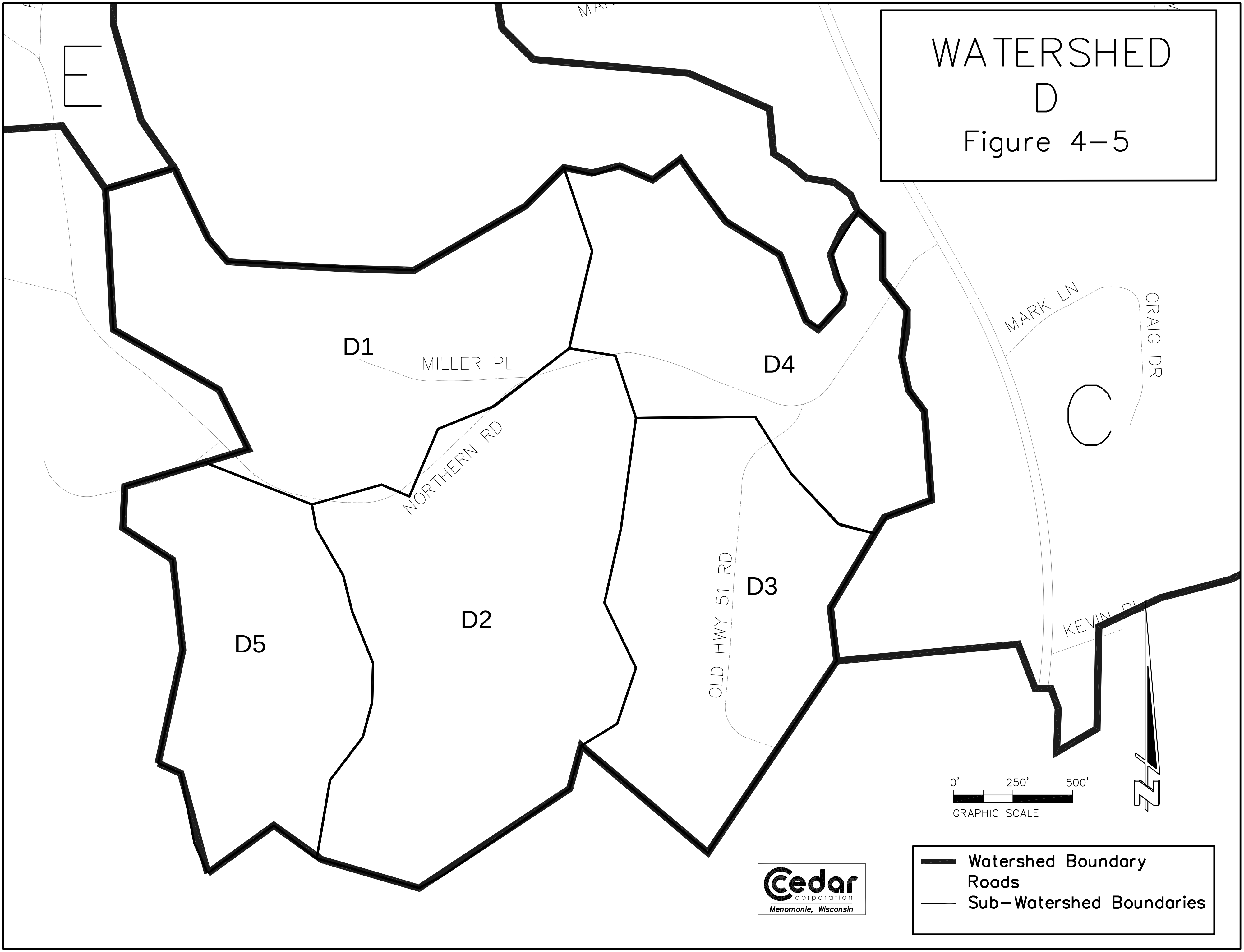


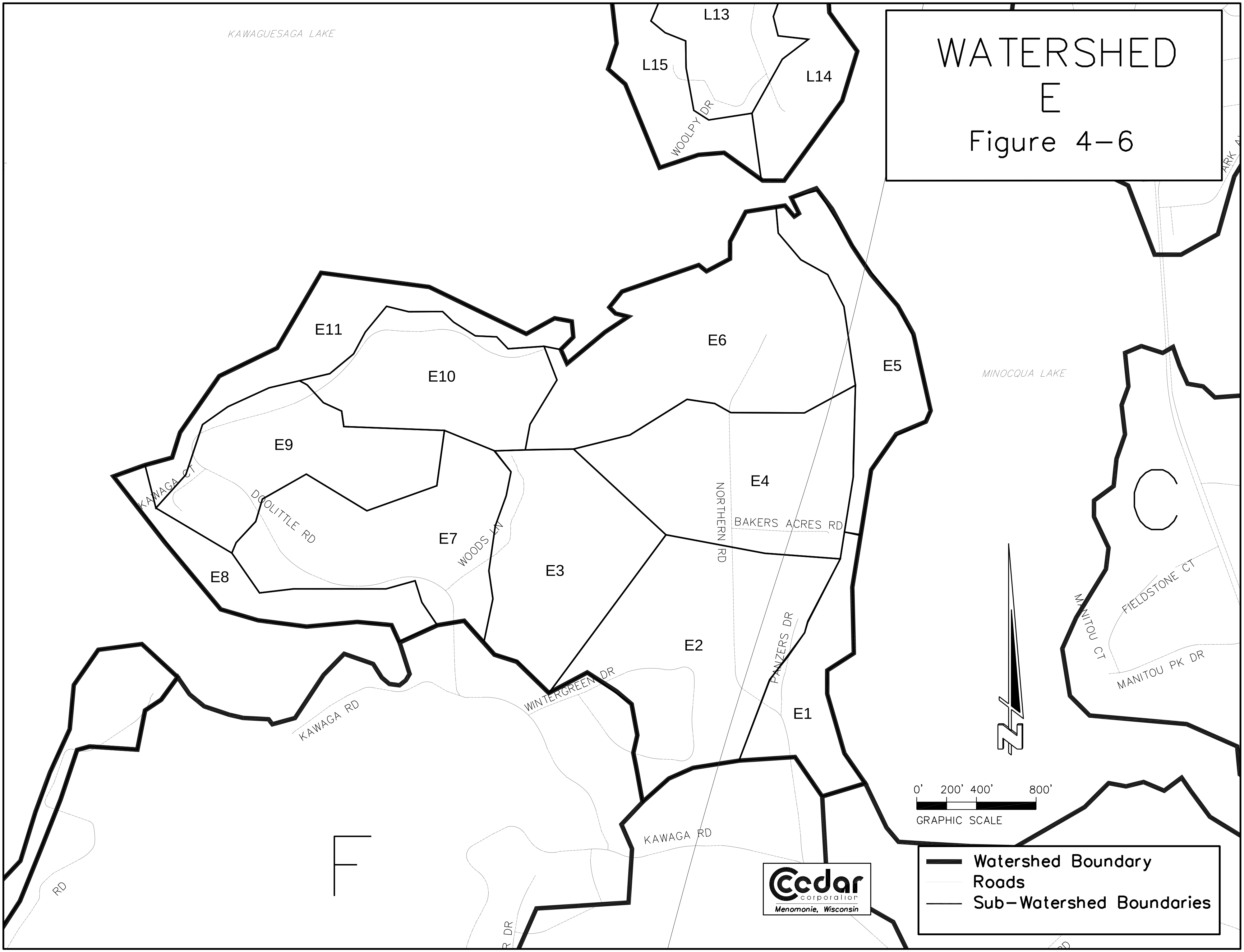

WATERSHED
A
Figure 4-2
MINOCQUA LAKE
HIGHWAY 47
A1
A2
A3
TIMBERLANE
RD
SCHLITZ
RD
COUNTRY
CLUB RD
Z
B
0' 100' 200' 400'
GRAPHIC SCALE
N
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries



WATERSHED
B
Figure 4-3
MINOCQUA LAKE
HOWARDS POINT RD
DALTON CT
COUNTRY CLUB RD
COUNTRY CLUB RD
SCHLITZ RD
GOLFVIEW DR
E BRINKLAND CIR
A
C
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
0' 150' 300' 600'
GRAPHIC SCALE
N
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

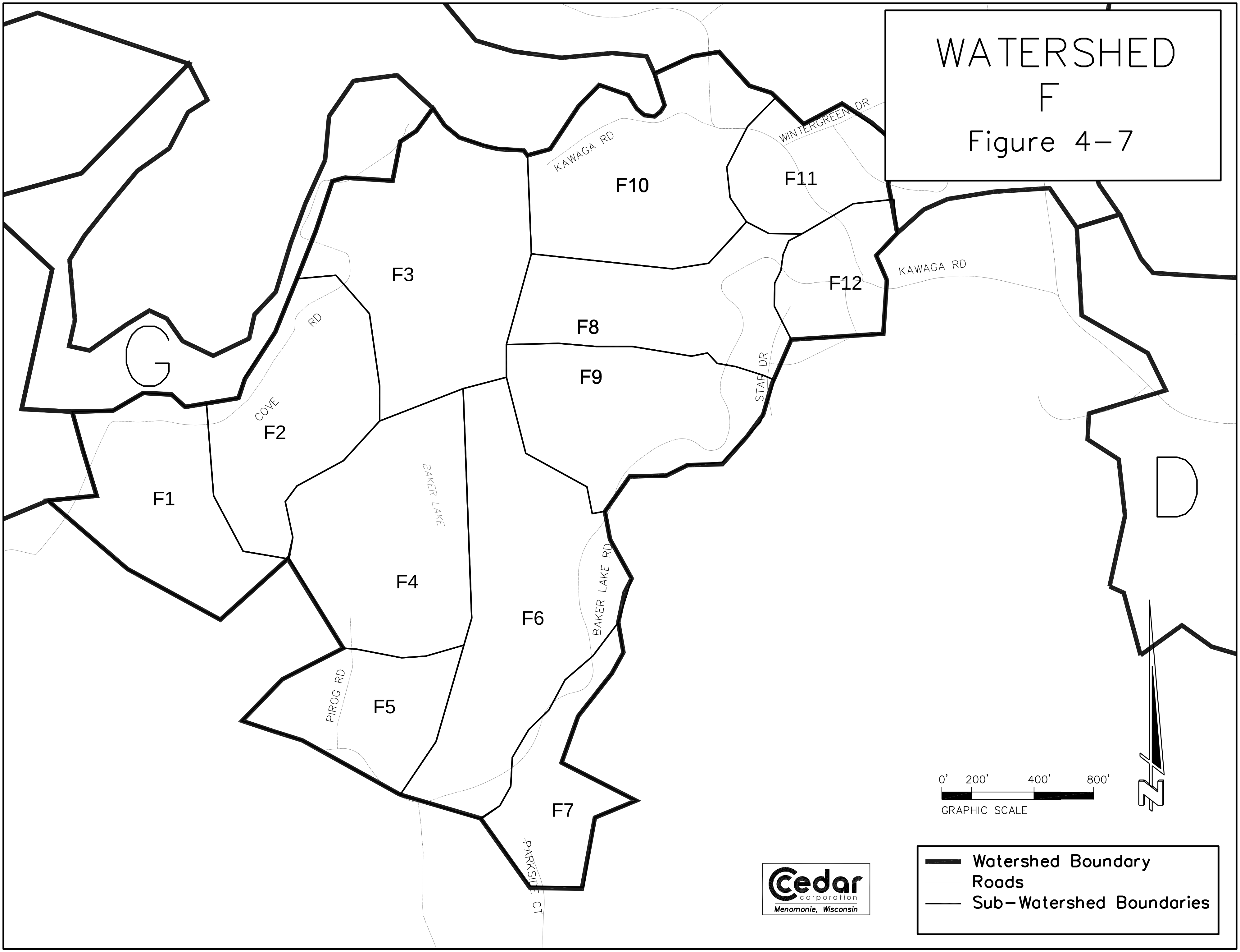

WATERSHED
C
Figure 4–4
B
D
MINOCQUA LAKE
CQUA LAKE
CLAWSON LAKE
JEROME LAKE
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
COUNTRY CLUB RD
CLAWSON DR
N CLAWSON DR
FIELDSTONE CT
MANITOU CT
MANITOU PK DR
DENOYER DR
MARK LN
CRAIG DR
KEVIN PL
W BRINKLAND CIR
E BRINKLAND CIR
BRINKLAND DR
BRINKLAND CT
NARROWS RD
MILLER PL
NORTHERN RD
OLD HWY 51 RD
0'
400'
800'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub–Watershed Boundaries
Cedar corporation
Menomonie, Wisconsin

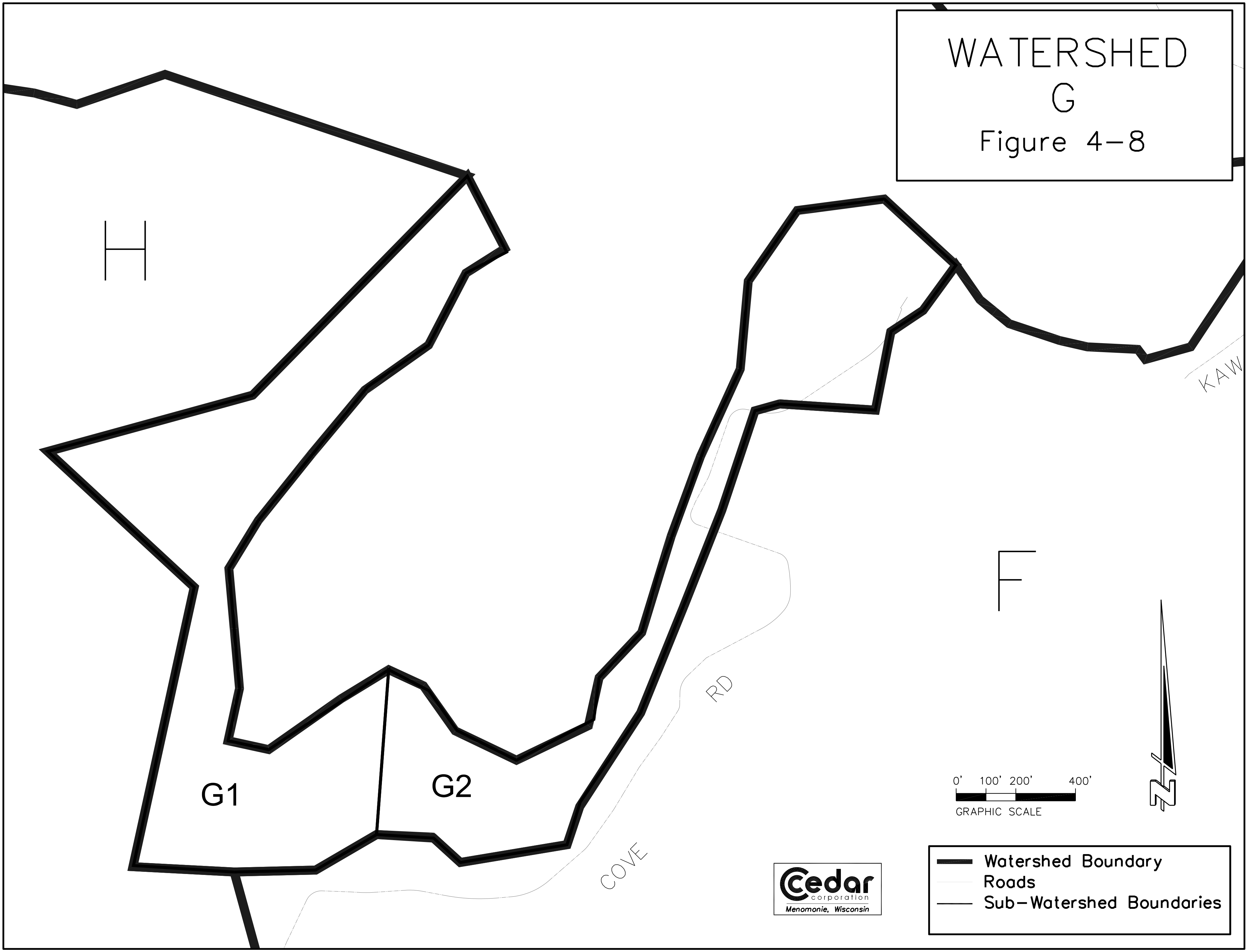

WATERSHED
D
Figure 4-5
E
D1
MILLER PL
NORTHERN RD
D4
MARK LN
CRAIG DR
C
D5
D2
D3
OLD HWY 51 RD
KEVIN PL
0'
250'
500'
GRAPHIC SCALE
N
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries


WATERSHED
E
Figure 4-6
KAWAGUESAGA LAKE
L13
L14
L15
WOOLPY DR
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
KAWAGA CT
DOOLITTLE RD
WOODS LN
NORTHERN RD
BAKERS ACRES RD
PANZERS DR
WINTERGREEN DR
KAWAGA RD
KAWAGA RD
RD
MINOCQUA LAKE
C
F
FIELDSTONE CT
MANITOU CT
MANITOU PK DR
0'
200'
400'
800'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

WATERSHED F

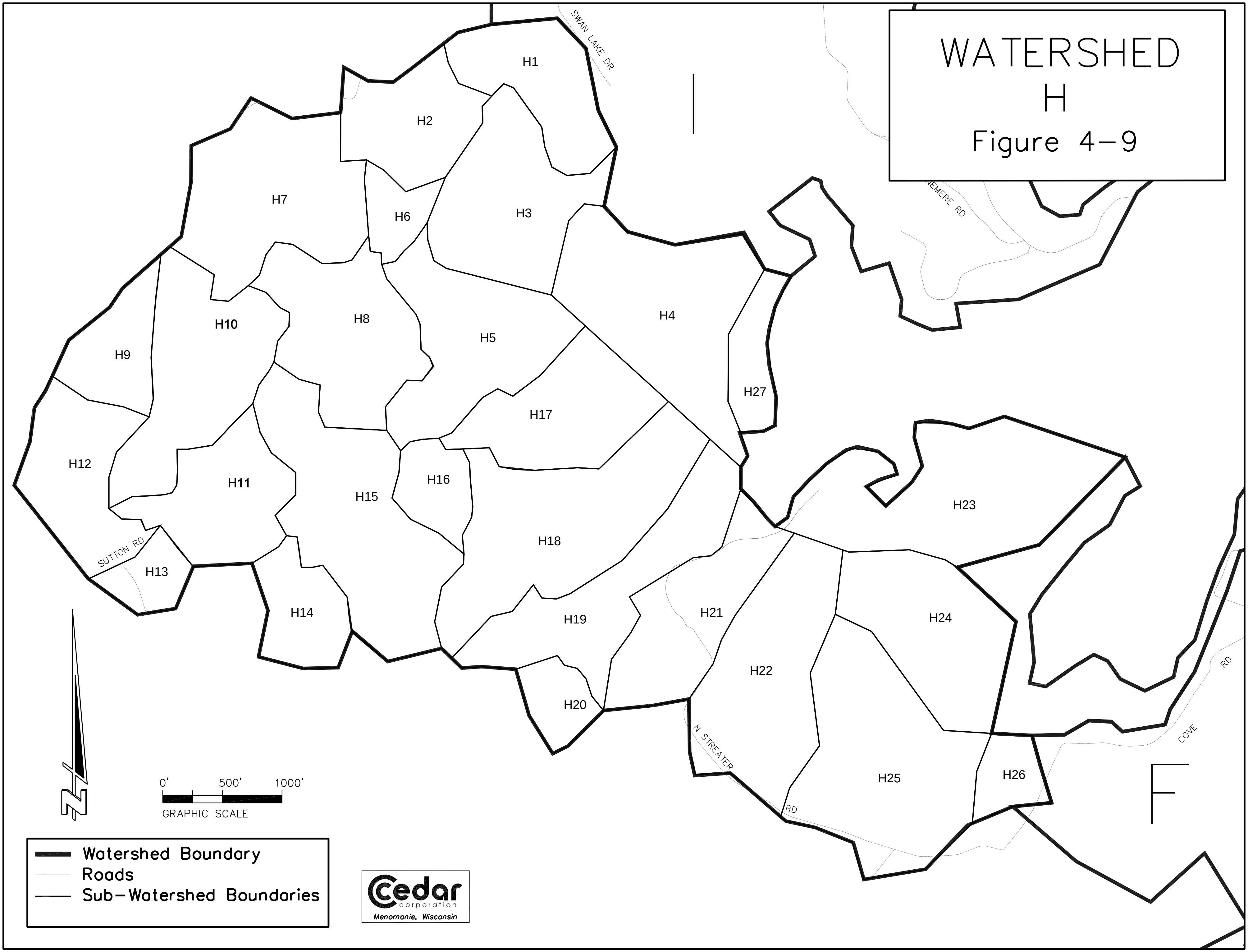
Figure 4-7

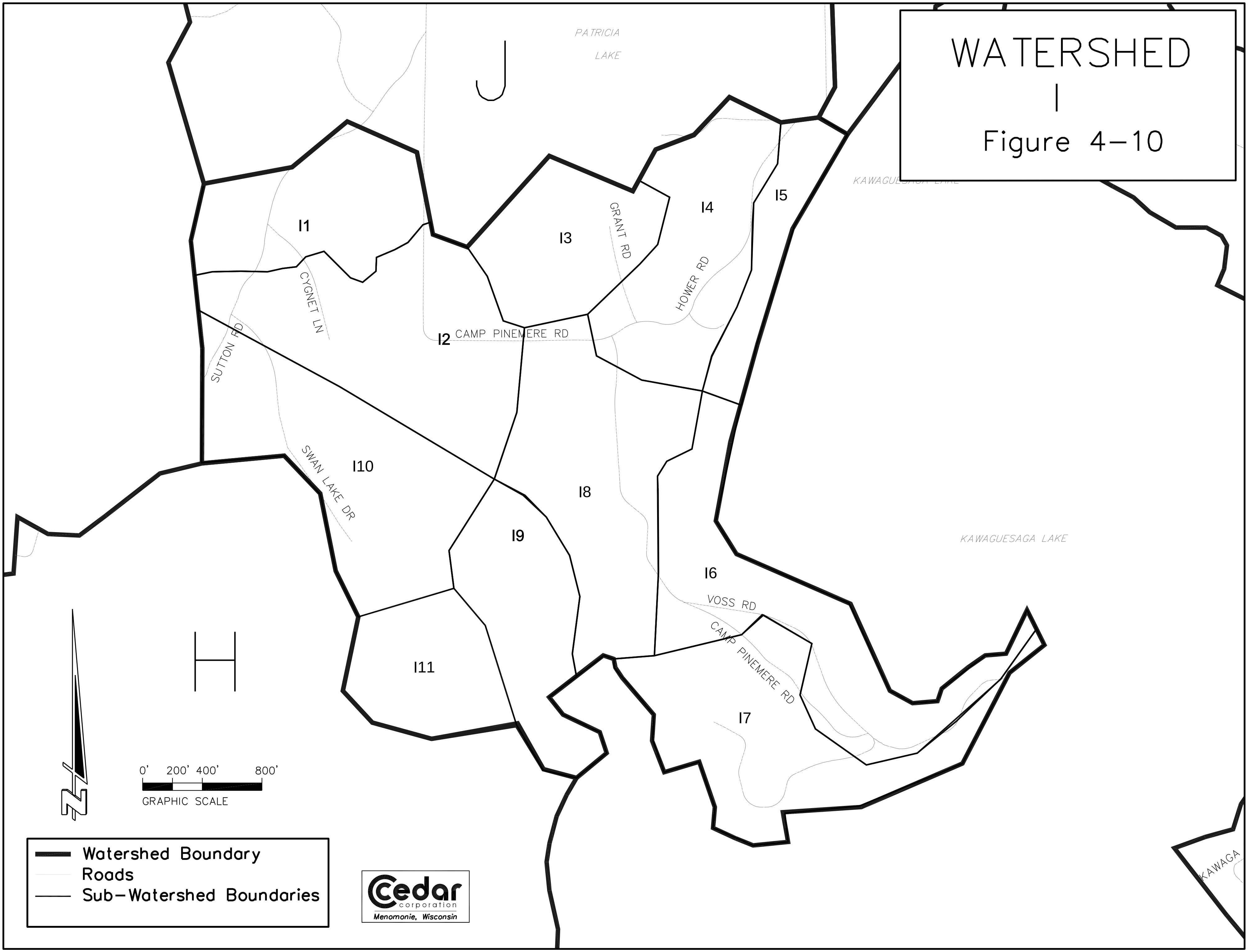



WATERSHED
G
Figure 4-8
H
F
G1
G2
KAW
RD
COVE
0'
100'
200'
400'
GRAPHIC SCALE
N
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

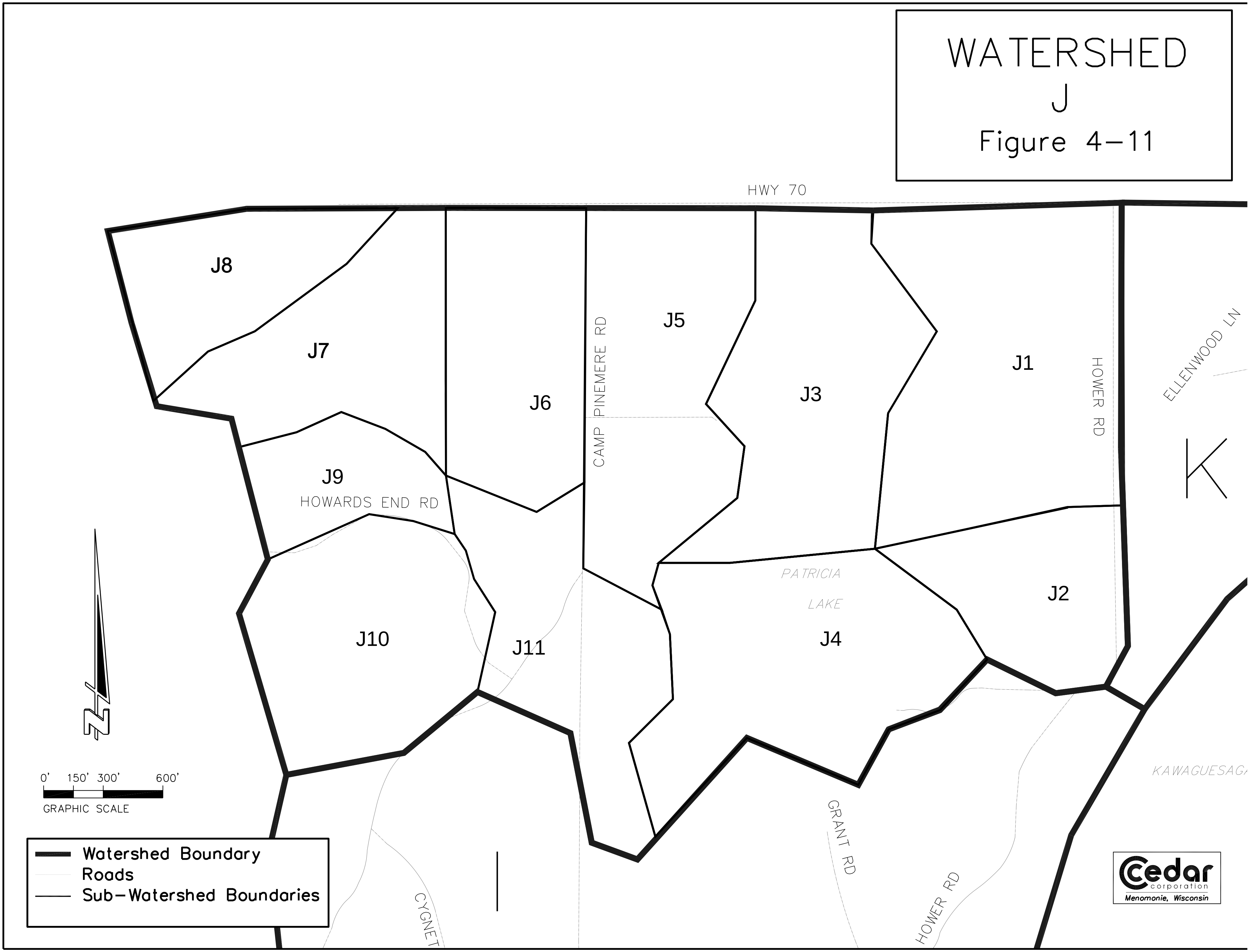
WATERSHED H

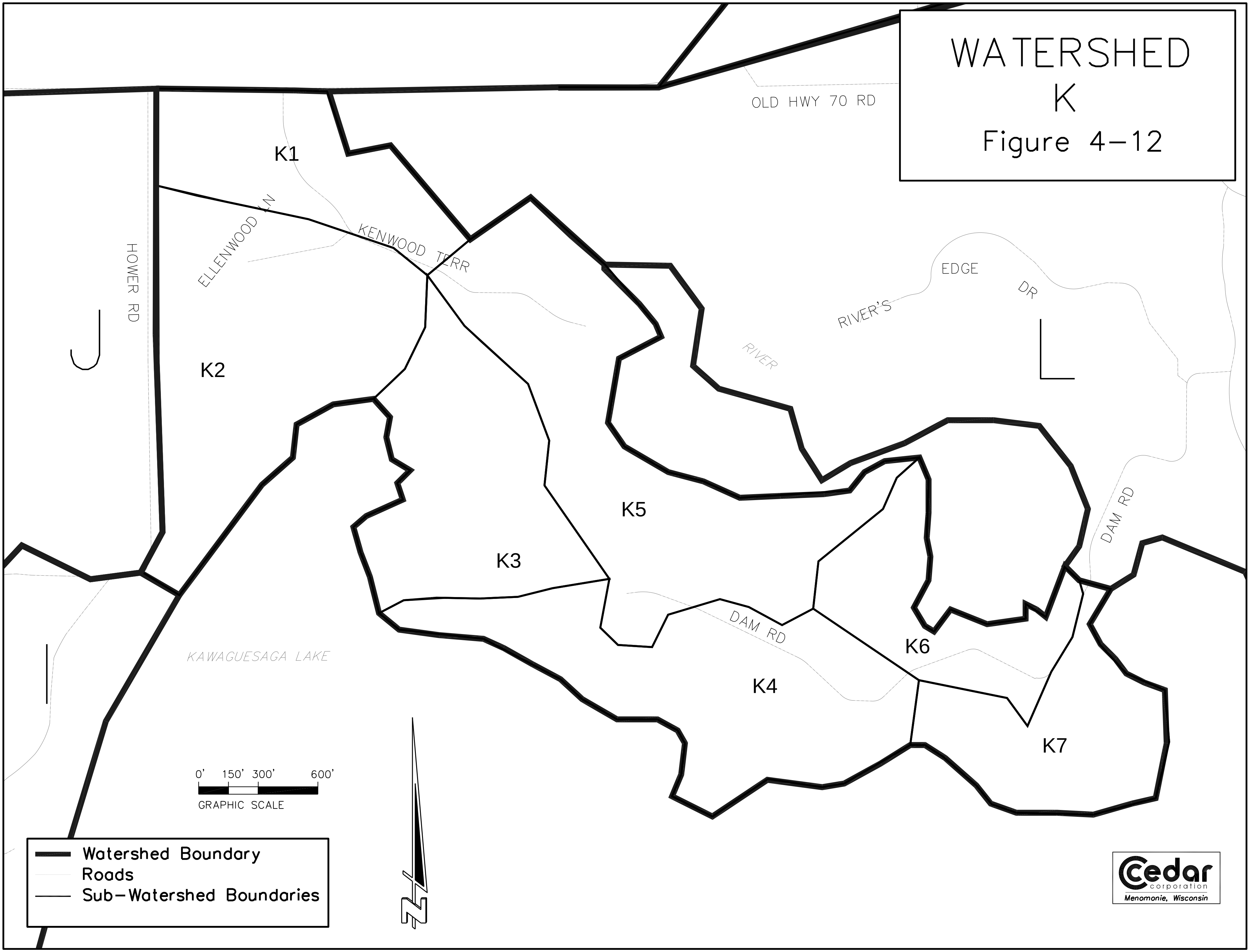
Figure 4-9

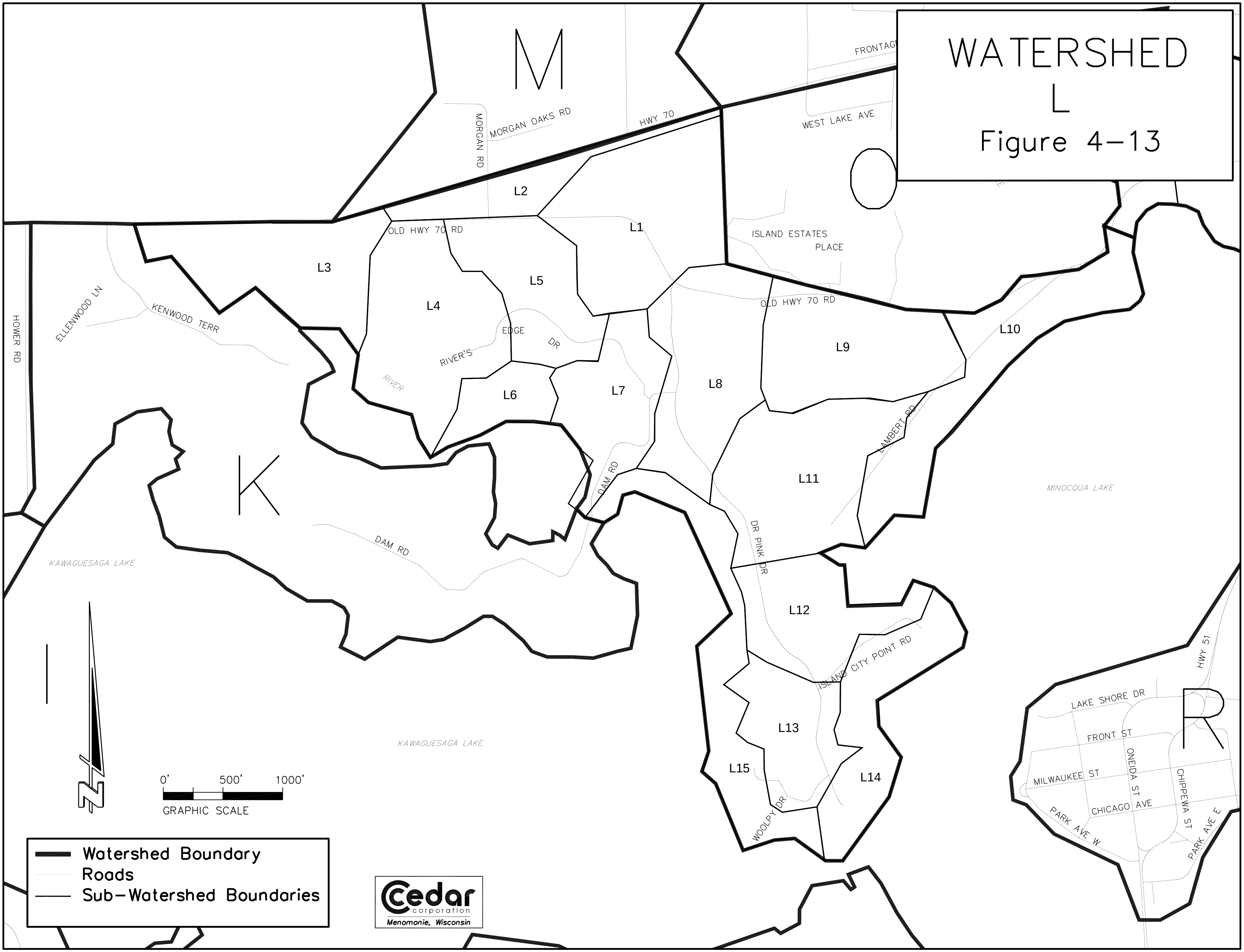




WATERSHED
I
Figure 4-10
PATRICIA LAKE
J
H
I1
I2
I3
I4
I5
I6
I7
I8
I9
I10
I11
GRANT RD
HOWER RD
CYGNET LN
SUTTON RD
CAMP PINEMERE RD
SWAN LAKE DR
VOSS RD
KAWAGUESAGA LAKE
KAWAGA
0' 200' 400' 800'
GRAPHIC SCALE
N
Watershed Boundary
Roads
Sub-Watershed Boundaries
Cedar corporation
Menomonie, Wisconsin

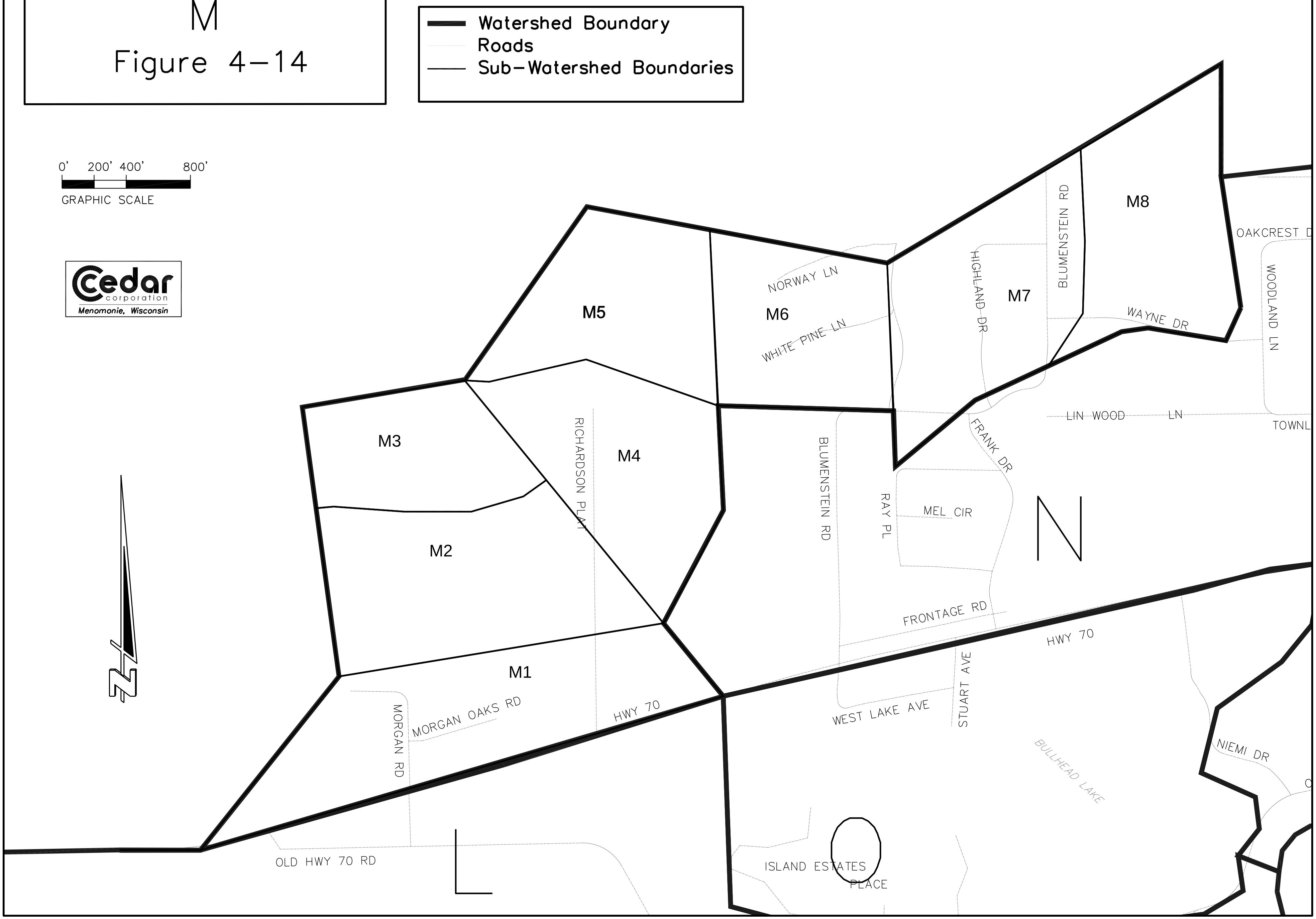

WATERSHED
J
Figure 4-11
HWY 70
J8
J7
J6
J5
J3
J1
J9
J10
J11
J4
J2
K
CAMP PINEMERE RD
HOWARDS END RD
HOWER RD
ELLENWOOD LN
PATRICIA
LAKE
GRANT RD
HOWER RD
CYGNET
0' 150' 300' 600'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries
Cedar corporation
Menomonie, Wisconsin

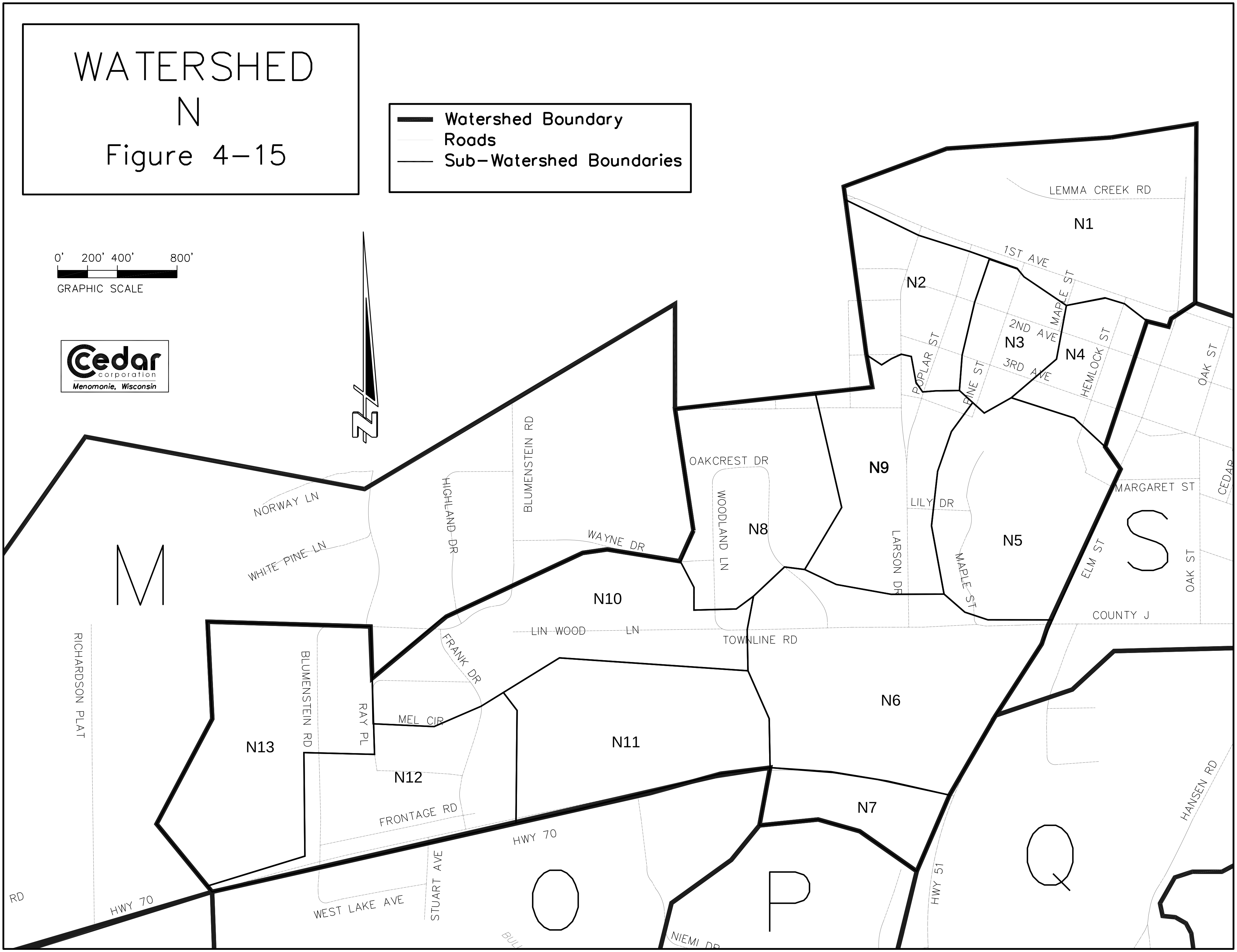

WATERSHED
K
Figure 4-12
OLD HWY 70 RD
K1
ELLENWOOD LN
KENWOOD TERR
HOWER RD
K2
EDGE
DR
RIVER'S
RIVER
K5
DAM RD
K3
DAM RD
K6
KAWAGUESAGA LAKE
K4
K7
0' 150' 300' 600'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries
N
Cedar corporation
Menomonie, Wisconsin

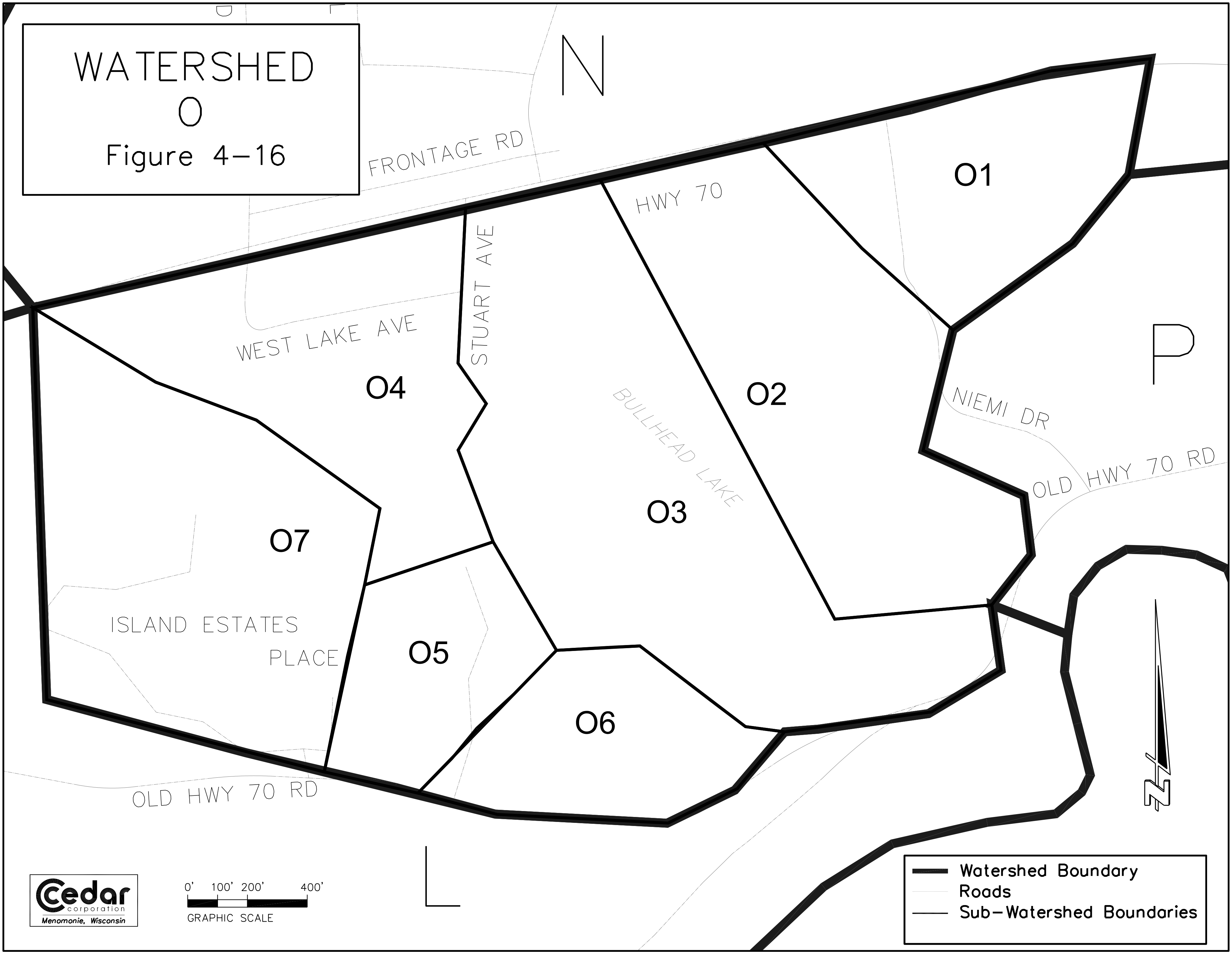

WATERSHED
L
Figure 4–13
M
O
K
I
R
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
L13
L14
L15
HWY 70
MORGAN OAKS RD
MORGAN RD
FRONTAGE
WEST LAKE AVE
ISLAND ESTATES
PLACE
OLD HWY 70 RD
OLD HWY 70 RD
ELLENWOOD LN
KENWOOD TERR
HOWER RD
EDGE
DR
RIVER'S
RIVER
DAM RD
DAM RD
DR PINK DR
LAMBERT RD
ISLAND CITY POINT RD
WOOLPY DR
MINOCQUA LAKE
KAWAGUESAGA LAKE
KAWAGUESAGA LAKE
HWY 51
LAKE SHORE DR
FRONT ST
MILWAUKEE ST
ONEIDA ST
CHIPPEWA ST
CHICAGO AVE
PARK AVE W
PARK AVE E
0'
500'
1000'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub–Watershed Boundaries
Cedar
corporation
Menomonie, Wisconsin

WATERSHED M

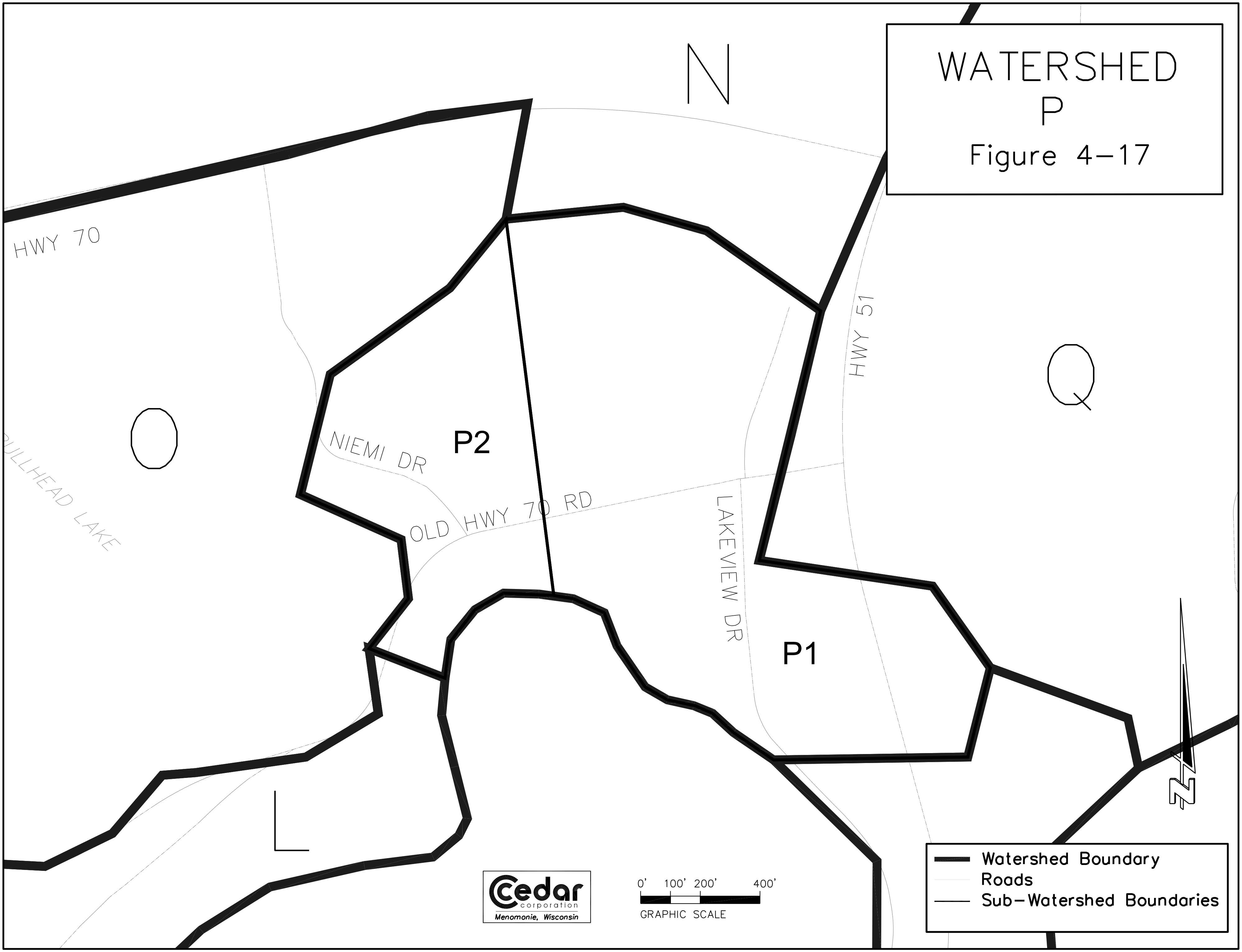
Figure 4–14

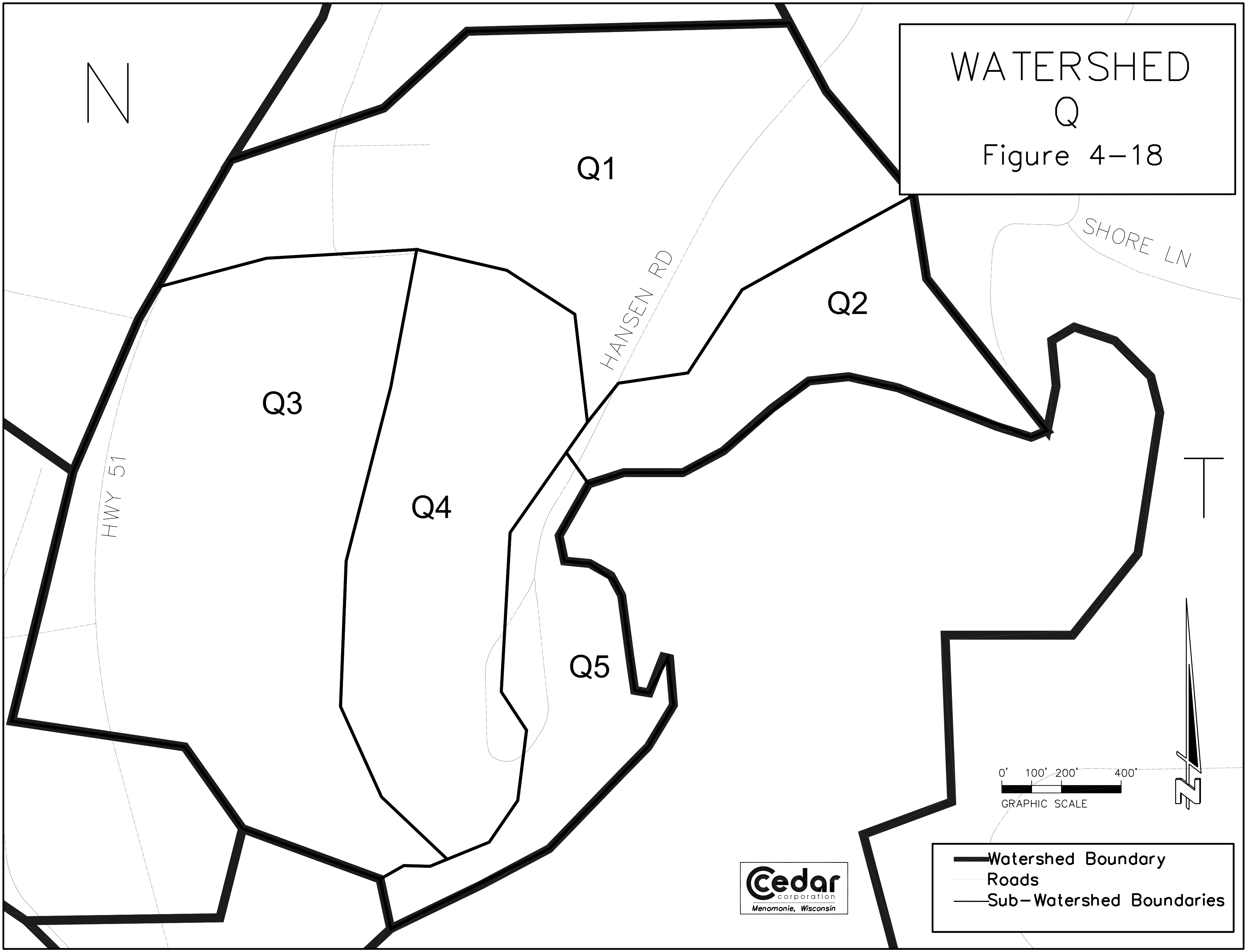


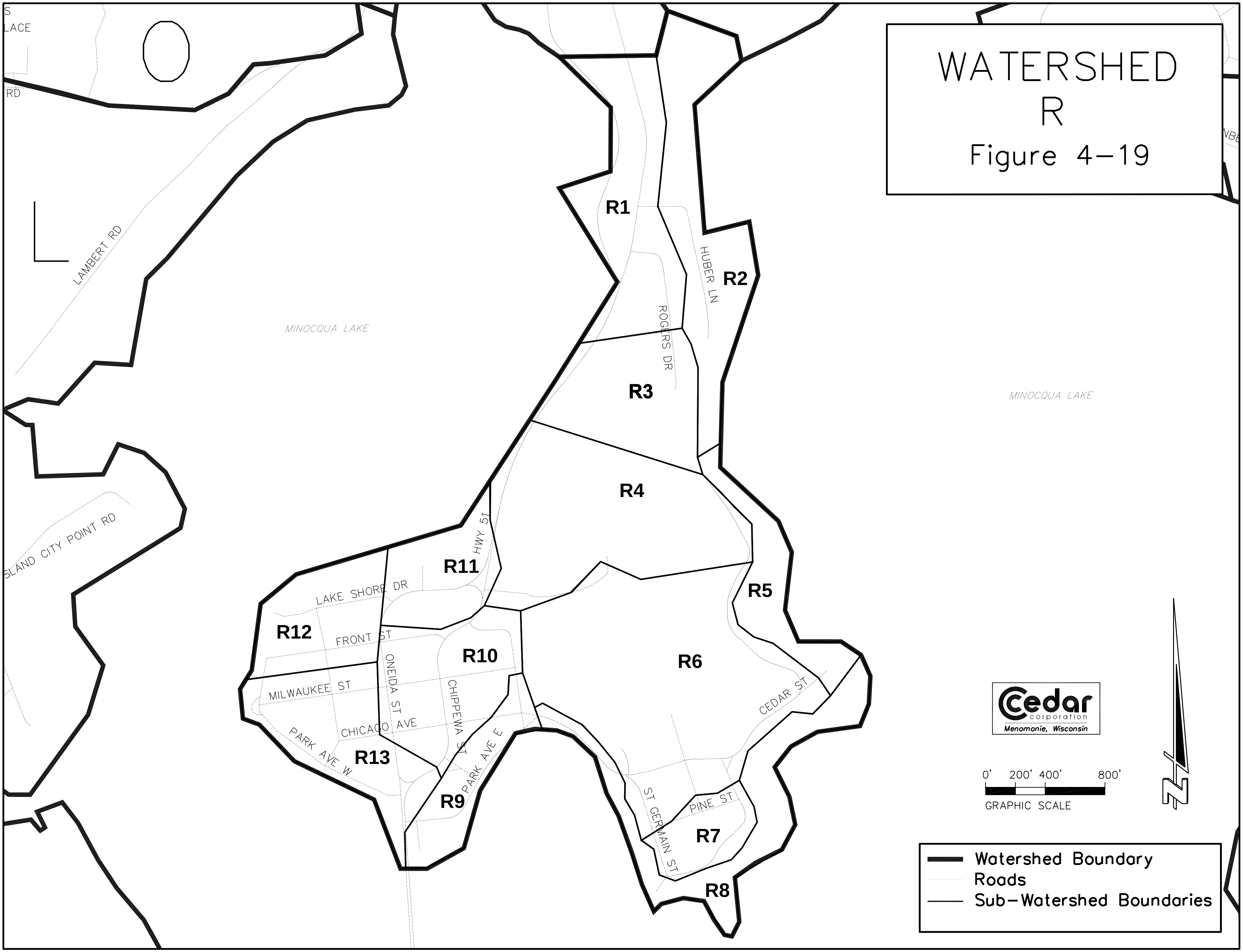

WATERSHED
N
Figure 4–15
Watershed Boundary
Roads
Sub–Watershed Boundaries
0'
200'
400'
800'
GRAPHIC SCALE
Cedar
corporation
Menomonie, Wisconsin
N
N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
N12
N13
M
O
P
Q
S
LEMMA CREEK RD
1ST AVE
2ND AVE
3RD AVE
MAPLE ST
POPLAR ST
PINE ST
HEMLOCK ST
OAK ST
CEDAR
MARGARET ST
ELM ST
COUNTY J
OAKCREST DR
WOODLAND LN
LILY DR
LARSON DR
TOWNLINE RD
LIN WOOD LN
WAYNE DR
NORWAY LN
WHITE PINE LN
HIGHLAND DR
BLUMENSTEIN RD
FRANK DR
MEL CIR
RAY PL
FRONTAGE RD
HWY 70
WEST LAKE AVE
STUART AVE
RICHARDSON PLAT
RD
HWY 51
HANSEN RD
NIEMI DR

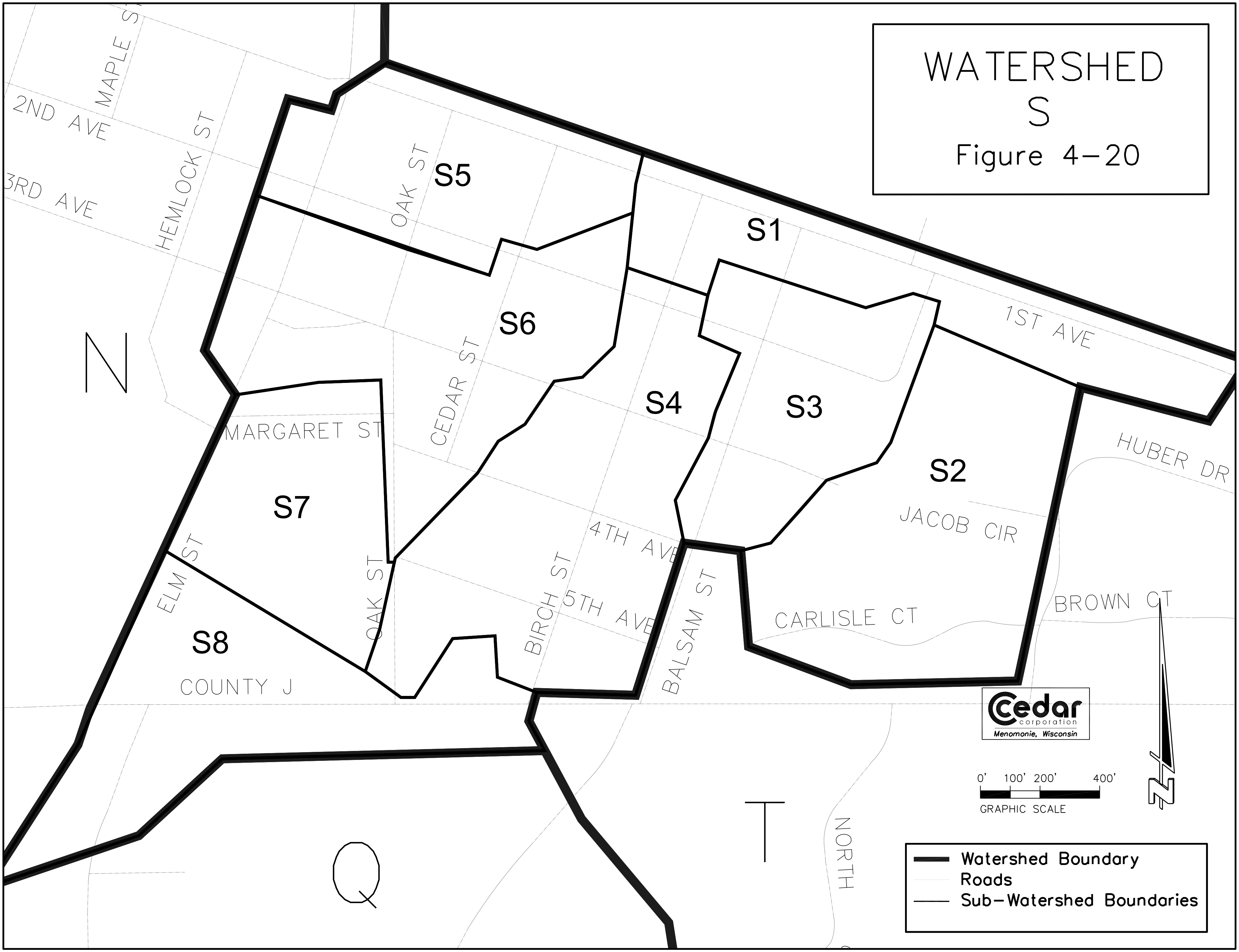


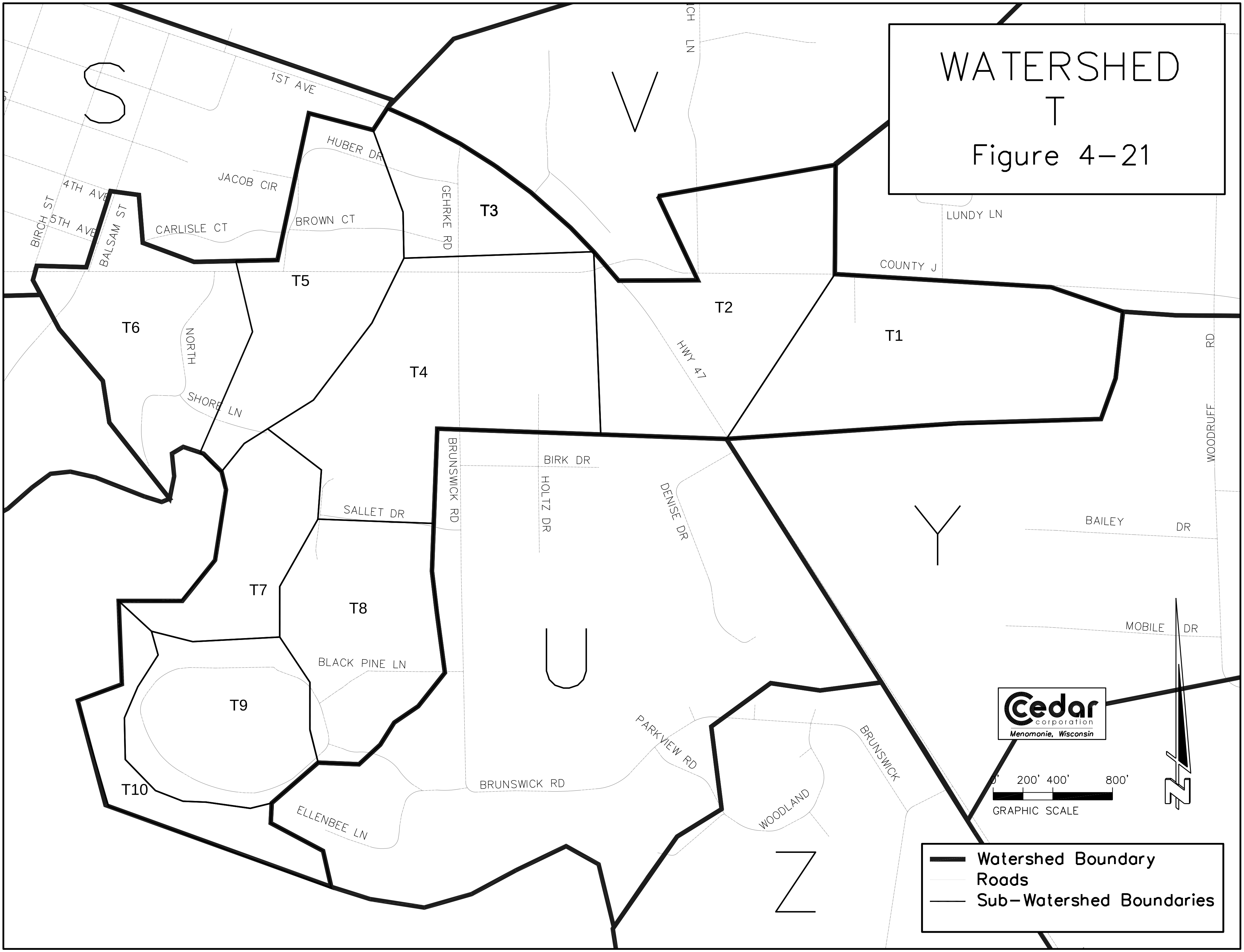
WATERSHED
O
Figure 4-16
N
P
L
FRONTAGE RD
HWY 70
STUART AVE
WEST LAKE AVE
BULLHEAD LAKE
NIEMI DR
OLD HWY 70 RD
ISLAND ESTATES PLACE
OLD HWY 70 RD
O1
O2
O3
O4
O5
O6
O7
0' 100' 200' 400'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries


WATERSHED
P
Figure 4–17
N
HWY 70
O
BULLHEAD LAKE
NIEMI DR
P2
OLD HWY 70 RD
LAKEVIEW DR
HWY 51
Q
P1
L
Cedar corporation
Menomonie, Wisconsin
0' 100' 200' 400'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub–Watershed Boundaries

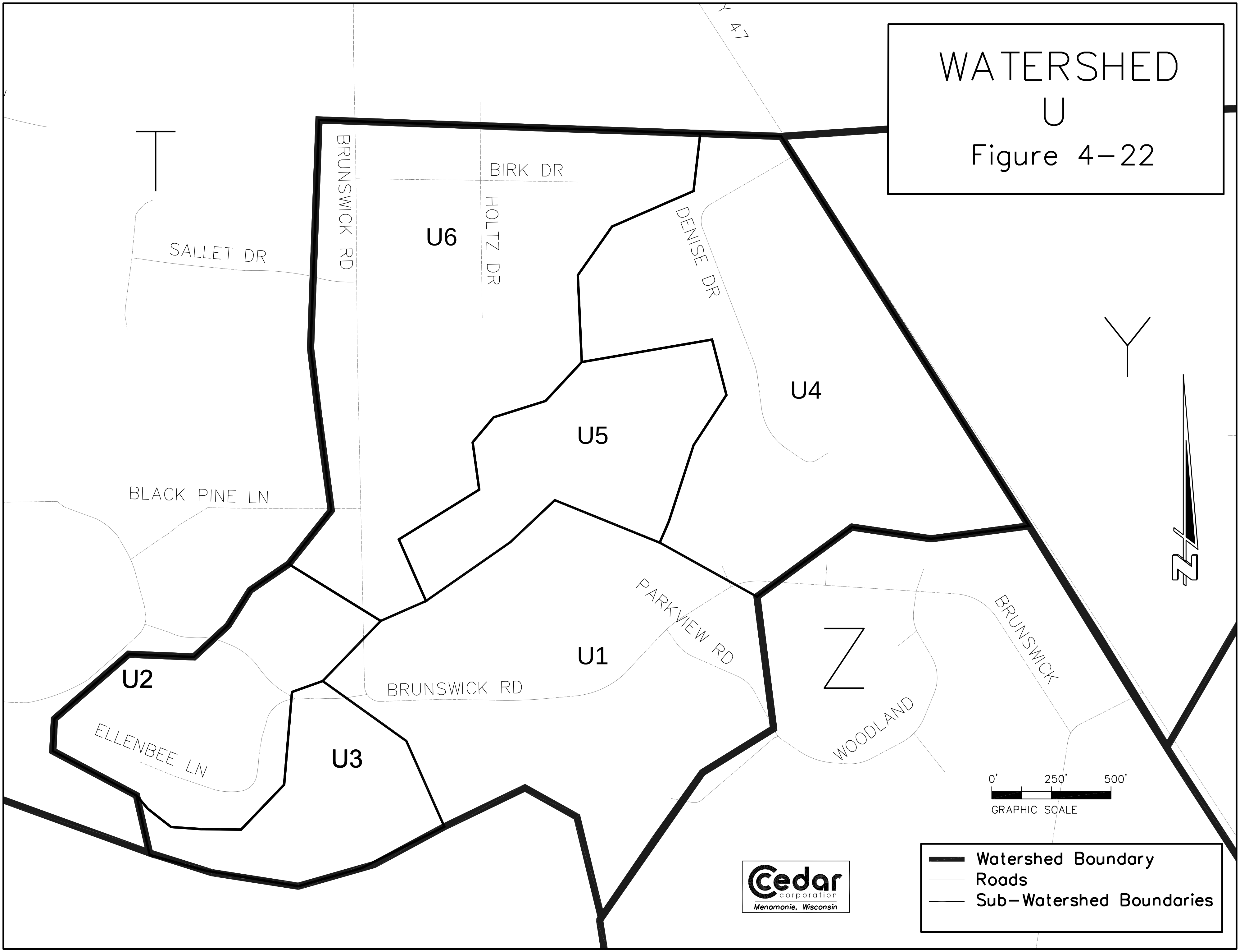

WATERSHED
Q
Figure 4-18
N
Q1
Q2
Q3
Q4
Q5
HANSEN RD
HWY 51
SHORE LN
0' 100' 200' 400'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries
Cedar corporation
Menomonie, Wisconsin

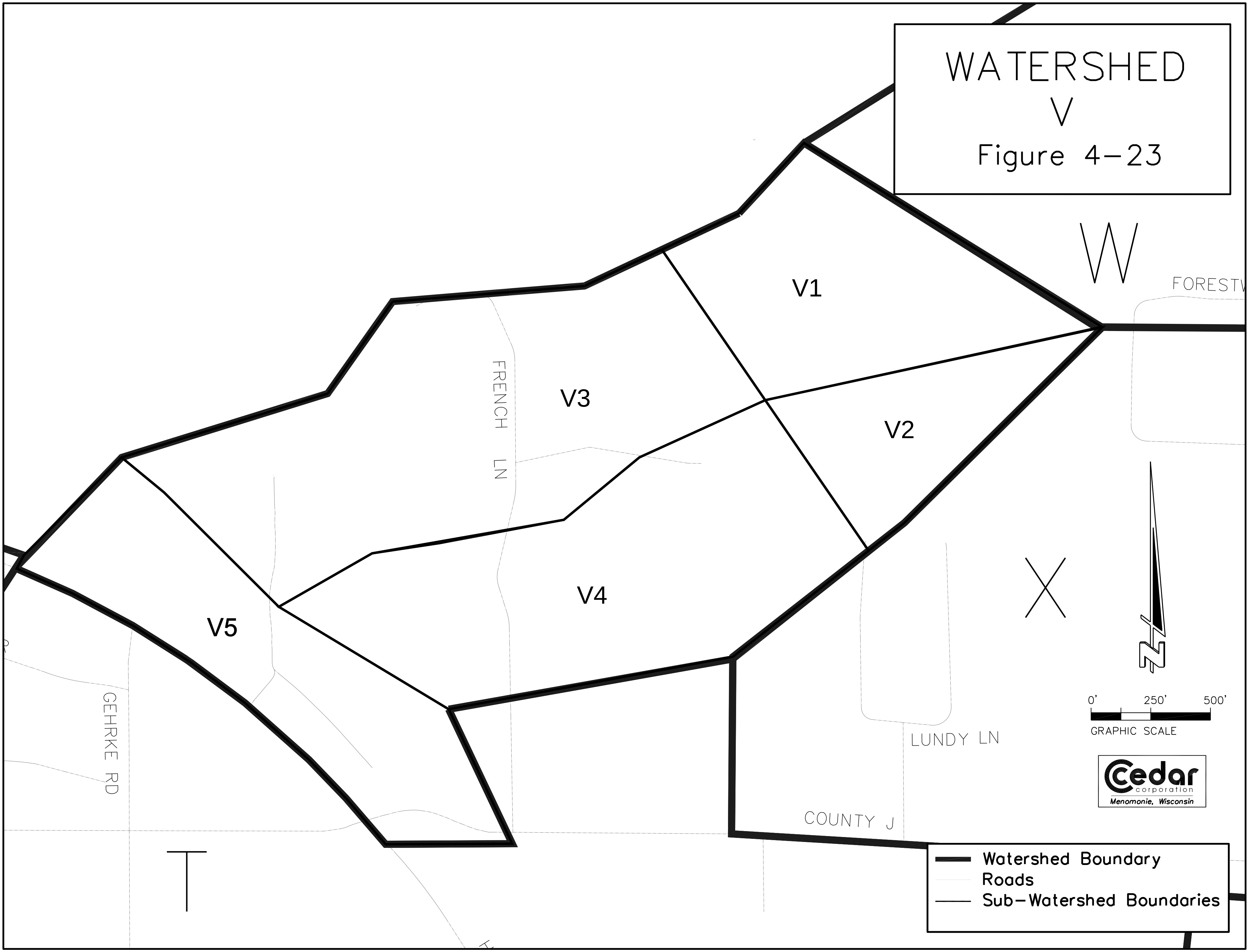

WATERSHED
R
Figure 4-19
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
MINOCQUA LAKE
MINOCQUA LAKE
LAMBERT RD
SLAND CITY POINT RD
HUBER LN
ROGERS DR
HWY 51
LAKE SHORE DR
FRONT ST
MILWAUKEE ST
ONEIDA ST
CHIPPEWA ST
CHICAGO AVE
PARK AVE W
PARK AVE E
CEDAR ST
PINE ST
ST GERMAIN ST
Cedar corporation
Menomonie, Wisconsin
0' 200' 400' 800'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries

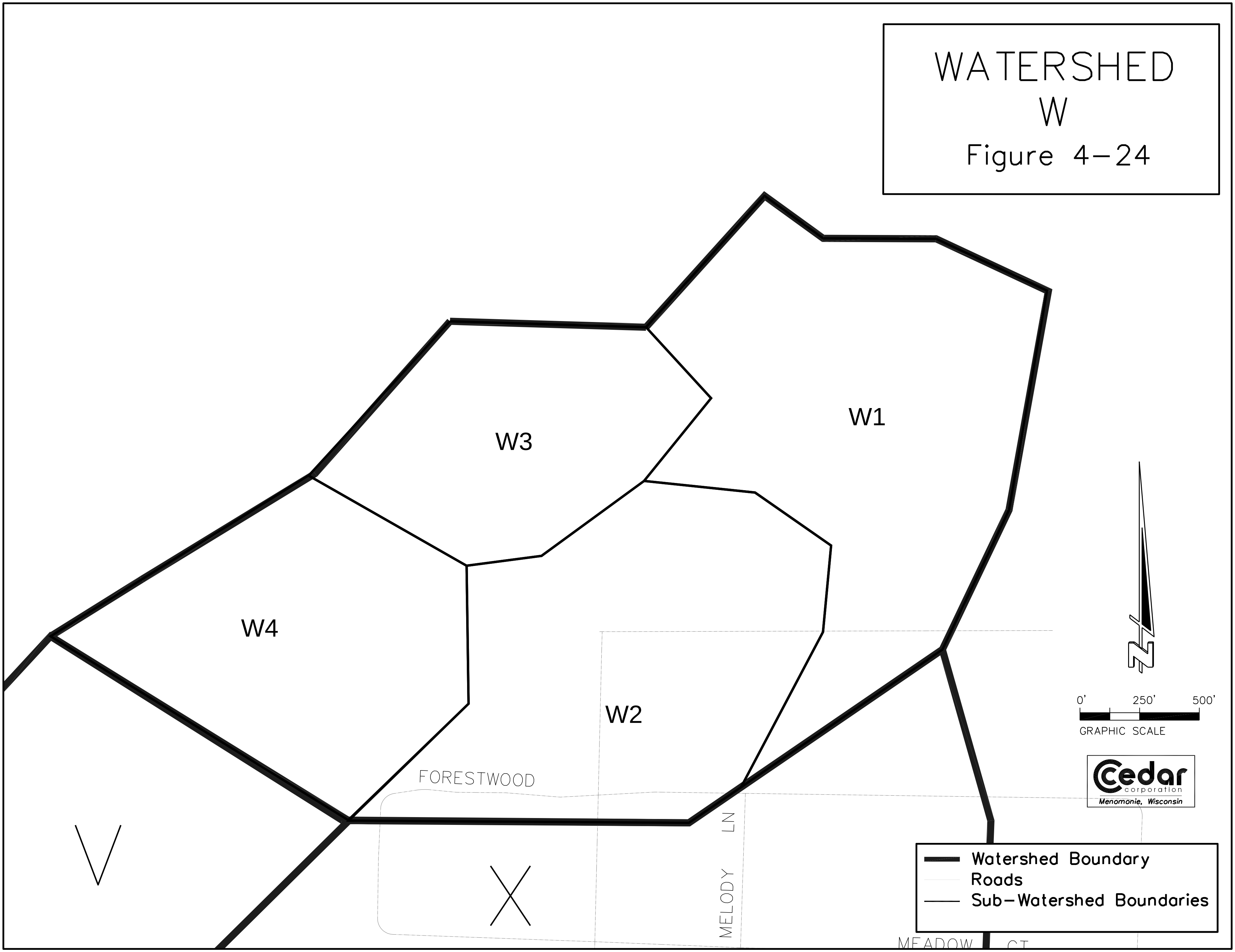

WATERSHED
S
Figure 4-20
S1
S2
S3
S4
S5
S6
S7
S8
N
Q
T
MAPLE ST
2ND AVE
3RD AVE
HEMLOCK ST
OAK ST
CEDAR ST
MARGARET ST
ELM ST
BIRCH ST
4TH AVE
5TH AVE
BALSAM ST
COUNTY J
1ST AVE
HUBER DR
JACOB CIR
CARLISLE CT
BROWN CT
NORTH
Cedar corporation
Menomonie, Wisconsin
0' 100' 200' 400'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries



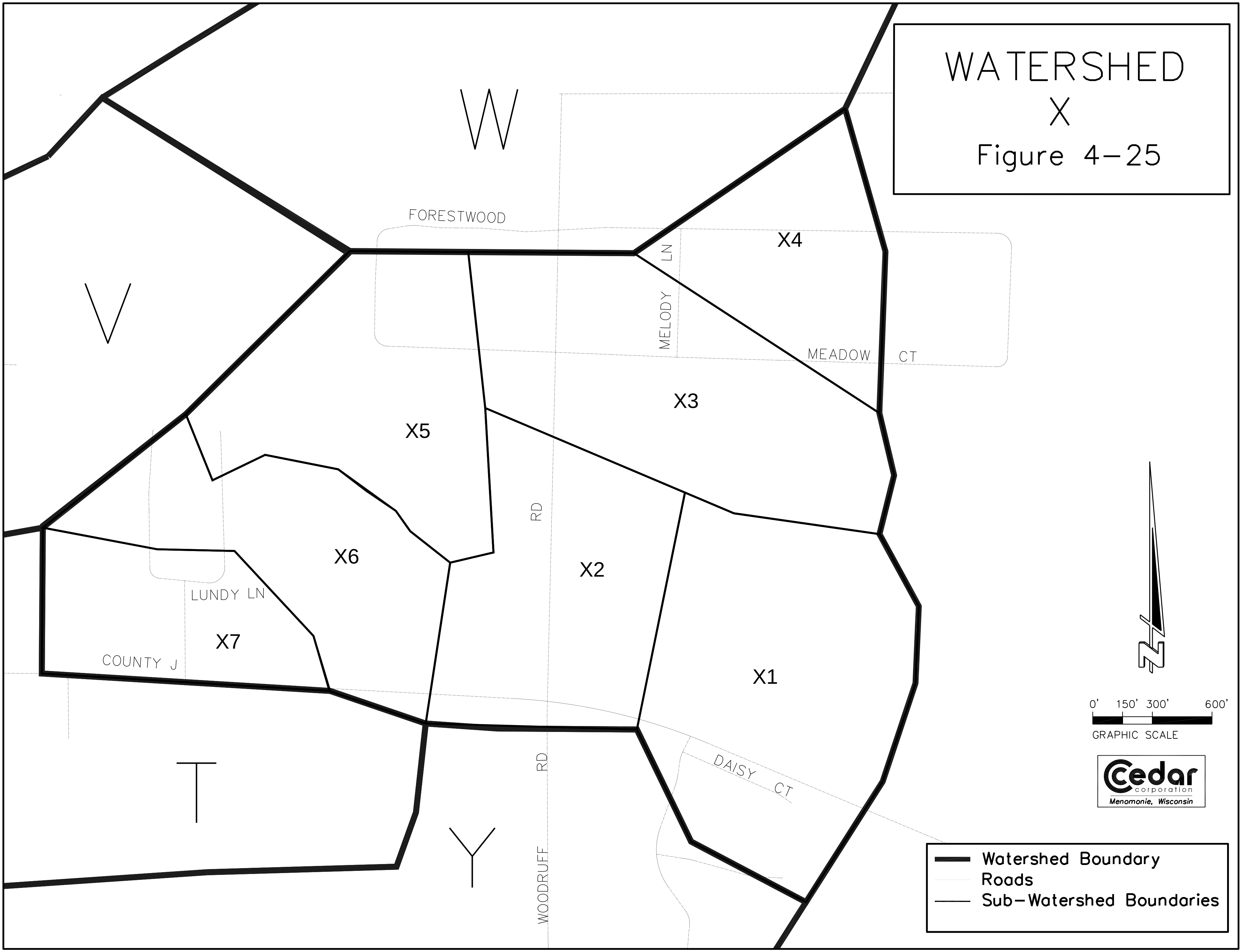
WATERSHED
T
Figure 4–21
S
V
Y
U
Z
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
1ST AVE
HUBER DR
JACOB CIR
4TH AVE
5TH AVE
BIRCH ST
BALSAM ST
CARLISLE CT
BROWN CT
GEHRKE RD
LUNDY LN
COUNTY J
HWY 47
NORTH
SHORE LN
WOODRUFF RD
BRUNSWICK RD
BIRK DR
HOLTZ DR
DENISE DR
SALLET DR
BAILEY DR
MOBILE DR
BLACK PINE LN
PARKVIEW RD
BRUNSWICK
WOODLAND
BRUNSWICK RD
ELLENBEE LN
Cedar corporation
Menomonie, Wisconsin
200' 400' 800'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub–Watershed Boundaries

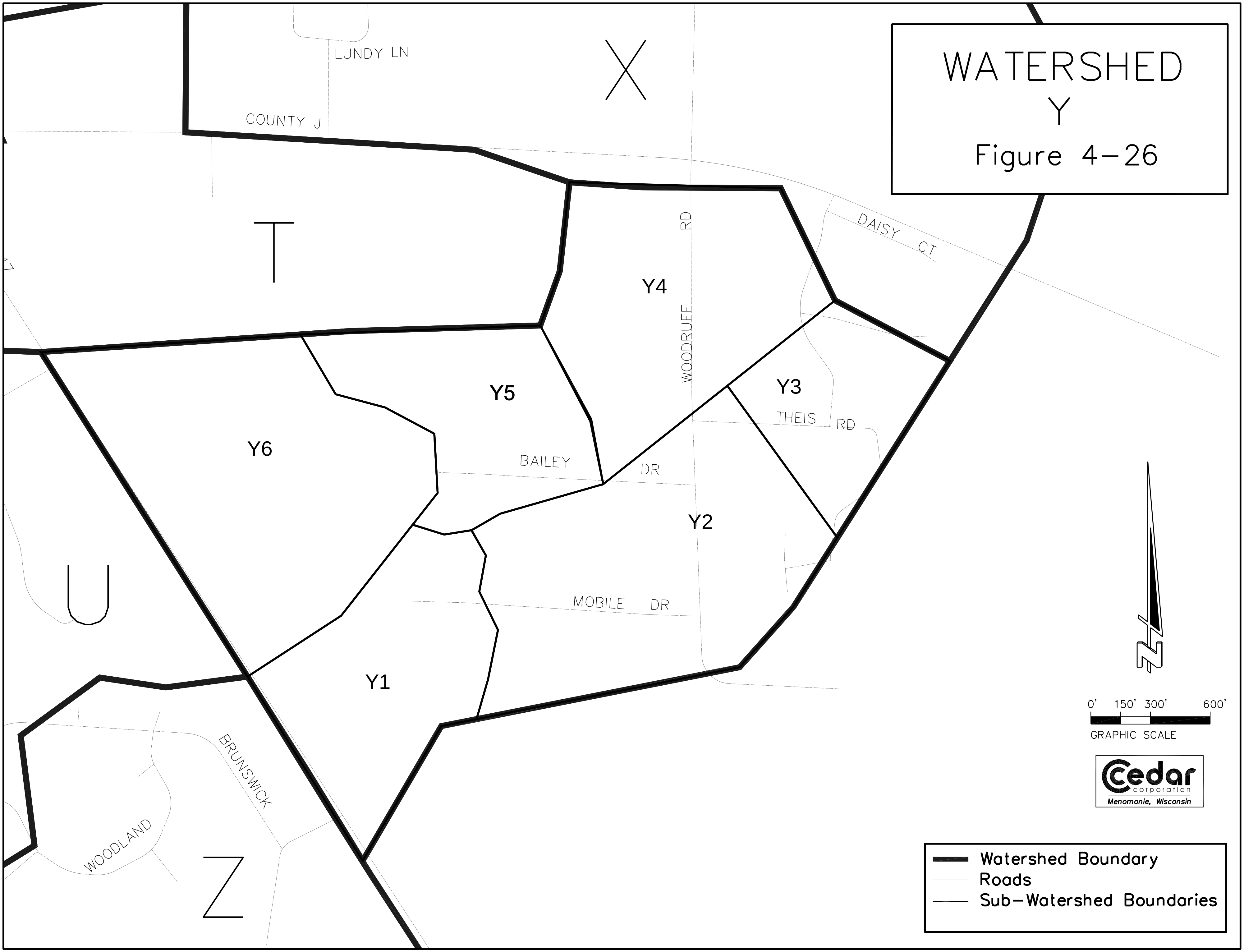

WATERSHED
U
Figure 4-22
T
Y
Z
U1
U2
U3
U4
U5
U6
BRUNSWICK RD
BIRK DR
HOLTZ DR
SALLET DR
DENISE DR
BLACK PINE LN
PARKVIEW RD
BRUNSWICK RD
ELLENBEE LN
WOODLAND
BRUNSWICK
0'
250'
500'
GRAPHIC SCALE
Watershed Boundary
Roads
Sub-Watershed Boundaries
Cedar corporation
Menomonie, Wisconsin


WATERSHED
V
Figure 4-23
V1
V2
V3
V4
V5
W
X
T
FRENCH LN
GEHRKE RD
LUNDY LN
COUNTY J
0'
250'
500'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

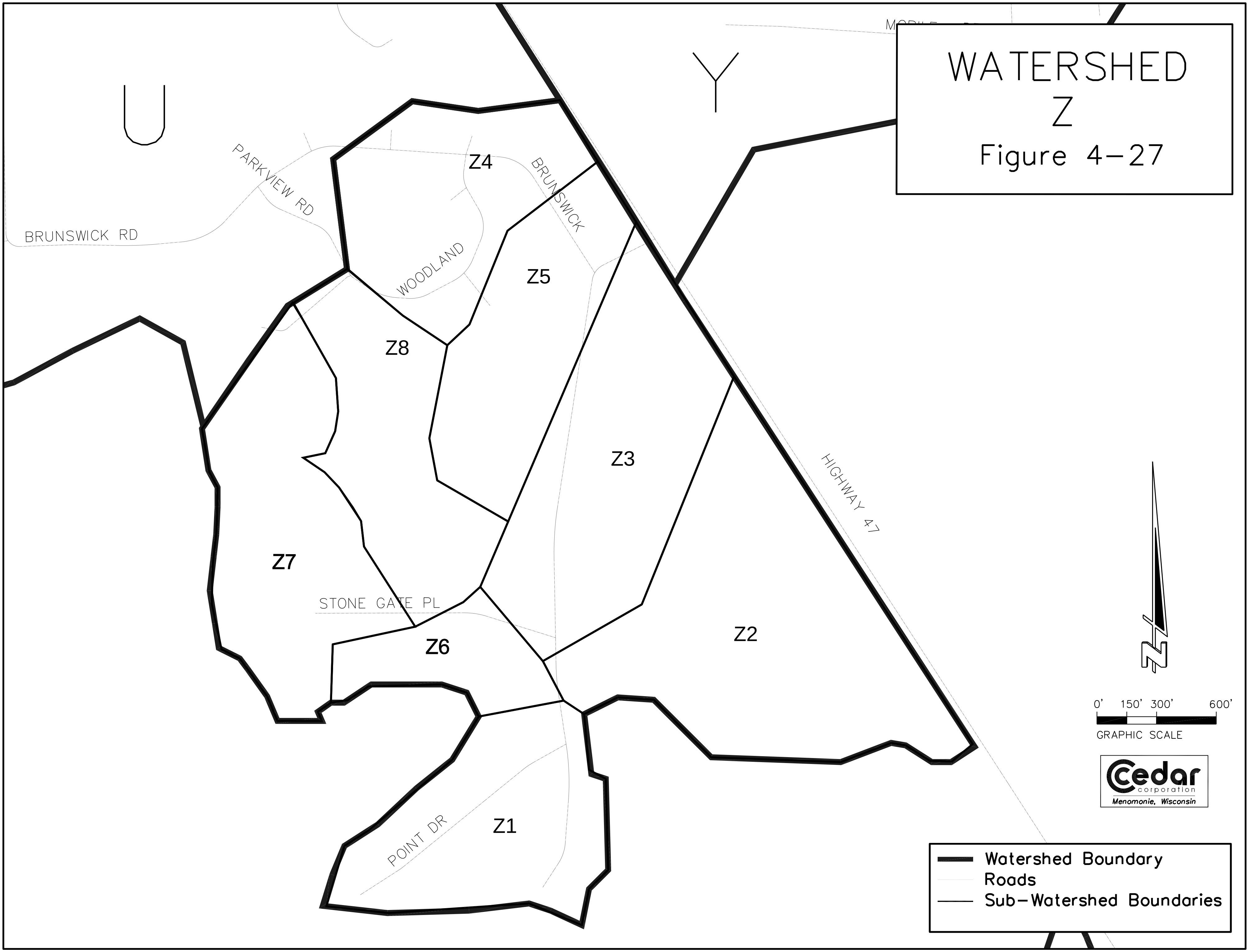


WATERSHED
W
Figure 4-24
W1
W2
W3
W4
V
X
FORESTWOOD
MELODY LN
MEADOW CT
0'
250'
500'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries


WATERSHED
X
Figure 4-25
W
V
T
Y
X1
X2
X3
X4
X5
X6
X7
FORESTWOOD
MELODY LN
MEADOW CT
RD
LUNDY LN
COUNTY J
WOODRUFF RD
DAISY CT
0' 150' 300' 600'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries



WATERSHED
Y
Figure 4-26
LUNDY LN
COUNTY J
X
T
DAISY CT
WOODRUFF RD
Y4
Y5
Y3
THEIS RD
Y6
BAILEY DR
Y2
U
MOBILE DR
Y1
BRUNSWICK
WOODLAND
Z
0' 150' 300' 600'
GRAPHIC SCALE
N
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

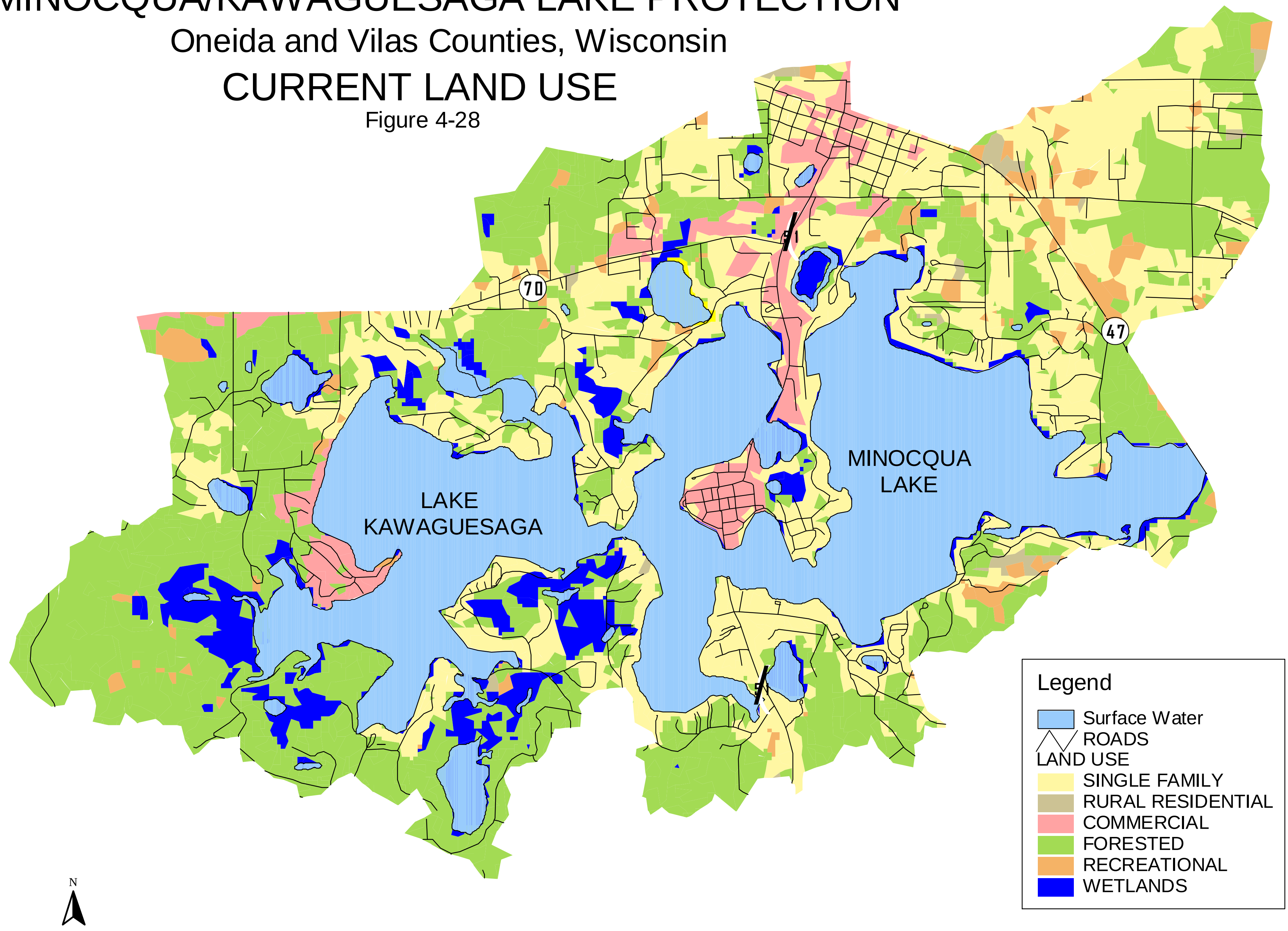

WATERSHED
Z
Figure 4-27
U
Y
PARKVIEW RD
BRUNSWICK RD
BRUNSWICK
WOODLAND
HIGHWAY 47
STONE GATE PL
POINT DR
Z1
Z2
Z3
Z4
Z5
Z6
Z7
Z8
0' 150' 300' 600'
GRAPHIC SCALE
Cedar corporation
Menomonie, Wisconsin
Watershed Boundary
Roads
Sub-Watershed Boundaries

MINOCQUA/KAWAGUESAGA LAKE PROTECTION

Oneida and Vilas Counties, Wisconsin

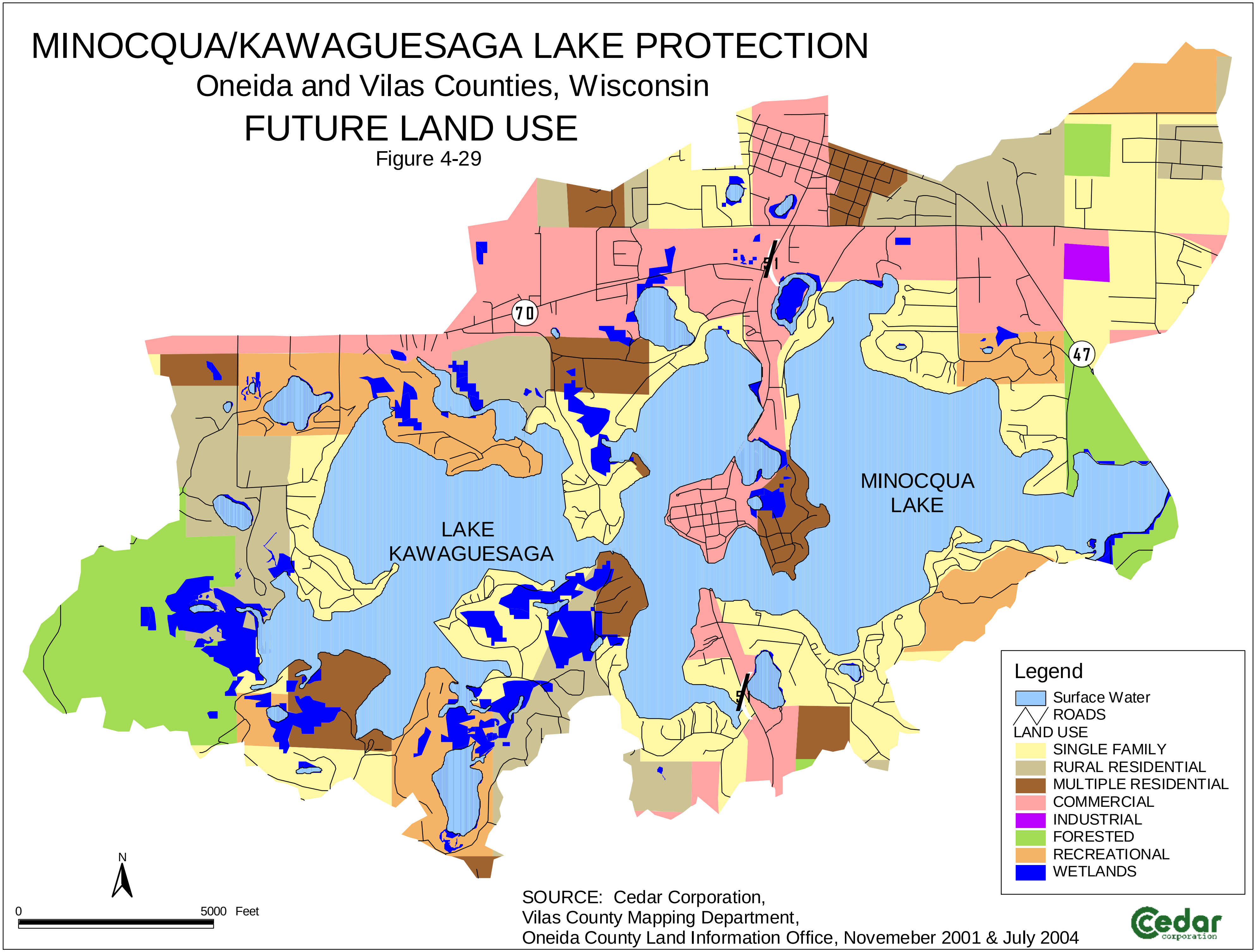
CURRENT LAND USE

Figure 4-28



SOURCE: WISCLAND 1993

Cedar corporation



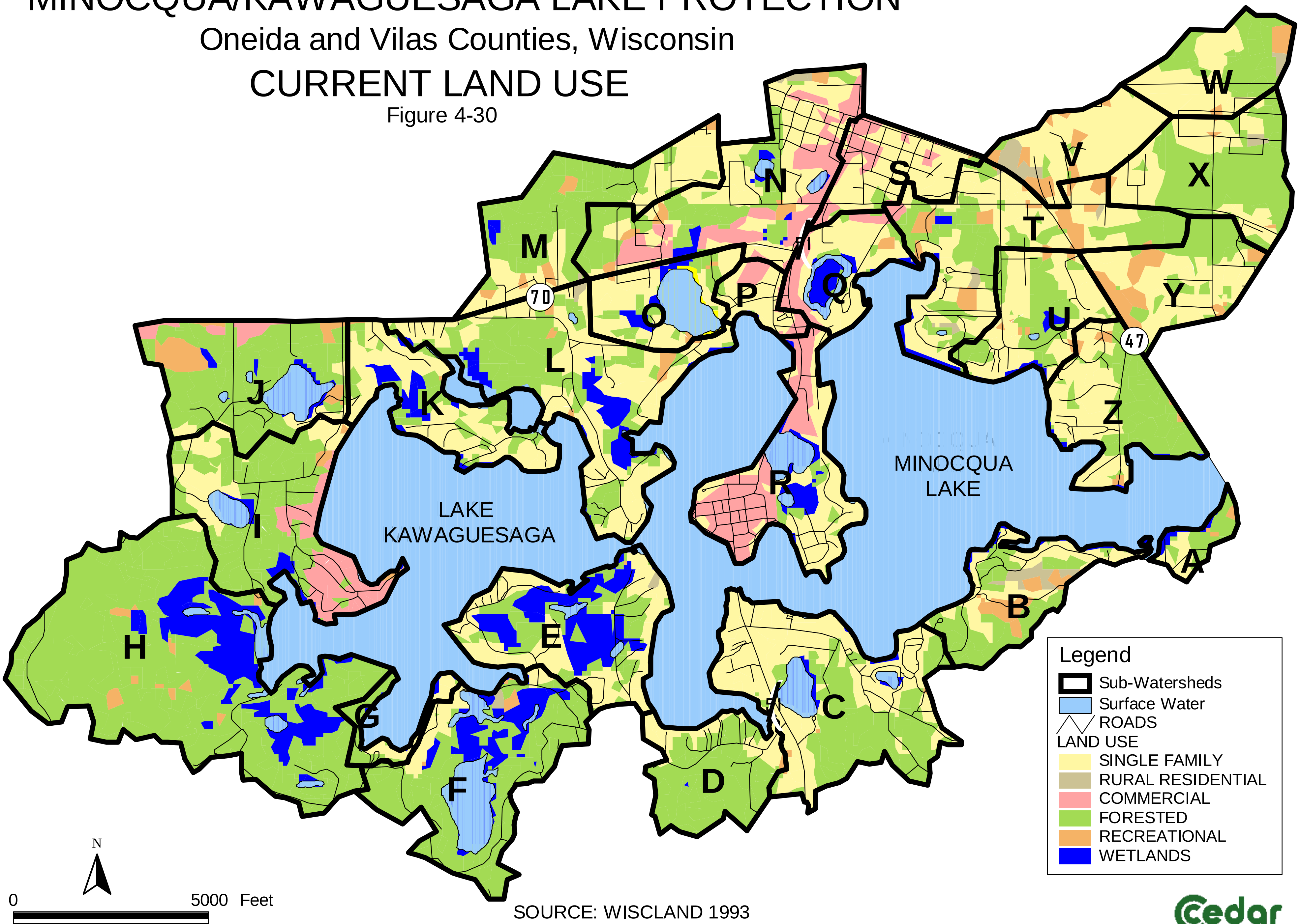
MINOCQUA/KAWAGUESAGA LAKE PROTECTION
Oneida and Vilas Counties, Wisconsin
FUTURE LAND USE
Figure 4-29
LAKE
KAWAGUESAGA
MINOCQUA
LAKE
70
51
47
51
Legend
Surface Water
ROADS
LAND USE
SINGLE FAMILY
RURAL RESIDENTIAL
MULTIPLE RESIDENTIAL
COMMERCIAL
INDUSTRIAL
FORESTED
RECREATIONAL
WETLANDS
N
0
5000 Feet
SOURCE: Cedar Corporation,
Vilas County Mapping Department,
Oneida County Land Information Office, Novemeber 2001 & July 2004
Cedar corporation

MINOCQUA/KAWAGUESAGA LAKE PROTECTION

Oneida and Vilas Counties, Wisconsin

CURRENT LAND USE

Figure 4-30



SOURCE: WISCLAND 1993

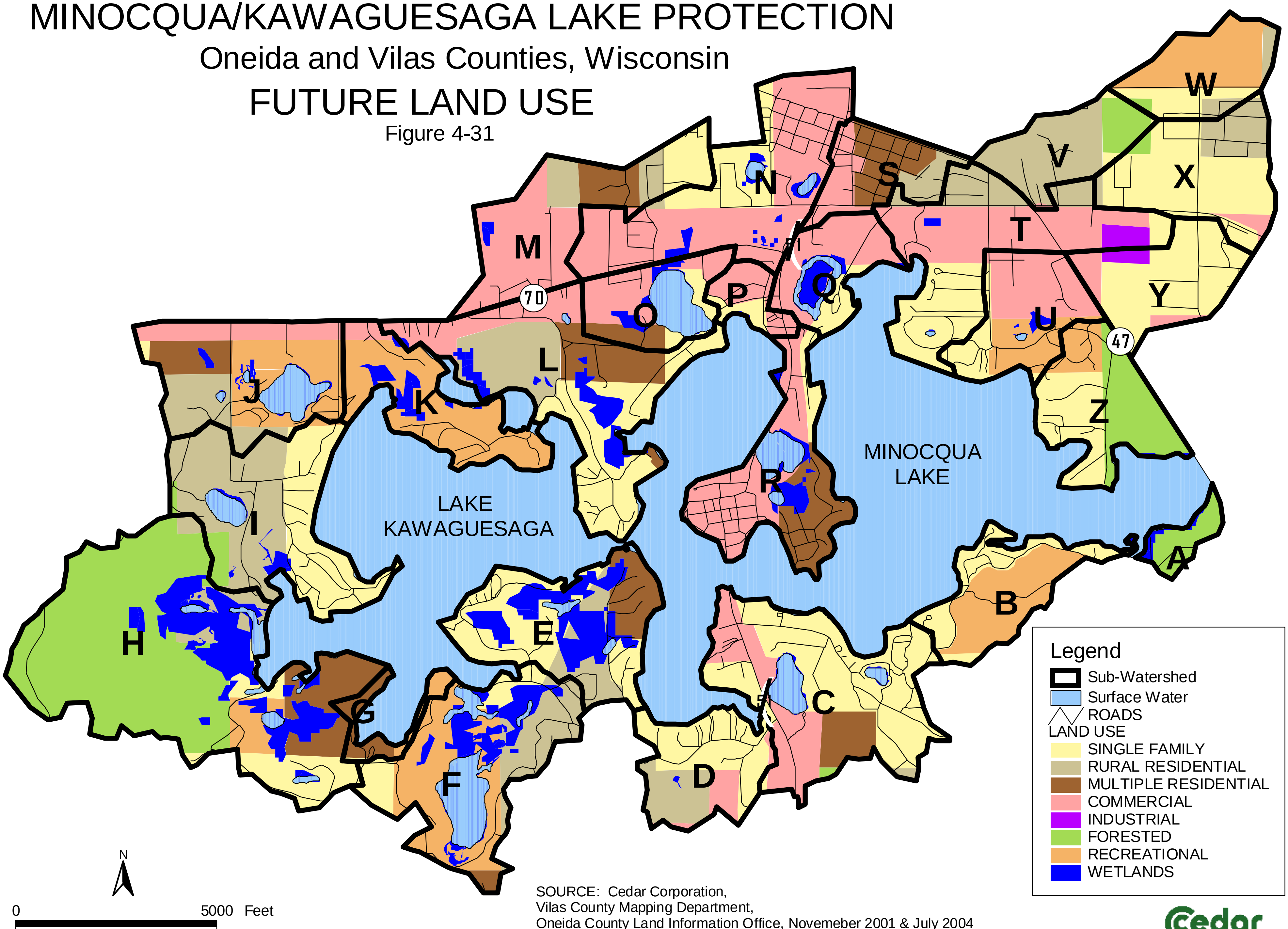
Cedar corporation

MINOCQUA/KAWAGUESAGA LAKE PROTECTION

Oneida and Vilas Counties, Wisconsin

FUTURE LAND USE

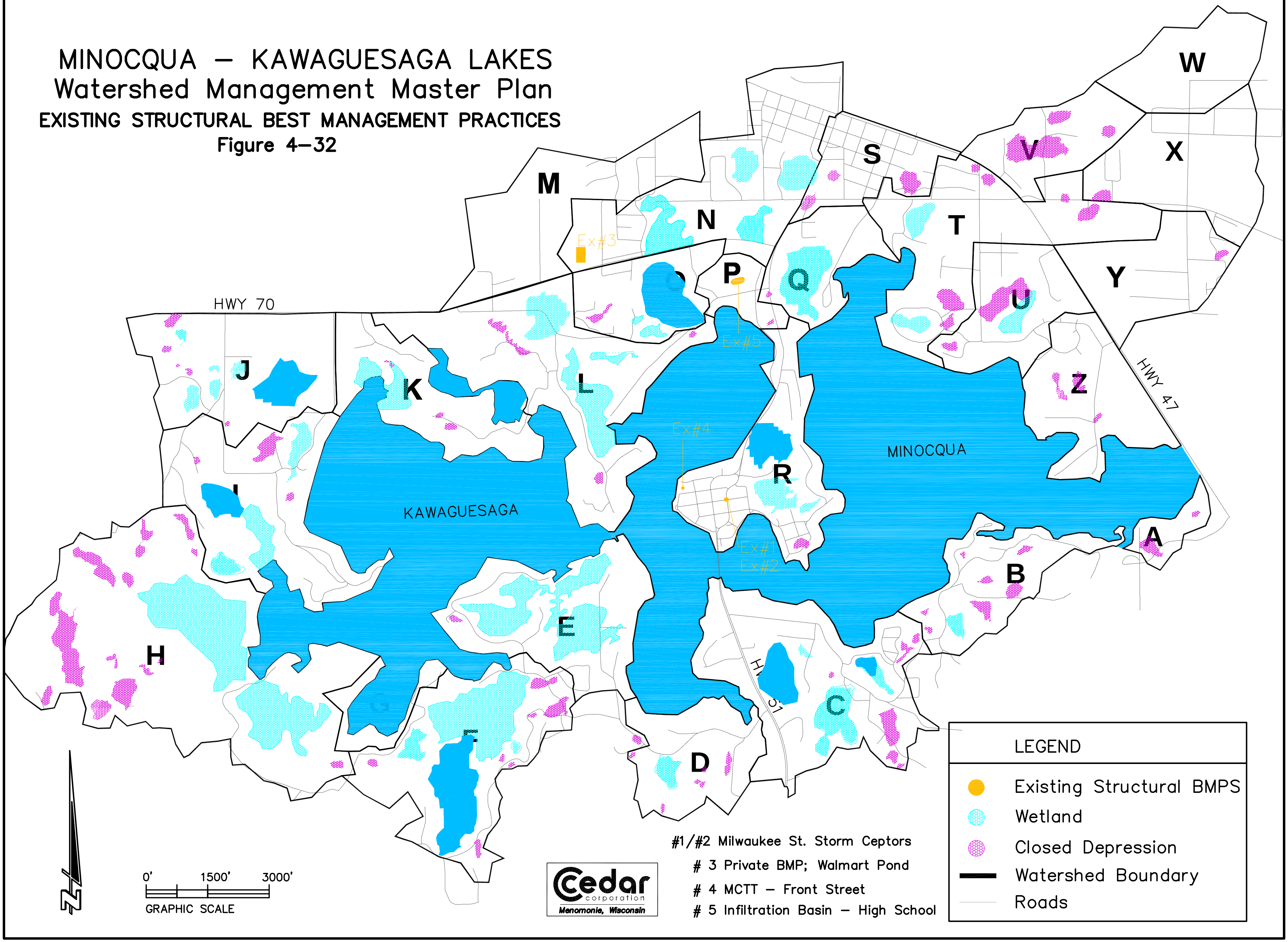
Figure 4-31

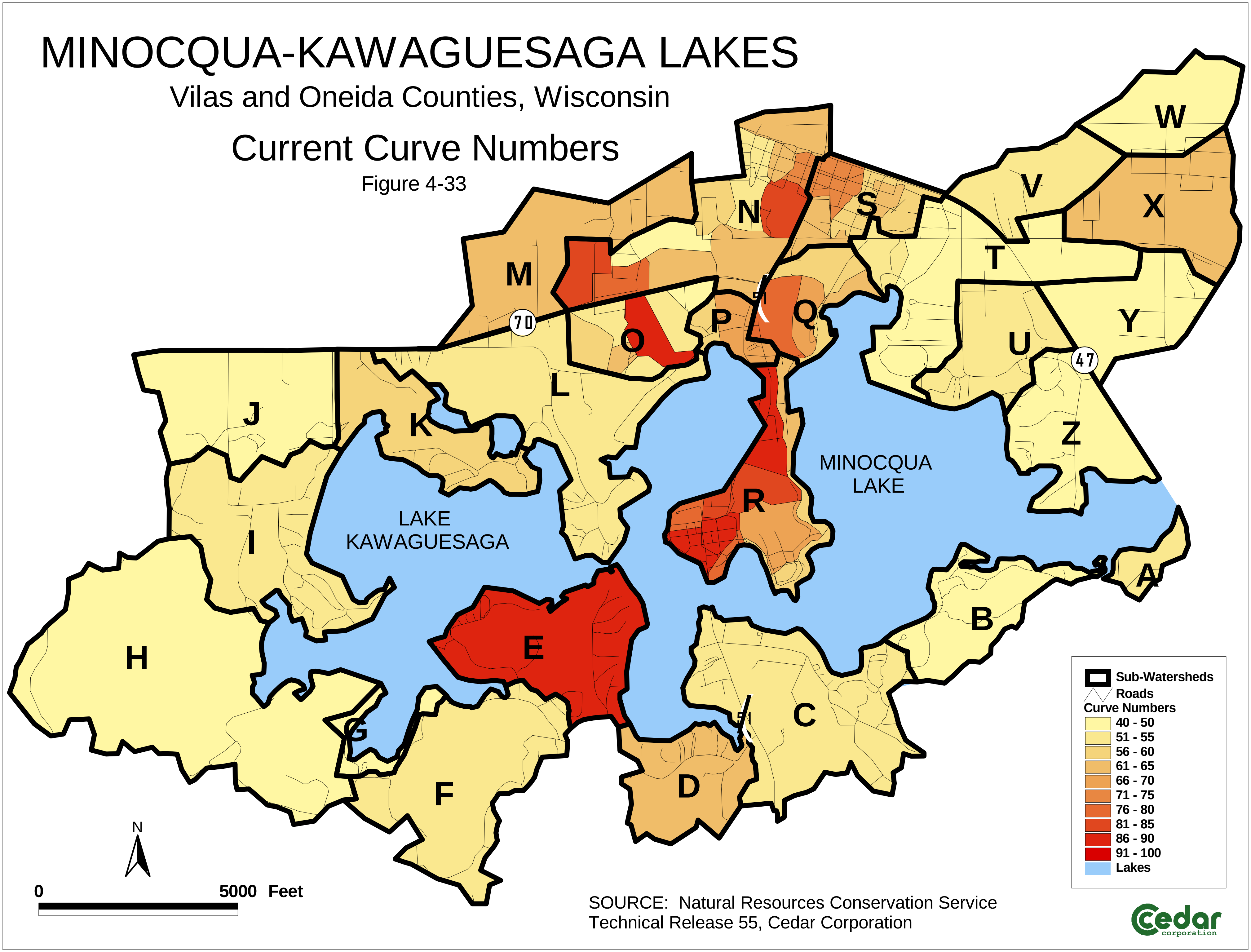


SOURCE: Cedar Corporation,
Vilas County Mapping Department,
Oneida County Land Information Office, Novemeber 2001 & July 2004

Cedar corporation

MINOCQUA – KAWAGUESAGA LAKES
Watershed Management Master Plan
EXISTING STRUCTURAL BEST MANAGEMENT PRACTICES
Figure 4–32



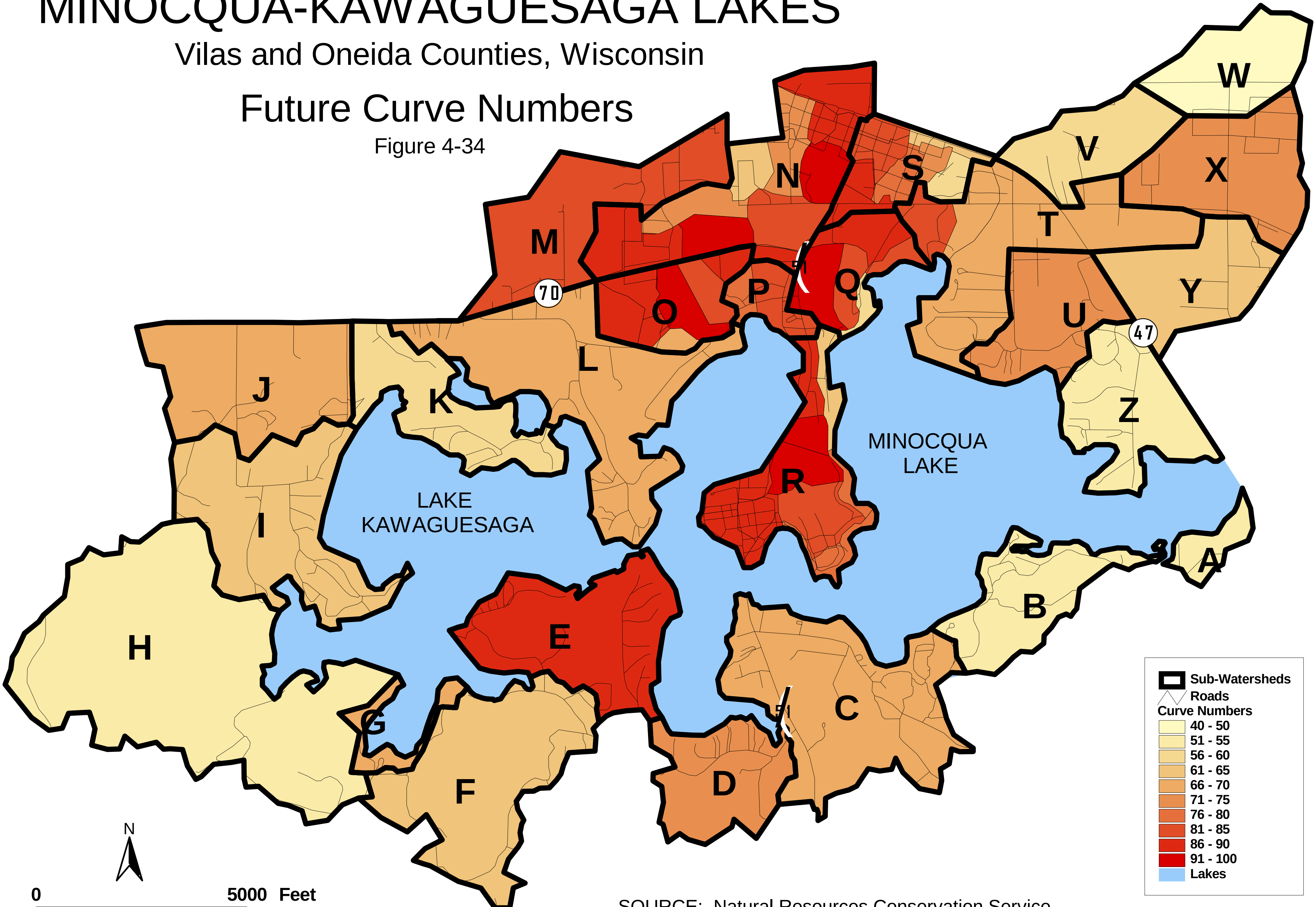

MINOCQUA-KAWAGUESAGA LAKES
Vilas and Oneida Counties, Wisconsin
Current Curve Numbers
Figure 4-33
LAKE KAWAGUESAGA
MINOCQUA LAKE
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
70
47
51
Sub-Watersheds
Roads
Curve Numbers
40 - 50
51 - 55
56 - 60
61 - 65
66 - 70
71 - 75
76 - 80
81 - 85
86 - 90
91 - 100
Lakes
N
0
5000 Feet
SOURCE: Natural Resources Conservation Service
Technical Release 55, Cedar Corporation
Cedar corporation

MINOCQUA-KAWAGUESAGA LAKES

Vilas and Oneida Counties, Wisconsin

Future Curve Numbers

Figure 4-34



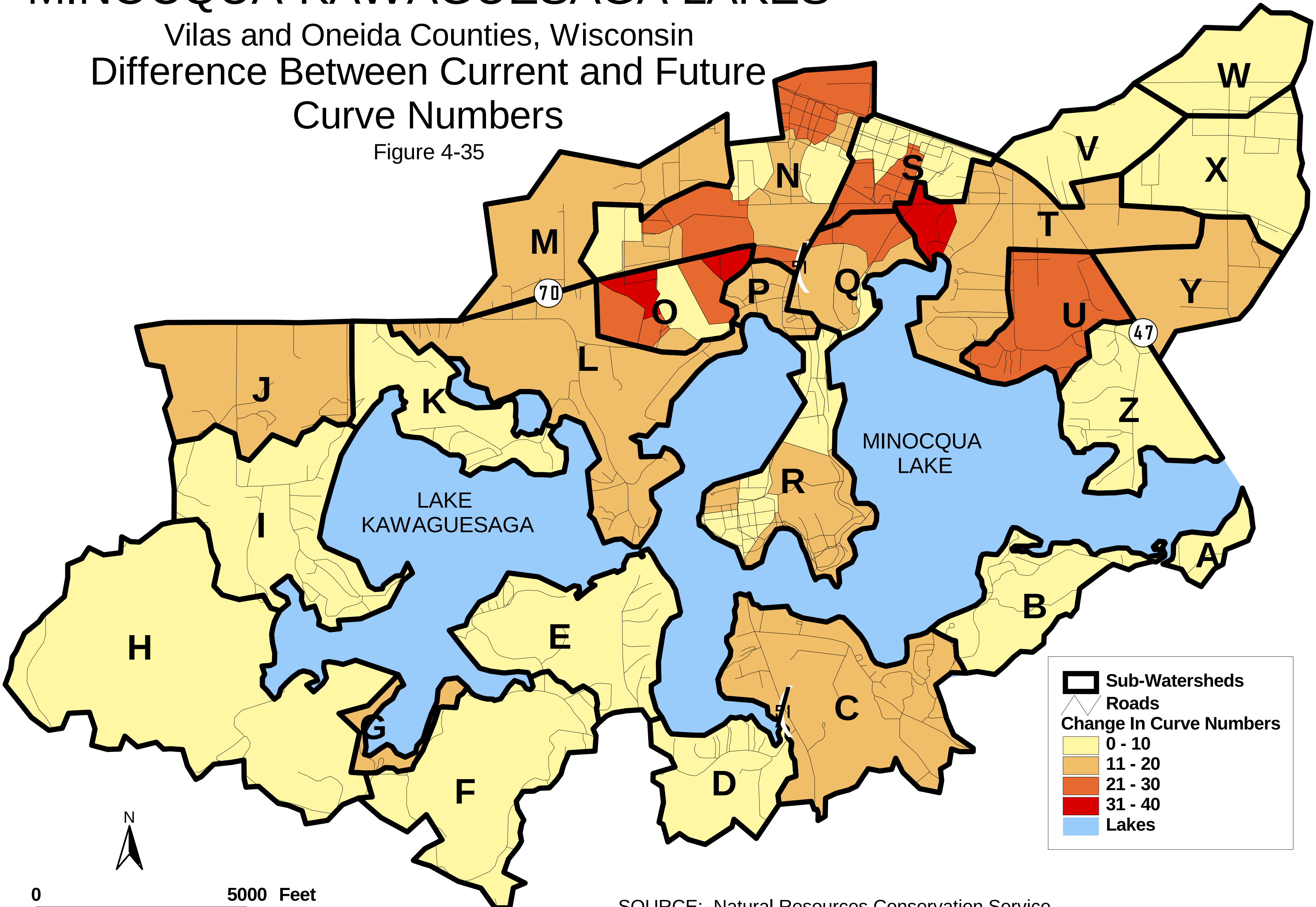
SOURCE: Natural Resources Conservation Service Technical Release 55, Cedar Corporation

MINOCQUA-KAWAGUESAGA LAKES

Vilas and Oneida Counties, Wisconsin

Difference Between Current and Future Curve Numbers

Figure 4-35



SOURCE: Natural Resources Conservation Service
Technical Release 55, Cedar Corporation

Cedar corporation

CHAPTER 5: SOURCES OF PROBLEMS (QUANTITY AND QUALITY)

5.1. Runoff Water Quantity—General Background

In order to provide a useful document that addresses several aspects of Lake Watershed management planning, an analysis using computer models of the existing system and proposed future improvements must be conducted. The system analysis is a technical investigation, analysis, and computed modeling of the land use, storm sewers, overland drainage, water quality, wetlands, lakes, ponds, streams, channels, and water quality, and drainage ways. The analysis is accomplished using standard hydrologic and hydraulic modeling methodologies for storm water quantity that includes components such as pipe flow, overland flow, drainage ways, and pond storage of storm water runoff.

In an ideal situation, most of the precipitation falling on a given drainage area would be absorbed or retained on-site. After development, the quantity and rate of water leaving the site would not exceed undeveloped conditions. The same principle would apply to nutrients and pollutants to avoid impacting the natural and water resources of the watershed. Unfortunately, the only true way to achieve this is by not developing or farming at all. Even when the pollutant loads and runoff rates could be matched under developed conditions, the wildlife habitat, ecology, and aquatic biota is displaced by human activities and impervious surfaces. Therefore, the “real world” solution is to achieve an economically feasible balance between pre-development and post-development storm water quality and quantity to the most practical extent possible.

The management recommendations discussed in this report consist of interconnected open channels, drainage ways, ditches, prairie grass vegetation, pipes, culverts, bridges, ponds, and wetlands. The analysis and modeling of the runoff water management system involves the following aspects:

- Division of the Watershed into sub-watersheds and sub-areas based on contour maps, road systems, grading plans, and natural topographic features.
- Determine the amount of runoff anticipated under existing land use conditions and future land use conditions.
- Select a method of conveying the runoff water.
- Delineate conveyance, detention areas, and BMPs (Best Management Practices) for runoff water volume, rate control, storage, sediment and constituent pollutant treatment.
- Identification of vegetation cover types, such as woods, meadows, grass, crops, wetlands, and water bodies.
- Develop measures to maintain and enhance the groundwater recharge and improve water quality in the Watershed.

5.1.a. Watersheds

The Towns of Minocqua and Woodruff are located in the Tomahawk River Basin. The Towns are broken into 26 sub-watersheds (A-Z) as shown in Figure 4-1. Each of these sub-watersheds was broken into multiple sub-areas to facilitate water quantity and quality modeling, as shown in Figures 4-2 through 4-15.

Hydrologic effects are influenced by tributary drainage areas, watershed shape, land use, soils, existing impoundment areas, and a variety of other factors. Delineation of existing impoundment areas was critical to the modeling of the Minocqua-Kawaguesaga Lakes Watershed. As seen in Figure 5-1, there are many areas in the Watershed that do not have positive surface drainage to the Lakes.

Two planning periods were chosen to assess the storm water runoff hydrology within each sub-watershed. Land use characteristics were projected for both planning periods. The planning periods used correspond to Wiscland, 1993, for present land use (Figure 4-30) and the zoning maps for the Towns of Minocqua and Woodruff for future (2020) projected land use (Figure 4-31).

5.1.b. Hydrology/Hydraulics

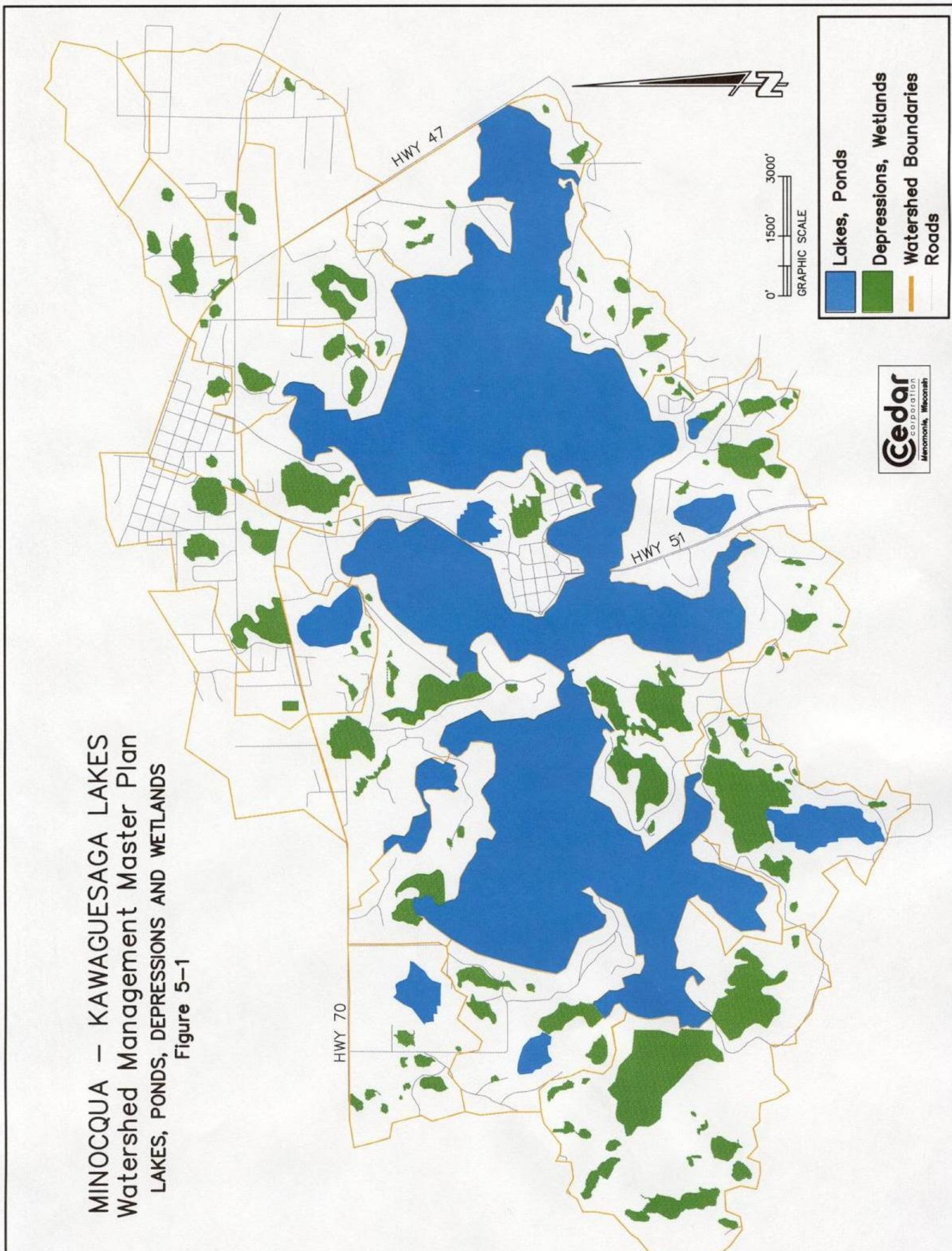
Runoff water is defined as the portion of precipitation that flows over the ground surface during, and for a short period of time after, a storm event. The quantity of runoff is dependent on:

- The intensity of the storm event,
- The initial moisture condition and infiltration capacity of the soil,
- The amount of antecedent rainfall,
- The length of the storm event,
- The type of surface the rain falls on, and
- The slope of the surface.

The intensity of the storm event is commonly associated with its period of return that designates the average period of years during which a storm of a certain magnitude has a percent of probability of occurring in any given year. The degree of protection is determined by selecting a return storm event interval to be used as the basis for analysis, modeling, and design. The storm events used in the report include 24-hour, 2-, 10-, 25-, and 100-year frequency storm events for overland drainage.

Example: A 10-year frequency storm has a 10 percent probability for occurring or being exceeded in any given year, and a 100-year frequency storm has a one percent probability of occurring or being exceeded in any given year, etc.

Based on historical data prepared by Soil Conservation Service Technical Release No. 55 (TR-55) Manual, a 10-year 24-hour frequency storm consists of 3.8 inches of rainfall, while a 100-year 24-hour frequency storm consists of 5.3 inches of rainfall in this area.


MINOCQUA – KAWAGUESAGA LAKES
Watershed Management Master Plan
LAKES, PONDS, DEPRESSIONS AND WETLANDS
Figure 5–1
HWY 47
HWY 51
HWY 70
N
0'
1500'
3000'
GRAPHIC SCALE
Lakes, Ponds
Depressions, Wetlands
Watershed Boundaries
Roads
Cedar corporation
Menomonie, Wisconsin

Complete protection against large, infrequent storms with return intervals greater than 100-years is not economically feasible and is usually justified only for large flood control projects. For most developing areas within the watershed, the cost of construction of an excessively large capacity storm water management system is much greater than the amount of property damage that would result from flooding caused by a storm event which a smaller capacity system could not hold.

The excess storm water runoff caused by storms greater than the designed storm will be accommodated by temporary ponding and nuisance flooding in low street areas and/or safe overflow conveyance through overland drainage routes. This short-term flooding and overland safe conveyance drainage will minimize much of the damage to property which would occur if those facilities were not provided. *Therefore, we recommend that provisions be made to provide or preserve overland drainage routes for emergency storm water runoff overflows.*

Hydrologic/Hydraulic Storm Water Runoff Water Quantity Analysis and Modeling are usually represented in present and future peak runoff rates in cubic feet per second (cfs) and total runoff volume in acre-feet (ac-ft). A number of methods are available to determine the expected maximum rate of runoff from a known area for a certain design storm. These methods include the Rational Method, the USDA-Soil Conservation Service TR-20 and TR-55 models, and the US. Army Corps of Engineers HEC-1 model, HydroCAD, Haestad Methods, SWMM, etc. The analysis and modeling methodology chosen for this Storm Water Management Plan is the HydroCAD software that uses both the TR-20 and TR-55 calculations.

The Rational Method is used for instantaneous storm events and the design of storm sewer pipe systems. It involves the selection and/or computation of a time of concentration, rainfall intensity, and duration, and a runoff coefficient. The time of concentration is the time required for storm water runoff to become established and flow from the hydraulically most distant point (in time not distance) of the drainage area to reach the design point. The time of concentration is usually computed by determining the storm water travel time through the drainage area.

It is assumed that during the time of concentration, the entire drainage area will be contributing runoff to the design point. Consequently, the maximum rate of runoff will occur at this time for a specific design frequency storm. Once the time of concentration is determined, the average rainfall intensity for the design storm frequency of occurrence can be taken from the appropriate Rainfall-Intensity-Frequency Duration Curves.

The percentage, or amount, of rainfall that must be collected by a detention pond or storm sewer facility is dependent on the watershed variables such as soil and cover conditions, land use, land slope, and antecedent rainfall. These factors are considered when selecting a runoff curve (CN) in the Soil Conservation Service Technical Release No. 55 (TR-55) and No. 20 (TR-20) method or a runoff coefficient (C) in the Rational Method for a certain drainage area.

Curve Number (CN) values depend on the hydrologic soil group, cover type, hydrologic condition, and antecedent runoff conditions. Soils in the Minocqua-Kawaguesaga Lakes Watershed are typically Hydrologic Soil Group Type A, as identified on Figure 5-2. Figure 5-3 shows the soil types that are present in the watershed. Table 5-1 shows the relationship between Curve Numbers and the Hydrologic Soil Groups.

The existing runoff CN and coefficient throughout undeveloped areas is less than what it will be when the anticipated level of development and urbanization is reached in the future. The values of the CN and runoff coefficient will increase with the increase in the amount of impervious areas resulting from street surfacing, lawn, development, building construction and grading.

Average runoff coefficients and CN values are used for each land use to design the storm water management and drainage conveyance facilities. For modeling, CN values are determined for each type of existing and proposed land use within each sub-area. The CN values do not need to be changed for different storm events. Runoff coefficients, for each type of development in the watershed, utilized for the analysis of storm sewer conveyance systems, and equivalent CN values for antecedent moisture conditions (AMC) Type II distributions for the analysis of storm water management facilities are presented in Table 5-1—Runoff Coefficients.

Table 5-1: Runoff Coefficients

	SCS Curve Number			
Description	HSG A	HSG B	HSG C	HSG D
Commercial	89	92	94	95
Industrial	81	88	91	93
Single Family	61	75	83	87
Multiple Family	77	85	90	92
Agriculture	64	75	82	85
Conservancy/Grassland	49	69	79	84
Woods	36	60	79	79
Open Water	100	100	100	100

HSG or hydrologic soil groups refers to the soil grouping classification (A, B, C or D) on the basis of the runoff producing characteristics (see page 2-4). Soils are ranked A through D on ever increasing run-off characteristics, thus a 'D' soil produces more run-off than and 'A' soil, for example. Soils in this project area are considered A and B soils, having low runoff potential.

5.1.c. Storm Sewer Hydraulics

Storm sewers are typical conduits to transport storm water runoff from minor storm events. The capacity of a storm sewer conduit is dependent on the pipe slope, pipe diameter, and the roughness of the inner surface of the pipe. The capacity is measured in volume per unit of time, or cubic feet per second as determined by the rational formula. Computations for storm sewer conduit capacity are based on Manning's formula:

$$\underline{1.49(A)}\ ^{2/3}\ (S)\ ^{1/2}A$$

$$Q = \qquad n \quad P$$

Where:

> Q = storm sewer capacity in cubic feet per second (cfs)
> *n* = roughness coefficient
> A = cross-sectional area (ft^2) of the transfer pipe
> P = wetted perimeter (ft) of the transfer pipe
> S = slope (ft/ft)

A roughness coefficient (n) of 0.013 is used for concrete storm sewer pipe and 0.024 for corrugated metal pipe. This value takes into account losses due to bends and manholes in the system as well as the roughness of the inner pipe surface. Lateral systems with velocities higher than six feet per second or with several manholes should consider head losses due to bends and manholes.

Open channels are normally designed with a trapezoidal cross-section with three feet horizontal to one foot vertical (3:1) maximum side slopes. The same Manning's formula is used to determine channel capacity with the roughness coefficient (n) increased to 0.04. For open channels, P in the equation equals the wetted perimeter of the channel.

Storm sewer pipe systems and related facilities have been analyzed as part of this Plan. Storm sewers connecting ponds and pipes larger than 24 inches in diameter are considered trunks. A complete working system consists of channels, ditches, ponds, trunk sewers, manholes, local lines, overland drainage ways, inlet leads, inlets, pond inlets and outlets, and all related items. Storm water conveyance systems currently in the Watershed and proposed as part of this Plan consists mainly of storm sewers, swales, ditches, open channels, and culverts. *Detailed storm sewer calculations should be provided at the time individual subdivision and site plans are engineered and street improvement plans are prepared.*

Although local storm sewer systems are typically designed for 10-year instantaneous storm events, their performance must be analyzed for storms exceeding the design storm. Surcharging of the system may occur when the design storm is exceeded. During surcharging, the system works as a closed conduit, and the pipe network becomes pressurized with different pressure heads throughout the system. Low areas that are commonly provided with catch basins become small retention ponds often performing as pressure relievers (water "gushing out" in some locations). For this reason, it is extremely important to ensure these low areas have an acceptable safe emergency overland drainage route with proper storm water transfer conveyance capacity.

Ponding or standing water on streets must meet the minimum requirements of the 100-year storm design criteria. *For safety reasons, the maximum depth of water in local streets should not exceed one foot at the deepest point, 6 inches deep in collector streets, and the lowest exposed building elevation should be at least 24 inches above the high water level.* The high water level for ponding on streets is defined as the elevation to which water rises before overflowing through adjacent safe emergency overland routes.

All storm sewer facilities, especially those conveying large quantities of water at high velocities, should be designed with efficient hydraulic characteristics. Manhole and other structures at points of transition should be designed and constructed to provide gradual changes in alignment and grade. Pond outlet control structures should be designed to provide good self-cleaning characteristics, and prevent damage from erosion.

Catch basins should be liberally provided at all low points where water collects and at points where overland flow is to be intercepted. Catch basin structures are of special importance, since it is a poor investment to have an expensive storm sewer line flowing partially full while property is being flooded due to inadequate inlet capacity. *Inlets should be placed to eliminate overland flow in excess of 400 feet or 5 cfs for a 10-year event.* Catch basin grates should be of self-cleaning type design to minimize capacity reduction when clogged with twigs, leaves, and other debris.

Effective energy dissipation devices or stilling basins to prevent stream bank or channel erosion at all storm sewer outfalls are recommended. *The following recommendations should be kept in mind when designing a runoff water outlet:*

- Inlet and outlet pipes from storm water management ponds should be extended to the normal static water level.

- Outfalls with velocities of less than 4 feet per second (fps) flowing into a channel or creek in a direction at less than 30 degrees from the channel axis generally do not require energy dissipaters or stilling basins, but do require rip-rap protection.

- Where an energy dissipater is used, it should be sized to provide an average final outlet velocity of less than 4 fps. Local and channel erosion should be considered when designing energy dissipaters.

- Where outlet velocities exceed 8 fps, the design should be based on the unique site conditions present. Submergence of the outlet and the installation of a stilling basin and heavy rip-rap are recommended.

- Rip-rap should be provided at all outlets to an adequate depth below the channel grade and to a height above the outfall or channel bottom. Rip-rap should be placed over a suitably graded crushed aggregate material and filter fabric to ensure that soil particles do not migrate through the rip-rap and reduce its stability. Rip-rap should be placed to a thickness at least 1.25 times the maximum stone size and a minimum of 12 to 18 inches thick to ensure that it will not be undermined or rendered ineffective by displacement. If rip-rap is used as protection for overland drainage routes, proper design, and grouting of rip rap may be necessary.

- Overland drainage routes where velocity exceeds 8 fps should be properly designed, reviewed, and approved by the appropriate governing agency.

Open prairie grass conveyance channels are recommended where practical and feasible in lieu of storm sewer pipes to attenuate the storm water flow and increase ground water recharge by maximizing the portion of runoff that infiltrates into the soil. This will improve water quality and enhance the aesthetic qualities of a development. A minimum slope of approximately 1.0% should be maintained in unlined open channels, swales and overland drainage routes whenever possible. Where site conditions would require a slope greater than 2%, properly designed energy dissipaters and drop structures should be used at necessary intervals to maintain the 2% slope. *We do not recommend that concrete or rip-rap lined channels be designed because water quality benefits are not available with lined channels.* Channel slopes less than 1.0% are difficult to construct and maintain and can create problems with stagnant standing water. Side slopes should be a maximum of 3:1, with 4:1 and gentler side slopes being desirable.

Rock rip-rap should be provided at all points of junction between two open channels, at hard corners of the channel, and where storm sewer pipes discharge into a channel. The design velocity of an open channel should be sufficiently low to prevent erosion of its banks and bottom. Rip-rap and concrete liners should be provided only in areas where high velocities cannot be avoided. Periodic cleaning of an open channel is required to ensure the design capacity is maintained. Therefore, all channels should be designed with appropriate width access easements to allow easy access for maintenance equipment.

Storm drainage facilities and sanitary sewer facilities are designed and located to take advantage of natural draws or lay of the land, and usually follow rivers, creeks, drainage ways, ravines, or gullies. As more area develops in the watershed, the total runoff in natural drainage ways will increase, and corresponding water levels will rise. In certain low lying areas, storm water could enter the sanitary sewer system, causing infiltration and capacity problems and added costs for treatment of effluent. For this reason, sanitary sewer manholes subject to temporary inundation of storm water runoff should be equipped with watertight castings and added precautions should be taken in construction of these manholes to prevent the entrance of storm water. *We recommend that sanitary sewer manholes located near low lying and ponding areas be designed at or above 100-year high water levels where feasible.* If access is not feasible or required, we recommend that flood proof, watertight, bolt down castings should be installed. Future storm water management and storm drainage construction should include provisions for mitigating inflow and infiltration of nearby sanitary sewer system. *We recommend that all newly constructed sanitary sewer manholes in vicinity of low lying and ponding areas and open channels be waterproofed.*

5.1.d. Wet Detention Pond Water Quantity Control

Storm water management wet detention ponds are an essential part of a storm water runoff drainage system for quantity and quality reasons. Wet detention ponds will provide the necessary storage requirement to retain or delay high intensity storm water runoff peaks and mitigate flooding downstream. Wet detention ponds minimize flood damage by detaining, controlling, retaining, and delaying peak storm flows. They also trap sediments, nutrients and pollutants associated with storm water runoff. Typically, Storm Water Ordinances require detention pond designs to reduce all post-development peak runoff rates to at or below pre-development rates. *Ideally, we recommend the Towns of Woodruff and Minocqua to consider,* *where feasible, that all detention ponds be designed to store the 100-year post-development storm event and discharge at the 10-year pre-development runoff rate. At a minimum, detention ponds should store additional storm water runoff for all storm events due to development, and discharge at rates equivalent to pre-development runoff rates for all storm events. We also recommend that detention storage facilities be designed to limit the design outflow to no more than the capacity of the existing downstream conveyance and storage systems.* Storm sewer pipe systems represent a sizable investment within the watershed. This investment can be more efficiently utilized by storing storm water runoff in designated wet detention ponds, thereby allowing smaller diameter storm sewer pipes to be used for conveyance to and from the detention ponds. *The effective use of storm water wet detention ponds enables the installation of outflow sewers and drainage ways with reduced sizes from the detention pond outlet to downstream receiving water bodies.* The total time required to fill and empty the wet detention pond reservoirs effectively increases the storm duration considered for the design since an equal volume of water is discharged at a lesser rate over a longer period of time.

In addition to cost considerations, wet detention ponds are important for:

- Improving water quality,
- Stabilizing or recharging the ground water table, and
- Increasing the water amenities in developments for aesthetic, recreational, and wildlife habitat purposes.

Storm water quality is improved when nutrients, heavy metals, and sediments carried by runoff are allowed to settle below the detention pond's normal static water control level to the bottom of the pond. Recharge of ground water is increased by restricting the outflow rates from the ponds. Amenity aspects are also maximized by careful planning in the initial development plans and by integrating the wet detention pond system into a park development program wherever feasible.

When land adjacent to an existing wet detention pond is developed, the rate of runoff is increased. The extra volume added by this increase in runoff upsets the existing balance of ponds established over years of natural ecological processes. In most existing ponds, this imbalance will cause frequent flooding of the surrounding areas and large fluctuations in pond water surface elevations. These existing ponds could remain at flood stage for many months during an extended wet weather period. Development around such ponds is difficult to plan, making it impossible to forecast exactly the long-term effect of wet cycles and large storms on the level of an existing pond. *For these reasons, it is recommended that outlets be planned and designed for all existing detention pond areas to mimic pre-development conditions.* A few ponds that are extremely large in relation to their drainage area and have large available storage capacity may be able to discharge sufficient water through evaporation and seepage to prevent damage due to flooding.

Most of the wet detention pond areas in the system collect water from large drainage areas. *To provide proper protection for adjacent property, the design storm interval for wet detention pond design should be for storms up to and including the 100-year 24-hour storm event as compared to a 10-year storm event design for storm sewer pipe conveyance systems.* To provide an additional safety factor, we recommend that lowest exposed floor or opening elevation of a structure in the development should be at least 2 feet above the calculated high water level of the wet detention pond. *We recommend that the lowest exposed elevations of structures adjacent to wet detention ponds should be reviewed and approved by the appropriate governing agency prior to basement and structure exposure construction to ensure adequate high water flood protection. All developed land areas should have positive drainage conveyance to detention ponds.*

Theoretically, a detention pond water surface elevation will change while it fills and empties, and the rate of discharge will vary with corresponding water surface elevation fluctuations. These changes are not significant in cases where pond elevations change only three to four feet. However, pond outlets should be designed carefully with peak flows at peak elevations taken into account. An under designed outlet can create local flooding by detaining more than the design volume of storm water, while an over designed outlet can reduce ponding efficiency, decrease detention time, and overload the downstream system during smaller storm events.

Wet detention pond outlet devices that will control outflows larger than three cubic feet per second should be designed to achieve high storage efficiencies. As a matter of policy, large pond outlets should be designed to provide a low outflow rate to a predetermined pond elevation. This design is intended to detain runoff during the early portions of the storm event, allowing the downstream system excess capacity (normally used by the pond outflow) to convey flows from short duration, high intensity storms. *We recommend the Towns should consider, where feasible, that wet detention ponds be designed for rate control for all storm events at pre-development rates and storm events greater than 10-year storm event be controlled at 10-year pre-development runoff rates. The detention pond control structure should also be designed to control storm events less than the 10-year event at or below their pre-development runoff rates.* This design will address both water quantity and water quality concerns within the Watershed to the maximum extent practical. *We recommend that the initial detention pond and outlet structures be designed and located in such a manner that will minimize operation and maintenance costs and allow proper access for maintenance.*

In new developments, special consideration must be given to areas with no safe overland conveyance relief. The excess runoff caused by storms greater than that used for design (100-year event) should be accommodated by ponding in low areas of streets and by flowing through suitable overland conveyance drainage routes. Provisions for short-term overland drainage will minimize much of the damage to property which would otherwise occur. Also, overland drainage routes should be provided for emergency overflows and for sediment blockage, snow melt and ice dam conditions.

Where feasible and in areas prone to spills that can contaminate the environment, such as in industrial and commercial area wet detention pond sites, we recommend that NR 151.12(5)(e) be followed to be consistent with future regulations. Pond outlet structures should be designed to "skim" the flow, and on-site water quality pretreatment systems should be provided prior to discharging to the wet detention ponds. "Skimming" the flow can allow a significant amount of time for cleaning and removing undesirable spills, floating debris, and polluting substances prior to discharging off-site. The intent is to reduce potential contamination from first flush storm events. Skimming structures for larger flows need to be carefully designed to avoid the creation of vortex or swirl type of action which can transport the skimmed substance. *Also, existing residential areas and proposed commercial areas, industrial areas and gas station-type establishments should provide individual on-site containment and storm water runoff pre-treatment systems, or pre-engineered proprietary devices, such as "Stormceptor®" and Vortechnics®", prior to discharging off-site to the regional storm water management system. The devices listed are for reference purposes and Cedar Corporation, the Lake Association and the Towns do not necessarily endorse these products.*

Pre-Engineered Commercially Available Proprietary Devices

5.1.e. Water Quantity Detention Pond Alternatives

Storm water management detention ponds recommended in this plan can be divided into two types depending on their outlet and storage characteristics.

Detention pond **Type A** in Figure 5-4 is a wet detention pond that can be a lake or pond with storage volume acquired by a differential in water levels. The outlet elevation is designed at a minimum of four to six feet above the pond bottom elevation which makes this type of pond excellent for water quality treatment. The outlet operates by gravity, thus when the water elevation in the pond is above normal static water elevation and the pond will release storm water at a controlled rate. A permanent body of water is always maintained assuming that seepage and evaporation do not exceed replenishment. In areas of high infiltration, sandy and granular soils, and low water table elevations, wet detention ponds will need to be constructed with a minimum 1.5 foot impermeable clay liner or synthetic liner material to maintain the intended design control water elevation. *Due to the emphasis on water quality, special analysis considerations are given in this plan to Type A ponds.*

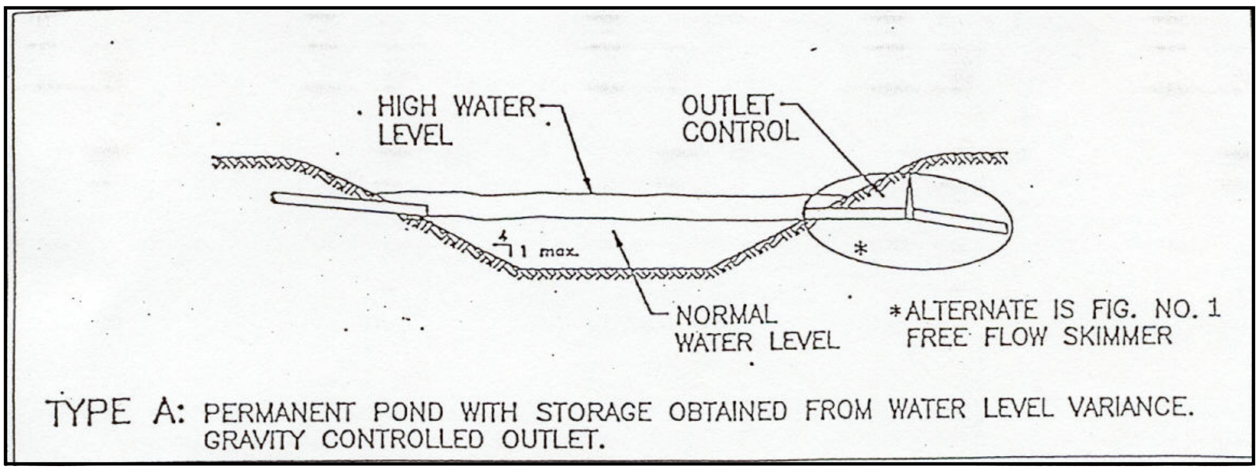


Figure 5-4: Permanent Pond, Type A

Detention pond **Type B** in Figure 5-5 is a dry detention pond that normally contains no water during dry weather. The basin area is a naturally occurring depression, swamp, marsh, wetland, or is artificially produced by the construction of an embankment across the drainageway such as a road or railroad, etc. The controlled outlet for this type of pond is located to provide complete drainage of the pond. Inlets discharging into the pond area are usually located at the upper end of the basin so that some overland flow exists from all storm conditions. A shallow ditch shaped passageway would be constructed into these ponds to confine overland flow from the pond inlets to pond outlet points during storms of low intensity and during emptying periods.

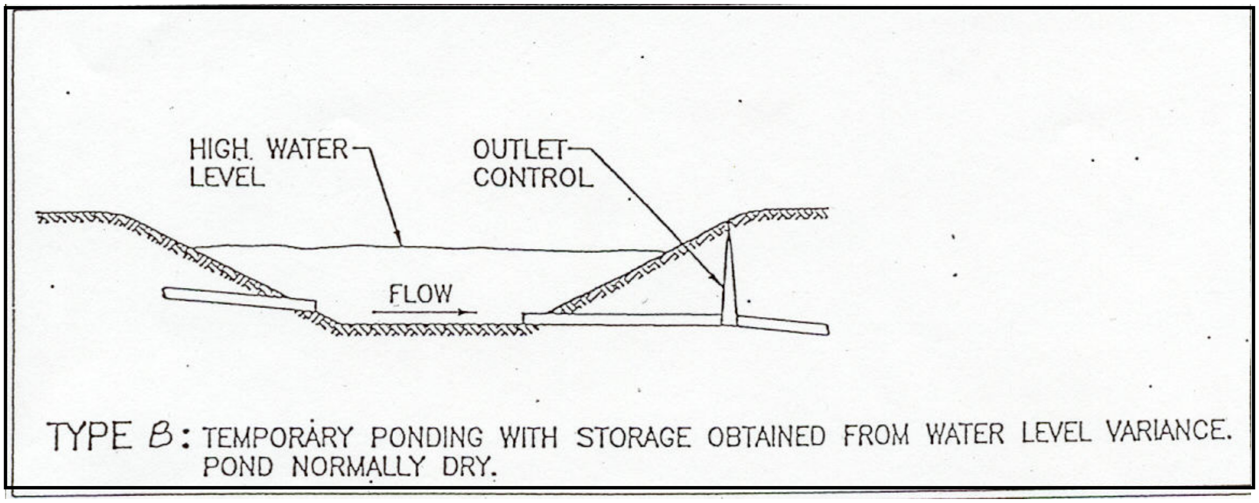


Figure 5-5: Temporary Pond, Type B

If it is desirable and economically feasible, a permanent wet detention pond Type A can be constructed in the dry detention pond Type B basin. This can be done by dredging out material below the present bottom of the basin, or in cases where hydraulics of the system allows it; the outlet can be raised to provide a desirable depth of water in the basin. If a permanent wet detention basin is desired at a location shown on the master plan map, it can easily be incorporated into this system plan at the time of final design.

An ideal storm water detention pond would have a large surface area with gradually sloping sides combined with substantial storage volume for storm water quantity and water quality purposes. *For water quality purposes, the ideal storm water pond is one which has a permanent pool volume greater than or equal to the volume of runoff from a two-inch storm event under full projected watershed development.* This volume has been derived from design criteria developed under EPA's Nationwide Urban Runoff Program (NURP) with a 25 percent increase in volume to allow for approximately 20 years of sediment accumulation. *To promote sediment and pollutant settling and provide space for sediment accumulation, the mean depth of the permanent pool volume should be greater than or equal to four feet. For ease of maintenance and to ensure the proper functioning of the water quality aspects of wet detention ponds, a forebay of approximately 10% of the permanent pool volume should be constructed at the main outfall into the pond.* The pond mean depth is equal to the wet volume divided by the pond area at the normal water level. To prevent development of thermal stratification, loss of oxygen and nutrient recycling, the maximum depth of the permanent pool should be less than or equal to ten feet. The side slopes of any pond should not be steeper than four feet horizontal to one foot vertical (4:1) and, where possible, should not be over ten feet horizontal to one foot vertical (10:1). *For safety purposes and to provide suitable habitat for rooted aquatic plants, the bench width (littoral shelf) should be at least ten feet and the bench slope should not be greater than 10:1 at a point 2 feet below normal design static water elevation.*

For existing detention ponds that do not have the desired storage capacity, a variety of methods can be used to increase their capacity. The two most common ways are by constructing a dike or a berm to block a drainageway and create an additional artificial pond or by enlarging an existing pond or low area to increase the wet volume and the storage capacity. The increase in storage provided by these methods will reduce the size of overflow pipe required which can result in wet pond volume increases, which reduces the amount of nutrients, sediments, and pollutants flowing to downstream facilities. The need for excavation or berming should be determined at the time of final design and must consider ecological and wildlife implications.

An alternative to providing wet volume for increasing water quality in drainage ways, buffer strips, and shallow lowlands is the planting of native prairie grass vegetation that can trap and infiltrate nutrients, pollutants, and sediments. Wetlands and native prairie grass with small storm water runoff sheet flows have been observed to be as effective as deep water quality ponds to trap and infiltrate nutrients, sediments, and pollutants, and may be more economical to construct. *We recommend that all pond types should be reevaluated during final development engineering and design when all factors affecting runoff, water quality, storage, seepage, land costs, and operation and maintenance costs of the pond have been determined.*

5.1.f. Detention Pond Open Space Compatibility

Close coordination between a storm water management system and park or public lands may result in the watershed's efficient use of open space. When open channels are proposed in the system, they can serve as part of a trail system as well as easements provided for installation, operation, and maintenance of storm sewer and sanitary sewer systems.

Since storm water detention ponds are infrequently used to their full capacity, certain parts of these ponds can be used for passive uses, such as parks, playgrounds, soccer, and baseball fields that contain recreational facility amenities which will suffer minimal damage from infrequent flooding. *Two alternative methods of combining parks and ponding areas for Type B dry detention ponds are available.* Both methods incorporate terracing of the pond bottom. This provides an added feature for park users recreating in areas adjacent to storm water detention ponds.

Alternate I in Figure 5-6 consists of an open channel or storm sewer entering a dry detention pond. As described under detention pond Type B, a channel is cut between the inlet and outlet of the pond to convey runoff from small storms through the pond. The channel is usually designed to handle the flow from a one- to ten-year frequency storm event. Open play areas, picnic areas, and trails could be built on land adjacent to the channel and would have a 10 percent probability of being flooded in any given year.

Alternate II in Figure 5-6 describes basically the same pond as Alternate I, but in this case, the recreational areas have been filled to an elevation that is substantially above the high water level in the channel through the pond. The pond can be designed so the play area is flooded infrequently, such as 4 to 10% probability in any given year. This open space would serve as an excellent recreation area with only an occasional disruption due to flooding.

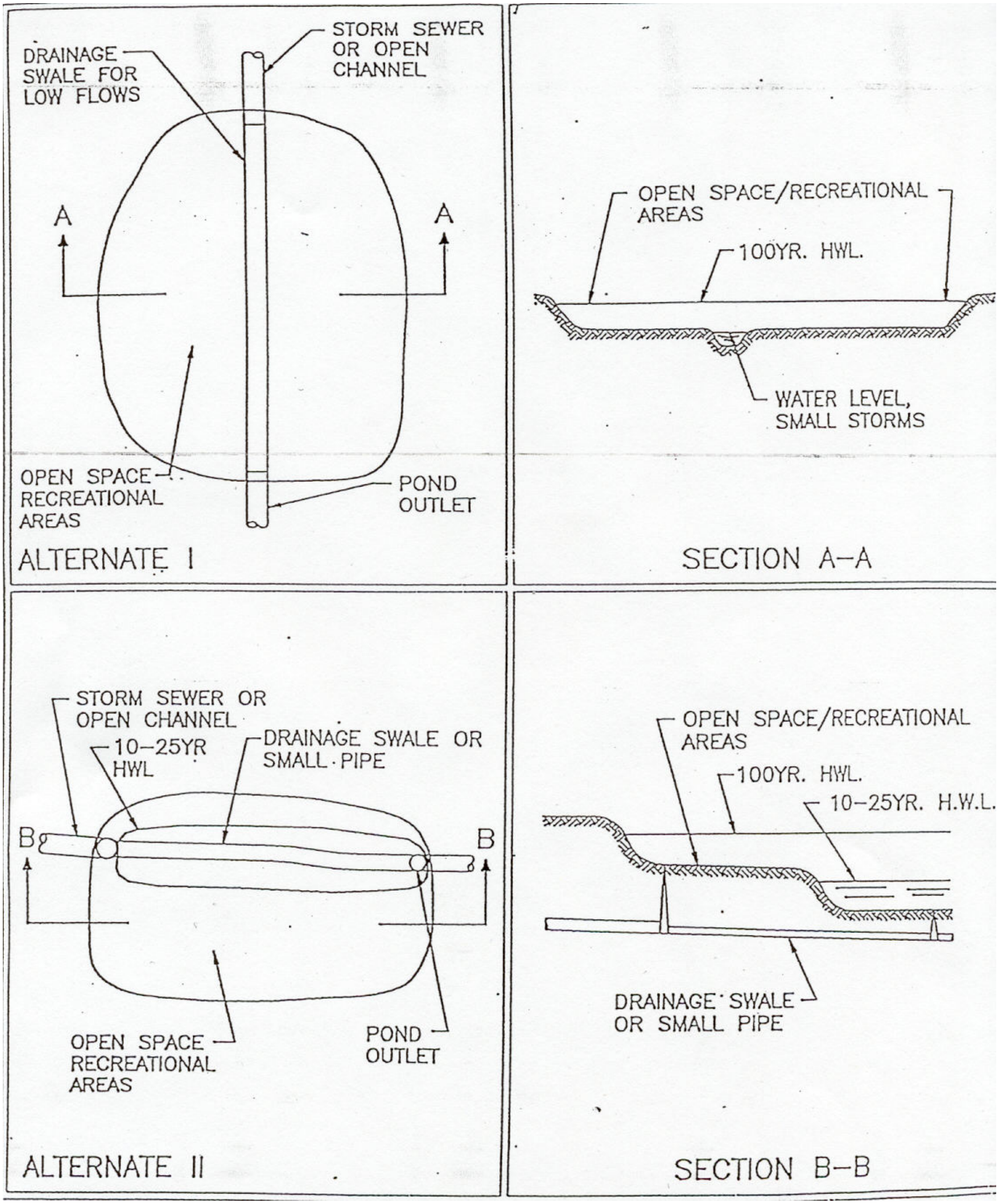


Figure 5-6: Detention Pond Open Space

Almost every detention pond Type B and some of detention pond Type A's can be combined with a park or playground. But, because of the varying design conditions for each area, the ponds will need to be carefully designed and engineered so that the desired frequency of flooding is not exceeded.

A trail or pathway system can be coordinated with the proposed detention pond system illustrated in this plan to make the most effective use of the open space. A body of water can be a very desirable amenity adjacent to a trail and homes and, when properly planned, occasional flooding of the trail system will not be a serious detriment. In many cases, the overflow drainage routes and/or storm sewer and sanitary sewer easements can be utilized for a continuation of trail system between areas of open space. The ecological and wildlife aspects of the detention pond system should be maximized in design, and the proper location of the trail system will allow good access to these areas for wildlife observation.

Recommended elevations for the construction of a park and trail system around and within storm water detention ponds based on inundation times from a 100-year storm are given in Table 5-2. The inundation time is the time period during which the storm water detention pond recedes to its normal water level after the storm event.

Table 5-2
Expected Inundation Time for Recreational Facilities Located Around Detention Ponds

Facility built at elevation corresponding to:	Expected Inundation Time:
3-year storm	More than 10-days
5-year storm	More than 5-days, less than 10 days
10-year storm	Less than 5-days

5.1.g. Infiltration

The topography of the Minocqua-Kawaguesaga Lakes Watershed results in some areas with no positive surface drainage outlets. Fortunately, the soils found in the Watershed are generally ideal for infiltration. *We recommend that infiltration is used to the maximum extent practical.*

It must be noted that there are major limitations on infiltration:

1. Storm water must be pretreated before being released into the infiltration basin. Release of untreated storm water to infiltration basins may result in premature failure due to sedimentation and clogging by fine particles.

2. Infiltration rates are difficult to predict. Conservative estimates must be used to protect surrounding properties.

3. Rehabilitation of failed infiltration basins is difficult. Backup outlet systems must be provided or planned for in the event of premature failure.

4. Infiltration basins are typically much larger than wet detention basins for similar watersheds.

5. Construction of infiltration basins is more difficult. Compaction of the infiltrative surface must be avoided. Typical construction practices must be modified to avoid excessive compaction of the basin.

6. Drawdown time of infiltration basins must be carefully evaluated. Long drawdown periods may result in the death of vegetation in the basin.

7. Infiltration is limited during frozen ground periods.

8. Wisconsin Administrative Codes do not allow infiltration within 400 feet of a municipal well (WAC NR 811.16(d)3) or within 100 feet of a private well (WAC NR 812.08, Table 4, Infiltration Basin).

Careful evaluation, design, construction and maintenance of infiltration practices are necessary. The Department of Natural Resources has prepared extensive guidelines for the evaluation, design, construction and maintenance of infiltration basins. *We recommend that the Towns of Minocqua and Woodruff carefully review storm water management designs in areas that currently are completely infiltrated.*

5.1.h. Water Quantity Modeling

Storm water quantity modeling was completed using the HydroCAD 7.0 model which is based upon TR-20 and TR-55 methodology. The models have been created using the information provided in Chapters 4 and 5 of this plan document.

We have made the following additional assumptions:

- Curve Numbers: TR-55 (as shown in Table 5-1).
- Time of Concentration: Lag/Curve Number method (developed by SCS).
- No infiltration has been taken into account <u>during</u> storm events.
- Ponding areas from the interpolated 2-foot contour maps, minor ponding areas have been ignored
- Culverts: Materials, sizes and entrances field checked.
- Storm Sewer: Materials and sizes taken from basemap, plan sheets and field checked as needed.
- Storm events: Type II, 24-hour event from Wisconsin Construction Site Best Management Practices Handbook.

Table 5-3 contains storm water quantity modeling results. Three cases have been examined for each watershed model: existing (existing land use, existing BMPs, existing conveyance network), future (future land use, existing BMPs, existing conveyance network), future with BMPs (per proposed Storm Water Management Ordinance). Peak rates (cubic feet per second) and runoff volumes (acre-feet) are recorded in Table 5-3.

Results for each watershed are presented in three parts. First "[Watershed] – Exist," is a summary of the predicted peak flow rate (cubic feet per second) and runoff volume (acre-feet) at key locations within the watershed for the current land use condition with current runoff water management practices in place. Second is "[Watershed] – Future," a summary of the predicted peak flow rate (cubic feet per second) and runoff volume (acre-feet) at key locations within the watershed for the future land use condition with current management practices in place. Finally, third is "[Watershed] - Future with BMP," a summary of the predicted peak flow rate (cubic feet per second) and runoff volume (acre-feet) at key locations within the watershed for the future land use condition with the proposed provisions of the Storm Water Management Ordinance in place. These provisions include: "pre- vs post-development" peak flow rate control (NR 151.12[5][b]1. expanded to include the 100-yr storm event) and infiltration of 25% of the 2-year, 24-hour storm event (NR 151.12[5][c]1.b.)

Predictably, parts of Watersheds L, M, N and O had the largest change in storm water peak flow rates and quantities between the current and future land use conditions. This result is in agreement with Table 4-1: Percent Impervious Current vs. Future.

As an example: Watersheds LMNO – Discharge into Minocqua Lake
Location: Please refer to Figure 4-1.

Current 25-yr storm event peak rate: 37.56 cubic feet per second (cfs)

Future 25-yr storm event peak rate (without BMPs): 136.40 cfs

Future 25-yr storm event peak rate (with BMPs per proposed ordinance): 37.56 cfs

Current 25-yr storm event volume: 5.18 acre-feet (ac-ft)

Future 25-yr storm event volume (without BMPs): 11.09 ac-ft

Current 2-yr storm event volume: 0.83 ac-ft

25% of Current 2-yr storm event volume: [0.83 * 0.25] = 0.21 ac-ft

Future 25-yr storm event volume (with BMPs per proposed ordinance): [11.09 – 0.21] ac-ft

Future 25-yr storm event volume (with BMPs per proposed ordinance): 10.88 ac-ft

Areas of concern and recommendations are addressed in Chapter 9, Section 9.1.

5.2 Storm Water Quality

5.2.a. General Background

Surface water quality, groundwater recharge, and wetland enhancement, are primary environmental issues within the Minocqua-Kawaguesaga Lakes Watershed. Maintaining the most practical water quality standards in the storm water system is an essential element of the Minocqua-Kawaguesaga Lakes Watershed Management Plan.

Plants require various substances for growth, including phosphorus, carbon, hydrogen, oxygen, and nitrogen. The concentrations of these constituents in water control the total amount of plant biomass. The necessary quantity of each constituent varies. If only one of these constituents is absent, or if there is an overabundance of these constituents, native plant growth is limited, even if the other constituents are abundantly available.

Lakes, ponds, rivers, streams, and wetlands are biological systems affected by increases in sediment and nutrients, especially phosphorus. In many water bodies, phosphorus is the least available nutrient. Thus, its abundance or scarcity controls the extent of algae growth, and when phosphorus is added to the water body, the algae population dramatically increases. A eutrophic or nutrient rich water body tends to be shallow, green, and have limited oxygen. Eutrophication is a natural aging process, but human activities can speed up eutrophication. Nutrients, such as nitrogen, phosphorus, and potassium, wash or runoff the land surface and into water bodies through erosion and fertilize the water. This encourages algae and other plants to grow. As plants die, they decompose and accumulate at the bottom of the water bodies as muck (organics). The combination of muck accumulation and the continuous erosion process eventually converts the water body into a fertile, shallow, low-quality water body.

Increased sedimentation and phosphorus concentrations can cause major changes in the ecological and biological communities of water bodies. Because game fish are more sensitive to low oxygen conditions, rough fish, carp and bullheads, eventually replace much of the sunfish, bass, and northern pike in lakes. In some instances, all of the oxygen in a lake is used up by decaying algae during the winter causing a major fish kill. Increased algae and macrophyte growth will escalate the build up of sediments in water bodies.

The water that runs off agricultural lands, municipal streets, parking lots, driveways, and lawns carries a heavy load of pollutants to the nearby drainage ways, wetlands, rivers, and creeks. Although some pollutants found in urban runoff are unique to urban areas, others are similar to the pollution found in rural runoff. Both urban and rural runoffs carry "conventional" pollutants: sediment, nutrients, oxygen-demanding materials, and bacteria. Runoff from urban and industrial areas typically contains quantities of the same types of pollutants found in waste waters and industrial discharges, including heavy metals, oil and grease, insecticides, herbicides, pesticides, nutrients, and organic compounds. By early recognition of the problems and implementing best management water quality practices, the Towns can maintain or enhance the surface water quality within the wetlands, drainage ways, and Lakes.

The main sources for degradation of water quality are associated with human activities: farming, construction, industrial activities, and road maintenance. Every day activities generate residuals that are transported by storm water runoff or snowmelt to the storm sewer, drainage way, channel, swale, ditch, etc. Water resources are directly affected by substances that are conveyed in storm water such as sediments, motor and transmission oils, anti-freeze, paint, detergents, wax, fine dusty residuals from tires, brakes, and street wear, lawns and farming fertilizers, herbicides, pesticides, and numerous other wastes.

Industrial areas are known for having toxic pollutants. Forms of toxic pollutants come from synthetic sources, such as heavy machinery, vehicle exhausts, smokestack emissions, weathered paint, roofs, parking lots, motor and lubricating oils, and wood preservatives. Heavy metals are typical variable concentrations in industrial runoff. Heavy metals include among others, chromium, cadmium, copper, lead, mercury, nickel, and zinc. Some of these, especially lead, zinc and copper are known to be toxic to aquatic organisms and can bio-accumulate in fish and can transfer to humans.

1. Erosion and Sediment Control

In the developed areas of Woodruff and Minocqua, runoff water frequently contains substantial quantities of sediments. This is due to impervious surfaces, construction grading, and inadequate erosion control practices. Erosion in agricultural areas and developments comes in the form of gullied waterways, riled and gullied slopes, undercut pavements and pipelines, and lost topsoil.

The natural processes of erosion, transport, and deposition of sediments have occurred throughout geological times and have shaped the landscape of the Watershed. Eroded soil is considered the largest pollutant of surface waters in the United States. Sediment transport affects water quality and its suitability for other uses, including: consumption, industrial use, recreation, wildlife and ecological sustainability. The source of most sediment transported by swales, channels, drainage ways, rivers, creeks, and storm sewers to receiving water bodies is soil eroded from upland areas. Erosion often causes serious damage to agricultural land by reducing the fertility and productivity of soils.

Problems associated with deposition of sediments vary. Sediment deposition in stream channels reduces the flood carrying capacity, which results in greater flood damage to adjacent properties. Receiving water bodies trap the incoming sediment load and flood risks increase due to aggregation upstream. Upstream aggradations depends on the stream slope, the sediment size distribution, and the water-level fluctuations in the receiving water body. Streams, drainage ways, and channels with minimal slopes carrying large quantities of sediment result in aggradations many miles upstream of the receiving water body. Receiving water body sedimentation results in loss of storage capacity for flood control.

Human activities typically increase the rate of erosion over the normal or geologic erosion rate. The erodibility of natural soils may be altered when the soil's natural condition is disturbed by plowing, tillage, and construction type activities. *Erosion rates* *accelerated due to human activities can be more than 100 times greater than geologic erosion rates of 0.10 ton/acre-year. Erosion rates of grazed areas can exceed 5-tons/acre-year, and we can expect average values of 30 to 50 tons/acre-year during urban construction development when the soil is not vegetated and it is consistently reworked.* Human activities also influence the natural characteristics of channel flows through channel stabilization and installed hydraulic structures. This Plan is a guidance document to assist the Towns in reducing erosion through sediment control.

2. Sources of Sediment:

i. Urban and Rural Areas

Both rural and urban areas contribute sediment loads. Soil erosion is the primary source of sediment. Typically, older parts of the Towns of Woodruff and Minocqua have less erosion than rural areas, since the land consists of established homes, grass, and pavement. The concentration of sediment is generally lower in low and medium density residential urban runoff than in rural runoff. However, the total amount of sediment from low and medium density residential urban areas is comparable to rural areas since more water runs off man-made impervious surfaces in developed areas.

ii. Construction Sites

Although existing urban areas such as parking lots and street surfaces are important sources of sediment, by far the highest amounts of sediment come from areas under construction. Studies and research estimate that an average unprotected acre under construction delivers 60,000 pounds (30 tons) of sediment per year to downstream waterways. This is about 60 times more than any other land use.

Two factors account for the importance of construction sites as sediment sources:

1. High Erosion Rates
2. Rapid Delivery Rates

Typical erosion rates for unprotected construction sites are 30 to 50 tons per acre per year compared to one to three tons per acre per year for cropland or low density residential areas.

Construction sites have high erosion rates because they are typically stripped of vegetation and topsoil for long periods of time. More importantly, construction sites have higher delivery rates compared to cropland. During the first phase of construction, the land is graded and ditches or storm sewers are installed to provide good drainage ways. Unfortunately, this efficient drainage system does not allow sediments to settle out. While some of the sediment from croplands is filtered out by ground cover, or deposited in a low spot of on the next field downhill, most soil erosion from a construction site gets delivered directly to the wetlands, and the Minocqua and Kawaguesaga Lakes.

Chapter 6: Best Management Practices and Appendix B provide reference to a proposed Storm Water Management Ordinance for protection of the area's unique natural resources by minimizing the amount of sediment carried by runoff or discharged from construction sites to the drainage ways, perennial waters, and wetlands within the Minocqua-Kawaguesaga Lakes Watershed.

iii. Shoreline Erosion

Shoreline erosion can be significant in lakes and watersheds with changes in flow volume. Shoreline erosion rates can be determined by comparison to earlier shoreline photographs. Shoreline erosion rates can be measured by comparing channel positions from a pair of recent aerial photographs to an old set of aerial photographs. Field observations and review of aerial photographs have confirmed that a considerable amount of shoreline erosion is present in the Watershed.

The Wisconsin Valley Improvement Company's erosion maps of the Minocqua reservoir were reviewed. The maps are based on fieldwork conducted in 1977 and 1997. Erosion levels are divided into three categories:

1. Mild Erosion: Erosion is easily perceptible
2. Moderate Erosion: Deep gullies and washed out areas where significant vegetation is lost.
3. Severe Erosion: Whole banks crumbling, tree roots exposed, total loss of vegetation.

Mild erosion is occurring at numerous locations in both lakes, but more so in Kawaguesaga Lake. There are also occurrences of severe erosion in both lakes. However, when comparing the two maps it is evident that the extent of erosion has not changed much from 1977 to 1997.

iv. Changes in Flow

From the beginning of farming and construction, urbanization and agricultural practices dramatically change the cycle of water movement. Clearing land removes much of the vegetated cover that intercepts rainfall before it reaches the ground. Once the trees and grasses are gone, less water is returned to the air through evaporation or transpiration (loss of water vapor from plants). Instead, rain falls directly on the exposed soil.

As farming, construction, and land disturbing activity proceeds, soil conditions also change. During construction, topsoil is usually stripped away and heavy construction equipment compacts the remaining subsoil that limits infiltration. More water runs off the compacted subsoil rather than percolating down to recharge groundwater supplies. The elevation of the shallow ground water is significant because it supplies much of the base flow in drainage ways between storms.

Runoff water problems continue after developers and builders complete construction. Water runs off hard (impervious) surfaces such as compacted soils, parking lots, buildings, and streets, picking up speed and carrying sediments and pollutants along the way. Developers and builders can help mitigate potential damage by spreading topsoil and planting grass vegetation as soon as practical after land disturbing activities to allow the soil to regain its ability to soak up and infiltrate storm water runoff.

Sediment and pollutant loading will increase as the effects of development on storm water are realized. These effects include:

- Peak Discharge: After farming and development, peak stream flows are two to five times higher than they were before farming and development. Consequently, the frequency and severity of flooding and sedimentation increases. A stream that once overflowed its banks once every two years may now flood three or four times per year. When the banks overflow, sediments are deposited within the flood plain or transported downstream.

- Volume: The volume of runoff increases about 50 percent in a moderately developed or altered watershed.

- Timing: Urban and farm drainage systems are so efficient that the time required for runoff to reach the stream can decrease as much as 50 percent. This results in high flows compressed into a shorter period of time. The river, wetlands, creeks, drainage ways, and channels are “flashy” because water levels rise and fall very quickly in response to storms.

- Velocity: Flow velocity increases in the wetlands, creeks, drainage ways, river, and channels during storms because peak discharges are higher and new drainage systems are smooth and efficient.

- Base Flow: Stream flow is reduced by farming and development activities. Portions of channels and drainage ways that were once wet and flowed year-round become seasonally dry.

The dramatic flow changes in the drainage ways, channels, wetlands, creeks, rivers, and lakes, have extensive consequences in terms of flooding patterns, stream flow channel erosion, and ecological and wildlife habitat degradation.

3. Consequences of Increased Sediment Loading:

i. Channel and Floodplain Impacts

Under natural conditions, the wetlands, creeks, rivers and drainage ways develop a channel large enough to hold approximately a two-year peak flow, which is the highest flow that has a 50 percent probability of occurring in any given year. Therefore, the conveyance systems are somewhat larger than the average annual flood.

Channel erosion is often quick and severe because most floodplain soils are loose and wash away easily. However, downstream transport of eroded sediment is slow and moves gradually as "bed load." Bed load is the total rate of sediment transport for sediment particle sizes readily apparent on the surface of the river bed in the processes of rolling, sliding, and/or hopping. Movement of these particles is related to the flow and sediment characteristics of the bed. These constantly shifting deposits form dikes and sand bars, and smother bottom ecological and aquatic life for many years.

Urbanization and farming activities significantly increase the typical two-year peak flows. In response, the conveyance systems erode to form a larger channel. The creeks, rivers and drainage ways become two to four times wider after farming and urbanizing within the watershed. Just as the two-year peak flow increases, so do peak flows for larger storms. Land, buildings, and homes that were once safe from the 100-year storm may now be at risk.

ii. Lost Value of Natural and Water Resources

Increased sediment loadings directly influence the value of the wetlands, water bodies, creeks, rivers and lakes. Sedimentation and a variety of pollutants conveyed by storm water runoff make waterways and wetlands unsafe for people, fish, and wildlife.

For example, water turbid with sediment or inundated with algae makes feeding difficult for sight feeders like northern pike and waterfowl. Small mouth bass are especially sensitive to sediment deposits that smother the gravel creek and lake bottoms where they spawn. Low oxygen content, warm discharge temperatures and sediments are intolerable for trout. Pollutants that attach to sediments may affect aquatic insects, fish, and waterfowl in a variety of ways varying from bioaccumulation, disorientation, impaired reproduction, lowered disease resistance, or even death. Over time, these individual impacts add up to three major changes in fish and waterfowl populations:

- Diversity decreases
- Abundance decreases
- Pollution-tolerant species replace pollution-sensitive species

As waterfowl and fish populations change, rural and urban water resources become less valuable for recreation and tourism. Tributary streams and creeks, *wetlands, and other inland ponds will be populated by carp, catfish, Buffalo, and suckers which are less popular for recreational fishing than panfish, Walleye Pike, and Small Mouth Bass that are typically found in unpolluted lakes and waterways.*

In addition to losing fishing and hunting value, the creeks, wetlands, the Minocqua and Kawaguesaga Lakes, and drainage ways will also lose value for other types of recreation. If they are turbid with sediment or algae and lose native vegetation, they are less attractive for boating, tubing, swimming, hiking, bicycling, sightseeing, and picnicking. If bacteria and chemical concentrations become too high, the water may become unsafe for swimming. As the wetlands, drainage ways, rivers, creeks, and lakes lose their recreational and aesthetic values, they will become forgotten and usually this means more impaired and less desirable over time.

iii. Sediment Control Methodology

During farming operations and construction, a substantial amount of suspended solids (sediment) can enter unprotected downstream water bodies, even if on-site erosion control practices like silt fences, straw bales, stone weepers, or vegetative cover are put in place. *We recommend that the Towns of Woodruff and Minocqua adopt a storm water management ordinance and update the erosion control ordinance to place a greater emphasis on construction site erosion control practices.* Sediment traps can intercept storm water with sediment from the property and prevent sediment from entering the Lakes, drainage ways, and wetlands. Temporary ponding and sediment storage should be provided with control release structures and emergency overflows to ensure that no serious property damage occurs during high-intensity storms while sediment ponds are in use. After development, the sediment ponds can be filled and the area connected to the Towns' storm water management system or the sediment pond may be included with permanent on-site storm water management system connected to the Towns' storm sewer system.

Even when precautions are taken during construction, a large amount of sediments may still enter the drainage conveyance system. For this reason, it is desirable to minimize the chances of these sediments reaching drainage ways, wetlands, streams, creeks, lakes and rivers. *We recommend that sedimentation basins, traps, and siltation basins or structural controls be engineered and located at the point of discharge from the construction site prior to discharge into a sensitive receiving water body and storm water conveyance system. These erosion control measures should be installed at the time of construction and prior to any land disturbing activities occurring on-site.*

We recommend that sediment and nutrient removal structures should be installed wherever a storm sewer discharges into a sensitivity priority water body or storm water conveyance system. In certain cases, settling chamber (sump) type catch basins or manhole structures should be provided in storm sewers prior to discharge. These structures can effectively provide removal of sediments, sand, and gravel that may be flushed down the storm sewer from parking lots, streets, and highways. These sump structures are not effective in the removal of nutrients and finer particles such as silts and clays. The use of sumps should be limited to areas where they can be regularly maintained and can realistically be expected to intercept the sand from winter sanding operations and gravel from driveways, parking lots, or development construction. *A sediment removal structure must be regularly maintained if it is to remain effective.*

If the outlet for a sedimentation/siltation basin is located below the normal water surface, these basins can also serve to confine floating solids and debris that may otherwise enter the creeks, river, drainage ways, wetlands, and lakes. Periodic skimming of the basin to remove floating solids can be accomplished once or twice a year. If a "spill" of a hazardous product (depending on density) such as gasoline or fuel oil occur, it would be retained within the basin and provide a point of easy access for prompt appropriate clean-up.

Even with the best and most expensive sediment removal system, contamination of ponds, drainage ways, wetlands, lakes, rivers, streams, and creeks will occur unless careful attention is given to the use of the land. However, the negative impact of increased sediment and nutrient loads can be minimized by following pollution prevention and source controls throughout the watershed. Property owners must use care in the development of their yards such as sodding bare areas and good management practices after the initial period of lawn establishment. Farmers must follow good land management practices, including no till in storm water drainage ways, establishment and maintenance of buffers adjacent to streams, etc. Also, developers must minimize erosion during grading and building construction. From the perspective of the Towns, the most effective, and least costly, way to prevent sedimentation is to vigorously enforce the provisions of current and future storm water management and erosion control ordinances.

Additional Best Management Practices are discussed in Chapter 6: Best Management Practices. Other recommendations to improve sediment and erosion control are listed in Chapter 9: Recommendations.

5.2.b. Treatment Based Storm Water Quality Control

There are many methods of practice available for controlling storm water quality including volatization, absorption, biofiltration and sedimentation. Volatization and absorption includes aeration and infiltration. These methods are used in highly impervious areas with high pollution, but have limited capacity to treat runoff from large areas. These types of treatments are very expensive and are not cost effective for areas larger than 20 acres.

Biofiltration and sedimentation include the use of grass and prairie grass filter strips, grass swales, wet detention ponds, constructed wetlands, infiltration basins/dry detention ponds, extended wet detention ponds, multiple wet and dry pond systems, infiltration trenches, sand filters, filter strips, and water quality inlets/oil grit separators. *These methods are more practical and economical for large areas in the control and treatment of storm water quality.* Each of these methods must be evaluated at the time of engineering and design to determine practical effectiveness because each practice is site specific and may not be applicable for every type of land use and site conditions. Again, Chapter 6 provides additional recommended best management practices for water quality control. *The USEPA has developed BMP Fact Sheet Summary Assessments of the various best management practice options available and recommended to address storm water management.* These fact sheets are available in *Additional Reading, EPA Fact Sheets – Select Best Management Practices.*

The primary treatment methods for the Minocqua-Kawaguesaga Lakes Watershed storm water runoff are wet detention ponds. Because the Watershed Storm Water Management Plan is based on a regional analysis methodology that takes advantage of existing topography and undeveloped land, wet detention ponds generally become the most cost effective method of treatment for water quality improvements within undeveloped areas. Wet detention ponds also provide water quantity storage and flood mitigation benefits. A permanent pool of water is a good design option because it allows for sedimentation, absorption, and biological uptake to occur; increases sedimentation efficiency and reduces bottom scouring potential; and provides habitat for algae and aquatic plants that can assist in the removal of soluble pollutants and promote wildlife. *Wet detention ponds are the most economical BMP for the Towns of Woodruff and Minocqua to operate and maintain.*

Since the majority of the soils within the watershed belongs to Hydrologic Soil Group "A" (sandy soils), it is likely that a liner is necessary to prevent the permanent pool in the wet detention ponds to drain. The liner could be a 1.5 foot thick clay liner or it could be a synthetic liner. The costs associated with the installation of a 1.5 foot impermeable clay liner are estimated to be (in 2005 dollars) approximately $15 per cubic yard installed, or $7.50 per square yard and $35,000 per acre.

Infiltration is another storm water treatment method that is suitable in sandy soils. However, it is necessary to pre-treat the storm water before it reaches the infiltration device. The most common pre treatment devices are wet ponds and swales. Refer to the following sections for further information on infiltration: 5.1.g, 6.4 and 6.5.

The United States Environmental Protection Agency (EPA) National Urban Runoff Program (NURP) studies and P8 Urban Catchment Model complete analysis have shown wet detention basins, in which permanent pools of water are maintained, are very effective for reducing loadings of suspended solids (sediments), heavy metals, and nutrients from urban and rural watersheds. Wet detention systems trap sediments and pollutants such as copper, lead, zinc, phosphorus, etc., that attach to sediments. Table 5-4 depicts the benefits of wet detention ponds.

Table 5-4
Benefits of Well Designed Wet Detention Ponds

Pollutant	Percent Reduction
Suspended Solids	50 to 90
Phosphorus	12 to 79
Nitrogen	6 to 62
Chemical Oxygen Demand	7 to 76
Lead	8 to 84
Copper	7 to 65
Zinc	13 to 87

Source: WDNR *The Wisconsin Storm Water Manual* Ch. 5, pg 48

An ideal storm water pond with wet detention for water quality is one that has a large surface area with gradually sloping sides to provide substantial storage volume for storm water quantity and quality purposes. *For water quality purposes, the ideal storm water pond is one that has a wet storage volume greater than or equal to the volume of runoff from a two-year storm event on a fully developed watershed and increased by 25% for sediment storage.* This volume will satisfy the NURP and water quality modeling recommendations. The side slopes of any pond should not be steeper than four feet horizontal to one foot vertical (4:1) and, where possible, should not be less than ten feet horizontal to one foot vertical (10:1).

Wet detention ponds designed to improve water quality are, in a very real sense, a pollutant trap. Without proper maintenance, pollutant removal efficiencies will reduce over time as the pond fills with sediment and reduces the water depth. Therefore, maintenance costs of wet detention basins should be taken into account during planning. Typically, the municipality assumes the responsibility of maintaining the basin, but in some cases homeowners' associates have taken responsibility of maintaining the basin in order to more closely monitor the condition of the basin. Table 5-5 presents projected maintenance costs of wet detention basins.

Table 5-5:
Maintenance Costs of Typical Wet Detention Basins (2004)

Component	Unit Cost	Basin Surface Area (acres)				Comment
		0.25	1	3	5	
Lawn Mowing	$1.85/1,000 square feet	$133	$533	$1,600	$2,666	Maintenance area equals cleared minus basin area. Mow eight times per year.
General Lawn Care	$16.20/1,000 square feet/year	$176	$706	$2,117	$3,528	Maintenance area equals area cleared minus basin area.
Basin Inlet Maintenance	3 percent of capital cost of inlet	$310	$310	$310	$310	--
Basin Outlet Maintenance	5 percent of capital cost of outlet	$608	$608	$608	$608	--
Basin Sediment Removal	1 percent of capital cost	$506	$1,294	$3,721	$6,158	--
Debris and Litter Removal	$100/year	$180	$180	$180	$180	--
Basin Nuisance Control	$200/acre of basin water surface	$90	$360	$1,080	$1,800	--
Program Administration and Inspection	$50/basin/year plus $25/inspection	$360	$360	$360	$360	Basins inspected six times per year.
Total Annual Operation and Maintenance	--	$2,369	$4,351	$9,976	$15,608	--

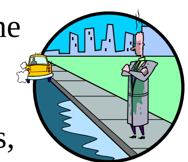
Source: Southeastern Wisconsin Regional Planning Commission TR 31 (1991 + 4% inflation rate)

We recommend that BMP surface areas and mean depths be provided in order to achieve the estimated removal efficiencies of 80% Total Suspended Solids (TSS) removals for new development and 40% TSS removals for redevelopment.

5.2.c. Pollutant Loading Analysis

Since it is not economically feasible to sample and monitor the quality of all water bodies in the Watershed, computer models are a planning and design tool to estimate the pollutant constituent loadings attribute to storm water runoff. Water quality computer models…

1. …were developed to better understand the relationships between sources of urban runoff pollutants and runoff quality.
2. …were improved upon since the late 1970s and now include a variety of source area and outfall control sources.
3. …are tools for simulating the movement of precipitation and pollutants from the ground surface through pipe and channel networks, storage treatment units and finally to receiving waters. Both single-event and continuous simulation may be performed on catchments having storm sewers and natural drainage, for prediction of flows, stages and pollutant concentrations.
4. ...each have their own unique purpose and simulation characteristics.



P8 Urban Catchment Model (Version 2.4) is the current method chosen by the EPA, WDNR, and storm water planners, for predicting current and future water quality and quantity in Minocqua-Kawaguesaga Lakes Watershed. This **p**rogram is primarily used for "**p**redicting **p**olluting **p**article **p**assage thru **p**its, **p**uddles, and **p**onds." This program was derived from other urban runoff models, such as SWMM, STORM, HSPF, D3RM, and TR-20, by William W. Walker, Jr., Ph.D., Environmental Engineer.

While the program may serve a useful purpose in planning or design, it is primarily used for evaluating runoff treatment systems (BMPs) for existing and/or proposed urban developments within minimal site-specific data. The model also predicts the generation and transportation for storm water runoff pollutants in small urban catchments.

The model simulates rainfall and precipitation data based on information collected from Minneapolis/St. Paul Minnesota Airport. The P8 model was initially calibrated with certain water quality parameters under the EPA's Nationwide Urban Runoff Program (NURP, Athayede et al., 1983) and watershed sample data results. Runoff calculations utilize curve numbers to simulate land use. Those used in the Minocqua-Kawaguesaga simulation for Land Use Type are located in Table 5-6.

Table 5-6 P8 Inputs for Land Use Type					
	Curve numbers for pervious area:				Impervious
Land Use Type	A	B	C	D	Fraction (%)
Single Family*	39	61	74	80	0.38
Multifamily **	39	61	74	80	0.65
Rural Residential***	39	61	74	80	0.12
Recreational	39	61	74	80	0.02
Industrial	39	61	74	80	0.72
Commercial	39	61	74	80	0.85
Forrest	39	61	74	80	0.02

Note: These curve numbers differ from those used in water quantity modeling because they are used for pervious area only.

* Based on 1/4 ac average lot size

** Based on 1/8 acre or less lot size (town houses)

*** Based on 2 acre average lot size

Primary Uses of the P8 Program:

1. Evaluate site plans for compliance with treatment objectives, expressed in terms of removal efficiency for total suspended solids (TSS) or a single particle class. An 85% TSS removal in "Sensitive Areas" is achievable (DNR previously proposed TMDL regulation).

2. In a design mode, selecting and sizing BMPs to achieve treatment objective. This program will automatically size BMPs to match user-defined watersheds, storm time series, target particle class, and target removal efficiency.

These two applications are insensitive to errors associated with predicting untreated runoff water quality and are therefore more accurate than predictions of concentrations or loads.

Secondary Uses of P8 Program ("Absolute Predictions"):

1. Predict runoff water quality, loads, and violation frequencies.

2. Predict water quality impacts due to proposed development.
   Upstream vs. downstream changes.
   Existing vs. future changes.

3. Calculate loads for driving receiving water quality models.

4. Watershed scale land-use planning.

These four applications are subject to greater error because of the high degree of variability (i.e., storm-to-storm and site-to-site) associated with urban runoff quality, as documented under the EPA's Nationwide Urban Runoff Program (NURP) (Athayde et al., 1983).

5.2.d. Pollutant Loading and Removal Results

In addition to the impervious fractions from Table 5-6, the calculations are based on the following assumptions: 2% general land slope (used by the P-8 model to estimate the volume of small depression areas within the watershed), street sweeping ignored (street sweeping is not done with the intent to provide storm water quality, only to pick up leaves and sand), yearly rainfall data from Minneapolis/St. Paul over the period of October 1, 1958 – September 30, 1959 and the NURP50 particle distribution. Tables 5-7 through 5-12 represent pollutant loadings and removals from the subject categories and watersheds for the following pollutants: Total Suspended Solids (TSS), Phosphorus, Nitrogen, Lead, Copper and Zinc. Included in these tables are the amount of pollutants that should be removed by BMPs that are installed in future development areas to comply with the proposed Storm Water Management Ordinance. Also included are pollutants removed by proposed Wetland and Depression BMPs and the Wetlands and Depressions themselves.

Table 5-13 illustrates how the most common pollutants vary with Land Use. Due to the amount of impervious (high Curve Numbers), Commercial and Industrial areas generate more pollutants per acre than other less dense areas such as Rural Residential and Forest. Figure 5-7 illustrates the relationship between TSS load and Land Use graphically. Similar relationships exist for the other pollutants.

Table 5-13
Pollutant Loading for Different Land Uses (Unit: [lb/ac])

Land Use	**TSS**	**P**	**N**	**Pb**	**Cu**	**Zn**
Commercial	538.47	1.70	7.62	0.11	0.15	0.69
Industrial	456.12	1.44	6.47	0.09	0.004	0.02
Multiple	411.80	1.30	5.85	0.08	0.17	0.81
Single	190.10	0.60	2.73	0.04	0.13	0.62
Rural	31.68	0.24	0.51	0.02	0.06	0.29
Forrest	12.67	0.04	0.24	0.004	0.004	0.02
Recreation	12.67	0.04	0.24	0.004	0	0

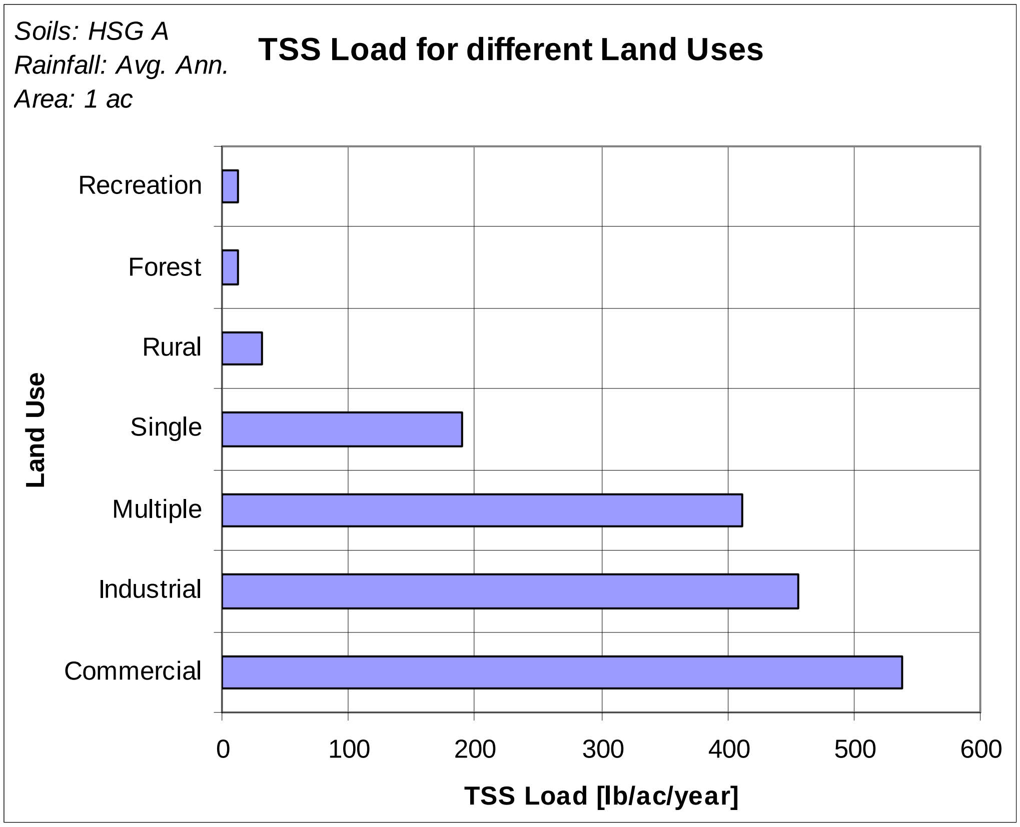


Figure 5-7: TSS Load for different Land Uses

In the initial calculations (not included in this report), each watershed is broken down into three categories: “Isolated”, “BMP” and “No BMP”. The “Isolated” category contains those sub-areas that are isolated from the Lakes by natural depressions or wetlands. The removal efficiency for all pollutants in this category is set to be 0% to separate them from the rest of the watershed area calculations and to emphasize that we should protect these areas. The “BMP” category contains those sub-areas that drain to an existing or proposed regional best management practice(s). The removal efficiencies assumed for this category are adapted from the wet detention standards found in Table 5-4 and correspond to the requirements of the proposed Storm Water Management Ordinance. The exception is the efficiency for the MCTT (Multi-chambered Treatment Train) on the Minocqua Island; these efficiencies are based on samples from the Minocqua MCTT. Pollutants generated in the “No BMP” category are assumed to be treated with new development BMPs in the Future per the proposed Storm Water Management Ordinance. If the Ordinance is not implemented, pollutants will be conveyed directly to surface water without treatment.

At such time as the unincorporated towns of Woodruff and Minocqua surpass a density of 1000 persons per square mile (which is not expected during the study period), the area would be required to follow NR 151.13 Developed Urban Area Performance Standard, which does take into consideration existing water quality modeling results.

Watershed N, R, and UYZ produce the largest pollutant loads to the Lakes. These watersheds are the oldest and most densely developed watersheds within the study area. At the time that these watersheds were developed, storm water quality was not considered during the planning, design and construction process. At that time, storm water was considered a nuisance that was most effectively dealt with by quickly conveying it to the nearest body of water. Corrections were made in the early 1990's as a local effort with WDNR led to the installation of two Stormceptors and one MCTT (in Watershed R) to deal with the increasing pollutant loading from the urban part of the Minocqua island to the Minocqua Lake. Chapter 9 contains recommendations to improve the storm water quality aspects of this watershed as well as several other hot spots within the study area.

Analysis of the modeling results indicates that 6.8 % of the TSS is currently removed before reaching the Lakes, excluding the wetlands and isolated areas. Figures 5-8 and 5-9 show the existing and future TSS Load and Phosphorus Load, respectively, for some of the key watersheds. The graphs show the *total load* for each watershed including wetlands, isolated areas, and areas with or without BMPs. It is evident that the pollutant loading will increase in most watersheds in the future. Similar relationships exist for the other pollutants types. Reviewing these results for theses watersheds, it is obvious that with the introduction of BMP's, a significant reduction in phosphorous and total suspended solids contribution to the lakes will be realized.

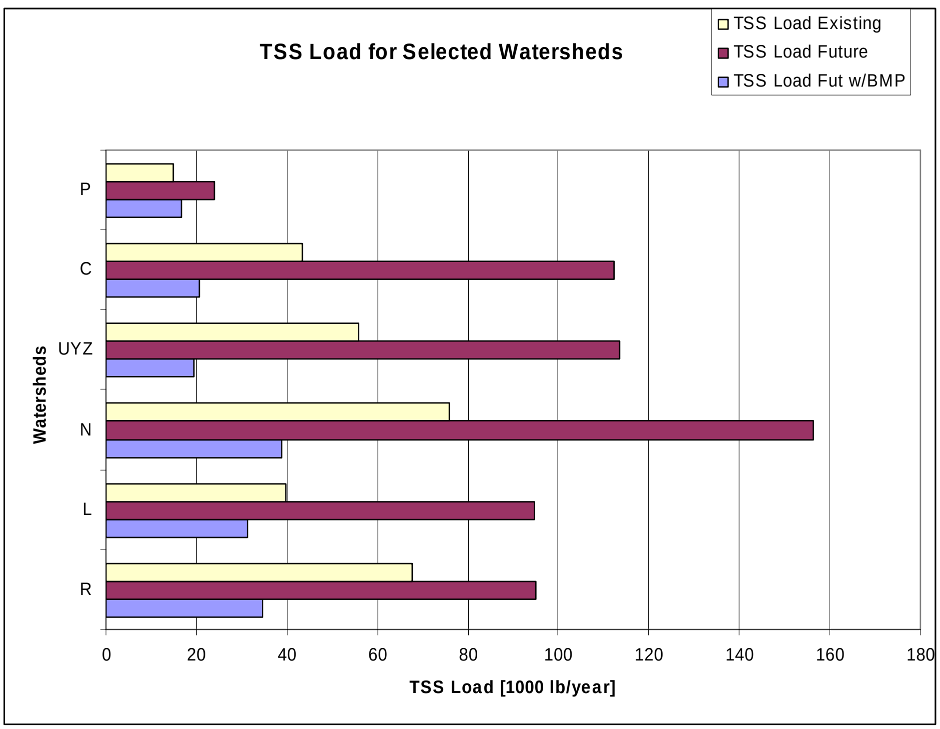


Figure 5-8: TSS Load for Important Watersheds

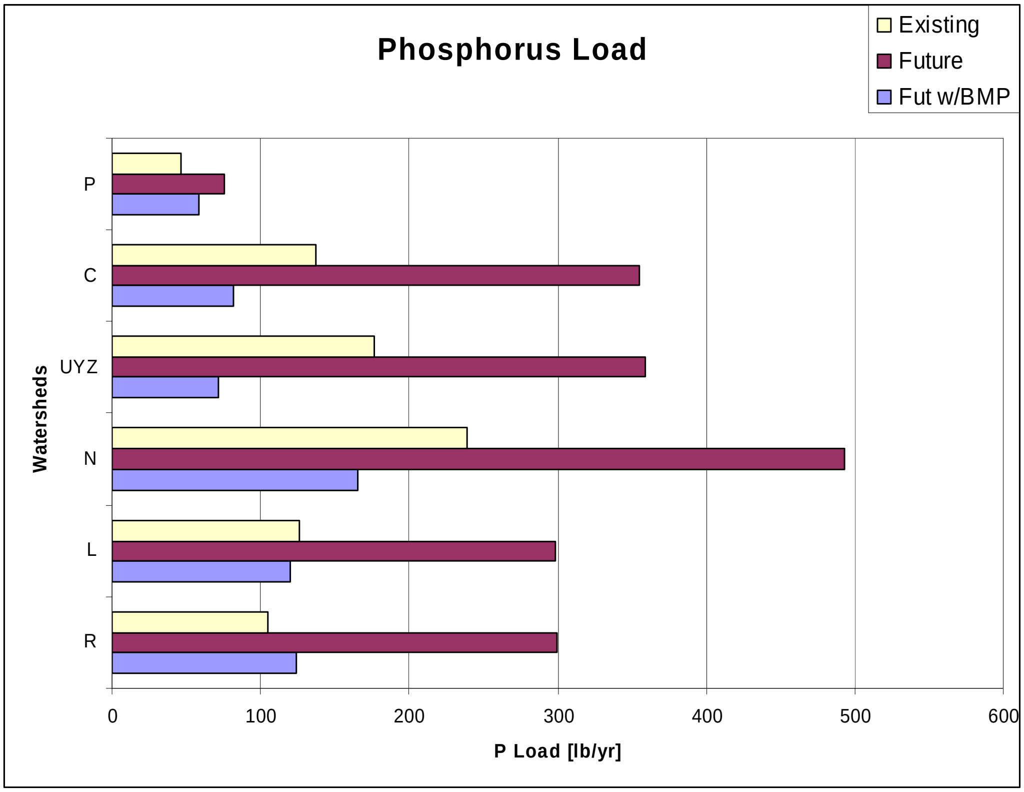


Figure 5-9: Phosphorus Load for Important Watersheds

5.3. Storm Water Outfall Sampling

5.3.a. Illicit Discharge Inspection and Sampling

We recommend that the discharge be investigated and utility personnel monitor storm sewer outfalls periodically during dry weather periods. If any illicit discharges are noted, we recommend that the DNR be contacted to determine the appropriate response. A program of dry weather storm sewer outlet inspections should be introduced to determine if there are discharges other than runoff water. This program should include sewer outfall sampling and analysis during dry weather periods.

Table 5-3: Storm Water Quantity Modeling Outputs

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
A - Exist	Minocqua	0.40	7.33	11.91	28.93	0.23	1.51	2.47	5.04
A - Future	Minocqua	0.78	10.30	15.45	31.39	0.31	1.31	1.79	3.13
A - Future with BMP	Minocqua	0.40	7.33	11.91	28.93	0.25	1.25	1.73	3.07

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
B - Exist	Minocqua	0.28	8.07	16.46	47.77	0.23	2.07	3.10	6.17
B - Future	Minocqua	1.23	23.36	38.75	85.15	0.69	3.36	4.68	8.45
B - Future with BMP	Minocqua	0.28	8.07	16.46	47.77	0.63	3.30	4.62	8.39

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
C - Exist	Minocqua	1.38	18.46	30.90	70.83	1.01	5.43	7.64	14.03
	Clawson Lake	0.96	11.47	19.46	44.65	0.69	3.67	5.17	9.49
C - Future	Minocqua	43.64	131.84	168.82	264.73	6.41	15.86	19.76	29.88
	Clawson Lake	27.38	82.96	106.44	167.44	4.34	10.73	13.37	20.21
C - Future	Minocqua	1.38	18.46	30.90	70.83	6.16	15.61	19.51	29.63
with BMP	Clawson Lake	0.96	11.47	19.46	44.65	4.09	10.48	13.12	20.04

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
D - Exist	Minocqua	10.75	47.15	63.92	108.89	1.95	5.70	7.33	11.67
D - Future	Minocqua	41.84	102.20	130.43	194.28	4.08	9.27	11.35	16.89
D - Future with BMP	Minocqua	10.75	47.15	63.92	108.89	3.59	8.78	10.86	16.40

Table 5-3: Storm Water Quantity Modeling Outputs

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
E - Exist	Minocqua	81.05	139.88	161.18	212.19	4.23	7.51	8.72	11.66
	Kawaguesaga	87.28	150.90	173.70	228.28	4.39	9.94	12.30	18.57
	Wetl. E2_EX	436.64	764.91	883.12	1166.55	30.43	54.03	62.74	83.96
E - Future	Minocqua	89.42	150.27	171.95	223.72	4.64	8.00	9.24	12.23
	Kawaguesaga	96.07	160.75	183.77	238.76	5.01	10.91	13.38	19.85
	Wetl. E2_EX	494.95	839.50	962.15	1255.23	33.39	57.63	66.50	88.01
E - Future with BMP	Minocqua	81.05	139.88	161.18	212.19	3.58	6.94	8.18	11.17
	Kawaguesaga	87.28	150.90	173.70	228.28	3.95	9.85	12.32	18.75
	Wetl. E2_EX	436.64	764.91	883.12	1166.55	32.33	56.57	65.44	80.40

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
F - Exist	Kawaguesaga	0.00	0.00	0.18	1.46	0.00	0.00	0.68	4.88
	Baker Lake	3.25	44.17	67.85	137.17	1.27	5.34	7.29	12.75
F - Future	Kawaguesaga	0.00	0.68	1.44	4.52	0.00	3.02	5.41	13.96
	Baker Lake	36.39	130.80	171.21	277.25	3.65	10.00	12.72	19.89
F - Future with BMP	Kawaguesaga	0.00	0.00	0.18	1.46	0.00	3.02	5.41	13.96
	Baker Lake	3.25	44.17	67.85	137.17	3.33	9.68	12.40	19.57

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.5"	3.8"	4.3"	5.3"	2.5"	3.8"	4.3"	5.3"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
G - Exist	Kawaguesaga	0.20	5.98	11.77	31.74	0.16	1.25	1.83	3.57
G - Future	Kawaguesaga	20.56	65.66	86.36	132.88	1.70	4.42	5.56	8.54
G - Future with BMP	Kawaguesaga	0.20	5.98	11.77	31.74	1.66	4.38	5.52	8.50

Table 5-3: Storm Water Quantity Modeling Outputs

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR
H - Exist	Kawaguesaga	0.17	3.12	5.82	15.40	0.13	1.43	2.88	10.65
	Wetl. H4	0.71	13.00	24.58	67.20	0.54	6.11	9.30	19.01
	Wetl. H21	0.42	8.73	18.60	56.01	0.32	3.63	5.53	11.30
H - Future	Kawaguesaga	0.91	9.95	15.30	31.92	0.54	4.30	7.53	26.18
	Wetl. H4	4.50	45.35	69.98	145.44	2.67	12.08	16.65	29.58
	Wetl. H21	2.74	37.30	59.21	124.84	1.59	7.18	9.89	17.57
H - Future with BMP	Kawaguesaga	0.17	3.12	5.82	15.40	0.51	4.27	7.50	26.15
	Wetl. H4	0.71	13.00	24.58	67.20	2.54	11.95	16.52	29.45
	Wetl. H21	0.42	8.73	18.60	56.01	1.51	7.10	9.81	17.49

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR
I - Exist	Kawaguesaga	2.17	20.86	31.78	64.48	1.06	4.78	6.11	13.15
I - Future	Kawaguesaga	10.52	47.51	64.98	112.35	2.36	7.12	10.56	25.14
I - Future with BMP	Kawaguesaga	2.17	20.86	31.78	64.48	2.10	6.86	10.30	24.88

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	4.2" 10-YR	4.7" 25-YR	5.9" 100-YR
J - Exist	Kawaguesaga	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Patricia Lake	0.55	9.23	16.94	43.85	0.50	3.76	5.52	11.22
J - Future	Kawaguesaga	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Patricia Lake	25.36	87.49	114.18	184.46	4.75	13.61	17.80	30.94
J - Future with BMP	Kawaguesaga	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Patricia Lake	0.55	9.23	16.94	43.85	4.63	13.49	17.68	30.82

Table 5-3: Storm Water Quantity Modeling Outputs

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.8"	4.2"	4.7"	5.9"	2.8"	4.2"	4.7"	5.9"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
K - Exist	Kawaguesaga	3.21	22.53	33.15	64.56	1.59	6.31	8.53	14.72
	Tomahawk	5.38	41.41	61.28	119.87	2.60	10.32	13.96	24.09
K - Future	Kawaguesaga	3.21	22.53	33.15	64.56	1.59	6.31	8.53	14.72
	Tomahawk	5.38	41.41	61.28	119.87	2.60	10.32	13.96	24.09
K - Future	Kawaguesaga	3.21	22.53	33.15	64.56	1.19	5.91	8.13	14.32
with BMP	Tomahawk	5.38	41.41	61.28	119.87	1.95	9.67	13.31	23.44

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.8"	4.2"	4.7"	5.9"	2.8"	4.2"	4.7"	5.9"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
LMNO - Exist	Minocqua	1.68	23.81	37.56	79.06	0.83	3.76	5.18	9.21
	Kawaguesaga	0.68	16.51	25.66	51.81	0.29	1.32	1.82	3.23
	Tomahawk	1.52	11.67	18.07	36.50	1.17	5.30	7.31	19.48
	Bullhead Lake	91.70	166.68	196.17	271.46	8.39	21.98	31.96	58.14
LMNO - Future	Minocqua	34.90	106.61	136.40	213.50	3.50	8.86	11.09	18.00
	Kawaguesaga	21.25	60.38	76.38	117.45	1.23	3.11	3.89	5.93
	Tomahawk	15.96	50.41	65.00	103.52	4.93	21.30	28.29	45.96
	Bullhead Lake	176.65	308.28	356.60	471.46	28.20	66.39	81.33	118.64
LMNO - Future	Minocqua	1.68	23.81	37.56	79.06	3.29	8.65	10.88	17.79
with BMP	Kawaguesaga	0.68	16.51	25.66	51.81	1.16	3.04	3.82	5.86
	Tomahawk	1.52	11.67	18.07	36.50	4.64	21.01	28.00	45.67
	Bullhead Lake	91.70	166.68	196.17	271.46	26.10	64.29	79.23	116.54

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.8"	4.2"	4.7"	5.9"	2.8"	4.2"	4.7"	5.9"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
P - Exist	Minocqua	5.89	24.46	33.45	58.50	1.36	4.13	5.36	8.68
P - Future	Minocqua	45.64	97.36	117.16	166.15	4.62	9.47	11.35	16.05
P - Future with BMP	Minocqua	5.89	24.46	33.45	58.50	4.28	9.13	11.01	15.71

Table 5-3: Storm Water Quantity Modeling Outputs

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	Peak Rate (cfs) 4.2" 10-YR	Peak Rate (cfs) 4.7" 25-YR	Peak Rate (cfs) 5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	Runoff Volume (acre-ft) 4.2" 10-YR	Runoff Volume (acre-ft) 4.7" 25-YR	Runoff Volume (acre-ft) 5.9" 100-YR
QS - Exist	Minocqua	3.68	20.26	28.11	49.43	0.55	1.78	2.33	3.82
	Wetl. Q3_EX	78.38	173.53	210.43	303.00	8.42	20.00	25.36	40.30
QS - Future	Minocqua	24.52	54.96	67.19	98.11	1.59	3.40	4.12	5.98
	Wetl. Q3_EX	188.84	327.87	378.06	498.64	18.91	39.15	46.93	66.10
QS - Future	Minocqua	3.68	20.26	28.11	49.43	1.45	3.26	3.98	5.84
with BMP	Wetl. Q3_EX	78.38	173.53	210.43	303.00	16.81	37.05	44.83	64.00

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	Peak Rate (cfs) 4.2" 10-YR	Peak Rate (cfs) 4.7" 25-YR	Peak Rate (cfs) 5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	Runoff Volume (acre-ft) 4.2" 10-YR	Runoff Volume (acre-ft) 4.7" 25-YR	Runoff Volume (acre-ft) 5.9" 100-YR
R - Exist	Minocqua	141.50	301.98	364.49	521.15	8.99	18.44	23.48	37.50
	Wetl. R3_EX	90.20	169.79	199.15	270.35	5.51	10.41	12.26	16.82
R - Future	Minocqua	225.92	415.88	486.33	659.51	13.19	27.27	33.54	53.43
	Wetl. R3_EX	149.05	243.01	276.34	355.81	8.21	13.79	15.81	25.30
R - Future	Minocqua	141.50	301.98	364.49	521.15	10.94	25.02	31.29	51.18
with BMP	Wetl. R3_EX	90.20	169.79	199.15	270.35	6.83	12.41	14.43	23.92

Watershed	Location	Peak Rate (cfs) 2.8" 2-YR	Peak Rate (cfs) 4.2" 10-YR	Peak Rate (cfs) 4.7" 25-YR	Peak Rate (cfs) 5.9" 100-YR	Runoff Volume (acre-ft) 2.8" 2-YR	Runoff Volume (acre-ft) 4.2" 10-YR	Runoff Volume (acre-ft) 4.7" 25-YR	Runoff Volume (acre-ft) 5.9" 100-YR
TVWX - Exist	Minocqua	0.46	6.48	12.46	31.62	0.45	3.19	5.91	26.98
	County J	2.56	8.98	11.85	34.30	0.69	6.04	11.89	27.47
TVWX - Future	Minocqua	25.66	16.18	86.84	132.28	4.61	19.36	30.67	57.47
	County J	5.39	14.65	21.78	59.65	1.07	13.32	20.14	37.71
TVWX - Future	Minocqua	0.46	6.48	12.46	31.62	4.50	19.25	30.56	57.36
with BMP	County J	2.56	8.98	11.85	34.30	0.90	13.15	19.97	37.54

Table 5-3: Storm Water Quantity Modeling Outputs

		Peak Rate (cfs)				Runoff Volume (acre-ft)			
		2.8"	4.2"	4.7"	5.9"	2.8"	4.2"	4.7"	5.9"
Watershed	Location	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
UYZ - Exist	Minocqua	0.61	11.06	19.24	46.95	0.62	4.66	6.84	13.30
UYZ - Future	Minocqua	25.20	74.16	96.25	156.35	3.90	11.40	14.76	25.50
UYZ - Future with BMP	Minocqua	0.61	11.06	19.24	46.95	3.75	11.25	14.61	25.35

Table 5-7: TSS Removal with Regional, New Development and Wetland BMPs

Watershed	Existing TSS Load w/ Existing BMPs	Future TSS Load w/o BMPs	TSS Removed w/ Regional BMPs	TSS Removed w/ New Development BMPs*	TSS Removed w/ Wetland BMP	TSS Trapped w/ Infiltration & Wetland	Future TSS Load w/ all BMPs
A+	2615	2615	0	0	176	44	2395
B	11778	14383	0	663	6895	1724	5101
C	43529	112370	0	19948	57305	14326	20791
D	8249	35056	0	9451	15689	3922	5994
E	24400	44572	0	4822	24865	6216	8668
F	8487	14746	0	0	11797	2949	0
G	3264	11362	0	6478	0	0	4884
H	8365	49788	0	3190	36000	9000	1597
I+	50188	50188	0	0	21167	5292	23730
J+	46299	46299	0	0	37036	9259	4
K+	22212	22212	0	0	0	0	22212
L	39832	94660	2773	23418	29665	7416	31389
M	18812	98295	32225	0	31292	7823	26955
N	75739	156244	22845	0	75525	18881	38993
O	13988	44193	0	14479	13502	3375	12836
P	14798	24109	267	7449	0	0	16393
Q	25677	46282	1034	4181	23958	5990	11119
R	67619	94963	6883	0	42782	10696	34603
S	33188	47421	13057	0	5927	1482	26955
T	34590	110603	40568	16849	23482	5871	23833
V+	20352	20352	742	0	3522	880	15208
W+	14762	14762	0	0	6383	1596	6783
X	17298	40022	6781	0	25237	6309	1695
UYZ	55840	113652	0	13062	64955	16239	19397
Overall	661883	1309149	127175	123991	557160	139290	361534
% Increase in TSS		198%					Total
% Removal			9.7%	9.5%	42.6%	10.6%	72.4%

* - Per proposed Ordiance for New Development, non-regional BMPs, shall be sized for 80% TSS Removal efficiency.

+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.

Table 5-8: P Removal with Regional, New Development, and Wetland BMPs

Watershed	Existing P Load w/o Existing BMPs	Future P Load w/o BMPs	P Removed w/ Regional BMPs	P Removed w/ New Development BMPs*	P Removed w/ Wetland BMP	P Trapped w/ Infiltration & Wetland	Future P Load w/ all BMPs
A+	8	8	0	0	0	0	7
B	37	45	0	2	16	11	17
C	137	355	0	47	136	90	81
D	26	111	0	22	37	25	26
E	81	145	0	11	60	40	32
F	27	47	0	0	28	19	0
G	10	36	0	15	0	0	21
H	26	157	0	8	85	57	8
I+	158	158	0	0	50	33	75
J+	146	146	0	0	88	58	0
K+	70	70	0	0	0	0	70
L	126	299	6	55	70	47	120
M	59	310	59	0	74	49	128
N	239	493	30	0	179	119	165
O	44	140	0	34	32	21	52
P	47	76	1	11	0	0	64
Q	81	146	0	10	57	38	42
R	105	300	7	0	101	68	124
S	214	150	15	0	14	9	112
T	109	349	88	40	56	37	129
V+	64	64	2	0	8	6	49
W+	47	47	0	0	15	10	21
X	55	126	15	0	60	40	12
UYZ	176	359	0	31	154	103	72
Overall	2094	4137	222	288	1321	881	1425
% INCREASE IN PHOSPHOROUS		198%					Total
% Removal (w/ infiltration areas)			5.4%	7.0%	31.9%	21.3%	65.5%

* - Estimated removal efficiency of New Development, non-regional BMPs, is 60%.

+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.

Table 5-9: Nitrogen Removal with Regional, New Development and Wetland BMPs

Watershed	Existing N Load Total	Future N Load Total	N Removed w/ Regional BMPs	N Removed w/ New Development BMPs*	N Removed w/ Wetland BMP	N Trapped w/ Infiltration & Wetland	Future N Load w/ all BMPs
A+	37	37	0	0.0	2	1	34
B	167	204	0	8.8	92	31	73
C	618	1591	0	264.3	761	254	313
D	117	496	0	125.4	208	69	93
E	365	653	0	64.4	341	114	133
F	121	209	0	0.0	157	52	0
G	46	161	0	85.7	0	0	75
H	119	705	0	42.3	478	159	25
I+	710	710	0	0.0	282	94	334
J+	655	655	0	0.0	491	164	0
K+	315	315	0	0.0	0	0	315
L	566	1340	37	309.9	394	131	468
M	266	1391	432	0.0	415	138	405
N	1072	2209	185	0.0	1001	334	689
O	199	625	0	191.5	179	60	195
P	210	341	4	63.0	0	0	274
Q	364	654	0	55.3	318	106	176
R	957	1342	26	0.0	567	189	561
S	470	670	89	0.0	79	26	476
T	491	1565	538	223.1	311	104	388
V+	289	289	10	0.0	47	16	217
W+	210	210	0	0.0	85	28	96
X	245	567	90	0.0	335	112	30
UYZ	793	1610	0	173.0	863	288	287
Overall	9402	18550	1411	1607	7405	2468	5659
% Increase in N		197%					Total
% Removal			7.6%	8.7%	39.9%	13.3%	69.5%

* - Per proposed Ordiance for New Development, non-regional BMPs, shall be sized for 80% TSS Removal efficiency.

+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.

Table 5-10: Lead Removal with Regional, New Development and Wetland BMPs

Watershed	Existing Pb Load w/ Existing BMPs	Future Pb Load w/o BMPs	Pb Removed w/ Regional BMPs	Pb Removed w/ New Development BMPs*	Pb Removed w/ Wetland BMP	Pb Trapped w/ Infiltration & Wetland	Future Pb Load w/ all BMPs
A+	0.6	6.0	0.0	1.8	2.2	0.9	1.1
B	2.5	3.1	0.0	0.1	1.3	0.6	1.1
C	9.2	23.1	0.0	3.5	10.3	4.4	4.9
D	1.8	7.0	0.0	1.6	2.7	1.2	1.5
E	5.1	9.0	0.0	0.8	4.4	1.9	1.9
F	1.9	3.0	0.0	0.0	2.1	0.9	0.0
G	0.7	2.2	0.0	1.1	0.0	0.0	1.2
H	2.0	10.1	0.0	0.6	6.4	2.7	0.4
I+	10.4	10.4	0.0	0.0	3.8	1.6	4.9
J+	9.3	9.3	0.0	0.0	6.5	2.8	0.0
K+	4.7	4.7	0.0	0.0	0.0	0.0	4.7
L	8.4	19.2	0.6	4.0	5.3	2.3	7.1
M	4.0	19.8	5.5	0.0	5.5	2.4	6.4
N	15.7	32.0	2.9	0.0	13.5	5.8	9.8
O	3.0	9.0	0.0	2.5	2.4	1.0	3.0
P	3.1	4.9	0.1	0.8	0.0	0.0	4.1
Q	5.3	9.5	0.0	0.7	4.3	1.8	2.6
R	13.9	19.1	0.9	0.0	7.5	3.2	7.5
S	6.9	9.4	1.3	0.0	1.0	0.4	6.6
T	7.3	22.6	8.3	3.0	4.2	1.8	5.4
V+	4.3	4.3	0.1	0.0	0.6	0.3	3.3
W+	3.1	3.1	0.0	0.0	1.2	0.5	1.4
X	3.7	8.1	1.4	0.0	4.5	1.9	0.3
UYZ	11.8	23.6	0.0	2.0	11.8	5.1	4.7
Overall	139	273	21	23	102	44	84
% Increase in Pb		197%					Total
% Removal			7.7%	8.3%	37.3%	16.0%	69.2%

* - Per proposed Ordiance for New Development, non-regional BMPs, shall be sized for 80% TSS Removal efficiency.

\+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.

Table 5-11: Copper Removal with Regional, New Development and Wetland BMPs

Watershed	Existing Cu Load w/ Existing BMPs	Future Cu Load w/o BMPs	Cu Removed w/ Regional BMPs	Cu Removed w/ New Development BMPs*	Cu Removed w/ Wetland BMP	Cu Trapped w/ Infiltration & Wetland	Future Cu Load w/ all BMPs
A+	0.8	0.8	0.0	0.0	0.0	0.0	0.8
B	3.7	4.5	0.0	0.1	1.4	1.4	1.7
C	13.7	35.5	0.0	3.9	11.3	11.3	8.9
D	2.6	10.9	0.0	1.8	3.0	3.0	3.0
E	7.8	14.4	0.0	1.0	5.0	5.0	3.4
F	2.7	4.7	0.0	0.0	2.3	2.3	0.0
G	1.0	3.6	0.0	1.3	0.0	0.0	2.3
H	2.6	15.7	0.0	0.6	7.1	7.1	0.9
I+	15.8	15.8	0.0	0.0	4.2	4.2	7.5
J+	14.6	14.6	0.0	0.0	7.3	7.3	0.0
K+	7.0	7.0	0.0	0.0	0.0	0.0	7.0
L	12.6	29.9	0.6	4.6	5.9	5.9	13.0
M	5.9	30.9	5.5	0.0	6.1	6.1	13.1
N	23.9	49.3	2.9	0.0	14.9	14.9	16.7
O	4.4	14.0	0.0	2.9	2.7	2.7	5.8
P	4.7	7.6	0.1	0.9	0.0	0.0	6.6
Q	8.1	14.6	0.0	0.8	4.7	4.7	4.3
R	21.3	30.0	0.9	0.0	8.4	8.4	12.2
S	10.5	15.0	1.3	0.0	1.2	1.2	11.3
T	10.9	35.0	8.3	3.3	4.6	4.6	14.1
V+	6.4	6.4	0.1	0.0	0.7	0.7	4.9
W+	4.7	4.7	0.0	0.0	1.3	1.3	2.1
X	5.5	12.4	1.4	0.0	4.9	4.9	1.3
UYZ	17.6	35.9	0.0	2.6	12.8	12.8	7.7
Overall	209	413	21	24	110	110	148
% Increase in Cu		198%					Total
% Removal			5.1%	5.8%	26.6%	26.6%	64.1%

* - Per proposed Ordiance for New Development, non-regional BMPs, shall be sized for 80% TSS Removal efficiency.

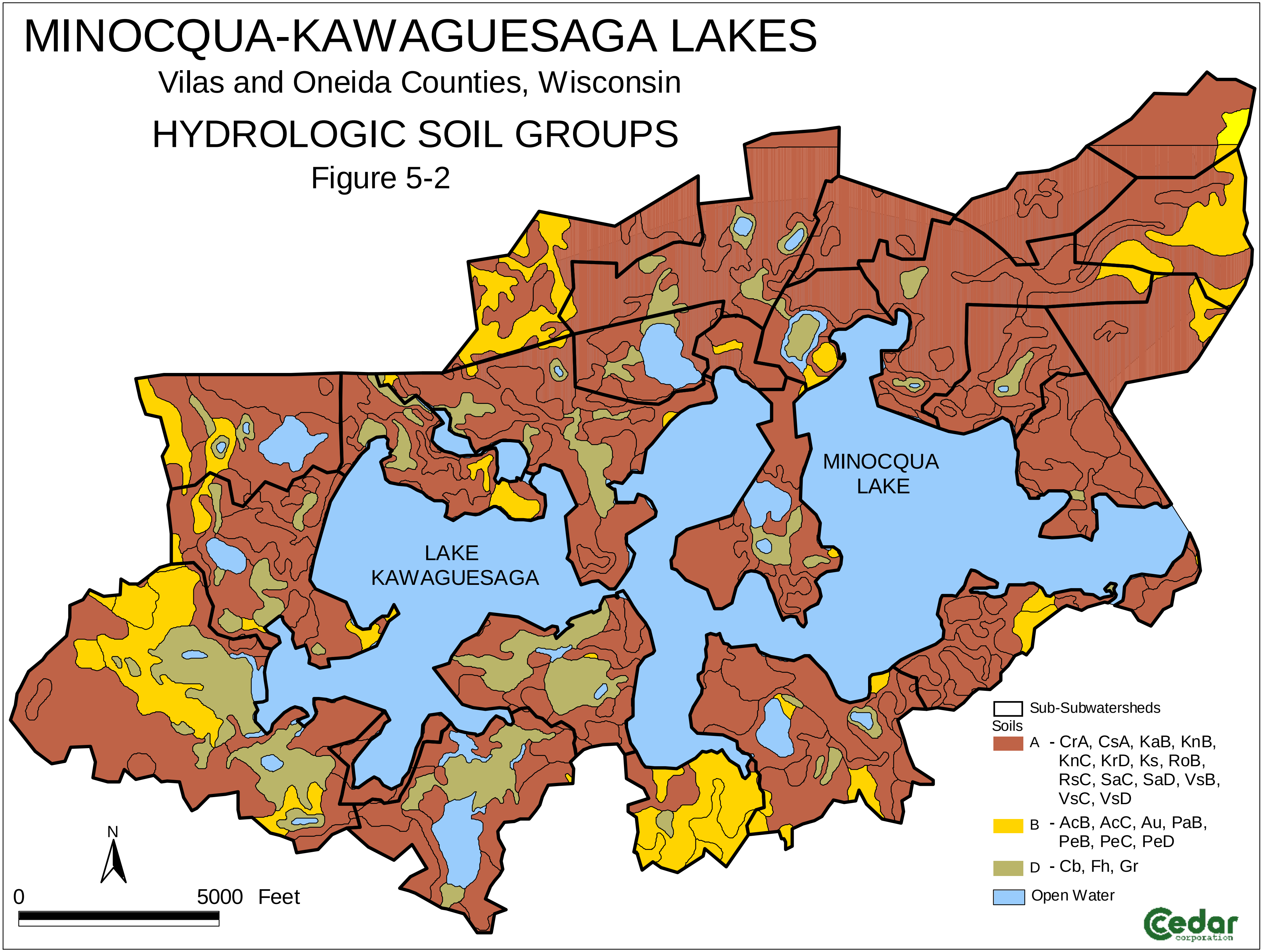
+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.

Table 5-12: Zinc Removal with Regional, New Development and Wetland BMPs

Watershed	Existing Zn Load w/ Existing BMPs	Future Zn Load w/o BMPs	Zn Removed w/ Regional BMPs	Zn Removed w/ New Development BMPs*	Zn Removed w/ Wetland BMP	Zn Trapped w/ Infiltration & Wetland	Future Zn Load w/ all BMPs
A+	4.0	4.0	0.0	0.0	0.0	0.0	3.9
B	18.0	22.0	0.0	0.9	1.9	0.8	18.4
C	66.5	170.0	0.0	26.2	15.8	6.8	121.1
D	12.7	53.4	0.0	12.6	4.3	1.8	34.8
E	38.8	69.4	0.0	6.4	7.0	3.0	53.0
F	13.1	22.5	0.0	0.0	3.3	1.4	17.8
G	5.0	17.1	0.0	8.5	0.0	0.0	8.6
H	13.2	75.7	0.0	4.2	9.9	4.3	57.2
I+	75.9	45.8	0.0	0.0	5.8	2.5	37.5
J+	69.8	69.8	0.0	0.0	10.2	4.4	55.2
K+	33.9	12.2	0.0	0.0	0.0	0.0	12.2
L	60.9	143.0	0.6	30.7	8.2	3.5	100.1
M	28.8	148.2	5.5	0.0	8.6	3.7	130.5
N	114.6	235.3	2.9	0.0	20.9	8.9	202.6
O	21.4	66.6	0.0	18.9	3.7	1.6	42.3
P	22.4	36.3	0.4	6.2	0.0	0.0	29.7
Q	38.9	69.7	0.0	5.5	6.6	2.8	54.8
R	102.1	143.0	0.9	0.0	11.8	5.1	125.2
S	50.3	71.4	1.3	0.0	1.6	0.7	67.7
T	52.8	166.9	8.3	22.1	6.5	2.8	127.2
V+	31.1	8.1	0.1	0.0	1.0	0.4	6.6
W+	22.6	12.2	0.0	0.0	1.8	0.8	9.7
X	26.5	61.2	1.4	0.0	6.9	2.9	50.0
UYZ	85.4	172.2	0.0	17.2	18.0	7.7	129.4
Overall	1009	1896	21	159	154	66	1496
% Increase in Zn		188%					Total
% Removal			1.1%	8.4%	8.1%	3.5%	21.1%

* - Per proposed Ordiance for New Development, non-regional BMPs, shall be sized for 80% TSS Removal efficiency.

+ - Discrepancy due to future zoning being less dense than exising land use (Wiscland -93), assume no increase in Pollutant Load.



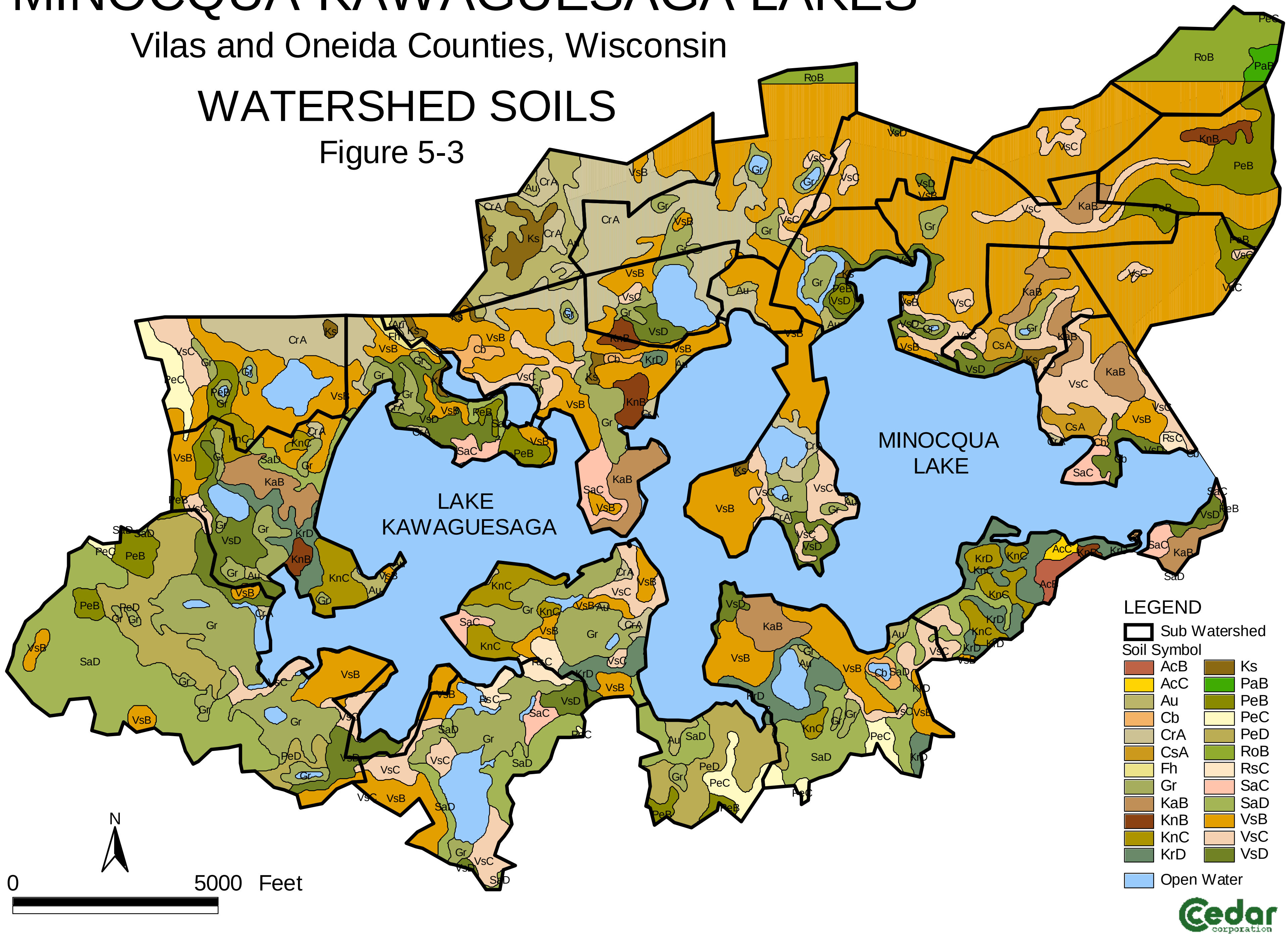
MINOCQUA-KAWAGUESAGA LAKES
Vilas and Oneida Counties, Wisconsin
HYDROLOGIC SOIL GROUPS
Figure 5-2
MINOCQUA LAKE
LAKE KAWAGUESAGA
Sub-Subwatersheds
Soils
A - CrA, CsA, KaB, KnB, KnC, KrD, Ks, RoB, RsC, SaC, SaD, VsB, VsC, VsD
B - AcB, AcC, Au, PaB, PeB, PeC, PeD
D - Cb, Fh, Gr
Open Water
N
0
5000 Feet
Cedar corporation

MINOCQUA-KAWAGUESAGA LAKES

Vilas and Oneida Counties, Wisconsin

WATERSHED SOILS

Figure 5-3



CHAPTER 6: WATERSHED WATER QUALITY IMPROVEMENT

This chapter presents recommendations for various actions to slow or stop the degradation of water quality in the Minocqua and Kawaguesaga Lakes. A significant task is the development and continuation of an information and education program to promote and foster among residents and non-residents of the region, an individual responsibility to protect water quality. This topic is large enough that Chapter 7 is dedicated to a description of the public education program to accomplish this objective.

Individuals, local government, and area businesses should assume an increasing responsibility for protecting water quality of the area lakes. This report documents that a variety of factors affect the water quality of the lakes, including nonpoint source pollutants – primarily sediments and nutrients (phosphorous and nitrogen), groundwater, precipitation, and background or natural sources. Existing USGS data documents that the state of the area lakes is good, but fragile. Water quality by visual inspection appears oligotrophic, but certain parameters such as phosphorous and chlorophyll*a* are considered mesotrophic (Appendix D, 2004 USGS Report, pg. 5). Clearly, the water quality of the Lakes as a whole should be considered as becoming more eutrophic. Thus, the Association Board and its members, the surrounding populace, and the Lakes visitors all need to be sensitive to the existing water quality and be encouraged, if not required, to adopt those necessary measures to be protective of the water quality of the Minocqua and Kawaguesaga Lakes.

This Plan is only as good as it is used and updated. To measure the progress of lake improvement and to document achieved goals, it is encouraged to schedule annual updates of the Plan and its initiatives with local political entities. Continuing the on-going lake water quality monitoring program will help assist in this process. It should be evident to all involved in this process, that lake protection follows the old adage:

"An ounce of prevention is worth a pound of cure."

6.1. Runoff Water Best Management Practices (BMPs)

Best Management Practices (BMPs) are measures intended to reduce or mitigate storm water runoff water quantity and water quality concerns to the maximum extent practical. Certain measures can help reduce impacts, but no BMP will reverse damages caused by pervious agricultural practices, construction and urban development.

In general, there are two types of BMPs for storm water pollution control.

1. **Source control** measures focus on minimizing or mitigating the source of the pollution so that pollutants are prevented from contacting storm water runoff or entering the drainage conveyance system.

2. **Treatment control** measures are designed to remove a percentage of the pollutants after they have entered storm water runoff. Treatment control measures tend to be more expensive than source control measures.

Specific educational and design *"EPA Fact Sheets on Select Best Management Practices" are available in Additional Reading*. Most source control measures tend to be non-structural, and most treatment BMPs tend to be structural in nature, although there can be exceptions.

Water Quality and Flood Control Best Management Practices can be categorized as either structural or non-structural controls.

Structural best management controls include:

- Wet detention sediment basins,
- Constructed wetlands,
- Infiltration basins,
- Infiltration trenches,
- Dry detention/retention basins,
- Sump storm sewer inlets,
- Riprap,
- Gabions,
- Construction of grassed channels and drainage ways,
- Silt fence,
- Multi-Chambered Treatment Train (MCTT)
- Water quality pre-treatment box structure, i.e. Stormceptor,
- **Stone weeper berms**,
- Straw bales and silt fence.

Chapter 5 presents an extensive discussion on structural controls.

Non-structural best management controls include:

- Street sweeping,
- Catch basin control on winter streets,
- Leaf and lawn waste control,
- Fertilizer and pesticide application control,
- Hazardous waste and spill prevention program,
- Pet and farm animal waste control,
- Construction site erosion control regulations and enforcement,
- Storm water management planning education,

- Ordinances; and
- Land use planning

Using non-structural best management practices rather than using expensive structural best management practices is likely most cost effective in gaining a large percentage of water quantity and quality control benefits. However, some structural controls must be provided in order to obtain the greatest amount of pollutant reduction and flood control within the Minocqua-Kawaguesaga Lakes Watershed.

Rural and developing areas allow for unique opportunities to incorporate creative BMPs into site design. The BMPs can be incorporated into natural areas serving as open spaces for community enjoyment. This idea can be expanded into a fingerprinting concept that requires developments to duplicate BMPs to some extent at each site.

Another technique is for the local authorities, with assistance of WDNR grant programs, to purchase land next to a water resource and create a buffer strip around the area and construct structural BMPs. In certain cases, this may be the only way to protect a sensitive water body from further degradation, even with several structural and non-structural BMPs in place.

We recommend that the following best management practices be implemented to address pollutant loadings and flood control within the Minocqua-Kawaguesaga Lakes Watershed.

6.2. Storm Water Ponds

Detention storm water pond BMPs capture storm water runoff and remove pollutants through settling and/or biological uptake. The BMPs presented in this Plan can reduce water quality pollutant discharges, stream bank erosion and flooding by temporarily detaining and controlling peak discharge rates and pretreating runoff before releasing it at flow rates and frequencies similar to those occurring under natural hydrologic and hydraulic conditions. Detention storm water ponds can be designed to enhance wildlife habitat, provide an aesthetic amenity and satisfy some of the site landscape needs. In some areas, they may require appropriate designs to prevent groundwater contamination. Additionally, consideration should be made of the long-term maintenance and sediment disposal requirements of detention storm water pond BMPs before they are applied.

6.2.a. Dry Extended Detention (ED) Ponds

Dry ED storm water ponds are designed to intercept a rate and volume of storm water runoff and temporarily detain, pre-treat, and impound the water for gradual release to the receiving stream or storm sewer conveyance system (Figure 6-1). Another common name associated to the Dry ED pond is “detention ponds.” Dry ED ponds are typically end-of pipe BMPs that are designed to completely empty after and between storm water runoff events, which allows for the control of storm runoff and provide some water quality treatment through infiltration.

Therefore, this BMP's benefits are primarily in its ability to reduce peak flows and reduce volume if soils are suitable. Stream bank erosion is minimized through the reduced peak discharges and water velocity.

Dry ED storm water ponds provide limited settling and capture of particulate matter. Portions of this particulate material can be resuspended by successive storm water runoff events. Consequently, this BMP should be used primarily for peak discharge shaving, or to reduce the peak discharge of storm water to receiving water bodies in order to mitigate downstream flooding and to provide downstream conveyance system erosion control protection.

Advantages:

1. Performs well in cold climates.
2. Limits downstream scour and loss of habitat by reducing peak flow discharge rates and through dissipation of energy from storm water discharging to receiving water bodies.
3. Provide for recreational uses (i.e. sports fields) in dry periods, if properly designed.

Limitations:

1. Do not provide high pollutant removal benefits.
2. Provides only peak discharge rate control (i.e. prevents increased over bank flooding).
3. Allows for the re-suspension of previously trapped sediment and particulate matter.

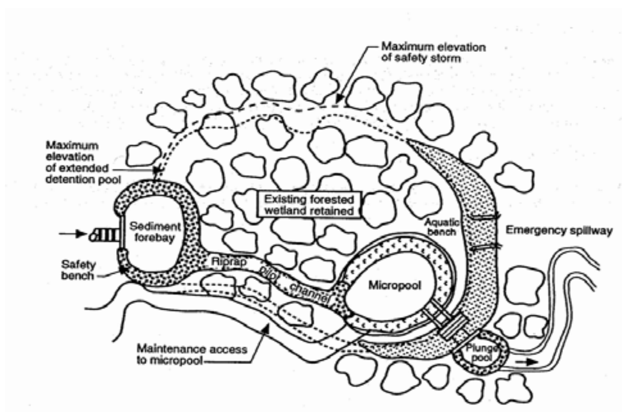


Figure 6-1: Dry Extended Detention Pond (U.S. EPA, 1993)

6.2.b. Wet Detention Ponds

Wet storm water detention ponds are the most effective and most commonly used best management practices for flood control, sedimentation control, and control of numerous pollutants found in storm water runoff. They are reliable and attractive systems that control storm water quality and quantity. They are the most cost effective systems to operate and maintain. These systems consist of single or multiple permanent pools of water or a combination of a single permanent pool of water with a pretreatment sedimentation area. Wet detention ponds treat incoming storm water and discharge improved storm water quality to sensitive receiving water bodies and groundwater recharge areas. Wet detention basins are typically engineered with four to eight feet of standing static water levels, allowing sediments and pollutants to settle out to the bottom of the wet detention pond. Wet detention ponds should have a defined sedimentation basin forebay, and an outlet control structure.

Many studies have shown that wet detention ponds consistently remove sediments and pollutants that attach to sediments. Removal rates can vary from 50 to 90 percent, depending on particle sizes and on the design size and shape of the system. Wet detention ponds can also control pollutants such as heavy metals, phosphorus, and bacteria, but at lower removal rates than sediments. Pollution control rates can vary depending on the construction of the system.

The change from existing to future land use with a constructed wet detention pond will decrease storm water runoff peak rates and decrease water quality pollutant loads. Significant pollutant loadings are apparent due to high-density residential, industrial and commercial developments, and increased presence of motor vehicles. The increase of pollutant loadings will be greatly reduced by the installation of structural controls and enforcement and implementation of non-structural controls. The affect of implementation of the recommended storm water management practices is quite apparent. A wet detention (BMP) pond would store the sediment and pollutants, so a wetland or receiving water body does not get filled in with sediment and the associated habitat does not get altered from excess nutrients or pollutants.

We recommend a 10-15 year sediment clean-out cycle for wet detention ponds. This schedule may need to be revised based on specific site design and field observations. Extra storage in the lower stage can be provided to accommodate additional sediment deposition. To reduce removal costs, we recommend provisions be made for on-site disposal or the local authorities should plan for use of the accumulated sediment at some future date.

Wet detention ponds (Figure 6-2) are one of the most common methods chosen by engineers and developers to handle storm water runoff generated from land development activities. Wet ponds also provide water quality benefits dry detention ponds cannot offer. Additionally, many existing dry storm water ponds can be converted to wet ponds through some minor adjustments to outlet structures and earthwork excavation.

A wet pond is an open pond with the discharge outlet set higher than the bottom of the pond. This BMP is designed to have a permanent pool of water, or dead storage, throughout the year, which is very effective in removing pollutants. The wet pond is constructed to store runoff during and after storms above the permanent pool of water. Wet ponds treat and filter storm water runoff through Stokes Law Settling Theory and through nutrient uptake by plants and other aquatic organisms.

<u>Advantages:</u>

1. Provide for downstream bank erosion protection.
2. Offers water quality and flood control.
3. Most cost-effective and widely used storm water treatment practices.
4. Stores runoff for longer time periods and decreases storm water peak flows.

5. Possible increased property value: The results of one study suggest that "pond front" property can increase the selling price of a new property by 10% (EPA, 1995). Another study found that the perceived value (value estimated by residents of a community) of homes increased by about 15-25% when located near a wet pond (Emmerling-Dinovo, 1995).
6. Pollutant control rates vary depending on the size and shape of the system, but the Wisconsin DNR Storm Water Manual presents these statistics:

Pollutant	% Reduction
Suspended Solids	50-90
Phosphorus	12-79
Nitrogen	6-62
Chemical Oxygen Demand	7-76
Lead	8-84
Copper	7-65
Zinc	13-87

Limitations:

1. Regulations restrict some locations where such ponds can be built.
2. Space requirement.
3. Mosquito breeding area.

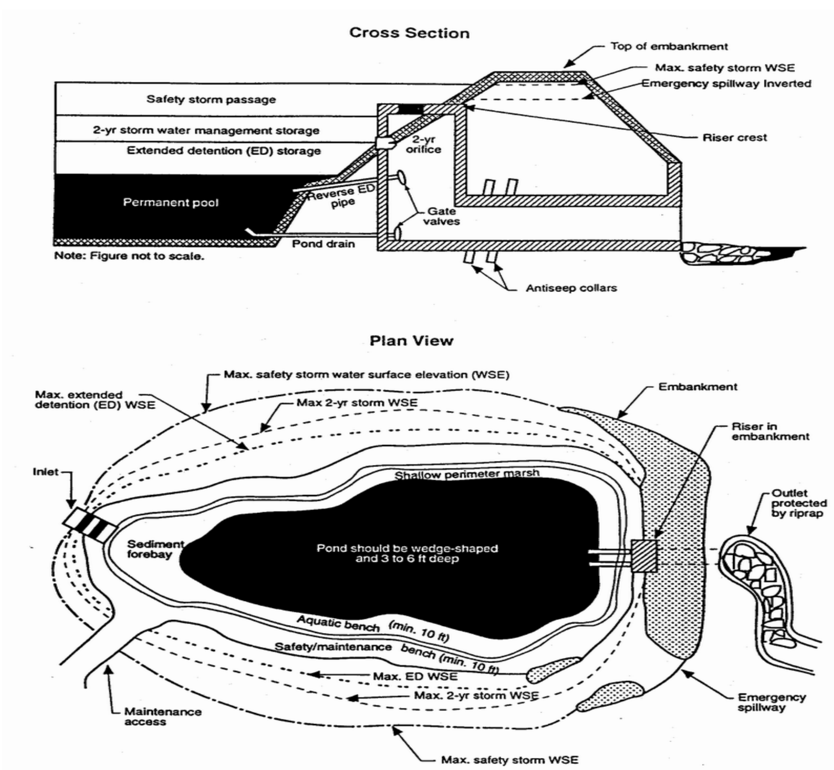


Figure 6-2: Wet Detention Pond

6.3. Constructed Storm Water Wetlands for Treatment

Constructed storm water wetland systems incorporate natural wetland functions to aid in peak flow reductions and pollutant removal from storm water runoff. These BMPs contain shallow pools that enhance growing conditions for marsh plants to maximize pollutant removal. Constructed storm water wetlands can also provide for quantity control of storm water by providing a significant volume storage of ponded water above the permanent pool elevation.

Advantages:

1. Known to effectively remove most pollutants from storm water.
2. Down-stream water quality improvements and peak discharge rate reduction.
3. Reduction in oxygen demanding substances and bacteria from urban runoff.
4. Biological uptake of pollutants by wetland plants.
5. Flood attenuation.
6. Enhancement of vegetation diversity in urban areas.
7. Aesthetic enhancement and valuable addition to communities.
8. Relatively low maintenance costs.
9. Pollutant control rates vary depending on the size and shape of the system, but the Wisconsin DNR StormWater Manual reports the following to generally be true:

Pollutant	% Reduction
Suspended Solids	14-98
Phosphorus	0-97
Nitrogen	23-30
Chemical Oxygen Demand	22-79
Iron	43-92
Lead	68-82
Zinc	34-50

Limitations:

1. Normally not located within natural wetlands.
2. Release of nutrients during large storm events.
3. May contain difficult maintenance of vegetation when flow rates vary.
4. May act as a heat sink and may discharge warmer water to downstream water bodies.
5. Relative high construction costs in comparison to other BMPs.

6.4. Infiltration Facilities

Infiltration facilities are designed to intercept surface runoff and retain it long enough to allow it to enter the underlying soil. Infiltration may be allowed on a case-by-case basis, depending on the soil and water table conditions and elevations of a site. Site-specific soil testing will be required. To help prevent clogging, pretreatment will be required whenever possible and feasible.

6.4.a. Infiltration Basin

Infiltration basins are also called Bioretention Basins (Figure 6-3). These Bioretention Basin BMPs are designed to normally contain the following components: a temporary ponding area, a mulch layer, a sandy or loamy planting soil, the plants, and, where necessary, under drains.

Most bioretention devices are off-line basins designed to infiltrate a portion or all of the flow up to the desired design storm event. However, bioinfiltration swales represent a cross between a biodetention basin and a vegetated swale. They are designed for conveyance as well as infiltration.

Advantages:

1. Groundwater recharge occurs to maintain stream baseflow and colder stream temperatures.
2. Infiltration reduces peak discharges and associated stream bank erosion.
3. Infiltration reduces storm water runoff volume discharges and excess storm water runoff.

Limitations:

1. Limited lifespan.
2. Maintenance in regards to maintaining vegetation cover.
3. Space requirement and suitable soils.

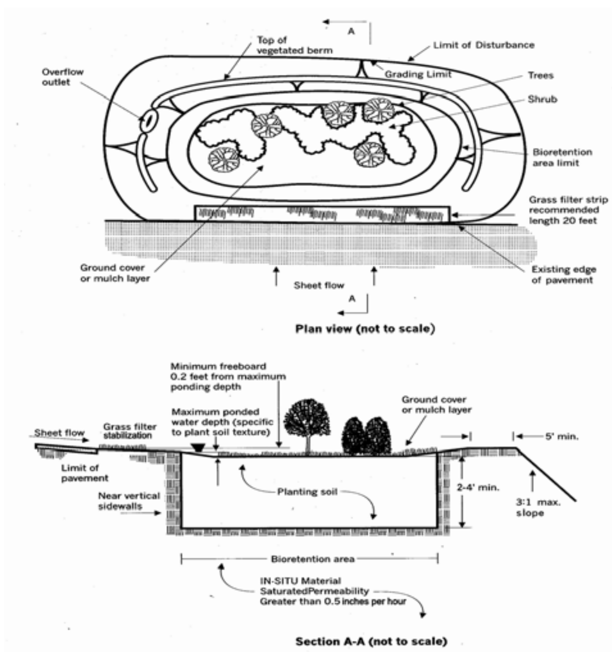


Figure 6-3: Bioretention Facility (EPA 2000)

6.4.b. Infiltration Trenches

Infiltration facilities such as trenches are designed to intercept and reduce direct site surface storm water runoff rates and volume. They hold runoff long enough to allow it to enter the underlying soil. They can include layers of coarse gravel, sand or other filtering media to filter the runoff before it infiltrates the soil.

Infiltration trenches are shallow (three to eight feet deep) and constructed in relatively permeable soils that are backfilled with a sand filter, coarse stone, and lined with filter fabric. The trench surface can be covered with grating and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet. Depending on the design, trenches allow for the partial or total infiltration of storm water runoff into the underlying soil. An alternative design is to install a pipe in the trench and surround it with coarse stone (French drain); this will increase the temporary storage capacity of the trench.

<u>Advantages:</u>

1. Infiltration maintains groundwater recharge, stream bank baseflow, and colder stream temperature.
2. Reduces storm water runoff rates and volume.

<u>Limitations</u>:

1. Trenches do not perform well in cold climates with deep freeze/thaw action.
2. If installed in cold climates, trenches may provide storage for snowmelt.
3. Pretreatment of storm water runoff is needed to prevent clogging and failure.
4. The failure rate is high.
5. Preventing soils compaction during construction is important.
6. Expensive operation, maintenance, and replacement costs.
7. May be considered an injection well if not properly designed.

6.5. Porous Pavement

Being an alternative to conventional pavement, porous pavement is a permeable pavement surface with a stone reservoir underneath. The stored storm water runoff gradually infiltrates into the ground and water table.

<u>Advantages:</u>

1. Maintain groundwater recharge, stream bank baseflow, and colder stream temperature.
2. If sub-soils absorb pollutants, dissolved pollutants may be removed.
3. Used in low traffic areas.

Limitations:

1. Challenge in cold climates.
2. Occasional sweeping or vacuuming of debris will be required to ensure the void spaces do not clog and system fails.
3. Avoid high traffic areas and high contamination sites.

6.6 Street Sweeping

An effective street sweeping program is important because removing debris from gutters and roadsides means less debris goes into storm drains and the waters of the Minocqua-Kawaguesaga Lakes. The Towns' street sweeping program is only part of the solution to addressing storm water runoff pollution. Residents can help by being aware of how their actions can contribute to or help solve the problem. For instance, over watering lawns and washing vehicles can wash pollutants from yards and streets into gutters and storm drains.

Figure 6-4: 3-D Street Sweeper Cutaway View of the Centurion, www.forester.net/sw_0207_street.html

These pollutants include phosphorous, detergents, pesticides, fertilizers, motor oil and yard clippings. Residents who rake leaves and yard clippings into the street make it difficult for crews to remove these potential pollutants.

Advantages:

1. Highly visible educational tool to promote awareness.
2. Mechanical street sweepers can remove almost 70% of large particles in its path.
3. More effective in industrial and commercial areas.

Limitations:

1. High initial cost and long-term maintenance and replacement costs.
2. Labor costs.

6.7. Catch Basin and Maintenance

Catch basin sump capture and removal of sediments from catch basins on a regular basis reduces the potential for pollutant discharges during rain events and thus reduces the potential for conveyance of urban storm water runoff particulates. Cleaning twice a year or more allows the catch basins to capture particulates for most rain events.

6.8. Exotics Management

- Assist Wisconsin DNR with Eurasian Milfoil inspections on the Minocqua-Kawaguesaga Lakes and at boat landings.

- Develop an Aquatic Plant Management Plan to describe problem species and areas of interest.

- Incorporate aquatic invasive species programs in the Aquatic Plant Management Plan.

6.9. Reduce Fertilizer Usage

- Soil test lawns and add only the necessary fertilizers. Implement by ordinance that no or low phosphorous fertilizers can be used in the Minocqua-Kawaguesaga Lakes watershed. Other communities have instituted such an ordinance and local stores only supply this type of fertilizer. For example, Minnesota currently has a 0% phosphorus regulation for the Twin Cities metro area and 3% phosphorus for all greater Minnesota, and Amery, Wisconsin, has an ordinance that does not allow the sale of fertilizer containing phosphorus.

6.10. Monitoring Programs

- Continue an annual water quality monitoring program.

- A proposed USGS study of groundwater should be completed to determine if groundwater contributes phosphorus to the Minocqua-Kawaguesaga Lakes.

- Historic water quality evaluation by conducting a paleolimnologic study. Evaluating historic trends in lake sediment through this research technique can provide insight to past water quality issues. Sediment cores would be taken at strategic locations throughout the lakes. The core samples are then sampled and analyzed for various nutrients, metals, and biological remains (diatoms) to evaluate past water conditions, sedimentation rates, etc.

6.11. Forest Land Management

- Reforestation.

- Follow Wisconsin DNR Forestry Best Management Practices.

- Leave timber on steep slopes.

- When crossing streams and gully areas, build bridges per Wisconsin DNR Forestry Best Management Practices and uphold NR 151 Runoff Management rules.

- If timber is taken from steep slopes or lowland areas, perform this work between January and March to ensure frozen ground.

6.12. Government Partnership and Policies

- As State, County, and Town transportation departments minimize the use of road salt, an increase in sand content is common. They should consider the use of alternative de-icing compounds in areas served by bridges over the Lakes, and related tributaries, swales, etc., boat landings, culverts or storm water outfalls, and other areas of high salt-use. Snow disposal areas should not drain into lakes or streams. State Highway 51 transects the Towns of Hazelhurst, Minocqua and Woodruff; the Wisconsin Department of Transportation should work with the Towns to explore the best method for ensuring safe roads, minimal salt usage, and minimum impact to the Lakes.

- Utility and Highway Corridors:

    a. Proper route selection.

    b. Encourage runoff from roads to be directed to sedimentation traps or water-quality pre-treatment ponds before runoff reaches the lakes.

    c. Require Wisconsin DOT construction contractors to follow Wisconsin DNR NR 151 runoff management ordinances for future construction. Encourage the use of BMP to trap road runoff for pretreatment before entering the Lakes.

    d. Don’t dump sand on the waterfront.

    e. Make docks and boat houses as unobtrusive as possible. Permits are required for many of these structures. Avoiding permanent structures will reduce shoreline alterations, tree cutting, and filling.

    f. Keep dock lighting to a minimum safe level.

- Local emergency officials should be prepared either as first responders or have readily available information to protect ground and surface water resources from spill contamination (i.e. gasoline, etc.). Spill preparedness should include adequate training and equipment, such as containment booms and spill absorbents. Emergency response consultants can assist fire fighters and emergency crews in spill contingency planning.

- As the Towns of Minocqua, Woodruff and Arbor Vitae complete Comprehensive Plans, it is recommended that these local officials adopt the Lake Watershed Management Plan, and any updates or amendments to the Lake Watershed Management Plan, into their Natural Resources section of their Comprehensive Plan.

6.13. Regional Partnerships

- Work with groups and building more partnerships will help implement more BMP practices throughout the Minocqua-Kawaguesaga Lakes watershed. Partnership development with Association/District members in the Lakes and adjoining watersheds is highly encouraged. Partnerships with related Townships and Counties, Natural Resource Conservation Service, UW-Extension, Wisconsin DNR Forestry and Water Quality, and others should be developed.

- Develop local ordinances to help reduce the degradation of the watershed waters from nonpoint source pollution. Ordinances provide the legal frame work for requiring suitable management practices to control nonpoint source pollution. Adopting erosion control and storm water management ordinances (these are Lake Protection grant eligible activities) can specify performance standards, specific BMP, or limit peak runoff flow. In future years, as more land is developed, managing runoff to protect water quality will become increasingly important and the ability to control runoff will be limited if the proper ordinances are not in effect.

- Various Wisconsin communities are using erosion control and storm water management ordinances to regulate pollution prevention for both water quality and water quantity objectives. A comprehensive storm water management ordinance can provide assurance that future growth will not be significantly detrimental to water resources in the lake watershed. To assist in ordinance creation, the Wisconsin DNR has developed model ordinances that can be adopted or used as a starting point in creation of Town’s own ordinance. Ordinances will consider runoff volumes, property size, pollutant loads, etc.

- Financing ordinance administration to avoid over burdening taxpayers is recognized as a major concern in ordinance adoption (Chapter 8). Developing financing alternatives and administrative strategies may reveal acceptable costs for enacting an erosion control and/or storm water management ordinance. The Town should consider retaining the services of an engineer or other professional experienced in storm water management and design, to review new development proposals for compliance with the Town’s ordinance(s).

CHAPTER 7: EDUCATION AND INFORMATION

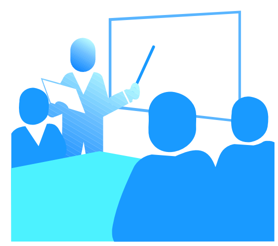
7.1. Importance of Public Involvement

Public involvement is an important aspect of this Plan. If the public does not understand the goals and reasoning behind these recommendations, the chance of sustained action on lake watershed management and protection is reduced dramatically. Simply put, the success of the implementation of the plan recommendations relies on the effort to educate and involve the public on the issues of lake management and protection. The key to improving water quality requires everyone to do their share. Also, a collective voice is more often heard than a single individual.

7.2. Target Audiences

Many different groups need to be targeted in the Education and Information Program for it to be effective. Examples of groups that should be included are:

- Public Officials/Policy Making Bodies
- Local Organizations and Environmental Groups
- Elementary, Middle, High School Students
- Adult Residents
- Business and Industry
- Homebuilders and Developers



Each group has a different view and knowledge level of lake management and protection. Some may be initially against recommendations identified in this plan, as it may result in increased project costs. The goal of this section of the plan is to incorporate all of the different approaches needed to properly address each group and educate them in the importance of lake management and protection and implementation of water quality improvement recommendations.

7.2.a. Public Officials/Policy Making Bodies

Minocqua-Kawaguesaga Lakes Protection Association has held and must continue to conduct presentations regarding the Lake Watershed Management Plan. Continued presentations should be made to the public at County and Town Board meetings. These public meetings are publicly noticed, open to the public, and will educate more residents and public officials in understanding the intent and benefits of the Plan. It may be appropriate to present the basis for the conclusions and recommendations to fully involve all affected parties.

These policy making bodies are encouraged to plan for the future and to adopt control erosion and runoff ordinances. Land owners should be offered the opportunity to attend various water quality information meetings. These meetings would offer a more thorough understanding of the topics, such as:

- The benefits of a lake association or district
- Options for aquatic plant management
- Septic and runoff management
- Lawn care and composting
- Nutrient loading
- The sensitivity of the lake ecosystem to influx of nutrients and sediments
- Involvement of more than just the local government in water quality improvement planning.

7.2.b. Local Organizations and Environmental Groups

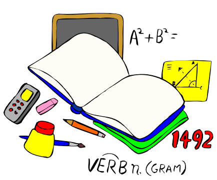
Invite or involve other organizations and environmental groups within the Tomahawk River Watershed to get involved in lake management and protection.

Other groups that have contributed support in the past include:

- Wisconsin Department of Natural Resources
- Oneida County Land Conservation Department
- Vilas County Land Conservation Department
- U.S. Geological Survey
- University of Wisconsin-Extension
- Various Lake and River Groups

The groups have established lines of communication with various other contacts and agencies that can prove beneficial in assisting the Minocqua-Kawaguesaga Lakes Protection Association in achieving its goals.

7.2.c. Elementary, Middle and High School Students



Perhaps the most important audience for promoting an education program is Elementary, Middle, and High School students. These groups can be the most willing to learn about lake management and protection and experience shows that educated students will attempt to educate their parents and develop into education leaders.

Involving youth in water quality education can have long-term benefits to the community and the water resources (surface and groundwater). Local teachers and administrators should be asked how the local project staff can assist them with environmental education.

Teachers could:

- Include lake management and protection practices into their lesson plans (examples are located in Appendix C).

- Plan a visit from a County official, Town official, or other professional to discuss lake management and protection.

- Coordinate a stream monitoring program with MKLPA.

- Utilize available educational programs on water quality to emphasize the need to sustain high quality surface and groundwater.

Students could:

- Participate in a stenciling programs in which “Drains to Lake/River” is painted on storm water inlets in their communities (information located in Appendix C.5).

- Create flyers or posters to be used in a community education campaign.

- Survey their parents and neighbors about their knowledge of lake management and compile the information with their classmates.

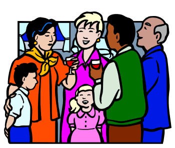
- Write articles or letters to the editor highlighting lake management and protection.

- Assist with long-term lake testing and monitoring and with shore land restoration programs.

Of course, there are countless options available to include students in the education and information phase of the plan implementation recommendations.

We recommend that the Minocqua-Kawaguesaga Lakes Protection Association focus on Elementary, Middle and High School students not only as an audience but also a resource for the education and information program.

7.2.d. Adult Residents



The primary concern of most adult residents will be the costs for implementation. Therefore, the primary information and educational campaign for this group should focus on the benefits of implementation of the recommended improvements, the costs of improvements, and the creative funding sources available. Public service announcements could target messages on various local water quality topics and where to receive assistance.

Methods of informing adult residents would be:

- Letters or Flyers
- Newspaper articles
- Surveys
- Public Meetings
- Seminars
- Demonstration Projects
- Public Service Announcements

7.2.e. Business and Industry

Businesses and industry are excellent locations to post information that will reach a large number of people. It would be incredibly beneficial to post information regarding lake management and protection in a public location with high pedestrian traffic, such as at the lunch room or at the entrance or lobby of any retail or service business. This would expose the information to a large number of individuals without incurring high printing and postage costs.

Some communities have requested sellers of phosphorus-based fertilizer to post a "kind reminder" next to such products informing them of the non-phosphorus-based choices. In the same vein, lawn care professionals can be a good means to distribute information about non-phosphorus-based fertilizers to their customers.

7.2.f. Homebuilders and Developers

Land developers and builders are a principal group that should be targeted for information purposes. Properly designed and maintained erosion control systems are vitally important in managing sediment and nutrient pollution to the Lakes. For instance, a subdivision designed and constructed in strict accordance with erosion control provisions can still be a major source of flooding and sedimentation downstream if erosion control and Best Management Practices are not properly installed and maintained. Homebuilders need to know that silt fence, aggregate tracking pads, and other single site erosion control methods and properly designed and sited Best Management Practices can be relatively inexpensive to install and maintain.

An understanding of the water quality impacts from construction and development sediment and various erosion control methods should be a focus for a "Construction Erosion Control Workshop." Building contractors, landscapers, developers, consultants, zoning officers, and others interested in erosion control should be invited. The Wisconsin DNR and UW-Extension has organized these programs in the past and provide regulatory information. Manufacturer representatives of various erosion control products could be asked to display their products.

Methods of disseminating information to this group of individuals may include:

- Letters/Flyers
- Fact Sheets

- Newspaper articles
- Public Meetings
- Seminars
- Ordinances

We recommend that this group be given the highest priority in the education and information program. Because this group is responsible for a majority of both the problems and solutions to lake management and protection, it is vital to have their cooperation.

CHAPTER 8: WATERSHED WATER QUALITY IMPROVEMENT FINANCING OPTIONS

Financing and funding the recommended storm water management projects has become more complex in recent years. In the past, municipal general funding and special assessments against benefited properties financed most of the necessary improvements. However, the financial options have broadened considerably. The main question is, "Which method(s) best suit the needs of the Minocqua-Kawaguesaga Lakes?"

The major categories of funding sources are:

- Taxation;
- Development Charges;
- Fee-In Lieu of On-Site Detention/Retention;
- Special Assessments;
- Plan Review and Inspection Fees;
- Storm Water Utility;
- Bonding; and,
- Grants.

Listed below are descriptions of funding options which may be available to the Minocqua-Kawaguesaga Lakes and adjacent watershed governments for storm water BMP improvement implementation.

8.1. Taxation

Local governments historically funded storm water management services with Property Tax Revenue.

- The rationale for local government involvement is the public benefit in managing runoff.

Unfortunately, this means storm water expenditures must compete with other local governmental services and, consequently, funding is highly variable. With this disparity, local governing officials often give low priority to maintenance of drainage and water quality infrastructure improvements.

With property taxes as a financing mechanism, equity of funding is a concern. Residential and commercial property owners may be better served under a storm water utility and industrial property owners, in general, are better served under a property tax system. Owners of agriculture land and exempt parcels are better off under the tax system. Exempt property often contributes to storm water issues; however, owners do not pay general property taxes to help offset the cost of BMP improvements.

Advantages	Disadvantages
1. Administrative structure for collection in place. 2. Simple and accepted source of revenue. 3. Allows for a larger revenue base. 4. Through tax districts, contributors pay.	1. No incentive to help reduce runoff or pollution. 2. No direct relationship to level of benefits recovered. 3. Discontinuous source of revenue. 4. Limitations on amount of expenditures due to budget and borrowing constraints. 5. Competition with other Town services (i.e., police, fire, etc.). 6. All users do not pay general property taxes.

8.2. Development Charges

As land is developed or built upon, surface storm water runoff and pollution loading increases. Administrative and capital costs can be recovered at the time of building permit issuance or land development approval. A city, town, or village can require dedication of land for ponding or drainage purposes.

Impact fees are contributions paid by public facility users who create a need for increased capacity in the public facility. These fees are authorized under the requirements of Section 66.617 of Wisconsin State Statutes.

These charges are designed so developers will pay the "fair share" of the cost of constructing on-site and regional storm water management BMP improvements. Storm water management BMP improvements are characteristically designed to last twenty years or more. The requirement that owners of future developed properties enjoy the benefits of the improvements at no incremental cost is often considered inequitable. The use of system development charges can provide important revenue source flexibility.

Advantages	Disadvantages
1. New development generating runoff pays for runoff management. 2. Administrative structure for reviewing plans and collecting fees is in place. 3. Systems can be tailored to the specific needs through regulatory changes. 4. Revenues are applied to water management. No competition with general services.	1. Only addresses problems within vicinity of the new development, not usually existing developments. 2. Only addresses prevention not correction of major problems. 3. Limited usefulness as a long-term financing mechanism for operation and maintenance.

8.3. Fee In Lieu of On-Site Detention/Retention and Other BMPs

In-lieu of fees are a regulatory requirement that provides developers the option to construct on-site detention/retention facilities in accordance with the established design criteria or pay a fee into a fund dedicated to the construction of an off-site detention regional storm water management facility serving multiple properties. The approach encourages the siting and construction of more regional versus on-site facilities. Fee-in-lieu of programs are effective in guiding development patterns within a watershed and are a tool to encourage comprehensive storm water planning.

Fee-in-lieu of procedures have a downside. Since construction timing and cash flow are critical, the usual fee for a single development property may not be large enough to fund the construction of an entire regional facility. Therefore, either multiple developments must occur simultaneously in a given area to generate enough revenue to fund the construction of a regional facility, or the project must be funded up-front from other sources. Service charges and borrowing from other funds can provide the necessary initial resources for construction. These funds can then be repaid by future in-lieu of fees.

8.4. Special Assessments

For over a century, municipalities have used special assessments as a method to finance local improvement projects. Special assessments are flexible and can be used to pay for public improvements such as storm water management facilities. In addition, only properties which benefit from the improvement bear the improvement cost, and the general fund is not further burdened. Therefore, special assessments are useful financial tools for municipalities. Their usefulness has increased as demand continues to grow for each municipal tax dollar.

The use of special assessments to fund storm water management projects often encounters obstacles to its implementation. Typically, the benefit is determined through frontage along the improvements or watershed areas within the improvements. In storm water management, owners of upstream or hillside properties that are major runoff quantity and quality contributors may not understand or comprehend downstream located project BMP benefits, and, therefore, are not supportive of storm water control efforts.

Advantages	Disadvantages
1. Only benefited properties pay. 2. Revenues from assessment are applied to a special project cost. No competition with general services. 3. Benefits directly related to cost for service. 4. Assessments can be deferred in hardship cases.	1. Rigid procedural requirements. 2. Runoff contributions cannot be assessed. 3. Difficult to determine and prove benefit. 4. May place an unfair burden on some segments of the population.

8.5. Plan Review and Inspection Fees

These are intended to recoup the expense of reviewing private development plans to ensure compliance with ordinances and storm water management plans, and to insure that design and construction standards and regulations are met in the field. These fees are not designed to be primary revenue generators. Charges are usually limited to administrative, engineering review, legal, and field inspection costs incurred by the governing agency. Plan review and inspection fees are designed to allocate direct costs back to those receiving the service.

8.6. Storm Water Utility

Over the past years, the concept of creating a storm water utility has become a viable option. The utility approach redefines how people think about runoff and storm water management. A basic premise in the utility approach is that runoff is a man-made problem and property owners are responsible. This approach designates property owners as storm water quantity and quality generators with a government authority controlling these discharges. To finance government activities, property owners pay user charges or fees proportionate to their impervious areas and water quantity and quality pollutant discharges similar to water and sewer services. This utility approach uses the "polluter pays" principal. The American Public Works Association (APWA) concluded:

"The user charge and utility concept are the most dependable and equitable approaches available to local governments for financing storm water management."

Care must be taken when forming utilities. Listed below are steps to consider:

- Document the need for Storm Water Utility Program
- Educate Administrative Staff
- Establish a Steering Committee
- Develop a Public Participation Program
- Develop a Comprehensive Implementation Plan
- Calculate Current Storm Water Program Costs
- Estimate the Storm Water Revenue Needs
- Prioritize Needs and Projects
- Establish a Preliminary Budget
- Create a Rate Structure
- Refine Budget and User Charges
- Prepare a Storm Water Utility and User Charge Ordinance
- Develop a Billing System

Funding mechanisms vary greatly among storm water utilities. In many instances, fees are based on a formula related to impervious surface area as a measure of the amount of runoff that flows from any individual site.

Like any other utility, the rate structure must be established on the basis of need. In some instances, a fee structure for a new storm water utility is established at two points in utility development: A small assessment to fund planning and permit processing start-up and a larger assessment to pay for new capital facilities. In other localities, the decision may be made to fund a project(s) by issuing bonds in order to have the construction money up front. The alternative is to establish a system in which improvements are made by the utility as the funds become available.

In many cases, fees are based on a standard often called an “Equivalent Residential Unit,” or ERU. For instance, each single-family residence can be estimated to cover an approximate square-foot of impervious surface (i.e. 2500 sq. ft = 1 ERU): A commercial or industrial structure actually covering 5,000 sq. ft. would then be equal to 2 ERUs (5,000/2,500) and be assessed a fee two times the single family rate. The utility concept, and especially a charge based on impervious surface or runoff, is a fair way to fund storm water management BMP improvements, operation, and maintenance. Fees are based on the actual use, operation, and maintenance of a public facility rather than on property values.

A storm water utility ensures a dependable, dedicated source of revenue earmarked for storm water management BMP’s operation and maintenance that can be restricted from use for other governmental purposes. A dedicated revenue source also enables governmental entities to issue revenue bonds to help finance the cost of major capital projects. In addition to acting as a financing mechanism, the utility acts as an organizational unit responsible for managing storm water concerns, by allowing a planned, systematic approach to both storm water runoff water quality and quantity management programs.

Advantages	Disadvantages
1. Properties causing or contributing to the need for runoff management pay. 2. Change is directly proportioned to runoff generated by specific class properties. 3. Self-financing system not in competition with general service funds. 4. Existing and new developments both pay. 5. Flexibility in the system. 6. Continuous source of revenues. 7. Specific dedicated fund for surface water management. 8. Administrative structure for collection already in place.	1. Some initial costs in development or rate formula and philosophy. 2. May require an expanded administrative structure and existing staff.

8.7. Bonding

Long term borrowing can effectively finance storm water projects within a municipality. A municipality can use bonding authority to issue long term bonds for storm water systems. A long-term municipal bond is characteristically exempt from federal taxation.

The following are example funding options:

1. <u>G.O. BONDING: General Obligation Bonding</u>

   - The taxes of the community pay off the debt.
   - A community can borrow up to 5% of its equalized value (G.O. capacity).
   - This is long-term debt (over 1 year).

2. <u>"B" BONDS:</u>

   - Paid back by special assessments against property.
   - Does not count against G.O. limit.

3. <u>REVENUE BONDING:</u>

   - Does not count against G.O. limit.
   - Requires a storm water utility to provide revenue.

8.8. Oneida County Cost sharing

Cost-share conservation practices eligible for funding include**:**

- Streambank and Shoreline protection
- Filter Strip
- Critical Area Stabilization
- Well Abandonment
- Wetland Restoration
- Waterway System
- Water and Sediment Basin Control
- Waste Transfer System
- Underground Outlet
- Terrace
- Subsurface Drain
- Sediment Basin
- Roof (for animal lot or manure storage)
- Roof Runoff System
- Relocating or Abandoning Animal Feeding Operations
- Milking Center Waste Control System
- Livestock Watering Facility
- Livestock Fencing
- Manure Storage System
- Manure Storage Abandonment
- Heavy Use Area Protection

- Grade Stabilization Structure
- Field Windbreak
- Diversion
- Cattle Mound
- Access Road or Cattle Crossing
- Direct Technical Assistance on Eligible Practices

The Oneida County Land and Water Conservation Department offers a cost-share program for county landowners. The primary emphasis of the program continues to be to restore native vegetation to shoreland property. However, cost-share program funding is available for other conservation practices. For shoreline restoration projects and other conservation practices including revegetation activities, landowners are reimbursed up to 70% of the costs of planting and purchasing native trees, shrubs, and wildflowers. Interested landowners can contact the Oneida County Land & Water Conservation Department at (715)369-7835 to request an application form for the program. Once an application form has been submitted, a staff member typically contacts you for an on-site visit to discuss specific site concnerns.

8.9. Grants

Historically, local governments have experienced infrastructure funding support from state and federal government agencies in the form of direct grants in aid, interagency loans, and more. It is important to assess likely trends regarding federal/state assistance for storm water management financing. Future trends within our state and national budget indicate that future available funding through the grant process is unknown; it is possible that these funding options could be eliminated due to state and federal budget issues.

The State of Wisconsin has reviewed the need to improve storm water management and water quality need based projects under the Clean Water Fund, which is partially funding this Storm Water Management Plan. The review first led to projects that were under the Clean Water Fund low interest loan program. This program has been used for years to finance projects, such as wastewater treatment plant upgrades.

The State has taken another step forward to improve storm water management and water quality planning by developing the WAC NR 155 Urban Nonpoint Source and Storm Water Construction, Planning and Land Acquisition grant program. Currently, the WDNR is reviewing the WAC NR 216 to update various items, including the list of communities that will need a permit for storm water discharges.

State grants are available to assist in surface water management and abate nonpoint source pollution. However, it is generally not good financial practice to rely totally on grants for a service program. This source of revenue is not dependable and requires constant speculation as to its availability. Grants are useful but should only be used to supplement a planned local revenue source.

Advantages	Disadvantages
1. Reduces cost burden to residents in the community.	1. Undependable source of revenue. 2. Increased administrative costs for securing and managing the funds. 3. Most often grants require cost sharing and thus additional funding source. This results in double administrative costs due to several funding sources. 4. Limited availability on an irregular schedule. 5. Requires application lead time.

Examples of some available grants include:

- **Wisconsin Department of Natural Resources (WDNR)**

  Additional information on the following programs can be found at http://www.dnr.state.wi.us/.

  (1) Wisconsin DNR Lake Grants

  The Wisconsin DNR Lake Grants are influenced by the Wisconsin gas tax revenue. Despite the budgetary changes and cutbacks, the lake grant funding increased from $2.6 to $3.1 million dollars annually.

  a. Aquatic Invasive Species Grants

  The DNR has recently developed (2005) an Aquatic Invasive Species grant program to assist in a state/local partnership to control aquatic invasive species. These grants require a 50% local share match and are available to units of government and lake protection and rehabilitation districts, qualified lake associations, qualified river management organizations, nonprofit conservation organizations, and qualified school districts. Eligible planning project activities include:

  - Education, Prevention, and Planning
  - Early Detection and Rapid Response to control the spread of aquatic invasive species
  - Controlling Established Infestations
  - Watercraft inspections
  - Investigation of control methods or prevention techniques.

  b. Lake Planning Grants

  Lake planning grants provide funding for the lake management planning process. Qualified applicants are Wisconsin counties, towns, villages, cities, qualified lake associations, town sanitary districts, lake districts, other governmental units as defined in Ch. 66.299, Wisconsin Statutes, tribal units of government, qualified nonprofit conservation organizations. These grants are offered twice annually (February 1 and August 1) for extensive studies and technical planning and there are large and small scale grants.

- Small scale lake planning grants of up to $3,000 are available for obtaining and disseminating basic lake information, conducting education projects, and developing management goals. These grants are ideal for applicants who are just beginning the planning process, education processes, or for activities that supplement an existing plan.

- Large scale lake planning grants up to $10,000 per project (maximum 2 projects per application cycle) are available for larger projects. The intent of a large-scale program is to conduct technical studies to help develop elements of or complete comprehensive management plans.

- The WDNR typically pays for 75% of the projects costs through grant cost share payments not to exceed $10,000 and the applicant local share is 25% (up to $3,333). These are competitive grants as they are typically over subscribed.

c. Lake Protection and Classification Grants

Lake protection grants provide funding for implementing the recommendations of a management plan. As one progresses from planning to implementation, the costs and the time involved increases. Because implementation is more expensive, protection grants are available for up to $200,000 per project, except that grants for regulation or ordinance development projects are limited to $50,000.

Grants are based on 75% of the total eligible project costs and capped at the maximum grant amount mentioned earlier. Grants are awarded annually and a priority project list is prepared each year on a state-wide basis. The grant deadline is May 1.

Activities that are acceptable for funding include purchasing property or easements which contribute to the protection or improvement of the natural ecosystem and water quality of a lake; restoring wetlands or lands draining to wetlands; and developing regulations and ordinances to protect lakes (stormwater and construction site erosion control) and the educational activities necessary for these regulations to be implemented.

(2) Runoff Management Grants

The WDNR recently completed rule-making and major revisions to a number of Wisconsin Administrative Natural Resource codes to protect and improve the quality of Wisconsin's surface waters. The new and revised codes put into place a system to control pollution of surface waters from nonpoint sources in Wisconsin. A point source is defined as an end of pipe discharge into a surface water, where as, a nonpoint source is one that has no single discharge point into a storm water collection system or into a surface water.

The DNR offers financial assistance for local efforts to control nonpoint source pollution. These grants support both the implementation of source-area controls to prevent runoff contamination and the installation of treatment systems to remove pollutants from runoff. The main goal of these nonpoint grants is to improve the quality of Wisconsin's water resources by decreasing the impacts of nonpoint pollution. These grants are as follows:

- **NR 153 Targeted Runoff Management (TRM) Grant Program**

  TRM grants are competitive financial awards to support small-scale, short-term projects that are completed by local governmental units within 24 months of the start of the grant period. Both urban and rural projects can be funded through a TRM Grant.

  Several million dollars each year are available to assist local units of government in controlling runoff pollution as targeted and nonpoint source runoff management grant. Dependent on eligibility of a project, the maximum cost-share rate available to TRM grant recipients is 70% of eligible costs, with the total of state funding not to exceed $150,000 in state funding.

  Project selection is competitive and is scored based on fiscal accountability, water quality priorities, local support, pollution control, and other factors. Some examples include: easements, land acquisitions, stream bank protection projects, wetland construction, detention ponds, design of BMP projects for construction, some cropland protection, livestock waste management practices, and other practices eligible for funding are listed under ch. NR 153 and s. NR 154.04, Wis. Adm. Code. Effective 2005, selected engineering design of structural practices will be eligible for cost sharing and be reimbursable. Land acquisition and design can be reimbursed retroactive after design and parcel appraisal approval by DNR.

- **NR 155 Urban Nonpoint Source Water Pollution Abatement and Storm Water Management Grant Program**

Urban Nonpoint Source and Storm Water Grants promote urban runoff management for existing urban areas, developing urban areas and urban re-development.

The primary goals include implementing urban runoff performance standards from WAC NR 151, achieving water quality standards, protecting ground water, minimizing flooding, and helping municipalities meet municipal storm water permit conditions.

Eligible projects include storm water detention pond construction, urban stream bank stabilization and land acquisition to increase permeable areas for infiltration. Urban Nonpoint Source Grants can fund 70% of technical assistance, while other cost-share funds are available at 50% of the project cost. The maximum that can be granted for a construction project is $150,000. The maximum that can be granted for a technical assistance project is $100,000.

An urban area meets one of these criteria:

- Has a population density of at least 1,000 people per square mile;
- Has a commercial land use;
- Is the non-permitted portion of a privately owned industrial site; or,
- Is a municipally owned industrial site (regardless of NR 216).

For a storm water planning project to be eligible for funding under this program:

- It must currently be an urban area, or
- Is projected to be urban within 20 years.

(3) Wisconsin River Protection Grants

The Wisconsin River Protection grants are referenced under Chapter 281.70 State Statutes and under WAC NR 195. Approximately $300,000 was available for annual appropriation in 2003 and is generated from the Wisconsin gas tax. Communities and nonprofit groups can receive state financial help to protect rivers under a project that aims to prevent water quality, fisheries habitat, and natural beauty from deteriorating as homes, recreation, industry, and other land uses increase along rivers. Ineligible projects include: dam repair and operations, purchase of property on which a dam is located unless for the purpose of dam removal, dredging, design, installation, operation or maintenance of sanitary sewers, treatment plants, or onsite sewerage systems, and others listed in application.

(4) River Planning Grants

A maximum of $10,000 is available for eligible river planning grant projects. Up to 75% of the project may be reimbursed by the State. The following are eligible activities under the river planning grant program:

- River Organization Development
- Information and Education
- Assessment of Water Quality, Habitat, Use, Watersheds, and Shorelands
- Data Collecting
- Ordinance Development
- Plans and Strategies

(5) River Management Grants

A maximum of $50,000 is available for eligible river management grant projects. Up to 75% of the project may be reimbursed as State Share. The following are eligible activities under the river management grant program:

- Acquisition and Easements
- Habitat Restoration
- Pollution control practices
- Ordinance Development
- Activities in Approved Plans

(6) Recreational Boating Facilities Grant Program

The WDNR Recreational Boating Facilities Program is a 50/50 grant program. Grant funds can be used for boat landings/docks, sanitary facilities, parking lots, basic landscaping, and security lighting. Repairing an existing ramp is eligible, however, not very competitive with other grant applications. A major scoring criteria in this program is introducing handicap accessibility. A boat landing (new or repaired) would require a handicap accessible dock and paced access to the dock from the parking lot. Applications are due quarterly.

(7) Stewardship Grant Program

The WDNR provides funding for stewardship projects such as the following:

- Land acquisition
- Trails
- Restrooms
- Parking lots
- Picnic areas
- Handicap accessibility modifications

Application deadline is May 1 each year. Grants are extremely competitive. The WDNR uses a detailed point system to fund the project and land acquisition projects score the highest. Land acquisitions involve the following:

- An acquisition brochure must be given out at the first contact with the land owner.
- An appraisal is required by WDNR.
- If the grant is awarded, WDNR will pay on-half of the appraisal value.

- **Young Wisconsin Conservationist Program of the Izaak Walton League**

The Wisconsin Division of the Izaak Walton League has developed a program to encourage and assist K-12 school classes and organizations to carry out environmental and conservation activities. Up to $200/project is available for worthwhile projects.

These funds may be used for a variety of purposes so long as they are legitimate expenses in getting a project completed. For instance, the funds could be used to purchase equipment and supplies, for travel to get to project locations, and even for food to provide lunch for projects that take more than 4 hours to complete. However, the project must be a hands-on project that will benefit the environment. Field trips will not be funded unless the students are accomplishing a worthwhile project.

- **National Science Teachers Association**

Over the past 12 years, the Toyota TAPESTRY grant program, sponsored by Toyota Motor Sales, U.S.A., Inc. and administered by the National Science Teachers Association, has awarded 552 grants totaling over $5 million to teachers in the United States and U.S. Territories. This year, 50 grants of up to $10,000 each and a minimum of 20 "mini-grants" of $2,500 each are available to K-12 teachers of science. To apply for funding, qualified teachers must write a Toyota TAPESTRY proposal and submit it for receipt at NSTA.

Open to K-12 teachers of science residing in the United States or U.S. territories or possessions. All middle and high school science teachers and elementary teachers who teach some science in the classroom are eligible. "Science teacher" is defined as anyone who spends at least 50% of his/her classroom time teaching science or teaches a minimum of two science classes per day. Elementary teachers who teach science in a self-contained classroom setting or as teaching specialists are eligible.

Proposals must describe a project including its potential impact on students, and a budget up to $10,000 (up to $2,500 for mini-grants). Toyota TAPESTRY grants will be awarded in three categories:

- Environmental Science Education
- Physical Science Applications
- Literacy and Science Education

- **State Land Trusts and Stewardship Programs**

  This voluntary program includes a stream bank component and an urban river component. Funds are available to public entities and provide non-profit organizations for property purchases from willing sellers, fencing, easements and public fishing areas.

  To date, Wisconsin's land trusts have been awarded $25 million in matching funds through the Warren Knowles-Gaylord Nelson Stewardship Fund. These funds have been matched dollar-for-dollar in federal and private funds and land donations from landowners. In addition, land trusts take on the permanent management responsibility of these lands and each project has clear public support in the community.

  For more information contact the West Wisconsin Land Trust by phone at (715) 235-8850.

- **River Country Resource Conservation & Development Council, Inc. (RC & D)**

  The council is a non-profit organization representing 12 counties in rural development issues. It consists of one individual from each county board and one at-large member. The council receives funding from a base grant from the USDA, however being a non-profit organization, RC & D is able to obtain monies from other grant sources. RC & D has limited matching funds available for erosion control projects. Most often these monies are administered through the county Soil and Water Conservation District. The team is currently focused on assisting the implementation of buffer strips to aid in erosion control projects.

- **Wisconsin Environmental Education Board (WEEB)**

  The Wisconsin Environmental Education Board (WEEB) was created by 1989 Act 299, becoming law in 1990. One of the Board's responsibilities is to award grants for the development, dissemination, and implementation of environmental education programs.

  Since 1997, when the WEEB was transferred from the Department of Public Instruction to the UW-System, the WEEB has distributed $2.6 million to 246 projects. During this time period, 547 applications were received requesting over $6.4 million. The funded projects have generated well beyond the 25% match required. In fact the matching totals over $2.8 million.

  > Funded projects have included state-wide initiatives as well as small localized efforts. Audiences served include K-12 public and private school children, members of various youth organizations, classroom teachers and other educators, landowners, park patrons, tourists, and of course the public.
  >
  > During the 2004-2005 grant cycle the WEEB anticipates allocating funds in five categories:

- WEEB identified initiatives
- General environmental education grants
- Forestry education grants
- School forest grants
- Mini-grants

- **U.S. Environmental Protection Agency (EPA)**

(1) 104(3)(b) – NPDES Grant

The EPA's 104(3)(b) Grant Program is targeted at water quality improvements in urban areas. The grant (previous 604b and 205j) is not a cost share program, but does require local participation. The grant is generally administered through the state.

(2) Environmental Education Grant

EPA's Office of Environmental Education supports environmental education projects that enhance the public's awareness, knowledge, and skills to make informed decisions that affect environmental quality. Since 1992, EPA has received between $2 and $3 million in grant funding per year and has awarded over 2,500 grants. Grants of $25,000 or less in federal funds are awarded in EPA's ten regional offices, and grants over $25,000 are awarded at EPA Headquarters in Washington, D.C.

Grantees must provide non-Federal matching funds of at least 25% of the total cost of the grant project. This may be cash or in-kind contributions. Colleges, universities, local and tribal education agencies, state education, environmental agencies, not-for-profit organizations, and non-commercial educational broadcasting entities are eligible to apply.

(3) Section 319 – Clean Water Act

Funding through EPA's Section 319 program supports priority watershed projects but is also available for urban BMP and project implementation coordination.

The grants program has a spring application period (May to June). The program is significant in that it funds implementation (i.e. construction) rather than planning efforts or studies. The funds are available as either full or matching funds.

- **U.S. Army Corps of Engineers (COE)**

(1) Section 22 Planning Assistance to States Programs

Funds are a 50/50 cost share. The program is administered through state planning (WDNR-Madison). Eligible projects are given to the COE to prepare a cost estimate which is negotiated with the "customer." The "customer" provides 50% cost share in the form of cash. The COE then completes the preliminary design or study.

- **Upper Mississippi River Basin Association**

  (1) Environmental Management Program (EMP)

  This policy and legislative group provides funding directly to COE for habitat projects. The WDNR suggests to the COE how the dollars should be spent on projects. EMP program applies when habitat issues can be linked to projects.

  (2) McKnight Foundation

  The McKnight Foundation provides funding for projects and programs that directly relate to the health of the Mississippi River.

- **Wallop-Breaux Funds**

  The Wallop-Breaux program refers to the 1984 amendments to the Dingell-Johnson program and named for its primary sponsors, Senator Malcolm Wallop (R-WY) and Senator John Breaux (D-LA). Its formal name is the Aquatic Resources Trust Fund, of which part is used for sport fishing enhancement ($215.3 million, in 1992) and part is used for boating safety in each state ($70 million, in 1992). Wallop-Breaux is an example of a user-pays/user-benefits program, where taxes on activity are strictly reinvested back into the activity's maintenance.

  To obtain Wallop-Breaux funds, a state sends a proposal to the U. S. Fish and Wildlife Service office in its region. The project must be "substantial in character and design," but there is no requirement that the project directly benefits sport fishermen. In 1991, 32.4% went to surveys and research. The balance is used for various special projects.

- **Fishing Organizations (i.e., Trout Unlimited, Sport Fishing Congress, etc.)**

- **FEMA Funds**

  (1) Funding to re-map floodplains is available through FEMA, but funding is limited.

  (2) If an area has been declared for emergency assistance through FEMA, the representatives will assist the communities through the special 406 Hazard Mitigation Funds.

- **Economic Development Grants**

(1) TEA: Transportation and Economic Development Assistance (State of Wisconsin Department of Transportation)

- Must have a business creating or retaining jobs.
- Storm sewer improvements.
- 50% State funds; 50% community funds.

(2) Tax Incremental Financing

- Storm sewer projects are TIF eligible expenses within existing districts.

(3) CDBG-PFED: Community Development Block Grant-Public Facilities for Economic Development (State of Wisconsin Department of Commerce)

- A grant to the community of up to 75% for infrastructure to accommodate a new or expanding business.
- Maximum of $500,000.
- The business investment must equal the PFED funding.
- There are job creation requirements.

- **Public Facilities**

(1) CDBG: Community Development Block Grant program (administered by the Department of Commerce)

- Grant funds to construct storm sewer projects.
- Application deadline: continuous funding cycle. Pre-application is required.
- Community survey may be required.
- Low-to-moderate income requirements.
- Community usually provides 60%; the remainder of the cost is a grant.
- Competitive grant.

CHAPTER 9: RECOMMENDATIONS

9.1. Existing and Future Conditions

The Towns of Woodruff and Minocqua are fortunate in that the existing storm water conveyance and management facilities are currently adequate as there are relatively few areas where persistent problems have been noted. However, the conveyance system may be adequate for water quantity; the degradation observed in the lake water quality suggests more could be done to protect lake water quality. And, as surrounding areas are developed the Towns must proceed with caution. Due to the topography of the Minocqua-Kawaguesaga Lakes Watershed, large areas of the community currently do not have a positive drainage outlet. Future plans to develop in these areas will pressure the Towns into one of two options:

1. Limit density of proposed developments by requiring complete retention of all storm events (i.e., pre-development outlet = zero, therefore post-development outlet = zero).

2. Commit to potentially high capital cost regional retention facilities outside of the proposed development(s).

Development without proper consideration of watershed management and planning should be avoided. Typically, it is more cost effective to address storm water issues during initial development rather than later on when problems may be compounded and space is limited.

As currently undeveloped lands begin to develop, storm water runoff quantity will increase substantially. Figure 4-28 presents a map of existing land uses. Figure 4-29 presents a map of future land uses. As a result, the Towns must plan for regional detention facilities and other BMPs on the outskirts of the existing developed areas to attenuate peak flow events and address pollutant loads. Without such facilities, existing storm water quantity conveyance structures, i.e. swales, storm sewers or culverts, will inevitably be overloaded beyond their capacity. As part of this Watershed Management Plan, the Towns have preliminarily sized the recommended regional detention facilities to reduce the 100-year post-development peak flow event to the 10-year pre-development peak flow. This allows future 100-year events to be conveyed by the existing storm water conveyance system (which is designed for the 10- to 25-year storm) without surcharging. In areas where storm water is handled primarily by retention/infiltration ponds, future growth will likely precipitate the need for additional and larger retention facilities. Retention, as opposed to detention, is used where there is no positive outlet to the pond. Retention ponds are sized conservatively to hold two back-to-back 100-year events. Discharge is accomplished by infiltration alone.

9.2. Sources of Pollutants

The P8 Urban Catchment Water Quality Model was used to predict the amounts of several pollutant constituents for all areas within the Watershed study area. Tables 5-7 to 5-12 indicate the pollutant removals in the current and future land use conditions. There is one table per pollutant, TSS, Phosphorus, Nitrogen, Lead, Copper and Zinc. Each table lists “Existing Pollutant Load with Existing BMPs”, “Future TSS Load without BMPs” and “Future TSS Load with all BMPs”. Included in the “Future TSS Load with all BMPs” are pollutants removed with Regional BMPs, New Development BMPs, BMPs around wetlands and closed depressions and pollutants trapped in wetlands and closed depressions. Most of the proposed BMPs will be constructed by developers as new development occurs, to comply with the proposed Storm Water Ordinance. Please note that 1) the exact order and size of development BMPs depend entirely upon growth rate and 2) the discretion of individual developers. The requirements for these future development areas are clearly set forth in the Storm Water Management Ordinance.

In developing areas, as part of this Storm Water Management Plan, the Towns have proposed water quality discharge reductions in Total Suspended Solids (TSS) in accordance with DNR regulations. The Towns have proposed that new developments reduce TSS by 80%; redevelopments and in-fill developments will be required to reduce TSS by 40%. An added benefit of the proposed large regional storm water management facilities is that water quality measures can be incorporated into land that is already reserved for quantity control use. In some instances, where land is scarce or conditions eliminate the possibility of water quality ponds, water quality pre-treatment boxes or sub-surface systems are proposed to be used to treat storm water.

Chapter 5, Section 2 presents a more thorough assessment of the storm water quality modeling procedures and results.

9.3. Goal Setting

Numerous recommendations have been made throughout this text. The listing below summarizes the recommendations and is prefaced by the page reference for additional information.

1) page 5-4: - *provisions be made to provide or preserve overland drainage routes for emergency storm water runoff overflows.*
2) Page 5-6: - *detailed storm sewer calculations should be provided at the time individual subdivision and site plans are engineered and street improvement plans are prepared.*
3) Page 5-6: - *for safety reasons, the maximum depth of water in local streets should not exceed one foot at the deepest point, 6 inches deep in collector streets, and the lowest exposed building elevation should be at least 24 inches above the high water level.*
4) Page 5-7: - *storm water* i*nlets should be placed to eliminate overland flow in excess of 400 feet or 5 cfs for a 10-year event.*
5) Page 5-8: - *open prairie grass conveyance channels are recommended where practical and feasible in lieu of storm sewer pipes to attenuate the storm water flow*

and increase ground water recharge by maximizing the portion of runoff that infiltrates into the soil.

6) Page 5-8: - *concrete or rip-rap lined channels are not recommend because water quality benefits are not available with lined channels.*
7) Page 5-8: - *sanitary sewer manholes located near low lying and ponding areas be designed at or above 100-year high water levels where feasible*.
8) Page 5-8: - *all recently constructed sanitary sewer manholes in vicinity of low lying and ponding areas and open channels be waterproofed.*
9) Page 5-8: - *consider, where feasible, that all detention ponds be designed to store the 100-year post-development storm event and discharge at the 10-year pre-development runoff rate*
10) Page 5-9: - *detention storage facilities be designed to limit the design outflow to no more than the capacity of the existing downstream conveyance and storage systems.*
11) Page 5-9: - *outlets be planned and designed for all existing detention pond areas to mimic pre-development conditions.*
12) Page 5-9: - *the design storm interval for wet detention pond design should be for storms up to and including the 100-year 24-hour storm event.*
13) Page 5-10: - *that the lowest exposed elevations of structures adjacent to wet detention ponds should be reviewed and approved by the appropriate governing agency prior to basement and structure exposure construction.*
14) Page 5-10: - *all developed land areas should have positive drainage conveyance to detention ponds.*
15) Page 5-10: - *wet detention ponds be designed for rate control for all storm events at pre-development rates and storm events greater than 10-year storm event be controlled at 10-year pre-development runoff rates.*
16) Page 5-10: - *the initial detention pond and outlet structures be designed and located in such a manner that will minimize operation and maintenance costs and allow proper access for maintenance.*
17) Page 5-11: - *existing residential areas and proposed commercial areas, industrial areas and gas station-type establishments should provide individual on-site containment and storm water runoff pre-treatment systems, or pre-engineered proprietary devices*
18) Page 5-13: - *to promote sediment and pollutant settling and provide space for sediment accumulation, the mean depth of the permanent pool volume should be greater than or equal to four feet.*
19) Page 5-13: - *For safety purposes and to provide suitable habitat for rooted aquatic plants, the bench width (littoral shelf) should be at least ten feet and the bench slope should not be greater than 10:1 at a point 2 feet below normal design static water elevation.*
20) Page 5-14: - *all pond types should be reevaluated during final development engineering and design when all factors affecting runoff, water quality, storage, seepage, land costs, and operation and maintenance costs of the pond have been determined.*
21) Page 5-16: - *recommended elevations for the construction of a park and trail system around and within storm water detention ponds*
22) Page 5-16: - *infiltration is used to the maximum extent practical*

23) Page 5-25: - the *Towns of Minocqua and Woodruff carefully review storm water management designs in areas that currently are completely infiltrated.*
24) Page 5-26: - *a sediment removal structure must be regularly maintained if it is to remain effective*
25) Page 5-27: - *the primary treatment methods for the Minocqua-Kawaguesaga Lakes Watershed storm water runoff are wet detention ponds.*
26) Page 5-28: - *BMP surface areas and mean depths be provided in order to achieve the estimated removal efficiencies of 80% Total Suspended Solids (TSS) removals for new development and 40% TSS removals for redevelopment.*
27) Page 5-34: - *illicit discharges be investigated and utility personnel monitor storm sewer outfalls periodically during dry weather periods*
28) Page 6-3: - *that best management practices be implemented to address pollutant loadings and flood control within the Minocqua-Kawaguesaga Lakes Watershed. Recommended BMP's follow page 6-3.*
29) Page 7-3: - *the Minocqua-Kawaguesaga Lakes Protection Association focus on Elementary, Middle and High School students not only as an audience but also a resource for the education and information program.*
30) Page 7-5: - *homebuilders and developers be given the highest priority in the education and information program*

9.3.a. Recommendations – Short-Term Goals

Implementation of Non-Structural BMPs – Year 2006 - 2010:

- Adopt Proposed Storm Water Management Ordinance and Update Erosion Control Ordinance. The most effective actions that the Towns can take in regards to storm water management are the adoption of the proposed Storm Water Management Ordinance and updating the Erosion Control Ordinance. Enforcement of these ordinances shares the burden of storm water management with developers.

- Maintain existing BMPs. Two Stormceptors and one Multi-Chambered Treatment Train (MCTT) are installed on the Minocqua island. These devices require maintenance to perform satisfactorily. A maintenance schedule should be implemented so that proper functioning of these devices is ensured at all times. The *Stormceptor* requires a full pump-out at least once a year, regular inspections, and should be cleaned out when accumulation reaches 15% of the operating storage volume. Cleanout is done using a vactor truck and a high pressure hose to clean the manhole. The maintenance requirements for the *MCTT* are to inspect, clean the catch basin, and renew sorbent pillows every 6 months, and to replace the sand/peat filter media every 3-5 years.

- Private Housekeeping Program. Encourage residents to implement local BMPs like Rain gardens, Swales etc. on their property by offering an amount taken off their taxes for active BMPs that improve Lake Water quality.

- Street Sweeping. Conduct an evaluation of existing street sweeping practices and develop a schedule to target the three sub-watersheds that are the largest contributors to the Total Suspended Solids (N, R, and UYZ) and other commercial and industrial areas. Studies show that street sweeping once a month is very effective at reducing pollutant levels in storm water runoff. Industrial and commercial areas are best targeted because of the relatively high traffic counts and percentage of heavy vehicles using streets in those areas. Historically, the effectiveness of street sweeping has been greatly limited by the need to drive around parked vehicles. Early morning street sweeping or limiting parking to certain areas on different days (such as parking is limited in some areas for snow plowing) can help avoid this problem. All other downtown areas should be swept a minimum of twice per year, once in the spring and once in the fall.

- Require Parking Lot Sweeping. Provides some water quality improvement; however, this non-structural BMP can be very effective as an educational tool, as large retail areas are very visible to residents.

- Increase Frequency of Curbside Pickup of Lawn Debris. Curbside pickup reduces the amount of organic material in the curb line. This increases the effectiveness of downstream structural BMPs and non-structural BMPs (such as street sweeping) because the amount of large organic particles is drastically reduced.

- Consider Limitations on Phosphorus-Based Fertilizers. Many communities now require a soil test before allowing phosphorous-based fertilizers to be used. Most tests performed in such communities reveal that soil concentrations of phosphorus are already higher than is recommended by lawn keeping organizations. Phosphorous limiting fertilizer would apply only to lawn fertilizer on established lawns. Some communities in the Minneapolis-St. Paul metropolitan area and in western Wisconsin (i.e., City of Amery) have banned the sale of phosphorus-based fertilizer or require that phosphorus content does not exceed 1%.

- Provide Public Education and Information to Residents. Methods may range from pamphlets sent with water bills to stencils such as "Drains to River" at all storm sewer inlets. Chapter 7 has more information about this particular topic.

- Storm Water Management Plan Updates. Update every 3-5 years.

- **Implementation of Structural BMPs:**

See Figure 9-1 for a map of BMP locations. The numbering of the BMPs below corresponds to the numbering on Figure 9-1. Please note that the majority of the BMPs shown on Figure 9-1 are New Development BMPs that will be installed by the developers.

1. Box Treatment System - Milwaukee Street
Location: Western part of Milwaukee Street
Target: Water Quality

Notes: The current storm sewer conveys runoff to Minocqua Lake without treatment from the Western part of Milwaukee Street. A Box Treatment System would reduce the pollutant loading to the Lake.

2. Box Treatment System – Chicago Street
Location: Western part of Chicago Street
Target: Water Quality
Notes: Storm sewer drains runoff into Minocqua Lake without treatment from the Western part of Chicago Avenue. A Box Treatment System would reduce the pollutant loading to the Lake.

3. Box Treatment System – Oneida Street and Chippewa Street
Location: Southern part of Oneida Street and Chippewa Street
Target: Water Quality
Notes: Storm sewer drains runoff into Minocqua Lake without treatment from the Southern part of Oneida Street and Chippewa Street. A Box Treatment System would reduce the pollutant loading to the Lake.

4/5. Box Treatment Systems – Wetland East of Hwy 51
Location: Wetland East of Highway 51 and West of Hansen Road
Target: Water Quality
Notes: Large quantities of storm water drains into this wetland from two storm sewer outlets. Box Treatment Systems would reduce runoff pollutants before reaching the wetland.

6/7. Box Treatment Systems – Bullhead Lake
Location: Highway 70 storm sewer outlets to Bullhead Lake
Target: Water Quality
Notes: Box Treatment systems can be used to treat runoff from the two Highway 70 storm sewer outlets before reaching Bullhead Lake.

9.3.b. Recommendations – Long-Term Goals – Year 2011 - 2026

8. Installation of proposed BMPs for new development areas.
Location: Multiple
Watershed: Multiple
Target: Quantity Control and Water Quality

Notes:

- A majority of the BMPs evaluated for this study were located in currently undeveloped areas that are projected to develop within twenty years. As such, as developers or land owners approach the Towns for the various approvals necessary to develop, the Towns should continually address the need to set aside land for the construction of these regional BMPs. Because it is unknown at this time the rate or sequence of development of these areas, all new development BMPs have been grouped into this item. Please refer to Figure 9-1 for approximate future locations of New Development BMPs.

- The Towns of Woodruff and Minocqua and the Minocqua-Kawaguesaga Lakes Protection Association have a variety of storm water financing options listed and described in Chapter 8. The new proposed Township Storm Water Management Ordinance will require developers to pay for storm water BMP implementations on their development property prior to acceptance and approval of the new development project by the Townships. The Townships do not intend to use general revenue funds to pay for any newly proposed BMPs for new developed areas. Thus, the proposed regional BMP sites may require creative developer agreements.

9. Construct Wet Detention Facility at Highway 47
Location: Ditch between Highway 47 and Thrall Road
Target: Quantity Control and Water Quality
Notes: The ditch can be made into a Wet Detention Facility that will reduce pollutants and storm water runoff peaks.

10. Construct Wet Detention Facility at Highway 70

Location: Highway 70 storm water outlet by Old Highway 70 Road intersection
Target: Quantity Control and Water Quality
Notes: A Wet Detention Facility can be used to treat and detain storm water runoff.

11. Construct Wet Detention Facility in the Sallet Drive area.
Location: Area around Sallet Drive
Target: Quantity Control and Water Quality
Notes: This area has high future growth potential. A Wet Detention Facility in this area will reduce pollutants and storm water runoff peaks before reaching Minocqua Lake.

12. Construct Wet Detention Facility – Huber Drive / Brown Court
Location: Area Southeast of downtown Woodruff – Huber Drive / Brown Court
Target: Quantity Control and Water Quality
Notes: This area has high future growth potential. A Wet Detention Facility in this area will reduce pollutants and storm water runoff peaks before reaching the wetland.

9.3.c. Recommendations – Timeline

We recommend that the proposed improvements as stated above be implemented according to the following schedule:

<u>Years 2006-2010</u>

- Implementation of non-structural BMPs.
- Install Box Treatment systems at the following storm sewer outlets locations:
    - Milwaukee Street

- Chicago Street
- Oneida Street / Chippewa Street
- Wetland east of Highway 51 and West of Hansen Road (two outlets)
- Highway 70 outlets to Bullhead Lake (two outlets)

<u>Years 2011-2026</u>

- Construct Wet Detention Facility at Highway 47
- Construct Wet Detention Facility at Highway 70
- Installation of BMPs for new development areas.
- Update Storm Water Management Plan.

9.4. Engineering Feasibility

The recommendations presented will require detailed full engineering and design and permitting at such a date that the Towns wish to implement the individual recommendations. The exact locations of structural BMPs have not been determined at this time. Many issues will affect the actual constructed size and location of each BMP, including but not limited to land acquisition, site suitability, public input, maintenance, access, and regulatory issues. The information herein can only be described as "planning-level" and must be verified at the time of detailed full engineering and design. Non-structural recommendations may require further individual study prior to implementation.

9.5. Implementation Recommendations

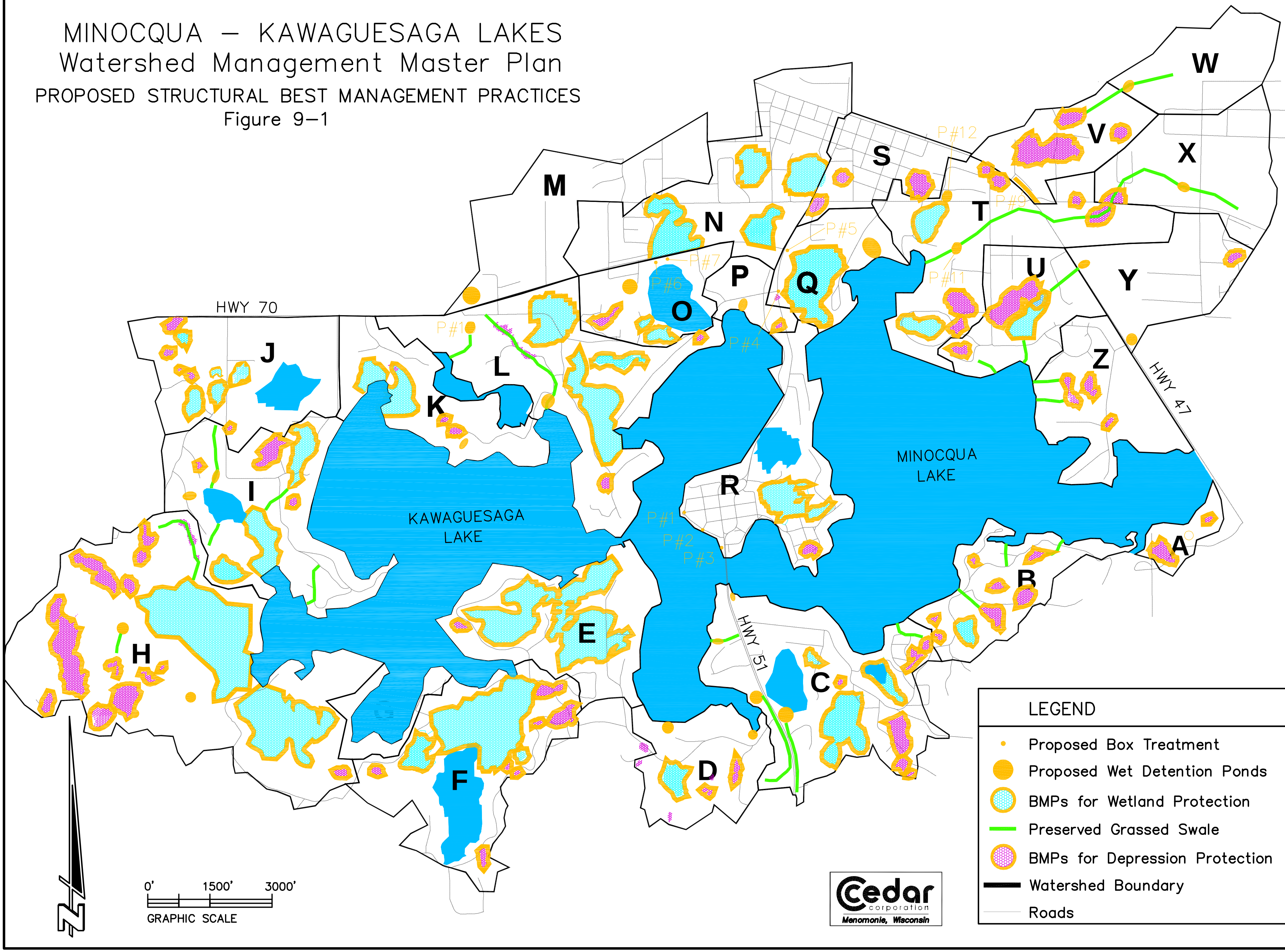
As discussed in Chapter 8, there are various financing mechanisms available to the Townships and Lakes Protection Association to allow implementation of the recommendations found herein. The Towns must recognize that <u>everyone</u> benefits from incremental improvements in water quality and reduction of localized flooding. Likewise, <u>everyone</u> is harmed by incremental degradations in water quality and increased instances of localized flooding. One approach in dealing with storm water on a city-wide basis that many communities are looking to is the establishment of a Storm Water Utility. A Storm Water Utility would allow the Towns of Woodruff and Minocqua to shift the cost of construction directly to developers and property owners, who stand to benefit from the improvements, without incurring further public debt. In many cases the regional facilities, presented as "New Development BMPs" in this document, will serve areas beyond the area developed initially. In this case, developers may balk at doing more than is necessary for their development alone. In instances such as this, it would be more practical for the Storm Water Utility District to finance, design and construct the regional facilities and then recapture that portion of the cost attributable to the initial development. The remainder of the costs would be spread among the Storm Water Utility District, again keeping in mind that <u>everyone</u> (Townships, county, residents, tourists, local businesses) benefits from incremental improvements in water quality and reduction of localized flooding.

As discussed throughout this document, all development and urbanization causes many problems associated with increased water quantity and decreased water quality. All residents and landowners in the Minocqua-Kawaguesaga Lakes Watershed contribute either directly or indirectly to the urbanization of previously undeveloped areas. Whether an area was developed one year ago or 100 years ago, previous to that it was most likely used for agricultural means or in its natural state. Therefore, resolution of storm water problems must be considered a community-wide goal.

We recommend that the Towns of Woodruff and Minocqua implement a Storm Water Utility to not only address existing storm water quality and quantity problems but also to eliminate potential future problems with regional facilities designed to reduce peak flows and increase water quality.

The *Minocqua-Kawaguesaga Lakes Watershed Management Plan* provides technical guidance for the selection and site design of storm water best management practices (BMPs). Measures such as those described in the *Wisconsin Storm Water Manual* and other recognized equivalents should be used to manage both the quantity and quality of storm water runoff from developed or proposed developments. The Plan is primarily intended for design professionals (i.e., developers, surveyors, landscape architects, engineers, geologists, soil scientists, etc.), landowners and general contractors. It is also intended for landowners in general, local public officials and staff who are responsible for the design and construction, or review and approval, of development applications or planning and design specification reviews.

MINOCQUA – KAWAGUESAGA LAKES
Watershed Management Master Plan
PROPOSED STRUCTURAL BEST MANAGEMENT PRACTICES
Figure 9–1



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3. Illicit Discharge Detection and Elimination
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5. Post Construction Storm Water Management in New Development and Re-Development
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Appendix C

Informational and Educational Fact Sheets

1. Polluted Urban Runoff: A Source of Concern (Source: UWEX)
2. Cleaning Up Storm Water Runoff (Source: WDNR and UWEX)
3. Erosion Control for Home Builders (Source: WDNR and UWEX)
4. Wetland Functional Values (Source: WDNR)
5. Storm Drain Stenciling (Source: UWEX)
6. Storm Sewers (Source: UWEX)

Polluted Urban Runoff:

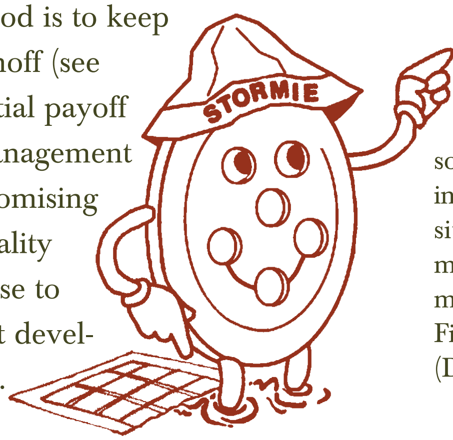
A Source of Concern

During the last twenty years, urban areas have invested billions of dollars in new wastewater treatment facilities to control water pollution. Despite this effort, many of our local lakes and streams are still plagued with pollution and cannot be used for fishing and swimming. Why? The answer lies in the ways we use our land and in the aftermath of a storm.

What we do on our land is reflected in our water

When rain falls or snow melts, the runoff washes pollutants off our streets, parking lots, construction sites, industrial storage yards, and lawns. Urban runoff carries a mixture of pollutants from our cars and trucks, outdoor storage piles, muddy construction sites and pesticide spills. Efficient systems of ditches, gutters and storm sewers carry the polluted runoff to nearby lakes and streams, bypassing wastewater treatment systems.

One way of cleaning up polluted urban runoff is to install stormwater treatment facilities. Another less expensive method is to keep pollutants out of runoff (see sidebar). The potential payoff from better land management practices is high, promising healthier waters, quality water recreation close to home and riverfront development possibilities.



From Streets to Streams

Urban runoff is a relatively recent concern, but it is not an insignificant issue. Although we have less urban area than rural area in Wisconsin, urban areas have more impervious surfaces. That means more water runs off instead of soaking in, and more enters lakes and streams unfiltered by soil or vegetation.

Some of the pollutants found in urban runoff are similar to pollutants found in rural runoff. These are the "conventional" pollutants – sediment, nutrients, oxygen-demanding materials, and bacteria. Urban areas on a per-acre basis deliver as much or more of these conventional pollutants as rural areas.

Sediment

Like rural runoff, urban runoff is loaded with sediment. Cities may have less soil erosion than rural areas, but urban areas produce their own distinctive mix of sediment – flakes of metal from rusting vehicles, particles from vehicle exhaust, bits of tires and brake linings, chunks of pavement, and soot from residential chimneys as well as industrial smokestacks.

As Figure 1 on the following page shows, the leading sources of sediment in existing urban areas are industrial sites, commercial development and freeways. But by far the highest loads of sediment come from areas under construction (not shown in Figure 1). The Wisconsin Department of Natural Resources (DNR) estimates that an average acre under construction

Although we have less urban area than rural area in Wisconsin, urban areas have more impervious surfaces. That means more water runs off instead of soaking in . . .

Keeping It Clean

Keeping pollutants out of stormwater runoff is less expensive than installing stormwater treatment facilities. Here are some ways that you can help prevent stormwater pollution:

Individuals

- Recycle oil
- Direct downspouts to lawns
- Sweep paved areas to keep waste out of stormsewers
- Keep your car tuned, repair leaks
- Limit fertilizer and pesticide use, leave grass clippings on lawn
- Clean up pet waste
- Dispose of toxic wastes properly
- Wash your car on your lawn or at a car wash

Municipalities

- Enforce construction site erosion control laws
- Enact laws requiring stormwater management in new development
- Develop and implement a comprehensive stormwater management plan
- Sponsor household hazardous waste collections

delivers 60,000 pounds (30 tons) of sediment per year to downstream waterways, which is much more than any other land use.

Two factors account for the large amount of sediment coming from construction sites – high erosion rates and high delivery rates. Construction sites have high *erosion rates* because they are usually stripped of vegetation and topsoil for a year or more. Typical erosion rates for construction sites are 35 tons to 45 tons per acre per year as compared to 1 to 10 tons per acre per year for cropland.

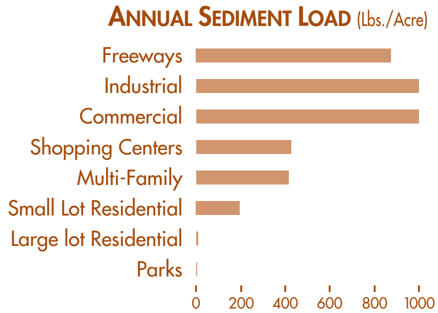
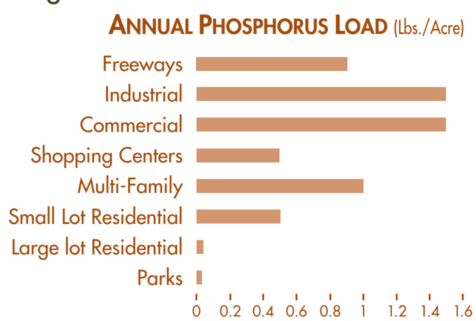


Figure 1

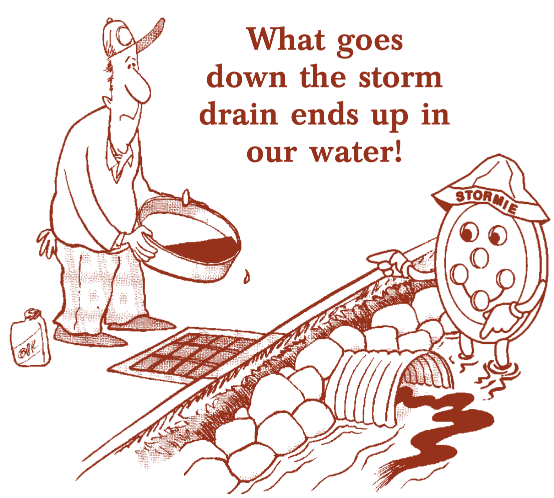


Even more importantly, construction sites have very high *delivery rates* compared to cropland. During the first phase of construction, the land is graded and ditches or storm sewers are installed to provide good drainage. This also provides an efficient delivery system for pollutants. Typically, 50% to 100% of the soil eroded from a construction site is delivered to a lake or stream, compared to only 3% to 10% of the soil from cropland delivered to lakes or streams.

Nutrients

Runoff from both urban and rural areas is loaded with nutrients such as phosphorus and nitrogen. **Phosphorus** is the nutrient of greatest concern because it promotes weed and algae growth in lakes and streams. Like sediment, phosphorus *concentrations* are lower in urban runoff than in rural runoff, but annual phosphorus *loads* per acre are at least comparable to rural areas.

Because phosphorus compounds attach to soil particles, areas with high sediment loads also produce high phosphorus loads (see Figure 1). This means that construction sites are significant sources of phosphorus as well as sediment. Other sources of phosphorus include fertilizer spills, leaves and grass left on paved areas, and orthophosphate in vehicle exhaust.



Oxygen Demanding Material

Urban runoff carries organic material such as pet waste, leaves, grass clippings and litter. As these materials decay, they use up oxygen needed by fish and other aquatic life. Shallow, slow-moving waterways are especially vulnerable to fish kills caused by oxygen demand from the organic materials in urban runoff. Indeed, the surge of oxygen demand after a storm dumps organic waste into an urban waterway can totally deplete its oxygen supply. Runoff from older residential areas (with more pavement, more pets, and combined storm and sanitary sewers) carries the highest load of oxygen demanding materials.

Bacteria

The levels of bacteria found in urban runoff almost always exceed public health standards for recreational swimming and wading. Generally, fecal coliform bacteria counts for urban runoff are 20 to 40 times higher than the health standard for swimming. Research shows these high levels of bacteria are typical of runoff from small as well as large cities in Wisconsin. Sources of bacteria in urban runoff include sanitary sewer overflows, pets, and populations of urban wildlife such as pigeons, geese and deer.

The DNR estimates that an average acre under construction delivers 60,000 pounds (30 tons) of sediment per year to downstream waterways, which is much more than any other land use.

Toxic Pollutants

One of the special challenges of urban watersheds is toxic pollution. Toxic pollutants are substances that may cause death, disease or birth defects or that may interfere with reproduction, child development or disease resistance. According to DNR studies, the toxic pollutants of most concern in urban runoff are metals, pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).

Metals

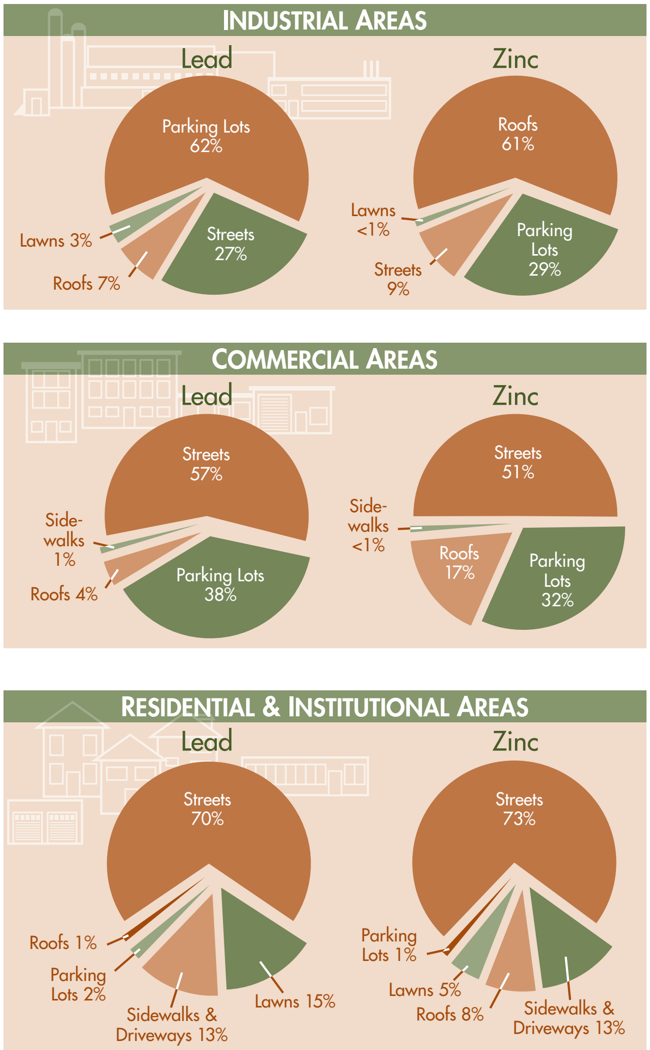
Metals are the best understood toxic pollutants in urban runoff. They were extensively monitored as part of the National Urban Runoff Program during the early 1980s. Recent data from Wisconsin cities confirms that runoff from small as well as large cities is contaminated with metals such as lead and zinc.

Lead has historically been used as an "indicator" for other toxic pollutants in urban stormwater because it is relatively easy to monitor and its dangers are well documented. Lead is a problem for both humans and aquatic life. Its human health effects include damage to the nervous system and kidneys, high blood pressure and digestive disorders.

Lead can also be toxic to aquatic life. Wisconsin monitoring shows that about 40% of the samples from

Figure 2

Sources of Total Lead and Zinc in Urban Runoff



storm sewer discharges in a primarily residential area and 70% of the samples from a commercial area had lead levels high enough to kill aquatic life. Although lead levels still exceed water quality standards, they are much lower today than they were before the shift to unleaded gasoline.

Zinc is another metal in urban runoff which commonly violates water quality standards. While zinc does not create human health problems, it can be toxic to aquatic life. In fact, zinc is even more likely than lead to exceed levels that kill aquatic life.

The primary source of many metals in urban runoff is vehicle traffic. Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic on streets that drain into a storm sewer system. As Figure 2 shows, streets and parking lots are the primary sources of lead in urban areas.

> **The primary source of many metals in urban runoff is vehicle traffic. Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic in streets . . .**

Roofs can also be a significant source of metals. Galvanized metal rooftops, gutters and downspouts are the primary source of zinc (61%) in industrial areas where downspouts discharge onto pavement or directly into storm sewers. Roofs are a less significant source of zinc (8%) in residential areas where downspouts discharge onto lawns. On some roofs, copper flashing contaminates runoff with copper and lead.

In some cities, a significant source of metals is outdoor storage of scrap metal, coal, and salt. According to U.S. Geological Survey monitoring, scrap metal piles are the primary source of mercury in the area surrounding the Milwaukee harbor. Other metals found in runoff from outdoor storage include chromium and lead from road salt piles and arsenic from scrap metal and coal piles.

The list of other sources of metals is long, ranging from combustion to deteriorating metal and paint. Airborne emissions from burning coal, oil or municipal waste may carry cadmium, copper, lead or mercury. In fact, this is the primary source of mercury for many Wisconsin lakes. Other sources of metals include paints and plated metals which commonly contain cadmium or chromium. Bullets, fishing weights, and paint sold before 1977 may contain lead. Wood used in outdoor construction may contain arsenic, chromium, copper or zinc to prevent rotting.

Pesticides

Wisconsin stormwater monitoring documents the presence of many pesticides in urban runoff. However, how they got there is currently the subject of some debate. Tests indicate that most properly applied pesticides are bound up in plants and soil; therefore, little runs off. Nevertheless, the pesticides listed above are frequently found in urban runoff at levels that violate surface and/or ground water quality standards.

> **PESTICIDES IN STORMWATER**
>
> **Regulated Insecticides:**
> Aldrin, Chlordane, DDT, Endrin, Heptachlor, Lindane, Toxaphene.
>
> **Lawn & Garden Insecticides:**
> Diazinon, Malathion
>
> **Agricultural Herbicides:**
> Alachlor, Atrazine, Cyanazine.

Regulated insecticides may no longer be widely used, but they are persistent chemicals which do not degrade rapidly in the environment. Except for lindane, these insecticides are banned in Wisconsin. Lindane is still sold at garden centers for home use in controlling woody plant pests. It is also available for some commercial uses including treatment of seeds, Christmas trees, and farm animals.

Common **lawn and garden insecticides** such as diazinon and malathion may not be persistent in the environment, but they are toxic to bees, fish, aquatic insects, and other wildlife. Diazinon is especially toxic to birds. It has been banned from golf courses because there are documented cases of waterfowl dying while feeding on areas treated with diazinon.

Finding **agricultural herbicides** like alachlor, atrazine and cyanazine in urban stormwater may seem surprising since these herbicides are not used in lawn and garden compounds. However, Midwest studies suggest that concentrations of atrazine in urban stormwater are consistent with concentrations found in rainfall. Both atrazine and alachlor easily evaporate from treated farm fields and later end up in rainfall or snow. Atrazine contamination of rainfall is more widespread than alachlor contamination because atrazine is more widely used and more persistent in the environment.

Some regulations now apply to the use of alachlor, atrazine and cyanazine. Only certified applicators may apply these chemicals. Furthermore, atrazine use is restricted in many Wisconsin counties due to groundwater contamination.

PAHs affect human health in a variety of ways, but they are of particular concern because several of these compounds are among the most potent carcinogens.

Other Chemicals

Other potentially toxic chemicals found in urban runoff have such long names that we commonly refer to them by their initials. Some of these chemicals are hazardous even in very small doses and require water quality standards set to parts per *billion*. Because sampling for these chemicals can be difficult and costly, information on them is very limited. Monitoring of urban runoff in Wisconsin suggests that two groups of chemicals are present in large enough concentrations to be of concern – PAHs and PCBs.

Polycyclic aromatic hydrocarbons (also called polynuclear aromatic hydrocarbons) are a large group of about 10,000 compounds. They are common by-products of incomplete combustion from vehicles, wood and oil burning furnaces, and incinerators. Some PAHs are used as ingredients in gasoline, asphalt and wood preservatives. According to monitoring data of storm sewer discharges in Wisconsin cities, the PAHs that most frequently exceed surface or ground water standards include:

- Benzo-a-pyrene
- Benzo-ghi-perylene
- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene

PAHs affect human health in a variety of ways but they are of particular concern because several of these compounds are among the most potent carcinogens. Laboratory tests on animals indicate that benzo-a-pyrene causes cancer and reproductive and fetal development problems. Other tests indicate that some PAHs damage the lungs, liver, skin and kidneys. Some studies also suggest that PAHs are responsible for tumors and lesions in fish, especially those that feed on river bottoms.

According to Wisconsin monitoring, more than 95% of the samples from storm sewer discharges violate human cancer criteria for benzo-a-pyrene and benzo-ghi-perylene. (Human cancer criteria are set at levels to keep the incremental risk of cancer below 1 in 100,000 for people who eat fish from lakes and streams in Wisconsin.) More than 60% of the samples violate human cancer criteria for chrysene, phenanthrene and pyrene. PAHs accumulate in bottom sediments in urban streams and are taken up by aquatic organisms such as crayfish. Unlike PCBs, they do not accumulate in living tissue or build up in the food chain.

Polychlorinated biphenyls (PCBs) are a group of over 200 compounds. They are very stable compounds which do not easily degrade, burn, dissolve in water, or conduct electricity. Therefore, PCBs have been used for many purposes including insulation in transformers and in electrical capacitors for old fluorescent light fixtures and appliances. They have also been used as coolants or lubricants.

PCBs are of special concern because they remain in the environment for a long time, build up in the food chain, accumulate in human fatty tissue, and may eventually cause health problems. Short term effects of PCB exposure include skin sores and liver problems. Longer term effects may include cancer as well as problems with reproduction, fetal development, immunity to disease, and liver functions.

PCB production stopped in 1977, but virtually all of the storm sewer discharge samples from Madison and Milwaukee still violate the human cancer criteria for PCBs. Sources of PCBs include sediment contaminated by past industrial waste discharges, landfill leachate, spills, and waste incineration.

Steps for Clean Water

Knowing what's in urban runoff is the first step in developing an effective stormwater strategy. Many communities in Wisconsin are already working on cleaning up urban runoff. Cities are sweeping streets more frequently and industries are covering outdoor storage piles. Youth groups are stenciling *Dump No Waste* beside storm drains. And many new developments have stormwater ponds or infiltration basins designed to filter pollutants from stormwater. What is your community doing?

A publication of the University of Wisconsin-Extension, in cooperation with the Wisconsin Department of Natural Resources under funding from the Wisconsin Nonpoint Source Water Pollution Abatement Program, Carolyn D. Johnson, UWEX Southeast Area Urban Water Quality Educator and Dotty Juengst, UWEX Northeast Urban Water Quality Educator. University of Wisconsin-Extension is an EEO/Affirmative Action employer and provides equal opportunities in employment and programming, including Title IX requirements. **GWQ020 Polluted Urban Runoff – A Source of Concern I-02-97-5M-20-S DNR: WT-483-97**

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Stormie's Clean Water Tips

Cleaning Up Stormwater Runoff

A SERIES OF WATER QUALITY FACT SHEETS ABOUT STORMWATER RUNOFF

What is stormwater runoff? It is the rain and melting snow that flows off streets, rooftops, lawns, and farmland. The flowing water carries salt, sand, soil, pesticides, fertilizers, leaves and grass clippings, oil, litter, and many other pollutants into nearby waterways. Since these pollutants are washed off a wide area and cannot be traced to a single source, they are called nonpoint source or runoff pollutants.

Storm Sewers – Rivers Beneath Our Feet

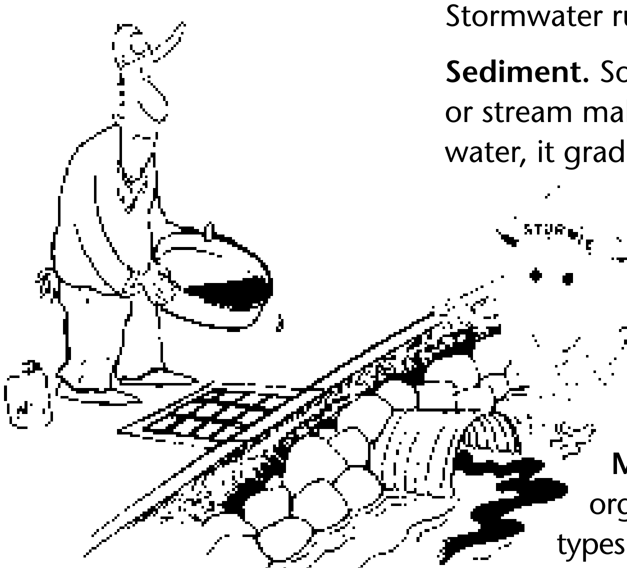
In developed areas, much of the land surface is covered by buildings and pavement which do not allow water to soak into the ground. Instead, storm sewers are used to carry the large amounts of runoff from these roofs and paved areas to nearby waterways.

Storm sewers are simply pipes laid underground, often below streets. Inlets or drains located along curbs and in parking areas collect the runoff, which then flows to nearby streams or lakes. A common misconception is that water running off streets goes into a sewage treatment plant. It does not. In fact, stormwater usually receives no treatment. Water that runs off lawns, streets, and parking lots flows directly into lakes and streams.

Stormwater is Not Clean Water

Stormwater runoff carries pollutants that seriously harm our waters:

Sediment. Soil particles washed off constuction sites or farm fields into a lake or stream make the water cloudy or turbid. When sediment settles out of the water, it gradually fills in the stream or lake bed.



Did you know that oil dumped into the storm sewer pollutes our water?

Phosphorus. This nutrient, often attached to soil particles, fuels the growth of algae and aquatic weeds. These plants are important in providing habitat for fish and wildlife. However, rapid and excessive growth of algae and aquatic plants can degrade water quality and interfere with swimming, boating and fishing.

Micro-organisms. Bacteria, viruses and other disease causing organisms make waterways unsafe for swimming, wading and other types of recreation. Some of these organisms, notably Cryptosporidium, are difficult to remove through water treatment and may endanger people who depend on drinking water supplies drawn from lakes or streams.

Toxic chemicals. Motor oil, lead from gas and auto exhaust, zinc from roof drains and tires, and pesticides in stormwater runoff may kill aquatic organisms or impair their health, growth or ability to reproduce.

The Goals of Urban Stormwater Programs are to:

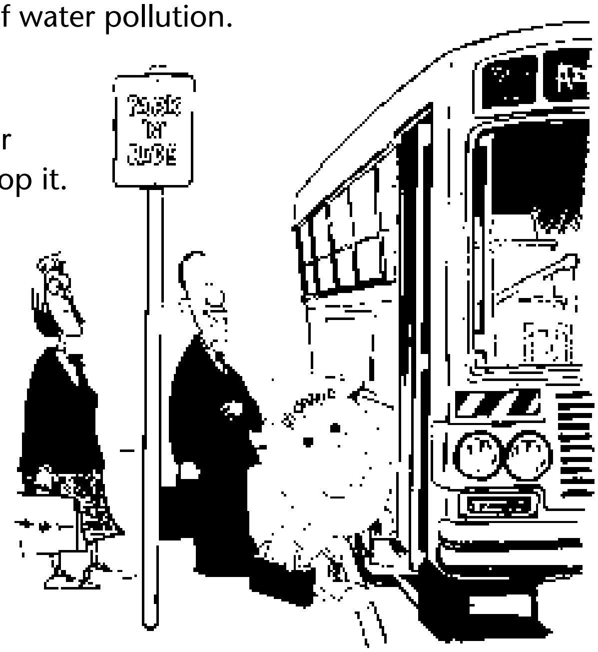
- **Slow down water, decreasing its ability to cause erosion and carry pollutants.**
- **Reduce the amount of runoff by encouraging water to soak into ground.**
- **Prevent pollution by reducing the use of toxic chemicals, controlling erosion and by covering outdoor storage piles.**
- **Remove pollutants by routing runoff through settling ponds, grass filter strips or other treatment devices.**

STORMWATER MANAGEMENT IS NOW THE LAW

Federally mandated stormwater permits require many industries and cities to control stormwater runoff. Even communities without stormwater permits require erosion controls on constuction sites and better stormwater management in new development.

Federal laws also require all farmers who participate in federal programs to develop farm conservation plans that help control cropland erosion, barnyard runoff and other sources of water pollution.

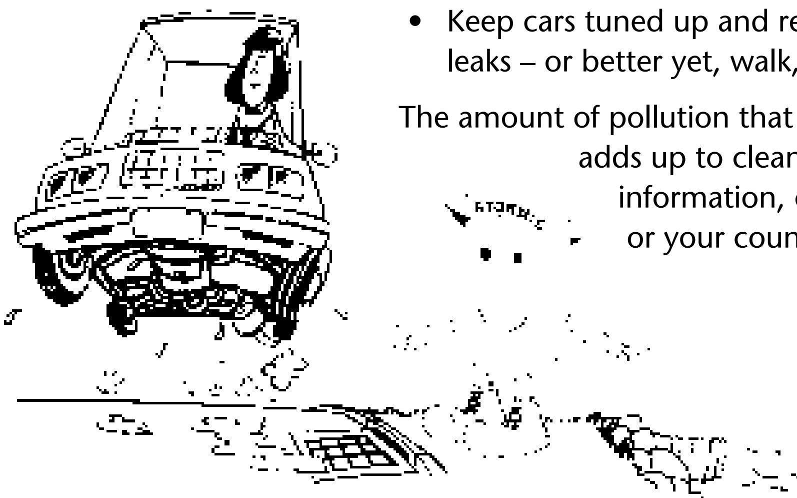
We Can All Help!



Each of us contributes to stormwater pollution and each of us can help stop it. Here are some ways you can help:

- Keep pesticides, oil, leaves and other pollutants off streets and out of storm drains.
- Divert roof water to lawns or gardens where it can safely soak in.
- Clean up pet waste – bury it or flush in down the toilet.
- Keep cars tuned up and repair leaks – or better yet, walk, bike or take the bus.

The amount of pollution that you stop may seem small, but together it all adds up to cleaner water for everyone to enjoy. For more information, contact the Department of Natural Resources or your county Extension or Land Conservation office.



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Author: Carolyn Johnson, UW–Extension.

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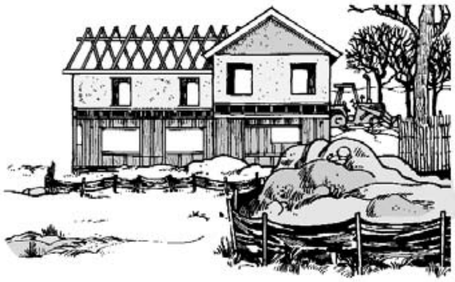
UW Extension

Wisconsin Dept. of Natural Resources

GWQ016 Cleaning Up Stormwater Runoff

DNR WT-532-99

R-09-99-10M-20-S



Erosion Control *for* Home Builders

By controlling erosion, home builders help keep our lakes and streams clean.

Eroding construction sites are a leading cause of water quality problems in Wisconsin. For every acre under construction, about a dump truck and a half of soil washes into a nearby lake or stream unless the builder uses erosion controls. Problems caused by this sediment include:

Taxes
Cleaning up sediment in streets, sewers and ditches adds extra costs to local government budgets.

Lower property values
Neighboring property values are damaged when a lake or stream fills with sediment. Shallow areas encourage weed growth and create boating hazards.

Poor fishing
Muddy water drives away fish like northern pike that rely on sight to feed. As it settles, sediment smothers gravel beds where fish like smallmouth bass find food and lay their eggs. Soil particles in suspension can act like a sand blaster during a storm and damage fish gills.

Nuisance growth of weeds and algae
Sediment carries fertilizers that fuel algae and weed growth.

Dredging
The expense of dredging sediment from lakes, harbors and navigation channels is paid for by taxpayers.

This fact sheet includes the diagrams and step-by-step instructions needed by builders on most home sites. Additional controls may be needed for sites that have steep slopes, are adjacent to lakes and streams, receive a lot of runoff from adjacent land, or are larger than an acre.

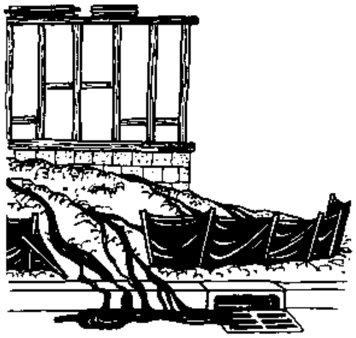
If you need help developing an erosion control plan or training your staff, contact your local building inspection, zoning or erosion control office.

Controlling Erosion is Easy

Erosion control is important even for home sites of an acre or less. The materials needed are easy to find and relatively inexpensive – straw bales or silt fence, stakes, gravel, plastic tubes, and grass seed. Putting these materials to use is a straightforward process. Only a few controls are needed on most sites:

- Preserving existing trees and grass where possible to prevent erosion;
- Revegetating the site as soon as possible;
- Silt fence or straw bales to trap sediment on the downslope sides of the lot;
- Placing soil piles away from any roads or waterways;
- Diversions on upslope side and around stockpilkes;
- Stone/rock access drive used by all vehicles to limit tracking of mud onto streets;
- Cleanup of sediment carried off-site by vehicles or storms; and
- Downspout extenders to prevent erosion from roof runoff.

GWQ001 Erosion Control for Home Builders. Additional copies are available from Cooperative Extension Publications, 45 N. Charter St., Madison, WI 53715, 608/262-3346 (toll-free 877-947-7827) or Dept. of Commerce, P.O. Box 2509, Madison, WI 53701-2509, 608/267-4405.



A poorly installed silt fence will not prevent soil erosion. Fabric must be buried in a trench and sections must overlap (see diagram on back of this fact sheet).

WARNING! Extra measures may be needed if your site:

- is within 300 feet of a stream or wetland;
- is within 1000 feet of a lake;
- is steep (slopes of 12% or more);
- receives runoff from 10,000 sq. ft. or more of adjacent land;
- has more than an acre of disturbed ground.

For information on appropriate measures for these sites, contact your local building inspection, zoning or erosion control office.

Straw Bale or Silt Fence

- Install within 24 hours of land disturbance.
- Install on downslope sides of site parallel to contour of the land.
- Extended ends upslope enough to allow water to pond behind fence.
- Bury eight inches of fabric in trench (see back page).
- Stake (two stakes per bale).
- Leave no gaps. Stuff straw between bales, overlap sections of silt fence, or twist ends of silt fence together.
- Inspect and repair once a week and after every ½-inch rain. Remove sediment if deposits reach half the fence height. Replace bales after three months.
- Maintain until a lawn is established.

Soil Piles

- Cover with plastic and locate away from any downslope street, driveway, stream, lake, wetland, ditch or drainageway.
- Temporary seed such as annual rye or winter wheat is recommended for topsoil piles.

Access Drive

- Install an access drive using two-to-three-inch aggregate prior to placing the first floor decking on foundation.
- Lay stone six inches deep and at least seven feet wide from the foundation to the street (or 50 feet if less).
- Use to prevent tracking mud onto the road by all vehicles.
- Maintain throughout construction.
- In clay soils, use of geotextile under the stone is recommended.

Sediment Cleanup

- By the end of each work day, sweep or scrape up soil tracked onto the road.
- By the end of the next work day after a storm, clean up soil washed off-site.

Sewer Inlet Protection

- Protect on-site storm sewer inlets with straw bales, silt fences or equivalent measures.
- Inspect, repair and remove sediment deposits after every storm.

Downspout Extenders

- Not required, but highly recommended.
- Install as soon as gutters and downspouts are completed to prevent erosion from roof runoff.
- Use plastic drainage pipe to route water to a grassed or paved area. Once a lawn is established, direct runoff to the lawn or other pervious areas.
- Maintain until a lawn is established.

Preserving Existing Vegetation

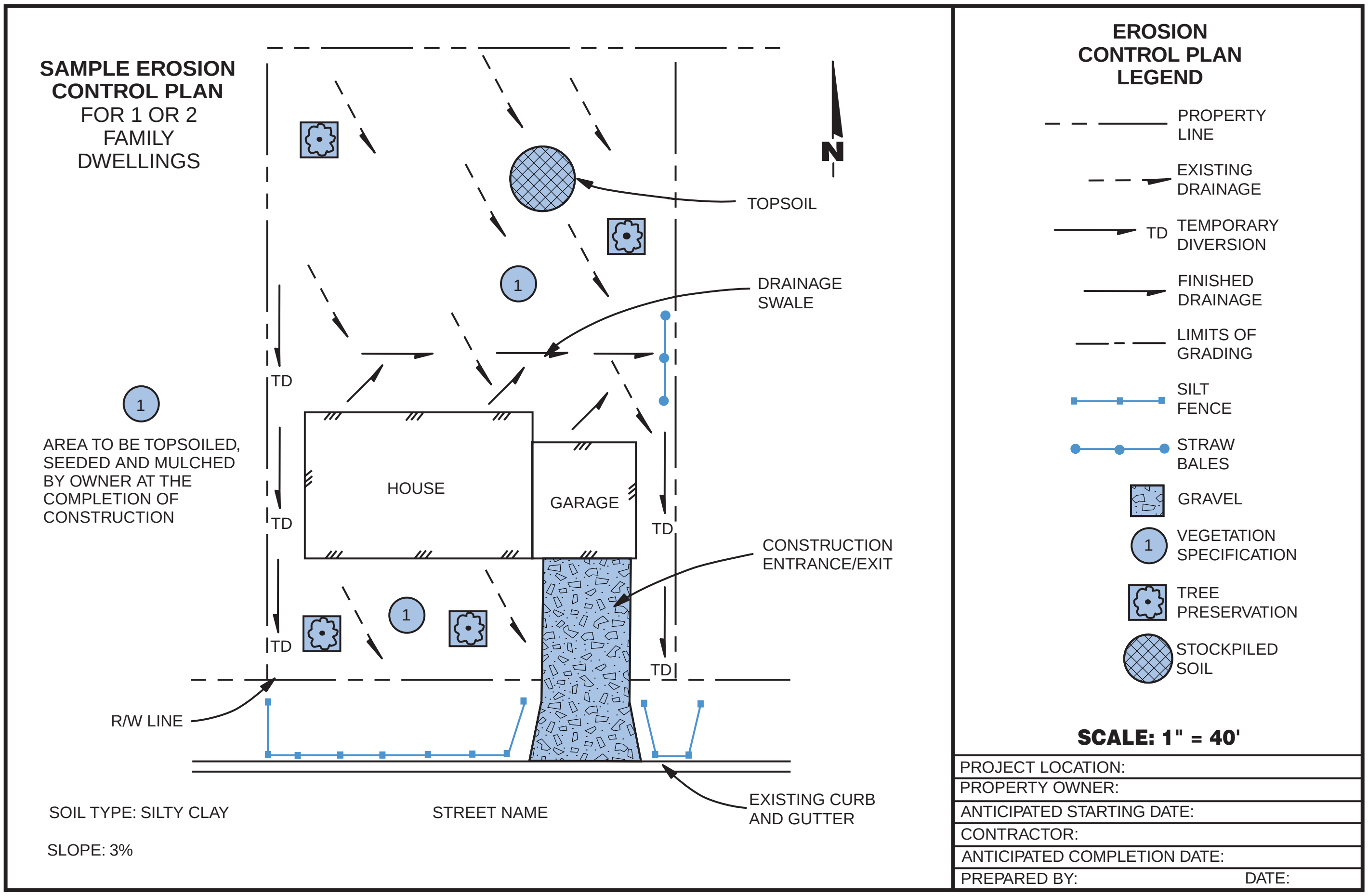
- Wherever possible, preserve existing trees, shrubs, and other vegetation.
- To prevent root damage, do not grade, place soil piles, or park vehicles near trees marked for preservation.
- Place plastic mesh or snow fence barriers around trees to protect the root area below their branches.

Revegetation

- Seed, sod or mulch bare soil as soon as possible. Vegetation is the most effective way to control erosion.

Seeding and Mulching

- Spread four to six inches of topsoil.
- Fertilize and lime if needed according to soil test (or apply 10 lb./1000 sq. ft. of 10-10-10 fertilizer).
- Seed with an appropriate mix for the site (see table).
- Rake lightly to cover seed with 1⁄4" of soil. Roll lightly.
- Mulch with straw (70-90 lb. or one bale per 1000 sq. ft.).
- Anchor mulch by punching into the soil, watering, or by using netting or other measures on steep slopes.
- Water gently every day or two to keep soil moist. Less watering is needed once grass is two inches tall.



Sodding

- Spread four to six inches of topsoil.
- Fertilize and lime if needed according to soil test (or apply 10 lb./1000 sq. ft. of 10-10-10 fertilizer).
- Lightly water the soil.
- Lay sod. Tamp or roll lightly.
- On slopes, lay sod starting at the bottom and work toward the top. Laying in a brickwork pattern. Peg each piece down in several places.
- Initial watering should wet soil six inches deep (or until water stands one inch deep in a straight-sided container). Then water lightly every day or two to keep soil moist but not saturated for two weeks.
- Generally, the best times to sod and seed are early fall (Aug. 15-Sept. 15) or spring (May). If construction is completed after September 15, final seeding should be delayed. Sod may be laid until November 1. Temporary seed (such as rye or winter wheat) may be planted until October 15. Mulch or matting may be applied after October 15, if weather permits. Straw bale or silt fences must be maintained until final seeding or sodding is completed in spring (by June 1).

Concrete Wash Water

- Dispose of concrete wash water in an area of soil away from surface waters where soil can act as a filter or evaporate the water. Dispose of remaining cement. Be aware that this water can kill vegetation.

De-Watering

- Dispose of de-watering water in a pervious area. Prevent the discharge of sediment from de-watering operations into storm sewers and surface waters.

Material Storage

- Manage chemicals, materials and other compounds to avoid contamination of runoff.

Typical Lawn Seed Mixtures

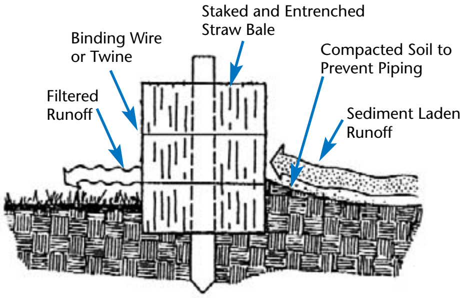
Grass	Percent by Weight: Sunny Site	Percent by Weight: Shady Site
Kentucky bluegrass	65%	15%
Fine fescue	20%	70%
Perennial ryegrass	15%	15%
Seeding rate (lb./1000 sq. ft.)	3-4	4-5

Source: R.C. Newman, Lawn Establishment, UW-Extension, 1988.

COMMONLY USED EROSION CONTROLS

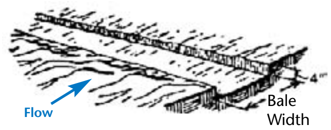
Straw Bale Fences

Cross Section of Straw Bale Installation



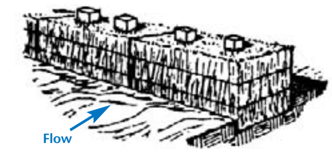
Source: Michigan Soil Erosion and Sedimentation Control Guidebook, 1975.

How to Install a Straw Bale Fence

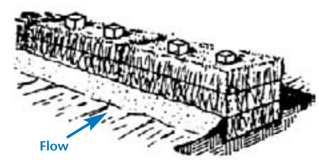


1. Excavate a 4" deep trench.

2. Place bales in trench with bindings around sides away from the ground. Leave no gaps between bales.



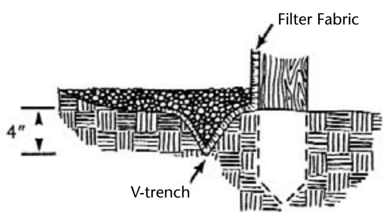
3. Anchor bales using two steel rebars or 2" x 2" wood stakes per bale. Drive stakes into the ground at least 8".

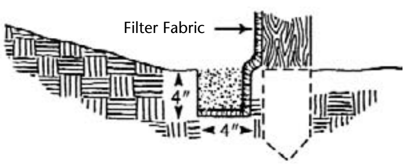


4. Backfill and compact the excavated soil.

Silt Fences

Cross Sections of Trenches for Silt Fences

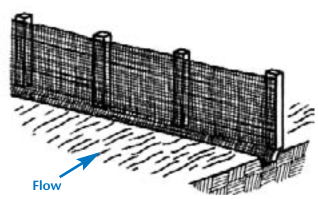




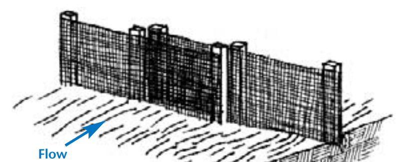
Sources: North Carolina Erosion and Sediment Control Planning and Design Manual, 1988.

How to Install a Silt Fence

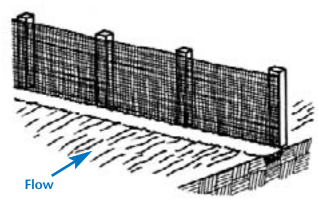
1. Excavate a 4" x 4" trench along the contour.



2. Stake the silt fence on downslope side of trench. Extended 8" of fabric into the trench.



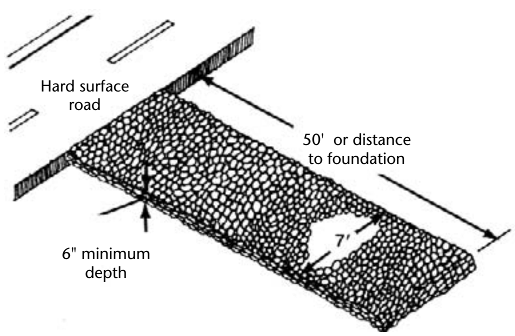
3. When joints are necessary, overlap ends for the distance between two stakes.



4. Backfill and compact the excavated soil.

Access Drive

How to Install an Access Drive



1. Install as soon as possible after start of grading.
2. Use two-to-three-inch aggregate stone.
3. Drive must be at least seven feet wide and 50 feet long or the distance to the foundation, whichever is less.
4. Replace as needed to maintain six-inch depth.

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Author: Carolyn Johnson, UW–Extension.

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GWQ001 Erosion Control for Home Builders

DNR WT-457-96

R-1-00-10M-25-S

Wisconsin Wetlands: Wetland Functional Values

Until recently, wetlands were often viewed as wastelands, useful only when drained or filled. Now, we know that wetlands benefit people and the natural world in remarkable ways. They provide critical habitat for wildlife, water storage to prevent flooding and protect water quality, and recreational opportunities for wildlife watchers, anglers, hunters, and boaters. These are known as "wetland functional values." Different wetlands perform different functions: even two wetlands that at first may appear similar.

Every wetland is unique. One wetland on the north edge of town may perform different functions than another on the south edge - even though they may appear at first glance to be very similar. A bog in northern Wisconsin may be valued for different reasons than a bog in southeastern Wisconsin. Wetland functional values are determined by a variety of different parameters including physcial, chemical and biological components.

Choose from the following list to learn more about the values of wetlands:

When Is a Wetland a Wetland?

Wetlands in Wisconsin were defined by the State Legislature in 1978. According to this definition, a wetland is:

> "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic (water-loving) vegetation and which has soils indicative of wet conditions."

Apart from these essential common characteristics, wetlands - and wetland function - vary. This page describes the basic functions that *can* occur in a wetland. Whether a specific wetland performs these functions depends on many variables (including wetland type, size, and previous physical influences/natural or human-induced) and *opportunity* (including the location of the wetland in landscape and surrounding land use). Wetlands also change over time and may function differently from year to year or season to season. These are very dynamic ecosystems.

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Determining Values

Standardized assessment methods are used to evaluate the extent to which a specific wetland may perform any given function. The presence or absence of specific characteristics are used to determine the importance of each functional value for the site in question.

These characteristics may or may not be obvious to the casual observer. The changing nature of wetlands can hide many of these traits. Migratory bird use, for example, is not always obvious except in spring and fall.

And the occurence of various wetland plants gives important, yet subtle, clues about habitat, water quality and biodiversity. These types of observations help us evaluate a wetland's intrinsic value and overall importance to society.

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Floral Diversity

Wetlands can support an abundance and variety of plants, ranging from duckweed and orchids to black ash. These plants contribute to the earth's biodiversity and provide food and shelter for many animal species at critical times during their life cycles. Many of the rare and endangered plant species in Wisconsin are found in wetlands.

The importance of floral diversity in a particular wetland is usually related to two factors. First, the more valuable wetlands usually support a greater variety of native plants (high diversity), than sites with little variety or large numbers of non-native species. Second, wetlands communities that are regionally scarce are considered particularly valuable.

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Fish and Wildlife Habitat

Many animals spend their whole lives in wetlands; for others, wetlands are critical habitat for feeding, breeding, resting, nesting, escape cover or travel corridors. Wisconsin wetlands are spawning grounds for northern pike, nurseries for fish and ducklings, critical habitat for shorebirds and songbirds and lifelong habitat for some frogs and turtles. Wetlands also provide essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, insects, and plankton.

Some of the most valuable wetlands for fish and wildlife provide diverse plant cover and open water within large, undeveloped tracts of land. This function may be considered particularly important if the habitat is regionally scarce, such as the last remaining wetland in an urban setting.

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Flood Protection

Due to dense vegetation and location within the landscape, wetlands are important for retaining stormwater from rain and melting snow rushing toward rivers and lakes, floodwater from rising streams. Wetlands slow stormwater runoff and can provide storage areas for floods, thus minimizing harm to downstream areas.

Preservation of wetlands can prevent needless expenses for flood and stormwater control projects such as dikes, levees, concrete-lined channels and detention basins.

Wetlands located in the mid or lower reaches of a watershed contribute most substantially to flood control since they lie in the path of more water than their upstream counterparts. When several wetland basins perform this function within a watershed, the effect may be a staggered, moderated discharge, reducing flood peaks.

Flood protection may be especially important in cities, where pavement contributes to runoff, and in areas with steep slopes or other land features which tend to increase stormwater amounts and velocity. These functional values can provide economic benefits to downstream property owners and taxpayers.

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Water Quality Protection

Wetland plants and soils have the capacity to store and filter pollutants ranging from pesticides to animal wastes. Calm wetland waters, with their flat surface and flow characteristics, allow particles of toxins and nutrients to settle out of the water column. Plants take up certain nutrients from the water. Other substances can be stored or transformed to a less toxic state within wetlands. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer.

Larger wetlands and those which contain dense vegetation are most effective in protecting water quality. If surrouding land uses contribute to soil runoff or introduce manure or other pollutants into a watershed, the value of this function may be especially high.

Wetlands which filter or store sediments or nutrients for extended periods may undergo fundmental changes. Sediments will eventually fill in wetlands and nutrients will eventually modify the vegetation. Such changes may result in the loss of this function over time.

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Shoreline Protection

Shoreland wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. Roots of wetland plants bind lakeshores and streambanks, providing further protection. Benefits include the protection of habitat and structures, as well as land which might otherwise be lost to erosion. This function is especially important in waterways where boat traffic, water current and/or wind cause substantial water movement which would otherwise damage the shore.

Trout streams and other high quality waterways often depend on shoreland wetlands to protect their characteristic clear, cold waters. Without this wetland buffer, the shoreline becomes undercut and collapses. When this happens, streams often become wider, shallower and turbid. Water temperatures rise and habitat quality deteriorates.

A wetland which reduces erosion can also reduce sedimentation to nearby waterways. If the waterway is a navigational channel, the reducation in sedimentation can help reduce the frequency of dredging to maintain the channel.

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Groundwater Recharge and Discharge

Groundwater recharge is the process by which water moves into the groundwater system. Although recharge usually occurs at higher elevations, some wetlands can provide a valuable service of replenishing groundwater supplies. The filtering capacity of wetland plants and substrates may also help protect groundwater quality.

Groundwater discharge is the process by which groundwater is discharged to the surface. Groundwater discharge is a more common wetland function and can be important for stabilizing stream flows, especially during dry months. Groundwater discharge through wetlands can enhance of the aquatic life communities in downstream areas. It also can contribute toward high quality water in our lakes, rivers and streams. In some cases, groundwater discharge sites are obvious, through visible springs or by the presence of certain plant species.

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Aesthetics, Recreation, Education and Science

Do you like to canoe? Cross country ski? Watch birds or listen to bullfrogs? Wetlands are some of our favorite places to study, hike or just drive by. They provide peaceful open spaces in landscapes which are under development pressure and have rich potential for hunters and anglers, scientists and students.

Wetlands provide exceptional educational and scientific research opportunities because of their unique combination of terrestrial and aquatic life and physical/chemical processes. Many species of endangered and threatened plants and animals are found in wetlands.

Wetlands located within or near urban settings and those frequently visited by the public are especially valuable for the social and educational opportunities they offer. Open water, diverse vegetation, and lack of pollution also contribute to the value of specific wetlands for recreational and educational purposes and general quality of life.

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More Information

For more information on wetlands, contact Pat Trochlell, Wetlands Ecologist, (608) 267-2453.

For a copy of DNR's assessment form, see Rapid Assessment Methodology for Evaluating Wetland Functional Values *(January 2001, PDF, 81KB)*.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement #X995257-01 to the Wisconsin Department of Natural Resources. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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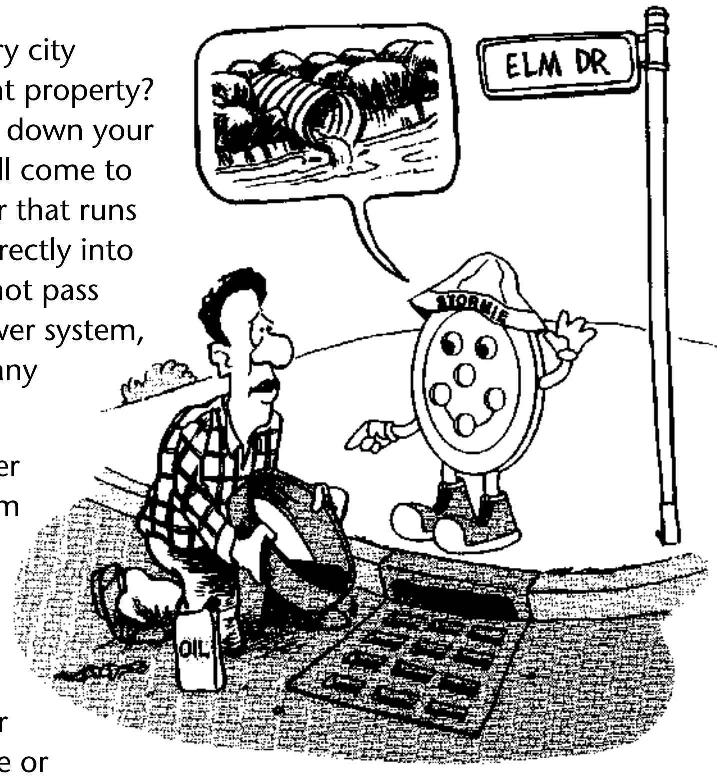
Last Revised: Monday September 08 2003

Storm Drain Stenciling

How You Can Prevent Water Pollution

Stormie's Clean Water Tips

A SERIES OF WATER QUALITY FACT SHEETS ABOUT STORMWATER RUNOFF

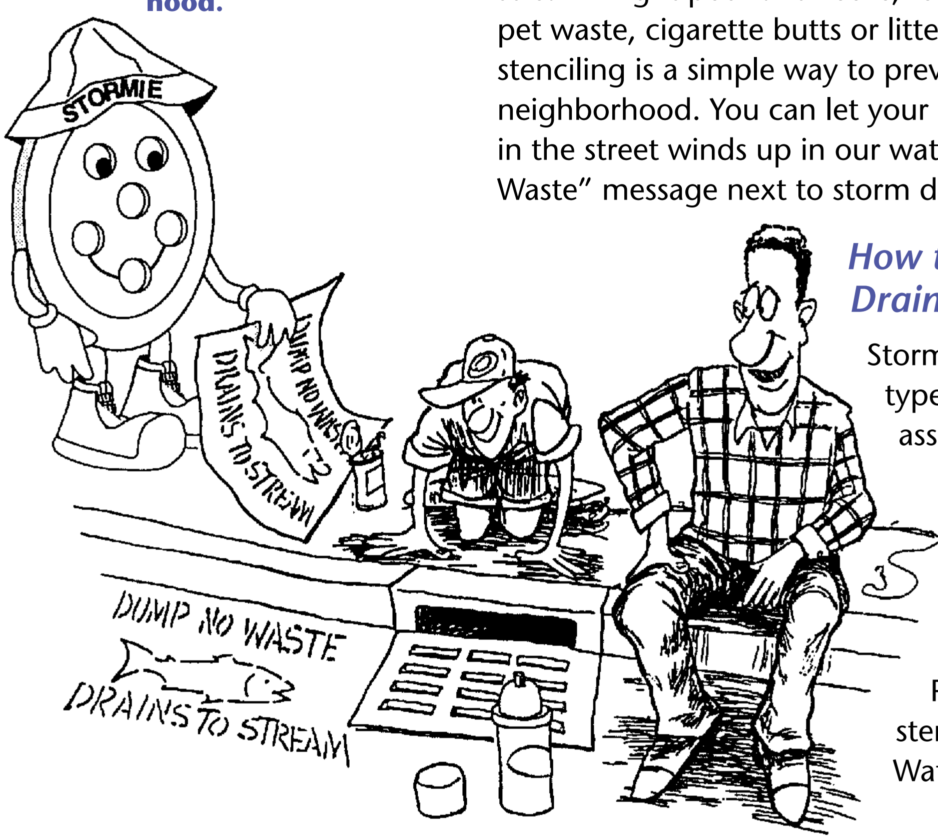


Did you know that every city street is like waterfront property? It's true. Just take a walk down your street. Before long, you'll come to a storm drain. Any water that runs down this drain flows directly into our waterways. It does not pass through the sanitary sewer system, and it does not receive any kind of treatment.

This means that whatever we put down these storm drains winds up in the lakes and streams where we go fishing, boating and swimming.

Storm drain stenciling is one way to help prevent runoff pollution in your neighborhood.

People who would never dream of polluting a lake or stream might pour antifreeze, fertilizer, paint or used motor oil, or toss pet waste, cigarette butts or litter down storm drains. Storm drain stenciling is a simple way to prevent this kind of pollution in your neighborhood. You can let your neighbors know that anything dumped in the street winds up in our waterways by stenciling a "Dump No Waste" message next to storm drains.



How to Sign Up for Storm Drain Stenciling

Storm drain stenciling is a great activity for all types of organizations from neighborhood associations to scout groups to service clubs. By participating, the members of your group will become more aware of the close link between our streets and waterways. And you will leave behind a reminder for others.

For more information about storm drain stenciling in your community, contact Water Action Volunteers, 608/264-8948.

It All Adds Up

We've cleaned up most of the big sources of water pollution like industries and sewage treatment plants. Now much of the pollution in our lakes and streams comes from small, scattered sources. Stenciling the storm drains in your neighborhood may seem like a small thing to do for clean water, but it is important.

It's up to each of us to reduce the pollution that comes from our cars, streets, driveways and yards. Together, our actions will add up to cleaner water for us and for our children.

MAKING YOUR MARK – SOME PRACTICAL ADVICE

Getting permission

You must have permission before stenciling storm drains. You or the sponsor can get permission from the local Department of Public Works. To stencil storm drains on private property (for example, in parking lots for businesses or apartments), you need permission from the property owner.

Organizing your teams

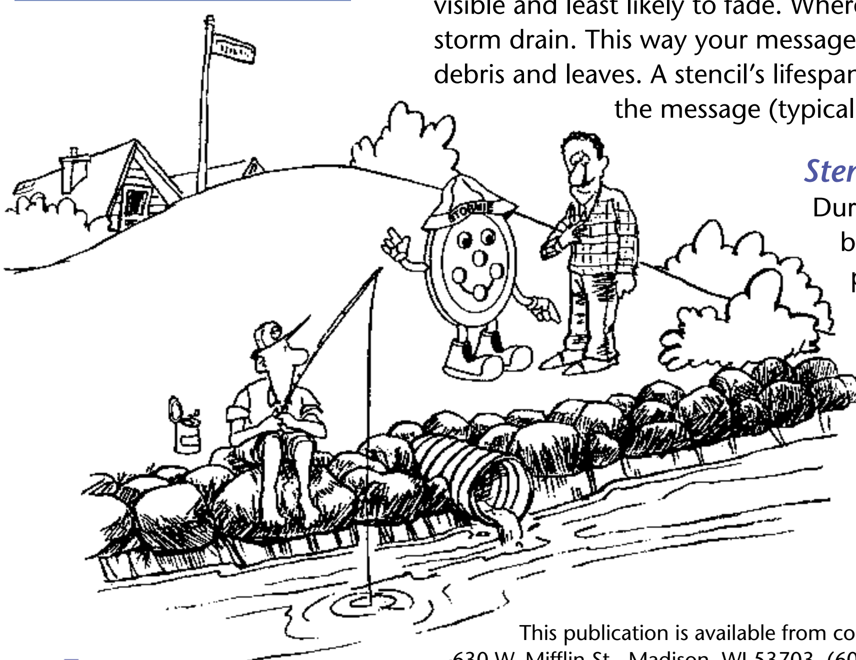
Before you start, take a careful look at the area your group will cover. Divide the area into routes and assign a team to each route so no storm drain goes unstenciled. If you have a large area to cover, have someone do a "quality check" to be sure all drains were stenciled. Assign another person to collect, clean up and return the stencil kits.

Telling your story

Send a news release or call your local newspaper, radio or television station announcing when and where your group will be stenciling. News coverage will educate more people about the importance of keeping storm drains clean. Another way to let the neighbors know what you are doing is to hang cards on their front doors explaining the project. Your sponsor has a supply of these cards.

Painting

Fair weather is essential for this project! The pavement must be dry and warm. Check your paint can for specific instructions. Use the wire brush in your kit to clean the area in the gutter next to the storm drain. Then, tape the stencil in place and spray paint the message. Two light coats of paint work better than one heavy coat. The best kind of paint to use is a traffic zone latex. White is the best color because it is the most visible and least likely to fade. Wherever possible, paint on the downhill side of the storm drain. This way your message won't be worn off by flowing water or covered by debris and leaves. A stencil's lifespan depends on use. When paint builds up and blurs the message (typically five to ten stenciling events), discard the stencil.



Stenciling Safety

During a stenciling outing, your group will frequently be in the street. Please follow all traffic safety practices. Wear safety vests or brightly colored clothes and be alert. On busy streets, choose a time of day when there is less traffic. When working with children, assign an adult to each team.

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GWQ015 Storm Drain Stenciling – How You Can Prevent Water Pollution

DNR WT-531-99

R-09-99-10M-20-S

Stormie's Clean Water Tips

Storm Sewers
The Rivers Beneath Our Feet

A SERIES OF WATER QUALITY FACT SHEETS ABOUT STORMWATER RUNOFF

If you look in the street outside of your home or office and search the parking lots around town, you will probably find storm sewer inlets. Did you ever wonder where they go?

A common misconception about storm sewers is that they go to a waste-water treatment plant. This is not the case. Storm sewers transport stormwater (rain and melting snow) to the nearest river, lake, stream or wetland.

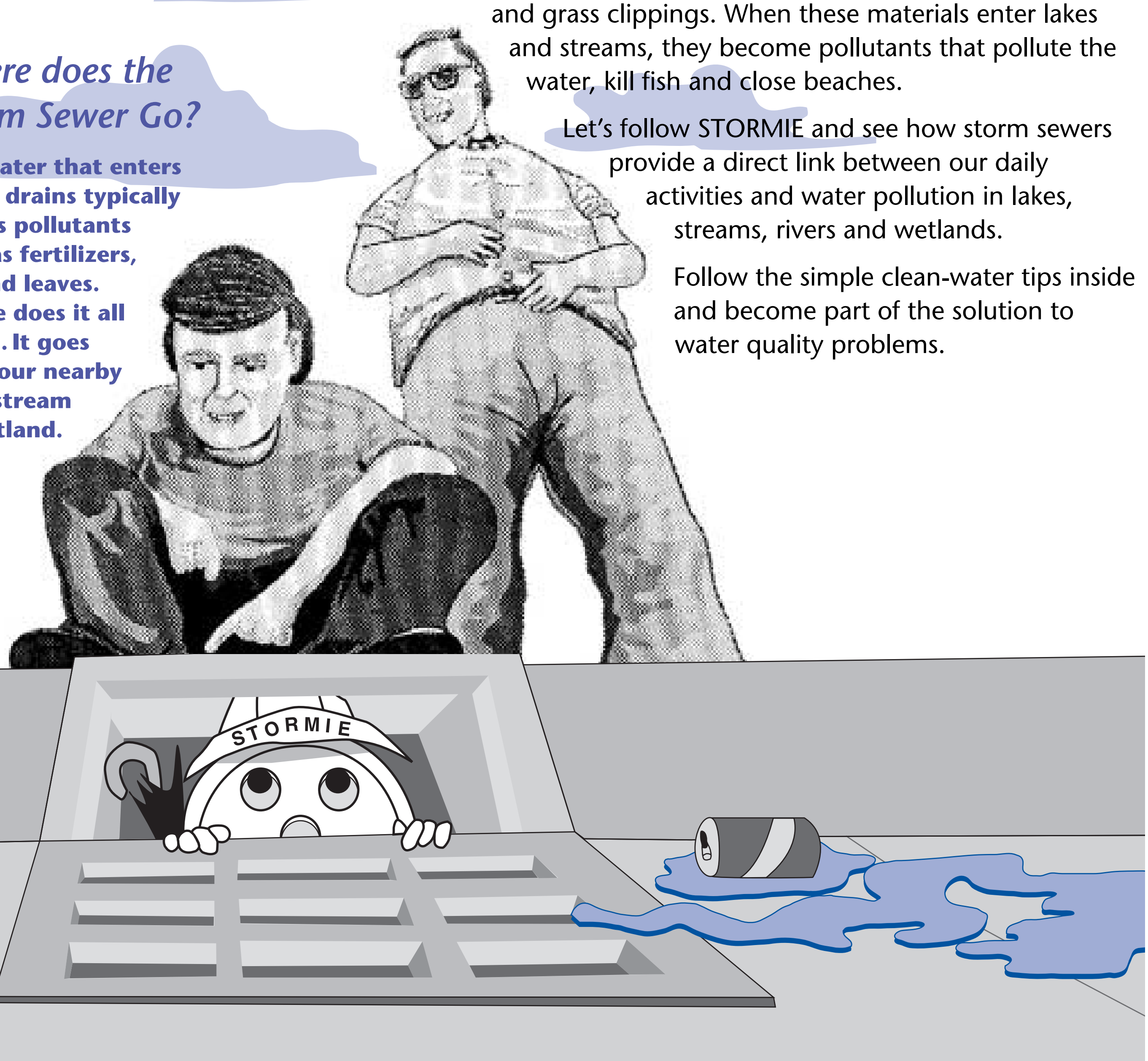
Stormwater often contains materials found on streets and parking lots such as oil, antifreeze, gasoline, soil, litter, pet wastes, fertilizers, pesticides, leaves and grass clippings. When these materials enter lakes and streams, they become pollutants that pollute the water, kill fish and close beaches.

Let's follow STORMIE and see how storm sewers provide a direct link between our daily activities and water pollution in lakes, streams, rivers and wetlands.

Follow the simple clean-water tips inside and become part of the solution to water quality problems.

Where does the Storm Sewer Go?

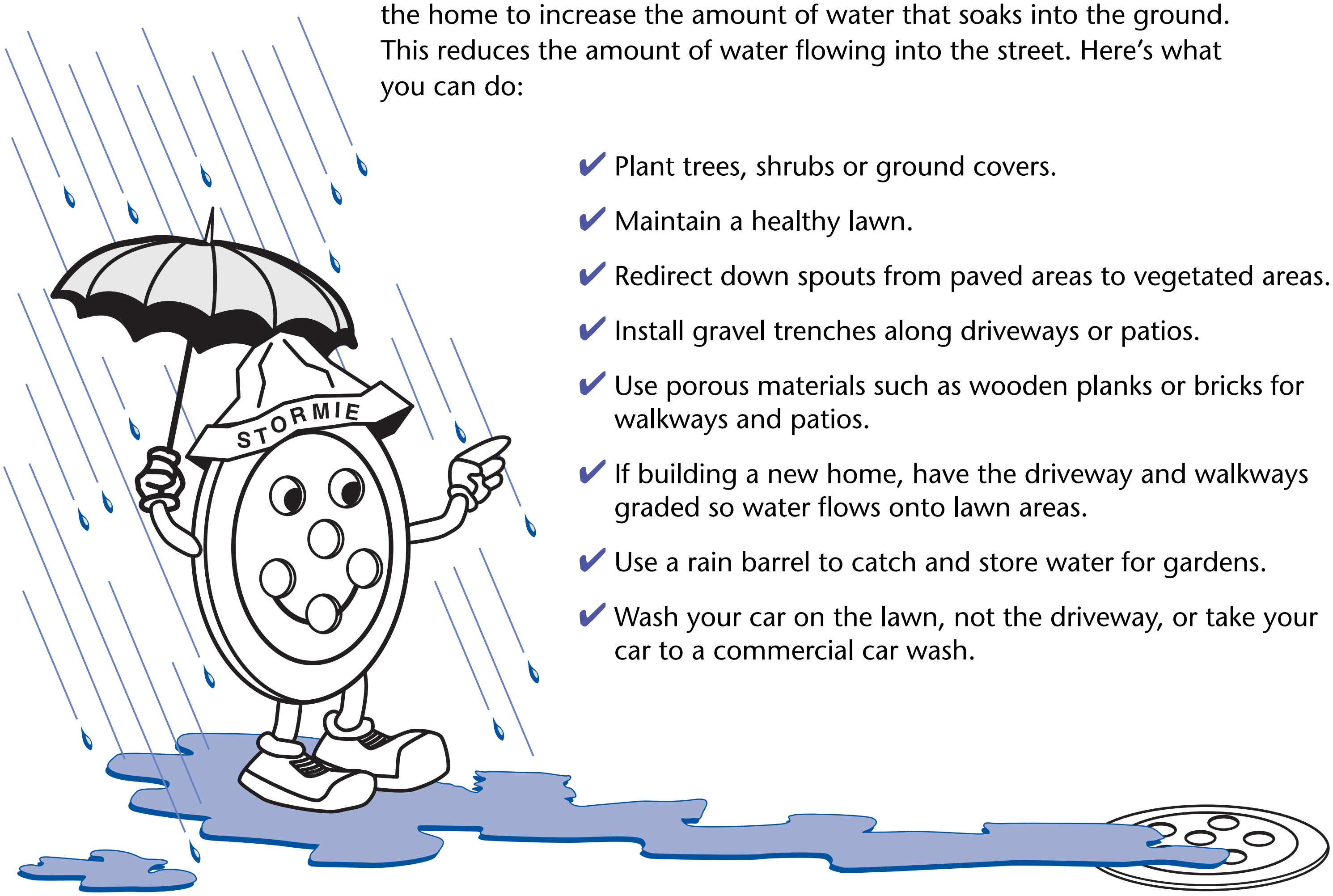
The water that enters storm drains typically carries pollutants such as fertilizers, oil, and leaves. Where does it all go? . . . It goes into your nearby lake, stream or wetland.



CONTROLLING STORMWATER POLLUTION – WE CAN ALL HELP

According to federal regulations, many cities and industries must reduce water pollution from storm sewers. We can help by taking steps around the home to increase the amount of water that soaks into the ground. This reduces the amount of water flowing into the street. Here's what you can do:

- ✔ Plant trees, shrubs or ground covers.
- ✔ Maintain a healthy lawn.
- ✔ Redirect down spouts from paved areas to vegetated areas.
- ✔ Install gravel trenches along driveways or patios.
- ✔ Use porous materials such as wooden planks or bricks for walkways and patios.
- ✔ If building a new home, have the driveway and walkways graded so water flows onto lawn areas.
- ✔ Use a rain barrel to catch and store water for gardens.
- ✔ Wash your car on the lawn, not the driveway, or take your car to a commercial car wash.



For more information about stormwater pollution and what you can do to reduce it, contact the Department of Natural Resources or your county UW-Extension or Land Conservation office.

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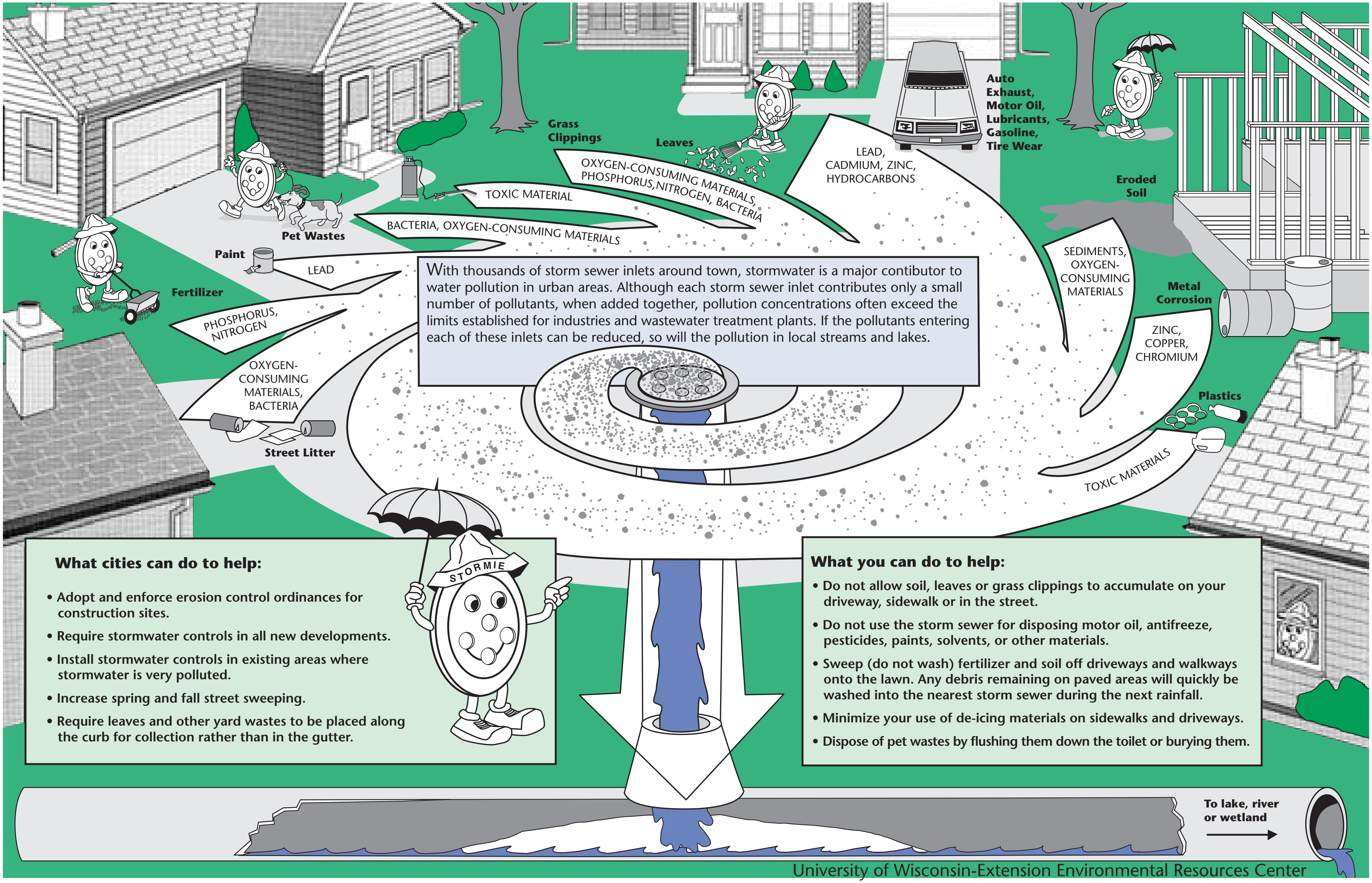
GWQ004 Storm Sewers – The Rivers Beneath Our Feet

DNR WR-460-94

R-09-99-15M-25-S



With thousands of storm sewer inlets around town, stormwater is a major contibutor to water pollution in urban areas. Although each storm sewer inlet contributes only a small number of pollutants, when added together, pollution concentrations often exceed the limits established for industries and wastewater treatment plants. If the pollutants entering each of these inlets can be reduced, so will the pollution in local streams and lakes.

What cities can do to help:

- Adopt and enforce erosion control ordinances for construction sites.
- Require stormwater controls in all new developments.
- Install stormwater controls in existing areas where stormwater is very polluted.
- Increase spring and fall street sweeping.
- Require leaves and other yard wastes to be placed along the curb for collection rather than in the gutter.

What you can do to help:

- Do not allow soil, leaves or grass clippings to accumulate on your driveway, sidewalk or in the street.
- Do not use the storm sewer for disposing motor oil, antifreeze, pesticides, paints, solvents, or other materials.
- Sweep (do not wash) fertilizer and soil off driveways and walkways onto the lawn. Any debris remaining on paved areas will quickly be washed into the nearest storm sewer during the next rainfall.
- Minimize your use of de-icing materials on sidewalks and driveways.
- Dispose of pet wastes by flushing them down the toilet or burying them.

University of Wisconsin-Extension Environmental Resources Center

Appendix D

USGS – Water Quality Summary 2004

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Discipline
8505 Research Way
Middleton, WI 53562-3586
Phone: (608) 828-9901
Fax: (608) 821-3817
http://wi.water.usgs.gov

May 4, 2004

Ms. Sally Murwin
Minocqua/Kawaguesaga Lake Protection Assoc.
8229 Brinkland Circle
Minocqua, Wisconsin 54548

Dear Sally:

As discussed previously, following is a summary of the data collected by the U.S. Geological Survey in fiscal year 2003, from the lake monitoring program under our joint cooperative agreement and DNR grant. This may be used to indicate completion of the planning grant. If you have any questions about these materials, please call. Thank you for your continued cooperation in this effort.

Sincerely,

Herbert S. Garn
Assistant District Chief

Enclosures

Minocqua and Kawaguesaga Lakes, Oneida County, WI
Water-Quality Data Summary-2003

U. S. Geological Survey, May 2004
Herbert S. Garn

This data summary covers the period May to September 2003, which is the period of water-quality monitoring by the U.S. Geological Survey (USGS). All data presented will be published in the USGS annual lake data report "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2003," which will be available in late May 2004. Data from previous years collected by others are included in graphs for comparison and to illustrate changes or trends.

The goals of the 2003 Phase 1 study were to:

- **Review and summarize pertinent existing documents and reports about the hydrology, water quality, and management plans for the lake system.**

- **Evaluate current and historical lake water quality and trophic state relative to longer-term trends.**

- **Use results and information from the above to design Phase 2, a proposal for a comprehensive diagnostic/feasibility study, to be submitted as part of a Lake Protection Grant application.**

In reviewing the data, it may be helpful to refer to the methods and explanations of physical and chemical characteristics sections in the USGS annual lake data report "Water-Quality and Lake-Stage Data for Wisconsin Lakes" and to Shaw and others (1994) "Understanding Lake Data."

Lake description and sampling locations

Minocqua and Kawaguesaga Lakes are a complex chain of drainage lakes in Oneida County in the northeastern lakes region of Wisconsin. The surface areas of the lakes are 1,360 and 670 acres, respectively, with maximum depths of 60 and 44 feet. Minocqua Lake receives inflows from upstream chain of lakes through the Tomahawk and Minocqua Thoroughfares and flows directly into Kawaguesaga Lake. Lake levels of both lakes are controlled by a dam at the outlet of Kawaguesaga Lake, which flows into the Tomahawk River. The dam and lake levels are managed by Wisconsin Valley Improvement Company for storage to augment the flow of the Wisconsin River. The total drainage area at the outlet dam is 72.5 square miles. The rapidly growing urban area of Minocqua is on the shore of these lakes.

Phase 1 consisted of lake water-quality monitoring beginning in May 2003 through September 2003 to identify and characterize current lake conditions and problems. Included in this phase is a review and summary of available historical water-quality data (WDNR long-term monitoring, Self-Help data, and previous studies that may have been conducted on the lakes. Results and information from this phase will be used to design phase 2, a comprehensive study to assess the hydrology and nutrient loading of the lakes, and model the effects of different potential loading scenarios.

Lake water-quality monitoring was done at three locations in Minocqua Lake; a main sampling site over the deepest location in the lake, and at additional auxiliary sites in the northwestern basin of the lake and in the bay near the outlet (fig. 1). Land uses within the immediate watersheds of the lakes are shown in figure 2. Two locations were sampled in Kawaguesaga Lake: the main sampling site over the deepest part of the lake and at one auxiliary site in the southern basin of the lake. Lake stage was monitored at the dam outlet. The sites were sampled according to the schedules shown in tables 1 and 2. Basic chemical characterization of the water was determined by analyzing a water sample for 19 constituents. This sample was taken from the main sampling site during spring turnover. Vertical profiles of temperature, dissolved oxygen, specific conductance, and pH were measured at all sampling locations during each sampling visit. The trophic state index (TSI) parameters of total phosphorus and chlorophyll a concentrations and Secchi depth, were measured or sampled at all sites at all open-water sampling visits. Samples for phosphorus and nitrogen species were collected to determine the nitrogen/phosphorus ratio, which is an indication of nitrogen or phosphorus limitation and the propensity for blue-green algal blooms.

The WDNR and Lake Association have conducted various studies of the lakes and watershed over the past ten years or more. The extensive amount of technical information and reports available about the system are generally not in a form that is easily used by the Lake Association, Town, other local governments, and residents for decision-making. Past lake water-quality data collected by the WDNR and Lake Association were summarized and evaluated. Self-Help data collection began in 2000 and is continuing, but no comprehensive chemical sampling has been done for the past several years.

Summary of past studies

Lake-bottom sediment cores were collected in 1991 and 1992 from Minocqua Lake by WDNR for analysis of the historical record (Garrison, written comm., 2003; Young, 1994). Development since about 1890 has caused a doubling of the sedimentation rate, with greater increases in rate since about 1965. The phosphorus accumulation rate remained relatively constant until about 1950, but has increased significantly since then to the present. Since 1920, the phosphorus accumulation rate has more than tripled, with the greatest rates occurring after about 1980. The southwestern basin had experienced more rapid impacts from shoreline and watershed development than the main basin.

The WDNR conducted macrophyte surveys in 1989, 1993, and 1996 as part of the long-term trend lake monitoring program (WDNR, written comm., 1996). The most common species found were coontail, which had increased in frequency of occurrence since 1989. The percentage of littoral area vegetated also increased from 87% in 1989 to 92% in 1996. The macrophyte community is characterized by high diversity and primarily submergent species. Related to this topic, soil fertility of the littoral zone sediments was surveyed in 2002 (Steve McComas, BlueWater Science, written comm.) to evaluate the potential to support nuisance Eurasian watermilfoil growth. Currently, Eurasian watermilfoil was found only in several small patches in Lake Minocqua covering several acres or less. Nitrogen levels in littoral soils were found to be low to moderate and the potential for supporting nuisance growths was limited to only a few small areas totaling less than 20 acres.

An evaluation of the impacts from septic systems on ground water and surface water was conducted in 1996 (Lindemann and others, 1997). The study included about half of the 160 homes on Lake Minocqua that have on-site sewage disposal systems. The presence of high groundwater tables and highly permeable sandy soils can cause incomplete on-site wastewater treatment and loading of nutrients to be a concern. The study found increased amounts of ammonium, nitrate, phosphorus and chloride entering the lake by groundwater flow. The study did not, however, attempt to quantify the nutrient loading contributed by septic systems. A number of sites had one or more nutrients at elevated concentrations at the lake edge and most of these were associated with developed areas using septic systems. The majority of septic systems studied were older than 25 years and any problems associated with them are likely to become greater in the future as they age further. Other areas having elevated concentrations may be associated with wetland seepage or stormwater runoff from urban areas.

Hydrologic conditions during 2003 water year

Annual variability in lake condition often reflects variability in climatic and hydrologic conditions. Air temperature in Northcentral Wisconsin was, on the average, cooler than normal for June and July, and warmer than normal in August (National Oceanic and Atmospheric Administration “Climatological Data--Wisconsin”). Precipitation during water year 2003 was 90 percent of normal for Northcentral Wisconsin (Ed Hopkins, State Climatology Office, Univ. of Wisconsin, written commun., 2004). Following a wet spring, monthly precipitation during summer was 78 percent of average for June, 73 percent for July, 50 percent for August, and 71 percent for September. May precipitation was above average with 143 percent. Annual watershed runoff in the region of Minocqua was 96 percent of long-term average runoff (Waschbusch and others, 2004, “Water Resources Data—Wisconsin, Water Year 2003”).

Lake Data for 2003:

The following is a summary of highlights from the data given in the tables and shown in the figures.

<u>Lake-stage fluctuations:</u>
Lake stages were obtained at Minocqua Dam from WVIC on sampling dates. The stages ranged from 1584.16 feet on May 8 to 1584.56 feet on June 18. Stage values are shown in the table on the top half of Figure 3.

<u>Lake-depth profiles:</u>
Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance. These profiles, which were measured over the deepest point in the lakes, are shown in Figure 3. During the May through September sampling period, water-column mixing was observed on May 8. The lake became thermally stratified through the summer. By June 18 the column of water became anoxic (devoid of oxygen) below a depth of 13 meters (43 feet) in Minocqua L. and below 9 meters (29.5 feet) in Kawaguesaga; by August, depths below 9 meters in Minocqua and 7 meters in Kawaguesaga were anoxic. The anoxic zone is unable to support fish. The pH, which ranged between 6.4 and 8.1, is common for northern Wisconsin lakes and poses no problems for aquatic life. Specific conductance increased while pH decreased in the anoxic zone during the summer.

<u>Chemical constituents:</u>
Analyses of water samples collected on May 8 for selected chemical constituents for characterization of the lake are shown in Figure 3. The constituent values for color, chlorophyll <u>a</u>, chloride, calcium, magnesium, pH, alkalinity, total nitrogen, and total phosphorus are within regional values for this area as described by Lillie and Mason in "Limnological Characteristics of Wisconsin Lakes," 1983, Technical Bulletin No. 138, Department of Natural Resources.

The ratio of total nitrogen to total phosphorus is 15 for Minocqua and 13 for Kawaguesaga based on the surface concentrations on May 8. These ratios suggest the lakes are phosphorus limited, which means phosphorus is the most likely nutrient controlling algal growth.

Three common measures of water quality used as indices are concentrations of near-surface total-phosphorus and chlorophyll <u>a</u>, and Secchi depth. Total phosphorus concentrations for Minocqua Lake ranged from 0.012 mg/L to 0.037 mg/L, chlorophyll <u>a</u> ranged from 1.78 ug/L to 21ug/L, and Secchi depths ranged from 1.6 to 4.6 m. Total phosphorus concentrations for Kawaguesaga Lake ranged from 0.011 mg/L to 0.028 mg/L, chlorophyll <u>a</u> ranged from 2.9 ug/L to 16.8ug/L, and Secchi depths ranged from 1.6 to 3.6 m.

Surface total phosphorus and chlorophyll <u>a</u> concentrations, and Secchi depths for 2003 and the historical period from 1973 are shown on time plots, Figure 4. No trends are apparent from these data for Kawaguesaga Lake. For Minocqua Lake, there appears to be an upward trend in total phosphorus data from about 1990-2003, but no apparent trend in chlorophyll <u>a</u> or Secchi data.

Total phosphorus concentrations 0.5 meters above the lake bottom at the deep sampling sites ranged from 0.02 mg/L on May 8 to 0.273 mg/L on August 12 for Minocqua Lake, and 0.033 mg/L on May 8 to 0.131 mg/L on August 12 for Kawaguesaga Lake. These total phosphorus concentrations observed during anoxic periods are indicative of moderate phosphorus release from the bottom sediments.

Lake condition:

Water-quality index:

Lillie and Mason (1983) classified all Wisconsin lakes using a random data set collected in the summer (July and August). The index, shown in "Water-Quality and Lake-Stage data for Wisconsin Lakes," is based on surface total phosphorus and chlorophyll a concentrations, and Secchi depths. According to the index, surface total phosphorus, chlorophyll a concentrations, and Secchi depths in Minocqua and Kawaguesaga Lakes generally indicate "good" water quality.

Trophic status:

Another means of assessing the nutrient, or trophic, status of a lake is to use Carlson's Trophic State Index (TSI). The bottom plot of the time plots is a graphical illustration of the variation in Trophic State Indices for Minocqua and Kawaguesaga Lakes from 1973 to 2003. The data from 2003 show the lake to be mesotrophic to borderline eutrophic, or a lake with moderate nutrient levels. The lakes are generally mesotrophic, but reach eutrophic conditions at times with the hypolimnion becoming anoxic.The northwest basin may generally have slightly poorer water quality than the main basin. Kawaguesaga lake has similar TSI's, and both lakes show no apparent trend over the 30-year period. Although water quality is generally good and trophic condititon of the lakes is borderline eutrophic, recent increasing trends in total phosphorus and moderately high bottom phosphorus concentrations are of some concern.

Phase 2 proposal

A proposal for a possible future diagnostic/feasibility study, entitled "**HYDROLOGY, WATER QUALITY, AND RESPONSE TO SIMULATED CHANGES IN PHOSPHORUS LOADING OF MINOCQUA AND KAWAGUESAGA LAKES, ONEIDA COUNTY, WISCONSIN"** was presented to the Minocqua/Kawaguesaga Lakes Protection Association in January 2004.

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Wisconsin Department of Natural Resources, 1996, Minocqua – Woodruff Priority lakes Project Plan, WDNR Publ. WT-477-96, 89 p.

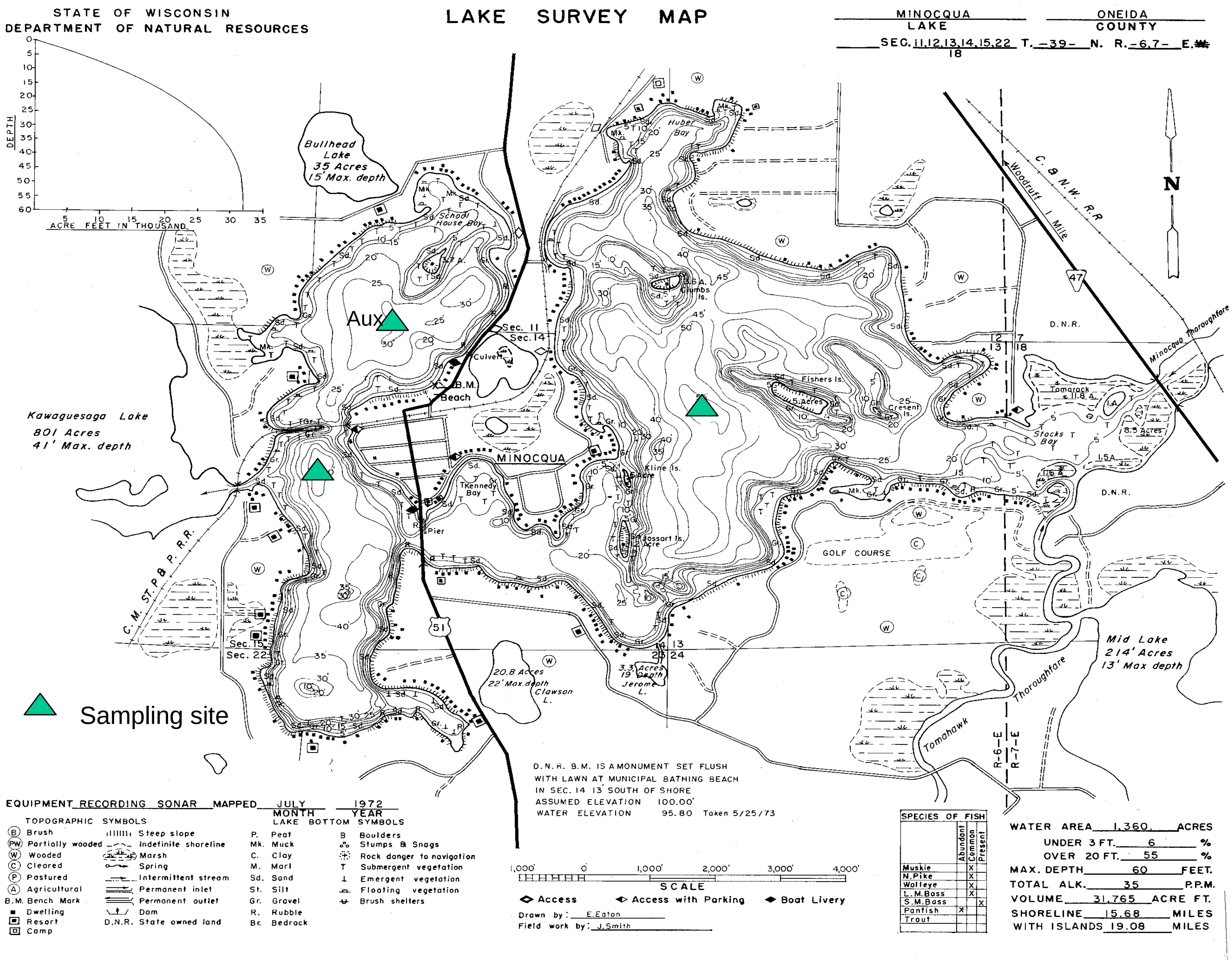
Young, Robert, 1994, Minocqua-Woodruff priority lake project water resources appraisal: Wisconsin Dept. of Natural Resources, North Central District, 18 p.

Table 1. Schedule and parameters for main, deep hole, water-quality monitoring sites in Minocqua and Kawaguesaga Lakes

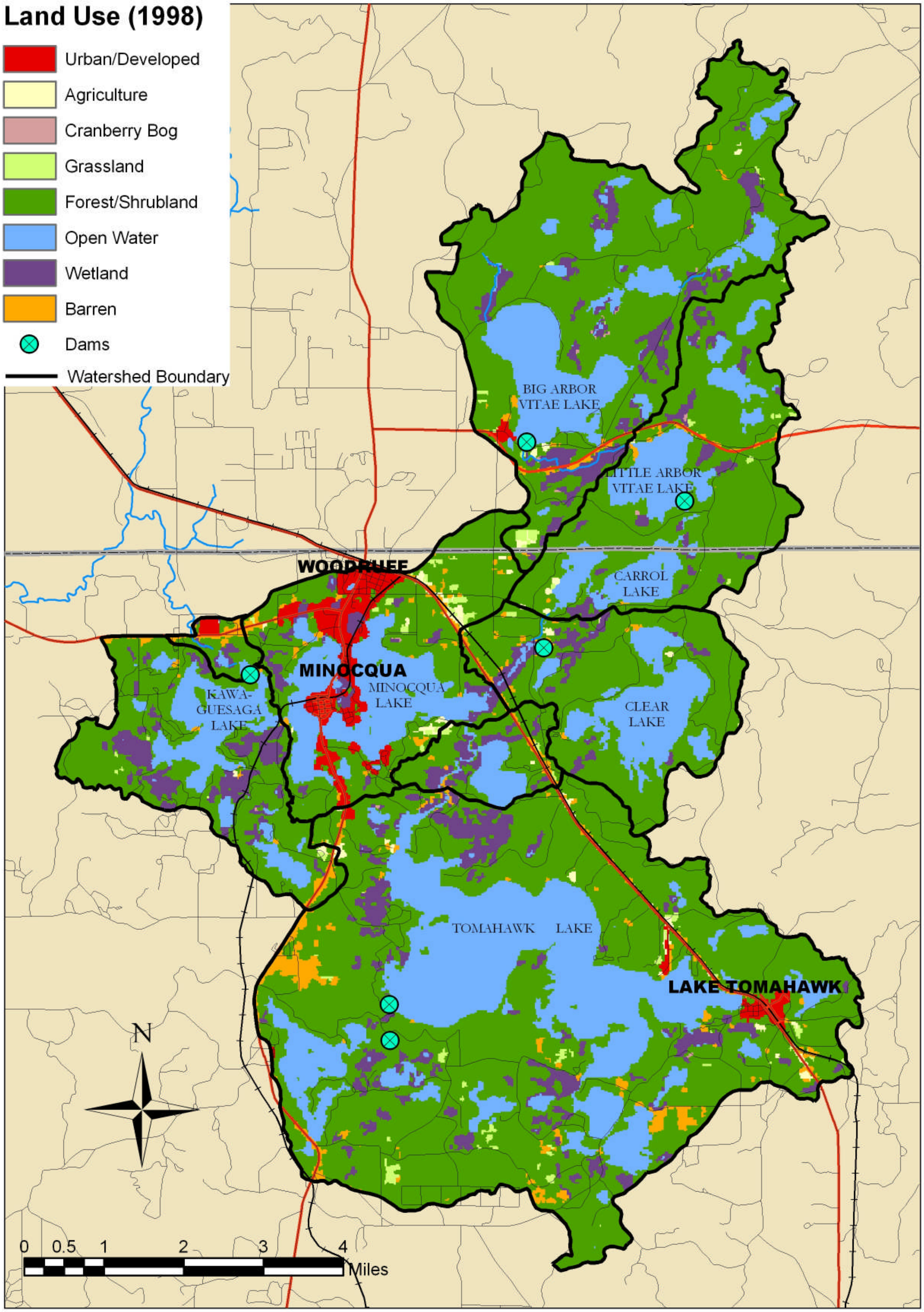
Parameter	Approximate date of collection						Remarks
	Feb. or Mar.	Spring, soon after ice-out	Mid-June	Mid-July	Mid-Aug.	Mid-Sep.	
Water chemistry		**X**					Sample 0.5 meter below surface. **19 constituents:** NO_2+NO_3-N, NH_4-N, NH_4+organic-N, P (dissolved), Ca, Cl, Mg, Na, K, pH, total alkalinity, hardness, Fe, Mn, color, turbidity, dissolved solids, SO_4, and SiO_2
Dissolved oxygen, temperature, pH, and specific conductance		**X**	**X**	**X**	**X**	**X**	Vertical profiles are defined by measuring the four parameters from 0.5 meters below the lake surface to the lake bottom at 0.5-1.0 meter intervals (interval depends on lake depth).
Total phosphorus (Number of samples)		**X (2)**	**X (2)**	**X (2)**	**X (3)**	**X (3)**	0.5 meter from surface and 0.5 meter from bottom, except for mid-Aug., Sep. when an additional sample from just below the thermocline will be analyzed.
Chlorophyll a		**X**	**X**	**X**	**X**	**X**	0 - 0.5 meter from the surface
Secchi depth		**X**	**X**	**X**	**X**	**X**	Index of clarity
Mid-summer dissolved nitrogen and phosphorus species					**X**		0 - 0.5 meter from the surface. NO_2+NO_3-N (dissolved), NH_4-N (dissolved), NH_4+organic-N (filtered), and P (dissolved)

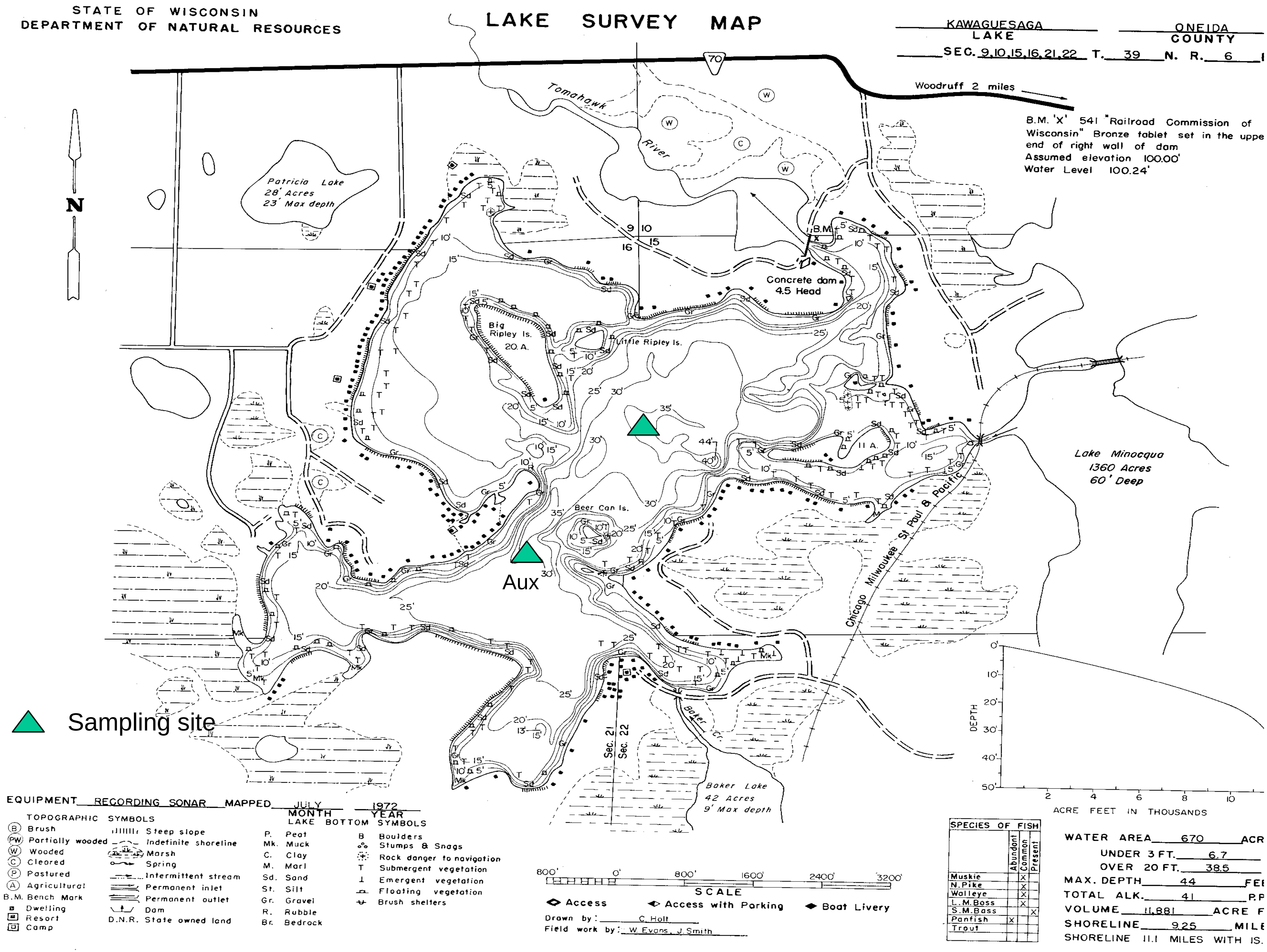
Table 2. Schedule and parameters for auxiliary water-quality monitoring sites in Minocqua and Kawaguesaga Lake

Parameter	Approximate date of collection						Remarks
	Feb. or Mar.	Spring, right after ice-out	Mid-June	Mid-July	Mid-Aug.	Mid-Sep.	
Dissolved oxygen, temperature, pH, and specific conductance		**X**	**X**	**X**	**X**	**X**	Vertical profiles are defined by measuring the four parameters from 0.5 meters below the lake surface to the lake bottom at 0.5-1.0 meter intervals (interval depends on lake depth).
Total phosphorus (Number of samples)		**X (2)**	**X (2)**	**X (2)**	**X (3)**	**X (3)**	0.5 meter from surface and 0.5 meter from bottom, except for mid-Aug., Sep. when an additional sample from just below the thermocline will be analyzed.
Chlorophyll a		**X**	**X**	**X**	**X**	**X**	0 - 0.5 meter from the surface
Secchi depth		**X**	**X**	**X**	**X**	**X**	Index of clarity



STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
LAKE SURVEY MAP
MINOCQUA LAKE
ONEIDA COUNTY
SEC. 11,12,13,14,15,22 18 T. -39- N. R. -6,7- E.
DEPTH
ACRE FEET IN THOUSAND
Bullhead Lake 35 Acres 15' Max. depth
Kawaguesaga Lake 801 Acres 41' Max. depth
School House Bay
Huber Bay
Clumbs Is.
Fishers Is.
Cresent Is.
Kline Is.
Jossart Is.
Tomarack
Stacks Bay
Kennedy Bay
MINOCQUA
B.M. Beach
Culvert
Pier
GOLF COURSE
D.N.R.
Minocqua Thoroughfare
C. & N.W. R.R.
Woodruff 1 Mile
C. M. ST. P. & P. R.R.
20.8 Acres 22' Max. depth Clawson L.
3.3 Acres 19' Depth Jerome L.
Mid Lake 214' Acres 13' Max depth
Thoroughfare
Tomahawk
R-6-E R-7-E
Aux
Sampling site
D.N.R. B.M. IS A MONUMENT SET FLUSH WITH LAWN AT MUNICIPAL BATHING BEACH IN SEC. 14 13' SOUTH OF SHORE
ASSUMED ELEVATION 100.00'
WATER ELEVATION 95.80 Taken 5/25/73
EQUIPMENT RECORDING SONAR MAPPED JULY 1972
MONTH YEAR
TOPOGRAPHIC SYMBOLS
LAKE BOTTOM SYMBOLS
SCALE
Access
Access with Parking
Boat Livery
Drawn by: E. Eaton
Field work by: J. Smith
SPECIES OF FISH
Muskie
N. Pike
Walleye
L. M. Bass
S. M. Bass
Panfish
Trout
WATER AREA 1,360 ACRES
UNDER 3 FT. 6 %
OVER 20 FT. 55 %
MAX. DEPTH 60 FEET.
TOTAL ALK. 35 P.P.M.
VOLUME 31,765 ACRE FT.
SHORELINE 15.68 MILES
WITH ISLANDS 19.08 MILES


Land Use (1998)
Urban/Developed
Agriculture
Cranberry Bog
Grassland
Forest/Shrubland
Open Water
Wetland
Barren
Dams
Watershed Boundary
BIG ARBOR VITAE LAKE
LITTLE ARBOR VITAE LAKE
CARROL LAKE
CLEAR LAKE
WOODRUFF
MINOCQUA
MINOCQUA LAKE
KAWAGUESAGA LAKE
TOMAHAWK LAKE
LAKE TOMAHAWK
N
0 0.5 1 2 3 4
Miles



STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
LAKE SURVEY MAP
KAWAGUESAGA LAKE
ONEIDA COUNTY
SEC. 9,10,15,16,21,22 T. 39 N. R. 6
Woodruff 2 miles
B.M. 'X' 541 "Railroad Commission of Wisconsin" Bronze tablet set in the upper end of right wall of dam
Assumed elevation 100.00'
Water Level 100.24'
N
70
Patricia Lake
28 Acres
23' Max depth
Tomahawk River
Concrete dam
4.5 Head
Big Ripley Is.
20 A.
Little Ripley Is.
11 A.
Beer Can Is.
Aux
Lake Minocqua
1360 Acres
60' Deep
Chicago Milwaukee St Paul & Pacific
Baker Cr.
Baker Lake
42 Acres
9' Max depth
Sec. 21
Sec. 22
Sampling site
DEPTH
ACRE FEET IN THOUSANDS
EQUIPMENT RECORDING SONAR MAPPED JULY 1972
MONTH YEAR
TOPOGRAPHIC SYMBOLS
B Brush
PW Partially wooded
W Wooded
C Cleared
P Pastured
A Agricultural
B.M. Bench Mark
Dwelling
Resort
Camp
Steep slope
Indefinite shoreline
Marsh
Spring
Intermittent stream
Permanent inlet
Permanent outlet
Dam
D.N.R. State owned land
LAKE BOTTOM SYMBOLS
P. Peat
Mk. Muck
C. Clay
M. Marl
Sd. Sand
St. Silt
Gr. Gravel
R. Rubble
Br. Bedrock
B Boulders
Stumps & Snags
Rock danger to navigation
T Submergent vegetation
Emergent vegetation
Floating vegetation
Brush shelters
SCALE
800' 0' 800' 1600' 2400' 3200'
Access
Access with Parking
Boat Livery
Drawn by: C. Holt
Field work by: W. Evans, J. Smith
SPECIES OF FISH
Abundant
Common
Present
Muskie
N. Pike
Walleye
L. M. Bass
S. M. Bass
Panfish
Trout
WATER AREA 670 ACR
UNDER 3 FT. 6.7
OVER 20 FT. 38.5
MAX. DEPTH 44 FEE
TOTAL ALK. 41 P.P
VOLUME 11,881 ACRE F
SHORELINE 9.25 MILE
SHORELINE 11.1 MILES WITH IS.

Appendix E

Wellhead Protection Plan and Ordinance

WELLHEAD PROTECTION PLAN
WELLS #3, #4 AND #5

Lakeland Sanitary District No. 1
Wisconsin

October 2004

Prepared by Lakeland Sanitary District
With assistance from
Wisconsin Rural Water Association

TABLE OF CONTENTS

FIGURES

APPENDICES

1. BACKGROUND

The Lakeland Sanitary District has prepared this wellhead protection plan for its existing supply wells (Wells #3 and #4) and proposed Well #5 for the purpose of minimizing the risk of contamination of the municipal water supply. Wells #1 and #2 were abandoned because of high iron content. A test well has been drilled and tested at the site of proposed Well #5 and data from the test well is used in delineating a wellhead protection area for the proposed well. The water system serves nearly the entire district with a permanent population of approximately 2,300 which increases to about 3,500 in the summer tourist season. Average demand is about 450,000 gpd and peak demand is about 1,000,000 gpd. The operational pumping capacities for the wells are:

Well #3	750 gpm
Well #4	850 gpm.
Well #5	500 gpm

The District has two elevated storage tanks with capacities of 300,000 and 75,000 gallons. The water is not treated.

Locations of the wells are shown in Figure 1 and lithologic logs and construction details for the wells are included in Appendix A. This plan was prepared in compliance with the Wisconsin Administrative Code, Chapter NR 811, Section 16(5) for wellhead protection planning.

2. HYDROGEOLOGIC SETTING

Lakeland Sanitary District includes about 20 square miles located in Oneida and Vilas Counties, an area that is characterized by a thick cover of glacial drift over Precambrian bedrock. Surface water drains through Minocqua Lake, into the Tomahawk River, which flows southward to the Wisconsin River. Wells #3 and #4 are located on essentially an island, the west part of which is occupied by downtown Minocqua. The flat area north of Minocqua Lake is a broad pitted outwash plain while the more rugged area to the south contains many kames and other ice-contact outwash features. Wells #3 and #4 are screened in ice-contact deposits of sand and gravel. At Well #5, the upper 120 feet is alluvium of the pitted outwash plain. The underlying clay is interpreted as glacial till, deposited during the Copper Falls glacial advance (Attig, 1985) and below the till is another layer of outwash, in which Well #5 is screened. The Precambrian bedrock encountered at a depth of 311 feet at Well #5 consists of metamorphic rock of low permeability. The static water level at Well #5 indicates that the lower outwash is under artesian conditions.

The clay till provides protection to the lower outwash aquifer, provided that it is not breached by improperly abandoned wells. At Wells #3 and #4, there is no significant clay to protect the shallow sand and gravel aquifer. Vertical relationships of the wells, aquifers and discharge points are illustrated in Figure 2.

3. GROUNDWATER RECHARGE AND MOVEMENT

The direction of groundwater movement may be inferred from the slope of the water table or potentiometric surface and the regional topography. Shallow groundwater generally moves in the direction toward which the water table slopes. The best available map of groundwater elevations for the area (Patterson, 1989) includes only Vilas County and indicates that shallow groundwater near Woodruff moves southward (Figure 3). A smaller scale map (Oakes and Cotter, 1975) shows groundwater generally moving southwestward following the course of the Tomahawk River. Actual flow paths are complicated by the variable permeability and thickness of the outwash and are difficult to predict. The direction of groundwater flow is especially problematic at Wells #3 and #4, where pumpage may induce groundwater recharge from the lake. Groundwater captured by the wells is recharged by infiltration of precipitation in an area extending up gradient from each well to groundwater divides, which cannot be determined without additional information.

4. ZONE OF INFLUENCE

The zone of influence is the area encompassed within a calculated radius around a well, representing the area of a cone of depression that would develop after 30 days of continuous pumping at the well's capacity, assuming that there is no recharge to the groundwater. It simulates theoretical worst-case conditions, in which the cone of depression would reach maximum extent. The zone of influence depends on aquifer thickness and permeability (transmissivity) and the pumping rate. Transmissivity at the well was determined from the "T-Guess" computer solution using pumping test data. Using the Theis equation, the zone of influence radii for the three wells are calculated to be:

Well #3	1,337 ft
Well #4	1,466 ft
Well #5	9,957 ft

Calculations of the zone of influence and supporting data are included in Appendix B.

5. WELLHEAD PROTECTION AREA

There are different methods of delineating a wellhead protection area, ranging from a simple fixed radius to the use of complex computer models. The fixed radius depends on the pumping rate, time of pumping and the aquifer's porosity and thickness. Using the Volumetric Flow Equation, the radius of a theoretical cylindrical volume of aquifer dewatered during five years of pumping is calculated. Calculated fixed radii for the wells are:

Well #3	2,541 ft
Well #4	2,705 ft
Well #5	1,870 ft

In another method, the Uniform Flow Equation is used to calculate the width and down-gradient length (null point) of the recharge area for a well, measured along the ambient groundwater flow line to the well. The "Zone of Contribution" delineated in this method depends on the pumping rate, groundwater gradient and the aquifer's transmissivity. Using this method, the following dimensions were calculated:

Well #3	Width	21,719 ft	Null Point	3,475 ft
Well #4		9,194 ft		1,471 ft
Well #5		13,613 ft		22,018 ft

The zone of contribution area extends up gradient to the groundwater divide; however, for practical reasons, the up-gradient extent of the wellhead protection area may be limited to a minimum distance of the 5-year time-of-travel (TOT) of groundwater to the well, for which the following distances were determined:

Well #3	934 ft
Well #4	2,499 ft
Well #5	80 ft

Calculations of the zone of contribution and time-of-travel distances are based on the assumptions of laterally extensive and homogeneous aquifers, which is not true for the outwash deposits in this area. Because of this and the uncertainty in groundwater flow directions, it is reasonable to use the nondirectional calculated fixed radii as the wellhead protection areas, as shown on Figure 4. Until the new Well #5 is constructed, the pumping capacity can only be estimated. Therefore, alternate calculations were made using a lower capacity of 250 gpm, shown as "5 Alt" in Appendix B. The calculated fixed radius for the smaller capacity is 1,322 feet. The wellhead protection areas can be extended to convenient geographic boundaries for use as overlay districts in a wellhead protection ordinance. Calculations used in the delineation of the wellhead protection areas are included in Appendix B.

6. POTENTIAL CONTAMINANT SOURCES

Potential contaminant sources near Wells #3 and #4 were identified in the Source Water Assessment (WDNR, 2003) and potential sources within a half-mile radius of Well #5 were identified by the wellhead protection team. The District wells meet construction code standards but are considered susceptible to some types of contamination primarily because of the lack of clay above the aquifer, proximity to potential sources and past detections at the wells (WDNR, 2003). Wells #3 and #4 are in a residential neighborhood. Well #3 has been affected by a spill at a former dry cleaning facility about 500 feet to the west. There are numerous remediation sites in downtown Minocqua, about 1,500 feet west of the wells. Well #5 is at the north edge of an undeveloped wooded area south of Townline Road. North of the road is a mobile home park with a lift station and a cemetery is located about 1,000 feet to the east. Primary concerns include sanitary sewers near the wells and the spill site near Well #3. The locations of potential contaminant sources are shown on Figure 5.

7. MANAGEMENT STRATEGY

The District has well-abandonment and cross-connection ordinances and plans to prepare a wellhead protection ordinance. That ordinance will include the required separation distances specified in NR 811.16. In addition, these separations will be maintained for future structures through the building permit review process conducted by the County Zoning Committee. Private wells at residences served by municipal water will be evaluated for abandonment requirements. The surrounding Towns of Minocqua, Woodruff and Arbor Vitae, as well as the Oneida and Vilas County Planning Commissions will be informed of the wellhead protection plan and asked for cooperation in protection of the recharge areas. The District will request incorporation of essential elements of its wellhead protection plan in Comprehensive Planning ("Smart Growth") for the area and possible locations of future wells will be taken into consideration in land use planning. The District will promote the periodic "Clean Sweep" operations for the collection of hazardous household wastes conducted by the County. An important additional method of reducing risk will be the program of education and public awareness discussed in Section 8.

8. PUBLIC EDUCATION

Public awareness and education are an important part of the management strategy for this plan. An article will be placed in the "Lakeland Times" explaining the wellhead protection plan and this plan will be made available to the public at the District offices and the Minocqua Public Library. Wellhead protection will be explained in school tours of the utility facilities. In addition, residents and businesses within the wellhead protection area will be notified and informed of the importance of preventing the release of pollutants within the area.

9. WATER CONSERVATION

Water conservation by customers will be promoted through the distribution of educational material. Water bills are screened to find anomalous spikes in water use that might be caused by leaking plumbing. Public Service Commission records show recent water loss for the system to be about 14 percent, which is within the PSC guideline of 25 percent for Class C systems. If future water audits indicate a substantial increase in unaccounted for water, the District will consider the use of leak detection surveys. The District has a meter testing and exchange program, which meets PSC guidelines. There are about five unmetered services. The only other unmetered water uses are main flushing, flooding of the skating rink and fire department use. Bulk sales are metered.

10. CONTINGENCY PLANNING

The District does not have a mutual aid agreement but commonly exchanges equipment and cooperates with surrounding townships and communities. If any two of the wells had to be shut down because of contamination or any other reason, the other well could temporarily meet system demand. In the event of loss of power, Wells #3 and #4 are equipped with backup engines. The District has 375,000 gallons of storage capacity, which would provide less than one day's supply if all three wells were out of service. Bottled water is available in limited amounts from local stores and larger amounts can be obtained from a distributor in Rhinelander. With all wells out of service for an extended period, water could be hauled from the neighboring community of Lac du Flambeau. For fire emergencies, water could be pumped from the numerous lakes. The first responder to a contaminant spill would be the appropriate township Fire Department, which has some HAZMAT training. The regional HAZMAT team is in Wausau.

11. REFERENCES

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Figure 1. Well Locations

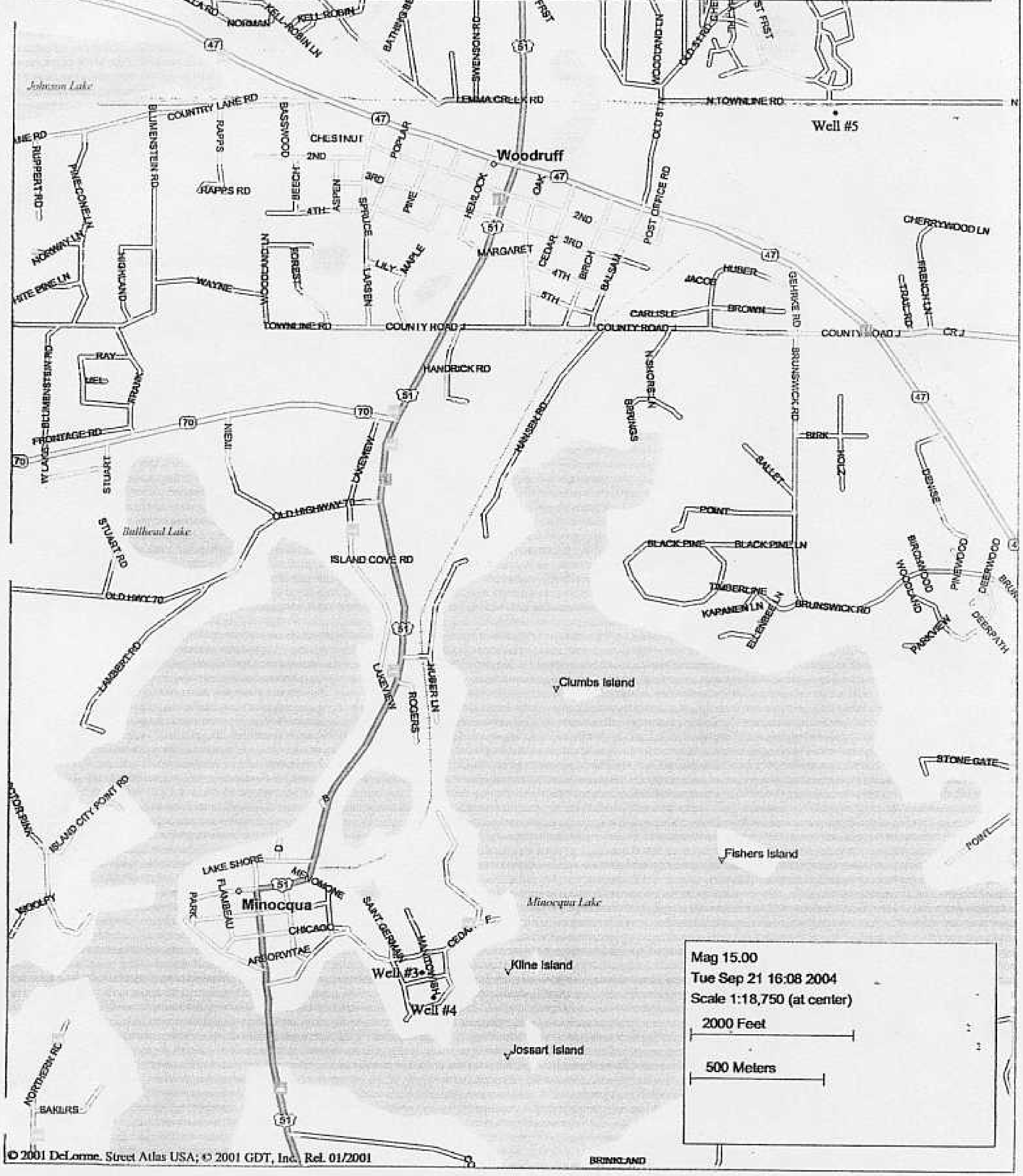


Figure 2. Vertical Relationships

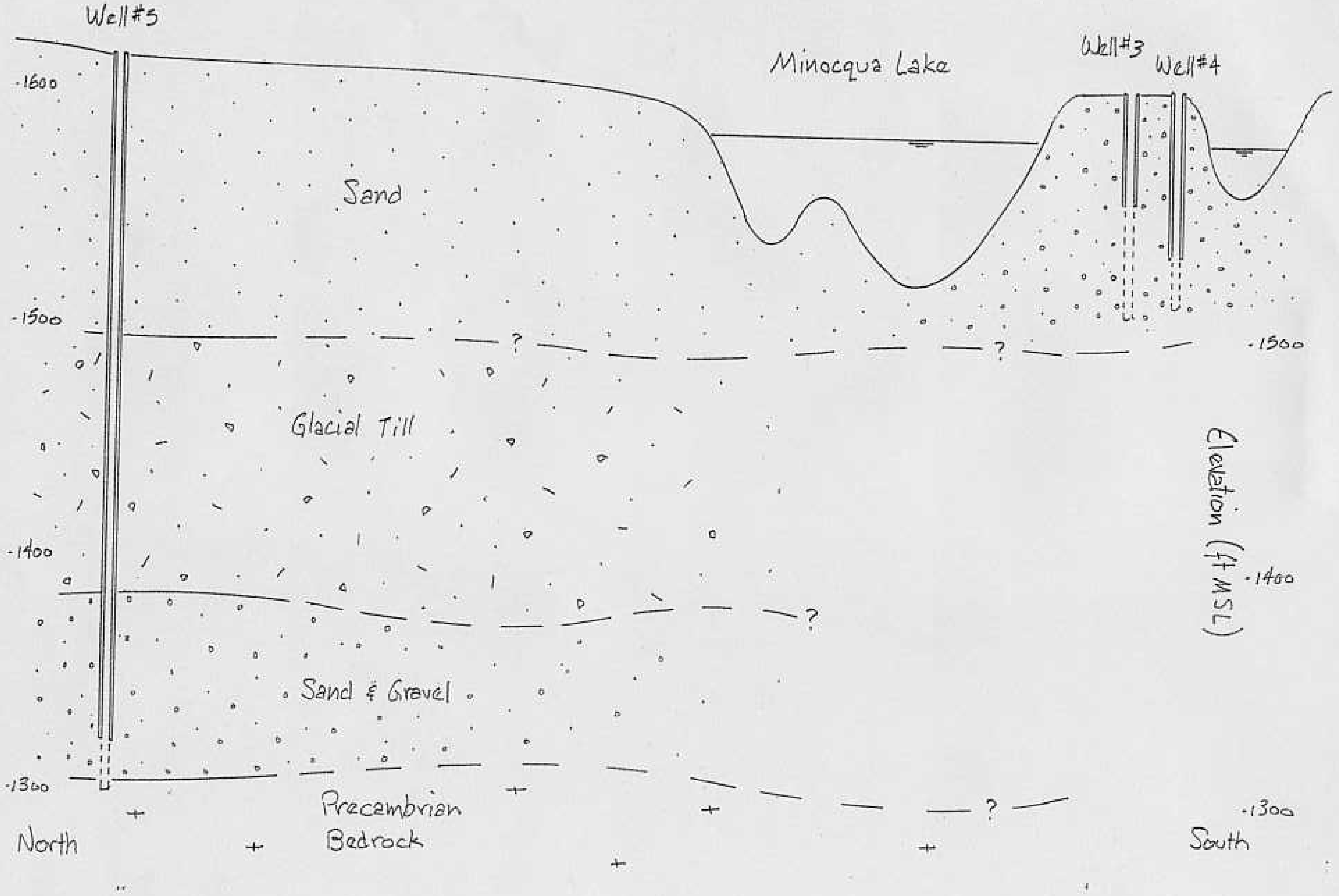
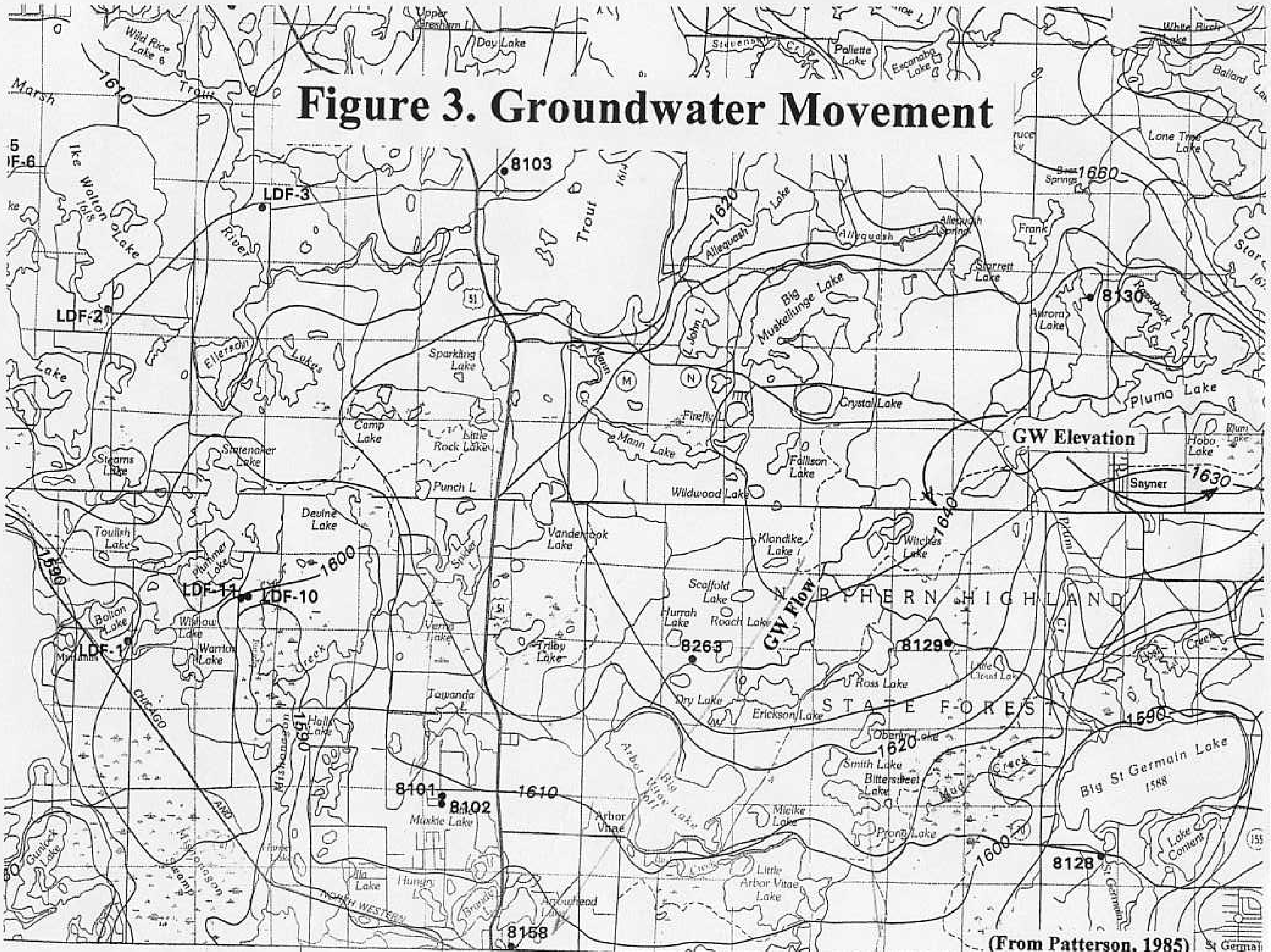
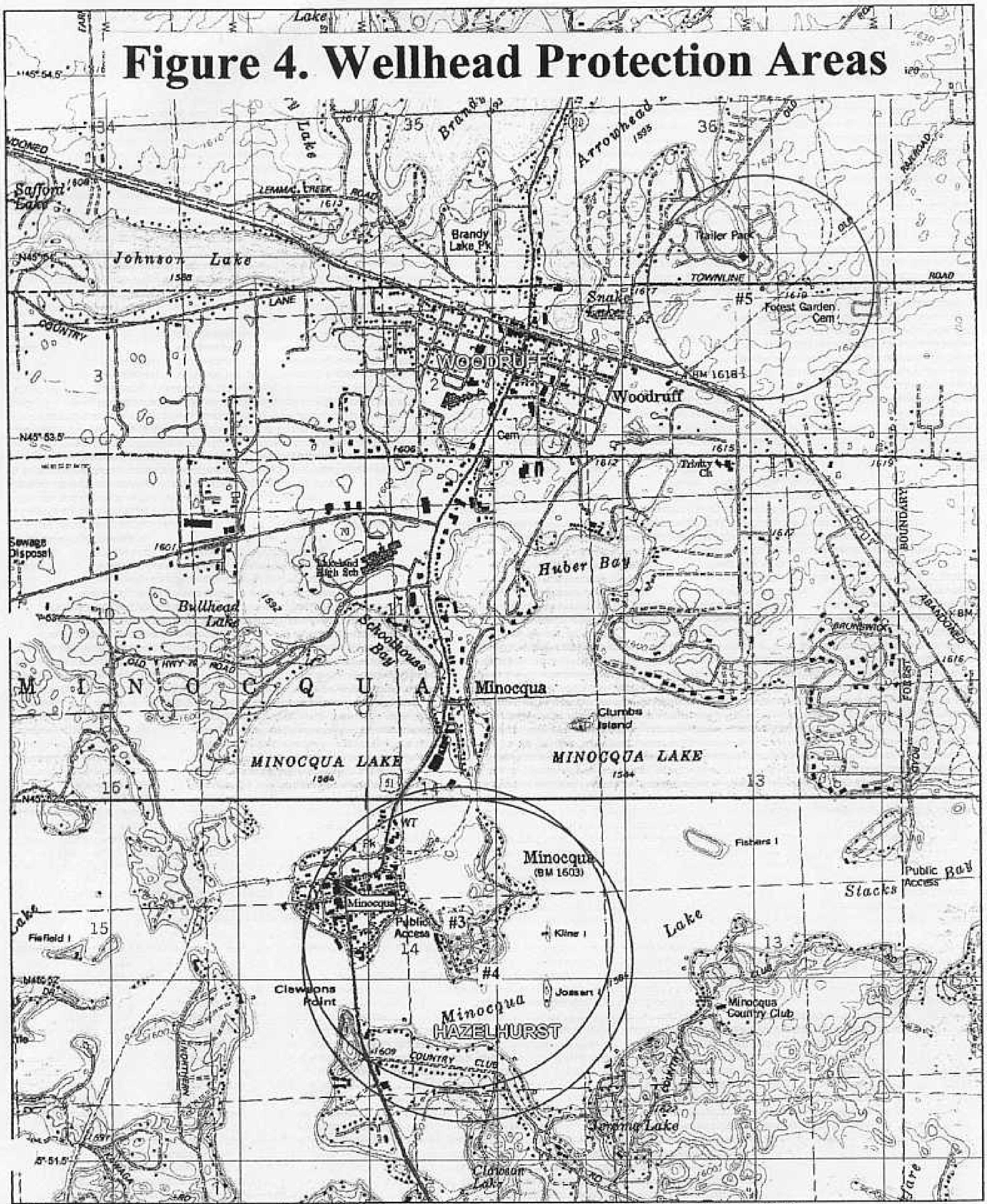


Figure 3. Groundwater Movement



(From Patterson, 1985)

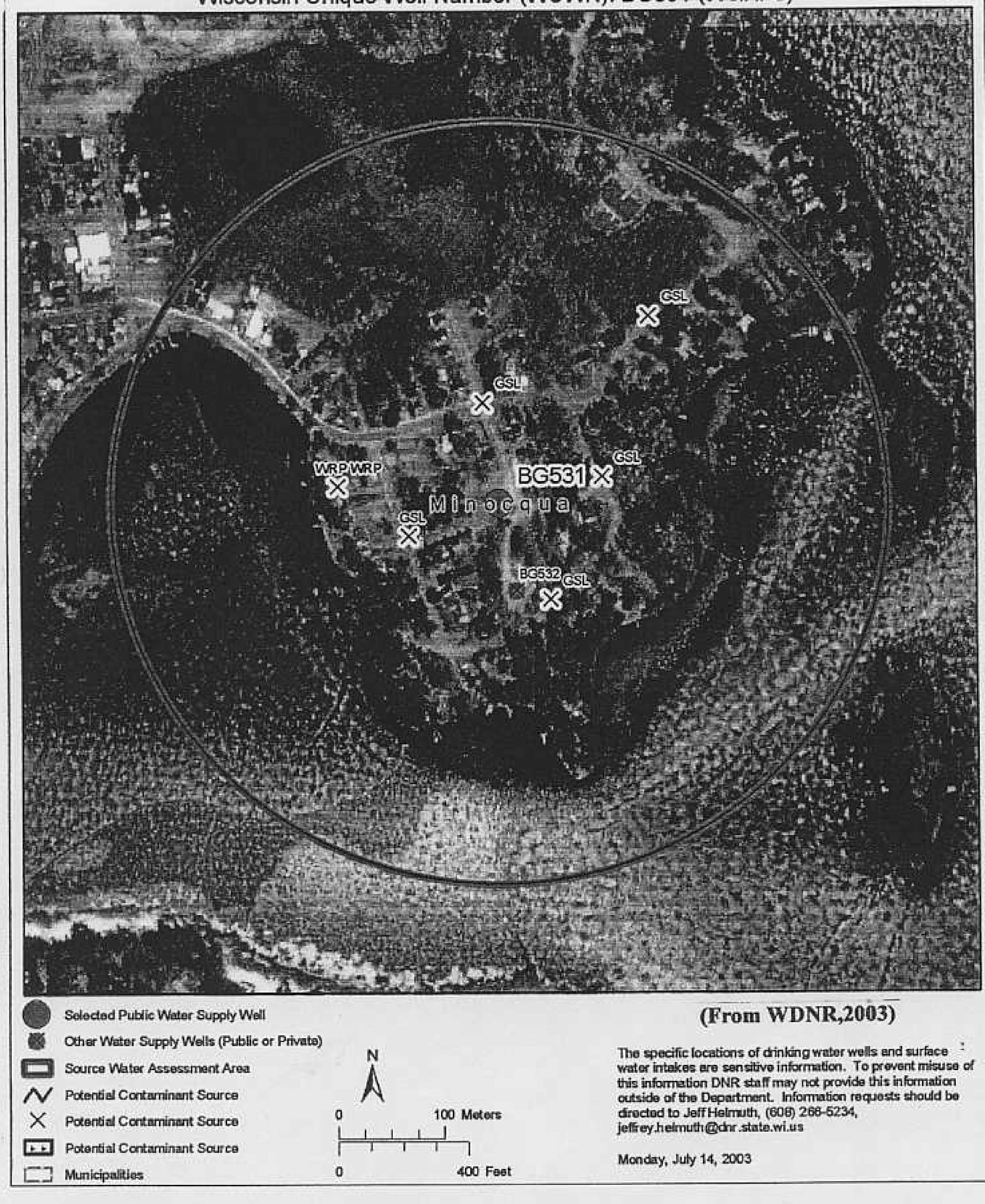
Figure 4. Wellhead Protection Areas



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 1000 ft Scale: 1 : 25,000 Detail: 13-0 Datum: WGS84

Figure 5. Potential Contaminant Sources

Wisconsin Unique Well Number (WUWN): BG531 (Well # 3)



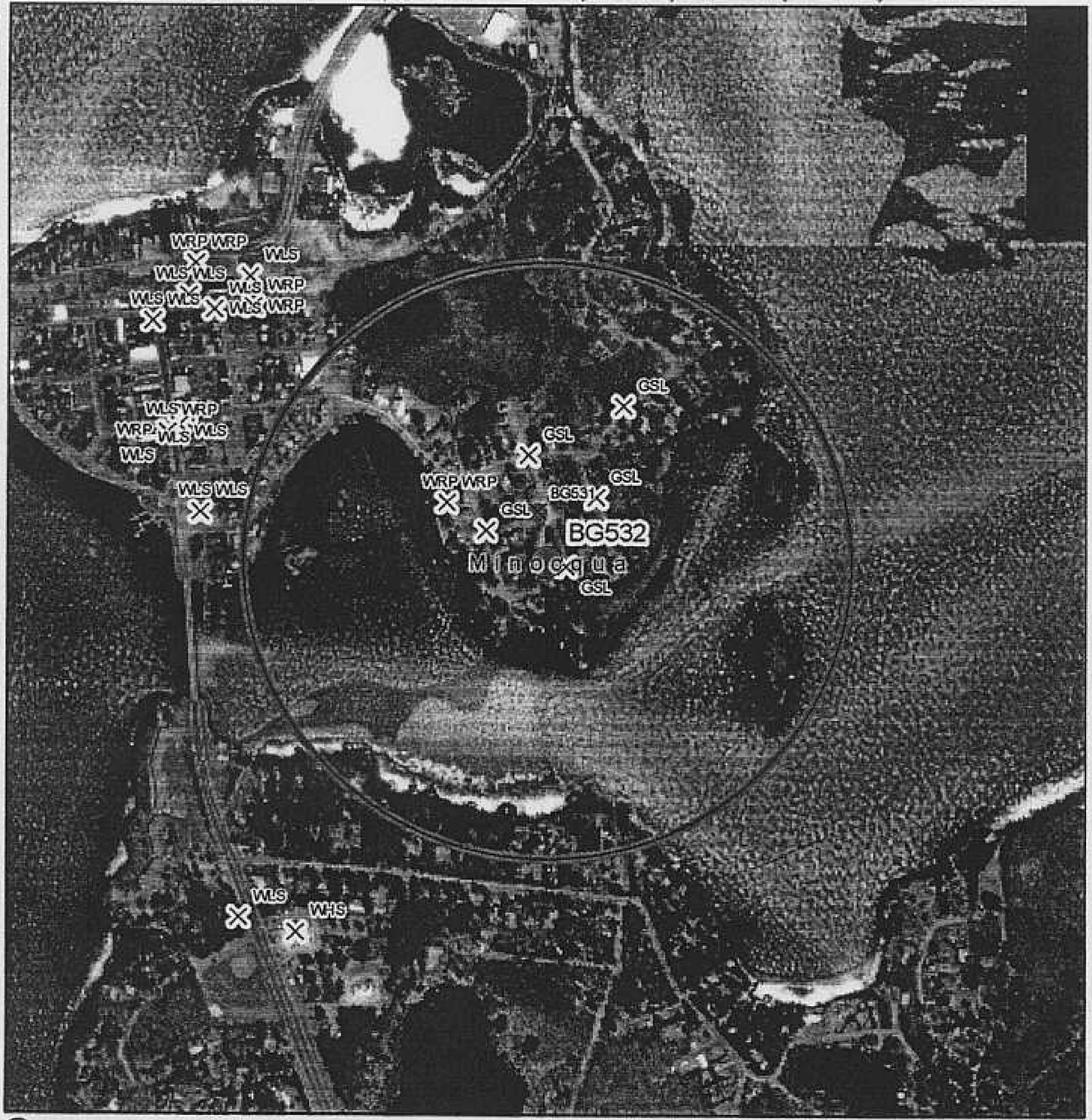
(From WDNR,2003)

The specific locations of drinking water wells and surface water intakes are sensitive information. To prevent misuse of this information DNR staff may not provide this information outside of the Department. Information requests should be directed to Jeff Helmuth, (608) 266-5234, jeffrey.helmuth@dnr.state.wi.us

Monday, July 14, 2003

Figure 5. Potential Contaminant Sources

Wisconsin Unique Well Number (WUWN): BG532 (Well # 4)



Selected Public Water Supply Well

Other Water Supply Wells (Public or Private)

Source Water Assessment Area

Potential Contaminant Source

Potential Contaminant Source

Potential Contaminant Source

Municipalities

N

0 300 Meters

0 900 Feet

(From WDNR, 2003)

The specific locations of drinking water wells and surface water intakes are sensitive information. To prevent misuse of this information DNR staff may not provide this information outside of the Department. Information requests should be directed to Jeff Helmuth, (608) 266-5234, jeffrey.helmuth@dnr.state.wi.us

Monday, July 14, 2003

Appendix A: POTENTIAL CONTAMINANT SOURCES
Rev 03/03

CONT CODE	CONTAMINANT SOURCE	DESCRIPTION	SPECIFIC CONTAMINANTS
AAH	Animal housing		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
AFA	Animal Feedlot		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
AFP	Agricultural farming	Active farming operations	Pesticides, fertilizers
AIA	Irrigation system	Agricultural irrigation	Pesticides, fertilizers
AMH	Agriculture milkhouse		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses, acids
AMS	Manure storage	Lined and unlined manure storage facilities	Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
BCT	Chemical storage	500 gallon or more	Specific to chemical product stored at site
BFS	Fertilizer storage/mixing	Feed mill, agricultural co-op	Nitrates
BFT	Petroleum storage.	500 gallon or more	Specific to petroleum product stored at site
BGS	Grain storage site		Fungicides
BPS	Pesticide storage / mixing / load	Feed mill, agricultural co-op	Herbicides, insecticides, rodenticides, fungicides, avicides
BSS	Road salt storage	Bulk storage sites	Sodium chloride, calcium chloride, waste oil
CAI	Airport		Jet fuels, deicers, batteries, diesel fuel, chlorinated solvents, automobile wastes, heating oil, building wastes
CBS	Auto body shop		Paints, solvents
CBY	Boat yard		Diesel fuels, batteries, oils, septage from boat waste disposal areas, wood preservatives, paints, waxes, varnishes, automotive wastes
CCE	Cemetery		Leachate (formaldehyde), lawn and maintenance chemicals
CCW	Car wash	Car washes in unsewered areas	Soaps, detergents, waxes, miscellaneous chemicals
CDC	Dry cleaning		Solvents (tetrachloroethylene, petroleum solvents, freon), spotting chemicals (trichloroethane, ammonia, rust removers)
CLD	Laundromat	Laundromats in unsewered areas	Detergents, bleaches, fabric dyes
CMP	Plating facility	Jewelry and metal plating	Cyanide, heavy metals
CMW	Machine / metal working shop		Solvents, metals, organics, sludges, cutting oils, degreasers
CPH	Photo processing	Only include processing facilities, don't include photo drop off sites	Cyanides, biosludges, silver sludges
CPR	Printing		Solvents, inks, dyes, oils, organics, chemicals
CPS	Paint shop		Paint, paint thinner, solvents
CRT	Railroad track		Spills
CRY	Rail yard		Spills
CSP	Seed production plant		Fumigants
CSS	Gas service station		Gasoline, oils, solvents, miscellaneous wastes
CSY	Scrap/junkyard		Oil, gasoline, antifreeze, PCB contaminated soils, lead acids batteries
CVR	Motor vehicle repair shop		Waste oils, solvents, acids, paints, automotive wastes,
GFA	Fuel storage tank - above ground	Non-service station tanks	Gasoline, diesel fuel, other petroleum products
GFB	Fuel storage tank - underground	Non-service station tanks	Gasoline, diesel fuel, other petroleum products
GSA	Sewage absorption area	Drainfields, mounds, dry wells	"
GSL	Sewer line (municipal)	Municipal sewer lines	Septage, coliform bacteria, viruses, nitrates
GSN	Sewer line (non-municipal)	Non-municipal sewer lines	"
GST	Sewage tank	Holding tanks, septic tanks, sumps	Septage, coliform bacteria, viruses, nitrates, heavy metals, synthetic detergents, cooking and motor oil, bleach, pesticides, paints, paint thinner, photographic chemicals, septic tank cleaner chemicals, chlorides, sulfate, calcium, magnesium, potassium, phosphate
GWA	Water well (active production)		Potential conduit
GWI	Water well (unused or improperly abandoned)		Potential conduit
IAS	Asphalt plant		Petroleum derivatives
ICM	Chemical production	Industrial chemical production facilities	Chemicals
IEE	Electrical and electronic products		Cyanides, metal sludges, caustics, solvents, oils, acids, alkalis,

	manufacturing		paints, methylene chloride, tetrachloroethylene, trichloroethane, acetone, toluene, PCBs
IES	Electroplating / metal finishing facility		Acids, alkaline solutions, cyanide, metallic salts, solvents, cyanide, heavy metal contaminated wastewater
IFM	Furniture or wood manufacturing / refinishing / stripping		Paints, solvents (toluene, methylene chloride), degreasing sludges
IFW	Foundry / smelting plant		Cyanides, sulfides
IGS	Gravel and Sand pits		Spills, miscellaneous chemicals, bacteria
IMQ	Mining / Mine waste		Cyanide, sulfides, metals, acids drainage
IPC	Plastics manufacturer / molder		Solvents, oils, organics and inorganics, paint wastes, cyanides, acids, alkalis, sludges, esters, surfactants, glycols, phenols, formaldehyde, peroxides
IPM	Paper mill		Metals, acids, minerals, sulfides, chemicals, sludges, chlorine, hypochlorite, chlorine dioxide, hydrogen peroxide
IPP	Pipeline (petro./chem.)		Petroleum, chemicals
ISQ	Stone quarries		Spills, miscellaneous chemicals, potential conduit, bacteria
ITP	Textile / polyester manufacturer		Chemicals
IWT	Wood preserving facility		Treated wood residue, preservatives (pentachlorophenol, chromate, copper arsenate,), tanner gas, paint sludges, solvents, creosote, coating wastes
MFT	Fire training facility		Chemicals
MGC	Golf course		Fertilizers, herbicides, pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests., automotive wastes
MGP	Manufactured gas plant / gasification plant		Petroleum VOCs, Benzo(a)pyrene, PAHs, cyanide
MLA	Laboratory (college, medical, school, private, etc.)		Biological wastes, disinfectants, acids, formaldehyde, miscellaneous chemicals
MMI	Military installation		
MMP	Medical Installation (e.g. Hospital)		X-ray developers and fixers, infectious wastes, radiological wastes, biological wastes, disinfectants, asbestos, beryllium, acids, formaldehyde, miscellaneous chemicals
MOT	Other (specify) ________		
WDR	Class V injection well	Any well, drilled or dug hole, used to inject fluids into the subsoil	Chlorides, pathogens, petroleum products, pesticides
WHS	Hazardous waste generator (SARA Title III) / RCRA authority clean-ups	Any facility listed on the SARA Title III list thought to pose a threat to the well / RCRA clean-ups	Hazardous waste
WIN	Incinerator (municipal)		Metals, combustion by-products
WLA	Landfill	Solid and hazardous waste sites listed in the DNR "Registry of Waste Disposal Sites in Wisconsin"	Leachate
WLS	Leaking underground storage tank (LUST)	LUST Sites included in the DNR "Leaking Underground Storage Tank List"	Gasoline, diesel fuel, other petroleum products
WRF	Recycling facility		Petroleum products, chemicals
WRP	ERRP Site	Sites on the DNR "Emergency and Remedial Response" list	Spills
WSI	Wastewater Spray Irrigation		Coliform bacteria, nitrate, chloride, pathogens, viruses
WSS	Sludge spreading	Municipal wastewater sludge, paper mill sludge	Viruses, coliform bacteria, heavy metals, dioxins
WSW	Storm water retention pond		Metals, petroleum products
WTS	Solid waste transfer station		Miscellaneous chemicals
WUC	Superfund site	Sites listed in the DNR "Superfund Sites in Wisconsin"	Miscellaneous contaminants
WWL	Wastewater lagoon	Treatment and/or storage lagoons	Coliform bacteria, viruses
WWO	Wastewater discharge to surface water	Surface water outfall	Coliform bacteria, viruses
WWP	Wastewater treatment plant		
WWS	Wastewater discharge to groundwater	Absorption and seepage cells, spray irrigation, subsurface systems, etc.	Coliform bacteria, viruses